DATA SHEET

NEC

MOS INTEGRATED CIRCUIT

μPD753036

4-BIT SINGLE-CHIP MICROCONTROLLER

DESCRIPTION

The μPD753036 is one of the 75XL series 4-bit single-chip microcontroller chips and has a data processing capability comparable to that of an 8-bit microcontroller.

It has an on-chip LCD controller/driver with a larger ROM capacity and extended CPU functions compared with the conventional μPD75336, and can provide high-speed operation at a low supply voltage of 1.8 V. It can be supplied in a small plastic TQFP package (12 × 12 mm) and is suitable for small sets using LCD panels.

For details of functions refer to the following User's Manual.
μPD753036 User's Manual: U10201E

FEATURES

- Low voltage operation V_{DD} = 1.8 to 5.5 V
  - Can be driven by two 1.5 V batteries
- On-chip memory
  - Program memory (ROM): 16384 × 8 bits
  - Data memory (RAM): 768 × 4 bits
- Capable of high-speed operation and variable instruction execution time for power saving
  - 0.95, 1.91, 3.81, 15.3 μs (@ 4.19 MHz)
  - 0.67, 1.33, 2.67, 10.7 μs (@ 6.0 MHz)
  - 122 μs (@ 32.768 kHz)
- Internal programmable LCD controller/driver
- Internal A/D converter which can be operated at a low voltage
  - 8-bit resolution × 8 channels (successive approximation type)
- Small plastic TQFP (12 × 12 mm)
  - Suitable for small sets such as cameras
- One-time PROM: μPD75P3036

APPLICATION

Radio transmitter/receiver, compact disc player, rice cooker, home bakery, etc.

ORDERING INFORMATION

Part number	Package
μPD753036GC-×××-3B9	80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)
μPD753036GK-×××-BE9	80-pin plastic TQFP (fine pitch) (12 × 12 mm, 0.5-mm pitch)

Remark ××× indicates ROM code suffix.

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The mark ★ shows major revised points.

Functional Outline

Parameter		Function	
Minimum instruction execution time		• 0.95, 1.91, 3.81, 15.3 μs (main system clock: during 4.19 MHz operation) • 0.67, 1.33, 2.67, 10.7 μs (main system clock: during 6.0 MHz operation) • 122 μs (subsystem clock: during 32.768 kHz operation)	
On-chip memory	ROM	16384 × 8 bits	
	RAM	768 × 4 bits	
General purpose register		• 4-bit operation: 8 × 4 banks • 8-bit operation: 4 × 4 banks	
Input/output port	CMOS input	8	On-chip pull-up resistors can be specified by using software: 27
	CMOS input/output	20	
	Bit port output	8	Also used for segment pins
	N-ch open-drain input/output pins	8	On-chip pull-up resistors can be specified by using mask option 13 V withstand voltage
	Total	44	
LCD controller/driver		• Segment selection: 12/16/20 segments (can be changed to bit port output in unit of 4; 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 drive can be specified by using mask option	
Timer		5 channels • 8-bit timer/event counter: 3 channels (16-bit timer/event counter, career generator, timer with gate) • Basic interval/watchdog timer: 1 channel • Watch timer: 1 channel	
Serial interface		• 3-wire serial I/O mode ... MSB or LSB can be selected for transferring first bit • 2-wire serial I/O mode • SBI mode	
A/D converter		8-bit resolution × 8 channels (1.8 V ≤ AV_{REF} ≤ V_{DD})	
Bit sequential buffer (BSB)		16 bits	
Clock output (PCL)		• 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)	
Buzzer output (BUZ)		• 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)	
Vectored interrupts		External: 3, Internal: 5	
Test input		External: 1, Internal: 1	
System clock oscillator		• Ceramic or crystal oscillator for main system clock oscillation • Crystal oscillator for subsystem clock oscillation	
Standby function		STOP/HALT mode	
Power supply voltage		V_{DD} = 1.8 to 5.5 V	
Package		• 80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch) • 80-pin plastic TQFP (fine pitch) (12 × 12 mm, 0.5-mm pitch)	

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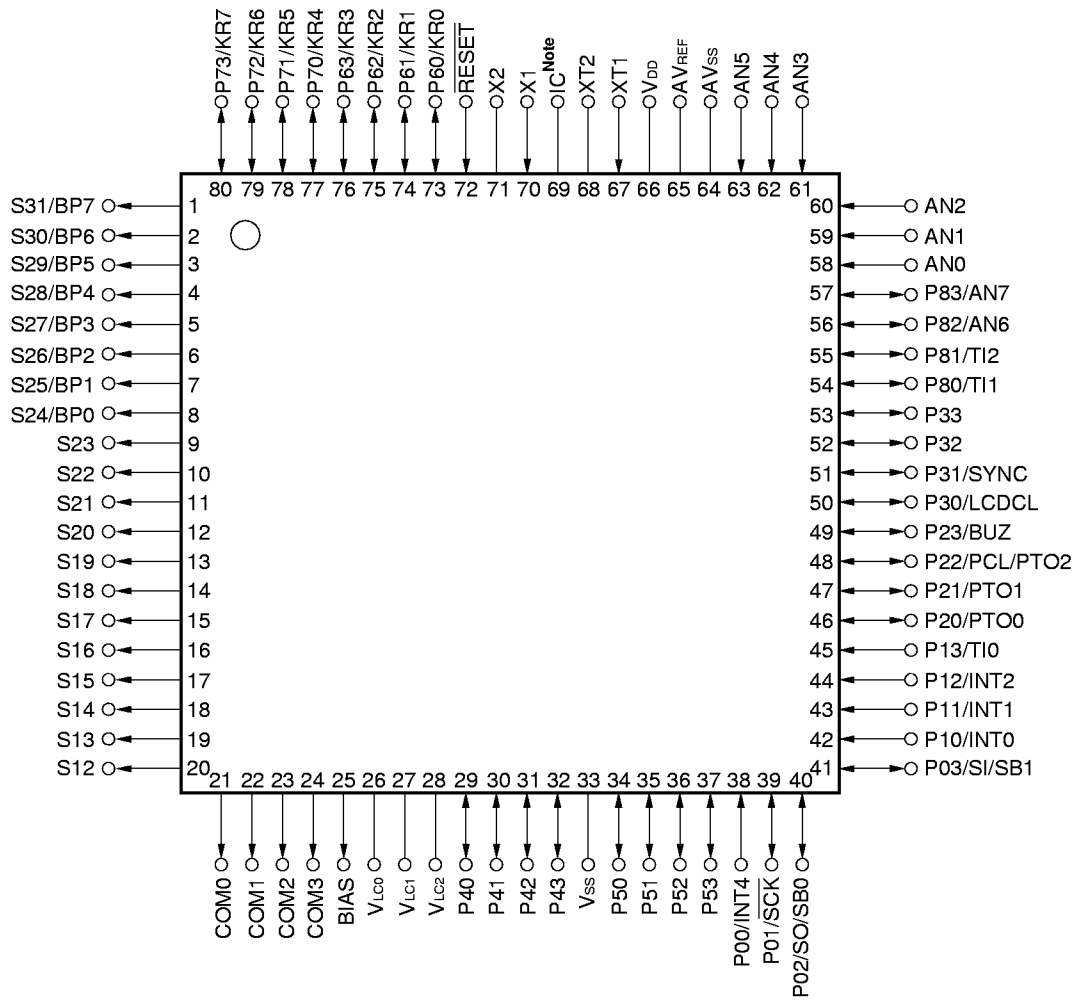
1. PIN CONFIGURATION (TOP VIEW)

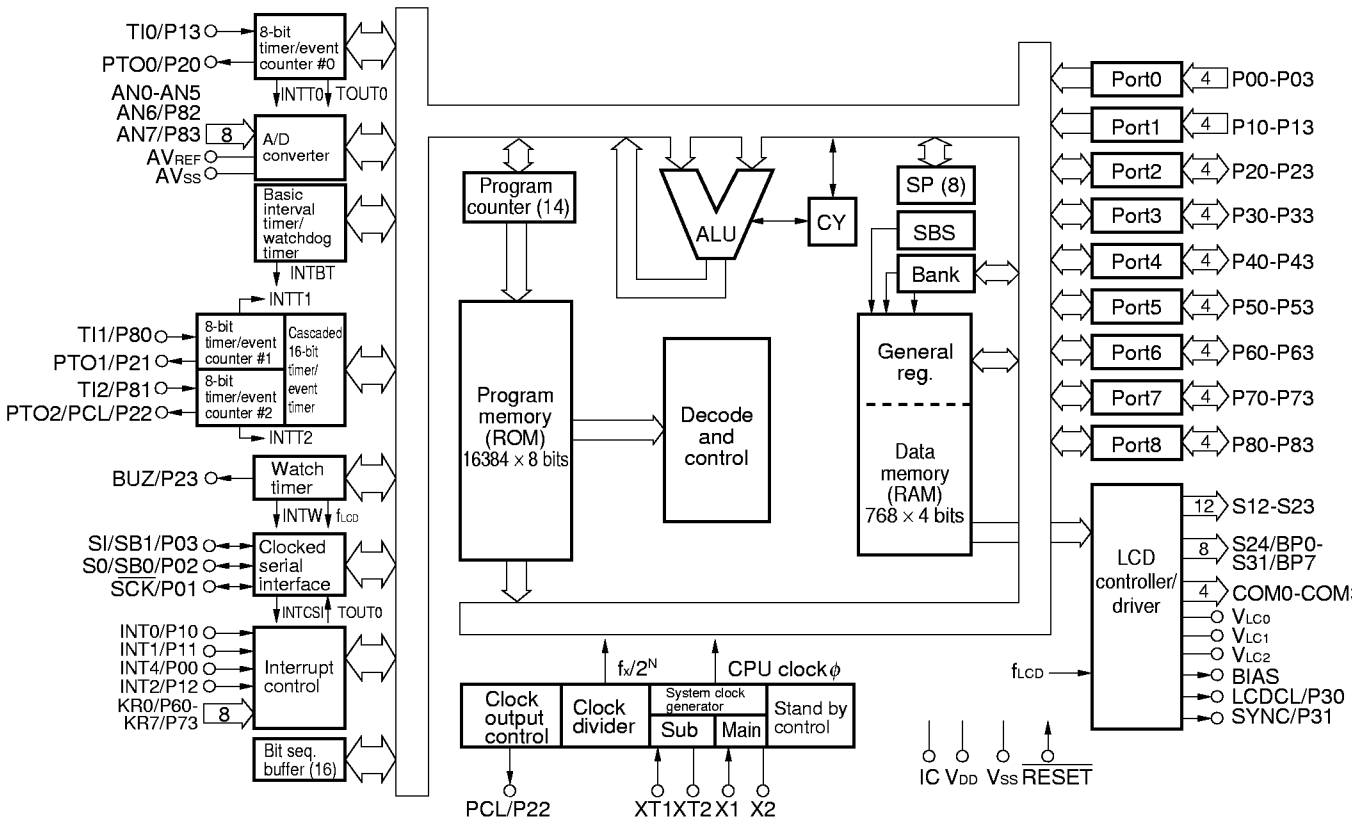
- 80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)
  μPD753036GC-×××-3B9
- 80-pin plastic TQFP (fine pitch) (12 × 12 mm, 0.5-mm pitch)
  μPD753036GK-×××-BE9



Note Connect the IC (Internally Connected) pin directly to V_{DD}.

P00-P03	: Port 0	V_{LC0}-V_{LC2}	: LCD Power Supply 0-2
P10-P13	: Port 1	BIAS	: LCD Power Supply Bias Control
P20-P23	: Port 2	LCDCL	: LCD Clock
P30-P33	: Port 3	SYNC	: LCD Synchronization
P40-P43	: Port 4	TI0-TI2	: Timer Input 0-2
P50-P53	: Port 5	PTO0-PTO2	: Programmable Timer Output 0-2
P60-P63	: Port 6	BUZ	: Buzzer Clock
P70-P73	: Port 7	PCL	: Programmable Clock
P80-P83	: Port 8	AV_{REF}	: Analog Reference
BP0-BP7	: Bit Port 0-7	AV_{SS}	: Analog Ground
KR0-KR7	: Key Return 0-7	AN0-AN7	: Analog Input 0-7
$\overline{SCK}$	: Serial Clock	INT0, INT1, INT4	: External Vectored Interrupt 0, 1, 4
SI	: Serial Input	INT2	: External Test Input 2
SO	: Serial Output	X1, X2	: Main System Clock Oscillation 1, 2
SB0, SB1	: Serial Data Bus 0, 1	XT1, XT2	: Subsystem Clock Oscillation 1, 2
$\overline{RESET}$	: Reset	V_{DD}	: Positive Power Supply
S12-S31	: Segment Output 12-31	V_{SS}	: Ground
COM0-COM3	: Common Output 0-3	IC	: Internally Connected

2. BLOCK DIAGRAM



3. PIN FUNCTION

3.1 Port Pins (1/2)

Pin Name	Input/Output	Alternate Function	Function	8-bit Access	State after Reset	I/O Circuit Type Note 1
P00	Input	INT4	4-bit input port (PORT0). For P01 to P03, connections of on-chip pull-up resistors can be specified by software in 3-bit units.	No	Input	Ⓑ
P01	Input/Output	$\overline{SCK}$				Ⓕ-A
P02	Input/Output	SO/SB0				Ⓕ-B
P03	Input/Output	SI/SB1				Ⓜ-C
P10	Input	INT0	4-bit input port (PORT1) Connections of on-chip pull-up resistors can be specified by software in 4-bit units. P10/INT0 can select noise eliminating circuit.	No	Input	Ⓑ-C
P11		INT1				
P12		INT2				
P13		TI0				
P20	Input/Output	PTO0	4-bit input/output port (PORT2) Connections of on-chip pull-up resistors can be specified by software in 4-bit units.	No	Input	E-B
P21		PTO1				
P22		PCL/PTO2				
P23		BUZ				
P30	Input/Output	LCDCL	Programmable 4-bit input/output port (PORT3). This port can be specified input/output in bit units. Connections of on-chip pull-up resistor can be specified by software in 4-bit units.	No	Input	E-B
P31		SYNC				
P32		–				
P33		–				
P40-P43 Note 2	Input/Output	–	N-ch open-drain 4-bit input/output port (PORT4). A pull-up resistor can be contained bit-wise (mask option). In the open-drain mode, withstands up to 13 V.	Yes	High level (when pull-up resistors are contained) or high impedance	M-D
P50-P53 Note 2	Input/Output	–	N-ch open-drain 4-bit input/output port (PORT5). A pull-up resistor can be contained bit-wise (mask option). In the open-drain mode, withstands up to 13 V.		High level (when pull-up resistors are provided) or high impedance	M-D

Notes 1. Circled characters indicate the Schmitt-trigger input.

2. If on-chip pull-up resistors are not specified by mask option (when used as N-ch open-drain input port), low level input leakage current increases when input or bit manipulation instruction is executed.

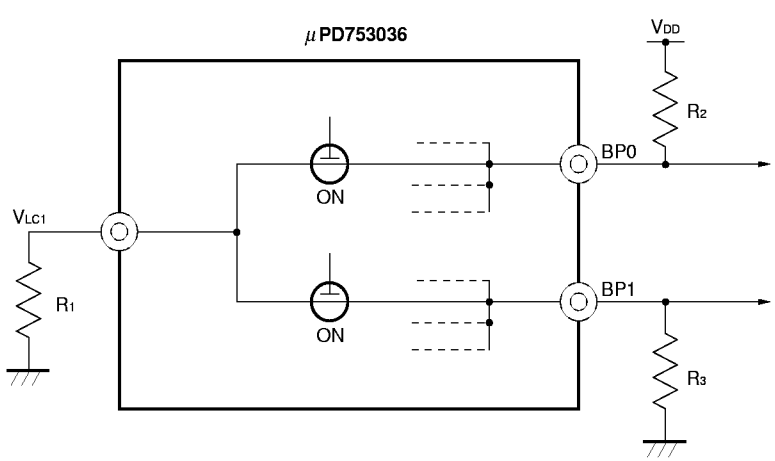
3.1 Port Pins (2/2)

Pin Name	Input/Output	Alternate Function	Function	8-bit Access	State after Reset	I/O Circuit Type Note 1
P60	Input/Output	KR0	Programmable 4-bit input/output port (PORT6). This port can be specified for input/output bit-wise. Connections of on-chip pull-up resistors can be specified by software in 4-bit units.	Yes	Input	Ⓕ-A
P61		KR1				
P62		KR2				
P63		KR3				
P70	Input/Output	KR4	4-bit input/output port (PORT7). Connections of on-chip pull-up resistors can be specified by software in 4-bit units.		Input	Ⓕ-A
P71		KR5				
P72		KR6				
P73		KR7				
P80	Input/Output	TI1	4-bit input/output port (PORT8). Connections of on-chip pull-up resistors can be specified by software in 4-bit units.	No	Input	Ⓔ-E
P81		TI2				
P82		AN6				Y-B
P83		AN7				
BP0	Output	S24	1-bit output port (BIT PORT) Also used for segment output pins.	No	**Note 2**	H-A
BP1		S25				
BP2		S26				
BP3		S27				
BP4	Output	S28				
BP5		S29				
BP6		S30				
BP7		S31				

Notes 1. Circled characters indicate the Schmitt-trigger input.

2. BP0 through BP7 select V_{LC1} as an input source.
However, the output levels change depending on the external circuit of BP0 through BP7 and V_{LC1}.

Example Because BP0 through BP7 are mutually connected inside the μPD753036, the output levels of BP0 through BP7 are determined by R_1, R_2, and R_3.



3.2 Non-Port Pins (1/2)

Pin Name	Input/Output	Alternate Function	Function		State after Reset	I/O Circuit Type Note 1
TI0	Input	P13	Inputs external event pulses to the timer/event counter.		Input	Ⓑ-C
TI1		P80				Ⓔ-E
TI2		P81				
PTO0	Output	P20	Timer/event counter output		Input	E-B
PTO1		P21				
PTO2		P22				
PCL			Clock output			
BUZ		P23	Optional frequency output (for buzzer output or system clock trimming)			
$\overline{SCK}$	Input/Output	P01	Serial clock input/output		Input	Ⓕ-A
SO/SB0		P02	Serial data output Serial data bus input/output			Ⓕ-B
SI/SB1		P03	Serial data input Serial data bus input/output			Ⓜ-C
INT4	Input	P00	Edge detection vectored interrupt input (both rising edge and falling edge detection)		Input	Ⓑ
INT0	Input	P10	Edge detection vectored interrupt input (detection edge can be selected) INT0/P10 can select noise eliminator.	Noise eliminator/ asynch selectable	Input	Ⓑ-C
INT1		P11		Asynchronous		
INT2	Input	P12	Edge-detection-testable input	Asynchronous	Input	Ⓑ-C
AN0-AN5	Input	–	Analog signal input for A/D converter		Input	Y
AN6		P82				Y-B
AN7		P83				
AV_{REF}	–	–	A/D converter reference voltage input		–	Z-N
AV_{SS}	–	–	A/D converter reference GND		–	Z-N
KR0-KR3	Input	P60-P63	Falling edge detection testable input		Input	Ⓕ-A
KR4-KR7	Input	P70-P73	Falling edge detection testable input		Input	Ⓕ-A
S12-S23	Output	–	Segment signal output		**Note 2**	G-A
S24-S31	Output	BP0-BP7	Segment signal output		**Note 2**	H-A
COM0-COM3	Output	–	Common signal output		**Note 2**	G-B
V_{LC0}-V_{LC2}	–	–	LCD drive power On-chip split resistor is enable (mask option).		–	–
BIAS	Output	–	Output for external split resistor disconnect		**Note 3**	–

Notes 1. Circled characters indicate the Schmitt trigger input.

2. Each display output selects the following V_{LCX} as input source.
S12-S31: V_{LC1}, COM0-COM2: V_{LC2}, COM3: V_{LC0}.

3. When a split resistor is contained ..... Low level
When no split resistor is contained .....High-impedance

3.2 Non-Port Pins (2/2)

Pin Name	Input/Output	Alternate Function	Function	State after Reset	I/O Circuit Type Note 1
LCDCL Note 2	Output	P30	Clock output for externally expanded driver	Input	E-B
SYNC Note 2	Output	P31	Clock output for externally expanded driver sync	Input	E-B
X1	Input	–	Crystal/ceramic connection pin for the main system clock oscillator. When inputting the external clock, input the external clock to pin X1, and the reverse phase of the external clock to pin X2.	–	–
X2	–				
XT1	Input	–	Crystal connection pin for the subsystem clock oscillator. When the external clock is used, input the external clock to pin XT1 and the reverse phase of the external clock to pin XT2. Pin XT1 can be used as a 1-bit input (test) pin.	–	–
XT2	–				
$\overline{\text{RESET}}$	Input	–	System reset input (low level active)	–	Ⓑ
IC	–	–	Internally connected. Connect directly to V_{DD}.	–	–
V_{DD}	–	–	Positive power supply	–	–
V_{SS}	–	–	GND	–	–

Notes 1. Circled characters indicate the Schmitt-trigger input.

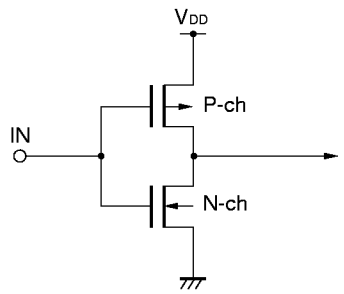
2. These pins are provided for future system expansion.
At present, these pins are used only as pins P30 and P31.

3.3 Pin Input/Output Circuits

The μPD753036 pin input/output circuits are shown schematically.

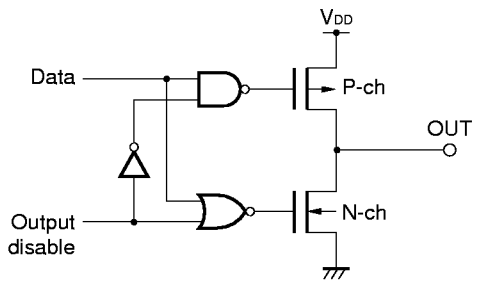
(1/3)

TYPE A



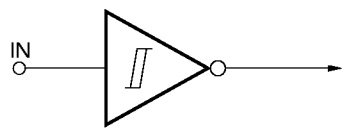
CMOS specification input buffer.

TYPE D



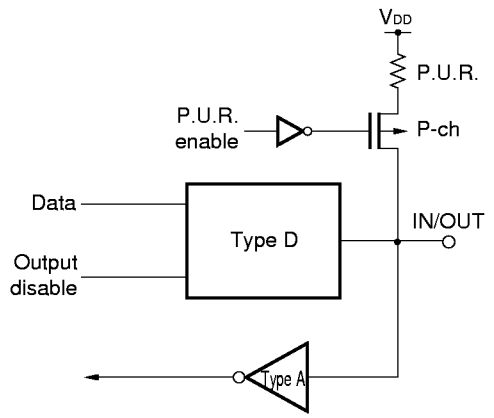
Push-pull output that can be placed in output high impedance (both P-ch, N-ch off).

