NEC

MOS INTEGRATED CIRCUIT

μPD78F4216A, 78F4218A, 78F4216AY, 78F4218AY

16-BIT SINGLE-CHIP MICROCONTROLLERS

DESCRIPTION

The μPD78F4216A/78F4218A and 78F4216AY/78F4218AY are products of μPD784216A/784218A, 784216AY/784218AY Subseries in the 78K/IV Series.

The μPD78F4216A/78F4218A have flash memory in place of the internal ROM of the μPD784216A/784218A. The incorporation of flash memory allows a program to be written or erased while mounted on the target board.

The μPD78F4216AY/78F4218AY are based on the μPD78F4216A/78F4218A Subseries with the addition of a multimaster-supporting I^2C bus interface.

Detailed function descriptions are provided in the following user's manuals. Be sure to read them before designing.

μPD784216A, 784216AY Subseries User's Manual Hardware: U13570E
μPD784218A, 784218AY Subseries User's Manual Hardware: U12970E
78K/IV Series User's Manual Instructions: U10905E

FEATURES

- Pin compatible with the mask ROM products
- Flash memory: 128 KB (μPD78F4216A/78F4216AY)
  256 KB (μPD78F4218A/78F4218AY)
- Internal RAM: 8,192 bytes (μPD78F4216A/78F4216AY)
  12,800 bytes (μPD78F4218A/78F4218AY)
- Supply voltage: V_{DD} = 1.9 to 5.5 V

APPLICATIONS

Cellular phones, PHS, cordless telephones, CD-ROM, AV equipment

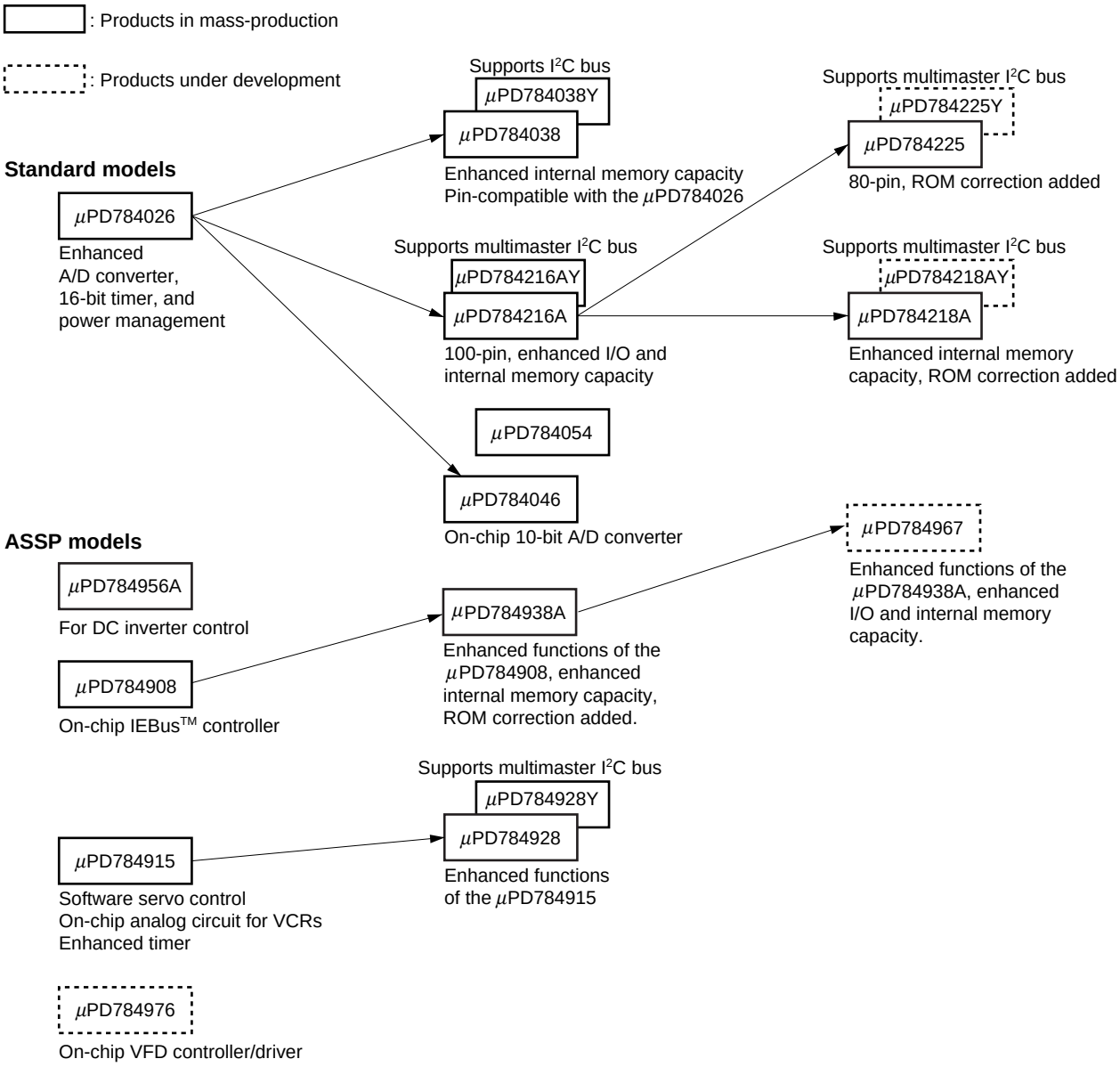
Unless otherwise specified, references in this document to the μPD78F4218AY refer to the μPD78F4216A, 78F4218A, 78F4216AY, and 78F4218AY.

Document No. U14125EJ1V0DS00 (1st edition)
Date Published November 2000 N CP(K)
Printed in Japan

ORDERING INFORMATION

Part Number	Package	Internal ROM (Bytes)	Internal RAM (Bytes)
μPD78F4216AGC-8EU	100-pin plastic LQFP (fine pitch) (14 × 14)	128 K	8,192
μPD78F4216AGF-3BA	100-pin plastic QFP (14 × 20)	128 K	8,192
μPD78F4218AGC-8EU	100-pin plastic LQFP (fine pitch) (14 × 14)	256 K	12,800
μPD78F4218AGF-3BA	100-pin plastic QFP (14 × 20)	256 K	12,800
μPD78F4216AYGC-8EU	100-pin plastic LQFP (fine pitch) (14 × 14)	128 K	8,192
μPD78F4216AYGF-3BA	100-pin plastic QFP (14 × 20)	128 K	8,192
μPD78F4218AYGC-8EU	100-pin plastic LQFP (fine pitch) (14 × 14)	256 K	12,800
μPD78F4218AYGF-3BA	100-pin plastic QFP (14 × 20)	256 K	12,800

78K/IV SERIES LINEUP



OVERVIEW OF FUNCTIONS (1/2)

Item \ Part Number		μPD78F4216A, μPD78F4216AY	μPD78F4218A, μPD78F4218AY
Number of basic instructions (mnemonics)		113	
General-purpose registers		8 bits × 16 registers × 8 banks, or 16 bits × 8 registers × 8 banks (memory mapping)	
Minimum instruction execution time		• 160 ns/320 ns/640 ns/1,280 ns/2,560 ns (@f_{XX} = 12.5 MHz operation with main system clock) • 61 μs (@f_{XT} = 32.768 kHz operation with subsystem clock)	
Internal memory	Flash memory	128 KB	256 KB
	RAM	8,192 bytes	12,800 bytes
Memory space		1 MB with program and data spaces combined	
I/O ports	Total	86	
	CMOS input	8	
	CMOS I/O	72	
	N-ch open-drain I/O	6	
Pins with additional functions[Note 1]	Pins with pull-up resistor	70	
	LED direct drive output	22	
	Middle-voltage pin	6	
Real-time output port		4 bits × 2 or 8 bits × 1	
Timer/event counter		Timer/event counter: (16-bit) — Timer counter × 1, Capture/compare register × 2 — Pulse output: • PPG output • Square wave output • One-shot pulse output	
		Timer/event counter 1: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
		Timer/event counter 2: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
		Timer/event counter 5: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
		Timer/event counter 6: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
		Timer/event counter 7: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
		Timer/event counter 8: (8-bit) — Timer counter × 1, Compare register × 1 — Pulse output: • PWM output • Square wave output	
Serial interface		• UART/IOE (3-wire serial I/O): 2 channels (on-chip baud rate generator) • CSI (3-wire serial I/O, multimaster supporting I^2C bus[Note 2]): 1 channel	
A/D converter		8-bit resolution × 8 channels	
D/A converter		8-bit resolution × 2 channels	

Notes 1. Pins with additional functions are included with the I/O pins.

2. μPD78F4216AY, 78F4218AY only

OVERVIEW OF FUNCTIONS (2/2)

Item \ Part Number		μPD78F4216A, μPD78F4216AY	μPD78F4218A, μPD78F4218AY
Clock output		Selectable from f_{XX}, $f_{XX}/2$, $f_{XX}/2^2$, $f_{XX}/2^3$, $f_{XX}/2^4$, $f_{XX}/2^5$, $f_{XX}/2^6$, $f_{XX}/2^7$, f_{XT}	
Buzzer output		Selectable from $f_{XX}/2^{10}$, $f_{XX}/2^{11}$, $f_{XX}/2^{12}$, $f_{XX}/2^{13}$	
Watch timer		1 channel	
Watchdog timer		1 channel	
Standby		• HALT/STOP/IDLE modes • In low power consumption mode (with subsystem clock): HALT/IDLE modes	
Interrupt	Hardware sources	29 (internal: 20, external: 9)	
	Software sources	BRK instruction, BRKCS instruction, operand error	
	Non-maskable	Internal: 1, external: 1	
	Maskable	Internal: 19, external: 8	
		• 4 programmable priority levels • 3 service modes: Vectored interrupt/macro service/context switching	
Supply voltage		V_{DD} = 1.9 to 5.5 V	
Package		100-pin plastic LQFP (fine pitch) (14 × 14) 100-pin plastic QFP (14 × 20)	

CONTENTS

1. DIFFERENCES AMONG MODELS IN μPD784216A/784216AY, 784218A/784218AY SUBSERIES

The only difference among the μPD784214A, 784215A, 784216A, 784217A, and 784218A lies in the internal memory capacity.

The μPD784214AY, 784215AY, 784216AY, 784217AY, and 784218AY are models with the addition of an I^2C bus control function.

The μPD78F4216A, 78F4216AY, 78F4218A, and 78F4218AY are provided with a 128 KB/256 KB flash memory instead of the mask ROM of the above models.

These differences are summarized in Table 1-1.

Table 1-1. Differences Among Models in μPD784216A/784216AY, 784218A/784218AY Subseries

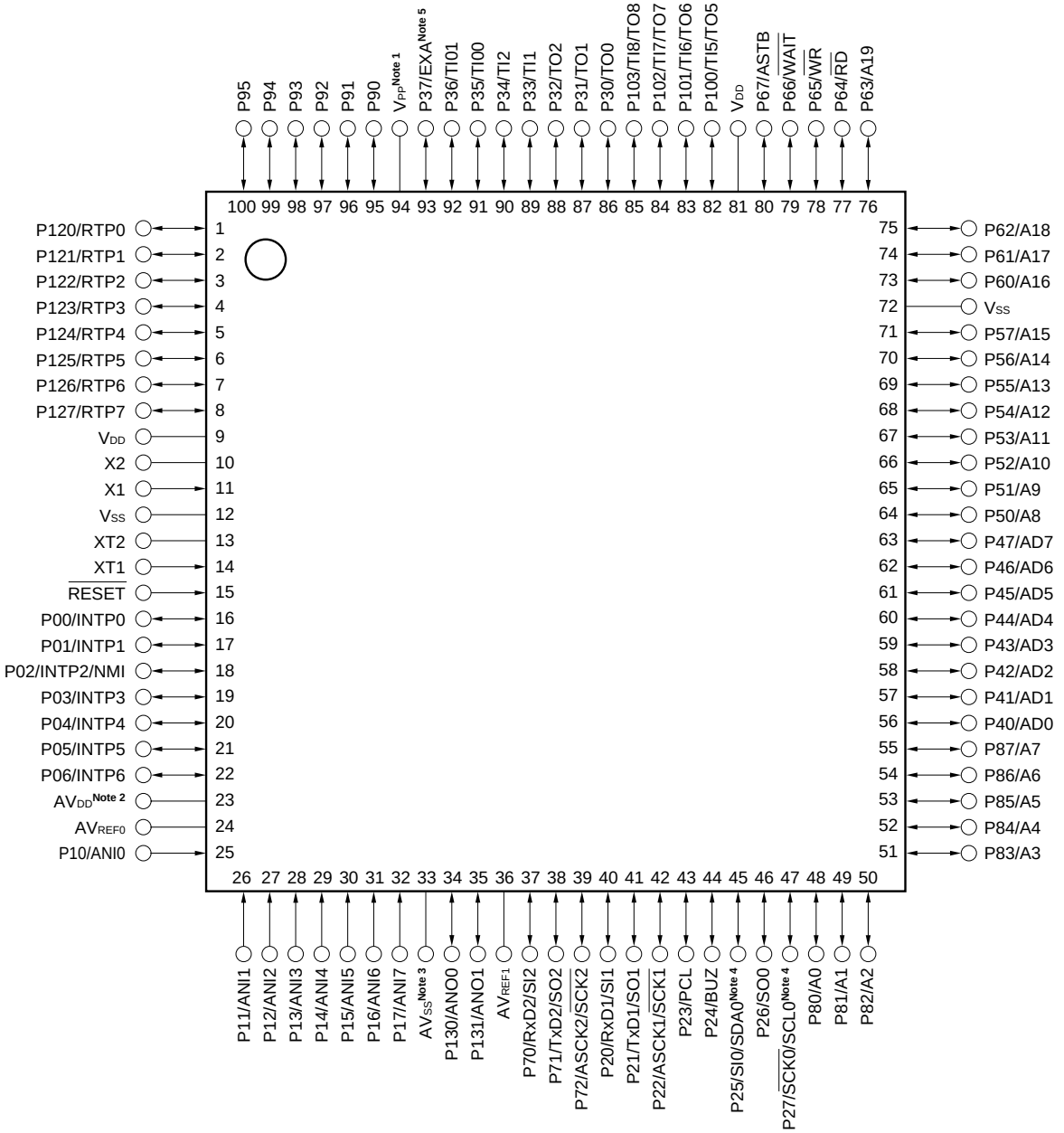
Item \ Part Number	μPD784214A, μPD784214AY	μPD784215A, μPD784215AY	μPD784216A, μPD784216AY	μPD784217A, μPD784217AY	μPD784218A, μPD784218AY	μPD78F4216A, μPD78F4216AY	μPD78F4218A, μPD78F4218AY
Internal ROM	96 KB (Mask ROM)	128 KB (Mask ROM)		192 KB (Mask ROM)	256 KB (Mask ROM)	128 KB (Flash memory)	256 KB (Flash memory)
Internal RAM	3,584 bytes	5,120 bytes	8,192 bytes	12,800 bytes		8,192 bytes	12,800 bytes
Internal memory size switching register (IMS)	Not provided					Provided[Note]	
ROM correction	Not provided			Provided		Not provided	Provided
External access status function	Not provided			Provided		Not provided	Provided
Supply voltage	V_{DD} = 1.8 to 5.5 V					V_{DD} = 1.9 to 5.5 V	
Electrical specifications	Refer to the data sheet for each device.						
Recommended soldering conditions							
EXA pin	Not provided			Provided		Not provided	Provided
TEST pin	Provided					Not provided	
V_{PP} pin	Not provided					Provided	

Note The internal flash memory capacity and internal RAM capacity can be changed using the internal memory size switching register (IMS).

Caution There are differences in noise immunity and noise radiation between the flash memory and mask ROM versions. When pre-producing an application set with the flash memory version and then mass-producing it with the mask ROM version, be sure to conduct sufficient evaluations on the commercial samples (not engineering samples) of the mask ROM version.

2. PIN CONFIGURATION (TOP VIEW)

- **100-pin plastic LQFP (fine pitch) (14 × 14)**
  μPD78F4216AGC-8EU, μPD78F4218AGC-8EU, μPD78F4216AYGC-8EU, μPD78F4218AYGC-8EU



Notes 1. Connect the V_{PP} pin to V_{SS} directly or via a pull-down resistor in normal operation mode. Connect the V_{PP} pin to V_{SS} via a pull-down resistor in a system in which the on-chip flash memory is written while mounted on the target board. For the pull-down connection, it is recommended to use a resistor with a resistance ranging from 470 Ω to 10 kΩ.

