DATA SHEET

NEC

MOS INTEGRATED CIRCUIT

μPD78064B

8-BIT SINGLE-CHIP MICROCONTROLLER

DESCRIPTION

The μPD78064B is a product in the μPD78064B Subseries within the 78K/0 Series.

The Electro Magnetic Interference (EMI) noise generated inside the μPD78064B is reduced compared to the μPD78064 Subseries.

A one-time PROM version, μPD78P064B that can operate in the same power supply voltage as the mask ROM version, and various development tools are also provided.

For the details of functional description, refer to the following user's manual. Be sure to read them before starting design.

μPD78064B Subseries User's Manual : U10785E
78K/0 Series User's Manual Instructions : U12326E

FEATURES

- Internal high-capacity ROM and RAM
  - Internal ROM : 32 Kbytes
  - Internal high-speed RAM : 1024 bytes
  - LCD display RAM : 40 × 4 bits
- Three packages
  - 100-pin plastic QFP (fine pitch) (14 × 14 mm)
  - 100-pin plastic LQFP (fine pitch) (14 × 14 mm)
  - 100-pin plastic QFP (14 × 20 mm)
- Minimum instruction execution time can be varied from high-speed (0.4 μs) to ultra-low-speed (122 μs)
- I/O ports: 57 (including segment signal output alternate-function pin)
- LCD controller/driver
  Power supply voltage : V_{DD} = 2.0 to 6.0 V (static display mode)
  : V_{DD} = 2.5 to 6.0 V (1/3 bias)
  : V_{DD} = 2.7 to 6.0 V (1/2 bias)
- 8-bit resolution A/D converter: 8 channels
- Serial interface: 2 channels
- Timer: 5 channels
- Power supply voltage: V_{DD} = 2.0 to 6.0 V

APPLICATIONS

Internal tuner audio equipment, communication equipment such as radio and cellular phone, pagers, meters, etc.

ORDERING INFORMATION

	Part Number	Package
	μPD78064BGC-×××-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)
★	μPD78064BGC-×××-8EU	100-pin plastic LQFP (fine pitch) (14 × 14 mm)
	μPD78064BGF-×××-3BA	100-pin plastic QFP (14 × 20 mm)

Caution Two types of packages are available for the μPD78064BGC (refer to **11. PACKAGE DRAWINGS**). For the suppliable packages, consult an NEC sales representative.

Remark ××× indicates ROM code suffix.

The information in this document is subject to change without notice.

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The mark ★ shows major revised points.

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★ 78K/0 SERIES DEVELOPMENT

The following shows the 78K/0 Series products development. Subseries names are shown inside frames.

Mass-produced products

Products under development

The subseries whose names end with Y supports the I^{2}C bus specifications.

78K/0 Series

Control

100-pin	μPD78075B	μPD78075BY	EMI noise reduced version of μPD78078
100-pin	μPD78078	μPD78078Y	Added timers to μPD78054 and enhanced external interface
100-pin	μPD78070A	μPD78070AY	ROM-less version of μPD78078
100-pin		μPD780018AY	Enhanced serial I/O of μPD78078 and functions are defined.
80-pin	μPD780058	μPD780058Y Note	Enhanced serial I/O of μPD78054, EMI noise reduced version
80-pin	μPD78058F	μPD78058FY	EMI noise reduced version of μPD78054
80-pin	μPD78054	μPD78054Y	Added UART and D/A to μPD78014 and enhanced I/Os
64-pin	μPD780034	μPD780034Y	Enhanced A/D of μPD780024
64-pin	μPD780024	μPD780024Y	Enhanced serial I/O of μPD78018F, EMI noise reduced version
64-pin	μPD78014H		EMI noise reduced version of μPD78018F
64-pin	μPD78018F	μPD78018FY	Low-voltage (1.8 V) version of μPD78014 and enhanced ROM/RAM size options
64-pin	μPD78014	μPD78014Y	Added A/D and 16-bit timer to μPD78002
64-pin	μPD780001		Added A/D to μPD78002
64-pin	μPD78002	μPD78002Y	Basic subseries for control applications
42-/44-pin	μPD78083		Equipped with UART and operates at low-voltage (1.8 V)

Inverter control

64-pin	μPD780964	Enhanced A/D of μPD780924
64-pin	μPD780924	Equipped with inverter control circuit and UART, EMI noise reduced version

FIP™ driving

100-pin	μPD780208	Enhanced I/O and FIP C/D of μPD78044F, 53 display outputs
100-pin	μPD780228	Enhanced I/O and FIP C/D of μPD78044H, 48 display outputs
80-pin	μPD78044H	Added N-ch open-drain I/O to μPD78044F, 34 display outputs
80-pin	μPD78044F	Basic subseries for driving FIPs, 34 display outputs

LCD driving

100-pin	μPD780308	μPD780308Y	Enhanced SIO of μPD78064, expanded ROM and RAM
100-pin	μPD78064B		EMI noise reduced version of μPD78064
100-pin	μPD78064	μPD78064Y	Basic subseries for driving LCDs, equipped with UART

IEBus™ supported

80-pin	μPD78098B	EMI noise reduced version of μPD78098
80-pin	μPD78098	Added IEBus controller to μPD78054

Meter control

80-pin	μPD780973	Equipped with controller/driver for driving automobile meters

LV

64-pin	μPD78P0914	Equipped with PWM output, LV digital code decoder, and Hsync counter

Note Planned

The following shows the major differences among subseries products.

Function / Subseries Name		ROM Capacity	Timer 8-bit	Timer 16-bit	Timer Watch	Timer WDT	8-bit A/D	10-bit A/D	8-bit D/A	Serial Interface	I/O	V_{DD} MIN. Value	External Expansion
Control	μPD78075B	32 K to 40 K	4ch	1ch	1ch	1ch	8ch	–	2ch	3ch (UART: 1ch)	88	1.8 V	√
	μPD78078	48 K to 60 K											
	μPD78070A	–									61	2.7 V	
	μPD780058	24 K to 60 K	2ch							3ch (Time division UART: 1ch)	68	1.8 V	
	μPD78058F	48 K to 60 K								3ch (UART: 1ch)	69	2.7 V	
	μPD78054	16 K to 60 K										2.0 V	
	μPD780034	8 K to 32 K					–	8ch	–	3ch (UART: 1ch, Time division 3-wire: 1ch)	51	1.8 V	
	μPD780024						8ch	–					
	μPD78014H									2ch	53		
	μPD78018F	8 K to 60 K											
	μPD78014	8 K to 32 K										2.7 V	
	μPD780001	8 K		–	–					1ch	39		–
	μPD78002	8 K to 16 K			1ch		–				53		√
	μPD78083				–		8ch			1ch (UART: 1ch)	33	1.8 V	–
Inverter control	μPD780964	8 K to 32 K	3ch	**Note**	–	1ch	–	8ch	–	2ch (UART: 2ch)	47	2.7 V	√
	μPD780924						8ch	–					
FIP driving	μPD780208	32 K to 60 K	2ch	1ch	1ch	1ch	8ch	–	–	2ch	74	2.7 V	–
	μPD780228	48 K to 60 K	3ch	–	–					1ch	72	4.5 V	
	μPD78044H	32 K to 48 K	2ch	1ch	1ch						68	2.7 V	
	μPD78044F	16 K to 40 K								2ch			
LCD driving	μPD780308	48 K to 60 K	2ch	1ch	1ch	1ch	8ch	–	–	3ch (Time division UART: 1ch)	57	2.0 V	–
	μPD78064B	32 K								2ch (UART: 1ch)			
	μPD78064	16 K to 32 K											
IEBus supported	μPD78098B	40 K to 60 K	2ch	1ch	1ch	1ch	8ch	–	2ch	3ch (UART: 1ch)	69	2.7 V	√
	μPD78098	32 K to 60 K											
Meter control	μPD780973	24 K to 32 K	3ch	1ch	1ch	1ch	5ch	–	–	2ch (UART: 1ch)	56	4.5 V	–
LV	μPD78P0914	32 K	6ch	–	–	1ch	8ch	–	–	2ch	54	4.5 V	√

Note 10-bit timer: 1 channel

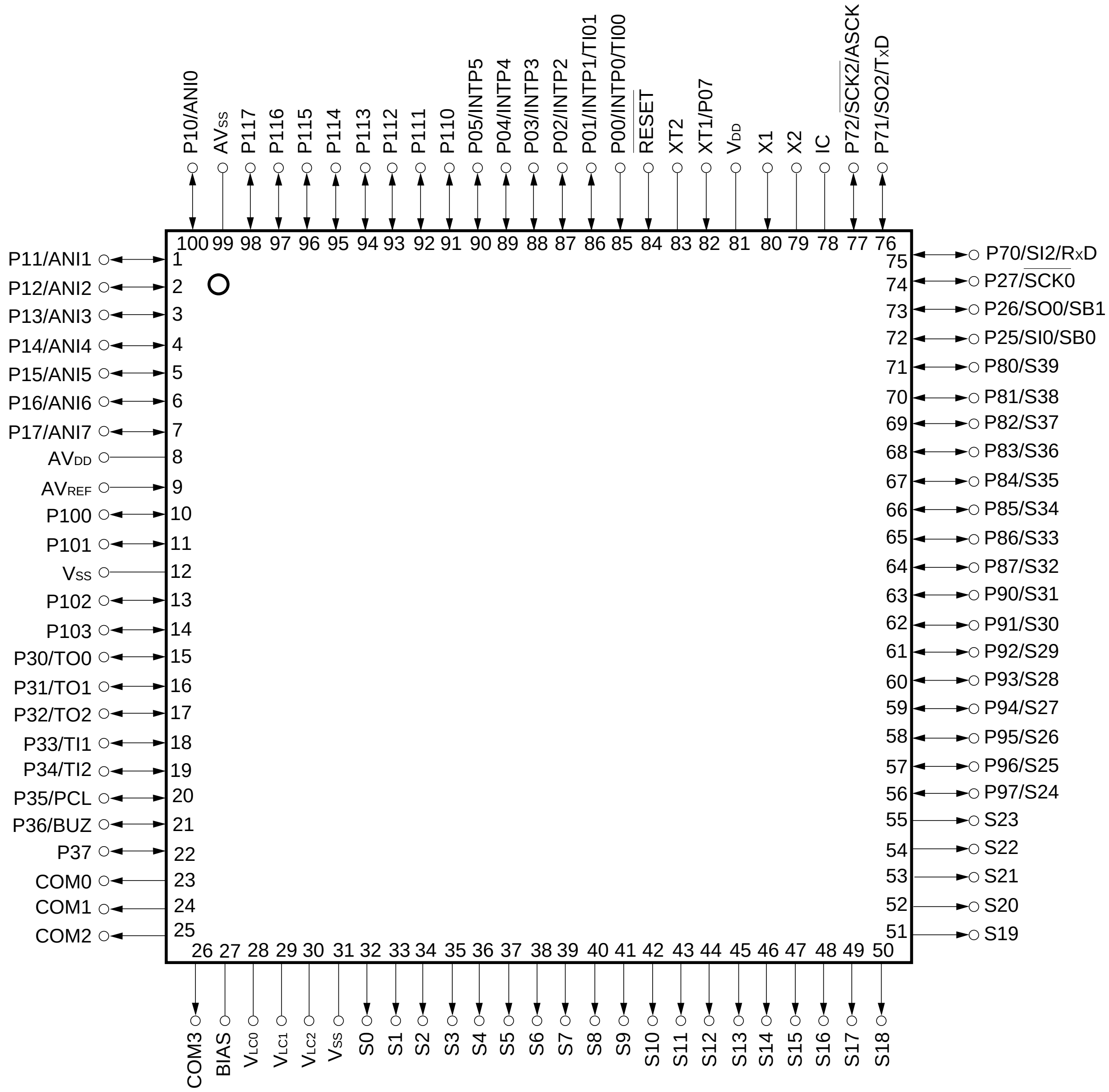
FUNCTION OVERVIEW

Item			Function
Internal memory	ROM		32 Kbytes
	High-speed RAM		1024 bytes
	LCD display RAM		40 × 4 bits
General registers			8 bits × 32 registers (8 bits × 8 registers × 4 banks)
Instruction cycle	When main system clock is selected		0.4 μs/0.8 μs/1.6 μs/3.2 μs/6.4 μs/12.8 μs (@ 5.0-MHz operation)
	When subsystem clock is selected		122 μs (@ 32.768-kHz operation)
Instruction set			• 16-bit operation • Multiply/divide (8 bits × 8 bits, 16 bits ÷ 8 bits) • Bit manipulate (set, reset, test, Boolean operation) • BCD adjust, etc.
I/O ports (including segment signal output alternate-function pins)			Total : 57 • CMOS input : 2 • CMOS I/O : 55
A/D converter			• 8-bit resolution × 8 channels
LCD controller/driver			• Segment signal output : Maximum 40 • Common signal output : Maximum 4 • Bias : 1/2 or 1/3 switchable
Serial interface			• 3-wire serial I/O/SBI/2-wire serial I/O mode selectable : 1 channel • 3-wire serial I/O/UART mode selectable : 1 channel
Timer			• 16-bit timer/event counter : 1 channel • 8-bit timer/event counter : 2 channels • Watch timer : 1 channel • Watchdog timer : 1 channel
Timer output			3 (14-bit PWM output capability: 1)
Clock output			19.5 kHz, 39.1 kHz, 78.1 kHz, 156 kHz, 313 kHz, 625 kHz, 1.25 MHz, 2.5 MHz, 5.0 MHz (@ 5.0-MHz operation with main system clock) 32.768 kHz (@ 32.768-kHz operation with subsystem clock)
Buzzer output			1.2 kHz, 2.4 kHz, 4.9 kHz, 9.8 kHz (@ 5.0-MHz operation with main system clock)
Vectored interrupt source	Maskable		Internal: 12, external: 6
	Non-maskable		Internal: 1
	Software		1
Test input			Internal: 1, external: 1
Power supply voltage			V_{DD} = 2.0 to 6.0 V
Package			• 100-pin plastic QFP (fine pitch) (14 × 14 mm) ★ • 100-pin plastic LQFP (fine pitch) (14 × 14 mm) • 100-pin plastic QFP (14 × 20 mm)

CONTENTS

1. PIN CONFIGURATION (Top View)

- **100-pin plastic QFP (fine pitch) (14 × 14 mm)**
  μPD78064BGC-×××-7EA
- **100-pin plastic LQFP (fine pitch) (14 × 14 mm)**
  ★ **μPD78064BGC-×××-8EU**

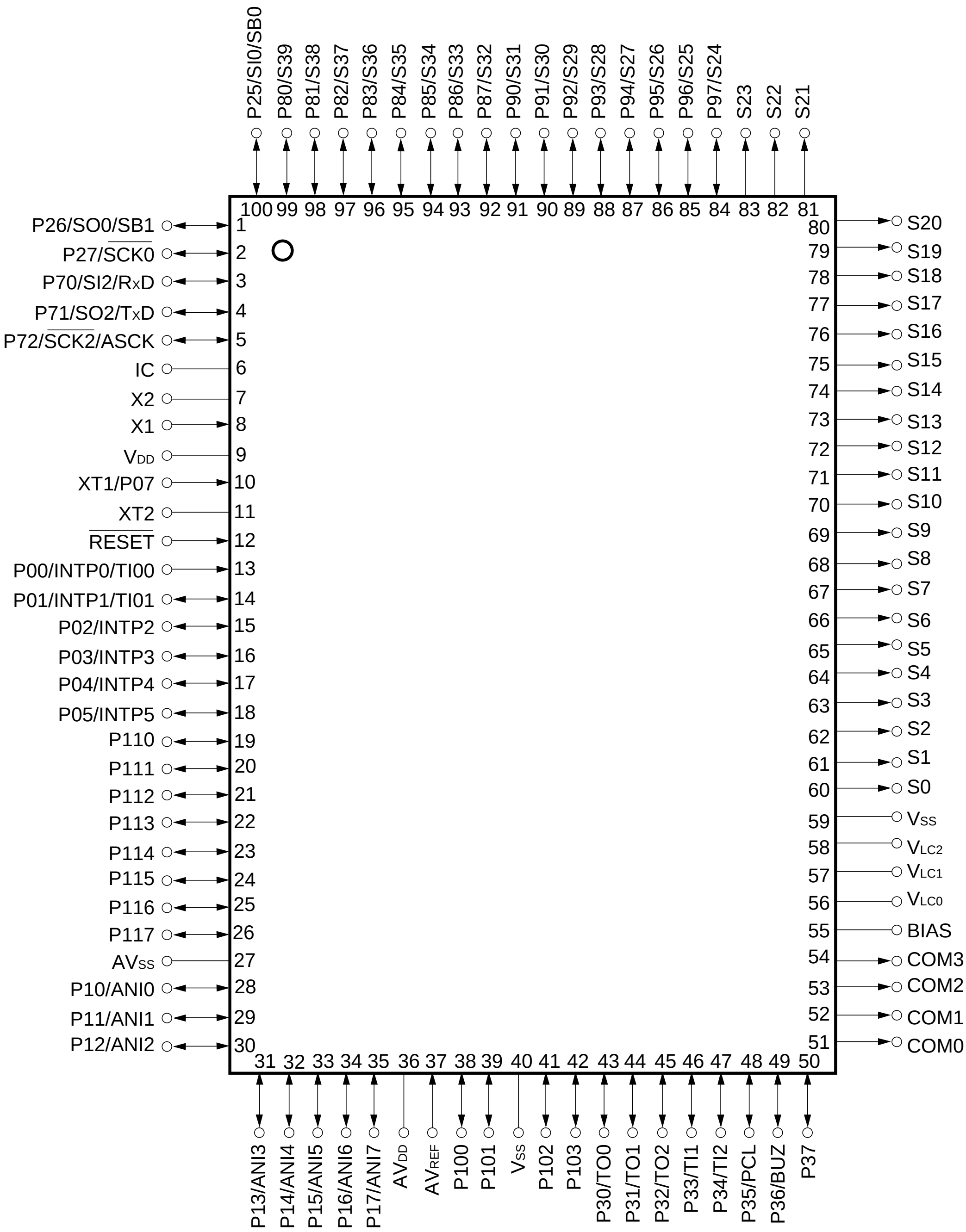


Cautions 1. Connect directly the IC (Internally Connected) pin to V_{SS}.

2. The AV_{DD} pin functions as both an A/D converter power supply and a port power supply. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{DD} pin to another power supply which has the same potential as V_{DD}.

3. The AV_{SS} pin functions as both an A/D converter ground and a port ground. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{SS} pin to another ground line than V_{SS}.

