NEC

MOS INTEGRATED CIRCUIT

μPD78F9306, 78F9316

8-BIT SINGLE-CHIP MICROCONTROLLERS

DESCRIPTION

The μPD78F9306 and 78F9316 belong to the μPD789306, 789316 Subseries (for LCD drivers) in the 78K/0S Series.

The μPD78F9306 has flash memory in place of the internal ROM of the μPD789304 and 789306, and the μPD78F9316 has flash memory in place of the internal ROM of the μPD789314 and 789316.

Because flash memory allows the program to be written and erased electrically with the device mounted on the board, this product is ideal for the evaluation stages of system development, small-scale production, and rapid development of new products.

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

μPD789306, 789316 Subseries User's Manual: U14800E
78K/0S Series User's Manual Instructions: U11047E

FEATURES

- Pin compatible with mask ROM version (except V_{PP} pin)
- Flash memory: 16 KB
- Main system clock
  Ceramic/crystal oscillation: μPD78F9306
  RC oscillation: μPD78F9316
- I/O ports: 23
- Serial interface: 2 channels
  Switchable between 3-wire serial I/O mode and UART mode: 1 channel
  3-wire serial I/O mode: 1 channel
- LCD controller/driver
  Segment signals: 24, common signals: 4
- Timer: 5 channels
- Power supply voltage: V_{DD} = 1.8 to 5.5 V

APPLICATIONS

Remote control devices, healthcare equipment, etc.

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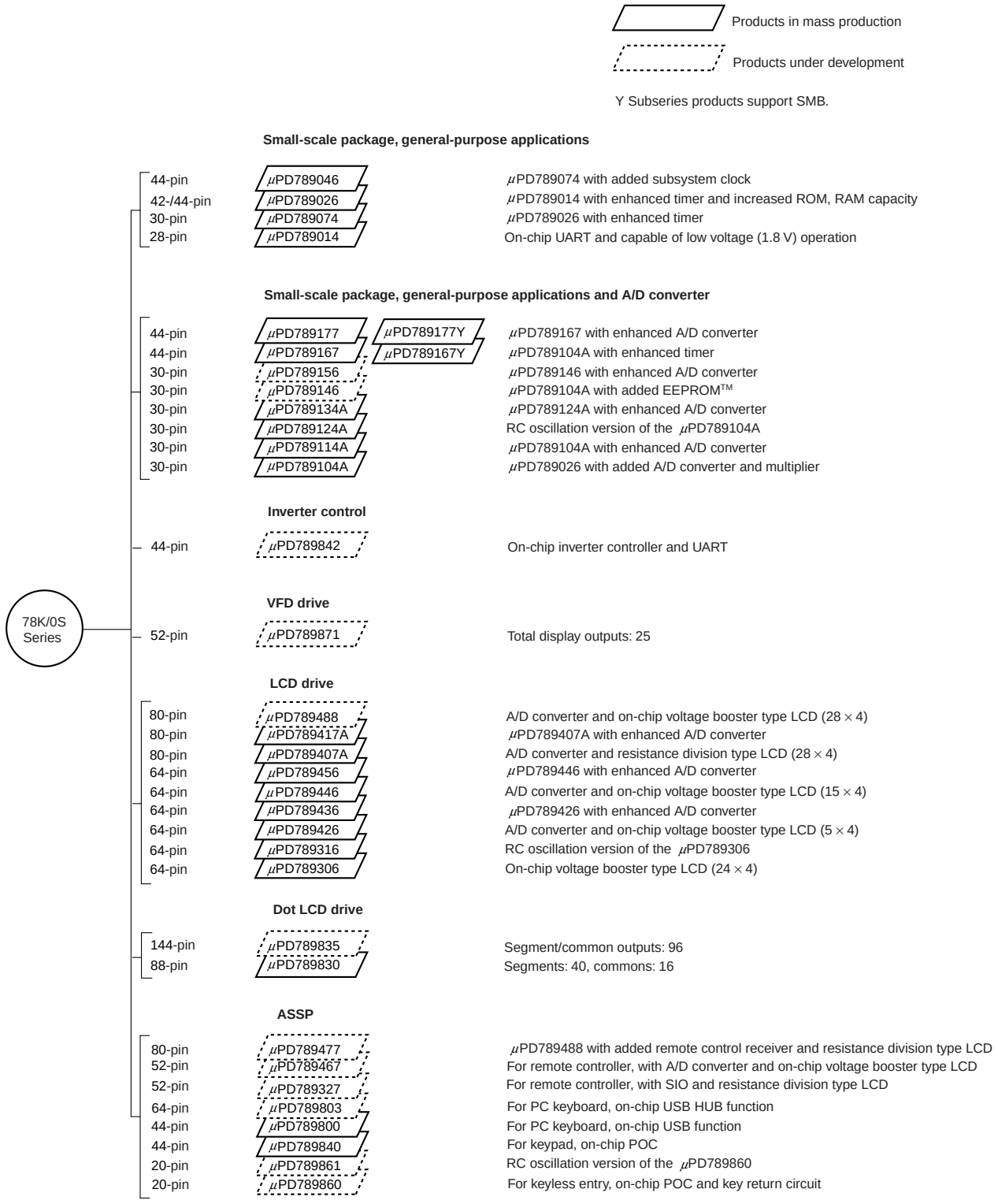
The mark ★ shows major revised points.