2. Connect the AV_{DD} pin to V_{DD}.

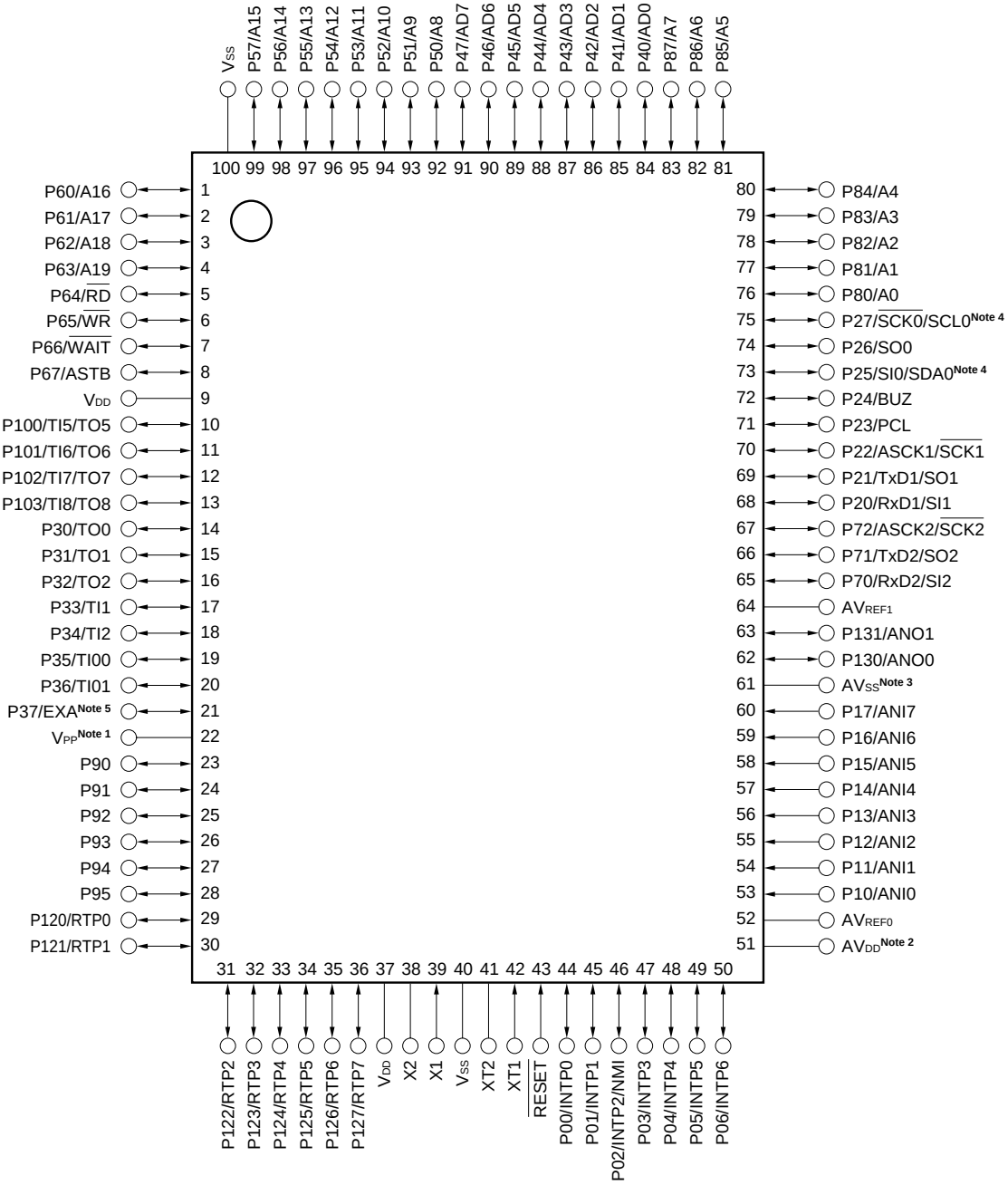
3. Connect the AV_{SS} pin to V_{SS}.

4. The SCL0 and SDA0 pins are available in the μPD78F4216AY, 78F4218AY only.

5. The EXA pin is available in the μPD78F4218A, 78F4218AY only.

- **100-pin plastic QFP (14 × 20)**

  μPD78F4216AGF-3BA, μPD78F4218AGF-3BA, μPD78F4216AYGF-3BA, μPD78F4218AYGF-3BA



Notes 1. Connect the V_{PP} pin to V_{SS} directly or via a pull-down resistor in normal operation mode. Connect the V_{PP} pin to V_{SS} via a pull-down resistor in a system in which the on-chip flash memory is written while mounted on the target board. For the pull-down connection, it is recommended to use a resistor with a resistance ranging from 470 Ω to 10 kΩ.

2. Connect the AV_{DD} pin to V_{DD}.

3. Connect the AV_{SS} pin to V_{SS}.

4. The SCL0 and SDA0 pins are available in the μPD78F4216AY, 78F4218AY only.

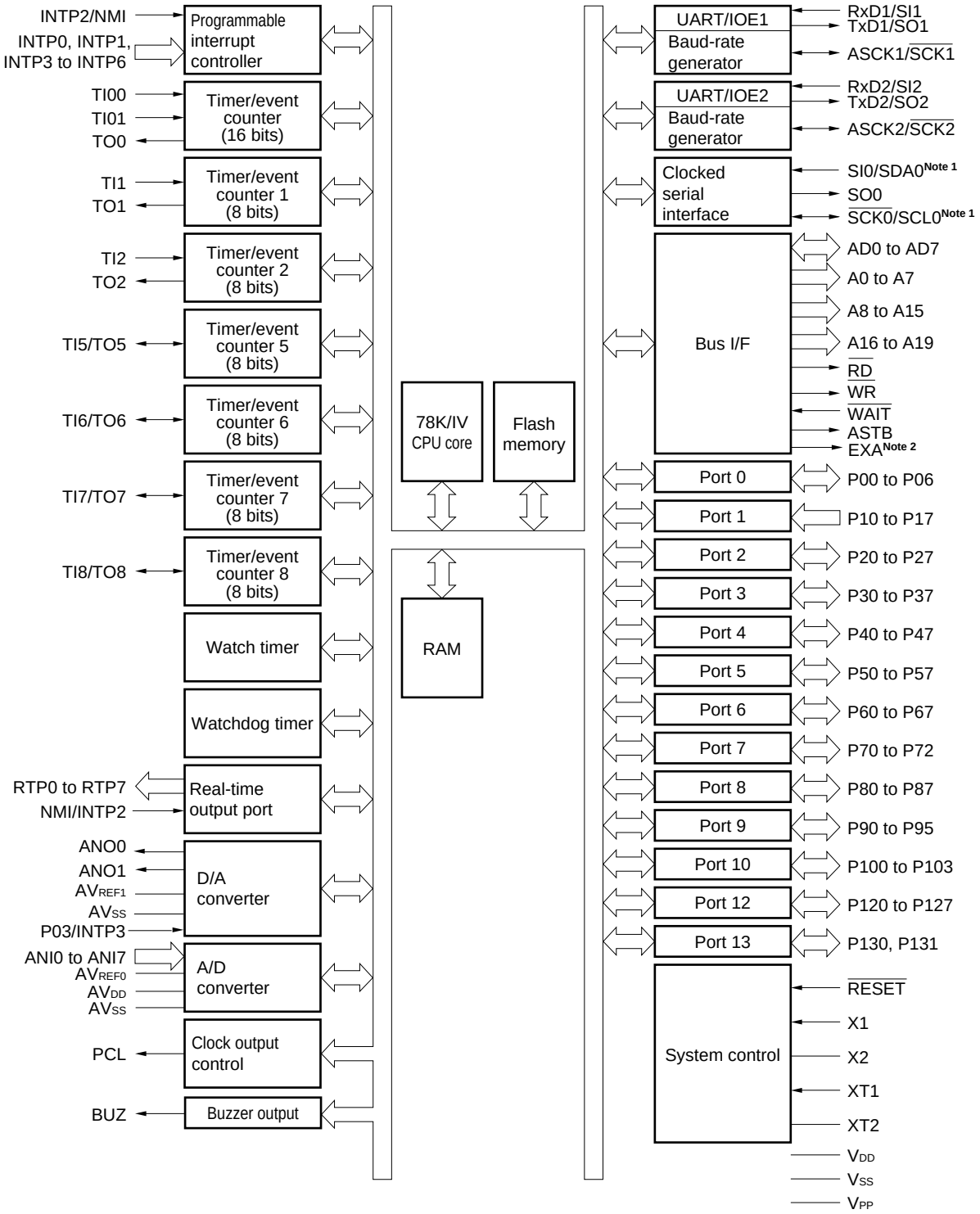
5. The EXA pin is available in the μPD78F4218A, 78F4218AY only.

A0 to A19:	Address Bus	P120 to P127:	Port 12
AD0 to AD7:	Address/Data Bus	P130, P131:	Port 13
ANI0 to ANI7:	Analog Input	PCL:	Programmable Clock
ANO0, ANO1:	Analog Output	$\overline{RD}$:	Read Strobe
ASCK1, ASCK2:	Asynchronous Serial Clock	$\overline{RESET}$:	Reset
ASTB:	Address Strobe	RTP0 to RTP7:	Real-time Output Port
AV_{DD}:	Analog Power Supply	RxD1, RxD2:	Receive Data
AV_{REF0}, AV_{REF1}:	Analog Reference Voltage	$\overline{SCK0}$ to $\overline{SCK2}$:	Serial Clock
AV_{SS}:	Analog Ground	SCL0[Note 1]:	Serial Clock
BUZ:	Buzzer Clock	SDA0[Note 1]:	Serial Data
EXA[Note 2]:	External Access Status Output	SI0 to SI2:	Serial Input
INTP0 to INTP6:	Interrupt from Peripherals	SO0 to SO2:	Serial Output
NMI:	Non-maskable Interrupt	TI00, TI01,	
P00 to P06:	Port 0	TI1, TI2, TI5 to TI8:	Timer Input
P10 to P17:	Port 1	TO0 to TO2, TO5 to TO8:	Timer Output
P20 to P27:	Port 2	TxD1, TxD2:	Transmit Data
P30 to P37:	Port 3	V_{DD}:	Power Supply
P40 to P47:	Port 4	V_{PP}:	Programming Power Supply
P50 to P57:	Port 5	V_{SS}:	Ground
P60 to P67:	Port 6	$\overline{WAIT}$:	Wait
P70 to P72:	Port 7	$\overline{WR}$:	Write Strobe
P80 to P87:	Port 8	X1, X2:	Crystal (Main System Clock)
P90 to P95:	Port 9	XT1, XT2:	Crystal (Subsystem Clock)
P100 to P103:	Port 10		

Notes 1. The SCL0 and SDA0 pins are available in the μPD78F4216AY, 78F4218AY only.

2. The EXA pin is available in the μPD78F4218A, 78F4218AY only.

3. BLOCK DIAGRAM



Notes 1. This function supports the I^2C bus interface and is available in the μPD78F4216AY, 78F4218AY only.

2. The EXA pin is available in the μPD78F4218A, 78F4218AY only.

4. PIN FUNCTIONS

4.1 Port Pins (1/2)

Pin Name	I/O	Alternate Function	Function
P00	I/O	INTP0	Port 0 (P0): • 7-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P01		INTP1	
P02		INTP2/NMI	
P03		INTP3	
P04		INTP4	
P05		INTP5	
P06		INTP6	
P10 to P17	Input	ANI0 to ANI7	Port 1 (P1): • 8-bit input only port
P20	I/O	RxD1/SI1	Port 2 (P2): • 8-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P21		TxD1/SO1	
P22		ASCK1/$\overline{\text{SCK1}}$	
P23		PCL	
P24		BUZ	
P25		SI0/SDA0[Note 1]	
P26		SO0	
P27		$\overline{\text{SCK0}}$/SCL0[Note 1]	
P30	I/O	TO0	Port 3 (P3): • 8-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P31		TO1	
P32		TO2	
P33		TI1	
P34		TI2	
P35		TI00	
P36		TI01	
P37		EXA[Note 2]	
P40 to P47	I/O	AD0 to AD7	Port 4 (P4): • 8-bit I/O port • Input/output can be specified in 1-bit units. • When used as an input port, an on-chip pull-up resistor can be specified by means of software. • LEDs can be driven directly.
P50 to P57	I/O	A8 to A15	Port 5 (P5): • 8-bit I/O port • Input/output can be specified in 1-bit units. • When used as an input port, an on-chip pull-up resistor can be specified by means of software. • LEDs can be driven directly.

Notes 1. This SDA0 and SCL0 are available in the μPD78F4216AY, 78F4218AY only.

2. This function is available in the μPD78F4218A, 784218AY only.

4.1 Port Pins (2/2)

Pin Name	I/O	Alternate Function	Function
P60	I/O	A16	Port 6 (P6): • 8-bit I/O port • Input/output can be specified in 1-bit units. • When used as an input port, an on-chip pull-up resistor can be specified by means of software.
P61		A17	
P62		A18	
P63		A19	
P64		$\overline{RD}$	
P65		$\overline{WR}$	
P66		$\overline{WAIT}$	
P67		ASTB	
P70	I/O	RxD2/SI2	Port 7 (P7): • 3-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P71		TxD2/SO2	
P72		ASCK2/$\overline{SCK2}$	
P80 to P87	I/O	A0 to A7	Port 8 (P8): • 8-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software. • The interrupt control flag (KRIF) is set to 1 when a falling edge is detected at a pin of this port.
P90 to P95	I/O	–	Port 9 (P9): • N-ch open-drain middle-voltage I/O port • 6-bit I/O port • Input/output can be specified in 1-bit units. • LEDs can be driven directly.
P100	I/O	TI5/TO5	Port 10 (P10): • 4-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P101		TI6/TO6	
P102		TI7/TO7	
P103		TI8/TO8	
P120 to P127	I/O	RTP0 to RTP7	Port 12 (P12): • 8-bit I/O port • Input/output can be specified in 1-bit units. • Whether specifying input mode or output mode, an on-chip pull-up resistor can be specified in 1-bit units by means of software.
P130, P131	I/O	ANO0, ANO1	Port 13 (P13): • 2-bit I/O port • Input/output can be specified in 1-bit units.

4.2 Non-Port Pins (1/2)

Pin Name	I/O	Alternate Function	Function
TI00	Input	P35	External count clock input to 16-bit timer counter
TI01		P36	Capture trigger signal input to capture/compare register 00
TI1		P33	External count clock input to 8-bit timer counter 1
TI2		P34	External count clock input to 8-bit timer counter 2
TI5		P100/TO5	External count clock input to 8-bit timer counter 5
TI6		P101/TO6	External count clock input to 8-bit timer counter 6
TI7		P102/TO7	External count clock input to 8-bit timer counter 7
TI8		P103/TO8	External count clock input to 8-bit timer counter 8
TO0	Output	P30	16-bit timer output (shared by 14-bit PWM output)
TO1		P31	8-bit timer output (shared by 8-bit PWM output)
TO2		P32	
TO5		P100/TI5	
TO6		P101/TI6	
TO7		P102/TI7	
TO8		P103/TI8	
RxD1	Input	P20/SI1	Serial data input (UART1)
RxD2		P70/SI2	Serial data input (UART2)
TxD1	Output	P21/SO1	Serial data output (UART1)
TxD2		P71/SO2	Serial data output (UART2)
ASCK1	Input	P22/$\overline{SCK1}$	Baud rate clock input (UART1)
ASCK2		P72/$\overline{SCK2}$	Baud rate clock input (UART2)
SI0	Input	P25/SDA0**Note**	Serial data input (3-wire serial I/O 0)
SI1		P20/RxD1	Serial data input (3-wire serial I/O 1)
SI2		P70/RxD2	Serial data input (3-wire serial I/O 2)
SO0	Output	P26	Serial data output (3-wire serial I/O 0)
SO1		P21/TxD1	Serial data output (3-wire serial I/O 1)
SO2		P71/TxD2	Serial data output (3-wire serial I/O 2)
SDA0**Note**	I/O	P25/SI0	Serial data input/output (I^2C bus)
$\overline{SCK0}$		P27/SCL0**Note**	Serial clock input/output (3-wire serial I/O 0)
$\overline{SCK1}$		P22/ASCK1	Serial clock input/output (3-wire serial I/O 1)
$\overline{SCK2}$		P72/ASCK2	Serial clock input/output (3-wire serial I/O 2)
SCL0**Note**		P27/$\overline{SCK0}$	Serial clock input/output (I^2C bus)
NMI	Input	P02/INTP2	Non-maskable interrupt request input
INTP0		P00	External interrupt request input
INTP1		P01	
INTP2		P02/NMI	
INTP3		P03	
INTP4		P04	
INTP5		P05	
INTP6		P06	

Note This function is available in the μPD78F4216AY, 78F4218AY only.