TYPE B



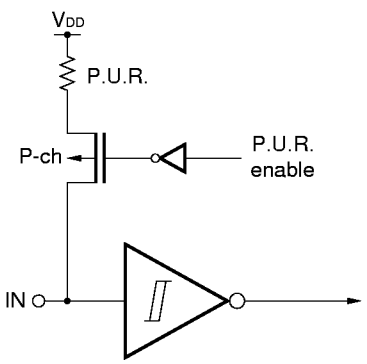
Schmitt trigger input having hysteresis characteristic.

TYPE E-B



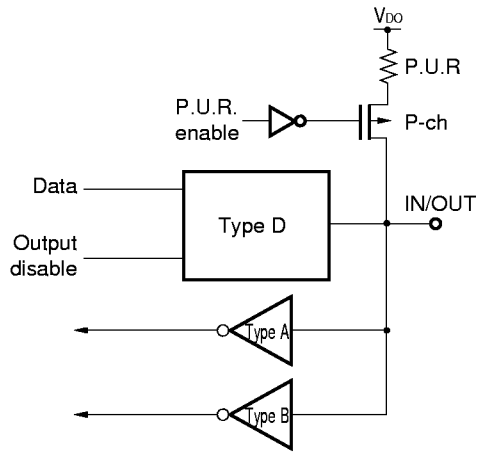
P.U.R. : Pull-Up Resistor

TYPE B-C



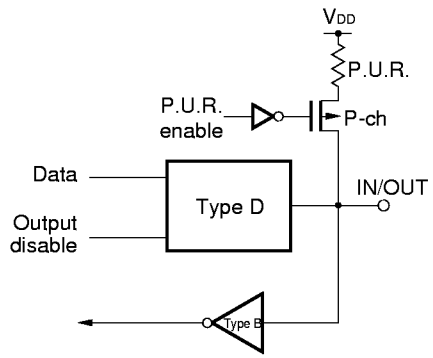
P.U.R. : Pull-Up Resistor

TYPE E-E



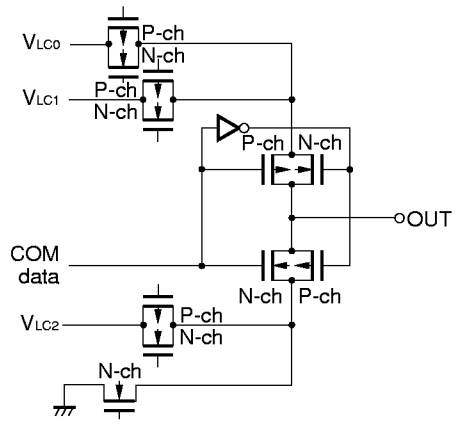
(2/3)

TYPE F-A

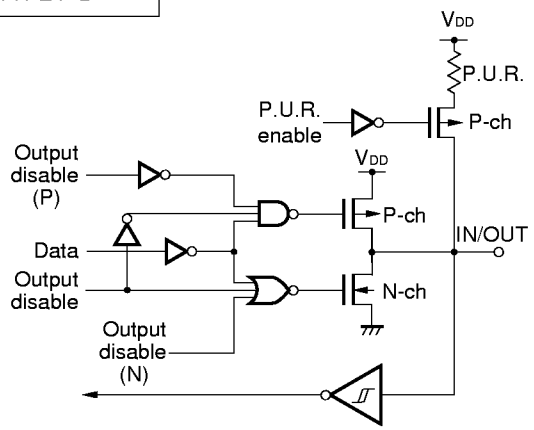


P.U.R. : Pull-Up Resistor

TYPE G-B

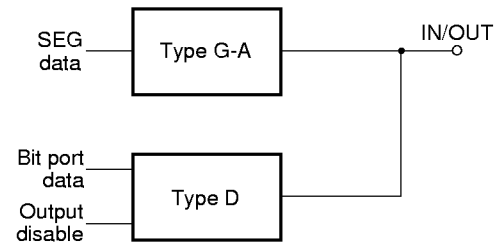


TYPE F-B

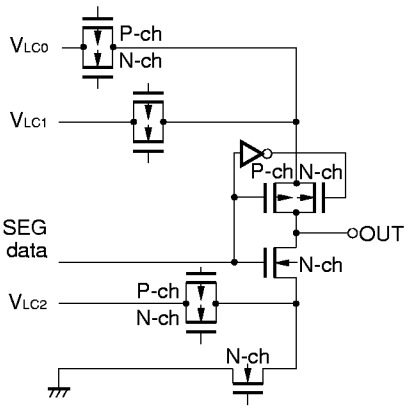


P.U.R. : Pull-Up Resistor

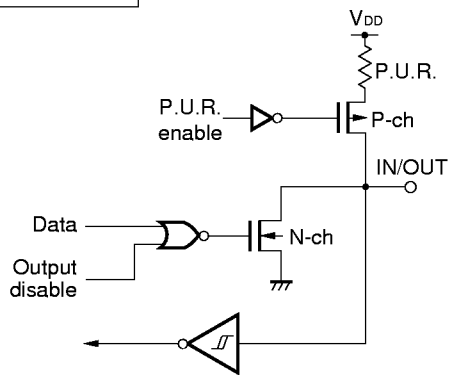
★TYPE H-A



TYPE G-A



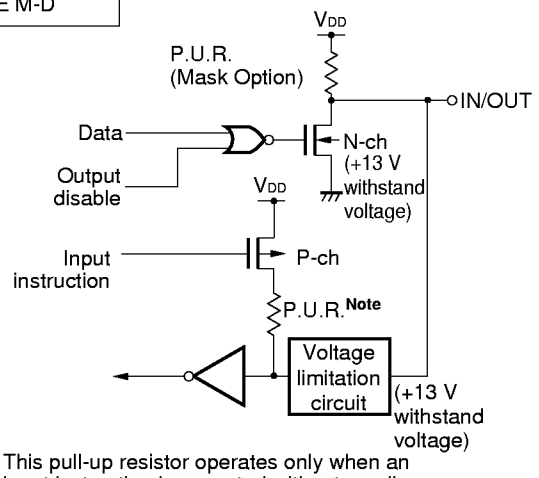
TYPE M-C



P.U.R. : Pull-Up Resistor

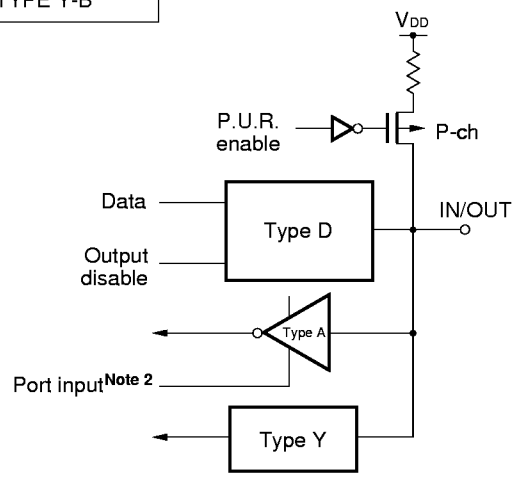
(3/3)

TYPE M-D



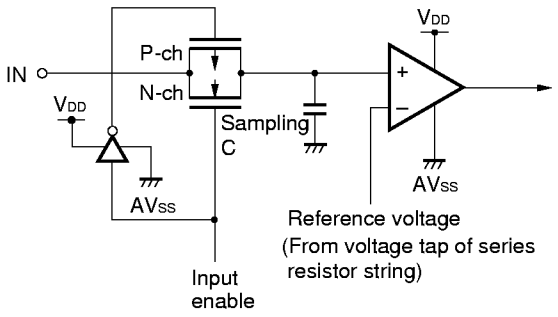
Note This pull-up resistor operates only when an input instruction is executed without a pull-up resistor connected using the mask option (current flows from V_{DD} to the pin when the pin is low).

TYPE Y-B

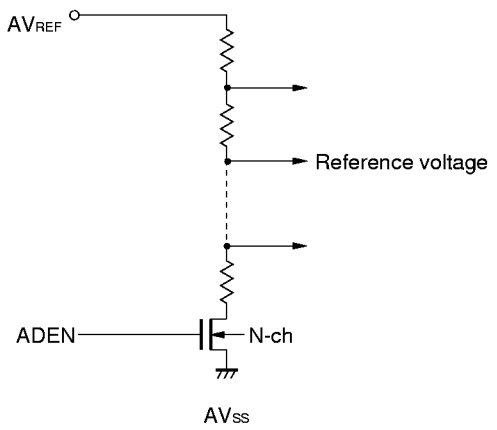


P.U.R. : Pull-Up Resistor

TYPE Y



TYPE Z-N



3.4 Recommended Connections for Unused Pins

Table 3-1. List of Recommended Connections for Unused Pins

Pin	Recommended Connection
P00/INT4	Connect to V_{SS} or V_{DD}
P01/$\overline{SCK}$	Connect to V_{SS} or V_{DD} individually via resistor
P02/SO/SB0	
P03/SI/SB1	Connect to V_{SS}
P10/INT0-P12/INT2	Connect to V_{SS} or V_{DD}
P13/TI0	
P20/PTO0	Input state: Individually connect to V_{SS} or V_{DD} via resistor
P21/PTO1	Output state: Leave unconnected
P22/PCL/PTO2	
P23/BUZ	
P30/LCDCL	
P31/SYNC	
P32	
P33	
P40-P43	Input state: Connect to V_{SS}.
P50-P53	Output state: Connect to V_{SS}. (Do not connect a pull-up resistor using the mask option.)
P60/KR0-P63/KR3	Input state: Individually connect to V_{SS} or V_{DD} via resistor
P70/KR4-P73/KR7	Output state: Leave unconnected
P80/TI1, P81/TI2	
P82/AN6, P83/AN7	
S12-S23	Leave unconnected
S24/BP0-S31/BP7	
COM0-COM3	
V_{LC0}-V_{LC2}	Connect to V_{SS}
BIAS	Only if all of V_{LC0}-V_{LC2} are unused, connect to V_{SS}. In other cases, no connection required.
★ XT1[Note]	Connect to V_{SS}
XT2[Note]	Leave unconnected
AN0-AN5	Connect to V_{SS} or V_{DD}
★ AV_{REF}	Connect to V_{SS}
★ AV_{SS}	
IC	Connect to V_{DD} directly

Note When the subsystem clock is not used, set SOS. 0 to 1 (so as not to use the internal feedback resistor).

4. SWITCHING FUNCTION BETWEEN MK I MODE AND MK II MODE

4.1 Difference between Mk I and Mk II

The CPU of μPD753036 has the following two modes: Mk I and Mk II, either of which can be selected. The mode can be switched by the bit 3 of the Stack Bank Select register (SBS).

- Mk I mode: Upward compatible with μPD75336.
  Can be used in the 75XL CPU with a ROM capacity of up to 16K bytes.
- Mk II mode: Incompatible with μPD75336.
  Can be used in all the 75XL CPU's including those products whose ROM capacity is more than 16 Kbytes.

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

	Mk I Mode	Mk II Mode
Program memory (bytes)	16384	
Number of stack bytes for subroutine instructions	2 bytes	3 bytes
BRA !addr1 instruction CALLA !addr1 instruction	Not available	Available
CALL !addr instruction	3-machine cycles	4-machine cycles
CALLF !faddr instruction	2-machine cycles	3-machine cycles

Caution Mk II supports a program area exceeding 16K bytes in the 75X and 75XL series. Therefore, this mode is useful for enhancing software compatibility with products exceeding 16K bytes.
When Mk II mode is selected, the number of stack bytes used can be increased by 1 byte per stack compared with Mk I mode. When the CALL !addr instruction and CALLF !faddr instruction are used, the number of machine cycles becomes greater by 1. Therefore, use Mk I mode if the RAM efficiency and processing capability is more important than software compatibility.

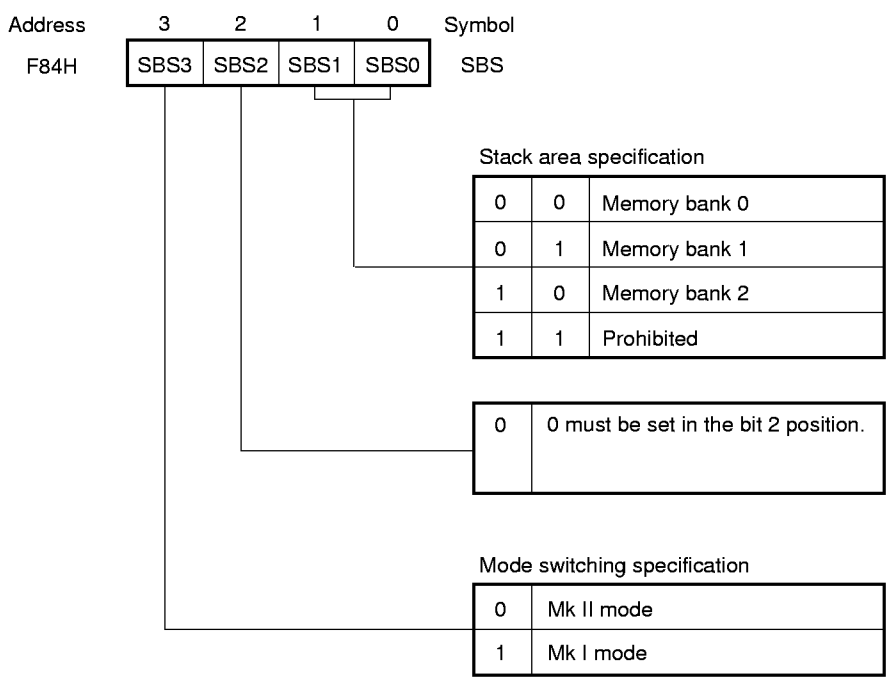
4.2 Setting Method of Stack Bank Select Register (SBS)

Switching between the Mk I mode and Mk II mode can be done by the SBS. Figure 4-1 shows the format. The SBS is set by a 4-bit memory manipulation instruction.

When using the Mk I mode, the SBS must be initialized to 10××B [Note] at the beginning of a program. When using the Mk II mode, it must be initialized to 00××B [Note].

Note The desired numbers must be set in the ×× positions.

Figure 4-1. Stack Bank Select Register Format



Caution Since SBS. 3 is set to "1" after a $\overline{\text{RESET}}$ signal is generated, the CPU operates in the Mk I mode. When executing an instruction in the Mk II mode, set SBS. 3 to "0" to select the Mk II mode.

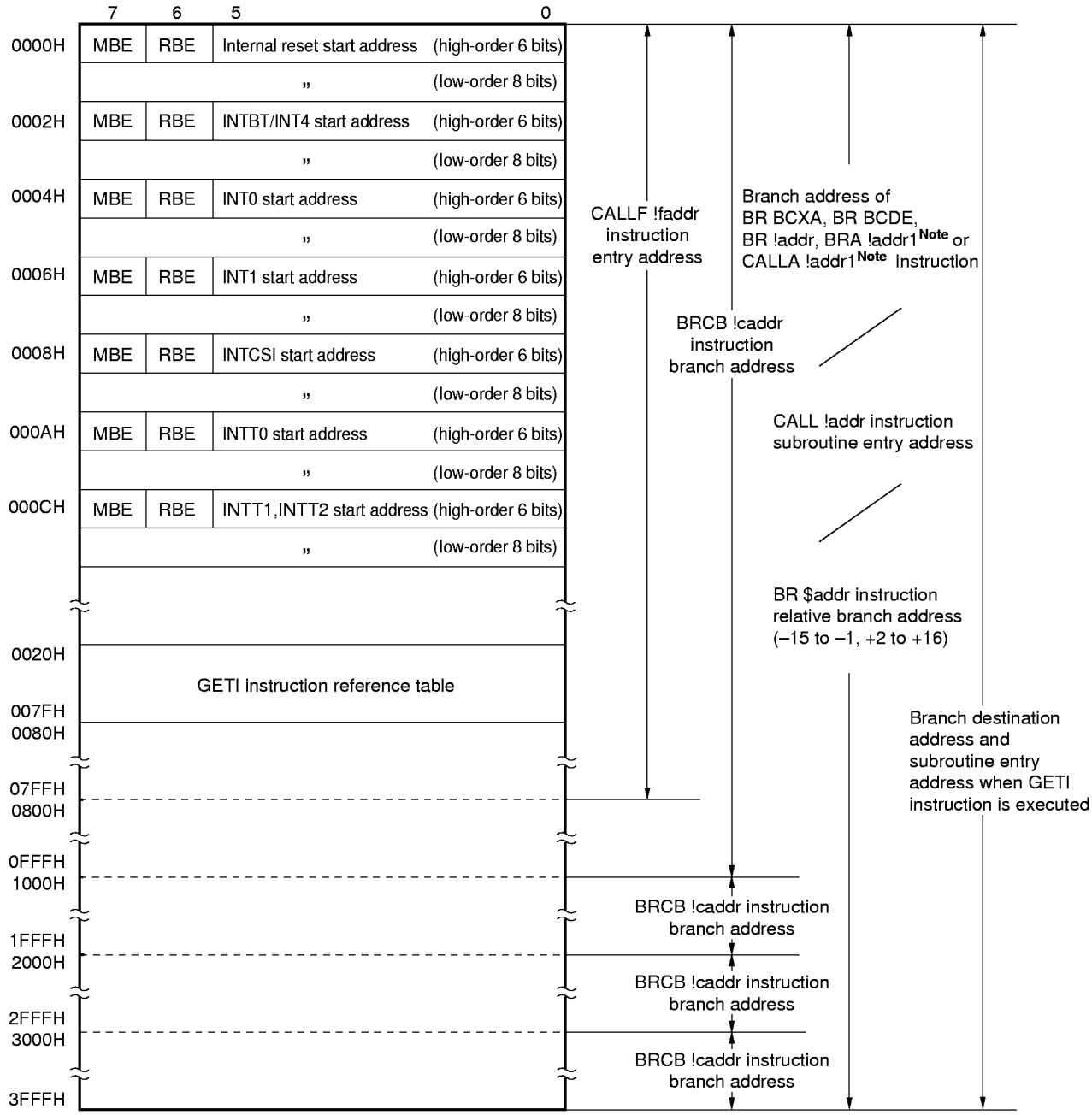
5. MEMORY CONFIGURATION

- Program memory (ROM) ····· 16384 × 8 bits
  - Addresses 0000H and 0001H
    Vector table wherein the program start address and the values set for the RBE and MBE at the time a $\overline{\text{RESET}}$ signal is generated are written. Reset and start are possible at an arbitrary address.
  - Addresses 0002H-000DH
    Vector table wherein the program start address and values set for the RBE and MBE by the vectored interrupts are written. Interrupt execution can start at an arbitrary address.
  - Addresses 0020H-007FH
    Table area referenced by the GETI instruction [Note].

  Note The GETI instruction realizes a 1-byte instruction on behalf of an arbitrary 2-byte instruction, 3-byte instruction, or two 1-byte instructions. It is used to decrease the program steps.

- Data memory (RAM)
  - Data area ··· 768 words × 4 bits (000H-2FFH)
  - Peripheral hardware area ··· 128 words × 4 bits (F80H-FFFH)

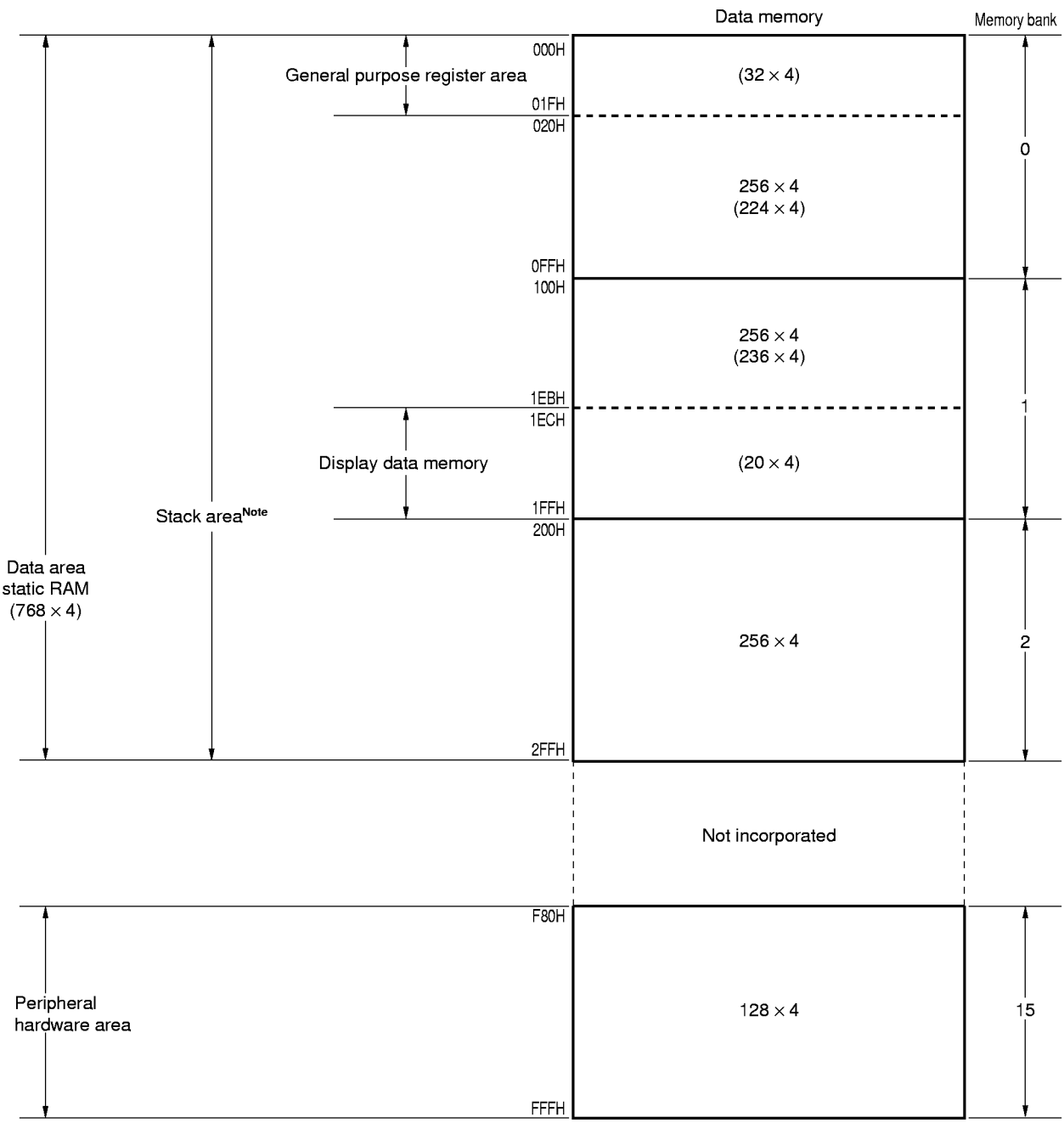
Figure 5-1. Program Memory Map



Note Can be performed only in the Mk II mode.