ORDERING INFORMATION

Part Number	Package
μPD78F9306GC-AB8	64-pin plastic QFP (14 × 14)
μPD78F9306GK-9ET	64-pin plastic TQFP (12 × 12)
μPD78F9316GC-AB8	64-pin plastic QFP (14 × 14)
μPD78F9316GK-9ET	64-pin plastic TQFP (12 × 12)

★ 78K/0S SERIES LINEUP

The products in the 78K/0S Series are listed below. The names enclosed in boxes are subseries names.



The major functional differences among the subseries are listed below.

Subseries Name \ Function		ROM Capacity	8-Bit	16-Bit	Watch	WDT	8-Bit A/D	10-Bit A/D	Serial Interface	I/O	V_{DD} MIN. Value	Remarks
Small-scale package, general-purpose applications	μPD789046	16 K	1 ch	1 ch	1 ch	1 ch	–	–	1 ch (UART: 1 ch)	34	1.8 V	–
	μPD789026	4 K to 16 K			–							
	μPD789074	2 K to 8 K								24		
	μPD789014	2 K to 4 K	2 ch	–						22		
Small-scale package, general-purpose applications and A/D converter	μPD789177	16 K to 24 K	3 ch	1 ch	1 ch		–	8 ch	1 ch (UART: 1 ch)	31		–
	μPD789167						8 ch	–				
	μPD789156	8 K to 16 K	1 ch		–		–	4 ch		20		On-chip EEPROM
	μPD789146						4 ch	–				
	μPD789134A	2 K to 8 K					–	4 ch				RC-oscillation version
	μPD789124A						4 ch	–				
	μPD789114A						–	4 ch				–
	μPD789104A						4 ch	–				
Inverter control	μPD789842	8 K to 16 K	3 ch	**Note**	1 ch	1 ch	8 ch	–	1 ch (UART: 1 ch)	30	4.0 V	–
VFD drive	μPD789871	4 K to 8 K	3 ch	–	1 ch	1 ch	–	–	1 ch	33	2.7 V	–
LCD drive	μPD789488	32 K	3 ch	1 ch	1 ch	1 ch	–	8 ch	2 ch (UART: 1 ch)	45	1.8 V	–
	μPD789417A	12 K to 24 K						7 ch	1 ch (UART: 1 ch)	43		
	μPD789407A						7 ch	–				
	μPD789456	12 K to 16 K	2 ch				–	6 ch		30		
	μPD789446						6 ch	–				
	μPD789436						–	6 ch		40		
	μPD789426						6 ch	–				
	μPD789316	8 K to 16 K					–		2 ch (UART: 1 ch)	23		RC-oscillation version
	μPD789306											–
Dot LCD drive	μPD789835	24 K to 60 K	6 ch	–	1 ch	1 ch	3 ch	–	1 ch (UART: 1 ch)	28	1.8 V	–
	μPD789830	24 K	1 ch	1 ch			–			30	2.7 V	
ASSP	μPD789477	24 K	3 ch	1 ch	1 ch	1 ch	8 ch	–	2 ch (UART: 1 ch)	45	1.8 V	On-chip LCD
	μPD789467	4 K to 24 K	2 ch	–			1 ch		–	18		
	μPD789327						–		1 ch	21		
	μPD789803	8 K to 16 K			–				2 ch (USB: 1 ch)	41	3.6 V	–
	μPD789800	8 K								31	4.0 V	
	μPD789840						4 ch		1 ch	29	2.8 V	
	μPD789861	4 K					–		–	14	1.8 V	RC-oscillation version, on-chip EEPROM
	μPD789860											On-chip EEPROM