4.2 Non-Port Pins (2/2)

Pin Name	I/O	Alternate Function	Function
PCL	Output	P23	Clock output (for trimming main system clock and subsystem clock)
BUZ	Output	P24	Buzzer output
RTP0 to RTP7	Output	P120 to P127	Real-time output port that outputs data in synchronization with trigger
AD0 to AD7	I/O	P40 to P47	Lower address/data bus for expanding memory externally
A0 to A7	Output	P80 to P87	Lower address bus for expanding memory externally
A8 to A15		P50 to P57	Middle address bus for expanding memory externally
A16 to A19		P60 to P63	Higher address bus for expanding memory externally
$\overline{RD}$	Output	P64	Strobe signal output for reading from external memory
$\overline{WR}$		P65	Strobe signal output for writing to external memory
$\overline{WAIT}$	Input	P66	Wait insertion at external memory access
ASTB	Output	P67	Strobe output that externally latches address information output to ports 4 through 6 and 8 to access external memory
EXA**Note**	Output	P37	Status signal output at external memory access
$\overline{RESET}$	Input	–	System reset input
X1	Input	–	Connecting crystal resonator for main system clock oscillation
X2	–		
XT1	Input	–	Connecting crystal resonator for subsystem clock oscillation
XT2	–		
ANI0 to ANI7	Input	P10 to P17	A/D converter analog input
ANO0, ANO1	Output	P130, P131	D/A converter analog output
AV_{REF0}	–	–	A/D converter reference voltage input
AV_{REF1}			D/A converter reference voltage input
AV_{DD}			A/D converter positive power supply. Connect to V_{DD}.
AV_{SS}			GND for A/D converter and D/A converter. Connect to V_{SS}.
V_{DD}			Positive power supply
V_{SS}			GND
V_{PP}			Flash memory programming mode setting. Applying high-voltage for program write/verify. Connect this pin to V_{SS} directly or via a pull-down resistor in normal operation mode. Connect the V_{PP} pin to V_{SS} via a pull-down resistor in a system in which the on-chip flash memory is written while mounted on the target board. For the pull-down connection, it is recommended to use a resistor with a resistance ranging from 470 Ω to 10 kΩ.

Note The EXA pin is available in the μPD78F4218A, 78F4218AY only.

4.3 Pin I/O Circuits and Recommended Connections of Unused Pins

The I/O circuit type of each pin and recommended connections of unused pins are shown in Table 4-1. For each type of input/output circuit, refer to Figure 4-1.

Table 4-1. Types of Pin I/O Circuits and Recommended Connection of Unused Pins (1/2)

Pin Name	I/O Circuit Type	I/O	Recommended Connection of Unused Pins
P00/INTP0	8-N	I/O	Input: Independently connect to V_{SS} via a resistor Output: Leave open
P01/INTP1			
P02/INTP2/NMI			
P03/INTP3 to P06/INTP6			
P10/ANI0 to P17/ANI7	9	Input	Connect to V_{SS} or V_{DD}
P20/RxD1/SI1	10-K	I/O	Input: Independently connect to V_{SS} via a resistor Output: Leave open
P21/TxD1/SO1	10-L		
P22/ASCK1/$\overline{SCK1}$	10-K		
P23/PCL	10-L		
P24/BUZ			
P25/SI0/SDA0[Note 1]	10-K		
P26/SO0	10-L		
P27/$\overline{SCK0}$/SCL0[Note 1]	10-K		
P30/TO0 to P32/TO2	12-E		
P33/TI1, P34/TI2	8-N		
P35/TI00, P36/TI01	10-M		
P37/EXA[Note 2]	12-E		
P40/AD0 to P47/AD7	5-A		
P50/A8 to P57/A15			
P60/A16 to P63/A19			
P64/$\overline{RD}$			
P65/$\overline{WR}$			
P66/$\overline{WAIT}$			
P67/ASTB			
P70/RxD2/SI2	8-N		
P71/TxD2/SO2	10-M		
P72/ASCK2/$\overline{SCK2}$	8-N		
P80/A0 to P87/A7	12-E		
P90 to P95	13-D		
P100/TI5/TO5	8-N		
P101/TI6/TO6			
P102/TI7/TO7			
P103/TI8/TO8			
P120/RTP0 to P127/RTP7	12-E		
P130/ANO0, P131/ANO1	12-F		

Notes 1. The SDA0 and SCL0 pins are available in the μPD78F4216AY, 78F4218AY only.
2. The EXA pin is available in the μPD78F4218A, 78F4218AY only.

Table 4-1. Types of Pin I/O Circuits and Recommended Connection of Unused Pins (2/2)

Pin Name	I/O Circuit Type	I/O	Recommended Connection of Unused Pins
$\overline{\text{RESET}}$	2-G	Input	–
XT1	16		Connect to V_{SS}
XT2		–	Leave open
AV_{REF0}	–		Connect to V_{SS}
AV_{REF1}			Connect to V_{DD}
AV_{DD}			
AV_{SS}			Connect to V_{SS}
V_{PP}			Connect this pin to V_{SS} directly or via a pull-down resist in normal operation mode. Connect the V_{PP} pin to V_{SS} via a pull-down resistor in a system in which the on-chip flash memory is written while mounted on the target board. For the pull-down connection, it is recommended to use a resistor with a resistance ranging from 470 Ω to 10 kΩ.

Remark Because the circuit type numbers are standardized among the 78K Series products, they are not sequential in some models (i.e., some circuits are not provided).

Figure 4-1. Types of Pin I/O Circuits (1/2)

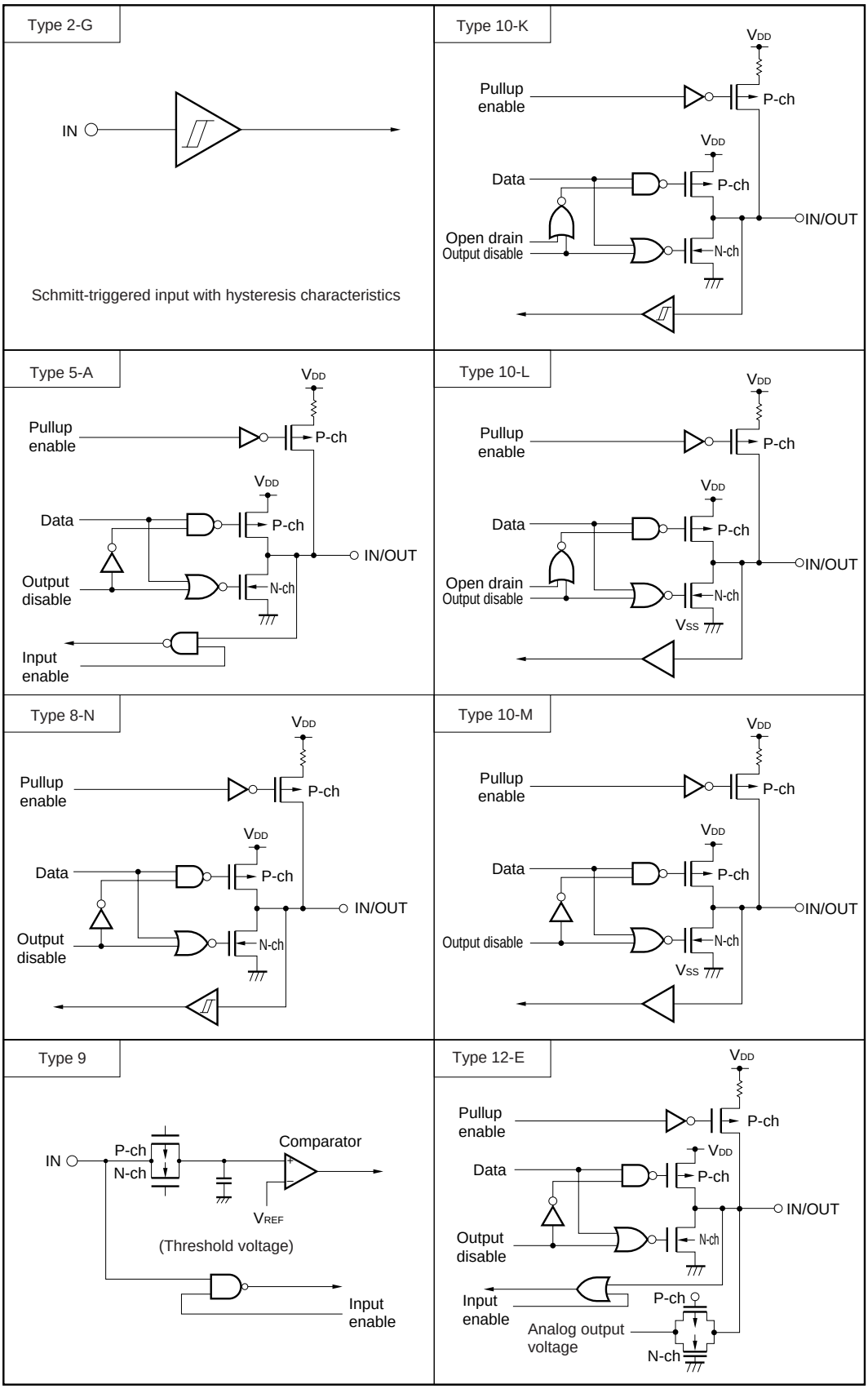
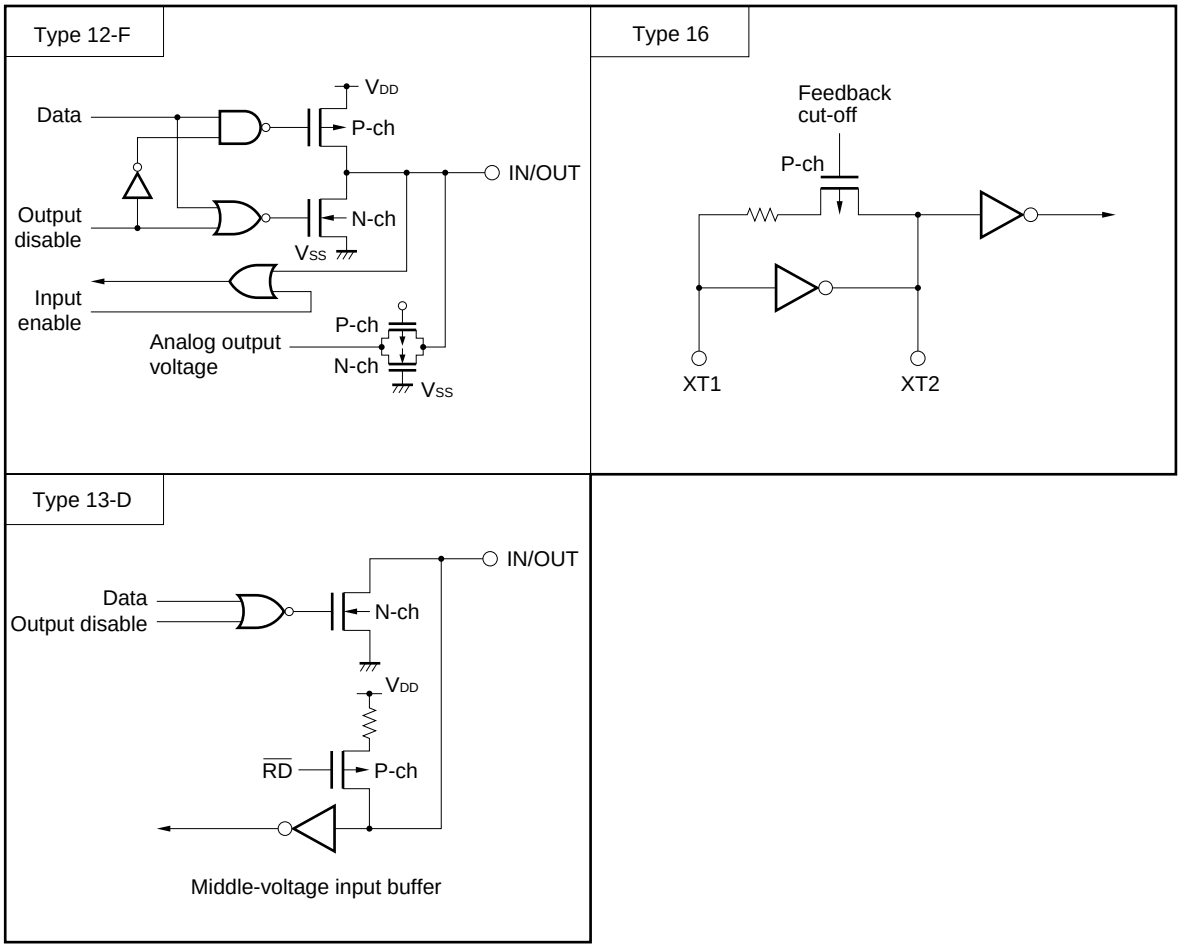


Figure 4-1. Types of Pin I/O Circuits (2/2)



5. INTERNAL MEMORY SIZE SWITCHING REGISTER (IMS)

IMS is a register that is set by software and is used to specify a part of the internal memory that is not to be used. By setting this register, the internal memory of the μPD78F4218AY can be mapped identically to that of a mask ROM version with a different internal memory (ROM and RAM) capacity.

IMS is set with an 8-bit memory manipulation instruction.

$\overline{\text{RESET}}$ input sets IMS to FFH.

(1) μPD78F4216A, 78F4216AY

Figure 5-1. Internal Memory Size Switching Register (IMS) Format

Address: 0FFFCH After reset: FFH W

	7	6	5	4	3	2	1	0
IMS	1	1	ROM1	ROM0	1	1	RAM1	RAM0

ROM1	ROM0	Internal ROM Capacity Selection
0	0	48 KB
0	1	64 KB
1	0	96 KB
1	1	128 KB

RAM1	RAM0	Peripheral RAM Capacity Selection
0	0	3,072 bytes
0	1	4,608 bytes
1	0	6,114 bytes
1	1	7,680 bytes

Caution IMS is not provided on the mask ROM versions (μPD784214A, 784215A, 784216A, μPD784214AY, 784215AY, and 784216AY).

Table 5-1 shows the IMS setting values to make the memory mapping the same as that of the mask ROM versions.

Table 5-1. Setting Value of Internal Memory Size Switching Register (IMS)

Target Mask ROM Version	IMS Setting Value
μPD784214A, 784214AY	ECH
μPD784215A, 784215AY	FDH
μPD784216A, 784216AY	FFH

(2) μPD78F4218A, 78F4218AY

Figure 5-2. Internal Memory Size Switching Register (IMS) Format

Address: 0FFFCH After reset: FFH W

	7	6	5	4	3	2	1	0
IMS	1	1	ROM1	ROM0	1	1	RAM1	RAM0

ROM1	ROM0	Internal ROM Capacity Selection
0	0	64 KB
0	1	128 KB
1	0	192 KB
1	1	256 KB

RAM1	RAM0	Peripheral RAM Capacity Selection
0	0	3,072 bytes
0	1	6,656 bytes
1	0	7,168 bytes
1	1	12,288 bytes

Caution IMS is not provided on the mask ROM versions (μPD784217A, 784218A, 784217AY, and 784218AY).

Table 5-2 shows the IMS setting values to make the memory mapping the same as that of the mask ROM versions.