- **100-pin plastic QFP (14 × 20 mm)**
  μPD78064BGF-×××-3BA



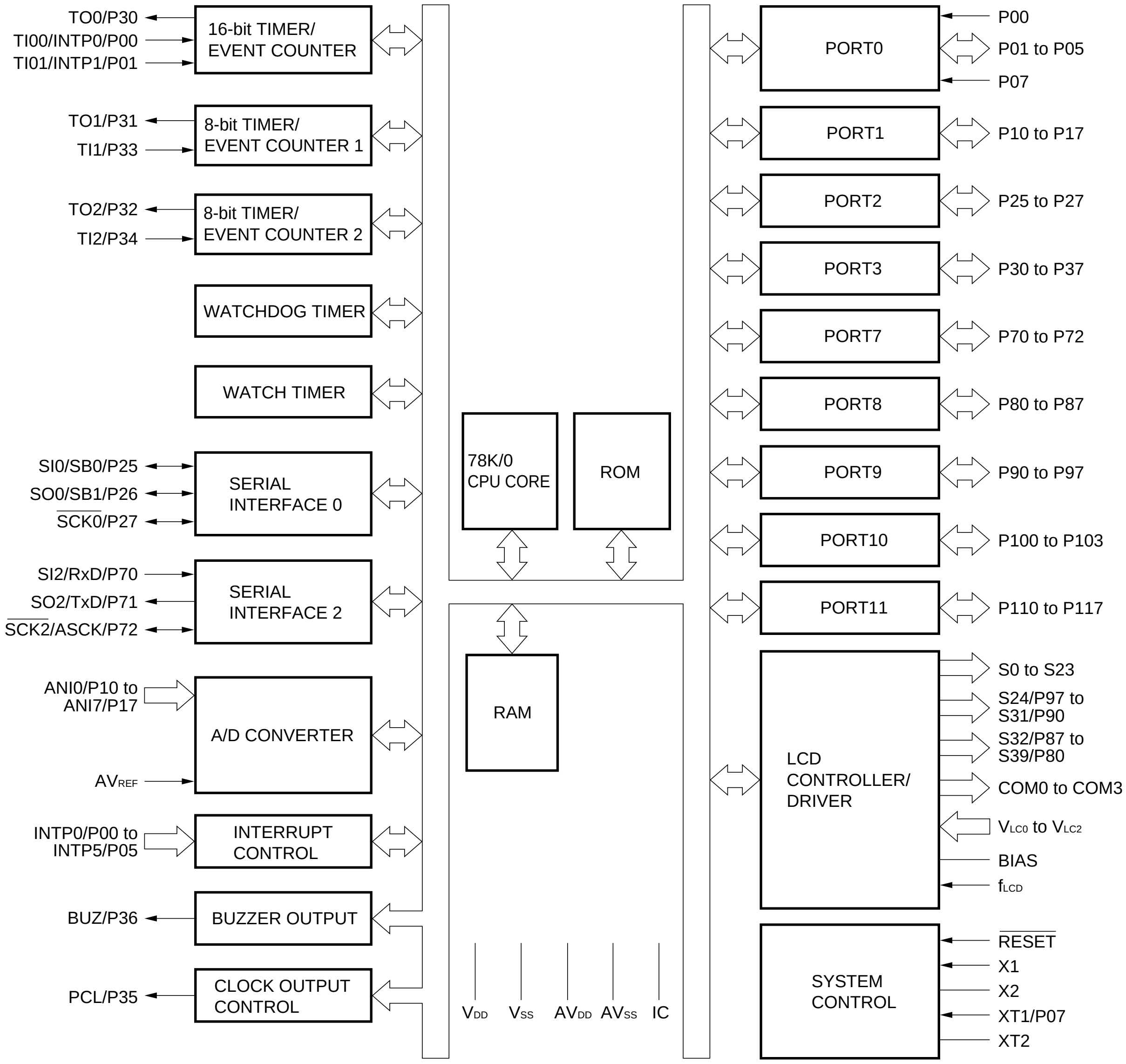
Cautions 1. Connect directly the IC (Internally Connected) pin to V_{SS}.

2. The AV_{DD} pin functions as both an A/D converter power supply and a port power supply. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{DD} pin to another power supply which has the same potential as V_{DD}.

3. The AV_{SS} pin functions as both an A/D converter ground and a port ground. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{SS} pin to another ground line than V_{SS}.

ANI0 to ANI7 : Analog Input
ASCK : Asynchronous Serial Clock
AV_{DD} : Analog Power Supply
AV_{REF} : Analog Reference Voltage
AV_{SS} : Analog Ground
BIAS : LCD Power Supply Bias Control
BUZ : Buzzer Clock
COM0 to COM3 : Common Output
IC : Internally Connected
INTP0 to INTP5 : Interrupt from Peripherals
P00 to P05, P07 : Port0
P10 to P17 : Port1
P25 to P27 : Port2
P30 to P37 : Port3
P70 to P72 : Port7
P80 to P87 : Port8
P90 to P97 : Port9
P100 to P103 : Port10
P110 to P117 : Port11
PCL : Programmable Clock
$\overline{\text{RESET}}$: Reset
RxD : Receive Data
S0 to S39 : Segment Output
SB0, SB1 : Serial Bus
SI0, SI2 : Serial Input
SO0, SO2 : Serial Output
$\overline{\text{SCK0}}$, $\overline{\text{SCK2}}$: Serial Clock
TI00, TI01 : Timer Input
TI1, TI2 : Timer Input
TO0 to TO2 : Timer Output
TxD : Transmit Data
V_{DD} : Power Supply
V_{LC0} to V_{LC2} : LCD Power Supply
V_{SS} : Ground
X1, X2 : Crystal (Main System Clock)
XT1, XT2 : Crystal (Subsystem Clock)

2. BLOCK DIAGRAM



3. PIN FUNCTIONS

3.1 Port Pins (1/2)

Pin Name	I/O	Function		After Reset	Alternate Function
P00	Input	Port 0	Input only.	Input	INTP0/TI00
P01	Input/output	7-bit I/O port.	Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software.	Input	INTP1/TI01
P02					INTP2
P03					INTP3
P04					INTP4
P05					INTP5
P07 Note 1	Input		Input only.	Input	XT1
P10 to P17	Input/output	Port 1 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software. Note 2		Input	ANI0 to ANI7
P25	Input/output	Port 2 3-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software.		Input	SI0/SB0
P26					SO0/SB1
P27					$\overline{SCK0}$
P30	Input/output	Port 3 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software.		Input	TO0
P31					TO1
P32					TO2
P33					TI1
P34					TI2
P35					PCL
P36					BUZ
P37					—
P70	Input/output	Port 7 3-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software.		Input	SI2/RxD
P71					SO2/TxD
P72					$\overline{SCK2}$/ASCK

Notes 1. When using the P07/XT1 pins as an input port, set (1) bit 6 (FRC) of the processor clock control register (PCC) (the on-chip feedback resistor of the subsystem clock oscillator should not be used).

2. When using the P10/ANI0 to P17/ANI7 pins as the A/D converter analog input, port 1 is set to input mode. However, the on-chip pull-up resistor is automatically disabled.

3.1 Port Pins (2/2)

Pin Name	I/O	Function	After Reset	Alternate Function
P80 to P87	Input/output	Port 8 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software. Input/output port/segment signal output function can be specified in 2-bit units by the LCD display control register (LCDC).	Input	S39 to S32
P90 to P97	Input/output	Port 9 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software. Input/output port/segment signal output function can be specified in 2-bit units by the LCD display control register (LCDC).	Input	S31 to S24
P100 to P103	Input/output	Port 10 4-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software. LEDs can be driven directly.	Input	—
P110 to P117	Input/output	Port 11 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, an on-chip pull-up resistor can be used by software. Falling edge detection capability.	Input	—

Caution For pins which also function as port pins, do not perform the following operations during A/D conversion. If these operations are performed, the total error ratings cannot be kept (except for LCD segment output alternate-function pin).
<1> Rewrite the output latch while the pin is used as a port pin.
<2> Change the output level of the pin used as an output pin, even if it is not used as a port pin.

3.2 Non-port Pins (1/2)

Pin Name	I/O	Function	After Reset	Alternate Function
INTP0	Input	External interrupt request input by which the effective edge (rising edge, falling edge, or both rising edge and falling edge) can be specified.	Input	P00/TI00
INTP1				P01/TI01
INTP2				P02
INTP3				P03
INTP4				P04
INTP5				P05
SI0	Input	Serial interface serial data input.	Input	P25/SB0
SI2				P70/RxD
SO0	Output	Serial interface serial data output.	Input	P26/SB1
SO2				P71/TxD
SB0	Input/output	Serial interface serial data input/output.	Input	P25/SI0
SB1				P26/SO0
$\overline{SCK0}$	Input/output	Serial interface serial clock input/output.	Input	P27
$\overline{SCK2}$				P72/ASCK
RxD	Input	Asynchronous serial interface serial data input.	Input	P70/SI2
TxD	Output	Asynchronous serial interface serial data output.	Input	P71/SO2
ASCK	Input	Asynchronous serial interface serial clock input.	Input	P72/$\overline{SCK2}$
TI00	Input	External count clock input to 16-bit timer (TM0).	Input	P00/INTP0
TI01		Capture trigger signal input to capture register (CR00).		P01/INTP1
TI1		External count clock input to 8-bit timer (TM1).		P33
TI2		External count clock input to 8-bit timer (TM2).		P34
TO0	Output	16-bit timer (TM0) output (shared with 14-bit PWM output).	Input	P30
TO1		8-bit timer (TM1) output.		P31
TO2		8-bit timer (TM2) output.		P32
PCL	Output	Clock output (for main system clock, subsystem clock trimming).	Input	P35
BUZ	Output	Buzzer output.	Input	P36
S0 to S23	Output	LCD controller/driver segment signal output.	Output	—
S24 to S31			Input	P97 to P90
S32 to S39				P87 to P80
COM0 to COM3	Output	LCD controller/driver common signal output.	Output	—
V_{LC0} to V_{LC2}	—	LCD drive voltage. Split resistors can be incorporated by mask option.	—	—
BIAS	—	LCD drive power supply.	—	—

3.2 Non-port Pins (2/2)

Pin Name	I/O	Function	After Reset	Alternate Function
ANI0 to ANI7	Input	A/D converter analog input.	Input	P10 to P17
AV_{REF}	Input	A/D converter reference voltage input.	—	—
AV_{DD}	—	A/D converter analog power supply (shared with the port power supply).	—	—
AV_{SS}	—	A/D converter ground potential (shared with the port ground potential).	—	—
$\overline{\text{RESET}}$	Input	System reset input.	—	—
X1	Input	Main system clock oscillation crystal connection.	—	—
X2	—		—	—
XT1	Input	Subsystem clock oscillation crystal connection.	Input	P07
XT2	—		—	—
V_{DD}	—	Positive power supply (except for port).	—	—
V_{SS}	—	Ground potential (except for port).	—	—
IC	—	Internal connection. Connect directly to V_{SS} pin.	—	—

Cautions 1. The AV_{DD} pin functions as both an A/D converter power supply and a port power supply. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{DD} pin to another power supply which has the same potential as V_{DD}.

2. The AV_{SS} pin functions as both an A/D converter ground and a port ground. When the μPD78064B is used in applications where the noise generated inside the microcontroller needs to be reduced, connect the AV_{SS} pin to another ground line than V_{SS}.

3.3 Pin I/O Circuits and Recommended Connection of Unused Pins

The input/output circuit type of each pin and recommended connection of unused pins are shown in Table 3-1.
For the input/output circuit configuration of each type, see Figure 3-1.

Table 3-1. Input/Output Circuit Type of Each Pin (1/2)

Pin Name	Input/Output Circuit Type	I/O	Recommended Connection when Not Used
P00/INTP0/TI00	2	Input	Connect to V_{SS}.
P01/INTP1/TI01	8-D	Input/output	Individually connect to V_{SS} via a resistor.
P02/INTP2			
P03/INTP3			
P04/INTP4			
P05/INTP5			
P07/XT1	16	Input	Connect to V_{DD}.
P10/ANI0 to P17/ANI7	11-C	Input/output	Individually connect to V_{DD} or V_{SS} via a resistor.
P25/SI0/SB0	10-C		
P26/SO0/SB1			
P27/$\overline{\text{SCK0}}$			
P30/TO0	5-J		
P31/TO1			
P32/TO2			

Table 3-1. Input/Output Circuit Type of Each Pin (2/2)

Pin Name	Input/Output Circuit Type	I/O	Recommended Connection when Not Used
P33/TI1	8-D	Input/output	Individually connect to V_{DD} or V_{SS} via a resistor.
P34/TI2			
P35/PCL	5-J		
P36/BUZ			
P37			
P70/SI2/RxD	8-D		
P71/SO2/TxD	5-J		
P72/$\overline{SCK2}$/ASCK	8-D		
P80/S39 to P87/S32	17-E		
P90/S31 to P97/S24			
P100 to P103	5-J		
P110 to P117	8-D		Individually connect to V_{DD} via a resistor.
S0 to S23	17-D	Output	Leave open.
COM0 to COM3	18-B		
V_{LC0} to V_{LC2}	—	—	
BIAS			
$\overline{RESET}$	2	Input	—
XT2	16	—	Leave open.
AV_{REF}	—		Connect to V_{SS}.
AV_{DD}			Connect to another power supply which has the same potential as V_{DD}.
AV_{SS}			Connect to another ground line which has the same potential as V_{SS}.
IC			Connect to V_{SS} directly.

Figure 3-1. Pin Input/Output Circuits (1/2)

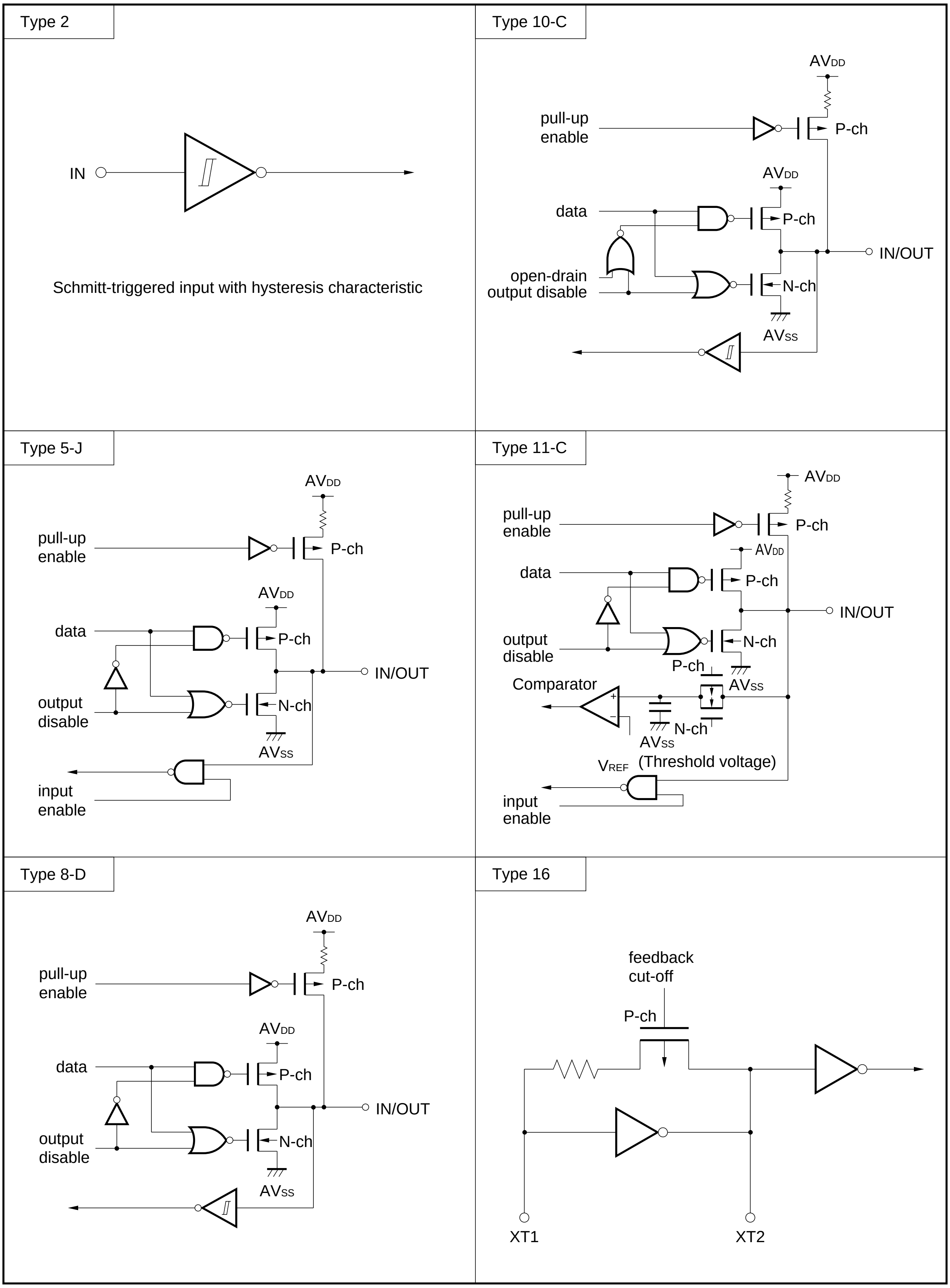
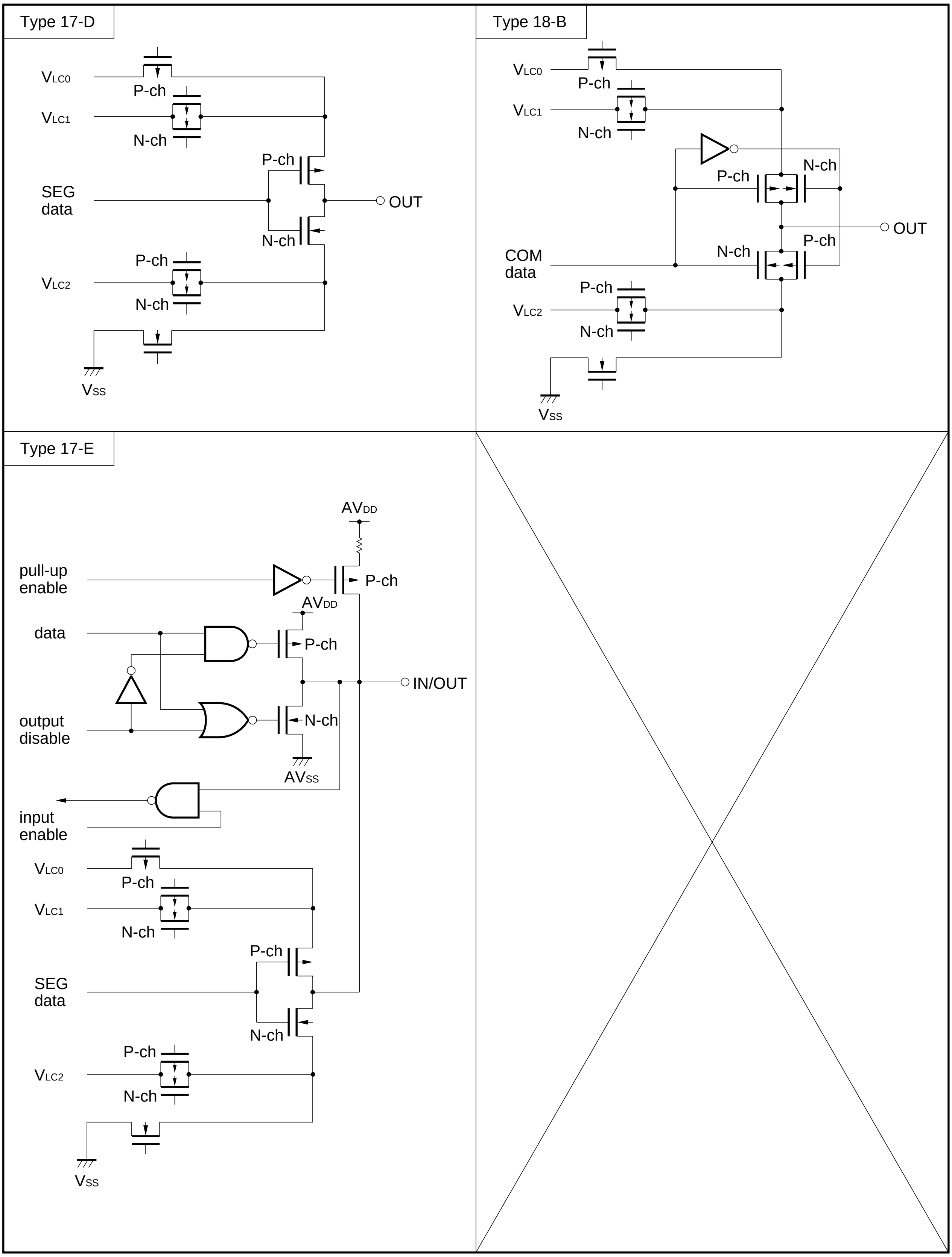