Remark In addition to the above, a branch can be taken to the address indicated by changing only the low-order 8 bits of PC by executing the BR PCDE, BR PCXA instruction.

Figure 5-2. Data Memory Map



Note For stack area, one memory bank can be selected among memory bank 0-2.

6. PERIPHERAL HARDWARE FUNCTIONS

6.1 Digital I/O Port

The following four types of I/O ports are available:

- CMOS input (PORT0 and 1) : 8 pins
- CMOS I/O (PORT2, 3, 6, 7, and 8) : 20 pins
- N-ch open-drain I/O (PORT4 and 5) : 8 pins
- Bit port output (BP0 through BP7) : 8 pins

Total : 44 pins

Table 6-1. Types and Features of Digital Ports

Port Name	Function	Operation & Features		Remarks
PORT0	4-bit input	When using serial interface function, the dual function pin can function as the output port depending on the operation mode.		Also used as the INT4, $\overline{SCK}$, SO/SB0, SI/SB1 pins.
PORT1		4-bit input port		Also used as the INT0-INT2 and TI0 pins.
PORT2	4-bit I/O	Can be set to input mode or output mode in 4-bit units.		Also used as the PTO0-PTO2, PCL, BUZ pins.
PORT3		Can be set to input mode or output mode in 1-bit units.		Also used as the LCDCL, SYNC pins.
PORT4	4-bit I/O (N-channel open-drain, 13 V with-stand voltage)	Can be set to input mode or output mode in 4-bit units.	Ports 4 and 5 are paired and data can be input/output in 8-bit units.	On-chip pull-up resistor can be specified bit-wise by mask option.
PORT5				
PORT6	4-bit I/O	Can be set to input mode or output mode in 1-bit units.	Ports 6 and 7 are paired and data can be input/output in 8-bit units.	Also used as the KR0-KR3 pins.
PORT7		Can be set to input mode or output mode in 4-bit units.		Also used as the KR4-KR7 pins.
PORT8		Can be set to input mode or output mode in 4-bit units		Also used as the TI1, TI2, AN6, AN7 pins.
★ BP0-BP7	1-bit output	Outputs data bit-wise. Can be switched to LCD drive segment output S24-S31 by software.		—

6.2 Clock Generator

The clock generator provides the clock signals to the CPU and peripheral hardware and its configuration is shown in Figure 6-1.

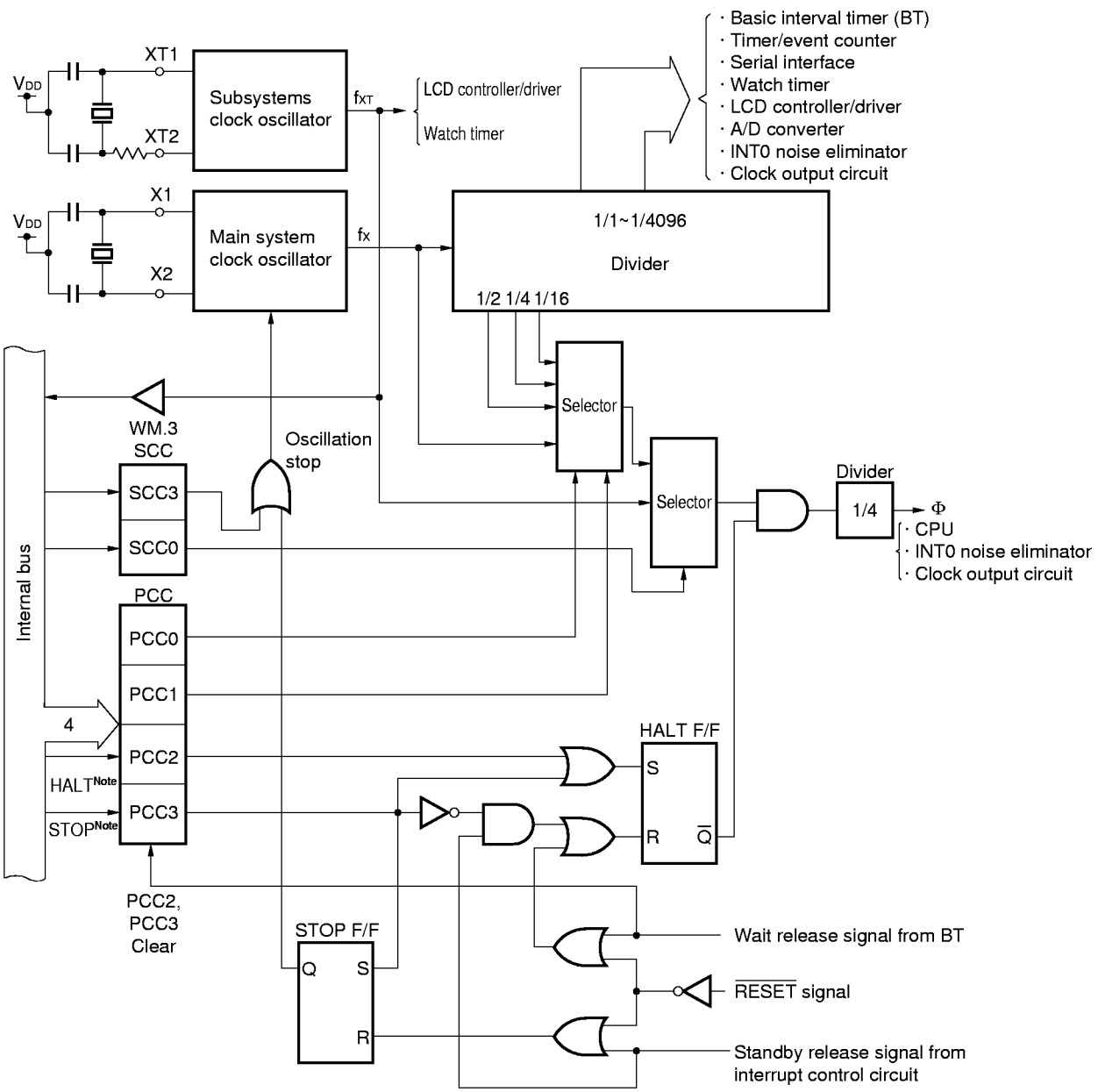
The operation of the clock generation circuit is determined by the processor clock control register (PCC) and system clock control register (SCC).

Two types of system clocks are available: main system clock and subsystem clock.

Furthermore, the instruction execution time can be changed.

- 0.95, 1.91, 3.81, 15.3 μs (main system clock: 4.19 MHz)
- 0.67, 1.33, 2.67, 10.7 μs (main system clock: 6.0 MHz)
- 122 μs (subsystem clock: 32.768 kHz)

Figure 6-1. Clock Generator Block Diagram



Note Instruction execution

Remarks 1. f_X = Main system clock frequency

2. f_{XT} = Subsystem clock frequency

3. Φ = CPU clock

4. PCC: Processor Clock Control Register

5. SCC: System Clock Control Register

6. One Clock cycle (t_{CY}) of the CPU clock equal to one machine cycle of the instruction.

6.3 Subsystem Clock Oscillator Control Functions

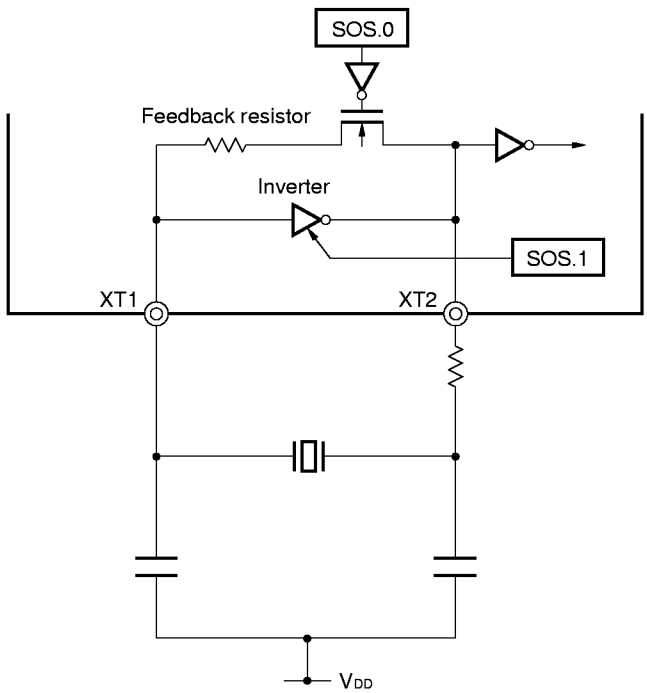
The μPD753036 subsystem clock oscillator has the following two control functions.

- Selects by software whether an on-chip feedback resistor is to be used or not[Note].
- Reduces current consumption by decreasing the drive current of the on-chip inverter when the supply voltage is high ($V_{DD} \geq 2.7$ V).

★ **Note** When the subsystem clock is not used, set SOS.0 to 1 (so as not to use the internal feedback resistor), connect the XT1 pin to V_{SS}, and open the XT2 pin to lower the supply current that is consumed in the subsystem clock oscillator.

The above functions can be used by switching the bits 0 and 1 of the sub-oscillator control register (SOS). (Refer to **Figure 6-2**.)

Figure 6-2. Subsystem Clock Oscillator

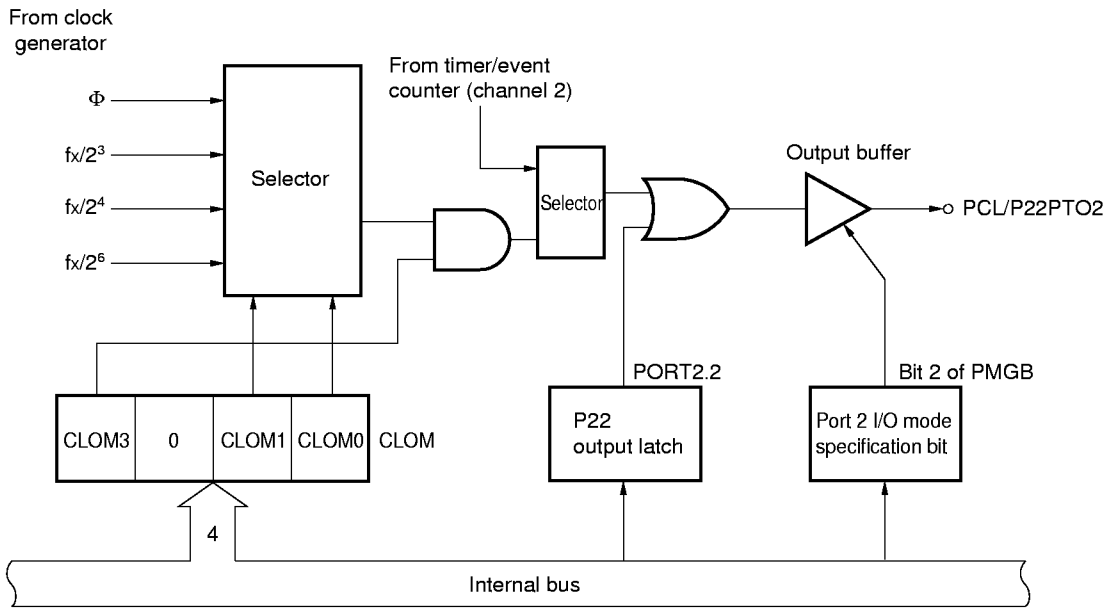


6.4 Clock Output Circuit

The clock output circuit is provided to output the clock pulses from the P22/PCL/PTO2 pin, and used to apply to the remote control waveform outputs and to supply clock pulses to the peripheral LSIs.

- Clock output (PCL): Φ, 524, 262, 65.5 kHz (main system clock: 4.19 MHz operation)
  Φ, 750, 375, 93.8 kHz (main system clock: 6.0 MHz operation)

Figure 6-3. Clock Output Circuit Block Diagram



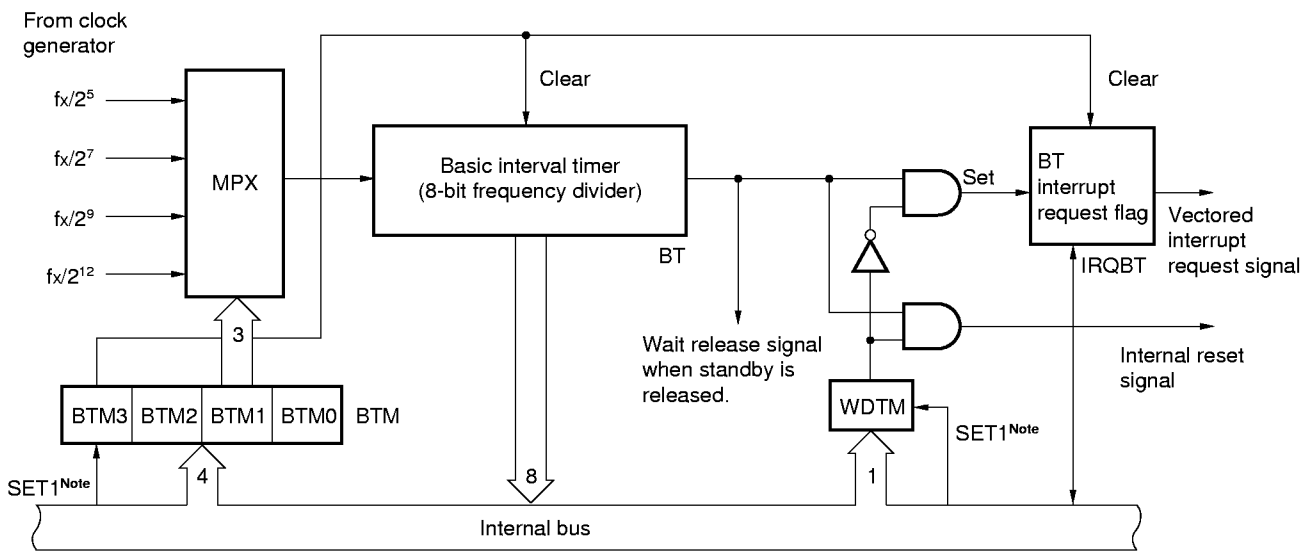
Remark Special care has been taken in designing the chip so that small-width pulses may not be output when switching clock output enable/disable.

6.5 Basic Interval Timer/Watchdog Timer

The basic interval timer/watchdog timer has the following functions.

- Interval timer operation to generate a reference time interrupt
- Watchdog timer operation to detect a runaway of program and reset the CPU
- Selects and counts the wait time when the standby mode is released
- Reads the contents of counting

Figure 6-4 Basic Interval Timer/Watchdog Timer Block Diagram



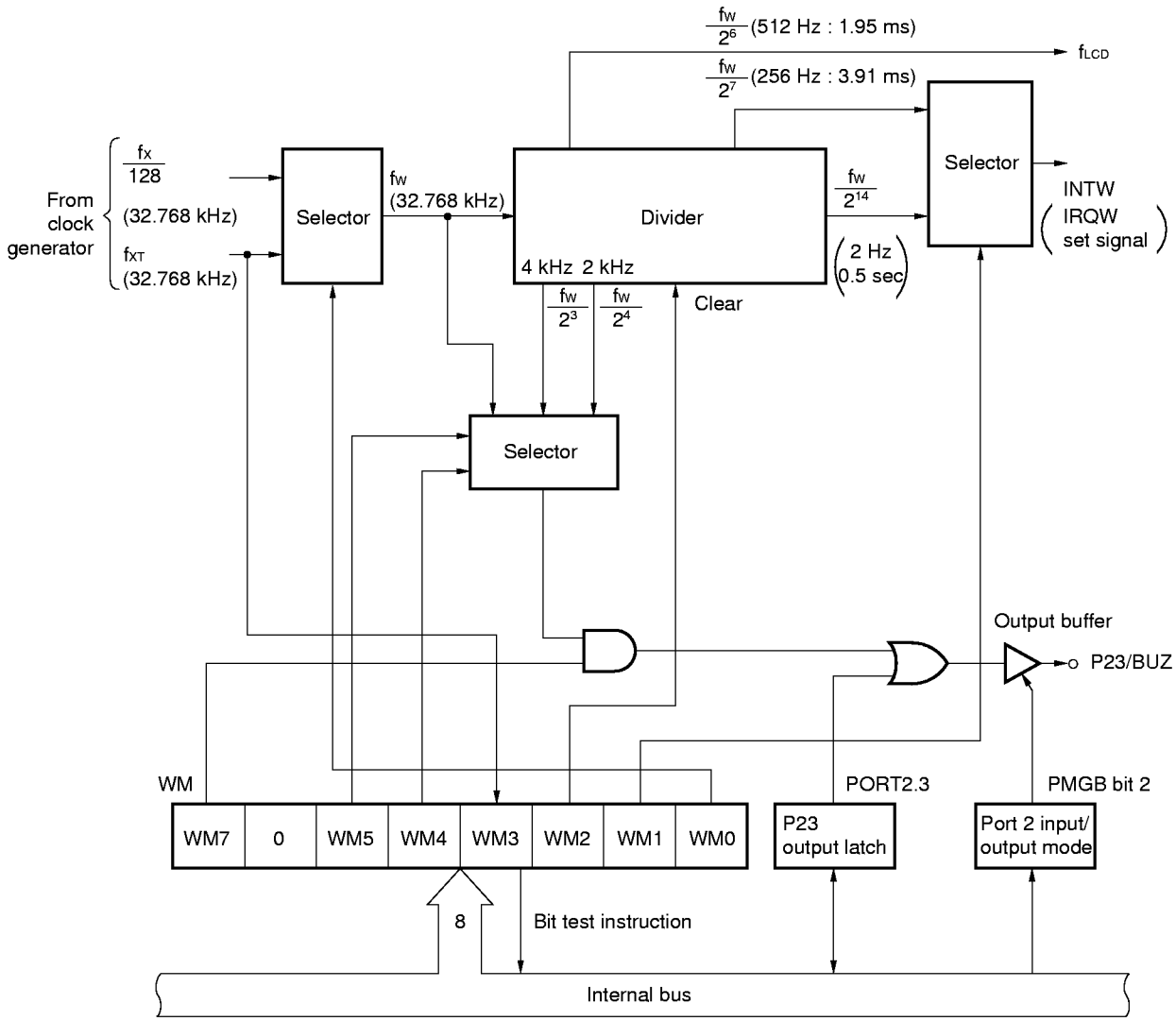
Note Instruction execution

6.6 Watch Timer

The μPD753036 has one channel of watch timer. The functions of the watch timer are as follows:

- Sets the test flag (IRQM) with 0.5 sec interval. The standby mode can be released by the IRQM.
- 0.5 sec interval can be created by both the main system clock (4.194304 MHz) and subsystem clock (32.768 kHz).
- Convenient for program debugging and checking as interval becomes 128 times shorter (3.91 ms) with the fast feed mode.
- Outputs the frequencies (2.048, 4.096, 32.768 kHz) to the BUZ pin (P23), usable for buzzer and trimming of system clock frequencies.
- Clears the frequency divider to make the clock start with zero seconds.

Figure 6-5. Watch Timer Block Diagram



The values enclosed in parentheses are applied when f_X = 4.194304 MHz and f_{XT} = 32.768 kHz.

6.7 Timer/Event Counter

The μPD753036 has three channels of timer/event counters. The configuration is shown in Figures 6-6 through 6-8. The functions of the timer/event counter are as follows:

- Programmable interval timer operation
- Square wave output of any frequency to the PTOn pin. (n = 0-2)
- Event counter operation
- Divides the frequency of signal input via the TIn pin to 1-Nth of the original signal and outputs the divided frequency to the PTOn pin (frequency division operation).
- Supplies the serial shift clock to the serial interface circuit.
- Reads the counting value.

The timer/event counter operates in the following four modes as set by the mode register.