Table 5-2. Setting Value of Internal Memory Size Switching Register (IMS)

Target Mask ROM Version	IMS Setting Value
μPD784217A, 784217AY	EFH
μPD784218A, 784218AY	FFH

6. PROGRAMMING FLASH MEMORY

The flash memory can be written with the μPD78F4218AY mounted on the target board (on-board). To do so, connect a dedicated flash programmer (Flashpro II (part number: FL-PR2), Flashpro III (part number: FL-PR3, PG-FP3) to the host machine and target system.

Writing to flash memory can also be performed using flash memory writing adapter connected to Flashpro II or Flashpro III.

Remark FL-PR2 and FL-PR3 are products of Naito Densei Machida Mfg. Co., Ltd.

6.1 Selecting Communication Mode

To write the flash memory, use Flashpro II and Flashpro III by serial communication. Select a serial communication mode from those listed in Table 6-1 in the format shown in Figure 6-1. Each communication mode is selected by the number of V_{PP} pulses shown in Table 6-1.

Table 6-1. Communication Modes

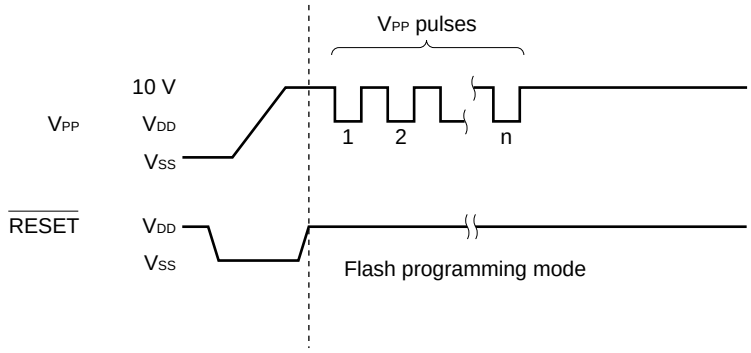
Communication Mode	Number of Channels	Pins Used	Number of V_{PP} Pulses
3-wire serial I/O	3	$\overline{SCK0}$/P27/SCL0[Note 1] SO0/P26 SI0/P25/SDA0[Note 1]	0
		$\overline{SCK1}$/ASCK1/P22 SO1/TxD1/P21 SI1/RxD1/P20	1
		$\overline{SCK2}$/ASCK2/P72 SO2/TxD2/P71 SI2/RxD2/P70	2
Handshake[Note 2]	1	$\overline{SCK0}$/P27/SCL0[Note 1] SO0/P26 SI0/P25/SDA0[Note 1] P24/BUZ	3
UART	2	TxD1/SO1/P21 RxD1/SI1/P20	8
		TxD2/SO2/P71 RxD2/SI2/P70	9

Notes 1. The SCL0 and SDA0 pins are available in the μPD78F4216AY, 78F4218AY only.

2. This made is available in the μPD78F4216A, 78F4216AY (other than I, K, E standard)
This made is available in the μPD78F4218A, 78F4218AY (other than I standard)

Caution Be sure to select a communication mode with the number of V_{PP} pulses shown in Table 6-1.

Figure 6-1. Communication Mode Selecting Format



6.2 Flash Memory Programming Function

The flash memory is written by transferring or receiving commands and data in a selected communication mode. The major functions of flash memory programming are listed in Table 6-2.

Table 6-2. Major Functions of Flash Memory Programming

Function	Description
Batch erasure	Erases all contents of memory.
Block erasure	Erases contents of specified memory block with one memory block consisting of 16 KB.
Batch blank check	Checks erased status of entire memory.
Block blank check	Checks erased status of specified block.
Data write	Writes flash memory based on write start address and number of data to be written (in bytes).
Batch verify	Compares all contents of memory with input data.
Block verify	Compares contents of specified memory block with input data.

6.3 Connecting Flashpro II and Flashpro III

The Flashpro II, Flashpro III and μPD78F4218AY are connected differently depending on the selected communication mode (3-wire serial I/O or UART). Figures 6-2 to 6-4 show the connections in the respective communication modes.

Figure 6-2. Connection of Flashpro II and Flashpro III in 3-Wire Serial I/O Mode

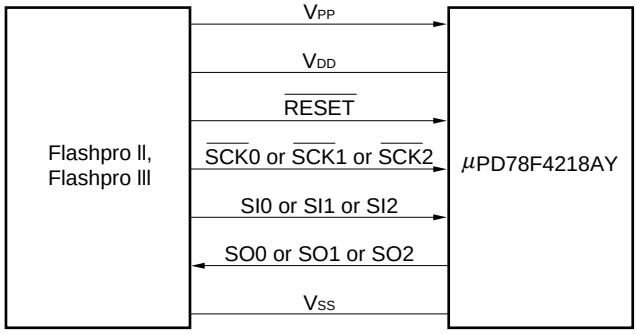


Figure 6-3. Connection of Flashpro III in Handshake Mode

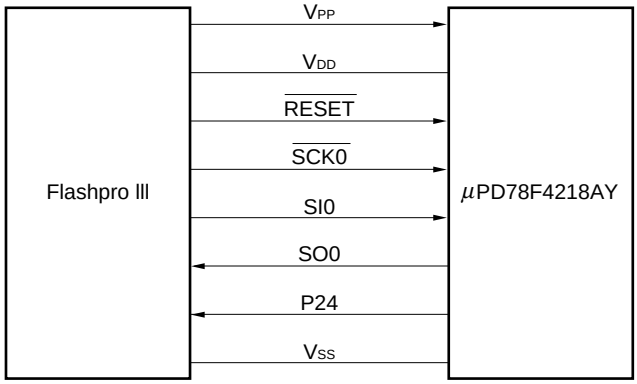
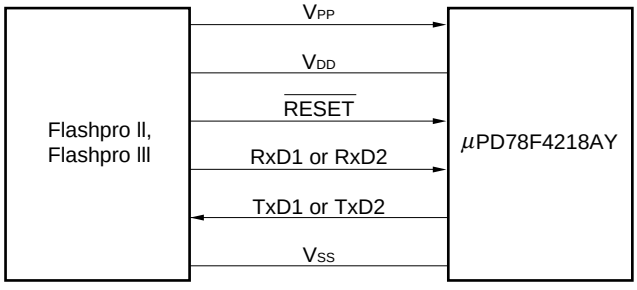


Figure 6-4. Connection of Flashpro II and Flashpro III in UART Mode



7. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C)

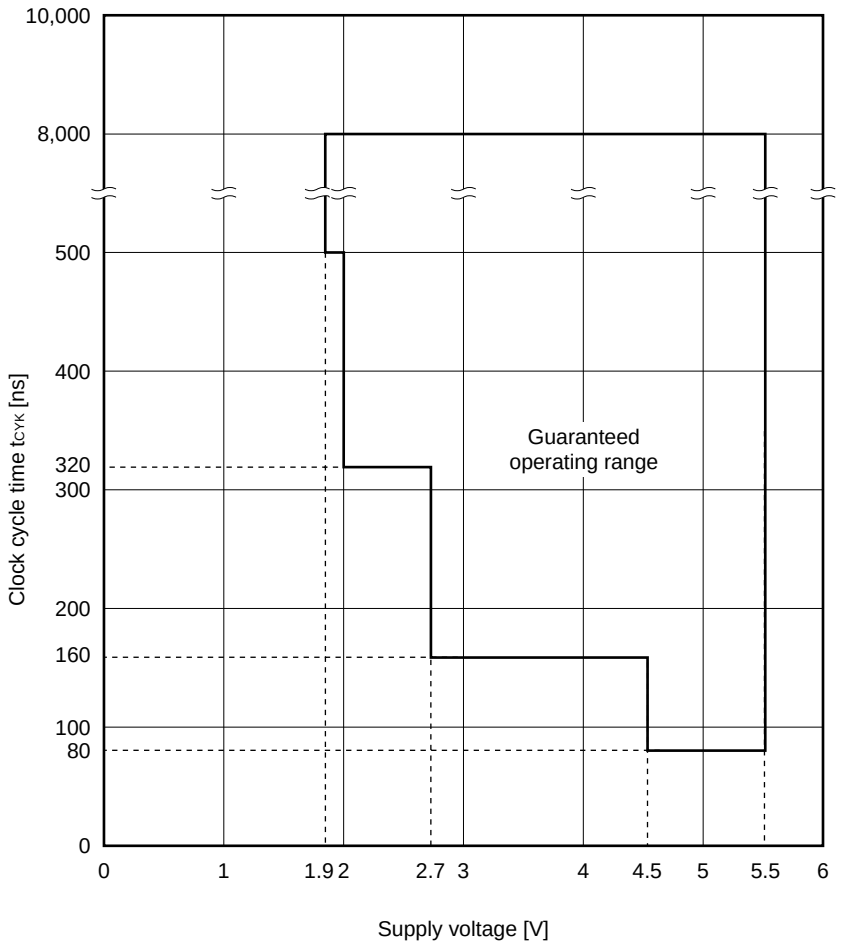
Parameter	Symbol	Conditions		Ratings	Unit
Supply voltage	V_{DD}			–0.3 to +6.5	V
	AV_{DD}			–0.3 to V_{DD} + 0.3	V
	AV_{SS}			–0.3 to V_{SS} + 0.3	V
	AV_{REF0}	A/D converter reference voltage input		–0.3 to V_{DD} + 0.3	V
	AV_{REF1}	D/A converter reference voltage input		–0.3 to V_{DD} + 0.3	V
Input voltage	V_{I1}	Other than P90 to P95		–0.3 to V_{DD} + 0.3	V
	V_{I2}	P90 to P95	N-ch open drain	–0.3 to +12	V
	V_{I3}	V_{PP} pin for programming		–0.3 to +10.5	V
Analog input voltage	V_{AN}	Analog input pin		AV_{SS} – 0.3 to AV_{REF0} + 0.3	V
Output voltage	V_O			–0.3 to V_{DD} + 0.3	V
Output current, low	I_{OL}	Per pin		15	mA
		Total of P2, P4 to P8		75	mA
		Total of P0, P3, P9, P10, P12, P13		75	mA
		Total of all pins		100	mA
Output current, high	I_{OH}	Per pin		–10	mA
		Total of all pins		–50	mA
Operating ambient temperature	T_A			–40 to +85	°C
Storage temperature	T_{stg}			–65 to +125	°C

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

Operating Conditions

- Operating ambient temperature (T_A): –40 to +85°C
- Supply voltage and clock cycle time: See Figure 7-1
- Operating voltage with subsystem clock operation: V_{DD} = 1.9 to 5.5 V

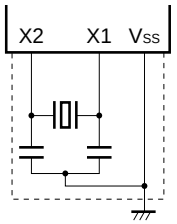
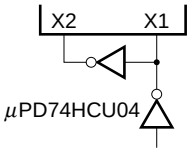
Figure 7-1. Supply Voltage and Clock Cycle Time (CPU Clock Frequency: f_{CPU})



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

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input capacitance	C_I	f = 1 MHz Unmeasured pins returned to 0 V.	Other than Port 9			15	pF
			Port 9			20	pF
Output capacitance	C_O		Other than Port 9			15	pF
			Port 9			20	pF
I/O capacitance	C_{IO}		Other than Port 9			15	pF
			Port 9			20	pF

Main System Clock Oscillator Characteristics (T_A = –40 to +85°C)

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Ceramic resonator or crystal resonator		Oscillation frequency (f_X)	4.5 V ≤ V_{DD} ≤ 5.5 V	2		12.5	MHz
			2.7 V ≤ V_{DD} < 4.5 V	2		6.25	
			2.0 V ≤ V_{DD} < 2.7 V	2		3.125	
			1.9 V ≤ V_{DD} < 2.0 V	2		2	
External clock		X1 input frequency (f_X)	4.5 V ≤ V_{DD} ≤ 5.5 V	2		12.5	MHz
			2.7 V ≤ V_{DD} < 4.5 V	2		6.25	
			2.0 V ≤ V_{DD} < 2.7 V	2		3.125	
			1.9 V ≤ V_{DD} < 2.0 V	2		2	
		X1 input high-/low-level width (t_{WXH}, t_{WXL})		15		250	ns
		X1 input rising/falling time (t_{XR}, t_{XF})	4.5 V ≤ V_{DD} ≤ 5.5 V	0		5	ns
			2.7 V ≤ V_{DD} < 4.5 V	0		10	
			2.0 V ≤ V_{DD} < 2.7 V	0		20	
			1.9 V ≤ V_{DD} < 2.0 V	0		30	

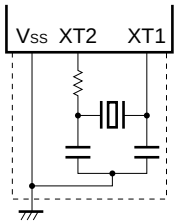
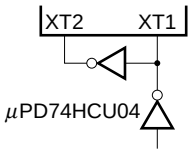
Cautions 1. When using the main system clock oscillator, wire as follows in the area enclosed by the broken lines in the above figures to avoid an adverse effect from wiring capacitance.

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

2. When the main system clock is stopped and the system is operated by the subsystem clock, the subsystem clock should be switched back to the main system clock after the oscillation stabilization time is secured by the program.

Remark For the resonator selection and oscillator constant, users are required to either evaluate the oscillation themselves or apply to the resonator manufacturer for evaluation.

Subsystem Clock Oscillator Characteristics (T_A = –40 to +85°C)

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Crystal resonator		Oscillation frequency (f_{XT})		32	32.768	35	kHz
		Oscillation stabilization time[Note]	4.5 V ≤ V_{DD} ≤ 5.5 V		1.2	2	s
			1.9 V ≤ V_{DD} < 4.5 V			10	
External clock		XT1 input frequency (f_{XT})		32		35	kHz
		XT1 input high-/low-level width (t_{XTH}, t_{XTL})		14.3		15.6	μs

Note Time required to stabilize oscillation after applying supply voltage (V_{DD}).

Cautions 1. When using the subsystem clock oscillator, wire as follows in the area enclosed by the broken lines in the above figures to avoid an adverse effect from wiring capacitance.

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

2. When the main system clock is stopped and the device is operating on the subsystem clock, wait until the oscillation stabilization time has been secured by the program before switching back to the main system clock.

Remark For the resonator selection and oscillator constant, users are required to either evaluate the oscillation themselves or apply to the resonator manufacturer for evaluation.