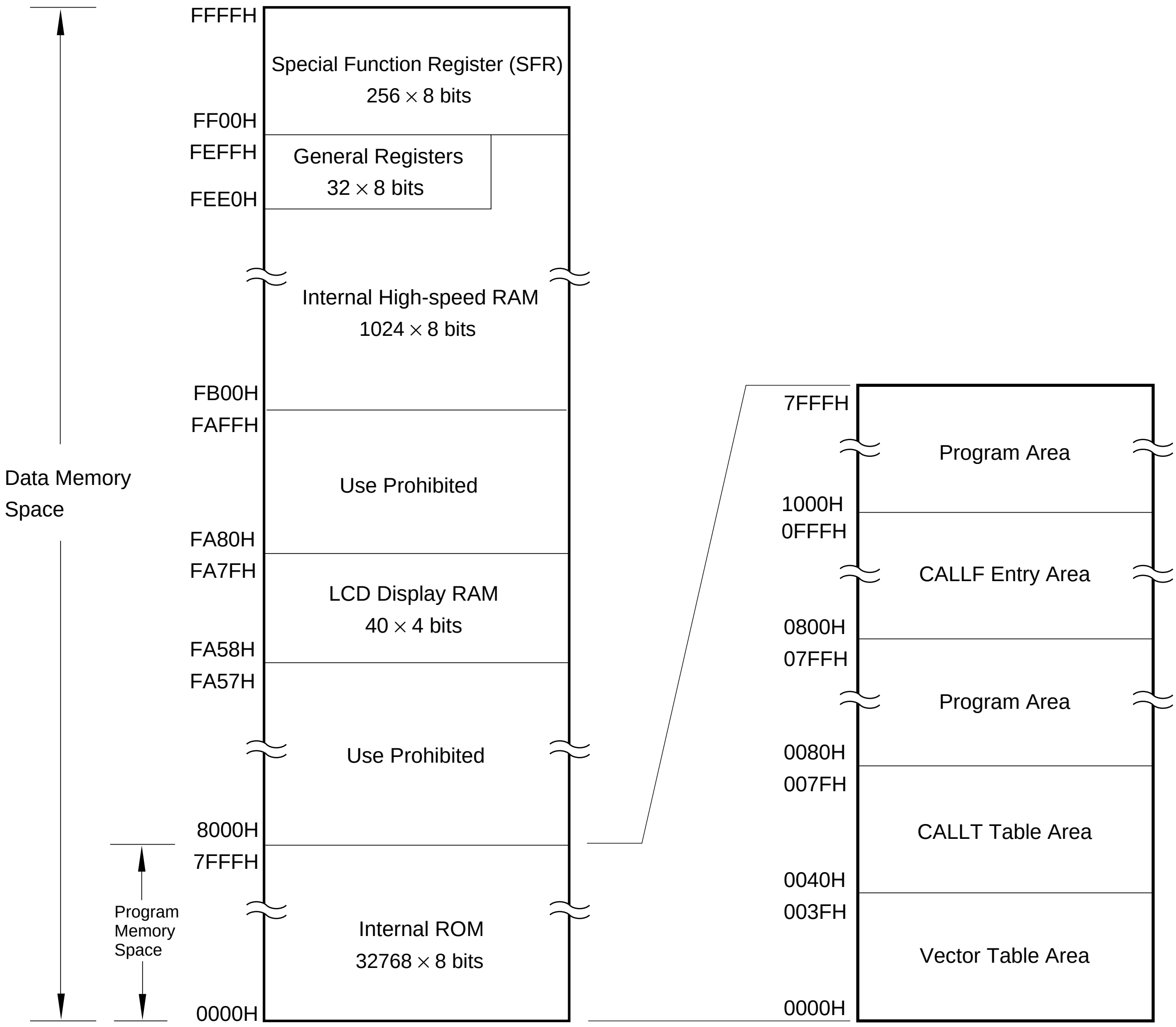
Figure 3-1. Pin Input/Output Circuits (2/2)



4. MEMORY SPACE

The memory map of the μPD78064B is shown in Figure 4-1.

Figure 4-1. Memory Map



5. PERIPHERAL HARDWARE FUNCTION FEATURE

5.1 Port

There are two kinds of I/O port.

• CMOS input (P00, P07)	: 2
• CMOS input/output (P01 to P05, Port 1 to 3, 7 to 11)	: 55
Total	: 57

Table 5-1. Functions of Ports

Name	Pin Name	Function
Port 0	P00, P07	Dedicated input port
	P01 to P05	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software.
Port 1	P10 to P17	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software.
Port 2	P25 to P27	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software.
Port 3	P30 to P37	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software.
Port 7	P70 to P72	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software.
Port 8	P80 to P87	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software. Input/output port/segment signal output function specifiable in 2-bit units by LCD display control register (LCDC).
Port 9	P90 to P97	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software. Input/output port/segment signal output function specifiable in 2-bit units by LCD display control register (LCDC).
Port 10	P100 to P103	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software. Can drive LEDs directly.
Port 11	P110 to P117	Input/output port. Input/output specifiable bit-wise. When used as input port, on-chip pull-up resistor can be used by software. Test input flag (KRIF) is set to 1 by falling edge detection.

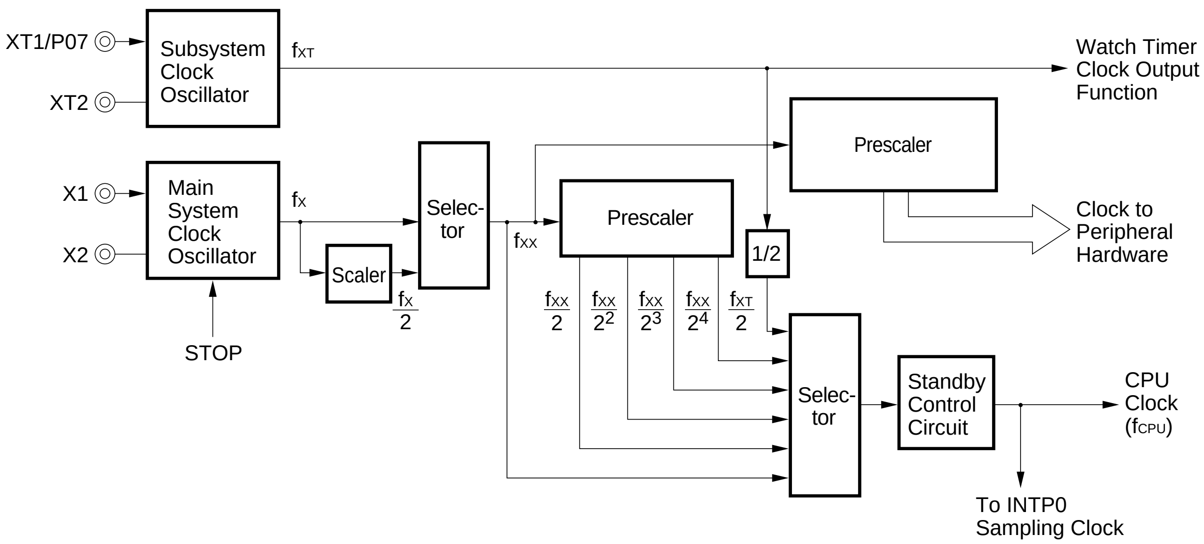
5.2 Clock Generator

There are two kinds of clocks, main system clock and subsystem clock.

The instruction execution time can also be changed.

- 0.4 μs/0.8 μs/1.6 μs/3.2 μs/6.4 μs/12.8 μs (@ 5.0-MHz operation with main system clock)
- 122 μs (@ 32.768-kHz operation with subsystem clock)

Figure 5-1. Clock Generator Block Diagram



5.3 Timer/Event Counter

Five timer/event counter channels are incorporated.

- 16-bit timer/event counter : 1 channel
- 8-bit timer/event counter : 2 channels
- Watch timer : 1 channel
- Watchdog timer : 1 channel

Table 5-2. Timer/Event Counter Types and Functions

		16-bit Timer/ Event Counter	8-bit Timer/ Event Counter	Watch Timer	Watchdog Timer
Type	Interval timer	1 channel	2 channels	1 channel	1 channel
	External event counter	1 channel	2 channels	—	—
Function	Timer output	1 output	2 outputs	—	—
	PWM output	1 output	—	—	—
	Pulse width measurement	2 inputs	—	—	—
	Square wave output	1 output	2 outputs	—	—
	One-shot pulse output	1 output	—	—	—
	Interrupt request	2	2	1	1
	Test input	—	—	1 input	—

Figure 5-2. 16-bit Timer/Event Counter Block Diagram

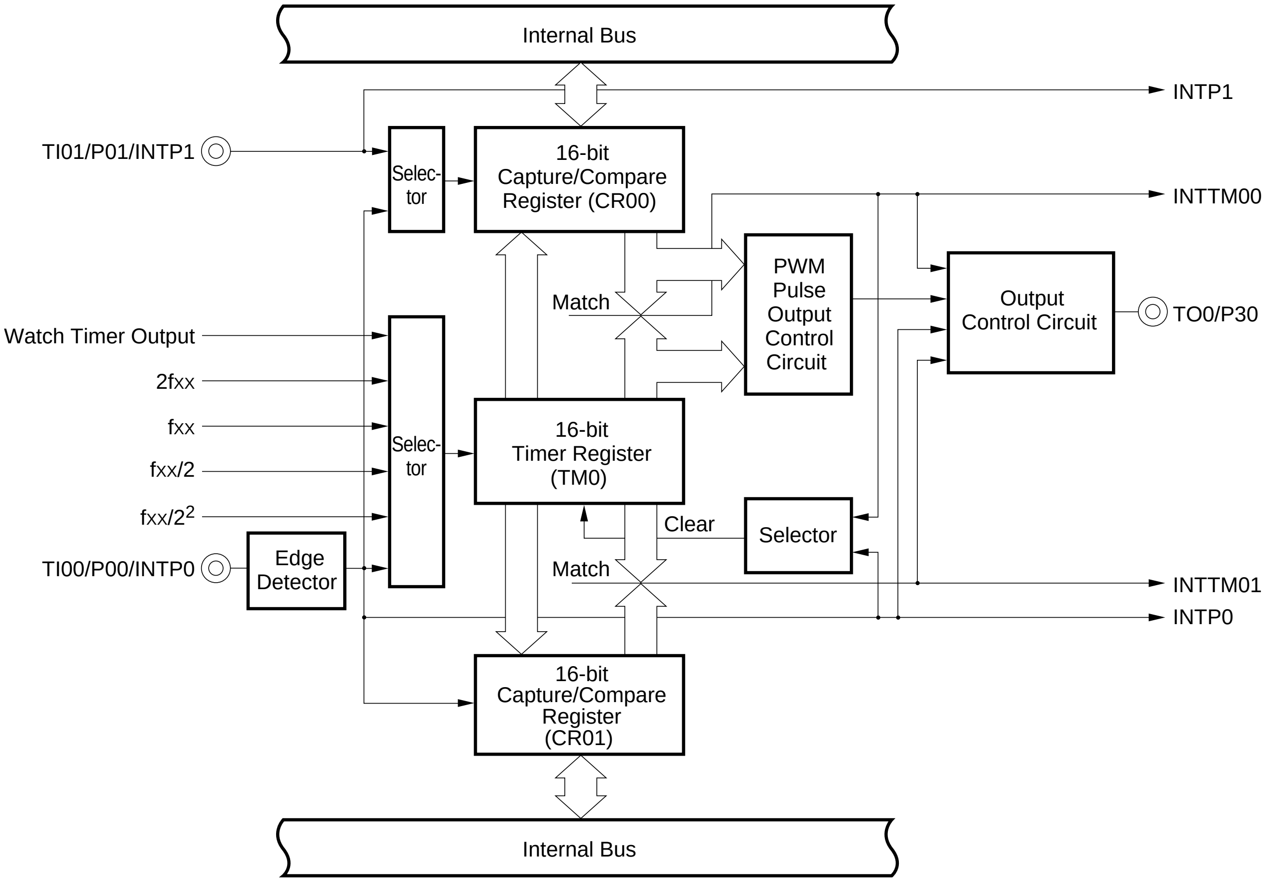


Figure 5-3. 8-bit Timer/Event Counter Block Diagram

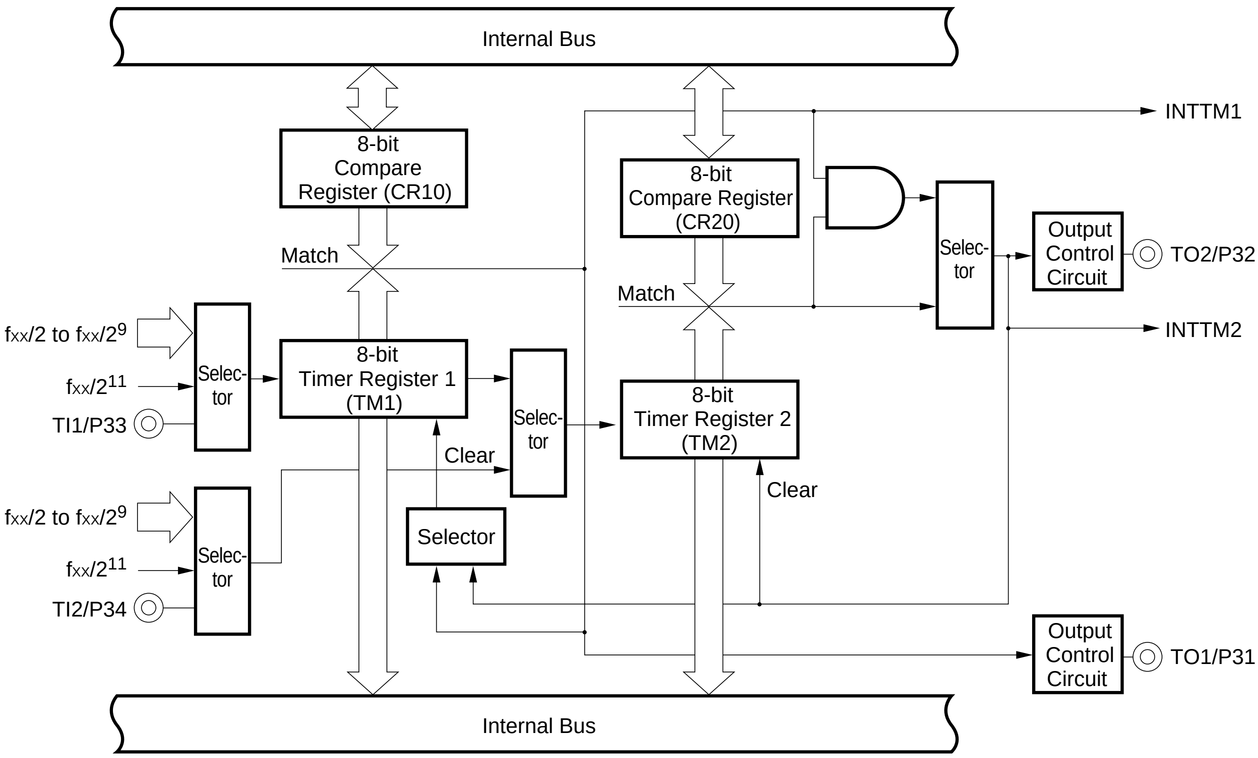


Figure 5-4. Watch Timer Block Diagram

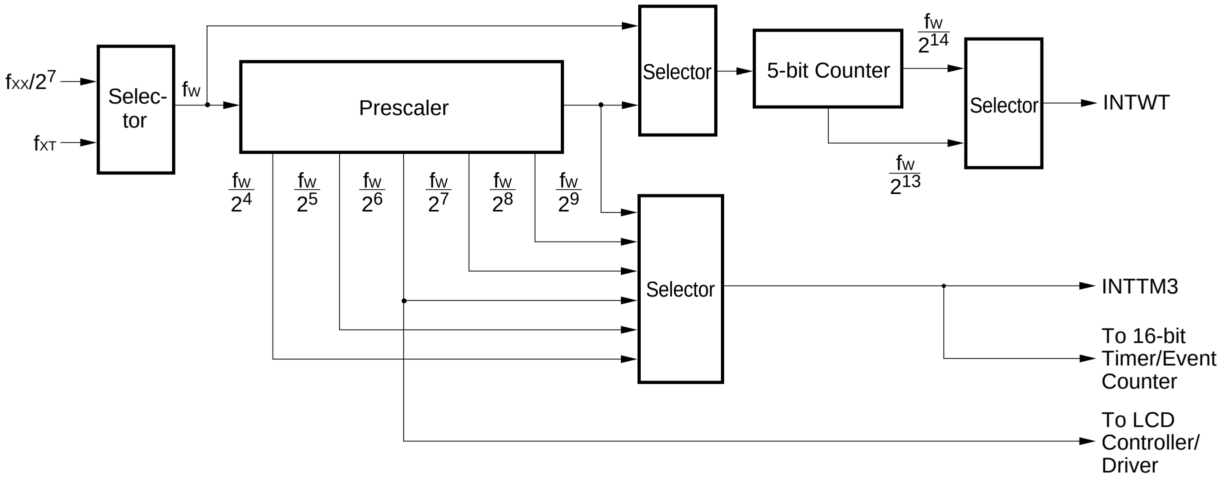
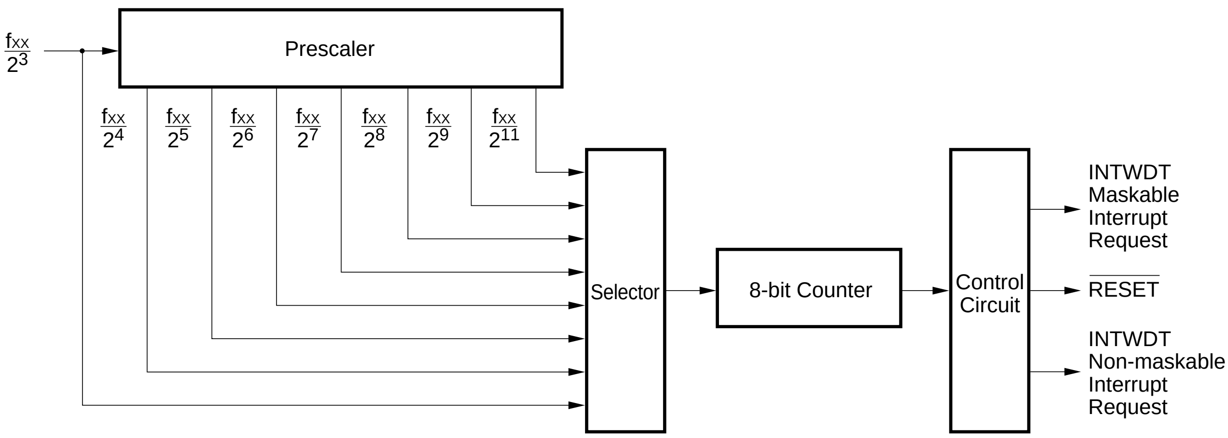


Figure 5-5. Watchdog Timer Block Diagram

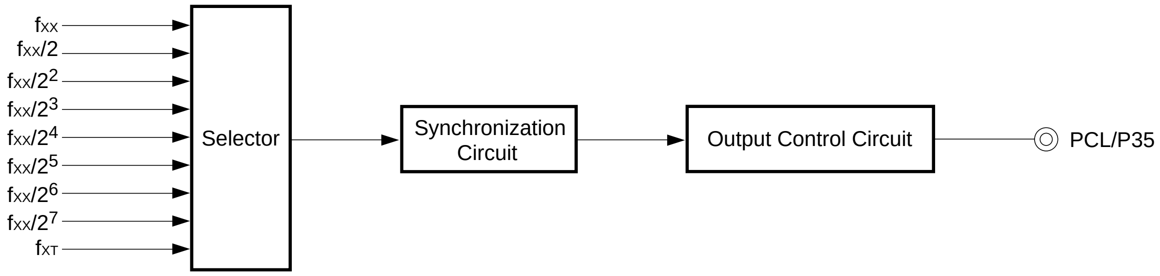


5.4 Clock Output Control Circuit

Clocks of the following frequency can be output as clock outputs.