Table 6-2. Operation Modes of Timer/Event Counter

Mode \ Channel		Channel 0	Channel 1	Channel 2
8-bit timer/event counter mode		Yes	Yes	Yes
	Gate control function	No[Note]	No	Yes
PWM pulse generator mode		No	No	Yes
16-bit timer/event counter mode		No	Yes	
	Gate control function	No[Note]	Yes	
Carrier generator mode		No	Yes	

Note Used for gate control signal generation

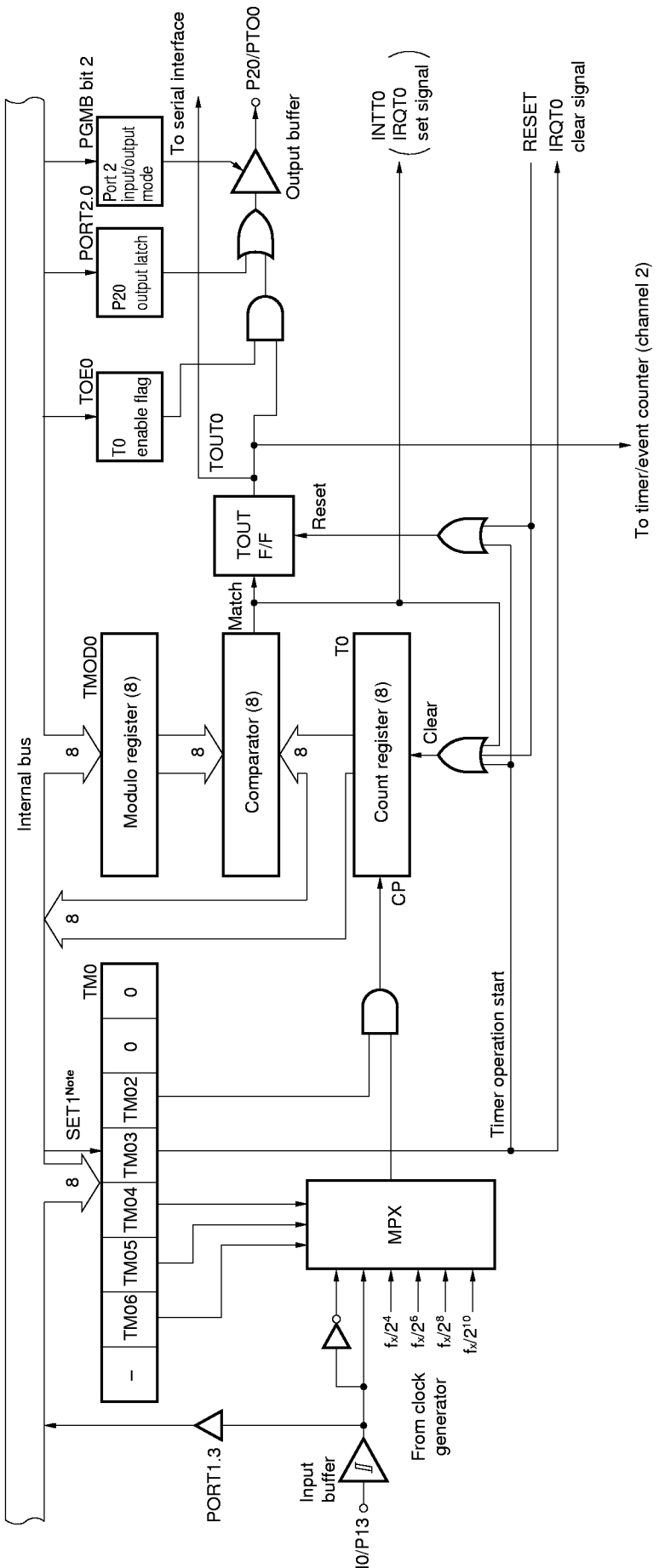
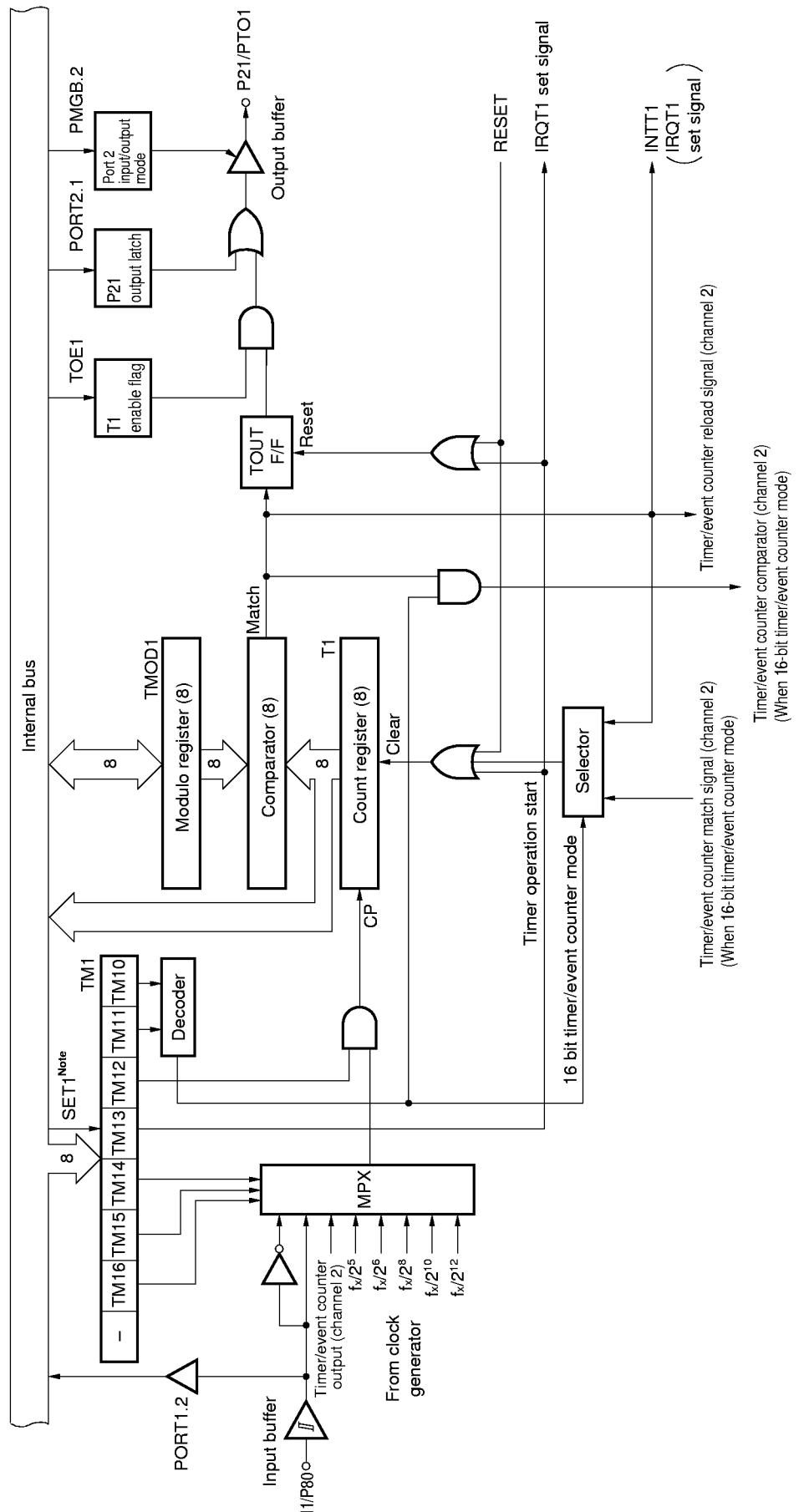


Figure 6-6. Timer/Event Counter Block Diagram (channel 0)

Note Instruction execution

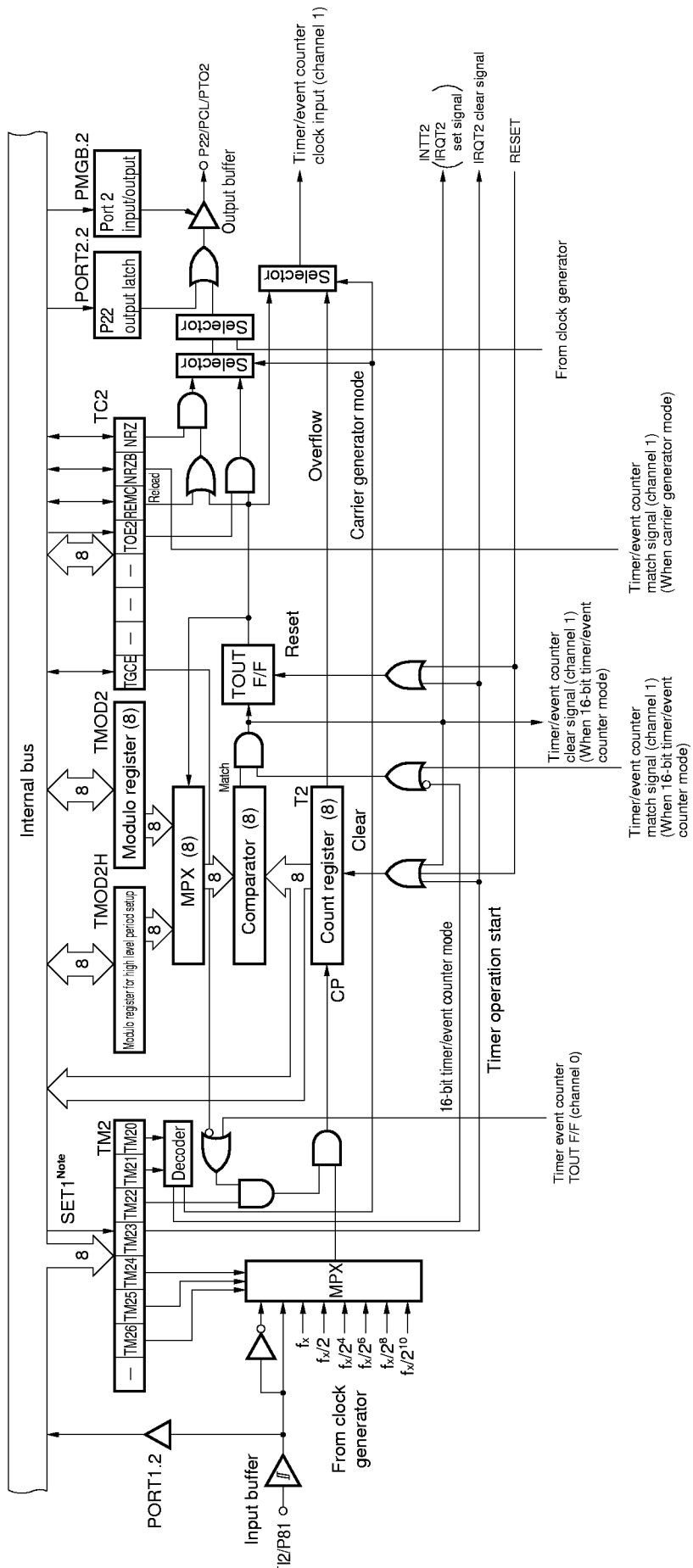
Caution When setting TM0, be sure to set bits 0 and 1 to 0.

Figure 6-7. Timer/Event Counter Block Diagram (channel 1)



Note Instruction execution

Figure 6-8. Timer/Event Counter Block Diagram (channel 2)★



Note Instruction execution

6.8 Serial Interface

The μPD753036 incorporates a clock-synchronous 8-bit serial interface and can be used in the following four modes.

- Operation stop mode
- 3-wire serial I/O mode
- 2-wire serial I/O mode
- SBI mode

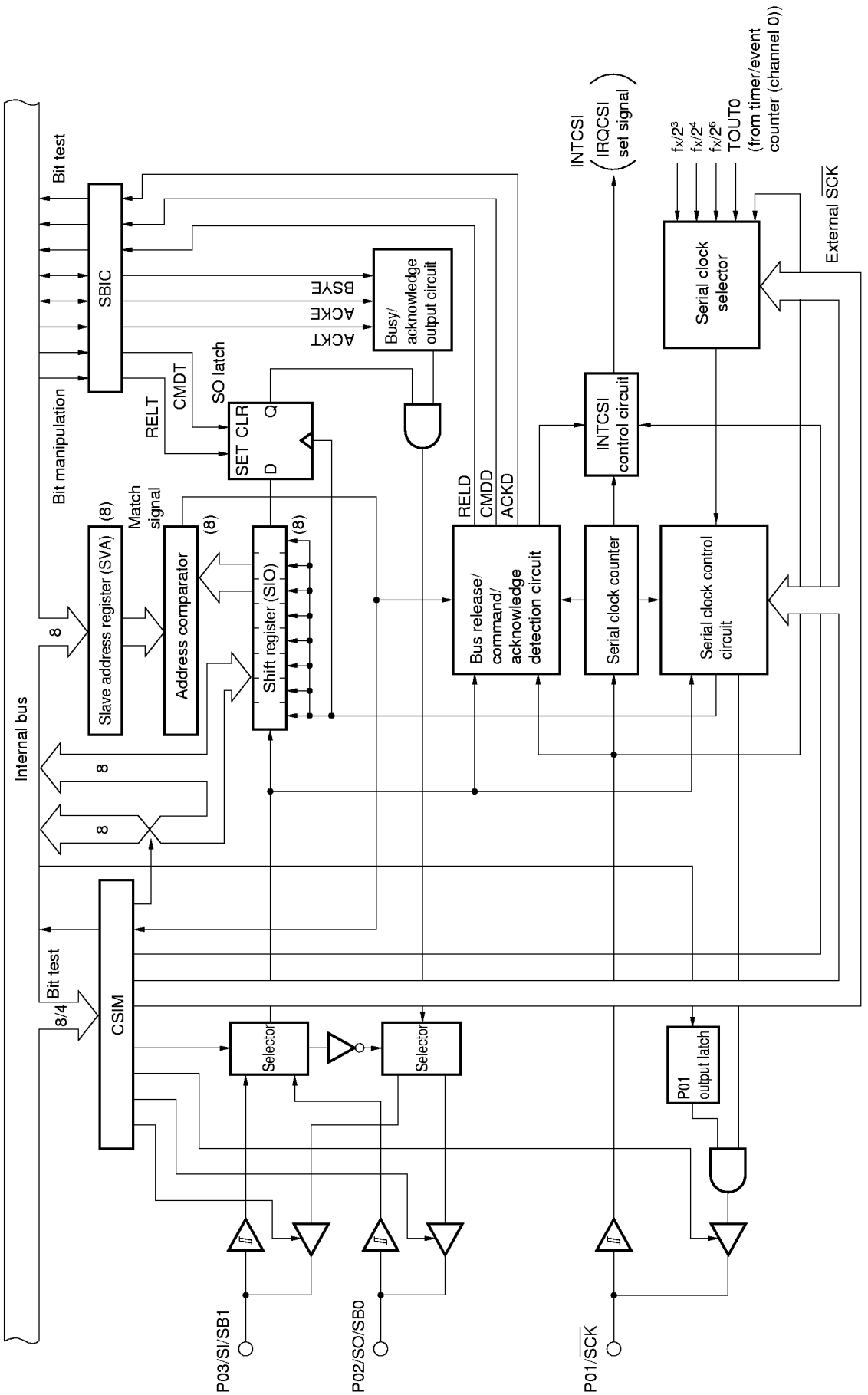


Figure 6-9. Serial Interface Block Diagram

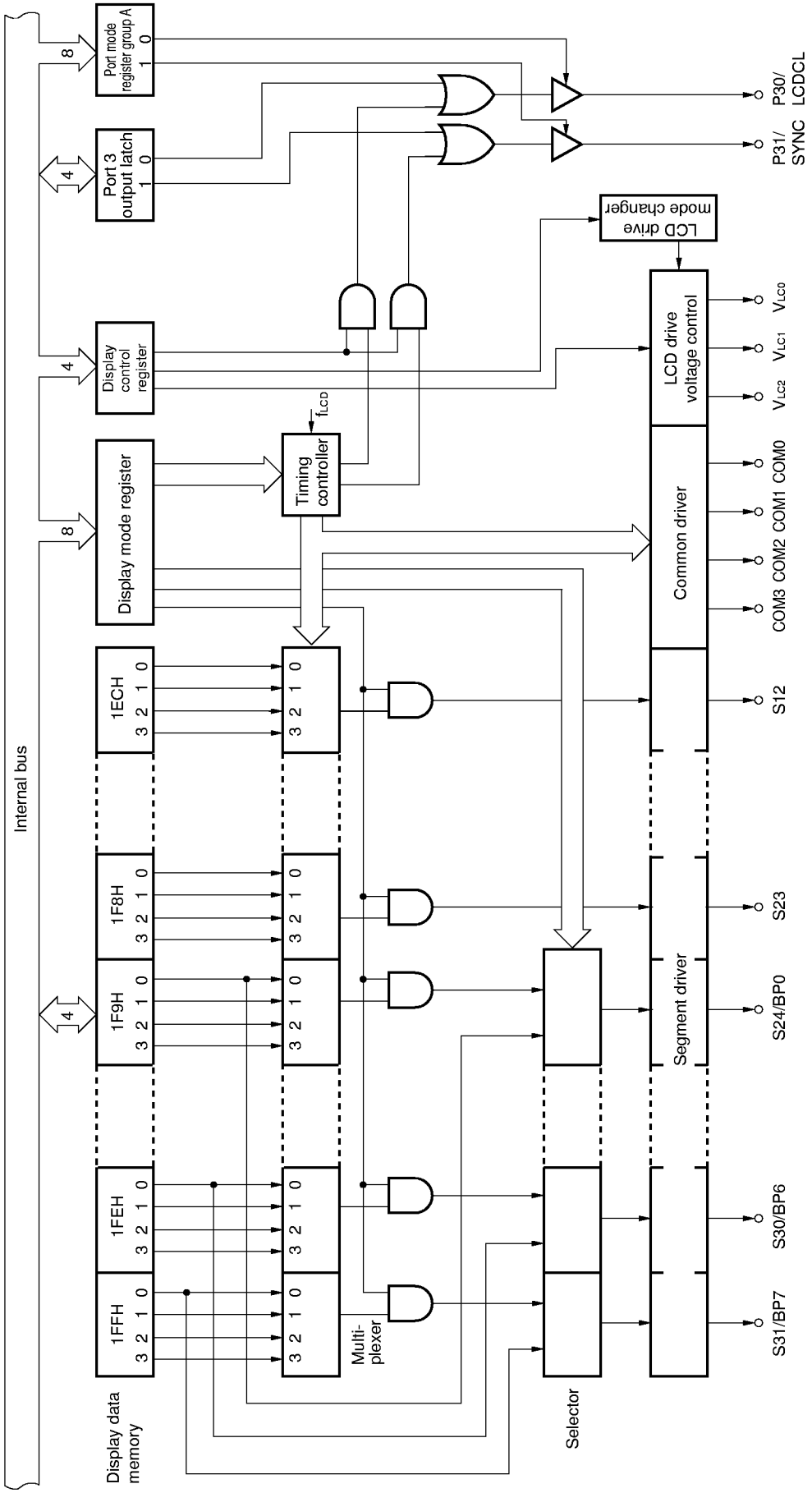
6.9 LCD Controller/Driver

The μPD753036 incorporates a display controller which generates segment and common signals according to the display data memory contents and incorporates segment and common drivers which can drive the panel directly.

The μPD753036 LCD controller/driver functions are as follows:

- Display data memory is read automatically by DMA operation and segment and common signals are generated.
- Display mode can be selected from among the following five:
  (1) Static
  (2) 1/2 duty (time multiplexing by 2), 1/2 bias
  (3) 1/3 duty (time multiplexing by 3), 1/2 bias
  (4) 1/3 duty (time multiplexing by 3), 1/3 bias
  (5) 1/4 duty (time multiplexing by 4), 1/3 bias
- A frame frequency can be selected from among four in each display mode.
- A maximum of 20 segment signal output pins (S12-S31) and four common signal bit port output (COM0-COM3).
- The segment signal output pins (S24-S27 and S28-S31) can be changed to the bit port output in 4-pin units.
- Split-resistor can be incorporated to supply LCD drive power. (Mask option)
  - Various bias methods and LCD drive voltages can be applicable.
  - When display is off, current flow to the split resistor is cut.
- Display data memory not used for display can be used for normal data memory.
- It can also operate by using the subsystem clock.

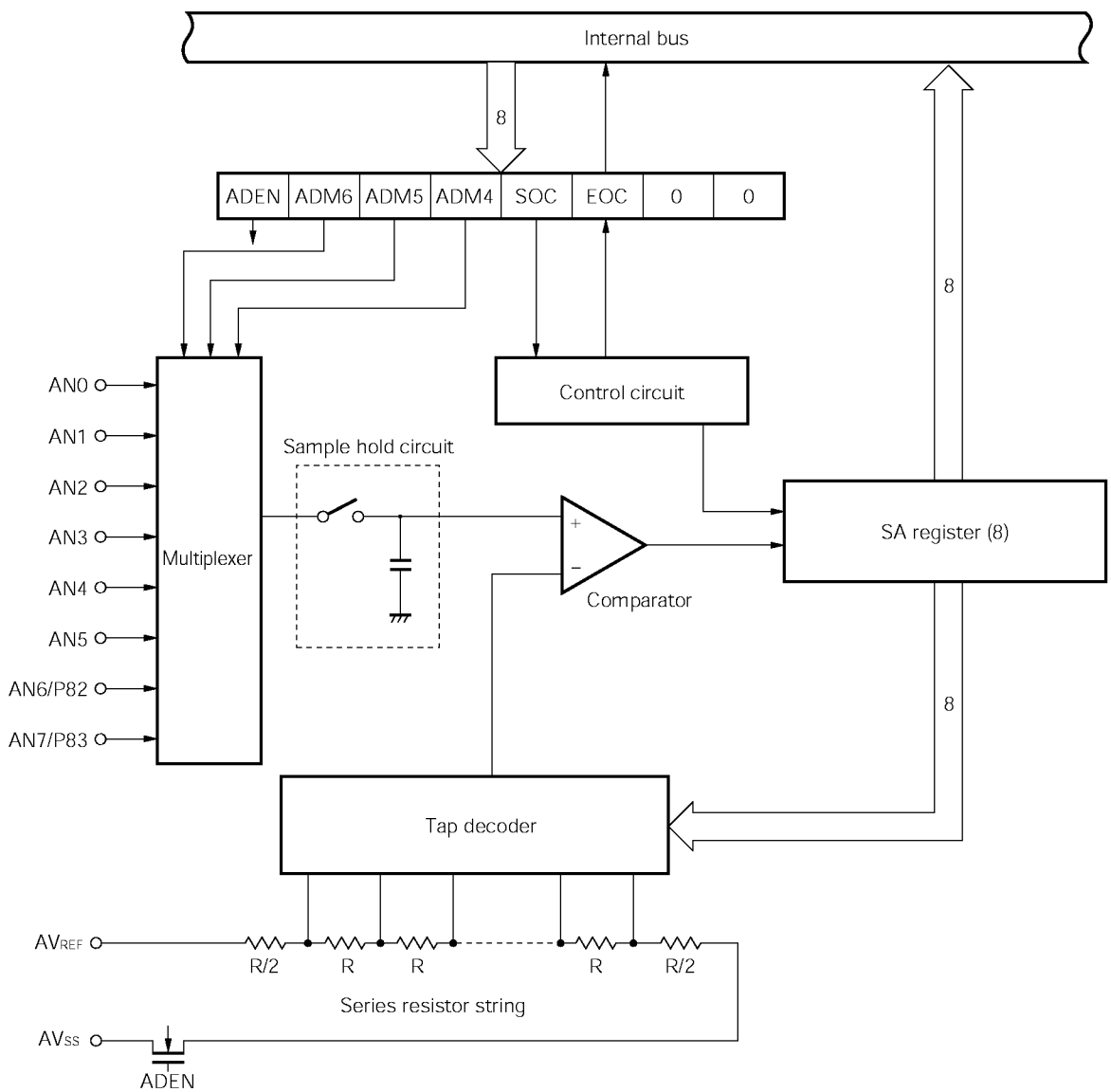
Figure 6-10. LCD Controller/Driver Block Diagram



6.10 A/D Converter

μPD753036 incorporates an 8-bit resolution A/D converter with an analog input (AN0-AN7). It uses the successive approximation method.

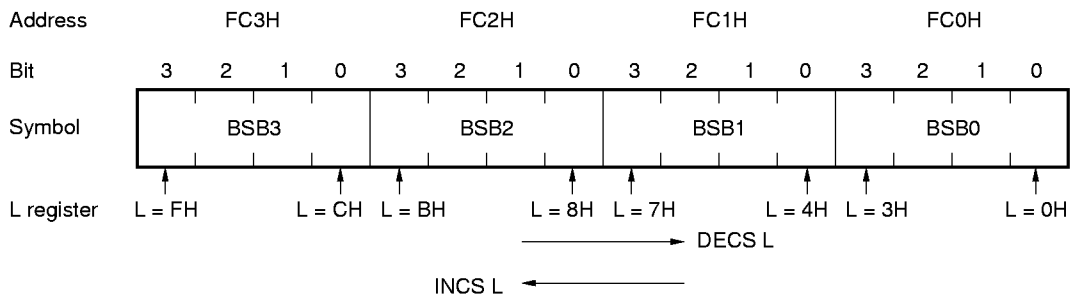
Figure 6-11. A/D Converter Block Diagram



6.11 Bit Sequential Buffer ..... 16 Bits

The bit sequential buffer (BSB) is a special data memory for bit manipulation and the bit manipulation can be easily performed by changing the address specification and bit specification in sequence, therefore it is useful when processing a long data bit-wise.