DC Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V) (1/3)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage, low	V_{IL1}	**Note 1**	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.2V_{DD}	
	V_{IL2}	P00 to P06, P20, P22, P33, P34, P70, P72, P100 to P103, $\overline{RESET}$	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.2V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.15V_{DD}	
	V_{IL3}	P90 to P95 (N-ch open drain)	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.2V_{DD}	
	V_{IL4}	P10 to P17, P130, P131	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.2V_{DD}	
	V_{IL5}	X1, X2, XT1, XT2	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.2V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.1V_{DD}	
	V_{IL6}	P25, P27	2.2 V ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0		0.2V_{DD}	
Input voltage, high	V_{IH1}	**Note 1**	2.2 V ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0.8V_{DD}		V_{DD}	
	V_{IH2}	P00 to P06, P20, P22, P33, P34, P70, P72, P100 to P103, $\overline{RESET}$	2.2 V ≤ V_{DD} ≤ 5.5 V	0.8V_{DD}		V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0.85V_{DD}		V_{DD}	
	V_{IH3}	P90 to P95 (N-ch open drain)	2.2 V ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		12	V
			1.9 V ≤ V_{DD} < 2.2 V	0.8V_{DD}		V_{DD}	
	V_{IH4}	P10 to P17, P130, P131	2.2 V ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0.8V_{DD}		V_{DD}	
	V_{IH5}	X1, X2, XT1, XT2	2.2 V ≤ V_{DD} ≤ 5.5 V	0.8V_{DD}		V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0.85V_{DD}		V_{DD}	
	V_{IH6}	P25, P27	2.2 V ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		V_{DD}	V
			1.9 V ≤ V_{DD} < 2.2 V	0.8V_{DD}		V_{DD}	
Output voltage, low	V_{OL1}	For pins other than P40 to P47, P50 to P57, P90 to P95 I_{OL} = 1.6 mA[Note 1]	4.5 V ≤ V_{DD} ≤ 5.5 V			0.4	V
		P40 to P47, P50 to P57 I_{OL} = 8 mA[Note 2]	4.5 V ≤ V_{DD} ≤ 5.5 V			1.0	V
		P90 to P95 I_{OL} = 15 mA[Note 2]	4.5 V ≤ V_{DD} ≤ 5.5 V		0.8	2.0	V
	V_{OL2}	I_{OL} = 400 μA[Note 2]				0.5	V
Output voltage, high	V_{OH1}	I_{OH} = –1 mA[Note 2]	4.5 V ≤ V_{DD} ≤ 5.5 V	V_{DD} – 1.0			V
		I_{OL} = –100 μA[Note 2]		V_{DD} – 0.5			V
Input leakage current, low	I_{LIL1}	V_{IN} = 0 V	Except X1, X2, XT1 XT2			–3	μA
	I_{LIL2}		X1, X2, XT1, XT2			–20	μA
Input leakage current, high	I_{LIH1}	V_{IN} = V_{DD}	Except X1, X2, XT1 XT2			3	μA
	I_{LIH2}		X1, X2, XT1, XT2			20	μA
	I_{LIH3}	V_{IN} = 12 V (N-ch open drain)	P90 to P95			20	μA
Output leakage current, low	I_{LOL1}	V_{OUT} = 0 V				–3	μA
Output leakage current, high	I_{LOH1}	V_{OUT} = V_{DD}				3	μA

Notes 1. P21, P23, P24, P26, P30 to P32, P35 to P37, P40 to P47, P50 to P57, P60 to P67, P71, P80 to P87, P120 to P127

2. Per pin

DC Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V) (2/3)

(1) μPD78F4216A, 78F4216AY

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply voltage	I_{DD1}	Operation mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		17	40	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		5	17	mA
			f_{XX} = 2 MHz, V_{DD} = 2.0 V ±5%		2	10	mA
	I_{DD2}	HALT mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		6	20	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		2	10	mA
			f_{XX} = 2 MHz, V_{DD} = 2.0 V ±5%		0.4	7	mA
	I_{DD3}	IDLE mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		1	3	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		0.5	1.3	mA
			f_{XX} = 2 MHz, V_{DD} = 2.0 V ±5%		0.3	0.9	mA
	I_{DD4}	Operation mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		130	500	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		90	350	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		80	300	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		70	250	μA
	I_{DD5}	HALT mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		60	200	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		20	160	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		15	120	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		10	100	μA
	I_{DD6}	IDLE mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		50	190	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		15	150	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		12	110	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		7	90	μA
Data retention voltage	V_{DDDR}	HALT, IDLE modes		1.9		5.5	V
Data retention current	I_{DDDR}	STOP mode	V_{DD} = 2.0 V ±5%		2	10	μA
			V_{DD} = 5.0 V ±10%		10	50	μA
Pull-up resistor	R_L	V_{IN} = 0 V		10	30	100	kΩ

Note When main system clock is stopped and subsystem clock is operating.

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

DC Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V) (3/3)

(2) μPD78F4218A, 78F4218AY

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply voltage	I_{DD1}	Operation mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		19	40	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		6	17	mA
			f_{XX} = 3 MHz, V_{DD} = 2.0 V ±5%		2	10	mA
	I_{DD2}	HALT mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		7	20	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		2	10	mA
			f_{XX} = 3 MHz, V_{DD} = 2.0 V ±5%		0.5	7	mA
	I_{DD3}	IDLE mode	f_{XX} = 12.5 MHz, V_{DD} = 5.0 V ±10%		1	3	mA
			f_{XX} = 6 MHz, V_{DD} = 3.0 V ±10%		0.5	1.3	mA
			f_{XX} = 3 MHz, V_{DD} = 2.0 V ±5%		0.3	0.9	mA
	I_{DD4}	Operation mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		140	500	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		100	350	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		90	300	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		80	250	μA
	I_{DD5}	HALT mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		60	200	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		20	160	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		15	120	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		10	100	μA
	I_{DD6}	IDLE mode[Note]	f_{XX} = 32 kHz, V_{DD} = 5.0 V ±10%		50	190	μA
			f_{XX} = 32 kHz, V_{DD} = 3.0 V ±10%		15	150	μA
			f_{XX} = 32 kHz, 2.0 V ≤ V_{DD} ≤ 2.7 V		12	110	μA
			f_{XX} = 32 kHz, 1.9 V ≤ V_{DD} < 2.0 V		7	90	μA
Data retention voltage	V_{DDDR}	HALT, IDLE modes		1.9		5.5	V
Data retention current	I_{DDDR}	STOP mode	V_{DD} = 2.0 V ±5%		2	10	μA
			V_{DD} = 5.0 V ±10%		10	50	μA
Pull-up resistor	R_L	V_{IN} = 0 V		10	30	100	kΩ

Note When main system clock is stopped and subsystem clock is operating.

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

AC Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

(1) Read/write operation (1/2)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Cycle time	t_{CYK}	4.5 V ≤ V_{DD} ≤ 5.5 V	80			ns
		2.7 V ≤ V_{DD} < 4.5 V	160			ns
		2.0 V ≤ V_{DD} < 2.7 V	320			ns
		1.9 V ≤ V_{DD} < 2.0 V	500			ns
Address setup time (to ASTB↓)	t_{SAST}	V_{DD} = 5.0 V ±10%	(0.5 + a)T – 20			ns
		V_{DD} = 3.0 V ±10%	(0.5 + a)T – 40			ns
		V_{DD} = 2.0 V ±5%	(0.5 + a)T – 80			ns
Address hold time (from ASTB↓)	t_{HSTLA}	V_{DD} = 5.0 V ±10%	0.5T – 19			ns
		V_{DD} = 3.0 V ±10%	0.5T – 24			ns
		V_{DD} = 2.0 V ±5%	0.5T – 34			ns
ASTB high-level width	t_{WSTH}	V_{DD} = 5.0 V ±10%	(0.5 + a)T – 17			ns
		V_{DD} = 3.0 V ±10%	(0.5 + a)T – 40			ns
		V_{DD} = 2.0 V ±5%	(0.5 + a)T – 110			ns
Address hold time (from $\overline{RD}$↑)	t_{HRA}	V_{DD} = 5.0 V ±10%	0.5T – 14			ns
		V_{DD} = 3.0 V ±10%	0.5T – 14			ns
		V_{DD} = 2.0 V ±5%	0.5T – 14			ns
Delay time from address to $\overline{RD}$↓	t_{DAR}	V_{DD} = 5.0 V ±10%	(1 + a)T – 24			ns
		V_{DD} = 3.0 V ±10%	(1 + a)T – 35			ns
		V_{DD} = 2.0 V ±5%	(1 + a)T – 80			ns
Address float time (from $\overline{RD}$↓)	t_{FAR}	V_{DD} = 5.0 V ±10%			0	ns
		V_{DD} = 3.0 V ±10%			0	ns
		V_{DD} = 2.0 V ±5%			0	ns
Data input time from address	t_{DAID}	V_{DD} = 5.0 V ±10%			(2.5 + a + n)T – 37	ns
		V_{DD} = 3.0 V ±10%			(2.5 + a + n)T – 52	ns
		V_{DD} = 2.0 V ±5%			(2.5 + a + n)T – 120	ns
Data input time from ASTB↓	t_{DSTID}	V_{DD} = 5.0 V ±10%			(2 + n)T – 35	ns
		V_{DD} = 3.0 V ±10%			(2 + n)T – 50	ns
		V_{DD} = 2.0 V ±5%			(2 + n)T – 80	ns
Data input time from $\overline{RD}$↓	t_{DRID}	V_{DD} = 5.0 V ±10%			(1.5 + n)T – 40	ns
		V_{DD} = 3.0 V ±10%			(1.5 + n)T – 50	ns
		V_{DD} = 2.0 V ±5%			(1.5 + n)T – 90	ns
Delay time from ASTB↓ to $\overline{RD}$↓	t_{DSTR}	V_{DD} = 5.0 V ±10%	0.5T – 9			ns
		V_{DD} = 3.0 V ±10%	0.5T – 9			ns
		V_{DD} = 2.0 V ±5%	0.5T – 20			ns
Data hold time (from $\overline{RD}$↑)	t_{HRID}	V_{DD} = 5.0 V ±10%	0			ns
		V_{DD} = 3.0 V ±10%	0			ns
		V_{DD} = 2.0 V ±5%	0			ns

Remark T: t_{CYK} = 1/f_{XX} (f_{XX}: main system clock frequency)

a: 1 (during address wait), otherwise, 0

n: Number of waits (n ≥ 0)

AC Characteristics

(1) Read/write operation (2/2)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Address active time from $\overline{RD}\uparrow$	t_{DRA}	V_{DD} = 5.0 V ±10%	0.5T – 2			ns
		V_{DD} = 3.0 V ±10%	0.5T – 12			ns
		V_{DD} = 2.0 V ±5%	0.5T – 35			ns
Delay time from $\overline{RD}\uparrow$ to ASTB↑	t_{DRST}	V_{DD} = 5.0 V ±10%	0.5T – 9			ns
		V_{DD} = 3.0 V ±10%	0.5T – 9			ns
		V_{DD} = 2.0 V ±5%	0.5T – 40			ns
$\overline{RD}$ low-level width	t_{WRL}	V_{DD} = 5.0 V ±10%	(1.5 + n)T – 25			ns
		V_{DD} = 3.0 V ±10%	(1.5 + n)T – 30			ns
		V_{DD} = 2.0 V ±5%	(1.5 + n)T – 25			ns
Delay time from address to $\overline{WR}\downarrow$	t_{DAW}	V_{DD} = 5.0 V ±10%	(1 + a)T – 24			ns
		V_{DD} = 3.0 V ±10%	(1 + a)T – 34			ns
		V_{DD} = 2.0 V ±5%	(1 + a)T – 70			ns
Address hold time (from $\overline{WR}\uparrow$)	t_{HRD}	V_{DD} = 5.0 V ±10%	0.5T – 14			ns
		V_{DD} = 3.0 V ±10%	0.5T – 14			ns
		V_{DD} = 2.0 V ±5%	0.5T – 14			ns
Delay time from ASTB↓ to data output	t_{DSTOD}	V_{DD} = 5.0 V ±10%			0.5T + 15	ns
		V_{DD} = 3.0 V ±10%			0.5T + 30	ns
		V_{DD} = 2.0 V ±5%			0.5T + 240	ns
Delay time from $\overline{WR}\downarrow$ to data output	t_{DWOD}	V_{DD} = 5.0 V ±10%			0.5T – 30	ns
		V_{DD} = 3.0 V ±10%			0.5T – 30	ns
		V_{DD} = 2.0 V ±5%			0.5T – 30	ns
Delay time from ASTB↓ to $\overline{WR}\downarrow$	t_{DSTW}	V_{DD} = 5.0 V ±10%	0.5T – 9			ns
		V_{DD} = 3.0 V ±10%	0.5T – 9			ns
		V_{DD} = 2.0 V ±5%	0.5T – 20			ns
Data setup time (to $\overline{WR}\uparrow$)	t_{SODWR}	V_{DD} = 5.0 V ±10%	(1.5 + n)T – 20			ns
		V_{DD} = 3.0 V ±10%	(1.5 + n)T – 25			ns
		V_{DD} = 2.0 V ±5%	(1.5 + n)T – 70			ns
Data hold time (from $\overline{WR}\uparrow$)	t_{HWOD}	V_{DD} = 5.0 V ±10%	0.5T – 14			ns
		V_{DD} = 3.0 V ±10%	0.5T – 14			ns
		V_{DD} = 2.0 V ±5%	0.5T – 50			ns
Delay time from $\overline{WR}\uparrow$ to ASTB↑	t_{DWST}	V_{DD} = 5.0 V ±10%	0.5T – 9			ns
		V_{DD} = 3.0 V ±10%	0.5T – 9			ns
		V_{DD} = 2.0 V ±5%	0.5T – 30			ns
$\overline{WR}$ low-level width	t_{WWL}	V_{DD} = 5.0 V ±10%	(1.5 + n)T – 25			ns
		V_{DD} = 3.0 V ±10%	(1.5 + n)T – 30			ns
		V_{DD} = 2.0 V ±5%	(1.5 + n)T – 30			ns

Remark T: t_{CYK} = 1/f_{XX} (f_{XX}: main system clock frequency)

a: 1 (during address wait), otherwise, 0

n: Number of wait states ($n \geq 0$)

AC Characteristics

(2) External wait timing

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input time from address to $\overline{WAIT}$↓	t_{DAWT}	V_{DD} = 5.0 V ±10%			(2 + a)T – 40	ns
		V_{DD} = 3.0 V ±10%			(2 + a)T – 60	ns
		V_{DD} = 2.0 V ±5%			(2 + a)T – 300	ns
Input time from ASTB↓ to $\overline{WAIT}$↓	t_{DSTWT}	V_{DD} = 5.0 V ±10%			1.5T – 40	ns
		V_{DD} = 3.0 V ±10%			1.5T – 60	ns
		V_{DD} = 2.0 V ±5%			1.5T – 260	ns
Hold time from ASTB↓ to $\overline{WAIT}$	t_{HSTWT}	V_{DD} = 5.0 V ±10%	(0.5 + n)T + 5			ns
		V_{DD} = 3.0 V ±10%	(0.5 + n)T + 10			ns
		V_{DD} = 2.0 V ±5%	(0.5 + n)T + 30			ns
Delay time from ASTB↓ to $\overline{WAIT}$↑	t_{DSTWTH}	V_{DD} = 5.0 V ±10%			(1.5 + n)T – 40	ns
		V_{DD} = 3.0 V ±10%			(1.5 + n)T – 60	ns
		V_{DD} = 2.0 V ±5%			(1.5 + n)T – 90	ns
Input time from $\overline{RD}$↓ to $\overline{WAIT}$↓	t_{DRWTL}	V_{DD} = 5.0 V ±10%			T – 40	ns
		V_{DD} = 3.0 V ±10%			T – 60	ns
		V_{DD} = 2.0 V ±5%			T – 70	ns
Hold time from $\overline{RD}$↓ to $\overline{WAIT}$↓	t_{HRWT}	V_{DD} = 5.0 V ±10%	nT + 5			ns
		V_{DD} = 3.0 V ±10%	nT + 10			ns
		V_{DD} = 2.0 V ±5%	nT + 30			ns
Delay time from $\overline{RD}$↓ to $\overline{WAIT}$↑	t_{DRWTH}	V_{DD} = 5.0 V ±10%			(1 + n)T – 40	ns
		V_{DD} = 3.0 V ±10%			(1 + n)T – 60	ns
		V_{DD} = 2.0 V ±5%			(1 + n)T – 90	ns
Data input time from $\overline{WAIT}$↑	t_{DWTID}	V_{DD} = 5.0 V ±10%			0.5T – 5	ns
		V_{DD} = 3.0 V ±10%			0.5T – 10	ns
		V_{DD} = 2.0 V ±5%			0.5T – 30	ns
Delay time from $\overline{WAIT}$↑ to $\overline{RD}$↑	t_{DWTR}	V_{DD} = 5.0 V ±10%	0.5T			ns
		V_{DD} = 3.0 V ±10%	0.5T			ns
		V_{DD} = 2.0 V ±5%	0.5T + 5			ns
Delay time from $\overline{WAIT}$↑ to $\overline{WR}$↑	t_{DWTW}	V_{DD} = 5.0 V ±10%	0.5T			ns
		V_{DD} = 3.0 V ±10%	0.5T			ns
		V_{DD} = 2.0 V ±5%	0.5T + 5			ns
Input time from $\overline{WR}$↓ to $\overline{WAIT}$↓	t_{DWWTL}	V_{DD} = 5.0 V ±10%			T – 40	ns
		V_{DD} = 3.0 V ±10%			T – 60	ns
		V_{DD} = 2.0 V ±5%			T – 90	ns
Hold time from $\overline{WR}$↓ to $\overline{WAIT}$	t_{HWWT}	V_{DD} = 5.0 V ±10%	nT + 5			ns
		V_{DD} = 3.0 V ±10%	nT + 10			ns
		V_{DD} = 2.0 V ±5%	nT + 30			ns
Delay time from $\overline{WR}$↓ to $\overline{WAIT}$↑	t_{DWWTH}	V_{DD} = 5.0 V ±10%			(1 + n)T – 40	ns
		V_{DD} = 3.0 V ±10%			(1 + n)T – 60	ns
		V_{DD} = 2.0 V ±5%			(1 + n)T – 90	ns

Remark T: t_{CYK} = 1/f_{XX} (f_{XX}: main system clock frequency)

a: 1 (during address wait), otherwise, 0

n: Number of wait states (n ≥ 0)