- 19.5 kHz/39.1 kHz/78.1 kHz/156 kHz/313 kHz/625 kHz/1.25 MHz/2.5 MHz/5.0 MHz (@ 5.0-MHz operation with main system clock)
- 32.768 kHz (@ 32.768-kHz operation with subsystem clock)

Figure 5-6. Clock Output Control Circuit Block Diagram

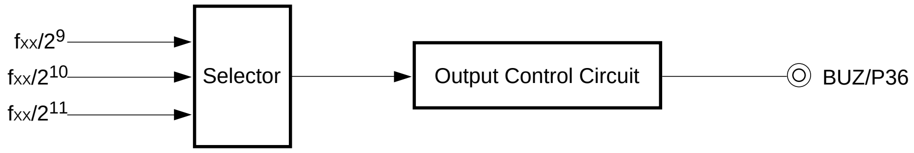


5.5 Buzzer Output Control Circuit

Clocks of the following frequency can be output as buzzer outputs.

- 1.2 kHz/2.4 kHz/4.9 kHz/9.8 kHz (@ 5.0-MHz operation with main system clock)

Figure 5-7. Buzzer Output Control Circuit Block Diagram



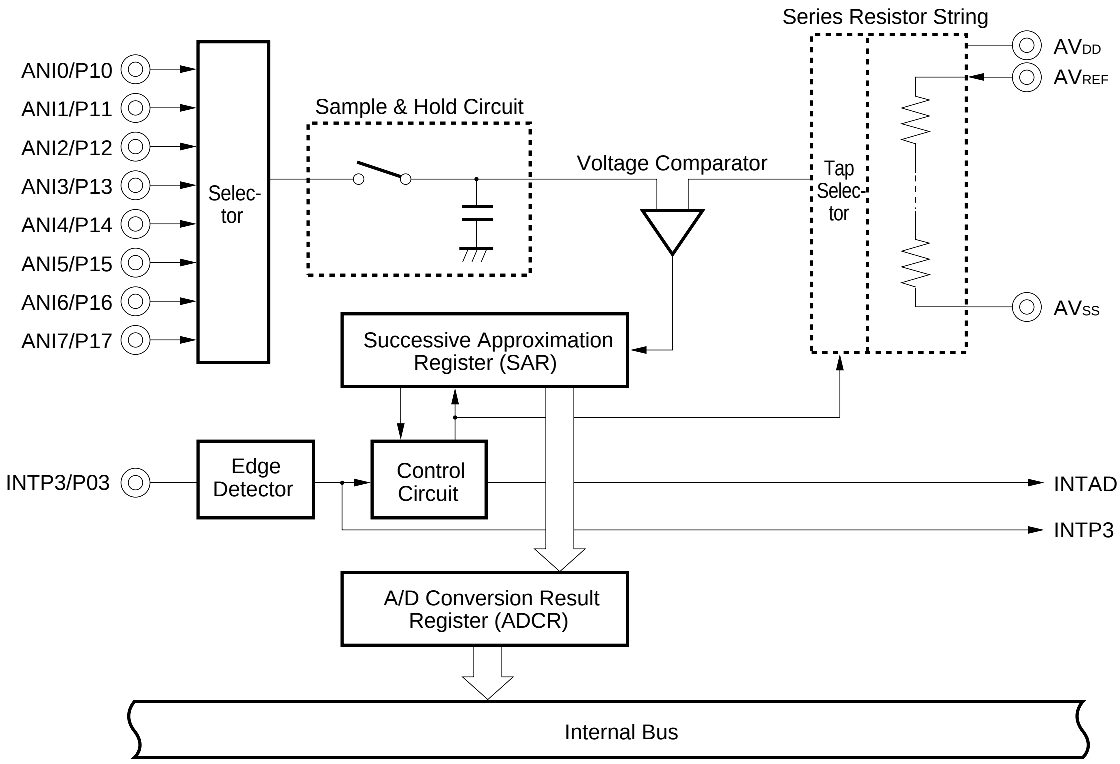
5.6 A/D Converter

Eight 8-bit resolution A/D converter channels are incorporated.

The following two types of start-up method are available.

- Hardware start
- Software start

Figure 5-8. A/D Converter Block Diagram



Caution For pins which also function as port pins (refer to 3.1 Port Pins), do not perform the following operations during A/D conversion. If these operations are performed, the total error ratings cannot be kept (except for LCD segment output alternate-function pin).

<1> Rewrite the output latch while the pin is used as a port pin.

<2> Change the output level of the pin used as an output pin, even if it is not used as a port pin.

5.7 Serial Interface

Two clocked serial interface channels are incorporated.

- Serial interface channel 0
- Serial interface channel 2

Table 5-3. Serial Interface Types and Functions

Function	Serial Interface Channel 0	Serial Interface Channel 2
3-wire serial I/O mode	Yes (MSB/LSB-first switchable)	Yes (MSB/LSB-first switchable)
SBI (serial bus interface) mode	Yes (MSB-first)	No
2-wire serial I/O mode	Yes (MSB-first)	No
Asynchronous serial interface (UART) mode	No	Yes (Dedicated baud rate generator incorporated)

Figure 5-9. Serial Interface Channel 0 Block Diagram

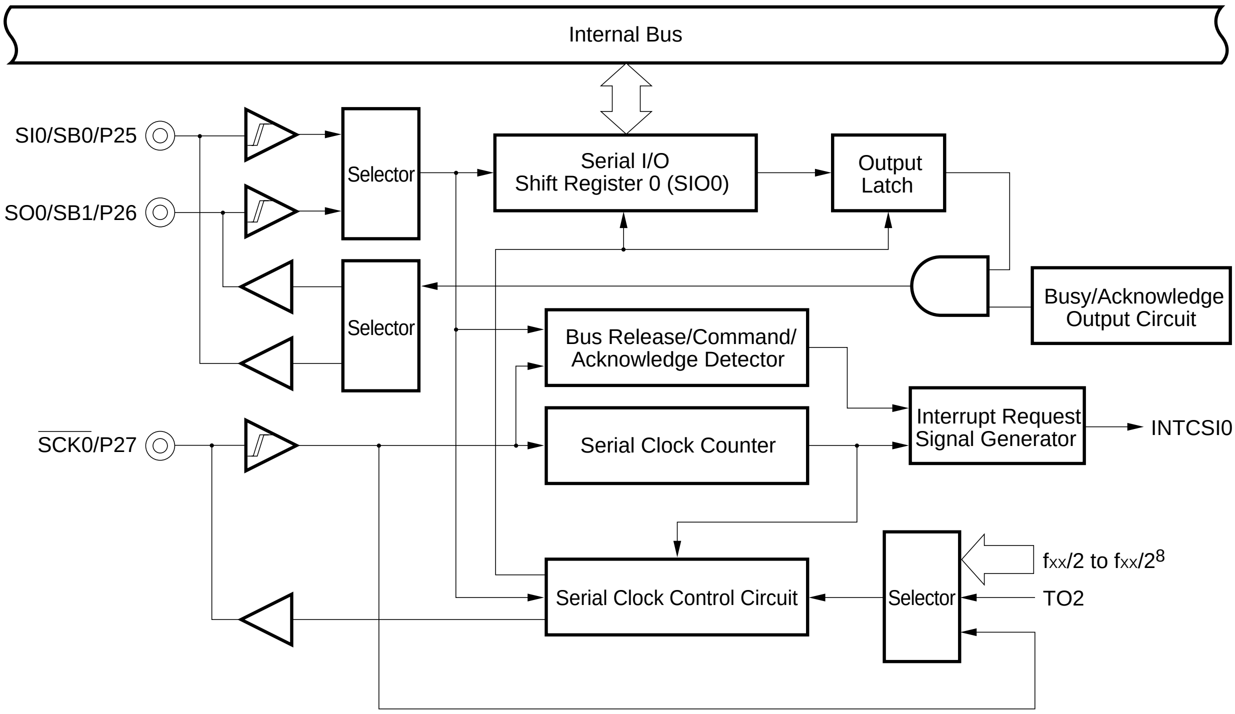
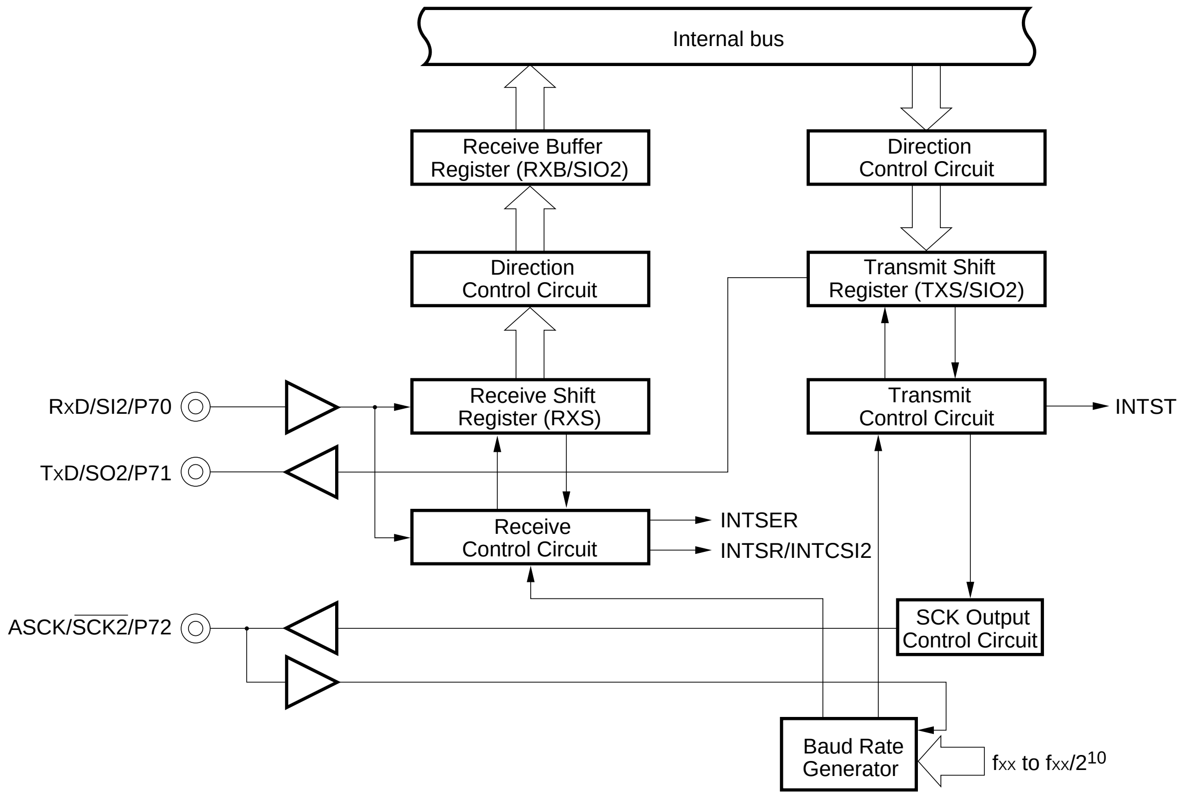


Figure 5-10. Serial Interface Channel 2 Block Diagram



5.8 LCD Controller/Driver

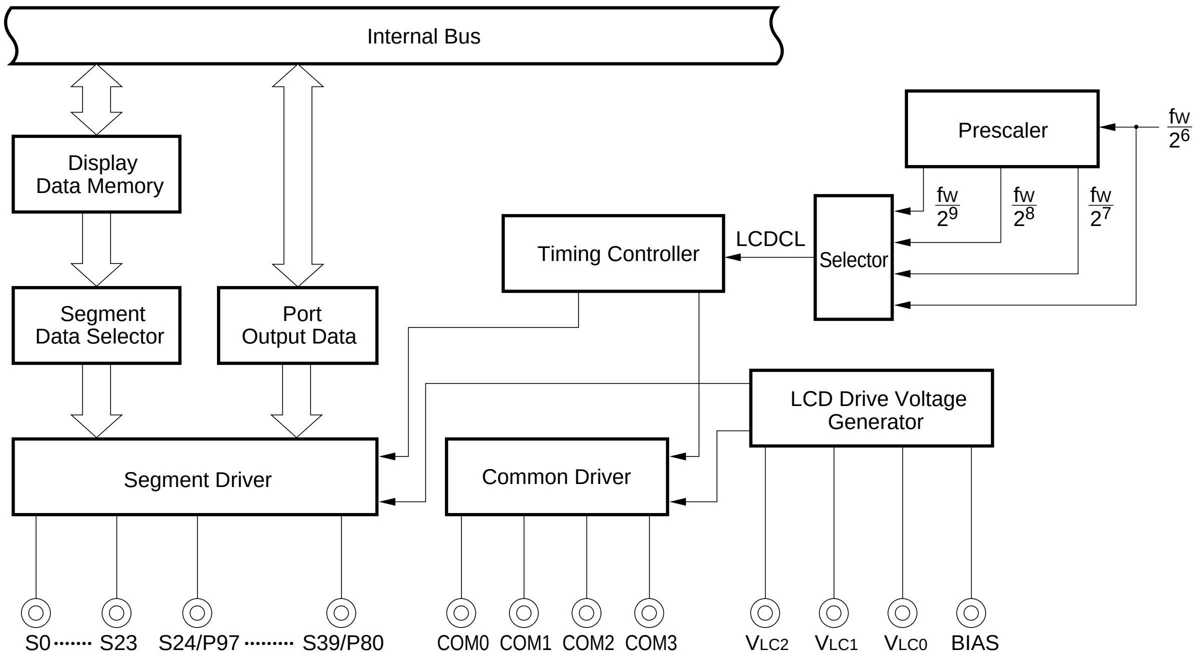
An LCD controller/driver with the following functions is incorporated.

- Selection of 5 types of display mode
- 16 of the segment signal of outputs can be switched to input/output ports in units of 2. (P80/S39 to P87/S32, P90/S31 to P97/S24)

Table 5-4. Display Mode Types and Maximum Number of Display Pixels

Bias Method	Time Multiplexing	Common Signal Used	Maximum Number of Display Pixels
—	Static	COM0 (COM1 to COM3)	40 (40 segments × 1 common)
1/2	2	COM0, COM1	80 (40 segments × 2 commons)
	3	COM0 to COM2	120 (40 segments × 3 commons)
1/3	3	COM0 to COM2	
	4	COM0 to COM3	160 (40 segments × 4 commons)

Figure 5-11. LCD Controller/Driver Block Diagram



6. INTERRUPT FUNCTIONS AND TEST FUNCTIONS

6.1 Interrupt Functions

There are twenty interrupt sources of three different kinds, as shown below.

- Non-maskable : 1
- Maskable : 18
- Software : 1

Table 6-1. Interrupt Source List

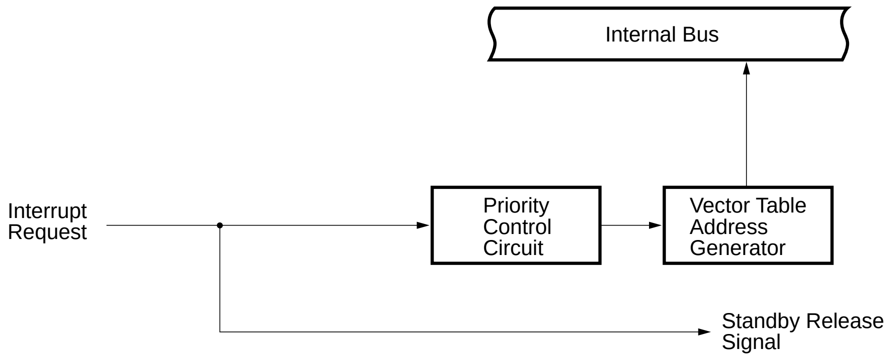
Interrupt Type	Default Priority[Note 1]	Interrupt Source		Internal/ External	Vector Table Address	Basic Configuration Type[Note 2]
		Name	Trigger			
Non-maskable	—	INTWDT	Watchdog timer overflow (with watchdog timer mode 1 selected)	Internal	0004H	(A)
Maskable	0	INTWDT	Watchdog timer overflow (with interval timer mode selected)			(B)
	1	INTP0	Pin input edge detection	External	0006H	(C)
	2	INTP1			0008H	(D)
	3	INTP2			000AH	
	4	INTP3			000CH	
	5	INTP4			000EH	
	6	INTP5			0010H	
	7	INTCSI0	Serial interface channel 0 transfer termination	Internal	0014H	(B)
	8	INTSER	Serial interface channel 2 UART reception error generation		0018H	
	9	INTSR	Serial interface channel 2 UART reception termination		001AH	
		INTCSI2	Serial interface channel 2 3-wire transfer termination			
	10	INTST	Serial interface channel 2 UART transmission termination		001CH	
	11	INTTM3	Reference time interval signal from watch timer		001EH	
	12	INTTM00	16-bit timer register and capture/compare register (CR00) match signal generation		0020H	
	13	INTTM01	16-bit timer register and capture/compare register (CR01) match signal generation		0022H	
	14	INTTM1	8-bit timer/event counter 1 match signal generation		0024H	
	15	INTTM2	8-bit timer/event counter 2 match signal generation		0026H	
	16	INTAD	A/D converter conversion termination		0028H	
Software	—	BRK	BRK instruction execution	—	003EH	(E)

Notes 1. Default priority is a priority order when more than one maskable interrupt request is generated simultaneously. 0 is the highest priority and 16 the lowest priority.