Figure 6-12. Bit Sequential Buffer Format



Remarks 1. In the pmem.@L addressing, the specified bit moves corresponding to the L register.

2. In the pmem.@L addressing, the BSB can be manipulated regardless of MBE/MSB specification.

7. INTERRUPT FUNCTION AND TEST FUNCTION

The μPD753036 has eight interrupt sources and two test sources. Of the test sources, INT2 has two types of edge-detected testable inputs.

The interrupt control circuit of the μPD753036 has the following functions:

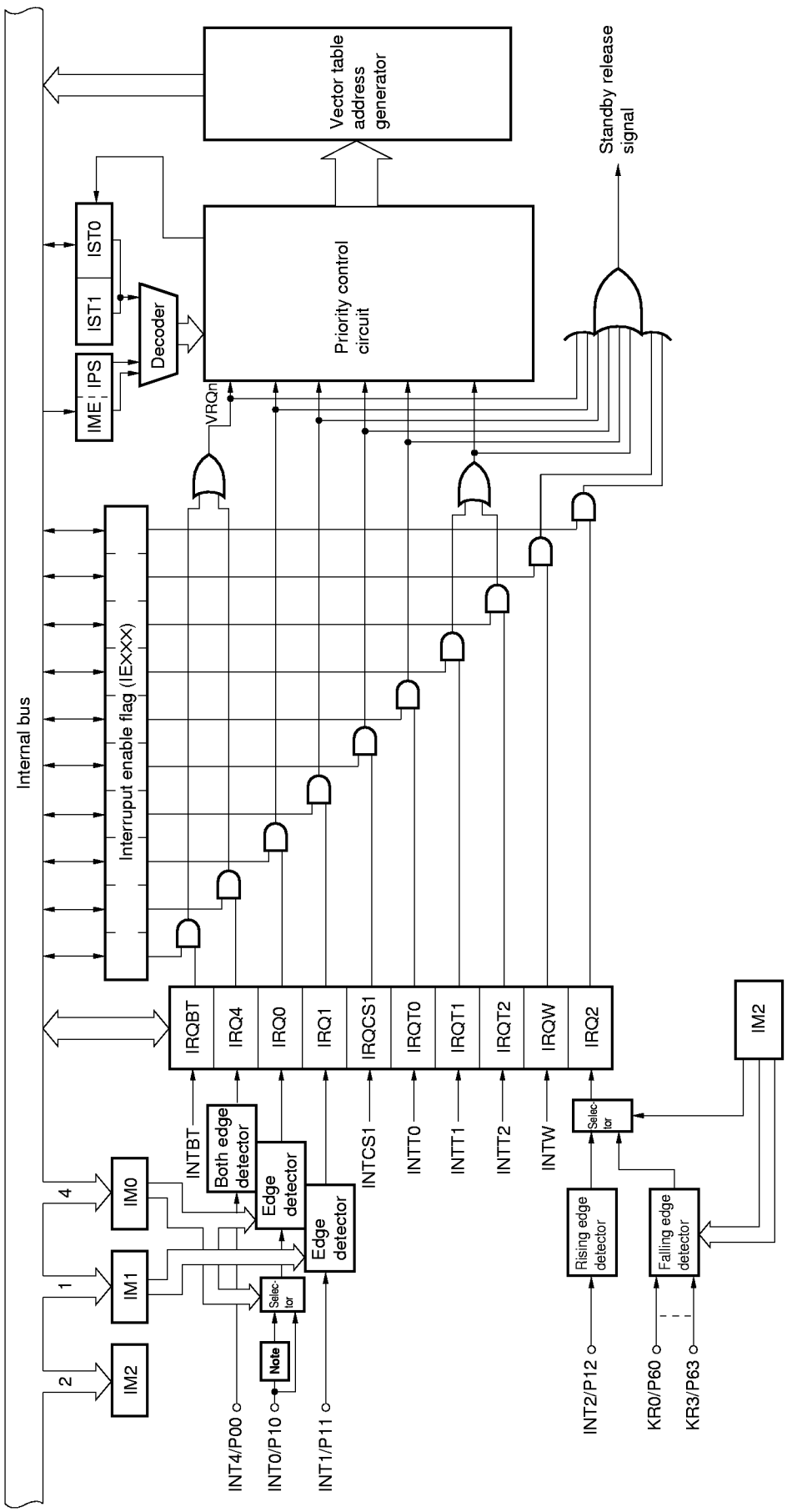
(1) Interrupt function

- Vectored interrupt function for hardware control, enabling/disabling the interrupt acceptance by the interrupt enable flag (IE×××) and interrupt master enable flag (IME).
- Can set any interrupt start address.
- Nesting wherein the order of priority can be specified by the interrupt priority select register (IPS).
- Test function of interrupt request flag (IRQ×××). An interrupt generated can be checked by software.
- Release the standby mode. A release interrupt can be selected by the interrupt enable flag.

(2) Test function

- Test request flag (IRQ×××) generation can be checked by software.
- Release the standby mode. The test source to be released can be selected by the test enable

Figure 7-1. Interrupt Control Circuit Block Diagram



Note Noise eliminator (Standby release is disable when noise eliminator is selected.)

8. STANDBY FUNCTION

In order to save power consumption while a program is in a standby mode, two types of standby modes (STOP mode and HALT mode) are provided for the μPD753036.

Table 8-1. Operation Status in Standby Mode

		STOP Mode	HALT Mode
Set instruction		STOP instruction	HALT instruction
System clock when set		Settable only when the main system clock is used.	Settable both by the main system clock and subsystem clock.
Operation status	Clock generator	The main system clock stops oscillation.	Only the CPU Φ halts (oscillation continues).
	Basic interval timer	Operation stops	Operation. (The IRQBT is set in the reference interval) Note 1.
	Serial interface	Operable only when an external $\overline{SCK}$ input is selected as the serial clock.	Operable Note 1
	Timer/event counter	Operable only when a signal input to the T10-T12 pins is specified as the count clock.	Operable Note 1
	Watch timer	Operable when f_{XT} is selected as the count clock.	Operable
	LCD driver controller	Operable only when f_{XT} is selected as the LCDCL.	Operable
	External interrupt	The INT1, 2, and 4 are operable. Only the INT0 is not operated. Note 2	
	CPU	The operation stops.	
★ Release signal		• Interrupt request signal sent from the operable hardware enabled by the interrupt enable flag. • Test request signal sent from the test source enabled by the test enable flag • $\overline{RESET}$ signal generation	

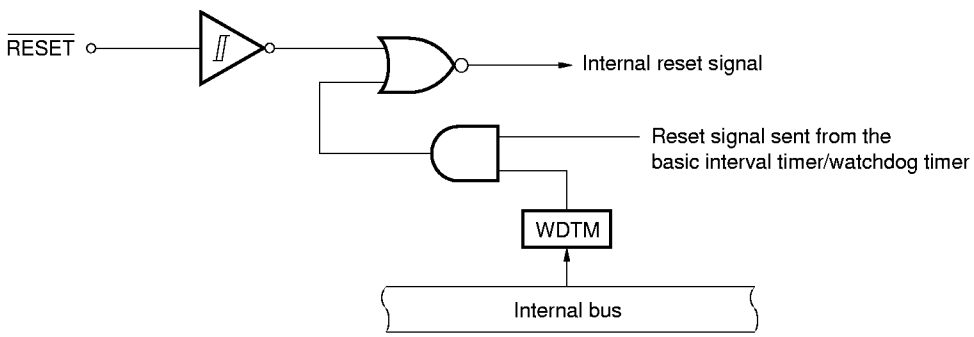
Notes 1. Cannot operate only when the main system clock stops.

2. Can operate only when the noise eliminator is not used (IM02 = 1) by bit 2 of the edge detection mode register(IM0).

9. RESET FUNCTION

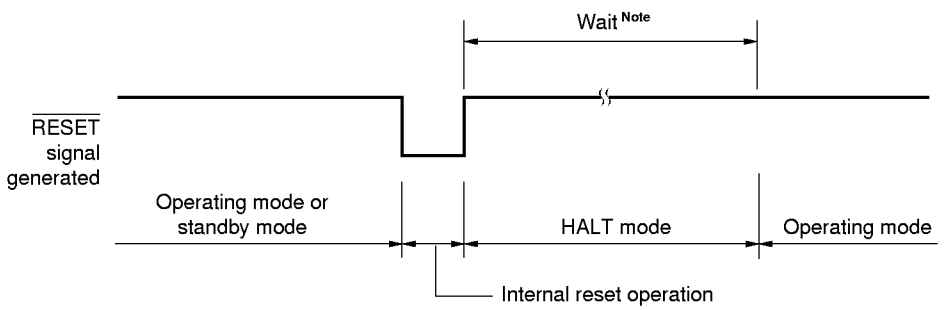
There are two reset inputs: external $\overline{\text{RESET}}$ signal and reset signal sent from the basic interval timer/watchdog timer. When either one of the reset signals are input, an internal reset signal is generated. Figure 9-1 shows the circuit diagram of the above two inputs.

Figure 9-1. Configuration of Reset Function



By the $\overline{\text{RESET}}$ signal generation, each device is initialized as listed in Table 9-1. Figure 9-2 shows the timing chart of the reset operation.

Figure 9-2. Reset Operation by $\overline{\text{RESET}}$ Signal Generation



Note The following two times can be selected by the mask option.

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)

Table 9-1. Status of Each Device After Reset (1/2)

Hardware		$\overline{\text{RESET}}$ Signal Generation in the Standby Mode	$\overline{\text{RESET}}$ Signal Generation in Operation
Program counter (PC)		Sets the low-order 6 bits of program memory's address 0000H to the PC13-PC8 and the contents of address 0001H to the PC7-PC0.	Sets the low-order 6 bits of program memory's address 0000H to the PC13-PC8 and the contents of address 0001H to the PC7-PC0.
PSW	Carry flag (CY)	Held	Undefined
	Skip flag (SK0-SK2)	0	0
	Interrupt status flag (IST0, 1)	0	0
	Bank enable flag (MBE, RBE)	Sets the bit 6 of program memory's address 0000H to the RBE and bit 7 to the MBE.	Sets the bit 6 of program memory's address 0000H to the RBE and bit 7 to the MBE.
Stack pointer (SP)		Undefined	Undefined
Stack bank select register (SBS)		1000B	1000B
Data memory (RAM)		Held	Undefined
General-purpose register (X, A, H, L, D, E, B, C)		Held	Undefined
Bank select register (MBS, RBS)		0, 0	0, 0
Basic interval timer/watch-dog timer	Counter (BT)	Undefined	Undefined
	Mode register (BTM)	0	0
	Watchdog timer enable flag (WDTM)	0	0
Timer/event counter (T0)	Counter (T0)	0	0
	Modulo register (TMOD0)	FFH	FFH
	Mode register (TM0)	0	0
	TOE0, TOUT F/F	0, 0	0, 0
Timer/event counter (T1)	Counter (T1)	0	0
	Modulo register (TMOD1)	FFH	FFH
	Mode register (TM1)	0	0
	TOE1, TOUT F/F	0, 0	0, 0
Timer/event counter (T2)	Counter (T2)	0	0
	Modulo register (TMOD2)	FFH	FFH
	High level period setting modulo register (TMOD2H)	FFH	FFH
	Mode register (TM2)	0	0
	TOE2, TOUT F/F	0, 0	0, 0
	REMC, NRZ, NRZB	0, 0, 0	0, 0, 0
	TGCE	0	0
Watch timer	Mode register (WM)	0	0

Table 9-1. Status of Each Device After Reset (2/2)

Hardware		$\overline{\text{RESET}}$ Signal Generation in the Standby Mode	$\overline{\text{RESET}}$ Signal Generation in Operation
Serial interface	Shift register (SIO)	Held	Undefined
	Operating mode register (CSIM)	0	0
	SBI control register (SBIC)	0	0
	Slave address register (SVA)	Held	Undefined
Clock generator, clock output circuit	Processor clock control register (PCC)	0	0
	System clock control register (SCC)	0	0
	Clock output mode register (CLOM)	0	0
Sub-oscillator control register (SOS)		0	0
LCD controller/ driver	Display mode register (LCDM)	0	0
	Display control register (LCDC)	0	0
Interrupt function	Interrupt request flag (IRQ×××)	Reset (0)	Reset (0)
	Interrupt enable flag (IE×××)	0	0
	Interrupt master enable flag (IME)	0	0
	INT0, 1, 2 mode registers (IM0, IM1, IM2)	0, 0, 0	0, 0, 0
	Interrupt priority selection register (IPS)	0	0
Digital port	Output buffer	Off	Off
	Output latch	Cleared (0)	Cleared (0)
	I/O mode registers (PMGA, PMGB, BMGC)	0	0
	Pull-up resistor setting register (POGA, POGB)	0	0
Bit sequential buffer (BSB0-BSB3)		Held	Undefined

10. MASK OPTION

The μPD753036 has the following mask options.

- P40-P43, P50-P53 mask options
  On-chip pull-up resistors can be connected.
  (1) On-chip pull-up resistors are specifiable bit-wise.
  (2) On-chip pull-up resistors are not specifiable.

- V_{LC0}-V_{LC2} pin, BIAS pin mask option
  On-chip dividing resistor for LCD drive can be connected.
  (1) Dividing resistor is not connected.
  (2) Four 10 kΩ (typ.) dividing resistors are connected at the same time.
  (3) Four 100 kΩ (typ.) dividing resistors are connected at the same time.

- Standby function mask option
  Wait times can be selected by a $\overline{\text{RESET}}$ signal.
  (1) 2^{17}/fx (21.8ms : at fx = 6.0 MHz, 31.3ms : at fx = 4.19MHz)
  (2) 2^{15}/fx (5.46ms : at fx = 6.0 MHz, 7.81ms : at fx = 4.19MHz)

- Subsystem clock mask option
  Use of the internal feedback resistor can be selected.
  (1) Internal feedback resistor can be used.
  (Switched ON/OFF via software)
  (2) Internal feedback resistor cannot be used.
  (Switched out in hardware)

11. INSTRUCTION SETS

(1) Expression formats and specification methods of operands

The operand is written in the operand column of each instruction in accordance with the specification method for the operand expression format of the instruction. For details, refer to **RA75X Assembler Package User's Manual – Language (U12385E)**. If there are several elements, one of them is selected. Capital letters and the + and – symbols are key words and are written as they are.

For immediate data, appropriate numbers and labels are written.

Instead of the labels such as mem, fmem, pmem, and bit, the symbols of the registers can be specified. However, there are restrictions in the labels that can be written for fmem and pmem. For details, refer to **User's Manual**.

Representation format	Specification Method
reg reg1	X, A, B, C, D, E, H, L X, B, C, D, E, H, L
rp rp1 rp2 rp' rp'1	XA, BC, DE, HL BC, DE, HL BC, DE XA, BC, DE, HL, XA', BC', DE', HL' BC, DE, HL, XA', BC', DE', HL'
rpa rpa1	HL, HL+, HL–, DE, DL DE, DL
n4 n8	4-bit immediate data or label 8-bit immediate data or label
mem bit	8-bit immediate data or label Note 2-bit immediate data or label
fmem pmem	FB0H-FBFH, FF0H-FFFH immediate data or label FC0H-FFFH immediate data or label
addr addr1 caddr faddr	0000H-3FFFH immediate data or label 0000H-3FFFH immediate data or label (Mk II mode only) 12-bit immediate data or label 11-bit immediate data or label
taddr	20H-7FH immediate data (where bit 0 = 0) or label
PORTn IE××× RBn MBn	PORT0-PORT8 IEBT, IET0-IET2, IE0-IE2, IE4, IECSI, IEW RB0-RB3 MB0, MB1, MB2, MB15

Note mem can be only used even address in 8-bit data processing.

(2) Legend in explanation of operation

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	: XA register pair; 8-bit accumulator
BC	: BC register pair
DE	: DE register pair
HL	: HL register pair
XA'	: XA' expanded register pair
BC'	: BC' expanded register pair
DE'	: DE' expanded register pair
HL'	: HL' expanded register pair
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 = 0-8)
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
.	: Separation between address and bit
(××)	: The contents addressed by ××
××H	: Hexadecimal data

(3) Explanation of symbols under addressing area column

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

Remarks 1. MB indicates memory bank that can be accessed.

2. In *2, MB = 0 independently of how MBE and MBS are set.

3. In *4 and *5, MB = 15 independently of how MBE and MBS are set.

4. *6 to *11 indicate the areas that can be addressed.

(4) Explanation of number of machine cycles column

S denotes the number of machine cycles required by skip operation when a skip instruction is executed. The value of S varies as follows.

- When no skip is made: S = 0
- When the skipped instruction is a 1- or 2-byte instruction: S = 1
- When the skipped instruction is a 3-byte instruction[Note]: S = 2

Note 3-byte instruction: BR !addr, BRA !addr1, CALL !addr or CALLA !addr1 instruction

Caution The GETI instruction is skipped in one machine cycle.

One machine cycle is equal to one cycle of CPU clock (= t_{CY}); time can be selected from among four types by setting PCC.

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	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, reg1	2	2	A ← reg1		
		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'		

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
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 ← $(B_{1,0}+CDE)_{ROM}$	*6	
		XA, @BCXA[Note]	1	3	XA ← $(B_{1,0}+CXA)_{ROM}$	*6	
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	
Operation	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		

Note Only the low-order 2-bits are valid for the B register.

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
Operation	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 and 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
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 ← $\overline{CY}$		

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
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	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
Branch	BR[Note1]	addr	–	–	$PC_{13-0} \leftarrow$ addr Select appropriate instruction from among BR !addr, BRCB !caddr, and BR $addr according to the assembler being used. BR !addr BRCB !caddr BR $addr	*6	
		addr1	–	–	$PC_{13-0} \leftarrow$ addr1 Select appropriate instruction from the following according to the assembler being used. BR !addr BRA !addr1 BRCB !caddr BR $sddr1	*11	
		!addr	3	3	$PC_{13-0} \leftarrow$ addr	*6	
		$addr	1	2	$PC_{13-0} \leftarrow$ addr	*7	
		$addr1	1	2	$PC_{13-0} \leftarrow$ addr1		
		PCDE	2	3	$PC_{13-0} \leftarrow PC_{13-8}$+DE		
		PCXA	2	3	$PC_{13-0} \leftarrow PC_{13-8}$+XA		
		BCDE[Note 2]	2	3	$PC_{13-0} \leftarrow B_{1,0}$+CDE	*6	
		BCXA[Note 2]	2	3	$PC_{13-0} \leftarrow B_{1,0}$+CXA	*6	
	BRA[Note 1]	!addr1	3	3	$PC_{13-0} \leftarrow$ addr1	*11	
	BRCB	!caddr	2	2	$PC_{13-0} \leftarrow PC_{13,12}+caddr_{11-0}$	*8	
Subroutine stack control	CALLA[Note 1]	!addr1	3	3	(SP–5)(SP–6)(SP–3)(SP–4) $\leftarrow$ 0, 0, PC_{13-0} (SP–2) $\leftarrow$ ×, ×, MBE, RBE $PC_{13-0} \leftarrow$ addr1, SP $\leftarrow$ SP–6	*11	
	CALL[Note 1]	!addr	3	3	(SP–4)(SP–1)(SP–2) $\leftarrow PC_{11-0}$ (SP–3) $\leftarrow$ MBE, RBE, PC_{13}, PC_{12} $PC_{13-0} \leftarrow$ addr, SP $\leftarrow$ SP–4	*6	
				4	(SP–5)(SP–6)(SP–3)(SP–4) $\leftarrow$ 0, 0, PC_{13-0} (SP–2) $\leftarrow$ ×, ×, MBE, RBE $PC_{13-0} \leftarrow$ addr, SP $\leftarrow$ SP–6		
	CALLF[Note 1]	!faddr	2	2	(SP–4)(SP–1)(SP–2) $\leftarrow PC_{11-0}$ (SP–3) $\leftarrow$ MBE, RBE, PC_{13}, PC_{12} $PC_{13-0} \leftarrow$ 000+faddr, SP $\leftarrow$ SP–4	*9	
				3	(SP–5)(SP–6)(SP–3)(SP–4) $\leftarrow$ 0, 0, PC_{13-0} (SP–2) $\leftarrow$ ×, ×, MBE, RBE $PC_{13-0} \leftarrow$ 000+faddr, SP $\leftarrow$ SP–6		

Notes 1. The above operations in the shaded boxes can be performed only in the Mk II mode. The other operations can be performed only in the Mk I mode.

2. Only the low-order 2 bits are valid for the B register.

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
Subroutine stack control	RET[Note 1]		1	3	MBE, RBE, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2), SP ← SP+4		
					×, ×, MBE, RBE ← (SP+4) 0, 0, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2), SP ← SP+6		
	RETS[Note 1]		1	3+S	MBE, RBE, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2), SP ← SP+4 then skip unconditionally		Unconditional
					×, ×, MBE, RBE ← (SP+4) 0, 0, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2), SP ← SP+6 then skip unconditionally		
	RETI[Note 1]		1	3	MBE, RBE, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) PSW ← (SP+4)(SP+5), SP ← SP+6		
					0, 0, PC_{13}, PC_{12} ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) PSW ← (SP+4)(SP+5), SP ← SP+6		
	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		
		IExxx	2	2	IExxx ← 1		
	DI		2	2	IME(IPS.3) ← 0		
		IExxx	2	2	IExxx ← 0		
Input/output	IN[Note 2]	A, PORTn	2	2	A ← PORTn (n = 0-8)		
		XA, PORTn	2	2	XA ← PORTn+1, PORTn (n = 4, 6)		
	OUT[Note 2]	PORTn, A	2	2	PORTn ← A (n = 2-8)		
		PORTn, XA	2	2	PORTn+1, PORTn ← XA (n = 4, 6)		
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		

Notes 1. The above operations in the shaded boxes can be performed only in the Mk II mode. The other operations can be performed only in the Mk I mode.

2. While the IN instruction and OUT instruction are being executed, the MBE must be set to 0 or 1 and MBS must be set to 15.

Instruction Group	Mnemonic	Operand	Number of Bytes	Number of Machine Cycles	Operation	Addressing Area	Skip Condition
Special	SEL	RBn	2	2	RBS ← n (n = 0-3)		
		MBn	2	2	MBS ← n (n = 0-2, 15)		
	GETI[Notes 1, 2]	taddr	1	3	• When TBR instruction PC_{13-0} ← (taddr)$_{5-0}$+(taddr+1)	*10	
					• When TCALL instruction (SP–4)(SP–1)(SP–2) ← PC_{11-0} (SP–3) ← MBE, RBE, PC_{13}, PC_{12} PC_{13-0} ← (taddr)$_{5-0}$+(taddr+1) SP ← SP–4		
					• When instruction other than TBR and TCALL instructions (taddr) (taddr+1) instruction is executed		Depending on the reference instruction
			1	3	• When TBR instruction PC_{13-0} ← (taddr)$_{5-0}$+(taddr+1) PC_{14} ← 0		
				4	• When TCALL instruction (SP–5)(SP–6)(SP–3)(SP–4) ← 0, 0, PC_{13-0} (SP–2) ← ×, ×, MBE, RBE PC_{13-0} ← (taddr)$_{5-0}$+(taddr+1) SP ← SP–6		
				3	• When instruction other than TBR and TCALL instructions (taddr) (taddr+1) instruction is executed		Depending on the reference instruction

Notes 1. The shaded box is applicable only to the Mk II mode. The other area is applicable only to Mk I mode.