Serial Operation (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

(a) 3-wire serial I/O mode ($\overline{SCK}$: Internal clock output)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY1}	2.7 V ≤ V_{DD} ≤ 5.5 V	800			ns
			3,200			ns
$\overline{SCK}$ high-/low-level width	t_{KH1}, t_{KL1}	2.7 V ≤ V_{DD} ≤ 5.5 V	350			ns
			1,500			ns
SI setup time (to $\overline{SCK}$↑)	t_{SIK1}	2.7 V ≤ V_{DD} ≤ 5.5 V	10			ns
			30			ns
SI hold time (from $\overline{SCK}$↑)	t_{KSI1}		40			ns
SO output delay time (from $\overline{SCK}$↓)	t_{KSO1}				30	ns

(b) 3-wire serial I/O mode ($\overline{SCK}$: External clock input)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY2}	2.7 V ≤ V_{DD} ≤ 5.5 V	800			ns
			3,200			ns
$\overline{SCK}$ high-/low-level width	t_{KH2}	2.7 V ≤ V_{DD} ≤ 5.5 V	400			ns
	t_{KL2}		1,600			ns
SI setup time (to $\overline{SCK}$↑)	t_{SIK2}	2.7 V ≤ V_{DD} ≤ 5.5 V	10			ns
			30			ns
SI hold time (from $\overline{SCK}$↑)	t_{KSI2}		40			ns
SO output delay time (from $\overline{SCK}$↓)	t_{KSO2}				30	ns

(c) UART mode

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ASCK cycle time	t_{KCY3}	4.5 V ≤ V_{DD} ≤ 5.5 V	417			ns
		2.7 V ≤ V_{DD} < 4.5 V	833			ns
			1,667			ns
ASCK high-/low-level width	t_{KH3}	4.5 V ≤ V_{DD} ≤ 5.5 V	208			ns
	t_{KL3}	2.7 V ≤ V_{DD} < 4.5 V	416			ns
			833			ns

(d) I^2C bus mode

Parameter		Symbol	Standard Mode		High-Speed Mode		Unit
			MIN.	MAX.	MIN.	MAX.	
SCL0 clock frequency		f_{CLK}	0	100	0	400	kHz
Bus free time (between stop and start conditions)		t_{BUF}	4.7	–	1.3	–	μs
Hold time[Note1]		$t_{HD:STA}$	4.0	–	0.6	–	μs
Low-level width of SCL0 clock		t_{LOW}	4.7	–	1.3	–	μs
High-level width of SCL0 clock		t_{HIGH}	4.0	–	0.6	–	μs
Setup time of start/restart conditions		$t_{SU:STA}$	4.7	–	0.6	–	μs
Data hold time	When using CBUS-compatible master	$t_{HD:DAT}$	5.0	–	–	–	μs
	When using I^2C bus		0[Note 2]	–	0[Note 2]	0.9[Note 3]	μs
Data setup time		$t_{SU:DAT}$	250	–	100[Note 4]	–	ns
Rise time of SDA0 and SCL0 signals		t_R	–	1,000	20 + 0.1Cb[Note 5]	300	ns
Fall time of SDA0 and SCL0 signals		t_F	–	300	20 + 0.1Cb[Note 5]	300	ns
Setup time of stop condition		$t_{SU:STO}$	4.0	–	0.6	–	μs
Pulse width of spike restricted by input filter		t_{SP}	–	–	0	50	ns
Load capacitance of each bus line		Cb	–	400	–	400	pF

Notes 1. For the start condition, the first clock pulse is generated after the hold time.

2. To fill the undefined area of the SCL0 falling edge, it is necessary for the device to provide an internal SDA0 signal (on $V_{IHmin.}$) with at least 300 ns of hold time.

3. If the device does not extend the SCL0 signal low-level hold time (t_{LOW}), only the maximum data hold time $t_{HD:DAT}$ needs to be satisfied.

4. The high-speed mode I^2C bus can be used in a standard mode I^2C bus system. In this case, the conditions described below must be satisfied.

- If the device does not extend the SCL0 signal low-level hold time
  $t_{SU:DAT} \geq 250$ ns
- If the device extends the SCL0 signal low-level hold time
  Be sure to transmit the data bit to the SDA0 line before the SCL0 line is released ($t_{Rmax.} + t_{SU:DAT}$ = 1,000 + 250 = 1,250 ns by standard mode I^2C bus specification)

5. Cb: Total capacitance per bus line (unit: pF)

Other Operations (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
NMI high-/low-level width	t_{WNIL} t_{WNIH}		10			μs
Interrupt input high-/low-level width	t_{WITL} t_{WITH}	INTP0 to INTP6	100			ns
$\overline{RESET}$ high-/low-level width	t_{WRSL} t_{WRSH}		10			μs

Clock Output Operation (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
PCL cycle time	t_{CYCL}	4.5 V ≤ V_{DD} ≤ 5.5 V, nT	80		31,250	ns
PCL high-/low-level width	t_{CLL} t_{CLH}	4.5 V ≤ V_{DD} ≤ 5.5 V, 0.5T – 10	30		15,615	ns
PCL rise/fall time	t_{CLR} t_{CLF}	4.5 V ≤ V_{DD} ≤ 5.5 V			5	ns
		2.7 V ≤ V_{DD} < 4.5 V			10	ns
		1.9 V ≤ V_{DD} < 2.7 V			20	ns

Remark T: t_{CYK} = 1/f_{XX} (f_{XX}: Main system clock frequency)

n: Divided frequency ratio set by software in the CPU

- When using the main system clock: n = 1, 2, 4, 8, 16, 32, 64, 128
- When using the subsystem clock: n = 1

A/D Converter Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution			8	8	8	bits
Overall error[Notes 1, 2]		2.7 V ≤ V_{DD} ≤ 5.5 V 2.2 V ≤ AV_{REF0} ≤ V_{DD}			±1.2	%FSR
		1.9 V ≤ V_{DD} < 2.7 V 1.9 V ≤ AV_{REF0} ≤ V_{DD}			±1.6	%FSR
Conversion time	t_{CONV}		14		144	μs
Sampling time	t_{SAMP}		24/f_{XX}			μs
Analog input voltage	V_{IAN}		AV_{SS}		AV_{REF0}	V
Reference voltage	AV_{REF0}		1.9		AV_{DD}	V
Resistance between AV_{REF0} and AV_{SS}	R_{AVREF0}	When not A/D converting		40		kΩ

Notes 1. Quantization error (±1/2 LSB) is not included.

2. Overall error is indicated as a ratio to the full-scale value.

Remark f_{XX} : Main system clock frequency

D/A Converter Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution				8	8	8	Bits
Overall error[Notes 1, 2]		R = 10 MΩ, 2.0 V ≤ AV_{REF1} ≤ V_{DD}, 2.0 V ≤ V_{DD} ≤ 5.5 V				±0.6	%FSR
		R = 10 MΩ, 1.9 V ≤ AV_{REF1} ≤ V_{DD}, 1.9 V ≤ V_{DD} ≤ 2.0 V				±1.2	%FSR
Settling time		Load conditions: C = 30 pF	4.5 V ≤ AV_{REF1} ≤ 5.5 V			10	μs
			2.7 V ≤ AV_{REF1} < 4.5 V			15	μs
			1.9 V ≤ AV_{REF1} < 2.7 V			20	μs
Output resistance	R_O	DACS0, 1 = 55H			8		kΩ
Reference voltage	AV_{REF1}			1.9		V_{DD}	V
AV_{REF1} current	AI_{REF1}	For only 1 channel				2.5	mA

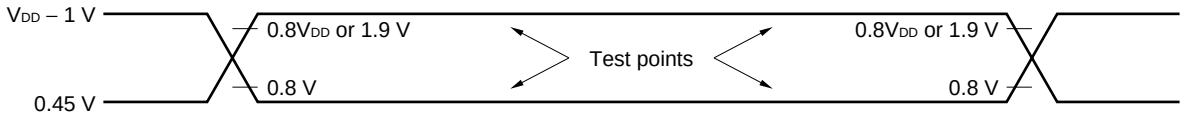
Notes 1. Quantization error (±1/2 LSB) is not included.

2. Overall error is indicated as a ratio to the full-scale value.

Data Retention Characteristics (T_A = –40 to +85°C, V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

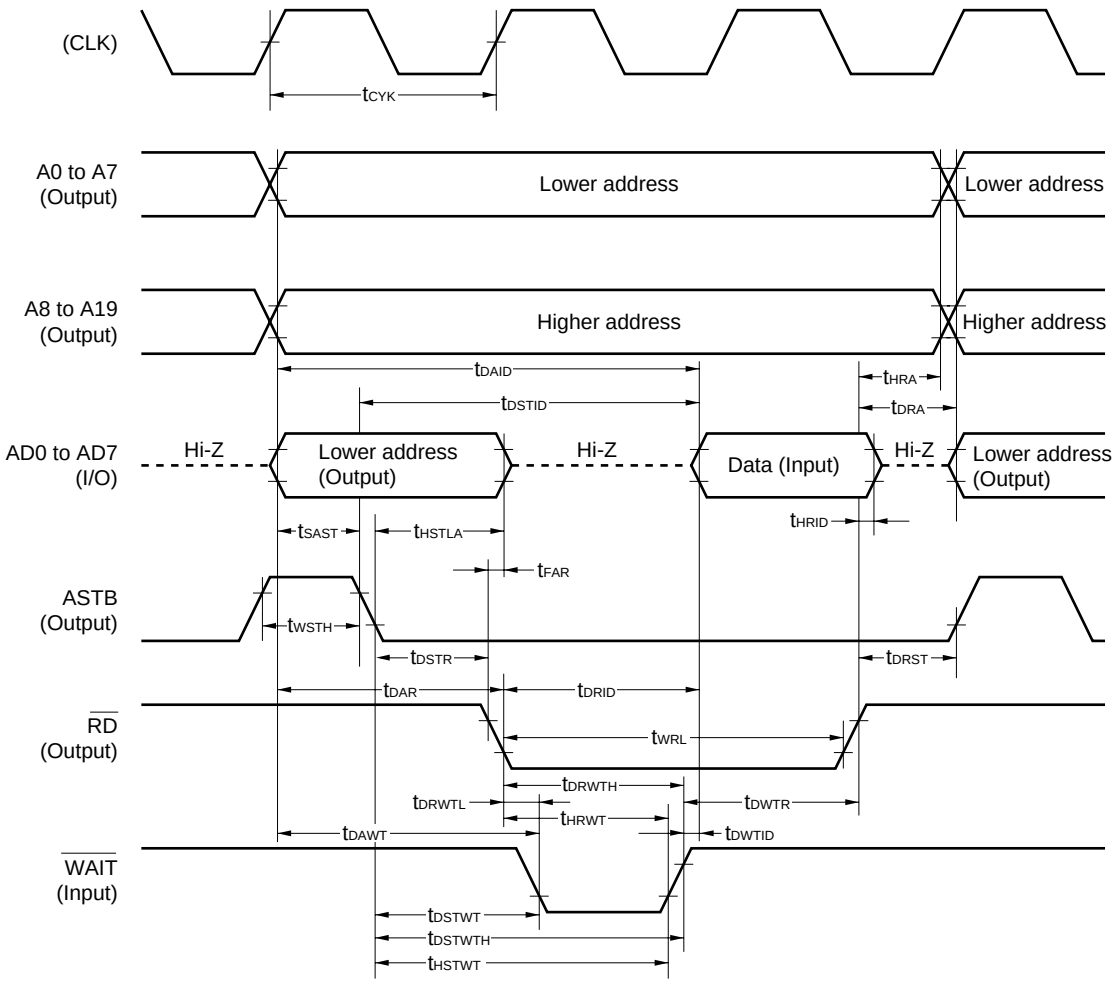
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Data retention voltage	V_{DDDR}	STOP mode	1.9		5.5	V
Data retention current	I_{DDDR}	V_{DDDR} = 5.0 V ±10%		10	50	μA
		V_{DDDR} = 2.0 V ±5%		2	10	μA
V_{DD} rise time	t_{RVD}		200			μs
V_{DD} fall time	t_{FVD}		200			μs
V_{DD} hold time (from STOP mode setting)	t_{HVD}		0			ms
STOP release signal input time	t_{DREL}		0			ms
Oscillation stabilization wait time	t_{WAIT}	Crystal resonator	30			ms
		Ceramic resonator	5			ms
Low-level input voltage	V_{IL}	$\overline{RESET}$, P00/INTP0 to P06/INTP6	0		$0.1V_{DDDR}$	V
High-level input voltage	V_{IH}		$0.9V_{DDDR}$		V_{DDDR}	V

AC Timing Test Points



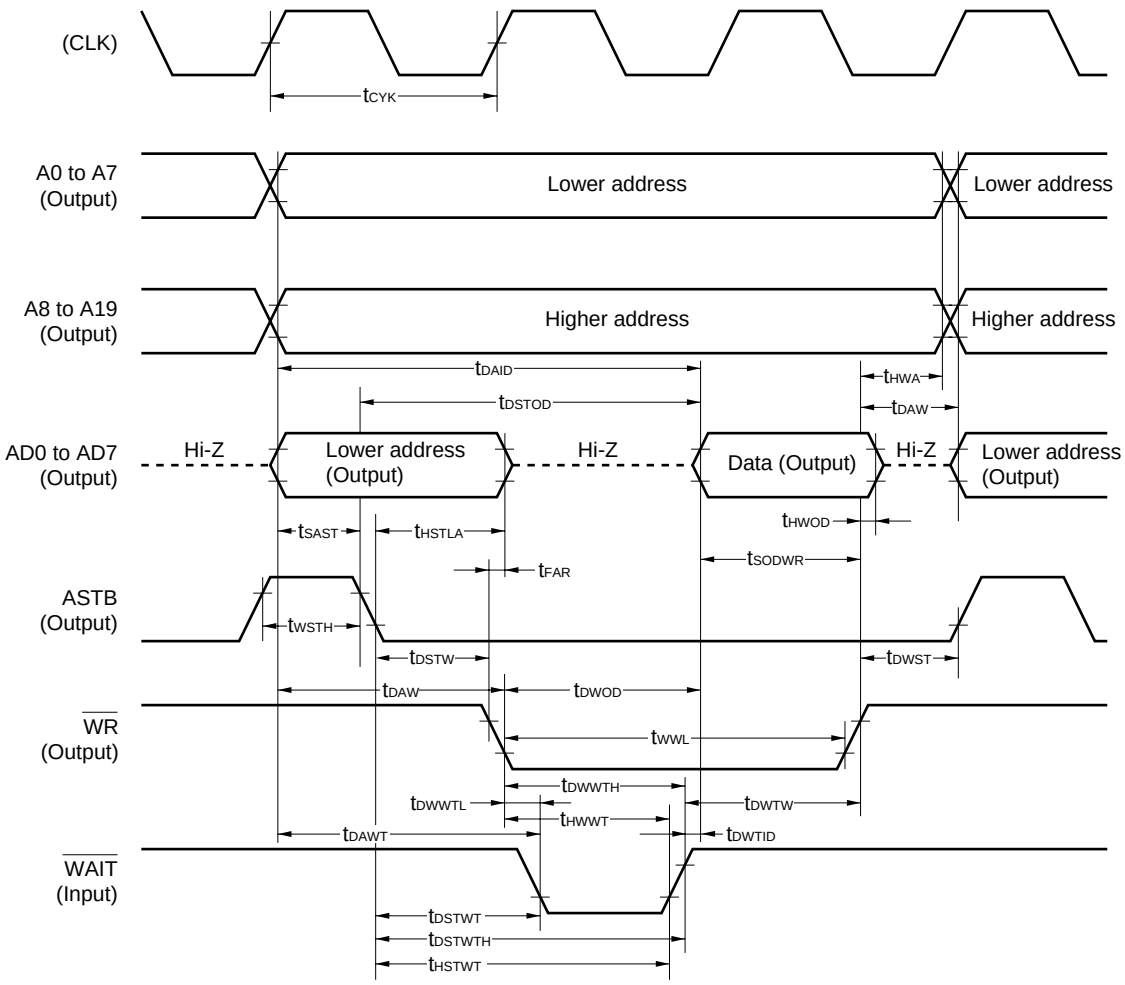
Timing Waveforms

(1) Read operations



Remark The signal is output from pins A0 to A7 when P80 to P87 are unused.