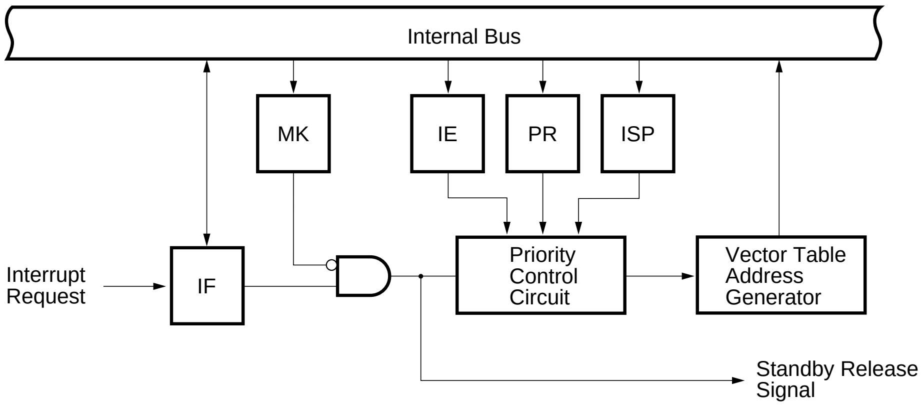
2. Basic configuration types (A) to (E) correspond to those shown in Figure 6-1.

Figure 6-1. Basic Configuration of Interrupt Functions (1/2)

(A) Internal non-maskable interrupt



(B) Internal maskable interrupt



(C) External maskable interrupt (INTP0)

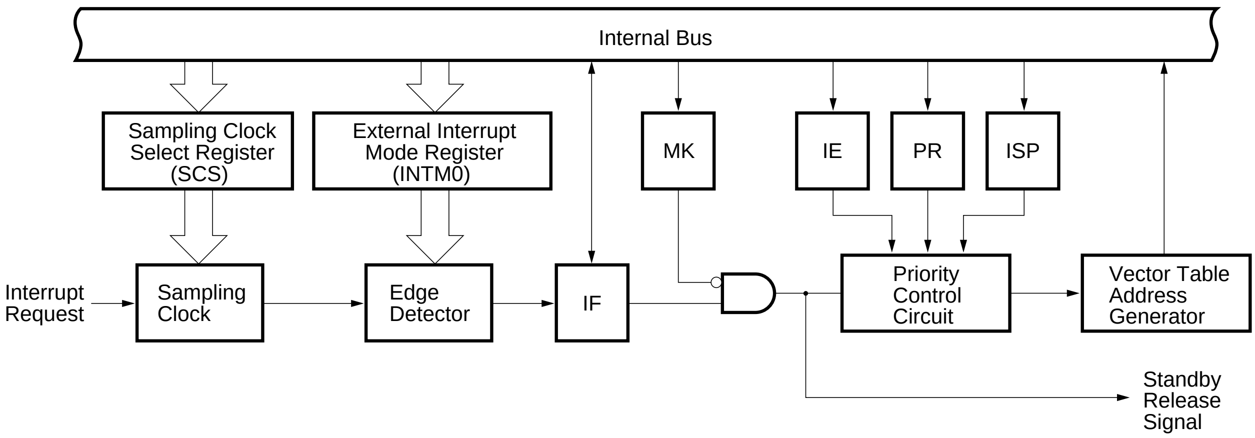
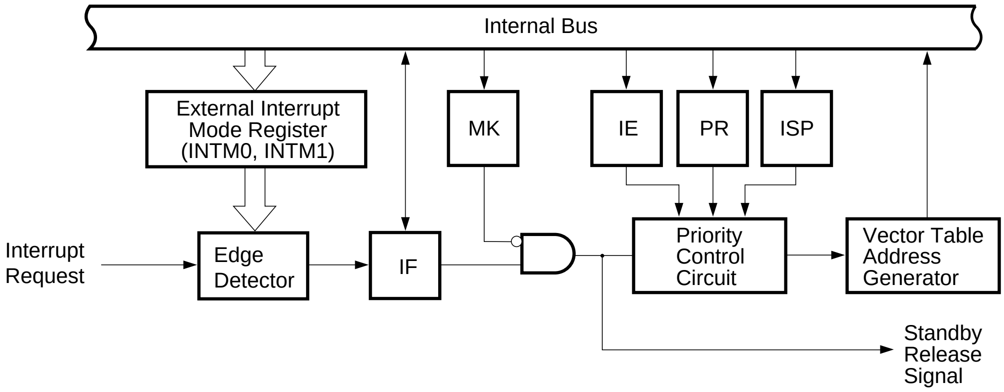
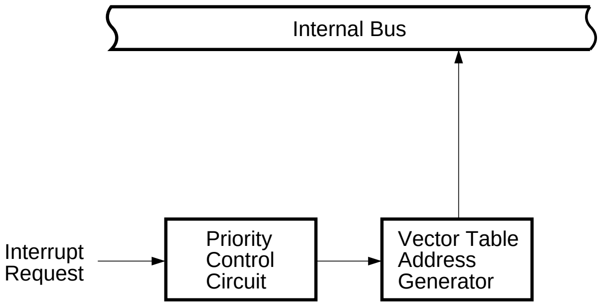


Figure 6-1. Basic Configuration of Interrupt Functions (2/2)

(D) External maskable interrupt (except INTP0)



(E) Software interrupt



IF : Interrupt request flag
IE : Interrupt enable flag
ISP : In-service priority flag
MK : Interrupt mask flag
PR : Priority specification flag

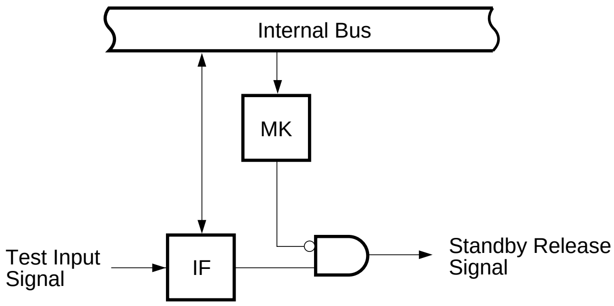
6.2 Test Functions

There are two test functions as shown in Table 6-2.

Table 6-2. Test Input Source List

Test Input Source		Internal/External
Name	Trigger	
INTWT	Watch timer overflow	Internal
INTPT11	Port 11 falling edge detection	External

Figure 6-2. Basic Configuration of Test Function



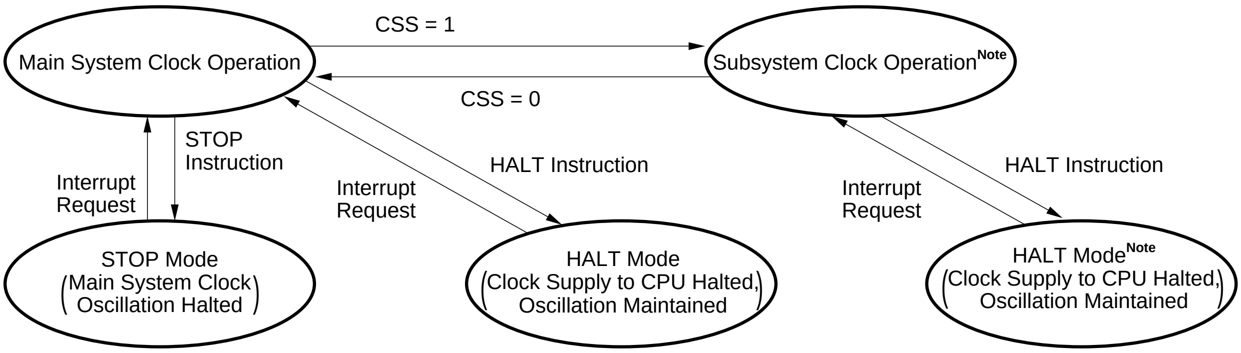
IF : Test input flag
MK : Test mask flag

7. STANDBY FUNCTION

The standby function is a function to reduce the consumption current and there are the following two kinds of standby functions.

- HALT mode : Halts CPU operating clock and can reduce average consumption current by the intermittent operation along with the normal operation.
- STOP mode : Halts main system clock oscillation. Halts all operations with the main system clock and sets ultra-low power dissipation state with subsystem clock only.

Figure 7-1. Standby Function



Note Halting the main system clock enables the consumption current to be reduced.
When the CPU is operated by the subsystem clock, the main system clock should be halted by setting the bit 7 (MCC) of the processor clock control register (PCC). The STOP instruction is not available.

Caution When the main system clock is stopped and the system is operated by the subsystem clock, the main system clock should be returned to after securing the oscillation stabilization time by a program.

8. RESET FUNCTION

There are the following two kinds of resetting methods.

- External reset by $\overline{\text{RESET}}$ pin
- Internal reset by watchdog timer runaway time detection

9. INSTRUCTION SET

(1) 8-bit instruction

MOV, XCH, ADD, ADDC, SUB, SUBC, AND, OR, XOR, CMP, MULU, DIVUW, INC, DEC, ROR, ROL, RORC, ROLC, ROR4, ROL4, PUSH, POP, DBNZ

2nd operand / 1st operand	#byte	A	r[Note]	sfr	saddr	!addr16	PSW	[DE]	[HL]	[HL+byte] [HL+B] [HL+C]	$addr16	1	None
A	ADD ADDC SUB SUBC AND OR XOR CMP		MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV	MOV XCH	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP		ROR ROL RORC ROLC	
r	MOV	MOV ADD ADDC SUB SUBC AND OR XOR CMP											INC DEC
B, C											DBNZ		
sfr	MOV	MOV											
saddr	MOV ADD ADDC SUB SUBC AND OR XOR CMP	MOV									DBNZ		INC DEC
!addr16		MOV											
PSW	MOV	MOV											PUSH POP
[DE]		MOV											
[HL]		MOV											ROR4 ROL4
[HL+byte] [HL+B] [HL+C]		MOV											
X													MULU
C													DIVUW

Note Except r = A

(2) 16-bit instruction

MOVW, XCHW, ADDW, SUBW, CMPW, PUSH, POP, INCW, DECW

2nd operand / 1st operand	#word	AX	rp[Note]	sfrp	saddrp	!addr16	SP	None
AX	ADDW SUBW CMPW		MOVW XCHW	MOVW	MOVW	MOVW	MOVW	
rp	MOVW	MOVW[Note]						INCW, DECW PUSH, POP
sfrp	MOVW	MOVW						
saddrp	MOVW	MOVW						
!addr16		MOVW						
SP	MOVW	MOVW						

Note Only when rp = BC, DE, HL

(3) Bit manipulation instruction

MOV1, AND1, OR1, XOR1, SET1, CLR1, NOT1, BT, BF, BTCLR

2nd operand / 1st operand	A.bit	sfr.bit	saddr.bit	PSW.bit	[HL].bit	CY	$addr16	None
A.bit						MOV1	BT BF BTCLR	SET1 CLR1
sfr.bit						MOV1	BT BF BTCLR	SET1 CLR1
saddr.bit						MOV1	BT BF BTCLR	SET1 CLR1
PSW.bit						MOV1	BT BF BTCLR	SET1 CLR1
[HL].bit						MOV1	BT BF BTCLR	SET1 CLR1
CY	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1			SET1 CLR1 NOT1

(4) Call instruction/branch instruction

CALL, CALLF, CALLT, BR, BC, BNC, BZ, BNZ, BT, BF, BTCLR, DBNZ

2nd operand / 1st operand	AX	!addr16	!addr11	[addr5]	$addr16
Basic instruction	BR	CALL BR	CALLF	CALLT	BR, BC, BNC, BZ, BNZ
Compound instruction					BT, BF, BTCLR DBNZ

(5) Other instructions

ADJBA, ADJBS, BRK, RET, RETI, RETB, SEL, NOP, EI, DI, HALT, STOP

10. ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

Parameter	Symbol	Test Conditions		Ratings	Unit
Supply voltage	V_{DD}			–0.3 to +7.0	V
	AV_{DD}			–0.3 to V_{DD} + 0.3	V
	AV_{REF}			–0.3 to V_{DD} + 0.3	V
	AV_{SS}			–0.3 to +0.3	V
Input voltage	V_I			–0.3 to V_{DD} + 0.3	V
Output voltage	V_O			–0.3 to V_{DD} + 0.3	V
Analog input voltage	V_{AN}	P10 to P17	Analog input pin	AV_{SS} – 0.3 to AV_{REF} + 0.3	V
Output current high	I_{OH}	1 pin		–10	mA
		Total for P01 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P100 to P103, P110 to P117		–15	mA
Output current low	I_{OL} **Note**	1 pin	Peak value	30	mA
			r.m.s. value	15	mA
		Total for P01 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P100 to P103, P110 to P117	Peak value	100	mA
			r.m.s. value	70	mA
Operating ambient temperature	T_A			–40 to +85	°C
Storage temperature	T_{stg}			–65 to +150	°C

Note The r.m.s. value should be calculated as follows: [r.m.s. value] = [Peak value] × $\sqrt{\text{Duty}}$

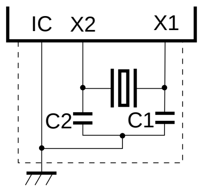
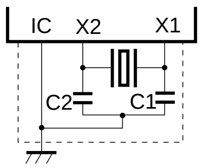
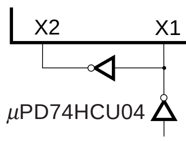
Caution The product quality may be damaged even if a value of only one of the above parameters exceeds the absolute maximum rating or any value exceeds the absolute maximum rating for an instant. That is, the absolute maximum rating is a rating value which may cause a product to be damaged physically. The absolute maximum rating values must therefore be observed in using the product.

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

CAPACITANCE (T_A = 25°C, V_{DD} = V_{SS} = 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			15	pF
I/O capacitance	C_{IO}	0 V.			15	pF

MAIN SYSTEM CLOCK OSCILLATOR CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

Resonator	Recommended circuit	Parameter	Test conditions	MIN.	TYP.	MAX.	Unit
Ceramic resonator		Oscillation frequency (f_X)Note 1	V_{DD} = Oscillation voltage range	1		5	MHz
		Oscillation stabilization timeNote 2	After V_{DD} reaches oscillation voltage range MIN.			4	ms
Crystal resonator		Oscillation frequency (f_X)Note 1		1		5	MHz
		Oscillation stabilization timeNote 2	V_{DD} = 4.5 to 6.0 V			10	ms
						30	
External clock		X1 input frequency (f_X)Note 1		1.0		5.0	MHz
		X1 input high-/low-level width (t_{XH}, t_{XL})		85		500	ns

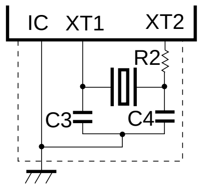
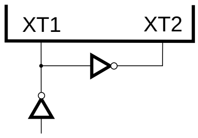
Notes 1. Indicates only oscillator characteristics. Refer to **AC CHARACTERISTICS** for instruction execution time.
2. Time required to stabilize oscillation after reset or STOP mode release.

Cautions 1. When using the main system clock oscillator, wiring in the area enclosed with the dotted line should be carried out as follows to avoid an adverse effect from wiring capacitance.

- **Wiring should be as short as possible.**
- **Wiring should not cross other signal lines.**
- **Wiring should not be placed close to a varying high current.**
- **The potential of the oscillator capacitor ground should be the same as V_{SS}.**
- **Do not ground it to the ground pattern in which a high current flows.**
- **Do not fetch a signal from the oscillator.**

2. If the main system clock oscillator is operated by the subsystem clock when the main system clock is stopped, reswitching to the main system clock should be performed after the oscillation stabilization time has been obtained by the program.

SUBSYSTEM CLOCK OSCILLATOR CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

Resonator	Recommended circuit	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 6.0 V		1.2	2	s
						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. Time required to stabilize oscillation after V_{DD} has reached the minimum oscillation voltage range.

Cautions 1. When using the subsystem clock oscillator, wiring in the area enclosed with the dotted line should be carried out as follows to avoid an adverse effect from wiring capacitance.

- **Wiring should be as short as possible.**
- **Wiring should not cross other signal lines.**
- **Wiring should not be placed close to a varying high current.**
- **The potential of the oscillator capacitor ground should be the same as V_{SS}.**
- **Do not ground it to the ground pattern in which a high current flows.**
- **Do not fetch a signal from the oscillator.**

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

RECOMMENDED OSCILLATOR CONSTANT

MAIN SYSTEM CLOCK: CERAMIC RESONATOR (T_A = –40 to +85°C)

Manufacturer	Product name	Frequency (MHz)	Recommended Circuit Constant		Oscillation Voltage Range		Remarks
			C1 (pF)	C2 (pF)	MIN. (V)	MAX. (V)	
Murata Mfg. Co., Ltd.	CSA5.00MG	5.00	30	30	2.2	6.0	
	CST5.00MGW	5.00	On-chip	On-chip	2.7	6.0	
Matsushita Electronics Components Co., Ltd.	EF0GC5004A4	5.00	On-chip	On-chip	2.7	6.0	Lead type
	EF0EC5004A4	5.00	On-chip	On-chip	2.0	6.0	Round lead type
	EF0EN5004A4	5.00	33	33	2.7	6.0	Lead type
	EF0S5004B5	5.00	On-chip	On-chip	2.7	6.0	Chip type
Kyocera Corporation	KBR-5.0MSA	5.00	33	33	2.7	6.0	Lead type
	PBRC5.00A	5.00	33	33	2.7	6.0	Chip type
	KBR-5.0MKS	5.00	On-chip	On-chip	2.7	6.0	Lead type
	KBR-5.0MWS	5.00	On-chip	On-chip	2.7	6.0	Chip type

SUBSYSTEM CLOCK: CRYSTAL RESONATOR (T_A = –40 to +60°C)

Manufacturer	Product name	Frequency (kHz)	Recommended Circuit Constant			Oscillation Voltage Range	
			C3 (pF)	C4 (pF)	R2 (kΩ)	MIN. (V)	MAX. (V)
Kyocera Corporation	KF-38G-12P0200 Note (Load capacitance 12 pF)	32.768	15	22	220	2.0	6.0

★ **Note** KF-38G-12P0200 is a maintainance product.

Caution The oscillator constant and the oscillation voltage range are the conditions required for stable oscillation, but do not guarantee oscillation frequency accuracy. In the case of application requiring oscillation frequency accuracy, the oscillation frequency of the resonator must be adjusted in a mounted circuit. For details, contact the resonator manufacturer directly.

DC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Input voltage high-level	V_{IH1}	P10 to P17, P30 to P32, P35 to P37, P80 to P87, P90 to P97, P100 to P103	V_{DD} = 2.7 to 6.0 V	0.7V_{DD}		V_{DD}	V
				0.8V_{DD}		V_{DD}	V
	V_{IH2}	P00 to P05, P25 to P27, P33, P34, P70 to P72, P110 to P117, $\overline{\text{RESET}}$	V_{DD} = 2.7 to 6.0 V	0.8V_{DD}		V_{DD}	V
				0.85V_{DD}		V_{DD}	V
	V_{IH3}	X1, X2	V_{DD} = 2.7 to 6.0 V	V_{DD} – 0.5		V_{DD}	V
				V_{DD} – 0.2		V_{DD}	V
	V_{IH4}	XT1/P07, XT2	4.5 V ≤ V_{DD} ≤ 6.0 V	0.8V_{DD}		V_{DD}	V
			2.7 V ≤ V_{DD} < 4.5 V	0.9V_{DD}		V_{DD}	V
			2.0 V ≤ V_{DD} < 2.7 V **Note**	0.9V_{DD}		V_{DD}	V
Input voltage low-level	V_{IL1}	P10 to P17, P30 to P32, P35 to P37, P80 to P87, P90 to P97, P100 to P103	V_{DD} = 2.7 to 6.0 V	0		0.3V_{DD}	V
				0		0.2V_{DD}	V
	V_{IL2}	P00 to P05, P25 to P27, P33, P34, P70 to P72, P110 to P117, $\overline{\text{RESET}}$	V_{DD} = 2.7 to 6.0 V	0		0.2V_{DD}	V
				0		0.15V_{DD}	V
	V_{IL3}	X1, X2	V_{DD} = 2.7 to 6.0 V	0		0.4	V
				0		0.2	V
	V_{IL4}	XT1/P07, XT2	4.5 V ≤ V_{DD} ≤ 6.0 V	0		0.2V_{DD}	V
			2.7 V ≤ V_{DD} < 4.5 V	0		0.1V_{DD}	V
			2.0 V ≤ V_{DD} < 2.7 V **Note**	0		0.1V_{DD}	V
Output voltage high-level	V_{OH}	V_{DD} = 4.5 to 6.0 V, I_{OH} = –1 mA		V_{DD} – 1.0		V_{DD}	V
		I_{OH} = –100 μA		V_{DD} – 0.5		V_{DD}	V
Output voltage low-level	V_{OL1}	P100 to P103	V_{DD} = 4.5 to 6.0 V, I_{OL} = 15 mA		0.4	2.0	V
		P01 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P110 to P117	V_{DD} = 4.5 to 6.0 V, I_{OL} = 1.6 mA			0.4	V
	V_{OL2}	SB0, SB1, $\overline{\text{SCK0}}$	V_{DD} = 4.5 to 6.0 V, open-drain, pulled high (R = 1 kΩ)			0.2V_{DD}	V
	V_{OL3}	I_{OL} = 400 μA				0.5	V

Note When P07/XT1 pin is used as P07, the inverse phase of P07 should be input to XT2 pin.