2. The TBR and TCALL instructions are the table definition assembler pseudo instructions of the GETI instruction.

12. ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (T_A = 25 °C)

Parameter	Symbol	Conditions		Ratings	Unit
Supply voltage	V_{DD}			–0.3 to +7.0	V
Input voltage	V_{I1}	Other than ports 4, 5		–0.3 to V_{DD} +0.3	V
	V_{I2}	Ports 4, 5	Pull-up resistor provided	–0.3 to V_{DD} +0.3	V
			N-ch open drain	–0.3 to +14	V
Output voltage	V_O			–0.3 to V_{DD} +0.3	V
High-level output current	I_{OH}	Per pin		–10	mA
		Total of all pins		–30	mA
Low-level output current	I_{OL}	Per pin		30	mA
		Total of all pins		200	mA
Ambient operating temperature	T_A			–40 to +85[Note]	°C
Storage temperature	T_{stg}			–65 to +150	°C

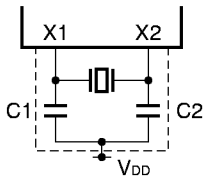
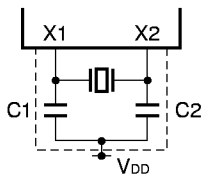
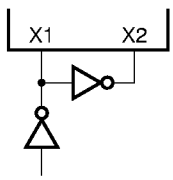
Note To drive LCD in the normal mode, T_A = –10 to +85 °C

Caution If the absolute maximum rating of even one of the parameters is exceeded even momentarily, the quality of the product may be degraded. The absolute maximum ratings are therefore values which, when exceeded, can cause the product to be damaged. Be sure that these values are never exceeded when using the product.

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

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{IN}	f = 1 MHz			15	pF
Output capacitance	C_{OUT}	Pins other than tested pins: 0 V			15	pF
I/O capacitance	C_{IO}				15	pF

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

Oscillator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Ceramic oscillator		Oscillation frequency (f_X)Note 1		1.0		6.0Note 2	MHz
		Oscillation stabilization timeNote 3	After V_{DD} has reached MIN. value of oscillation voltage range			4	ms
Crystal resonator		Oscillation frequency (f_X)Note 1		1.0		6.0Note 2	MHz
		Oscillation stabilization timeNote 3	V_{DD} = 4.5 to 5.5 V			10	ms
						30	
External clock		X1 input frequency (f_X)Note 1		1.0		6.0Note 2	MHz
		X1 input high-, low-level widths (t_{XH}, t_{XL})		83.3		500	ns

Notes 1. The oscillation frequency and X1 input frequency shown above indicate characteristics of the oscillation circuit only. For the instruction execution time, refer to AC Characteristics.

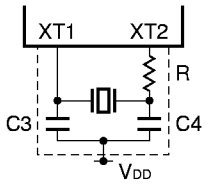
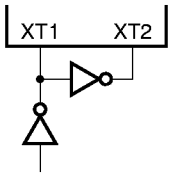
2. If the oscillation frequency is 4.19 MHz < f_X < 6.0 MHz at 1.8 V ≤ V_{DD} < 2.7 V, do not select the processor clock control register (PCC) = 0011. If PCC = 0011, one machine cycle is less than 0.95 μs, falling short of the rated value of 0.95 μs.

3. The oscillation stabilization time is the time required for oscillation to be stabilized after V_{DD} has been applied or STOP mode has been released.

Caution When using the main system clock oscillation circuit, wire the portion enclosed in the dotted line in the above figure as follows to prevent adverse influences due to wiring capacitance:

- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with other signal lines.**
- **Do not route the wiring in the vicinity of a line through which a high alternating current flows.**
- **Always keep the ground point of the capacitor of the oscillation circuit at the same potential as V_{DD}.**
- **Do not ground to a power supply pattern through which a high current flows.**
- **Do not extract signals from the oscillation circuit.**

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

Oscillator	Recommended Circuit	Parameter	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
						10	
External clock		XT1 input frequency (f_{XT})Note 1		32		100	kHz
		XT1 input high-, low-level widths (t_{XTH}, t_{XTL})		5		15	μs

Notes 1. The oscillation frequency shown above indicate characteristics of the oscillation circuit only. For the instruction execution time, refer to AC Characteristics.

2. The oscillation stabilization time is the time required for oscillation to be stabilized after V_{DD} has been applied.

Caution When using the subsystem clock oscillation circuit, wire the portion enclosed in the dotted line in the above figure as follows to prevent adverse influences due to wiring capacitance:

- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with other signal lines.**
- **Do not route the wiring in the vicinity of a line through which a high alternating current flows.**
- **Always keep the ground point of the capacitor of the oscillation circuit at the same potential as V_{DD}.**
- **Do not ground to a power supply pattern through which a high current flows.**
- **Do not extract signals from the oscillation circuit.**

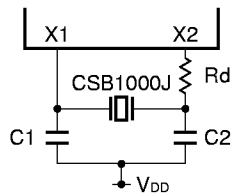
The subsystem clock oscillation circuit has a low amplification factor to reduce current dissipation and is more susceptible to noise than the main system clock oscillation circuit. Therefore, exercise utmost care in wiring the subsystem clock oscillation circuit.

Recommended Oscillation Circuit Constants

Ceramic resonator (T_A = –20 to +80 °C)

Manufacturer	Part Number	Frequency (MHz)	Oscillation Circuit Constant (pF)		Oscillation Voltage Range (V_{DD})		Remark
			C1	C2	MIN. (V)	MAX. (V)	
Murata Mfg. Co., Ltd.	CSB1000J[Note]	1.0	100	100	2.0	5.5	Rd = 2.2 kΩ
	CSA2.00MG040	2.0	100	100	2.0	5.5	–
	CST2.00MG040		–	–			Capacitor-contained model
	CSA4.19MG	4.19	30	30	2.0	5.5	–
	CST4.19MGW		–	–			Capacitor-contained model
	CSA4.19MGU		30	30	1.8		–
	CST4.19MGWU		–	–			Capacitor-contained model
	CSA6.00MG	6.0	30	30	2.7	5.5	–
	CST6.00MGW		–	–			Capacitor-contained model
	CSA6.00MGU		30	30	2.4		–
	CST6.00MGWU		–	–			Capacitor-contained model
Kyocera Corp.	KBR-1000F/Y	1.0	100	100	1.8	5.5	–
	KBR-2.0MS	2.0	68	68	2.0	5.5	
	KBR-4.19MKC	4.19	–	–	1.9	5.5	Capacitor-contained model
	KBR-4.19MSB		33	33			–
	PBRC 4.19A						
	PBRC 4.19B		–	–			Capacitor-contained model
	KBR-6.0MKC	6.0	–	–	1.9	5.5	Capacitor-contained model
	KBR-6.0MSB		33	33			–
	PBRC 6.00A						
	PBRC 6.00B		–	–			Capacitor-contained model

Note When using the CSB1000J (1.0 MHz) by Murata Mfg. Co., Ltd. as a ceramic resonator, a limiting resistor (Rd = 2.2 kΩ) is necessary (refer to the figure below). The resistor is not necessary when using the other recommended resonators.



Caution The oscillation circuit constants and oscillation voltage range indicate conditions for stable oscillation but do not guarantee accuracy of the oscillation frequency. If the application circuit requires accuracy of the oscillation frequency, it is necessary to set the oscillation frequency of the resonator in the application circuit. For this, it is necessary to directly contact the manufacturer of the resonator being used.

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

Parameter	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Low-level output current	I_{OL}	Per pin					15	mA
		Total of all pins					120	mA
High-level input voltage	V_{IH1}	Ports 2, 3		2.7 V ≤ V_{DD} ≤ 5.5 V	0.7 V_{DD}		V_{DD}	V
				1.8 V ≤ V_{DD} < 2.7 V	0.9 V_{DD}		V_{DD}	V
	V_{IH2}	Ports 0, 1, 6-8, $\overline{\text{RESET}}$		2.7 V ≤ V_{DD} ≤ 5.5 V	0.8 V_{DD}		V_{DD}	V
				1.8 V ≤ V_{DD} < 2.7 V	0.9 V_{DD}		V_{DD}	V
	V_{IH3}	Ports 4, 5	Pull-up resistor provided	2.7 V ≤ V_{DD} ≤ 5.5 V	0.7 V_{DD}		V_{DD}	V
				1.8 V ≤ V_{DD} < 2.7 V	0.9 V_{DD}		V_{DD}	V
			N-ch open drain	2.7 V ≤ V_{DD} ≤ 5.5 V	0.7 V_{DD}		13	V
				1.8 V ≤ V_{DD} < 2.7 V	0.9 V_{DD}		13	V
	V_{IH4}	X1, XT1			V_{DD} –0.1		V_{DD}	V
Low-level input voltage	V_{IL1}	Ports 2-5		2.7 ≤ V_{DD} ≤ 5.5 V	0		0.3 V_{DD}	V
				1.8 V ≤ V_{DD} < 2.7 V	0		0.1 V_{DD}	V
	V_{IL2}	Ports 0, 1, 6-8, $\overline{\text{RESET}}$		2.7 ≤ V_{DD} ≤ 5.5 V	0		0.2 V_{DD}	V
				1.8 V ≤ V_{DD} < 2.7 V	0		0.1 V_{DD}	V
	V_{IL3}	X1, XT1			0		0.1	V
High-level output voltage	V_{OH}	$\overline{\text{SCK}}$, SO, ports 2, 3, 6-8, BP0-BP7 I_{OH} = –1.0 mA			V_{DD} –0.5			V
Low-level output voltage	V_{OL1}	$\overline{\text{SCK}}$, SO, ports 2-8, BP0-BP7		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	N-ch open drain Pull-up resistor ≥ 1 kΩ				0.2 V_{DD}	V
High-level input leakage current	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	Ports 4, 5 (N-ch open drain)				20	μA
Low-level input leakage current	I_{LIL1}	V_{IN} = 0 V	Pins other than ports 4, 5, X1, XT1				–3	μA
	I_{LIL2}		X1, XT1				–20	μA
	I_{LIL3}		Ports 4, 5 (N-ch open drain) When input instruction is not executed				–3	μA
			Port 4, 5 (N-ch open drain) When input instruction is executed				–30	μA
				V_{DD} = 5.0 V		–10	–20	μA
				V_{DD} = 3.0 V		–3	–6	μA
High-level output leakage current	I_{LOH1}	V_{OUT} = V_{DD}	$\overline{\text{SCK}}$, SO/SB0, SB1, ports 2, 3, 6-8 Ports 4, 5 (Pull-up resistor provided)				3	μA
	I_{LOH2}	V_{OUT} = 13 V	Ports 4, 5 (N-ch open drain)				20	μA
Low-level output leakage current	I_{LOL}	V_{OUT} = 0 V					–3	μA
Internal pull-up resistor	R_{L1}	V_{IN} = 0 V	Ports 0-3, 6-8 (except pin P00)		50	100	200	kΩ
	R_{L2}		Ports 4, 5 (Mask option)		15	30	60	kΩ

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

Parameter	Symbol	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 divider resistor[Note 2]	R_{LCD1}				50	100	200	kΩ
	R_{LCD2}				5	10	20	kΩ
LCD output voltage deviation[Note 3] (common)	V_{ODC}	Io = ±1.0 μA	V_{LCD0} = V_{LCD} V_{LCD1} = V_{LCD} × 2/3 V_{LCD2} = V_{LCD} × 1/3 1.8 V ≤ V_{LCD} ≤ V_{DD}		0		±0.2	V
LCD output voltage deviation[Note 3] (segment)	V_{ODS}	Io = ±0.5 μA			0		±0.2	V
Supply current[Note 4]	I_{DD1}	6.00 MHz[Note 5] crystal oscillation C1 = C2 = 22 pF	V_{DD} = 5.0 V ±10 %[Note 6]			2.5	7.5	mA
			V_{DD} = 3.0 V ±10 %[Note 7]			0.6	1.8	mA
	I_{DD2}		HALT mode	V_{DD} = 5.0 V ±10 %		0.9	2.7	mA
				V_{DD} = 3.0 V ±10 %		0.5	1.0	mA
	I_{DD1}	4.19 MHz[Note 5] crystal oscillation C1 = C2 = 22 pF	V_{DD} = 5.0 V ±10 %[Note 6]			1.7	4.5	mA
			V_{DD} = 3.0 V ±10 %[Note 7]			0.33	1.0	mA
	I_{DD2}		HALT mode	V_{DD} = 5.0 V ±10 %		0.7	2.0	mA
				V_{DD} = 3.0 V ±10 %		0.3	0.9	mA
	I_{DD3}	32.768 kHz[Note 8] crystal oscillation	Low-voltage mode[Note 9]	V_{DD} = 3.0 V ±10 %		12	35	μA
				V_{DD} = 2.0 V ±10 %		5.5	16	μA
				V_{DD} = 3.0 V, T_A = 25 °C		12	24	μA
	I_{DD4}		Low current consumption mode[Note 10]	V_{DD} = 3.0 V ±10 %		9.2	27	μA
				V_{DD} = 3.0 V, T_A = 25 °C		9.2	18	μA
			HALT mode	Low-voltage mode[Note 9] V_{DD} = 3.0 V ±10 %		8.5	25	μA
				Low-voltage mode[Note 9] V_{DD} = 2.0 V ±10 %		3.0	12.0	μA
				Low-voltage mode[Note 9] V_{DD} = 3.0 V, T_A = 25 °C		8.5	17	μA
				Low power consumption mode[Note 10] V_{DD} = 3.0 V ±10 %		4.6	13.8	μA
				Low power consumption mode[Note 10] V_{DD} = 3.0 V, T_A = 25 °C		4.6	9.2	μA
	I_{DD5}	XT1 = 0V[Note 11] STOP mode	V_{DD} = 5.0 V ±10 %			0.05	10	μA
			V_{DD} = 3.0 V ±10 %			0.02	5.0	μA
				T_A = 25 °C		0.02	3.0	μA

Notes 1. Clear VAC0 to 0 in the low-current mode and STOP mode. When VAC0 is set to 1, the current increases by about 1 μA.

2. Either R_{LCD1} or R_{LCD2} can be selected by mask option.

3. Voltage deviation is the difference between the ideal values (V_{LCDn}; n = 0, 1, 2) of the segment and common outputs and the output voltage.

4. The current flowing through the internal pull-up resistor and the LCD divider resistor is not included.

5. Including the case when the subsystem clock oscillates.

6. When the device operates in high-speed mode with the processor clock control register (PCC) set to 0011.

7. When the device operates in low-speed mode with PCC set to 0000.

8. When the device operates on the subsystem clock, with the system clock control register (SCC) set to 1001 and oscillation of the main system clock stopped.

9. When the sub oscillation circuit control register (SOS) is set to 0000.

10. When SOS is set to 0010.

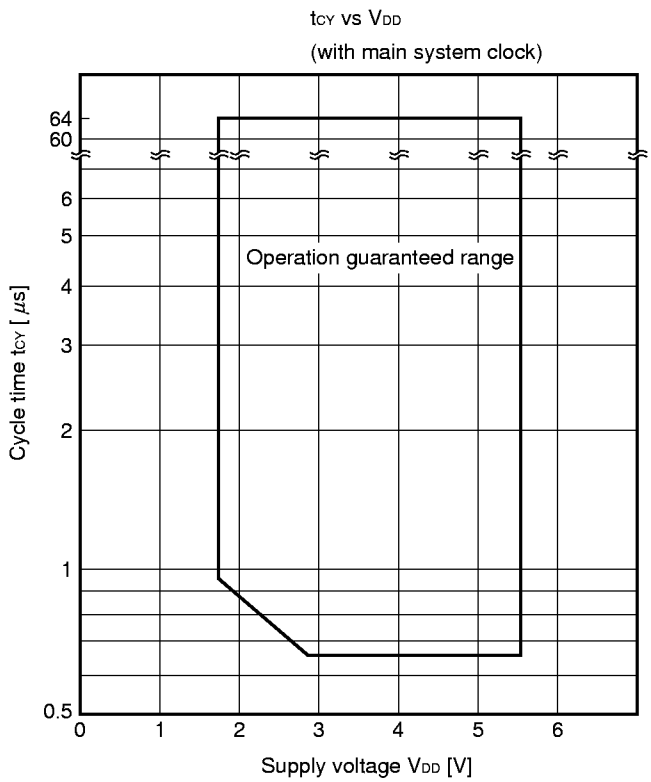
11. When SOS is set to 00×1 and the sub oscillation circuit feedback resistor is not used (×: don't care).

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

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
CPU clock cycle time[Note 1] (minimum instruction execution time = 1 machine cycle)	t_{CY}	Operates with main system clock	V_{DD} = 2.7 to 5.5 V	0.67		64	μs
				0.95		64	μs
		Operates with 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
				0		275	kHz
TI0, TI1, TI2 input high-, low-level widths	t_{TIH}, t_{TIL}	V_{DD} = 2.7 to 5.5 V		0.48			μs
				1.8			μs
Interrupt input high-, low-level widths	t_{INTH}, t_{INTL}	INT0	IM02 = 0	**Note 2**			μs
			IM02 = 1	10			μs
		INT1, 2, 4		10			μs
		KR0-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 processor clock control register (PCC).
The figure on the right shows the supply voltage V_{DD} vs. cycle time t_{CY} characteristics when the device operates with the main system clock.

2. $2t_{CY}$ or 128/fx depending on the setting of the interrupt mode register (IM0).



Serial transfer operation

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

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

Notes 1. Read as SB0 or SB1 when using the 2-wire serial I/O mode.

2. R_L and C_L respectively indicate the load resistance and load capacitance of the SO output line.

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

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

Notes 1. Read as SB0 or SB1 when using the 2-wire serial I/O mode.

2. R_L and C_L respectively indicate the load resistance and load capacitance of the SO output line.

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

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY3}	V_{DD} = 2.7 to 5.5 V		1300			ns
				3800			ns
$\overline{SCK}$ high-, low-level widths	t_{KL3},	V_{DD} = 2.7 to 5.5 V		$t_{KCY3}/2-50$			ns
	t_{KH3}			$t_{KCY3}/2-150$			ns
SB0, 1 setup time	t_{SIK3}	V_{DD} = 2.7 to 5.5 V		150			ns
(vs. $\overline{SCK}$ ↑)				500			ns
SB0, 1 hold time (vs. $\overline{SCK}$ ↑)	t_{KSI3}			$t_{KCY3}/2$			ns
$\overline{SCK}$ ↓ → SB0, 1 output	t_{KSO3}	R_L = 1 kΩ Note	V_{DD} = 2.7 to 5.5 V	0		250	ns
delay time		C_L = 100 pF		0		1000	ns
$\overline{SCK}$ ↑ → SB0, 1 ↓	t_{KSB}			t_{KCY3}			ns
SB0, 1 ↓ → $\overline{SCK}$ ↓	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 respectively indicate the load resistance and load capacitance of the SB0 and 1 output lines.

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

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY4}	V_{DD} = 2.7 to 5.5 V		800			ns
				3200			ns
$\overline{SCK}$ high-, low-level widths	t_{KL4},	V_{DD} = 2.7 to 5.5 V		400			ns
	t_{KH4}			1600			ns
SB0, 1 setup time	t_{SIK4}	V_{DD} = 2.7 to 5.5 V		100			ns
(vs. $\overline{SCK}$ ↑)				150			ns
SB0, 1 hold time (vs. $\overline{SCK}$ ↑)	t_{KSI4}			$t_{KCY4}/2$			ns
$\overline{SCK}$ ↓ → SB0, 1 output	t_{KSO4}	R_L = 1 kΩ Note	V_{DD} = 2.7 to 5.5 V	0		300	ns
delay time		C_L = 100 pF		0		1000	ns
$\overline{SCK}$ ↑ → SB0, 1 ↓	t_{KSB}			t_{KCY4}			ns
SB0, 1 ↓ → $\overline{SCK}$ ↓	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 respectively indicate the load resistance and load capacitance of the SB0 and 1 output lines.

★ **A/D Converter Characteristics (TA = –40 to +85 °C, V_{DD} = 1.8 to 5.5 V, 1.8 V ≤ AV_{REF} ≤ V_{DD}, AV_{SS} = V_{SS})**

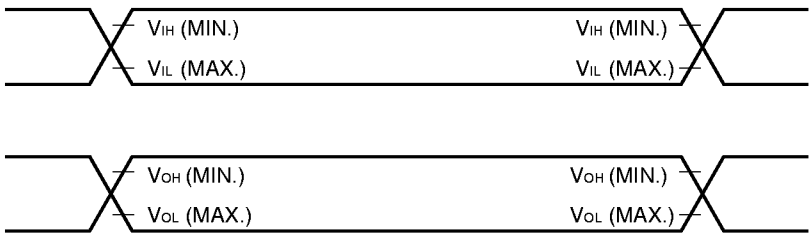
Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution				8	8	8	bit
Absolute accuracy[Note 1]		V_{DD} = AV_{REF}	2.7 V ≤ V_{DD}			1.5	LSB
			1.8 V ≤ V_{DD} < 2.7 V			3	LSB
		V_{DD} ≠ AV_{REF}				3	LSB
Conversion time	t_{CONV}	**Note 2**				168/fx	μs
Sampling time	t_{SAMP}	**Note 3**				44/fx	μs
Analog input voltage	V_{IAN}			AV_{SS}		AV_{REF}	V
Analog input impedance	R_{AN}				1000		MΩ
AV_{REF} current	I_{REF}				0.25	2.0	mA

Notes 1. Absolute accuracy excluding quantization error (±1/2LSB)

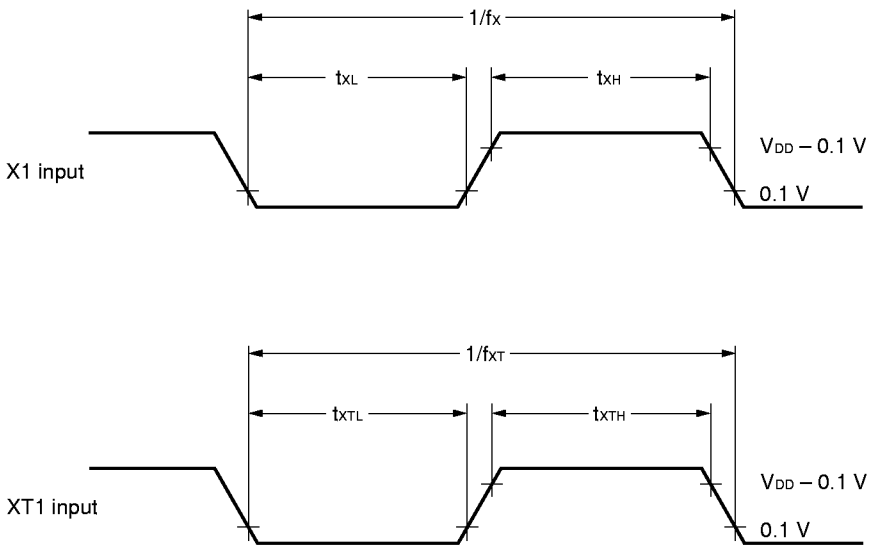
2. Time until end of conversion (EOC = 1) after execution of conversion start instruction (40.1 μs: fx = 4.19 MHz).