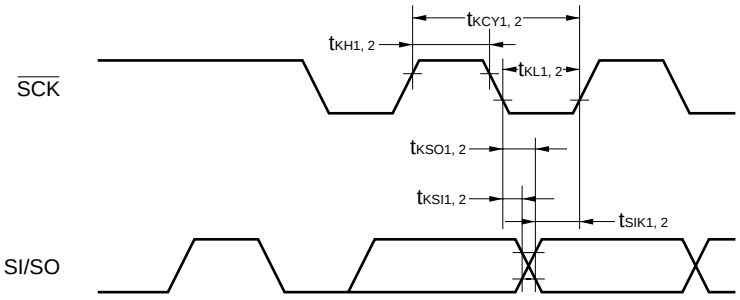
(2) Write operation



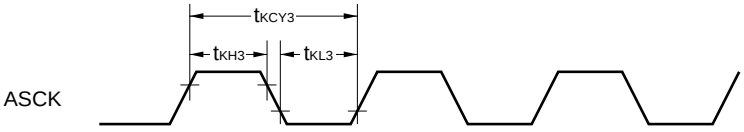
Remark The signal is output from pins A0 to A7 when P80 to P87 are unused.

Serial Operation

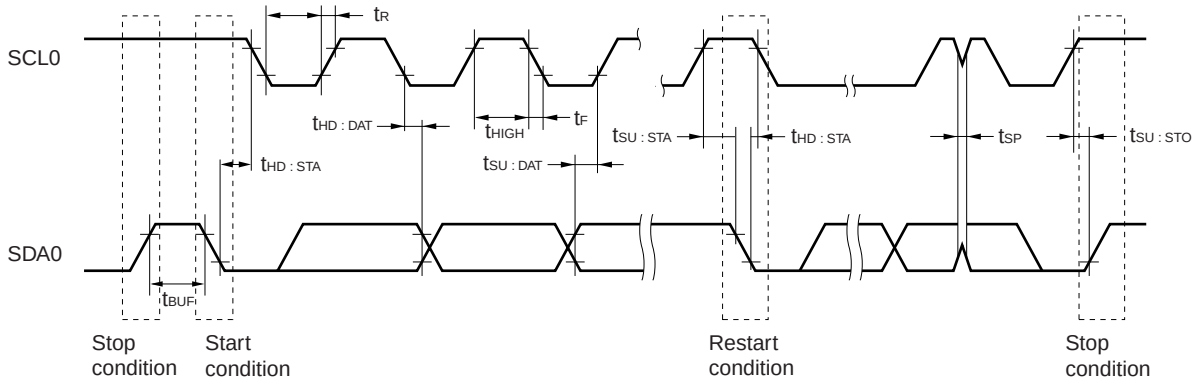
(1) 3-wire serial I/O mode



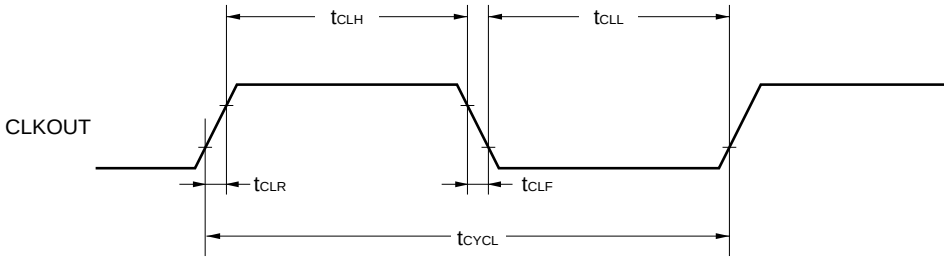
(2) UART mode



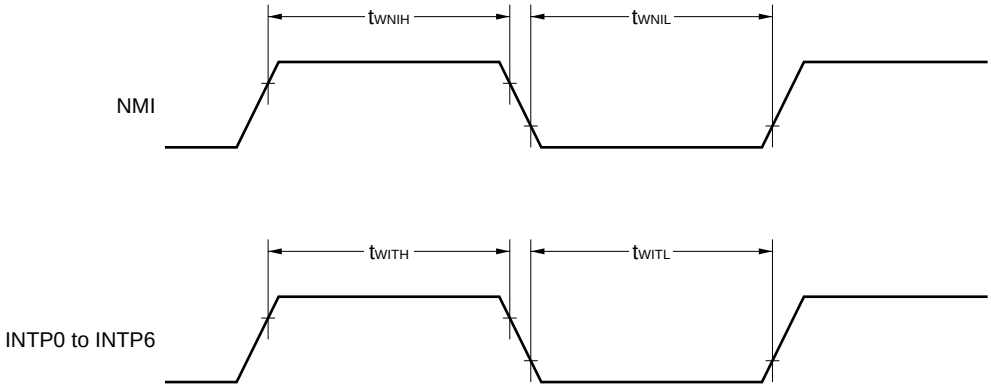
(3) I²C bus mode (μPD78F4216AY, 78F4218AY only)



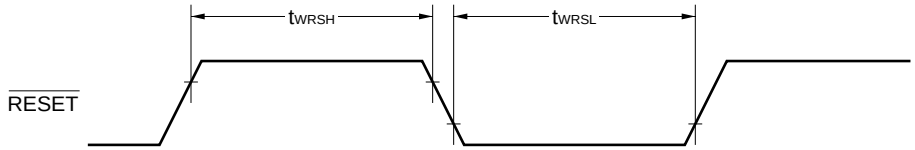
Clock Output Timing



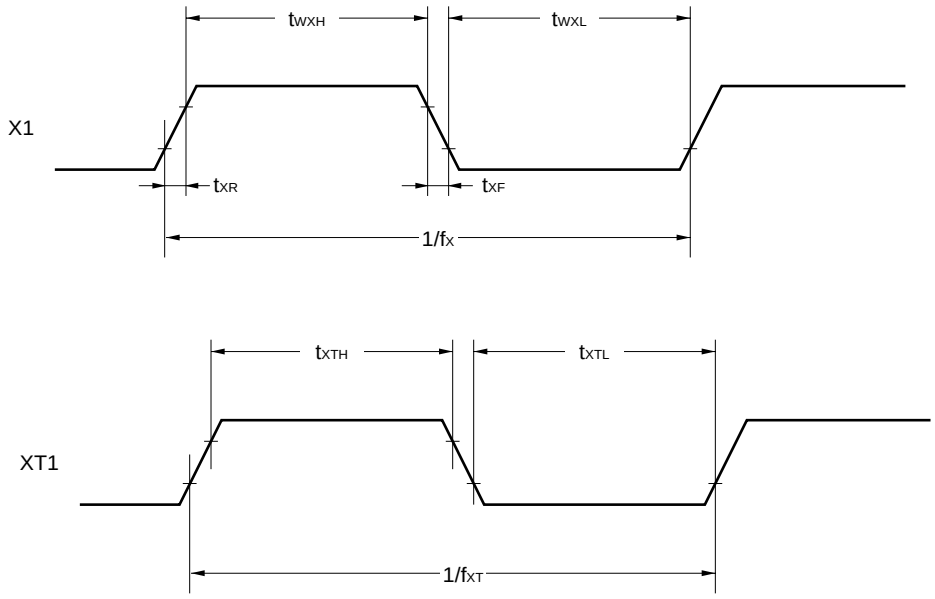
Interrupt Input Timing



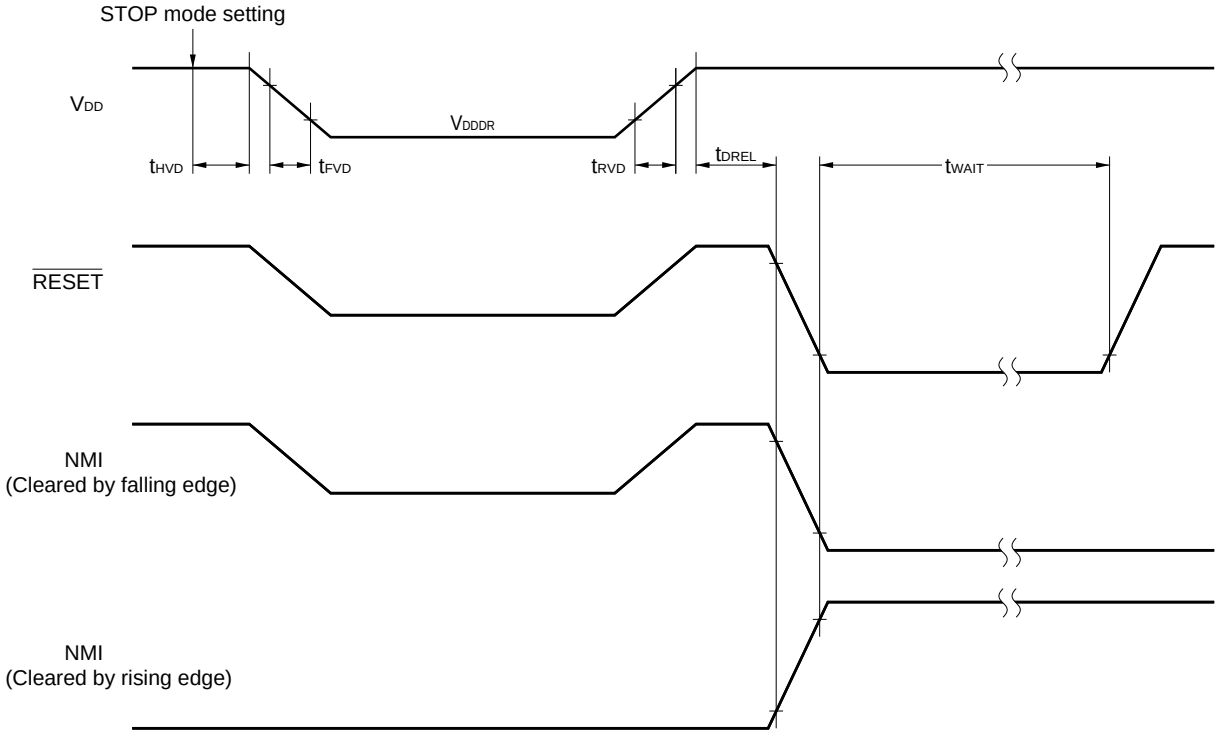
Reset Input Timing



Clock Timing



Data Retention Characteristics



Flash Memory Programming Characteristics (V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V, V_{PP} = 9.7 to 10.3 V)

(1) Basic characteristics

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating frequency	f_X	4.5 V ≤ V_{DD} ≤ 5.5 V	2		12.5	MHz
		2.7 V ≤ V_{DD} < 4.5 V	2		6.25	MHz
		2.0 V ≤ V_{DD} < 2.7 V	2		3.125	MHz
		1.9 V ≤ V_{DD} < 2.0 V	2	2	2	MHz
Supply voltage[Note 1]	V_{DD}		1.9		5.5	V
	V_{PPL}	Upon V_{PP} low-level detection	0		0.2V_{DD}	V
	V_{PP}	Upon V_{PP} high-level detection	0.9V_{DD}	V_{DD}	1.1V_{DD}	V
	V_{PPH}	Upon V_{PP} high-voltage detection	9.7	10	10.3	V
V_{DD} supply current	I_{DD}				40	mA
V_{PP} supply current	I_{PP}	V_{PP} = 10 V			100	mA
Write count	C_{WRT}		20[Note2]			Times
Operating temperature[Note 3]	T_A		–40		85	°C
Storage temperature[Note 4]	T_{stg}		–65		125	°C
Programming temperature	T_{PRG}		10		40	°C

Notes 1. μPD78F4216A, 78F4216AY K standard: 2.7 V ≤ V_{DD} < 5.5 V, V_{PP} = 10.3 ±0.3 V
E standard: 2.7 V ≤ V_{DD} < 5.5 V, V_{PP} = 10.0 ±0.3 V

2. Operation cannot be guaranteed when the number of writes exceeds 20 times. In the case of the μPD78F4216A and 78F4216AY with K standard, operation cannot be guaranteed when the number of writes exceeds 5 times.

3. μPD78F4216A, 78F4216AY K standard: T_A = –10 to +60°C

4. μPD78F4216A, 78F4216AY K standard: T_A = –10 to +80°C

Cautions 1. If writing is not successful in write operation, execute the program command again, and execute the verify command to confirm the normal completion of the write operation. (μPD78F4216A, 78F4216AY: I, K, E, P standard)

2. Handshake mode is supported by the following products.
μPD78F4216A, 78F4216AY: Other than I, K, E standard
μPD78F4218A, 78F4218AY: Other than I standard

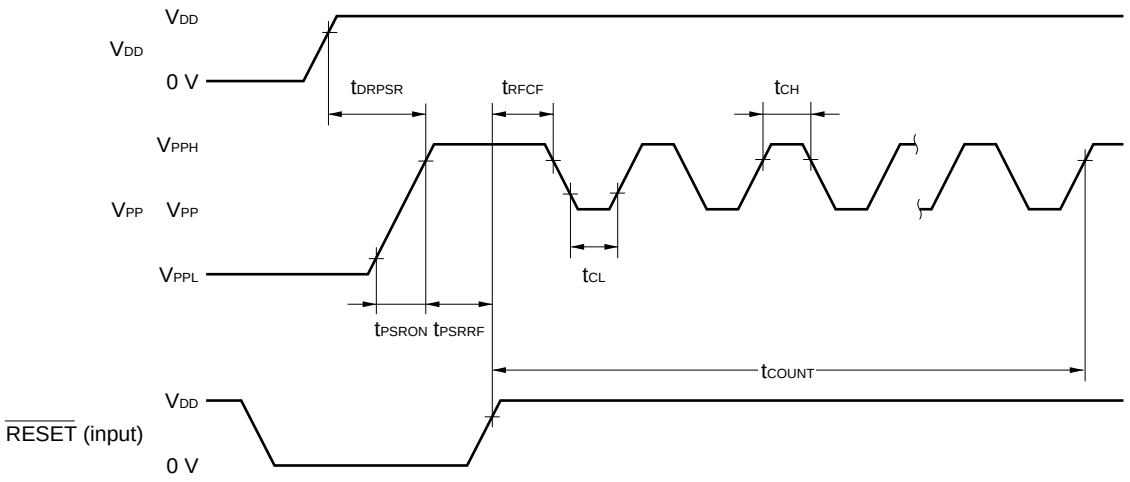
Remark The fifth alphabetic character from the left in the lot number indicates the standard of the product. After executing the program command, execute the verify command to confirm the normal completion of the write operation.
Handshake mode is the CSI write mode that uses P24.