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

DC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Input leakage current high-level	I_{LIH1}	V_{IN} = V_{DD}	P00 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P100 to P103, P110 to P117			3	μA
	I_{LIH2}		X1, X2, XT1/P07, XT2			20	μA
Input leakage current low-level	I_{LIL1}	V_{IN} = 0 V	P00 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P100 to P103, P110 to P117			–3	μA
	I_{LIL2}		X1, X2, XT1/P07, XT2			–20	μA
Output leakage current high-level	I_{LOH}	V_{OUT} = V_{DD}				3	μA
Output leakage current low-level	I_{LOL}	V_{OUT} = 0 V				–3	μA
Software pull-up resistor	R	V_{IN} = 0 V, P01 to P05, P10 to P17, P25 to P27, P30 to P37, P70 to P72, P80 to P87, P90 to P97, P100 to P103, P110 to P117	4.5 V ≤ V_{DD} ≤ 6.0 V	15	40	90	kΩ
			2.7 V ≤ V_{DD} < 4.5 V	20		500	kΩ
Supply current Note 1	I_{DD1}	5.00-MHz crystal oscillation (f_{XX} = 2.5 MHz) Note 2 operating mode	V_{DD} = 5.0 V ± 10 % Note 4		4	12	mA
			V_{DD} = 3.0 V ± 10 % Note 5		0.6	1.8	mA
			V_{DD} = 2.2 V ± 10 % Note 5		0.35	1.05	mA
		5.00-MHz crystal oscillation (f_{XX} = 5.0 MHz) Note 3 operating mode	V_{DD} = 5.0 V ± 10 % Note 4		6.5	19.5	mA
			V_{DD} = 3.0 V ± 10 % Note 5		0.8	2.4	mA
	I_{DD2}	5.00-MHz crystal oscillation (f_{XX} = 2.5 MHz) Note 2 HALT mode	V_{DD} = 5.0 V ± 10 %		1.4	4.2	mA
			V_{DD} = 3.0 V ± 10 %		500	1500	μA
			V_{DD} = 2.2 V ± 10 %		280	840	μA
		5.00-MHz crystal oscillation (f_{XX} = 5.0 MHz) Note 3 HALT mode	V_{DD} = 5.0 V ± 10 %		1.6	4.8	mA
			V_{DD} = 3.0 V ± 10 %		650	1950	μA

Notes
1. The current flowing in V_{DD} and AV_{DD}, excluding the current flowing in an A/D converter, on-chip pull-up resistors and LCD split resistors
2. Main system clock f_{XX} = f_X/2 operation (when oscillation mode selection register (OSMS) is set to 00H)
3. Main system clock f_{XX} = f_X operation (when OSMS is set to 01H)
4. High-speed mode operation (when processor clock control register (PCC) is set to 00H)
5. Low-speed mode operation (when PCC is set to 04H)

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

DC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Supply current[Note 1]	I_{DD3}	32.768-kHz crystal oscillation operating mode[Note 2]	V_{DD} = 5.0 V ± 10 %		60	120	μA
			V_{DD} = 3.0 V ± 10 %		32	64	μA
			V_{DD} = 2.2 V ± 10 %		24	48	μA
	I_{DD4}	32.768-kHz crystal oscillation HALT mode[Note 2]	V_{DD} = 5.0 V ± 10 %		25	55	μA
			V_{DD} = 3.0 V ± 10 %		5	15	μA
			V_{DD} = 2.2 V ± 10 %		2.5	12.5	μA
★	I_{DD5}	XT1 = V_{DD} STOP mode When feedback resistor is connected	V_{DD} = 5.0 V ± 10 %		1	30	μA
			V_{DD} = 3.0 V ± 10 %		0.5	10	μA
			V_{DD} = 2.2 V ± 10 %		0.3	10	μA
★	I_{DD6}	XT1 = V_{DD} STOP mode When feedback resistor is disconnected	V_{DD} = 5.0 V ± 10 %		0.1	30	μA
			V_{DD} = 3.0 V ± 10 %		0.05	10	μA
			V_{DD} = 2.2 V ± 10 %		0.05	10	μA

Notes **1.** The current flowing in V_{DD} and AV_{DD}, excluding the current flowing in an A/D converter, on-chip pull-up resistors and LCD split resistors

2. When the main system clock is stopped.

DC CHARACTERISTICS (T_A = –10 to +85°C)

(1) Static Display Mode (V_{DD} = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{LCD}			2.0		V_{DD}	V
LCD split resistor	R_{LCD}			60	100	150	kΩ
LCD output voltage deviation[Note] (common)	V_{ODC}	I_O = ±5 μA	2.0 V ≤ V_{LCD} ≤ V_{DD} V_{LCD0} = V_{LCD}	0		±0.2	V
LCD output voltage deviation[Note] (segment)	V_{ODS}	I_O = ±1 μA		0		±0.2	V

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

(2) 1/3 Bias Method (V_{DD} = 2.5 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{LCD}			2.5		V_{DD}	V
LCD split resistor	R_{LCD}			60	100	150	kΩ
LCD output voltage deviation[Note] (common)	V_{ODC}	I_O = ±5 μA	2.5 V ≤ V_{LCD} ≤ V_{DD} V_{LCD0} = V_{LCD}	0		±0.2	V
LCD output voltage deviation[Note] (segment)	V_{ODS}	I_O = ±1 μA	V_{LCD1} = V_{LCD} × 2/3 V_{LCD2} = V_{LCD} × 1/3	0		±0.2	V

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

(3) 1/2 Bias Method (V_{DD} = 2.7 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{LCD}			2.7		V_{DD}	V
LCD split resistor	R_{LCD}			60	100	150	kΩ
LCD output voltage deviation[Note] (common)	V_{ODC}	I_O = ±5 μA	2.7 V ≤ V_{LCD} ≤ V_{DD} V_{LCD0} = V_{LCD}	0		±0.2	V
LCD output voltage deviation[Note] (segment)	V_{ODS}	I_O = ±1 μA	V_{LCD1} = V_{LCD} × 1/2 V_{LCD2} = V_{LCD1}	0		±0.2	V

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

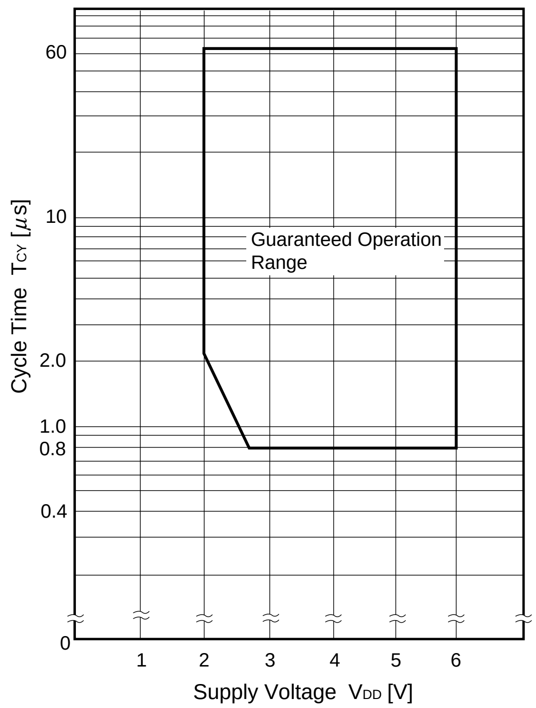
AC CHARACTERISTICS

(1) Basic Operation (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

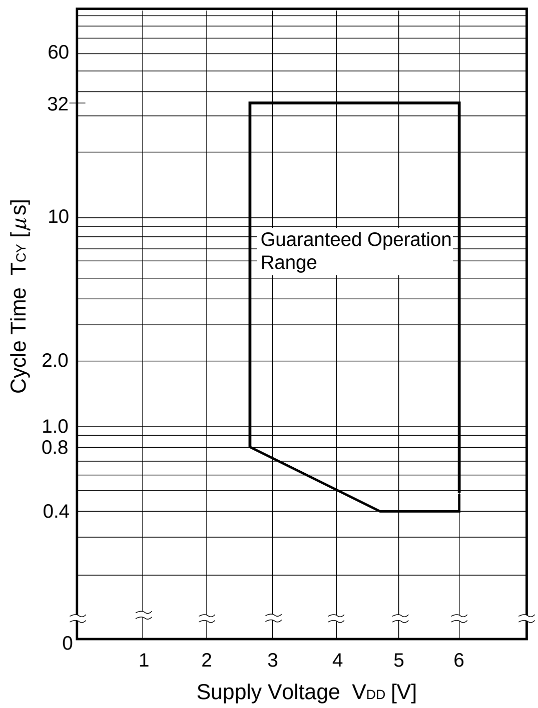
Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Cycle time (Minimum instruction execution time)	T_{CY}	Operating on main system clock (f_{XX} = 2.5 MHz)Note 1	V_{DD} = 2.7 to 6.0 V	0.8		64	μs
				2.2		64	μs
		Operating on main system clock (f_{XX} = 5.0 MHz)Note 2	4.5 ≤ V_{DD} ≤ 6.0 V	0.4		32	μs
			2.7 ≤ V_{DD} < 4.5 V	0.8		32	μs
		Operating on subsystem clock		40Note 3	122	125	μs
★ TI00 input high-/low-level width	t_{TIH00}, t_{TIL00}	4.5 V ≤ V_{DD} ≤ 6.0 V		$2/f_{sam}$ + 0.1Note 4			μs
		2.7 V ≤ V_{DD} < 4.5 V		$2/f_{sam}$ + 0.2Note 4			μs
		2.0 V ≤ V_{DD} < 2.7 V		$2/f_{sam}$ + 0.5Note 4			μs
★ TI01 input high-/low-level width	t_{TIH01}, t_{TIL01}	V_{DD} = 2.7 to 6.0 V		10			μs
				20			μs
TI1, TI2 input frequency	f_{TI1}	V_{DD} = 4.5 to 6.0 V		0		4	MHz
				0		275	kHz
TI1, TI2 input high-/low-level width	t_{TIH1}, t_{INTL1}	V_{DD} = 4.5 to 6.0 V		100			ns
				1.8			μs
Interrupt input high-/low-level width	t_{INTH}, t_{INTL}	INTP0		$8/f_{sam}$Note 4			μs
		INTP1 to INTP5, P110 to P117	V_{DD} = 2.7 to 6.0 V	10			μs
				20			μs
$\overline{\text{RESET}}$ low-level width	t_{RSL}	V_{DD} = 2.7 to 6.0 V		10			μs
				20			μs

Notes **1.** Main system clock f_{XX} = f_X/2 operation (when oscillation mode selection register (OSMS) is set to 00H)
2. Main system clock f_{XX} = f_X operation (when OSMS is set to 01H)
3. This is the value when the external clock is used. The value is 114 μs (MIN.) when the crystal resonator is used.
4. In combination with bits 0 (SCS0) and 1 (SCS1) of sampling clock select register (SCS), selection of f_{sam} is possible between $f_{XX}/2^N$, f_{XX}/32, f_{XX}/64 and f_{XX}/128 (when N = 0 to 4).

T_{CY} vs V_{DD} (At main system clock $f_{XX} = f_X/2$ operation)



T_{CY} vs V_{DD} (At main system clock $f_{XX} = f_X$ operation)



(2) Serial Interface (T_A = –40 to +85°C, V_{DD} = 2.0 to 6.0 V)

(a) Serial interface channel 0

(i) 3-wire serial I/O mode ($\overline{SCK0}$... Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY1}	4.5 V ≤ V_{DD} ≤ 6.0 V	800			ns
		2.7 V ≤ V_{DD} < 4.5 V	1600			ns
			3200			ns
$\overline{SCK0}$ high-/low-level width	t_{KH1}, t_{KL1}	V_{DD} = 4.5 to 6.0 V	t_{KCY1}/2 – 50			ns
			t_{KCY1}/2 – 100			ns
SI0 setup time (to $\overline{SCK0}$↑)	t_{SIK1}	4.5 V ≤ V_{DD} ≤ 6.0 V	100			ns
		2.7 V ≤ V_{DD} < 4.5 V	150			ns
			300			ns
SI0 hold time (from $\overline{SCK0}$↑)	t_{KSI1}		400			ns
SO0 output delay time from $\overline{SCK0}$↓	t_{KSO1}	C = 100 pF Note			300	ns

Note C is the load capacitance of $\overline{SCK0}$, SO0 output line.

(ii) 3-wire serial I/O mode ($\overline{SCK0}$... External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY2}	4.5 V ≤ V_{DD} ≤ 6.0 V	800			ns
		2.7 V ≤ V_{DD} < 4.5 V	1600			ns
			3200			ns
$\overline{SCK0}$ high-/low-level width	t_{KH2}, t_{KL2}	4.5 V ≤ V_{DD} ≤ 6.0 V	400			ns
		2.7 V ≤ V_{DD} < 4.5 V	800			ns
			1600			ns
SI0 setup time (to $\overline{SCK0}$↑)	t_{SIK2}		100			ns
SI0 hold time (from $\overline{SCK0}$↑)	t_{KSI2}		400			ns
SO0 output delay time from $\overline{SCK0}$↓	t_{KSO2}	C = 100 pF Note			300	ns
$\overline{SCK0}$ rise, fall time	t_{R2}, t_{F2}				1000	ns

Note C is the load capacitance of SO0 output line.

(iii) SBI mode ($\overline{SCK0}$... Internal clock output)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY3}	V_{DD} = 4.5 to 6.0 V		800			ns
				3200			ns
$\overline{SCK0}$ high-/low-level width	t_{KH3}, t_{KL3}	V_{DD} = 4.5 to 6.0 V		t_{KCY3}/2 – 50			ns
				t_{KCY3}/2 – 150			ns
SB0, SB1 setup time (to $\overline{SCK0}$↑)	t_{SIK3}	V_{DD} = 4.5 to 6.0 V		100			ns
				300			ns
SB0, SB1 hold time (from $\overline{SCK0}$↑)	t_{KSI3}			t_{KCY3}/2			ns
SB0, SB1 output delay time from $\overline{SCK0}$↓	t_{KSO3}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 4.5 to 6.0 V	0		250	ns
				0		1000	ns
SB0, SB1↓ from $\overline{SCK0}$↑	t_{KSB}			t_{KCY3}			ns
$\overline{SCK0}$↓ from SB0, SB1↓	t_{SBK}			t_{KCY3}			ns
SB0, SB1 high-level width	t_{SBH}			t_{KCY3}			ns
SB0, SB1 low-level width	t_{SBL}			t_{KCY3}			ns

Note R and C are the load resistance and load capacitance of the $\overline{SCK0}$, SB0 and SB1 output line.

(iv) SBI mode ($\overline{SCK0}$... External clock input)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY4}	V_{DD} = 4.5 to 6.0 V		800			ns
				3200			ns
$\overline{SCK0}$ high-/low-level width	t_{KH4}, t_{KL4}	V_{DD} = 4.5 to 6.0 V		400			ns
				1600			ns
SB0, SB1 setup time (to $\overline{SCK0}$↑)	t_{SIK4}	V_{DD} = 4.5 to 6.0 V		100			ns
				300			ns
SB0, SB1 hold time (from $\overline{SCK0}$↑)	t_{KSI4}			t_{KCY4}/2			ns
SB0, SB1 output delay time from $\overline{SCK0}$↓	t_{KSO4}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 4.5 to 6.0 V	0		300	ns
				0		1000	ns
SB0, SB1↓ from $\overline{SCK0}$↑	t_{KSB}			t_{KCY4}			ns
$\overline{SCK0}$↓ from SB0, SB1↓	t_{SBK}			t_{KCY4}			ns
SB0, SB1 high-level width	t_{SBH}			t_{KCY4}			ns
SB0, SB1 low-level width	t_{SBL}			t_{KCY4}			ns
$\overline{SCK0}$ rise, fall time	t_{R4}, t_{F4}					1000	ns

Note R and C are the load resistance and load capacitance of the SB0 and SB1 output line.

(v) 2-wire serial I/O mode ($\overline{SCK0}$... Internal clock output)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY5}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 2.7 to 6.0 V	1600			ns
				3200			ns
$\overline{SCK0}$ high-level width	t_{KH5}		V_{DD} = 2.7 to 6.0 V	$t_{KCY5}/2 - 160$			ns
				$t_{KCY5}/2 - 190$			ns
$\overline{SCK0}$ low-level width	t_{KL5}		V_{DD} = 4.5 to 6.0 V	$t_{KCY5}/2 - 50$			ns
				$t_{KCY5}/2 - 100$			ns
SB0, SB1 setup time (to $\overline{SCK0}$↑)	t_{SIK5}		4.5 V ≤ V_{DD} ≤ 6.0 V	300			ns
			2.7 V ≤ V_{DD} < 4.5 V	350			ns
				400			ns
SB0, SB1 hold time (from $\overline{SCK0}$↑)	t_{KSI5}			600			ns
SB0, SB1 output delay time from $\overline{SCK0}$↓	t_{KSO5}					300	ns

Note R and C are the load resistance and load capacitance of the $\overline{SCK0}$, SB0 and SB1 output line.

(vi) 2-wire serial I/O mode ($\overline{SCK0}$... External clock input)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK0}$ cycle time	t_{KCY6}	V_{DD} = 2.7 to 6.0 V		1600			ns
				3200			ns
$\overline{SCK0}$ high-level width	t_{KH6}	V_{DD} = 2.7 to 6.0 V		650			ns
				1300			ns
$\overline{SCK0}$ low-level width	t_{KL6}	V_{DD} = 2.7 to 6.0 V		800			ns
				1600			ns
SB0, SB1 setup time (to $\overline{SCK0}$↑)	t_{SIK6}			100			ns
SB0, SB1 hold time (from $\overline{SCK0}$↑)	t_{KSI6}			$t_{KCY6}/2$			ns
SB0, SB1 output delay time from $\overline{SCK0}$↓	t_{KSO6}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 4.5 to 6.0 V	0		300	ns
				0		500	ns
$\overline{SCK0}$ rise, fall time	t_{R6}, t_{F6}					1000	ns

Note R and C are the load resistance and load capacitance of the SB0 and SB1 output line.