3. Time until end of sampling after execution of conversion start instruction (10.5 μs: fx = 4.19 MHz).

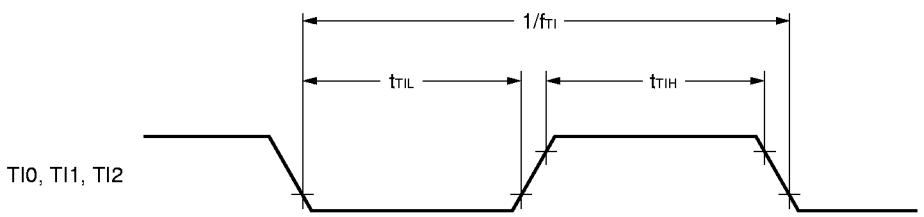
AC timing test points (except X1 and XT1 inputs)



Clock timing

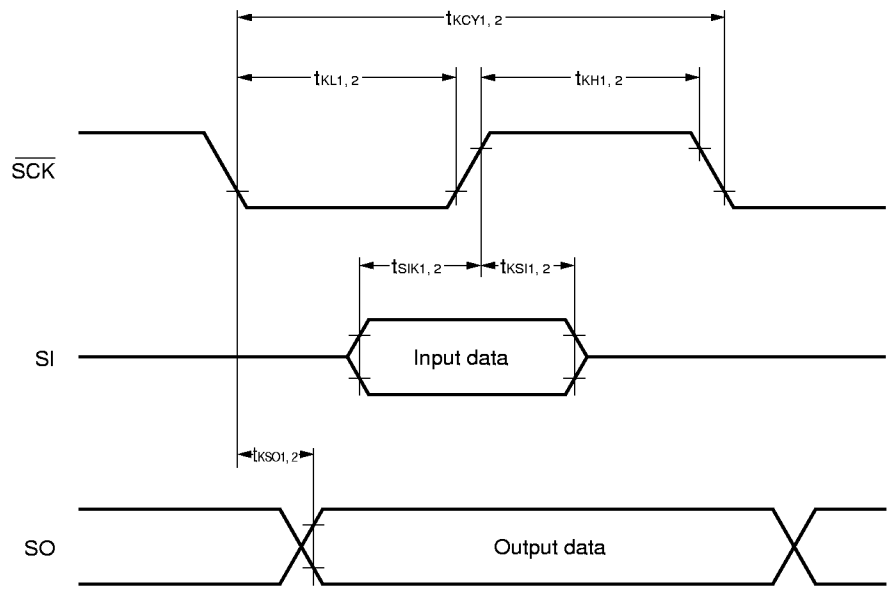


TI0, TI1, TI2 timing

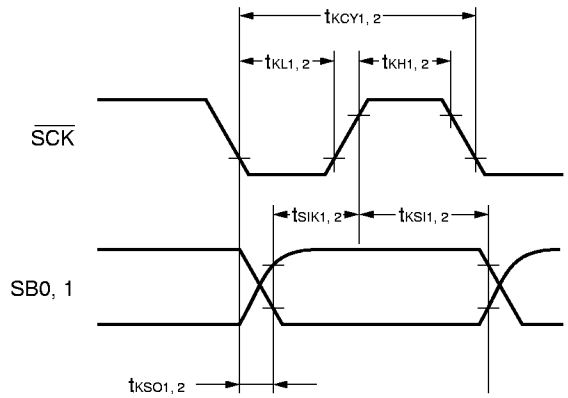


Serial transfer timing

3-wire serial I/O mode

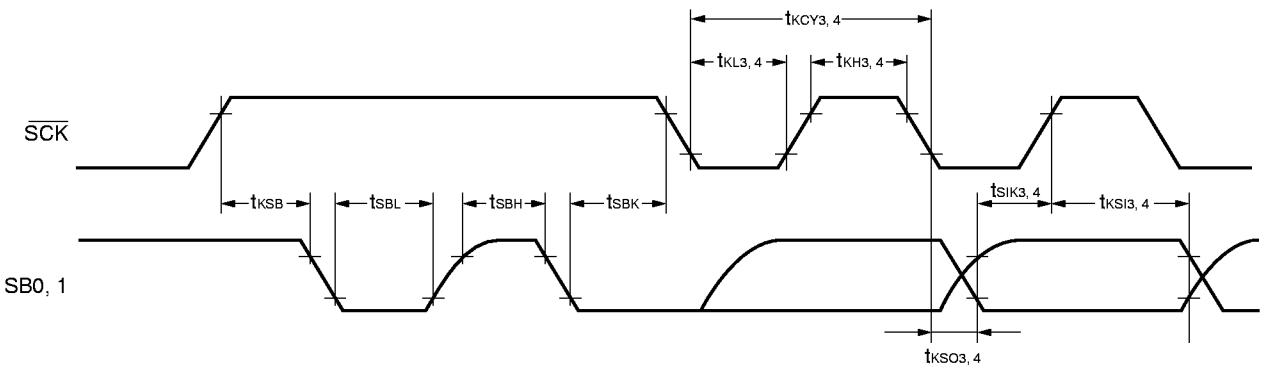


2-wire serial I/O mode

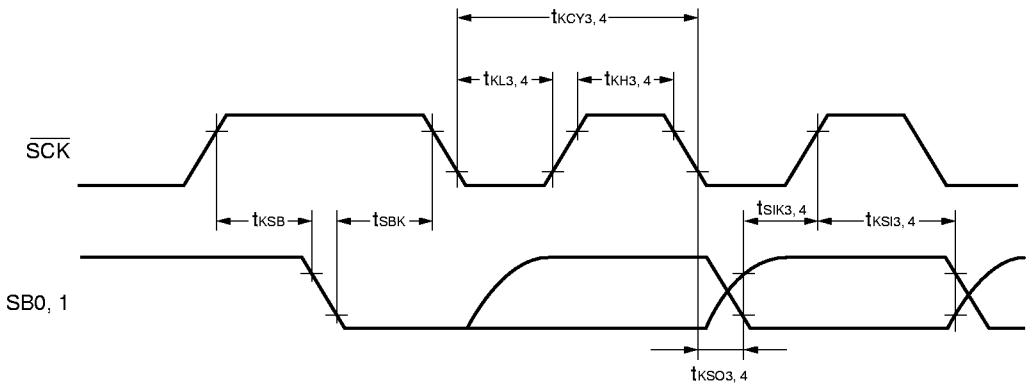


Serial transfer timing

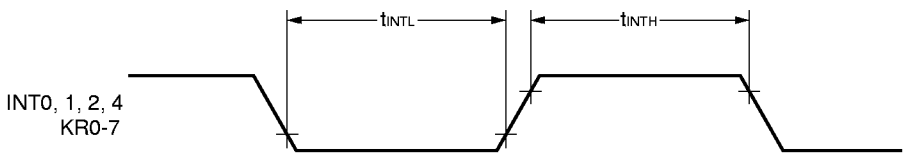
Bus release signal transfer



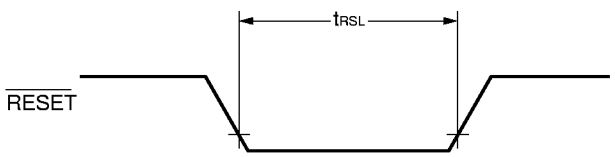
Command signal transfer



Interrupt input timing



$\overline{\text{RESET}}$ input timing



Data retention characteristics of data memory in STOP mode and at low supply voltage
(T_A = –40 to +85 °C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Release signal setup time	t_{SREL}		0			μs
Oscillation stabilization wait time[Note 1]	t_{WAIT}	Released by $\overline{RESET}$		**Note 2**		ms
		Released by interrupt request		**Note 3**		ms

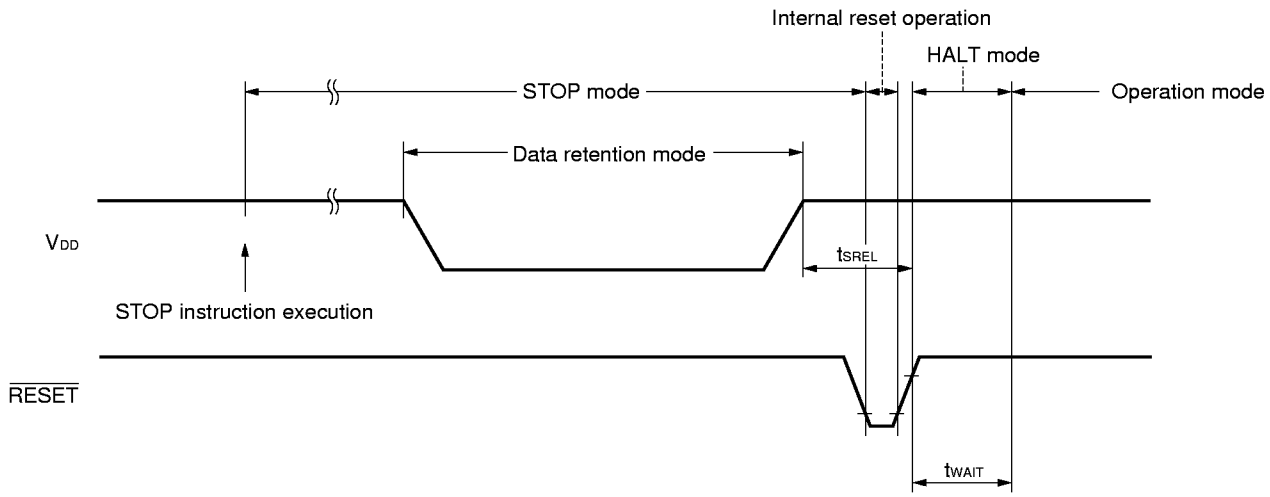
Notes 1. The oscillation stabilization wait time is the time during which the CPU stops operating to prevent unstable operation when oscillation is started.

2. Either $2^{17}/f_x$ or $2^{15}/f_x$ can be selected by mask option.

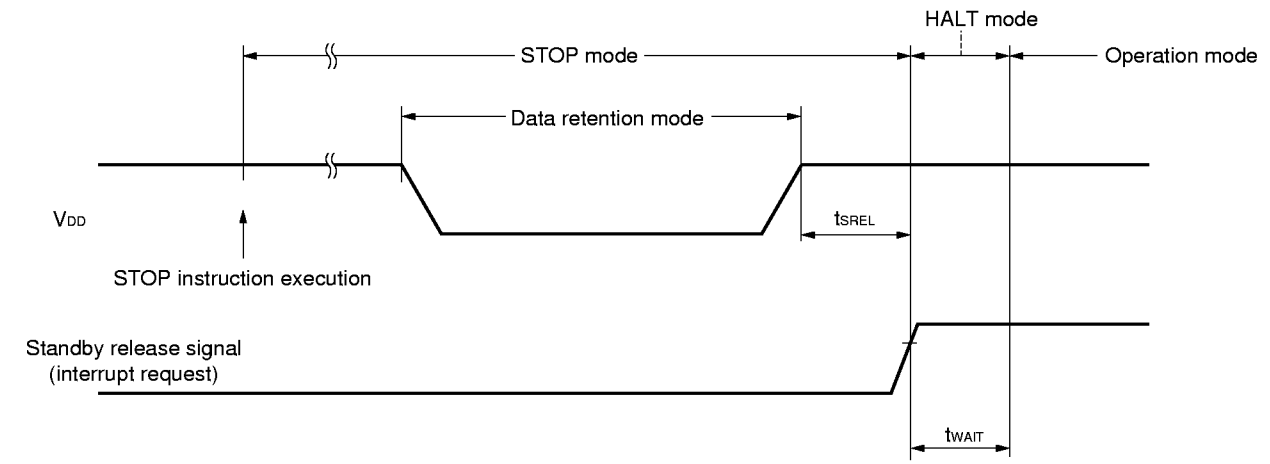
3. Set by the basic interval timer mode register (BTM). (Refer to the table below.)

BTM3	BTM2	BTM1	BTM0	Wait Time	
				f_x = 4.19 MHz	f_x = 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 (when STOP mode released by $\overline{RESET}$)

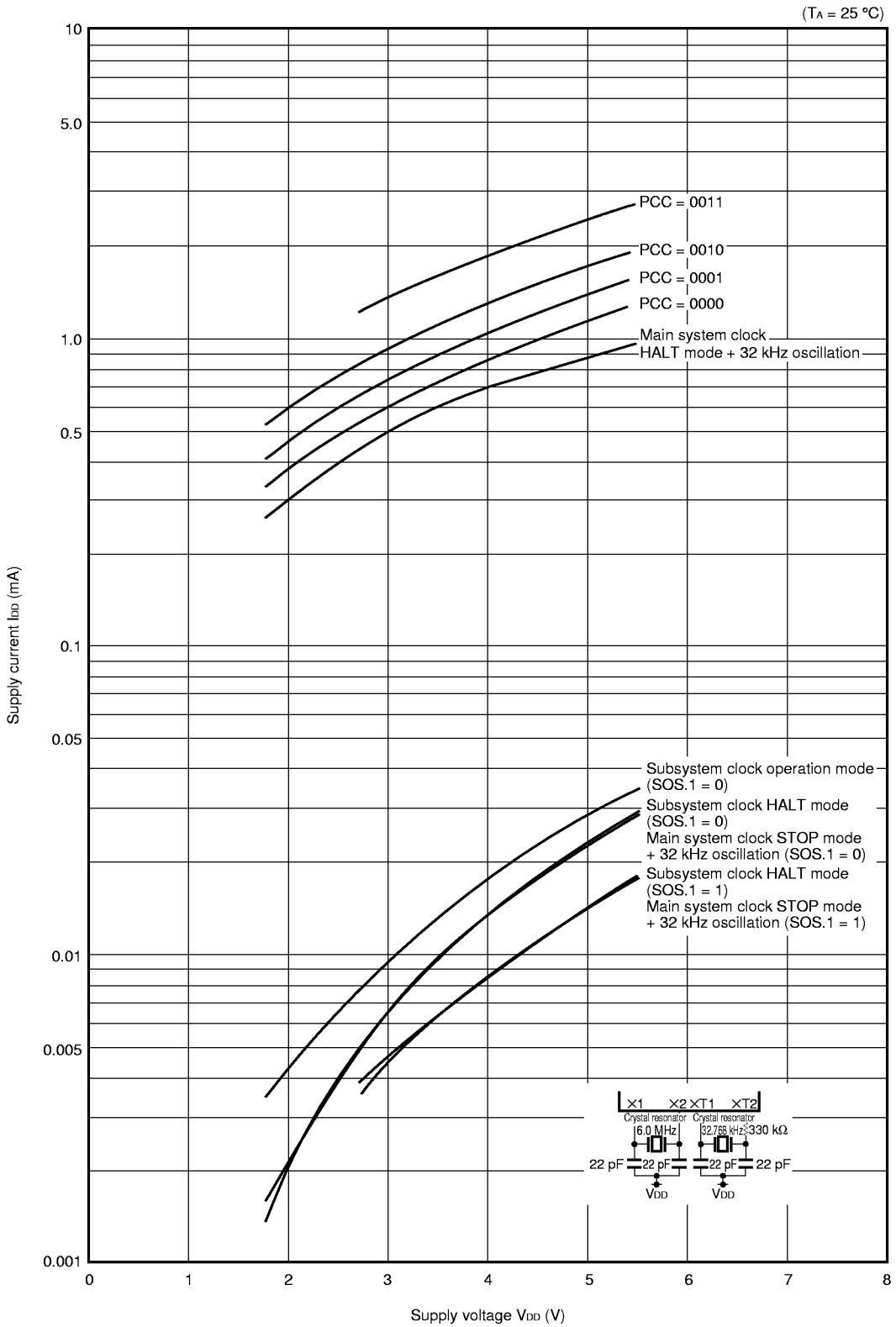


Data retention timing (standby release signal: when STOP mode released by interrupt signal)

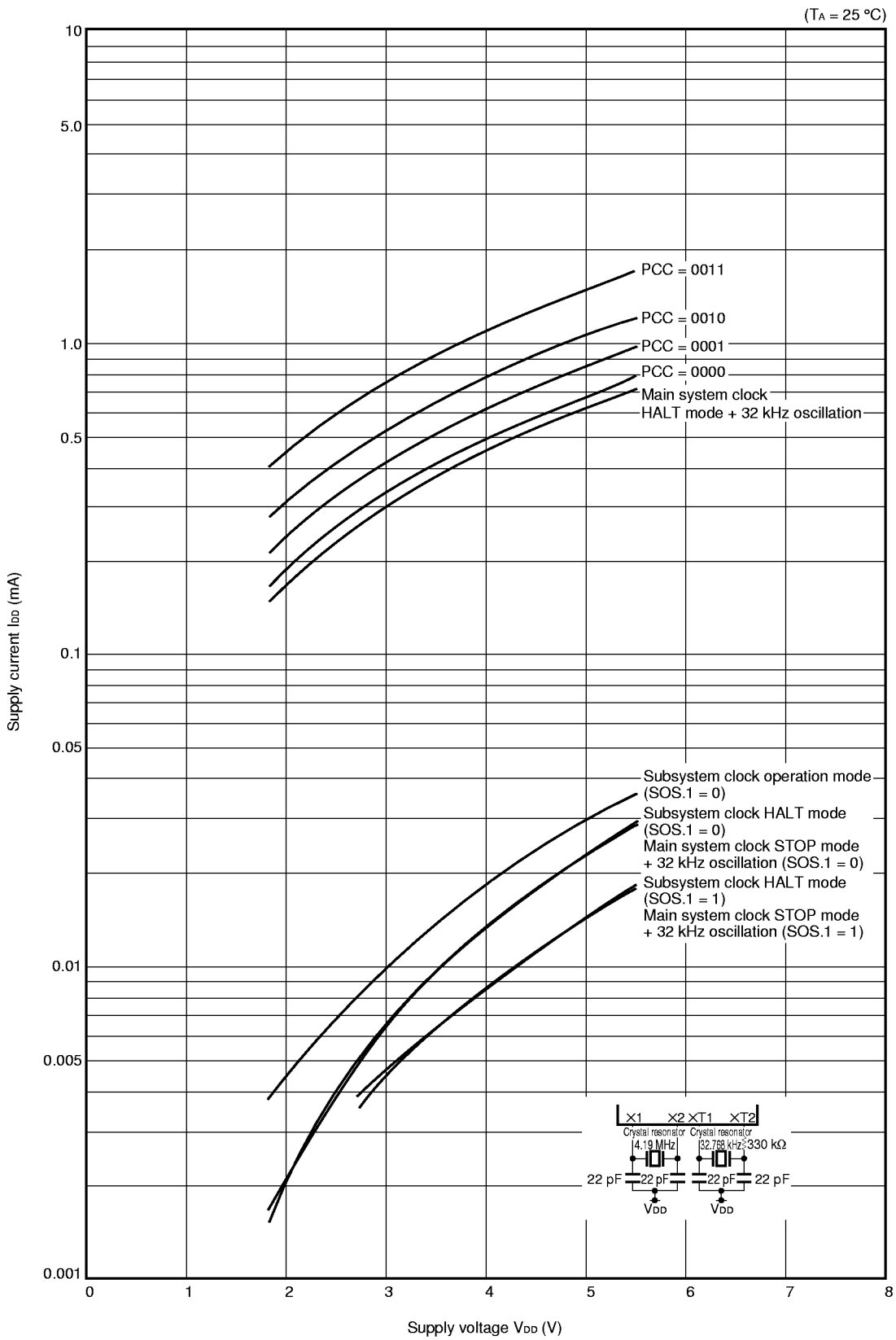


13. CHARACTERISTIC CURVE (reference)

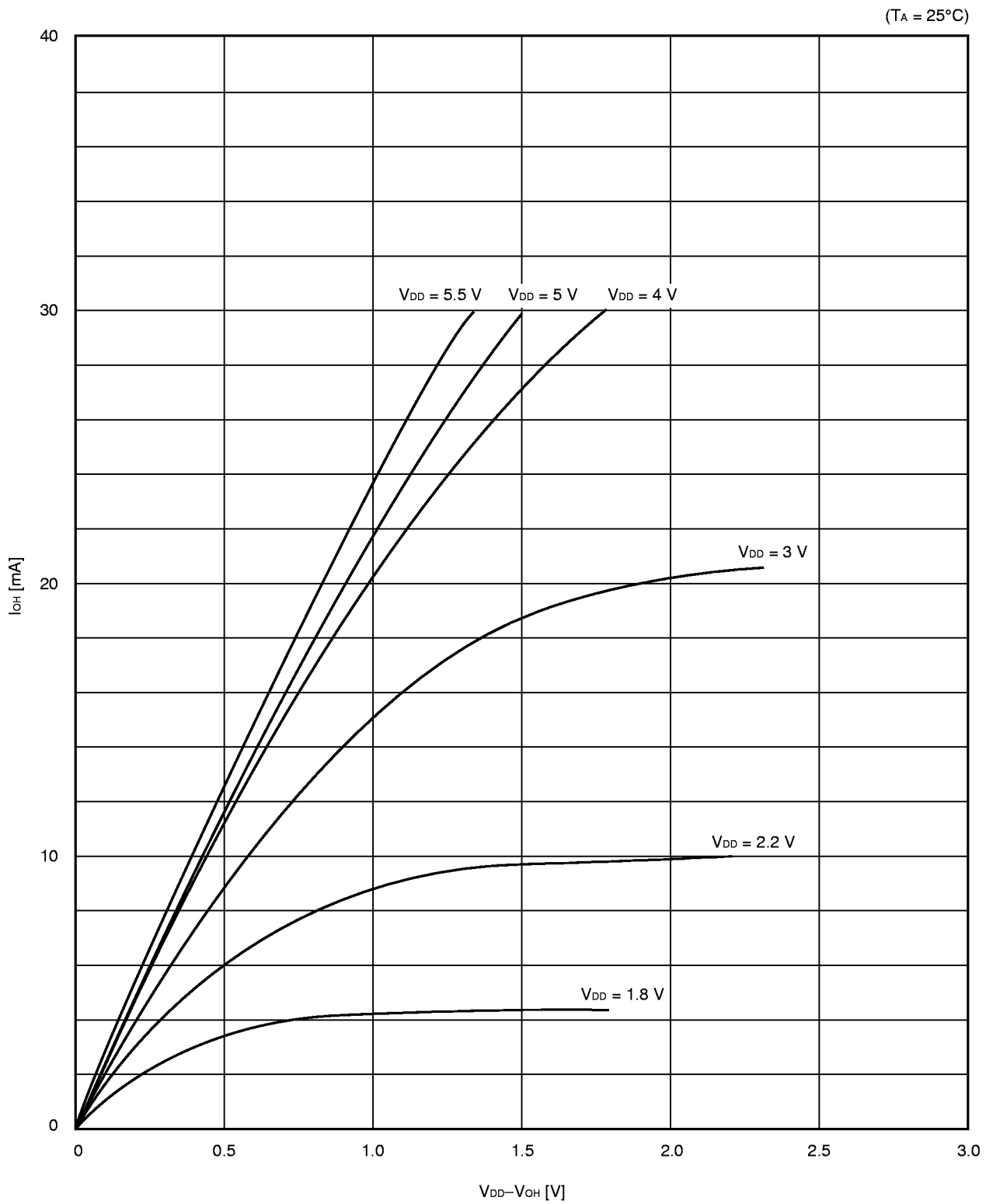
I_{DD} vs. V_{DD} (main system clock: 6.0 MHz crystal resonator)