Flash Memory Programming Characteristics (V_{DD} = AV_{DD} = 1.9 to 5.5 V, V_{SS} = AV_{SS} = 0 V, V_{PP} = 9.7 to 10.3 V)

(2) Serial write operation characteristics

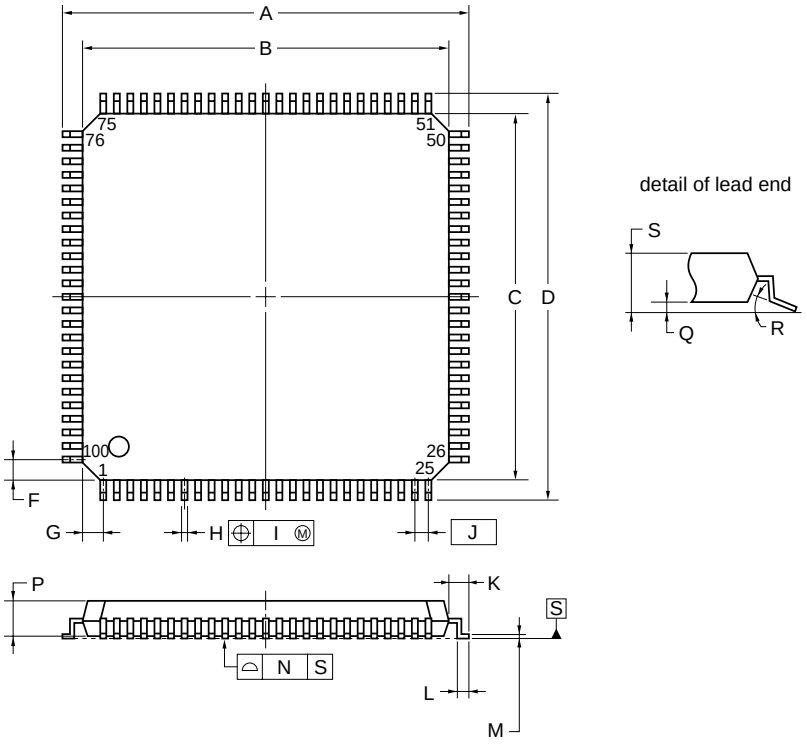
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
V_{PP} setup time	t_{PSRON}	V_{PP} high voltage	1.0			μs
V_{PP}↑ setup time to V_{DD}↑	t_{DRPSR}	V_{PP} high voltage	10			μs
$\overline{RESET}$↑ set up time to V_{PP}↑	t_{PSRRF}	V_{PP} high voltage	1.0			μs
V_{PP} count start time from $\overline{RESET}$↑	t_{RFCF}		1.0			μs
Count execution time	t_{COUNT}				1.0	ms
V_{PP} counter high-level width	t_{CH}		8.0			μs
V_{PP} counter low-level width	t_{CL}		8.0			μs
V_{PP} counter noise elimination width	t_{NFW}			40		ns

Flash Memory Write Mode Setting Timing



8. PACKAGE DRAWINGS

100-PIN PLASTIC LQFP (FINE PITCH) (14x14)



NOTE

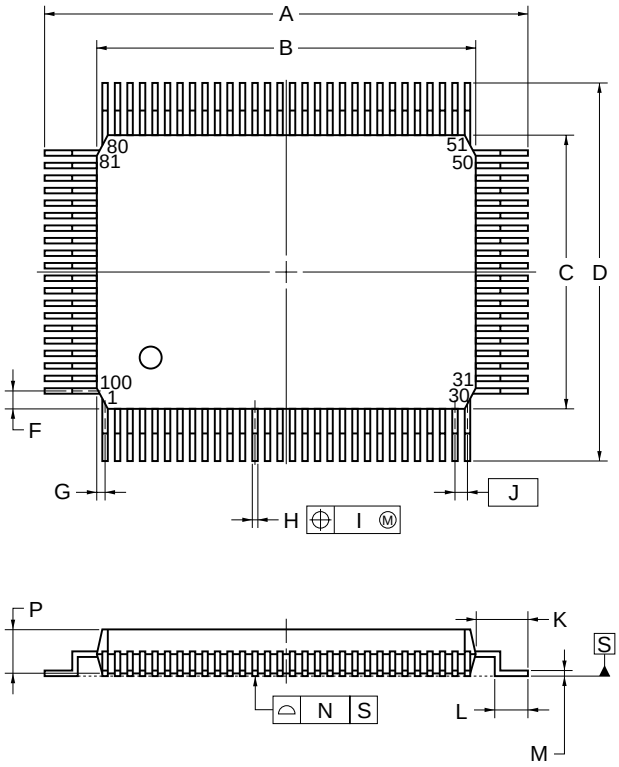
Each lead centerline is located within 0.08 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	16.00±0.20
B	14.00±0.20
C	14.00±0.20
D	16.00±0.20
F	1.00
G	1.00
H	$0.22^{+0.05}_{-0.04}$
I	0.08
J	0.50 (T.P.)
K	1.00±0.20
L	0.50±0.20
M	$0.17^{+0.03}_{-0.07}$
N	0.08
P	1.40±0.05
Q	0.10±0.05
R	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$
S	1.60 MAX.

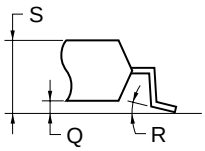
S100GC-50-8EU, 8EA-2

Remark The external dimensions and material of the ES version are the same as those of the mass-produced version.

100-PIN PLASTIC QFP (14x20)



detail of lead end



NOTE

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

ITEM	MILLIMETERS
A	23.6±0.4
B	20.0±0.2
C	14.0±0.2
D	17.6±0.4
F	0.8
G	0.6
H	0.30±0.10
I	0.15
J	0.65 (T.P.)
K	1.8±0.2
L	0.8±0.2
M	$0.15^{+0.10}_{-0.05}$
N	0.10
P	2.7±0.1
Q	0.1±0.1
R	5°±5°
S	3.0 MAX.

P100GF-65-3BA1-4

Remark The external dimensions and material of the ES version are the same as those of the mass-produced version.

9. RECOMMENDED SOLDERING CONDITIONS

The μPD78F4218AY should be soldered and mounted under the following recommended conditions. For the details of the recommended soldering conditions, refer to the document **Semiconductor Device Mounting Technology Manual (C10535E)**.

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

Table 9-1. Surface Mounting Type Soldering Conditions

(1) μPD78F4216AGC-8EU:100-pin plastic LQFP (fine pitch) (14 × 14)
μPD78F4218AGC-8EU:100-pin plastic LQFP (fine pitch) (14 × 14)
μPD78F4216AYGC-8EU:100-pin plastic LQFP (fine pitch) (14 × 14)
μPD78F4218AYGC-8EU: 100-pin plastic LQFP (fine pitch) (14 × 14)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Two times or less, Exposure limit: 7 days[Note] (after that, prebake at 125°C for 10 hours)	IR35-107-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Two times or less, Exposure limit: 7 days[Note] (after that, prebake at 125°C for 10 hours)	VP15-107-2
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	–

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

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

(2) μPD78F4216AGF-3BA:100-pin plastic QFP (14 × 20)
μPD78F4218AGF-3BA:100-pin plastic QFP (14 × 20)
μPD78F4216AYGF-3BA:100-pin plastic QFP (14 × 20)
μPD78F4218AYGF-3BA: 100-pin plastic QFP (14 × 20)

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

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

APPENDIX A. DEVELOPMENT TOOLS

The following development tools are available for system development using the μPD78F4218AY. Also refer to **(5) Cautions on using development tools**.

(1) Language processing software

RA78K4	Assembler package common to 78K/IV Series
CC78K4	C compiler package common to 78K/IV Series
DF784218	Device file common to μPD784216A, 784216AY, 784218A, 784218AY Subseries
CC78K4-L	C compiler library source file common to 78K/IV Series

(2) Flash memory writing tools

Flashpro II (Part number: FL-PR2), Flashpro III (Part number: FL-PR3, PG-FP3)	Dedicated flash programmer for microcontroller incorporating flash memory
FA-100GF	Adapter for writing 100-pin plastic QFP (GF-3BA type) flash memory. Connection must be performed in accordance with the target product.
FA-100GC	Adapter for writing 100-pin plastic LQFP (GC-8EU type) flash memory. Connection must be performed in accordance with the target product.

(3) Debugging tools

- **When IE-78K4-NS in-circuit emulator is used**

IE-78K4-NS	In-circuit emulator common to 78K/IV Series
IE-70000-MC-PS-B	Power supply unit for IE-78K4-NS
IE-70000-98-IF-C	Interface adapter required when PC-9800 series PC (except notebook type) is used as host machine (C bus supported)
IE-70000-CD-IF-A	PC card and cable when PC-9800 series notebook PC is used as host machine (PCMCIA socket supported)
IE-70000-PC-IF-C	Interface adapter required when using IBM PC/AT™ compatibles as host machine (ISA bus supported)
IE-70000-PCI-IF	Interface adapter required when using PC that incorporates PCI bus as host machine
IE-784225-NS-EM1	Emulation board to emulate μPD784216A, 784216AY, 784218A, 784218AY Subseries
NP-100GF	Emulation probe for 100-pin plastic QFP (GF-3BA type)
NP-100GC	Emulation probe for 100-pin plastic LQFP (GC-8EU type)
EV-9200GF-100	Socket to be mounted on a target system board made for 100-pin plastic QFP (GF-3BA type)
TGC-100SDW	Conversion adapter to connect the NP-100GC and a target system board on which a 100-pin plastic LQFP (GC-8EU type) can be mounted
ID78K4-NS	Integrated debugger for IE-78K4-NS
SM78K4	System simulator common to 78K/IV Series
DF784218	Device file common to μPD784216A, 784216AY, 784218A, 784218AY Subseries

- **When IE-784000-R in-circuit emulator is used**

IE-784000-R	In-circuit emulator common to 78K/IV Series
IE-70000-98-IF-C	Interface adapter required when PC-9800 series PC (except notebook type) is used as host machine (C bus supported)
IE-70000-PC-IF-C	Interface adapter required when using IBM PC/AT and compatibles as host machine (ISA bus supported)
IE-70000-PCI-IF	Interface adapter required when using PC that incorporates PCI bus as host machine
IE-78000-R-SV3	Interface adapter and cable required when EWS is used as host machine
IE-784225-NS-EM1	Emulation board to emulate μPD784216A, 784216AY, 784218A, 784218AY Subseries
IE-784000-R-EM	Emulation board common to 78K/IV Series
IE-78K4-R-EX3	Emulation probe conversion board required when using IE-784225-NS-EM1 on IE-784000-R.
EP-784218GF-R	Emulation probe for 100-pin plastic QFP (GF-3BA type)
EP-78064GC-R	Emulation probe for 100-pin plastic LQFP (GC-8EU type)
EV-9200GF-100	Socket to be mounted on a target system board made for 100-pin plastic QFP (GF-3BA type)
TGC-100SDW	Conversion adapter to connect the EP-78064GC-R and a target system board on which a 100-pin plastic LQFP (GC-8EU type) can be mounted
ID78K4	Integrated debugger for IE-784000-R
SM78K4	System simulator common to 78K/IV Series
DF784218	Device file common to μPD784216A, 784216AY, 784218A, 784218AY Subseries

(4) Real-time OS

RX78K/IV	Real-time OS for 78K/IV Series
MX78K4	OS for 78K/IV Series

(5) Cautions on using development tools

- The ID78K4-NS, ID78K4, and SM78K4 are used in combination with the DF784218.
- The CC78K4 and RX78K/IV are used in combination with the RA78K4 and DF784218.
- The FL-PR2, FL-PR3, FA-100GF, FA-100GC, NP-100GF, and NP-100GC are products made by Naito Densei Machida Mfg. Co., Ltd. (TEL: +81-44-822-3813).
- The TGC-100SDW is a product made by TOKYO ELETECH CORPORATION.
  For further information, contact Daimaru Kogyo, Ltd.
  Tokyo Electronic Division (TEL: +81-3-3820-7112)
  Osaka Electronic Division (TEL: +81-6-6244-6672)
- For third party development tools, see the **Single-Chip Microcontroller Development Tool Selection Guide (U11069E).**
- The host machine and OS suitable for each software are as follows:

Host Machine / [OS] / Software	PC	EWS
	PC-9800 series [Windows] IBM PC/AT and compatibles [Japanese/English Windows]	HP9000 Series 700™ [HP-UX™] SPARCstation™ [SunOS™, Solaris™] NEWS™ (RISC) [NEWS-OS™]
RA78K4	√Note	√
CC78K4	√Note	√
ID78K4-NS	√	–
ID78K4	√	√
SM78K4	√	–
RX78K/IV	√Note	√
MX78K4	√Note	√

Note DOS-based software

APPENDIX B. RELATED DOCUMENTS

Documents related to devices

Document Name	Document No.
μPD784214A, 784215A, 784216A, 784217A, 784218A, 784214AY, 784215AY, 784216AY, 784217AY, 784218AY Data Sheet	U14121E
μPD78F4216A, 78F4216AY, 78F4218A, 78F4218AY Data Sheet	This document
μPD784216A, 784216AY Subseries User's Manual Hardware	U13570E
μPD784218A, 784218AY Subseries User's Manual Hardware	U12970E
78K/IV Series User's Manual Instructions	U10905E
78K/IV Series Instruction Table	–
78K/IV Series Instruction Set	–
78K/IV Series Application Note Software Basics	–

Documents related to development tools (user's manuals)

Document Name		Document No.
RA78K4 Assembler Package	Language	U11162E
	Operation	U11334E
RA78K Structured Assembler Preprocessor		U11743E
CC78K4 C Compiler	Language	U11571E
	Operation	U11572E
IE-78K4-NS		U13356E
IE-784000-R		U12903E
IE-784218-R-EM1		U12155E
IE-784225-NS-EM1		U13742E
EP-78064		EEU-1469
SM78K4 System Simulator Windows Based	Reference	U10093E
SM78K Series System Simulator	External Part User Open Interface Specifications	U10092E
ID78K4-NS Integrated Debugger PC Based	Reference	U12796E
ID78K4 Integrated Debugger Windows Based	Reference	U10440E
ID78K4 Integrated Debugger HP-UX, SunOS, NEWS-OS Based	Reference	U11960E

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

Documents related to embedded software (user's manuals)

Document Name		Document No.
78K/IV Series Real-Time OS	Fundamental	U10603E
	Installation	U10604E
	Debugger	–
78K/IV Series OS MX78K4	Fundamental	–

Other documents

Document Name	Document No.
SEMICONDUCTOR SELECTION GUIDE Products & Packages (CD-ROM)	X13769X
Semiconductor Device Mounting Technology Manual	C10535E
Quality Grades on NEC Semiconductor Devices	C11531E
NEC Semiconductor Device Reliability/Quality Control System	C10983E
Guide to Prevent Damage for Semiconductor Devices by Electrostatic Discharge (ESD)	C11892E
Guide to Microcomputer-Related Products by Third Party	–

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

[MEMO]

[MEMO]

[MEMO]

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 devices 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, pIease 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.

NEC Electronics Inc. (U.S.)
Santa Clara, California
Tel: 408-588-6000
800-366-9782
Fax: 408-588-6130
800-729-9288

NEC Electronics (Germany) GmbH
Duesseldorf, Germany
Tel: 0211-65 03 02
Fax: 0211-65 03 490

NEC Electronics (UK) Ltd.
Milton Keynes, UK
Tel: 01908-691-133
Fax: 01908-670-290

NEC Electronics Italiana s.r.l.
Milano, Italy
Tel: 02-66 75 41
Fax: 02-66 75 42 99

NEC Electronics (Germany) GmbH
Benelux Office
Eindhoven, The Netherlands
Tel: 040-2445845
Fax: 040-2444580

NEC Electronics (France) S.A.
Velizy-Villacoublay, France
Tel: 01-30-67 58 00
Fax: 01-30-67 58 99

NEC Electronics (France) S.A.
Madrid Office
Madrid, Spain
Tel: 91-504-2787
Fax: 91-504-2860

NEC Electronics (Germany) GmbH
Scandinavia Office
Taeby, Sweden
Tel: 08-63 80 820
Fax: 08-63 80 388

NEC Electronics Hong Kong Ltd.
Hong Kong
Tel: 2886-9318
Fax: 2886-9022/9044

NEC Electronics Hong Kong Ltd.
Seoul Branch
Seoul, Korea
Tel: 02-528-0303
Fax: 02-528-4411

NEC Electronics Singapore Pte. Ltd.
United Square, Singapore
Tel: 65-253-8311
Fax: 65-250-3583

NEC Electronics Taiwan Ltd.
Taipei, Taiwan
Tel: 02-2719-2377
Fax: 02-2719-5951

NEC do Brasil S.A.
Electron Devices Division
Guarulhos-SP Brasil
Tel: 55-11-6462-6810
Fax: 55-11-6462-6829

J00.7

Purchase of NEC I^2C components conveys a license under the Philips I^2C Patent Rights to use these components in an I^2C system, provided that the system conforms to the I^2C Standard Specification as defined by Philips.

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

- **The information in this document is current as of August, 2000. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**
- No part of this document may be copied or reproduced in any form or by any means without prior written consent of NEC. NEC assumes no responsibility for any errors that may appear in this document.
- NEC does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC semiconductor products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC or others.
- Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of customer's equipment shall be done under the full responsibility of customer. NEC assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.
- While NEC endeavours to enhance the quality, reliability and safety of NEC semiconductor products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC semiconductor products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment, and anti-failure features.
- NEC semiconductor products are classified into the following three quality grades:
  "Standard", "Special" and "Specific". The "Specific" quality grade applies only to semiconductor products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of a semiconductor product depend on its quality grade, as indicated below. Customers must check the quality grade of each semiconductor product before using it in a particular application.
  "Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
  "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
  "Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.
  The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.
  (Note)
  (1) "NEC" as used in this statement means NEC Corporation and also includes its majority-owned subsidiaries.
  (2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).

M8E 00.4