(b) Serial interface channel 2

(i) 3-wire serial I/O mode ($\overline{SCK2}$... Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK2}$ cycle time	t_{KCY7}	4.5 V ≤ V_{DD} ≤ 6.0 V	800			ns
		2.7 V ≤ V_{DD} < 4.5 V	1600			ns
			3200			ns
$\overline{SCK2}$ high-/low-level width	t_{KH7}, t_{KL7}	4.5 V ≤ V_{DD} ≤ 6.0 V	t_{KCY7}/2 – 50			ns
			t_{KCY7}/2 – 100			ns
SI2 setup time (to $\overline{SCK2}$↑)	t_{SIK7}	4.5 V ≤ V_{DD} ≤ 6.0 V	100			ns
		2.7 V ≤ V_{DD} < 4.5 V	150			ns
			300			ns
SI2 hold time (from $\overline{SCK2}$↑)	t_{KSI7}		400			ns
SO2 output delay time from $\overline{SCK2}$↓	t_{KSO7}	C = 100 pF[Note]			300	ns

Note C is the load capacitance of $\overline{SCK2}$, SO2 output line.

(ii) 3-wire serial I/O mode ($\overline{SCK2}$... External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK2}$ cycle time	t_{KCY8}	4.5 V ≤ V_{DD} ≤ 6.0 V	800			ns
		2.7 V ≤ V_{DD} < 4.5 V	1600			ns
			3200			ns
$\overline{SCK2}$ high-/low-level width	t_{KH8}, t_{KL8}	4.5 V ≤ V_{DD} ≤ 6.0 V	400			ns
		2.7 V ≤ V_{DD} < 4.5 V	800			ns
			1600			ns
SI2 setup time (to $\overline{SCK2}$↑)	t_{SIK8}		100			ns
SI2 hold time (from $\overline{SCK2}$↑)	t_{KSI8}		400			ns
SO2 output delay time from $\overline{SCK2}$↓	t_{KSO8}	C = 100 pF[Note]			300	ns
$\overline{SCK2}$ rise, fall time	t_{R8}, t_{F8}				1000	ns

Note C is the load capacitance of SO2 output line.

(iii) UART mode (Dedicated baud rate generator output)

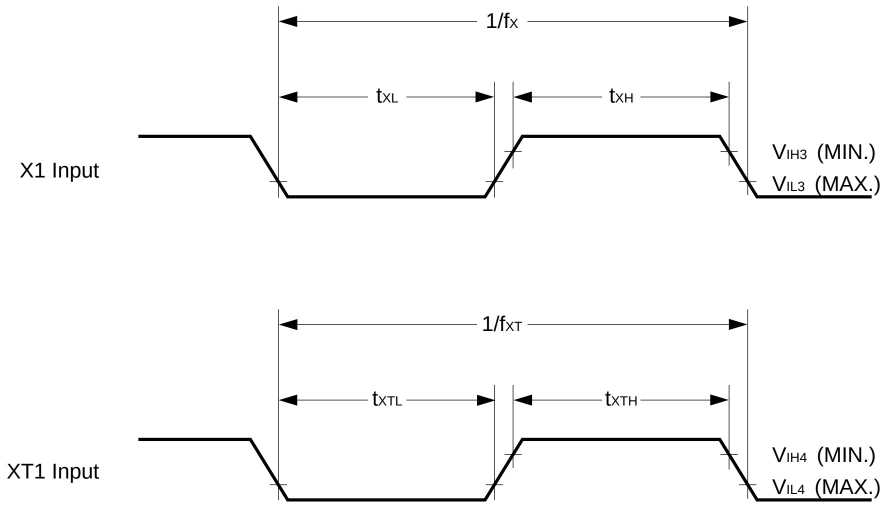
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate		4.5 V ≤ V_{DD} ≤ 6.0 V			78125	bps
		2.7 V ≤ V_{DD} < 4.5 V			39063	bps
					19531	bps

(iv) UART mode (External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
ASCK cycle time	t_{KCY9}	4.5 V ≤ V_{DD} ≤ 6.0 V	800			ns
		2.7 V ≤ V_{DD} < 4.5 V	1600			ns
			3200			ns
ASCK high-/low-level width	t_{KH9}, t_{KL9}	4.5 V ≤ V_{DD} ≤ 6.0 V	400			ns
		2.7 V ≤ V_{DD} < 4.5 V	800			ns
			1600			ns
Transfer rate		4.5 V ≤ V_{DD} ≤ 6.0 V			39063	bps
		2.7 V ≤ V_{DD} < 4.5 V			19531	bps
					9766	bps
ASCK rise, fall time	t_{R9}, t_{F9}				1000	ns

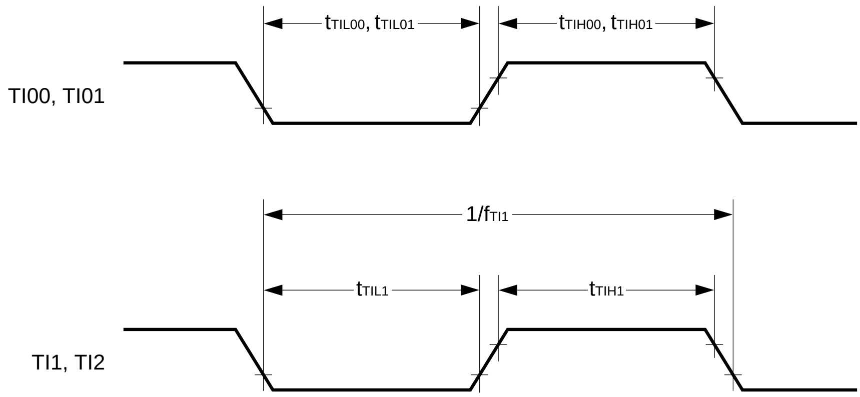
AC Timing Test Point (Excluding X1, XT1 Input)

Clock Timing



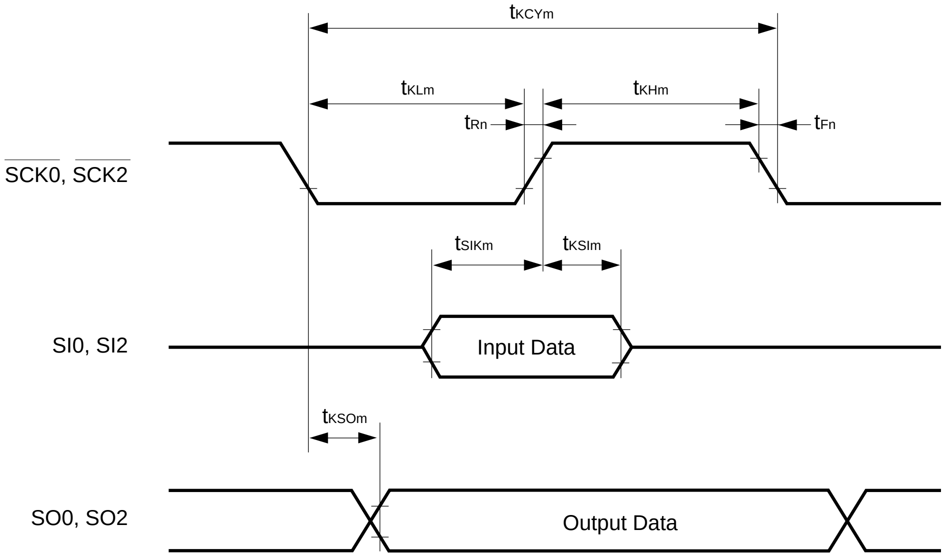
TI Timing

★



Serial Transfer Timing

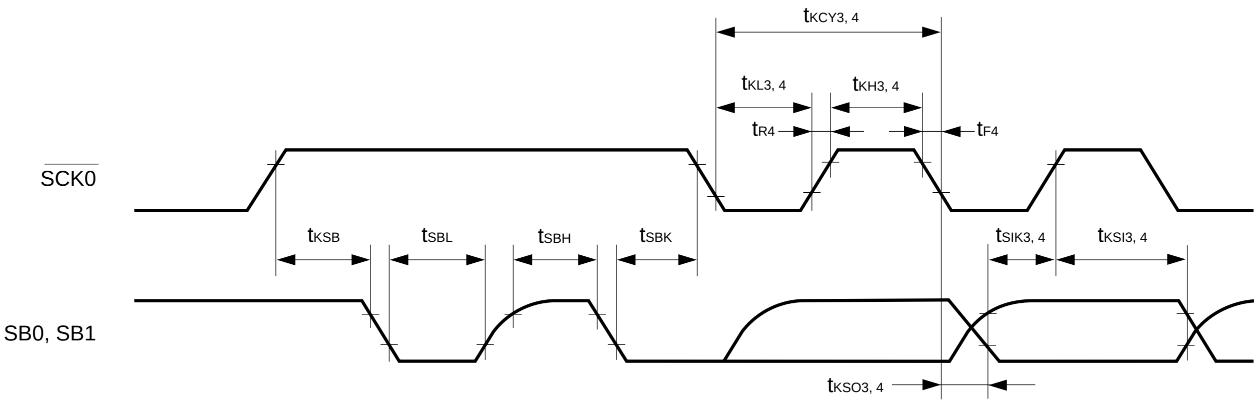
3-wire serial I/O mode:



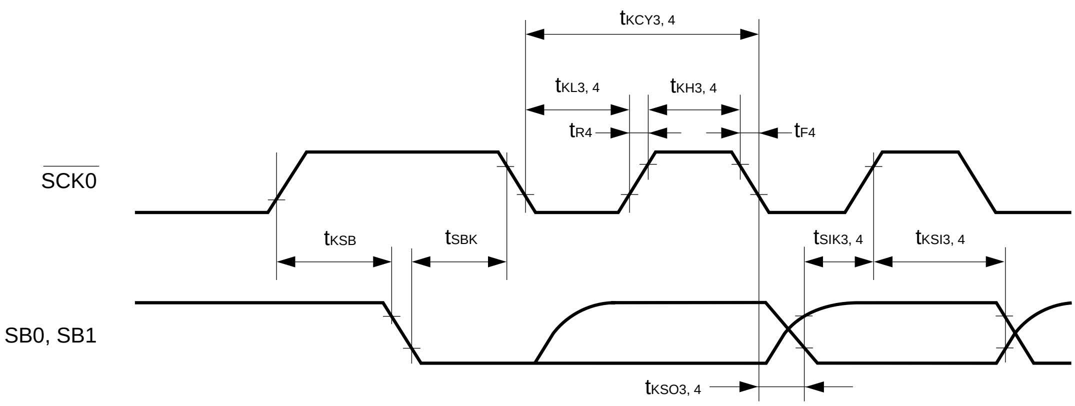
m = 1, 2, 7, 8

n = 2, 8

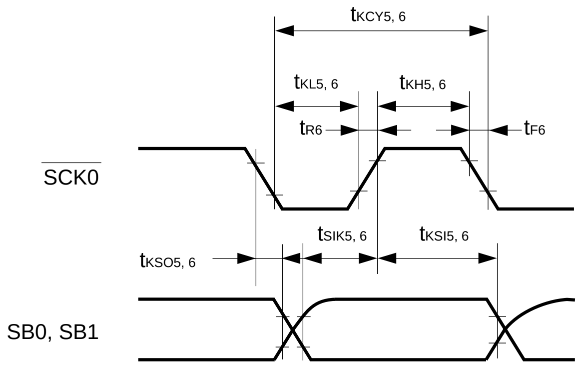
SBI mode (bus release signal transfer):



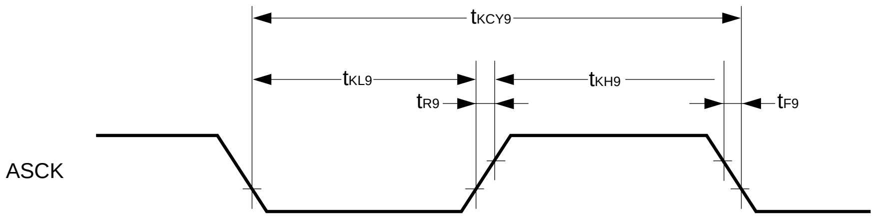
SBI mode (command signal transfer):



2-wire serial I/O mode:



UART mode:



A/D Converter Characteristics (T_A = –40 to +85°C, AV_{DD} = V_{DD} = 2.0 to 6.0 V, AV_{SS} = V_{SS} = 0 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Resolution			8	8	8	bit
Total error**Note**		2.7 V ≤ AV_{REF} ≤ 6.0 V			±0.6	%
					±1.4	%
Conversion time	t_{CONV}		19.1		200	μs
Sampling time	t_{SAMP}		12/f_{XX}			μs
Analog input voltage	V_{IAN}		AV_{SS}		AV_{REF}	V
Reference voltage	AV_{REF}		2.0		AV_{DD}	V
AV_{REF}-AV_{SS} resistance	R_{AIREF}		4	14		kΩ

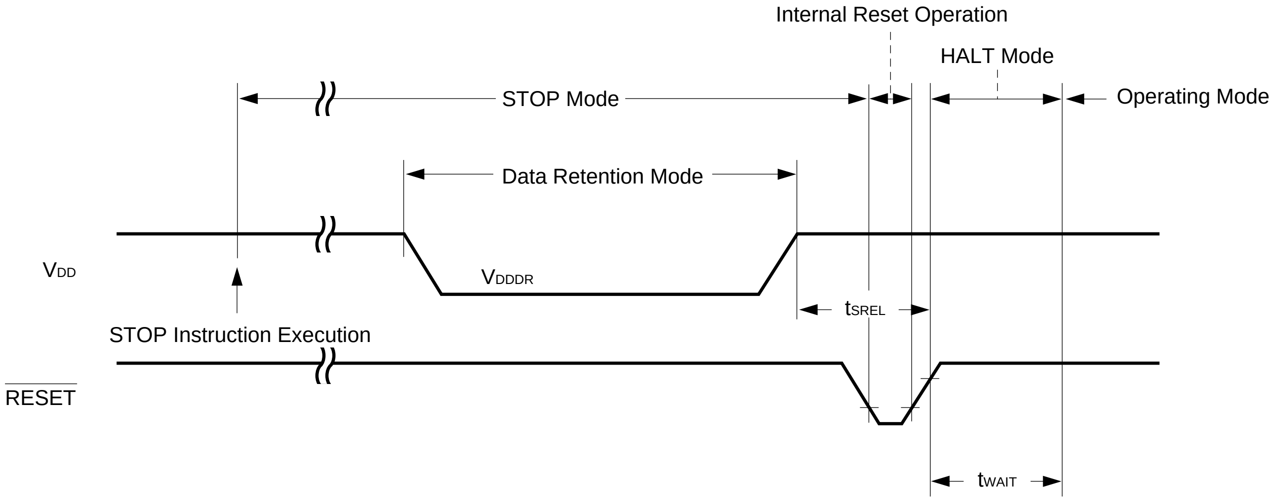
Note Quantization error (±1/2 LSB) is not included. This is expressed in proportion to the full-scale value.

DATA MEMORY STOP MODE LOW SUPPLY VOLTAGE DATA RETENTION CHARACTERISTICS (T_A = –40 to +85°C)

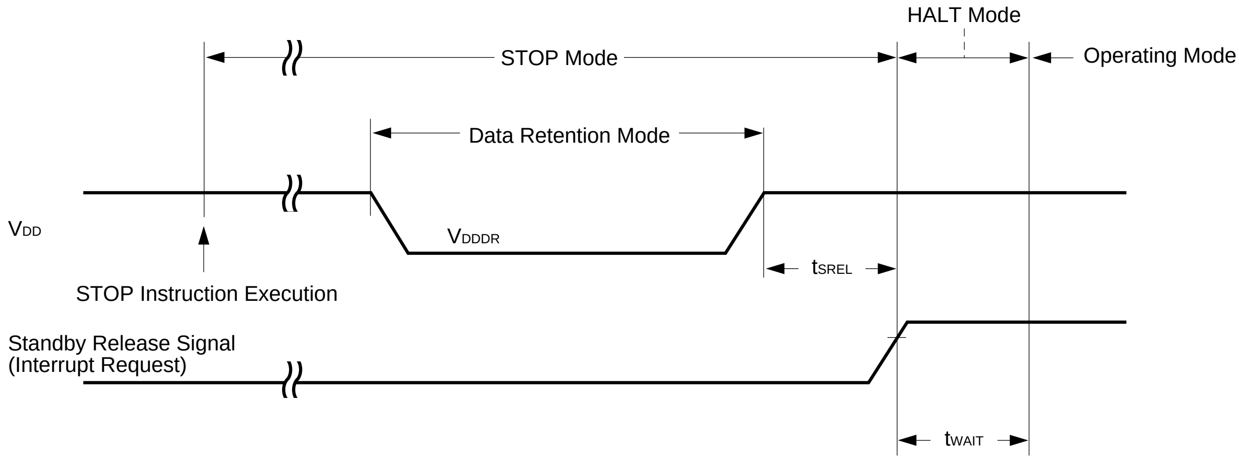
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Data retention supply voltage	V_{DDDR}		1.8		6.0	V
Data retention supply current	I_{DDDR}	V_{DDDR} = 1.8 V Subsystem clock stopped and feedback resistor disconnected		0.1	10	μA
Release signal set time	t_{SREL}		0			μs
Oscillation stabilization wait time	t_{WAIT}	Release by $\overline{RESET}$		$2^{17}/f_x$		ms
		Release by interrupt		**Note**		ms

Note In combination with bit 0 to bit 2 (OSTS0 to OSTS2) of oscillation stabilization time select register (OSTS), selection of $2^{12}/f_{XX}$ and $2^{14}/f_{XX}$ to $2^{17}/f_{XX}$ is possible.