I_{DD} vs. V_{DD} (main system clock: 4.19 MHz crystal resonator)

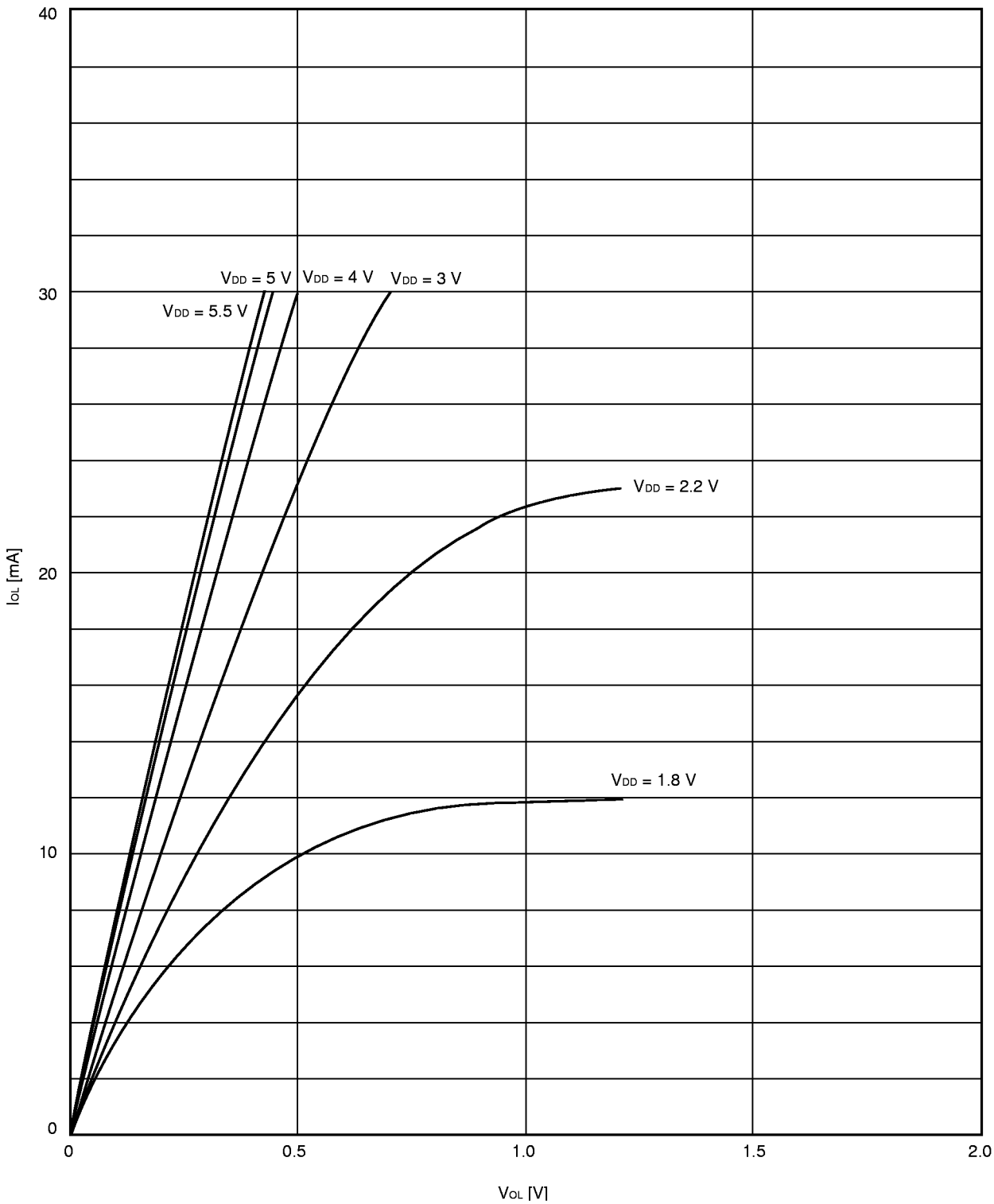


★ **I_{OH} vs. $V_{DD} - V_{OH}$ (ports 2, 3, 6-8)**



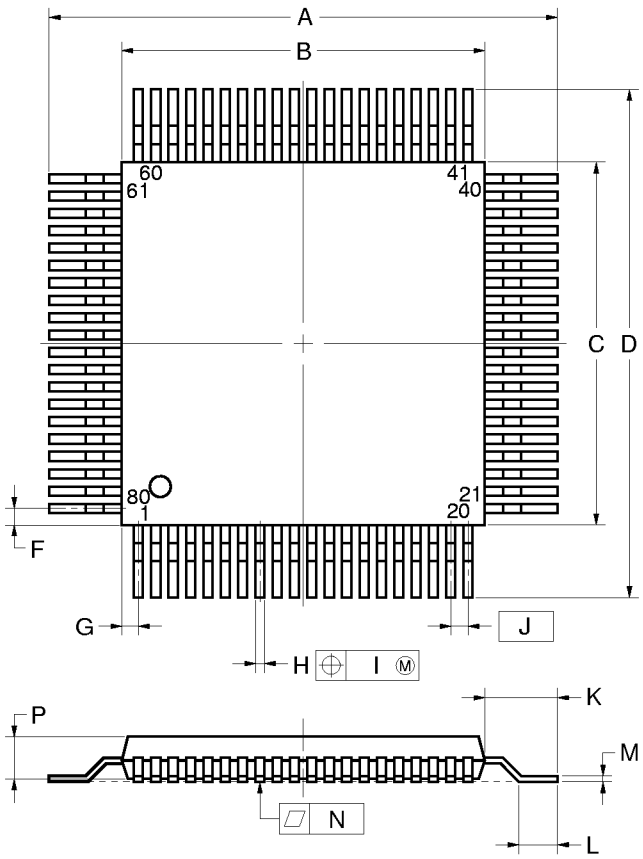
★ **I_{OL} vs. V_{OL} (ports 2, 3, 6-8)**

(T_A = 25°C)

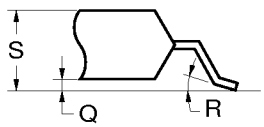


14. PACKAGE DRAWINGS

★ 80 PIN PLASTIC QFP (14x14)



detail of lead end



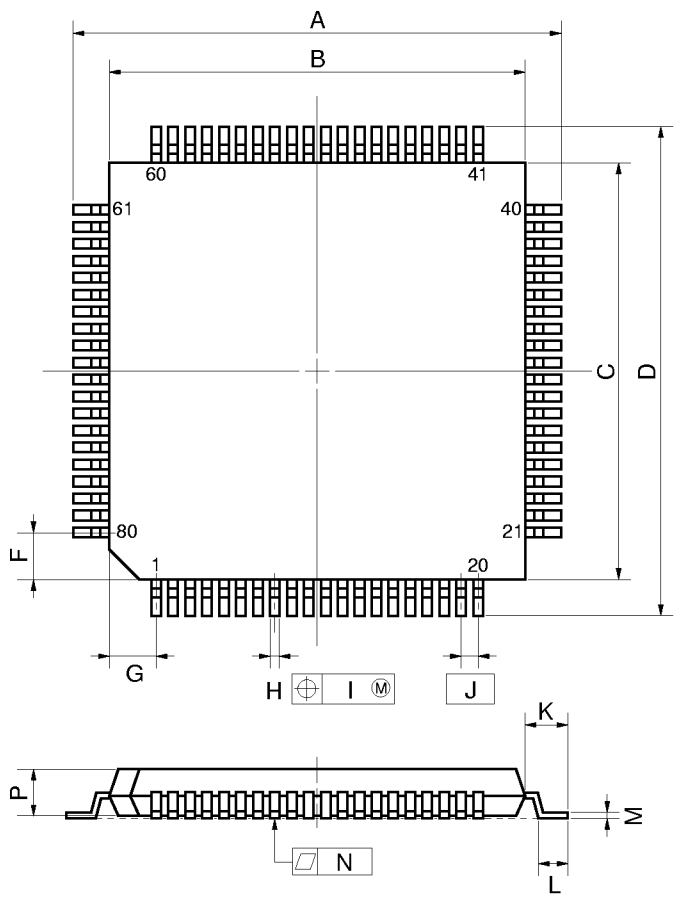
NOTE

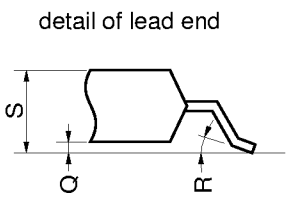
Each lead centerline is located within 0.13 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	17.2±0.4	0.677±0.016
B	14.0±0.2	$0.551^{+0.009}_{-0.008}$
C	14.0±0.2	$0.551^{+0.009}_{-0.008}$
D	17.2±0.4	0.677±0.016
F	0.825	0.032
G	0.825	0.032
H	0.30±0.10	$0.012^{+0.004}_{-0.005}$
I	0.13	0.005
J	0.65 (T.P.)	0.026 (T.P.)
K	1.6±0.2	0.063±0.008
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±0.1	$0.106^{+0.005}_{-0.004}$
Q	0.1±0.1	0.004±0.004
R	5°±5°	5°±5°
S	3.0 MAX.	0.119 MAX.

S80GC-65-3B9-5

80 PIN PLASTIC TQFP (FINE PITCH) (12 × 12)





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	14.0±0.2	$0.551^{+0.009}_{-0.008}$
B	12.0±0.2	$0.472^{+0.009}_{-0.008}$
C	12.0±0.2	$0.472^{+0.009}_{-0.008}$
D	14.0±0.2	$0.551^{+0.009}_{-0.008}$
F	1.25	0.049
G	1.25	0.049
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	$0.145^{+0.055}_{-0.045}$	0.006±0.002
N	0.10	0.004
P	1.05	0.041
Q	0.05±0.05	0.002±0.002
R	5°±5°	5°±5°
S	1.27 MAX.	0.050 MAX.

P80GK-50-BE9-4

15. RECOMMENDED SOLDERING CONDITIONS

Solder the μPD753036 under the following recommended conditions.

For the details on the recommended soldering conditions, refer to Information Document **Semiconductor Device Mounting Technology Manual (C10535E)**.

For the soldering methods and conditions other than those recommended, consult NEC.

Table 15-1. Soldering Conditions of Surface Mount Type

(1) μPD753036GC-×××-3B9: 80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)

Soldering Method	Soldering Conditions	Symbol of Recommended Condition
Infrared reflow	Package peak temperature: 235 °C, Time: 30 seconds max. (210 °C min.), Number of times: 3 max.	IR35-00-3
VPS	Package peak temperature: 215 °C, Time: 40 seconds max. (200 °C min.), Number of times: 3 max.	VP15-00-3
Wave soldering	Soldering bath temperature: 260 °C max., Time: 10 seconds max., Number of times: 1 Preheating temperature: 120 °C max. (package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 300 °C max., Time: 3 seconds max. (per side of device)	–

(2) μPD753036GK-×××-BE9: 80-pin plastic TQFP (fine pitch) (12 × 12 mm, 0.5-mm pitch)

Soldering Method	Soldering Conditions	Symbol of Recommended Condition
Infrared reflow	Package peak temperature: 235 °C, Time: 30 seconds max. (210 °C min.), Number of times: 2 max.	IR35-00-2
VPS	Package peak temperature: 215 °C, Time: 40 seconds max. (200 °C min.), Number of times: 2 max.	VP15-00-2
Partial heating	Pin temperature: 300 °C max., Time: 3 seconds max. (per side of device)	–

APPENDIX A. μPD75336, 753036, 75P3036 FUNCTION LIST

Parameter		μPD75336	μPD753036	μPD75P3036
Program memory		Mask ROM 0000H-3F7FH (16256 × 8 bits)	Mask ROM 0000H-3FFFH (16384 × 8 bits)	One-time PROM 0000H-3FFFH (16384 × 8 bits)
Data memory		000H-2FFH (768 × 4 bits)		
CPU		75X High-End	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)		
Pin connection	48	P22/PCL	P22/PCL/PTO2	
	50-53	P30-P33		P30/MD0-P33/MD3
	55	P81	P81/T12	
	57	IC		V_{PP}
Stack	SBS register	None	SBS.3 = 1: Mk I mode selection SBS.3 = 0: Mk II mode selection	
	Stack area	000H-0FFH	n00H-nFFH (n = 0-2)	
	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	
Timer		4 channels • Basic interval timer: 1 channel • 8-bit timer/event counter: 2 channels • 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, career generator, timer with gate) • Watch timer: 1 channel	

Parameter		μPD75336	μPD753036	μPD75P3036
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, 4, 32 kHz (Main system clock: during 4.19 MHz operation, or subsystem clock: during 32.762 kHz 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)		Yes		
Standby release by INT0		No	Yes	
Vectored interrupt		External: 3, internal: 4	External: 3, internal: 5	
Operating supply voltage		V_{DD} = 2.7 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 TQFP (fine pitch) (12 × 12 mm, 0.5-mm pitch) • 80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)		

APPENDIX B. DEVELOPMENT TOOLS

The following development tools are provided for system development using the μPD753036.

In 75XL series, relocatable assemblers common to the entire series are used in combination with the device file for each product type.

Language processor

RA75X relocatable assembler	Host machine	OS	Distribution media	Part number (product name)
	PC-9800 series	MS-DOS™ (Ver. 3.30 to Ver. 6.2 Note)	3.5-inch 2HD	μS5A13RA75X
			5-inch 2HD	μS5A10RA75X
	IBM PC/AT™ compatible machines	Refer to "**OS for IBM PC**"	3.5-inch 2HC	μS7B13RA75X
			5-inch 2HC	μS7B10RA75X

Device file	Host machine	OS	Distribution media	Part number (product name)
	PC-9800 series	MS-DOS (Ver. 3.30 to Ver. 6.2 Note)	3.5-inch 2HD	μS5A13DF753036
			5-inch 2HD	μS5A10DF753036
	IBM PC/AT compatible machines	Refer to "**OS for IBM PC**"	3.5-inch 2HC	μS7B13DF753036
			5-inch 2HC	μS7B10DF753036

Note Ver.5.00 and the upper versions of Ver.5.00 have the task swap function, but it cannot be used for this software.

Remark The operation of the assembler and the device file is guaranteed only on the above host machines and OSs.

PROM write tools

<table>
<tr><td rowspan="4">Hardware</td><td>PG-1500</td><td colspan="4">PG-1500 is a PROM programmer which enables you to program single chip microcontrollers containing PROM by stand-alone or host machine operation by connecting an attached board and optional programmer adapter to PG-1500. It also enables you to program typical PROM devices of 256 Kbits to 4 Mbits.</td></tr>
<tr><td>PA-75P328GC</td><td colspan="4">PROM programmer adapter for the μPD75P3036GC. Connect the programmer adapter to PG-1500 for use.</td></tr>
<tr><td>PA-75P316GK</td><td colspan="4">PROM programmer adapter for the μPD75P3036GK. Connect the programmer adapter to PG-1500 for use.</td></tr>
<tr><td>PA-75P3036KK-T</td><td colspan="4">PROM programmer adapter for the μPD75P3036KK-T. Connect the programmer adapter to PG-1500 for use.</td></tr>
<tr><td rowspan="5">Software</td><td rowspan="5">PG-1500 controller</td><td colspan="4">PG-1500 and a host machine are connected by serial and parallel interfaces and PG-1500 is controlled on the host machine.</td></tr>
<tr><td rowspan="2">Host machine</td><td rowspan="2">OS</td><td rowspan="2">Distribution media</td><td rowspan="2">Part number (product name)</td></tr>
<tr></tr>
<tr><td>PC-9800 series</td><td>MS-DOS (Ver. 3.30 to Ver. 6.2 Note)</td><td>3.5-inch 2HD</td><td>μS5A13PG1500</td></tr>
<tr><td>IBM PC/AT compatible machines</td><td>Refer to “OS for IBM PC”</td><td>5-inch 2HD</td><td>μS5A10PG1500</td></tr>
<tr><td></td><td></td><td>3.5-inch 2HD</td><td>μS7B13PG1500</td></tr>
<tr><td></td><td></td><td>5-inch 2HC</td><td>μS7B10PG1500</td></tr>
</table>

Note Ver.5.00 and the upper versions of Ver.5.00 have the task swap function, but it cannot be used for this software.

Remark The operation of the PG-1500 controller is guaranteed only on the above host machines and OSs.

Debugging tool

The in-circuit emulators (IE-75000-R and IE-75001-R) are available as the program debugging tool for the μPD753036.

The system configurations are described as follows.

Hardware	IE-75000-R[Note 1]	In-circuit emulator for debugging the hardware and software when developing the application systems that use the 75X series and 75XL series. When developing a μPD753036 subseries, the emulation board IE-75300-R-EM and emulation probe EP-75336GC-R or EP-75336GK-R that are sold separately must be used with the IE-75000-R. By connecting with the host machine and the PROM programmer, efficient debugging can be made. It contains the emulation board IE-75000-R-EM which is connected.			
	IE-75001-R	In-circuit emulator for debugging the hardware and software when developing the application systems that use the 75X series and 75XL series. When developing a μPD753036 sub-series, the emulation board IE-75300-R-EM and emulation probe EP-75336GC-R or EP-75336GK-R which are sold separately must be used with the IE-75001-R. It can debug the system efficiently by connecting the host machine and PROM programmer.			
	IE-75300-R-EM	Emulation board for evaluating the application systems that use the μPD753036 subseries. It must be used with the IE-75000-R or IE-75001-R.			
	EP-75336GC-R EV-9200GC-80	Emulation probe for the μPD753036GC. It must be connected to IE-75000-R (or IE-75001-R) and IE-75300-R-EM. It is supplied with the 80-pin conversion socket EV-9200GC-80 which facilitates connection to a target system.			
	EP-75336GK-R TGK-080SDW[Note 2]	Emulation probe for the μPD753036GK. It must be connected to the IE-75000-R (or IE-75001-R) and IE-75300-R-EM. It is supplied with the 80-pin conversion adapter TGK-080SDW which facilitates connection to a target system.			
Software	IE control program	Connects the IE-75000-R or IE-75001-R to a host machine via RS-232-C and Centronics I/F and controls the above hardware on a host machine.			
		Host machine	OS	Distribution media	Part number (product name)
		PC-9800 series	MS-DOS Ver. 3.30 to Ver. 6.2 [Note 3]	3.5-inch 2HD	μS5A13IE75X
				5-inch 2HD	μS5A10IE75X
		IBM PC/AT compatible machines	Refer to "**OS for IBM PC**"	3.5-inch 2HC	μS7B13IE75X
				5-inch 2HC	μS7B10IE75X

Notes 1. Maintenance parts

2. This is a product of Tokyo Eletech Corp. (03-5295-1661).
When purchasing this product, consult your NEC distributor.

3. Ver.5.00 and the upper versions of Ver.5.00 have the task swap function, but it cannot be used for this software.

Remarks 1. The operation of the IE control program is guaranteed only on the above host machines and OSs.

2. The μPD753036 subseries consists of the μPD753036 and 75P3036.

OS for IBM PC

The following IBM PC OS's are supported.

OS	Version
PC DOS™	Ver. 5.02 to Ver. 6.3 J6.1/V[Note] to J6.3/V[Note]
MS-DOS	Ver. 5.0 to Ver. 6.22 5.0/V[Note] to 6.2/V[Note]
IBM DOS™	J5.02/V[Note]

Note Only English version is supported.

Caution Ver.5.00 and the upper versions of Ver.5.0 have the task swap function, but it cannot be used for this software.

APPENDIX C. RELATED DOCUMENTS

Some of the following related documents are preliminary.

Device Related Documents

Document Name	Document No.	
	Japanese	English
μPD753036 Data Sheet	U11353J	U11353E (this document)
μPD75P3036 Data Sheet	U11575J	U11575E
μPD753036 User's Manual	U10201J	U10201E
μPD753036 Instruction	IEM-5063	–
75XL Series Selection Guide	U10453J	U10453E

Development Tool Related Documents

Document Name			Document No.	
			Japanese	English
Hardware	IE-75000 R/IE-75001-R User's Manual		EEU-846	EEU-1416
	IE-75300-R-EM User's Manual		U11354J	U11354E
	EP-75336GC/GK-R User's Manual		U10644J	U10644E
★	PG-1500 User's Manual		U11940J	U11940E
Software	RA75X Assembler Package User's Manual	Operation	U12622J	U12622E
★		Language	U12385J	U12385E
		Structured Assembler Preprocessor	U12598J	U12598E
	PG-1500 Controller User's Manual	PC-9800 Series (MS-DOS) Base	EEU-704	EEU-1291
		IBM PC Series (PC DOS) Base	EEU-5008	U10540E

Other Documents

Document Name	Document No.	
	Japanese	English
IC Package Manual	C10943X	
Semiconductor Device Mounting Technology Manual	C10535J	C10535E
Quality Grades on NEC Semiconductor Devices	C11531J	C11531E
NEC Semiconductor Device Reliability/Quality Control System	C10983J	C10983E
Guide to Prevent Damage for Semiconductor Devices by Electrostatic Discharge (ESD)	C11892J	–
Semiconductor Device Quality/Reliability Handbook	C12769J	–
Microcomputer Product Series Guide	U11416J	–

Caution The above related documents are subject to change without notice. For design purpose, etc., be sure to use the latest documents.

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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