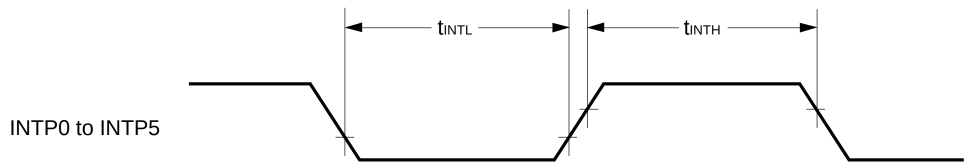
Data Retention Timing (STOP Mode Release by $\overline{RESET}$)



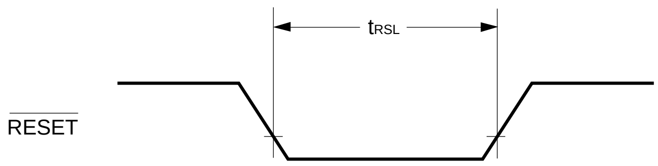
Data Retention Timing (Standby Release Signal: STOP Mode Release by Interrupt Signal)



Interrupt Input Timing

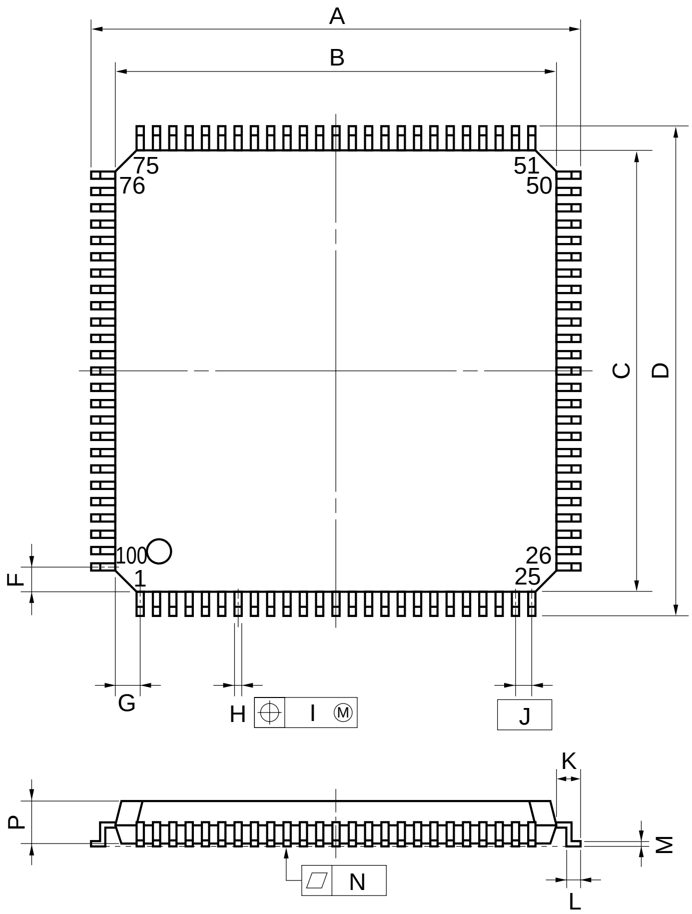


RESET Input Timing

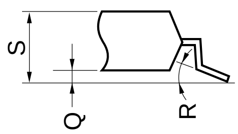


11. PACKAGE DRAWINGS

100-PIN PLASTIC QFP (FINE PITCH) (14 × 14 mm)



detail of lead end



NOTE

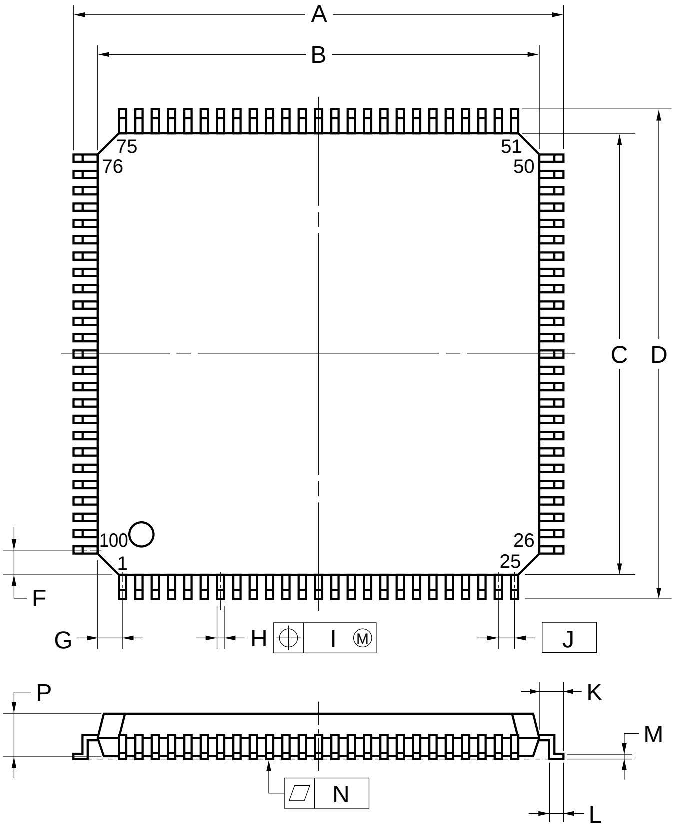
Each lead centerline is located within 0.10 mm (0.004 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	16.0±0.2	0.630±0.008
B	14.0±0.2	$0.551^{+0.009}_{-0.008}$
C	14.0±0.2	$0.551^{+0.009}_{-0.008}$
D	16.0±0.2	0.630±0.008
F	1.0	0.039
G	1.0	0.039
H	$0.22^{+0.05}_{-0.04}$	0.009±0.002
I	0.10	0.004
J	0.5 (T.P.)	0.020 (T.P.)
K	1.0±0.2	$0.039^{+0.009}_{-0.008}$
L	0.5±0.2	$0.020^{+0.008}_{-0.009}$
M	$0.17^{+0.03}_{-0.07}$	$0.007^{+0.001}_{-0.003}$
N	0.10	0.004
P	1.45	0.057
Q	0.125±0.075	0.005±0.003
R	5°±5°	5°±5°
S	1.7 MAX.	0.067 MAX.

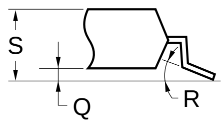
P100GC-50-7EA-2

Remark Dimensions and materials of ES products are the same as those of mass-produced products.

100-PIN PLASTIC LQFP (FINE PITCH) (14 × 14 mm)



detail of lead end



NOTE

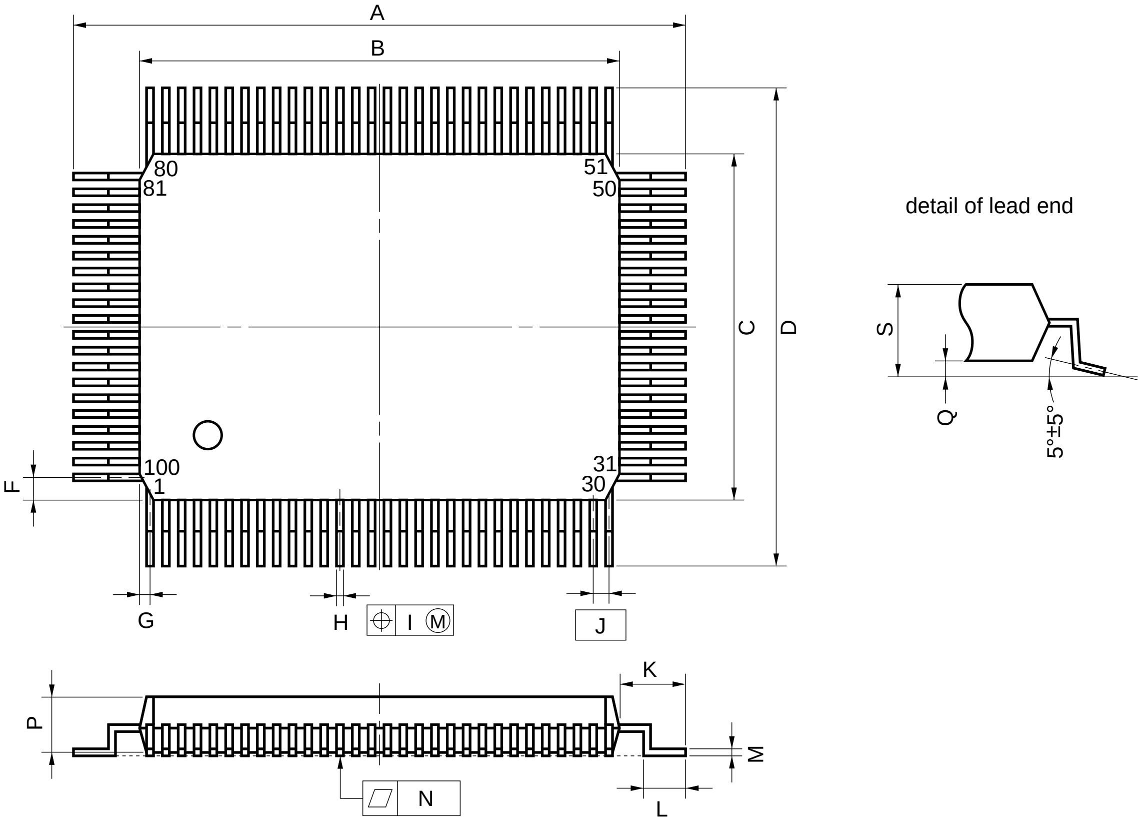
Each lead centerline is located within 0.08 mm (0.003 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	16.00±0.20	0.630±0.008
B	14.00±0.20	$0.551^{+0.009}_{-0.008}$
C	14.00±0.20	$0.551^{+0.009}_{-0.008}$
D	16.00±0.20	0.630±0.008
F	1.00	0.039
G	1.00	0.039
H	$0.22^{+0.05}_{-0.04}$	0.009±0.002
I	0.08	0.003
J	0.50 (T.P.)	0.020 (T.P.)
K	1.00±0.20	$0.039^{+0.009}_{-0.008}$
L	0.50±0.20	$0.020^{+0.008}_{-0.009}$
M	$0.17^{+0.03}_{-0.07}$	$0.007^{+0.001}_{-0.003}$
N	0.08	0.003
P	1.40±0.05	0.055±0.002
Q	0.10±0.05	0.004±0.002
R	$3°^{+7°}_{-3°}$	$3°^{+7°}_{-3°}$
S	1.60 MAX.	0.063 MAX.

S100GC-50-8EU

Remark Dimensions and materials of ES products are the same as those of mass-produced products.

100-PIN PLASTIC QFP (14 × 20 mm)



NOTE

Each lead centerline is located within 0.15 mm (0.006 inch) of its true position (T.P.) at maximum material condition.

P100GF-65-3BA1-2

ITEM	MILLIMETERS	INCHES
A	23.6±0.4	0.929±0.016
B	20.0±0.2	$0.795^{+0.009}_{-0.008}$
C	14.0±0.2	$0.551^{+0.009}_{-0.008}$
D	17.6±0.4	0.693±0.016
F	0.8	0.031
G	0.6	0.024
H	0.30±0.10	$0.012^{+0.004}_{-0.005}$
I	0.15	0.006
J	0.65 (T.P.)	0.026 (T.P.)
K	1.8±0.2	$0.071^{+0.008}_{-0.009}$
L	0.8±0.2	$0.031^{+0.009}_{-0.008}$
M	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.003}$
N	0.10	0.004
P	2.7	0.106
Q	0.1±0.1	0.004±0.004
S	3.0 MAX.	0.119 MAX.

Remark Dimensions and materials of ES products are the same as those of mass-produced products.

12. RECOMMENDED SOLDERING CONDITIONS

The μPD78064B should be soldered and mounted under the conditions recommended in the table below.

For details of recommended soldering conditions, refer to the information document **Semiconductor Device Mounting Technology Manual (C10535E)**.

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

Table 12-1. Surface Mounting Type Soldering Conditions

(1) μPD78064BGC-×××-7EA : 100-pin plastic QFP (fine pitch) (14 × 14 mm)

★ **μPD78064BGC-×××-8EU : 100-pin plastic LQFP (fine pitch) (14 × 14 mm)**

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 235°C, Duration: 30 sec. max. (at 210°C or above), Number of times: Twice max., Time limit: 7 days[Note] (thereafter 10 hours prebaking required at 125°C)	IR35-107-2
VPS	Package peak temperature: 215°C, Duration: 40 sec. (at 200°C or above), Number of times: Twice max., Time limit: 7 days[Note] (thereafter 10 hours prebaking required at 125°C)	VP15-107-2
Partial heating	Pin temperature: 300°C max. Duration: 3 sec. max. (per device side)	—

Note For the storage period after dry-pack decapsulation, storage conditions are max. 25°C, 65% RH.

(2) μPD78064BGF-×××-3BA: 100-pin plastic QFP (14 × 20 mm)

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 235 °C, Duration: 30 sec. max. (at 210 °C or above), Number of times: 3 times max.	IR35-00-3
VPS	Package peak temperature: 215 °C, Duration: 40 sec. max. (at 200 °C or above), Number of times: 3 times max.	VP15-00-3
Wave soldering	Solder bath temperature: 260 °C max., Duration: 10 sec. max., Number of times: Once, Preliminary heat temperature: 120 °C max. (Package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 300 °C max. Duration: 3 sec. max. (per device side)	—

Caution Use of more than one soldering method should be avoided (except in the case of partial heating).

APPENDIX A. DEVELOPMENT TOOLS

The following development tools are available for system development using the μPD78064B.

Language Processing Software

RA78K/0[Notes 1, 2, 3, 4]	78K/0 Series common assembler package
CC78K/0[Notes 1, 2, 3, 4]	78K/0 Series common C compiler package
DF78064[Notes 1, 2, 3, 4]	μPD78064 Subseries common device file
CC78K/0-L[Notes 1, 2, 3, 4]	78K/0 Series common C compiler library source file

PROM Writing Tools

PG-1500	PROM programmer
PA-78P0308GC, PA-78P064GC PA-78P0308GF, PA-78P064GF	Programmer adapters connected to PG-1500
PG-1500 controller[Notes 1, 2]	PG-1500 control program

Debugging Tools

IE-78000-R	78K/0 Series common in-circuit emulator
IE-78000-R-A	78K/0 Series common in-circuit emulator (for integrated debugger)
IE-78000-R-BK	78K/0 Series common break board
★ IE-780308-R-EM	μPD780308 Subseries common emulation board
EP-78064GC-R EP-78064GF-R	μPD78064 Subseries common emulation probes
★ TGC-100SDW	Adapter to be mounted on a target system board made for 100-pin plastic QFP (GC-7EA and GC-8EU types). This product is manufactured by TOKYO ELETECH Corporation. Consult your local NEC sales representative when purchasing it.
EV-9200GF-100	Socket to be mounted on a target system board made for 100-pin plastic QFP (GF-3BA type)
SM78K0[Notes 5, 6, 7]	78K/0 Series common system simulator
ID78K0[Notes 4, 5, 6, 7]	IE-78000-R-A integrated debugger
SD78K/0[Notes 1, 2]	IE-78000-R screen debugger
DF78064[Notes 1, 2, 4, 5, 6, 7]	μPD78064 Subseries common device file

Real-time OS

RX78K/0[Notes 1, 2, 3, 4]	78K/0 Series real-time OS
MX78K0[Notes 1, 2, 3, 4]	78K/0 Series OS

Fuzzy Inference Development Support System

FE9000Note 1, FE9200Note 6	Fuzzy knowledge data creation tool
FT9080Note 1, FT9085Note 2	Translator
FI78K0Notes 1, 2	Fuzzy inference module
FD78K0Notes 1, 2	Fuzzy inference debugger

Notes
1. PC-9800 Series (MS-DOS™) based
2. IBM PC/AT™ and compatibles (PC DOS™/IBM DOS™/MS-DOS) based
3. HP9000 Series 300™ (HP-UX™) based
4. HP9000 Series 700™ (HP-UX) based, SPARCstation™ (SunOS™) based, EWS-4800 Series (EWS-UX/V) based
5. PC-9800 Series (MS-DOS + Windows™) based
6. IBM PC/AT and compatibles (PC DOS/IBM DOS/MS-DOS + Windows) based
7. NEWS™ (NEWS-OS™) based

Remarks
1. For third party development tools, see the **78K/0 Series Selection Guide (IF-1185)**.
2. RA78K/0, CC78K/0, SM78K0, ID78K0, SD78K/0, and RX78K/0 are used in combination with DF78064.

★ APPENDIX B. RELATED DOCUMENTS

Device Related Documents

Document Name	Document No.	
	English	Japanese
μPD78064B Subseries User's Manual	U10785E	U10785J
μPD78064B Data Sheet	This manual	U11590J
μPD78064B(A) Data Sheet	U11597E	U11597J
78K/0 Series User's Manual Instructions	U12326E	U12326J
78K/0 Series Instruction Table	—	U10903J
78K/0 Series Instruction Set	—	U10904J
μPD78064B Subseries Special Function Register Table	—	To be prepared

Development Tool Related Documents (User's Manual)

Document Name		Document No.	
		English	Japanese
RA78K Series Assembler Package	Operation	EEU-1399	EEU-809
	Language	EEU-1404	EEU-815
RA78K Series Structured Assembler Preprocessor		EEU-1402	EEU-817
RA78K0 Assembler Package	Operation	U11802E	U11802J
	Assembly Language	U11801E	U11801J
	Structured Assembly Language	U11789E	U11789J
CC78K Series C Compiler	Operation	EEU-1280	EEU-656
	Language	EEU-1284	EEU-655
CC78K0 C Compiler	Operation	U11517E	U11517J
	Language	U11518E	U11518J
CC78K/0 C Compiler Application Note	Programming know-how	EEA-1208	EEA-618
CC78K Series Library Source File		—	U12322J
PG-1500 PROM Programmer		EEU-1335	U11940J
PG-1500 Controller PC-9800 Series (MS-DOS) based		EEU-1291	EEU-704
PG-1500 Controller IBM PC Series (PC DOS) based		U10540E	EEU-5008
IE-78000-R		U11376E	EEU-810
IE-78000-R-A		U10057E	U10057J
IE-78000-R-BK		EEU-1427	EEU-867
IE-780308-R-EM		U11362E	U11362J
EP-78064		EEU-1469	EEU-934
SM78K0 System Simulator Windows based	Reference	U10181E	EEU-5002
SM78K Series System Simulator	External Parts User Open Interface Specifications	U10092E	U10092J
ID78K0 Integrated Debugger EWS based	Reference	—	U11151J
ID78K0 Integrated Debugger PC based	Reference	U11539E	U11539J
ID78K0 Integrated Debugger Windows based	Guides	U11649E	U11649J
SD78K/0 Screen Debugger PC-9800 Series (MS-DOS) based	Introduction	U10539E	EEU-852
	Reference	—	U10952J
SD78K/0 Screen Debugger IBM PC/AT (PC DOS) based	Introduction	EEU-1414	EEU-5024
	Reference	U11279E	U11279J

Caution The above related documents are subject to change without prior notice. Be sure to use the latest version when starting design.

Embedded Software Related Documents (User's Manual)

Document Name		Document No. English	Document No. Japanese
78K/0 Series Real-time OS	Basics	—	EEU-912
	Installation	—	EEU-911
78K/0 Series OS MX78K0	Basics	—	U12257J
Fuzzy Knowledge Data Creation Tool		EEU-1438	EEU-829
78K/0, 78K/II, 87AD Series Fuzzy Inference Development Support System Translator		EEU-1444	EEU-862
78K/0 Series Fuzzy Inference Development Support System Fuzzy Inference Module		EEU-1441	EEU-858
78K/0 Series Fuzzy Inference Development Support System Fuzzy Inference Debugger		EEU-1458	EEU-921

Other Related Documents

Document Name	Document No. English	Document No. Japanese
IC Package Manual	C10943X	
Semiconductor Device Mounting Technology Manual	C10535E	C10535J
Quality Grades on NEC Semiconductor Devices	C11531E	C11531J
Reliable Quality Maintenance on NEC Semiconductor Devices	C10983E	C10983J
Electrostatic Discharge (ESD) Test	—	MEM-539
Semiconductor Devices Quality Guarantee Guide	MEI-1202	C11893J
Microcomputer Product Series Guide	—	U11416J

Caution The above related documents are subject to change without prior notice. Be sure to use the latest version when starting design.

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: 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 once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build 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 bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS device behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

Regional Information

Some information contained in this document may vary from country to country. Before using any NEC product in your application, please contact the NEC office in your country to obtain a list of authorized representatives and distributors. They will verify:

- Device availability
- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

In addition, trademarks, registered trademarks, export restrictions, and other legal issues may also vary from country to country.

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Milton Keynes, UK
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Fax: 02-528-4411

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Tel: 253-8311
Fax: 250-3583

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“Standard”, “Special”, and “Specific”. The Specific quality grade applies only to devices developed based on a customer designated “quality assurance program” for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is “Standard” unless otherwise specified in NEC’s Data Sheets or Data Books.
If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.
Anti-radioactive design is not implemented in this product.

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