Note 10-bit timer: 1 channel

OVERVIEW OF FUNCTIONS

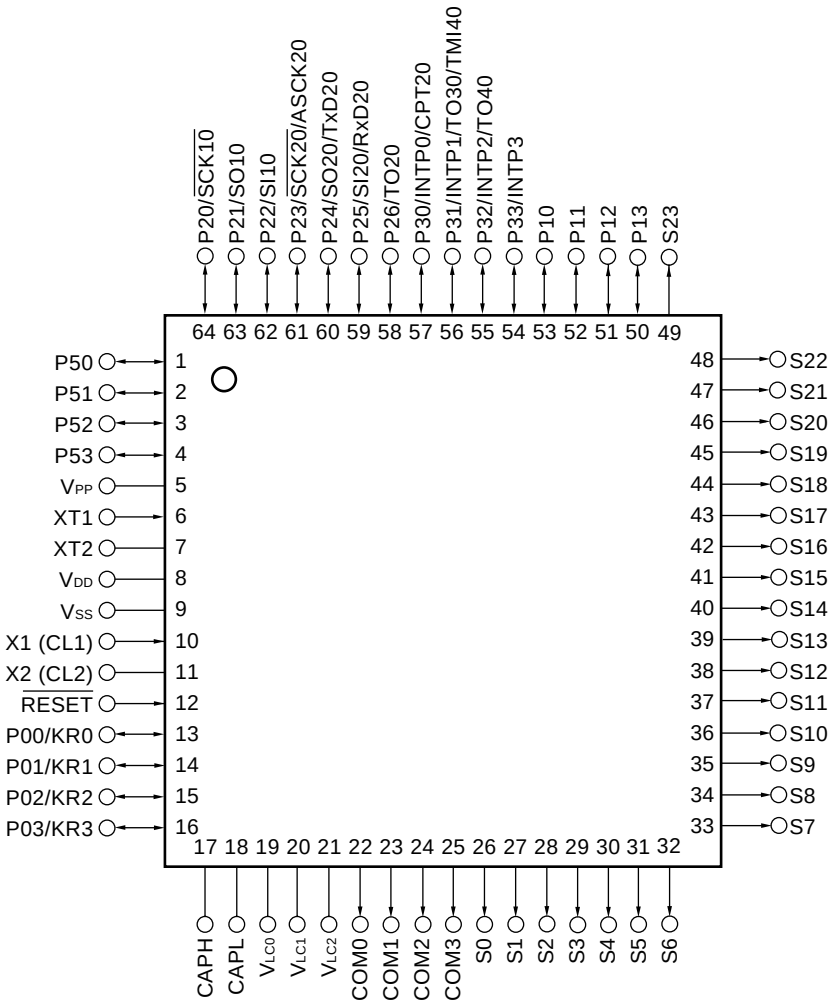
Item		μPD78F9306	μPD78F9316
Internal memory	Flash memory	16 KB	
	High-speed RAM	512 bytes	
	LCD display RAM	24 bytes	
Main system clock (oscillation frequency)		Ceramic/crystal oscillation (1.0 to 5.0 MHz)	RC oscillation (2.0 to 4.0 MHz)
Subsystem clock (oscillation frequency)		Crystal oscillation (32.768 kHz)	
Minimum instruction execution time		0.4 μs/1.6 μs (@ 5.0 MHz operation with main system clock)	0.5 μs/2.0 μs (@ 4.0 MHz operation with main system clock)
		122 μs (@ 32.768 kHz operation with subsystem clock)	
General-purpose registers		8 bits × 8 registers	
Instruction set		• 16-bit operation • Bit manipulation (set, reset, test)	
I/O ports		Total: 23 • CMOS I/O: 19 • N-ch open drain: 4	
Timers		• 16-bit timer: 1 channel • 8-bit timer/event counter: 2 channels • Watch timer: 1 channel • Watchdog timer: 1 channel	
Serial interface		• Switchable between 3-wire serial I/O mode and UART mode: 1 channel • 3-wire serial I/O mode: 1 channel	
LCD controller/driver		• Segment signal outputs: 24 (Max.) • Common signal outputs: 4 (Max.)	
Vectored interrupt sources	Maskable	Internal: 9, External: 5	
	Non-maskable	Internal: 1	
Power supply voltage		V_{DD} = 1.8 to 5.5 V	
Operating ambient temperature		T_A = –40 to +85°C	
Package		• 64-pin plastic QFP (14 × 14) • 64-pin plastic TQFP (12 × 12)	

CONTENTS

1. PIN CONFIGURATION (Top View)

64-pin plastic QFP (14 × 14)
μPD78F9306GC-AB8
μPD78F9316GC-AB8

64-pin plastic TQFP (12 × 12)
μPD78F9306GK-9ET
μPD78F9316GK-9ET

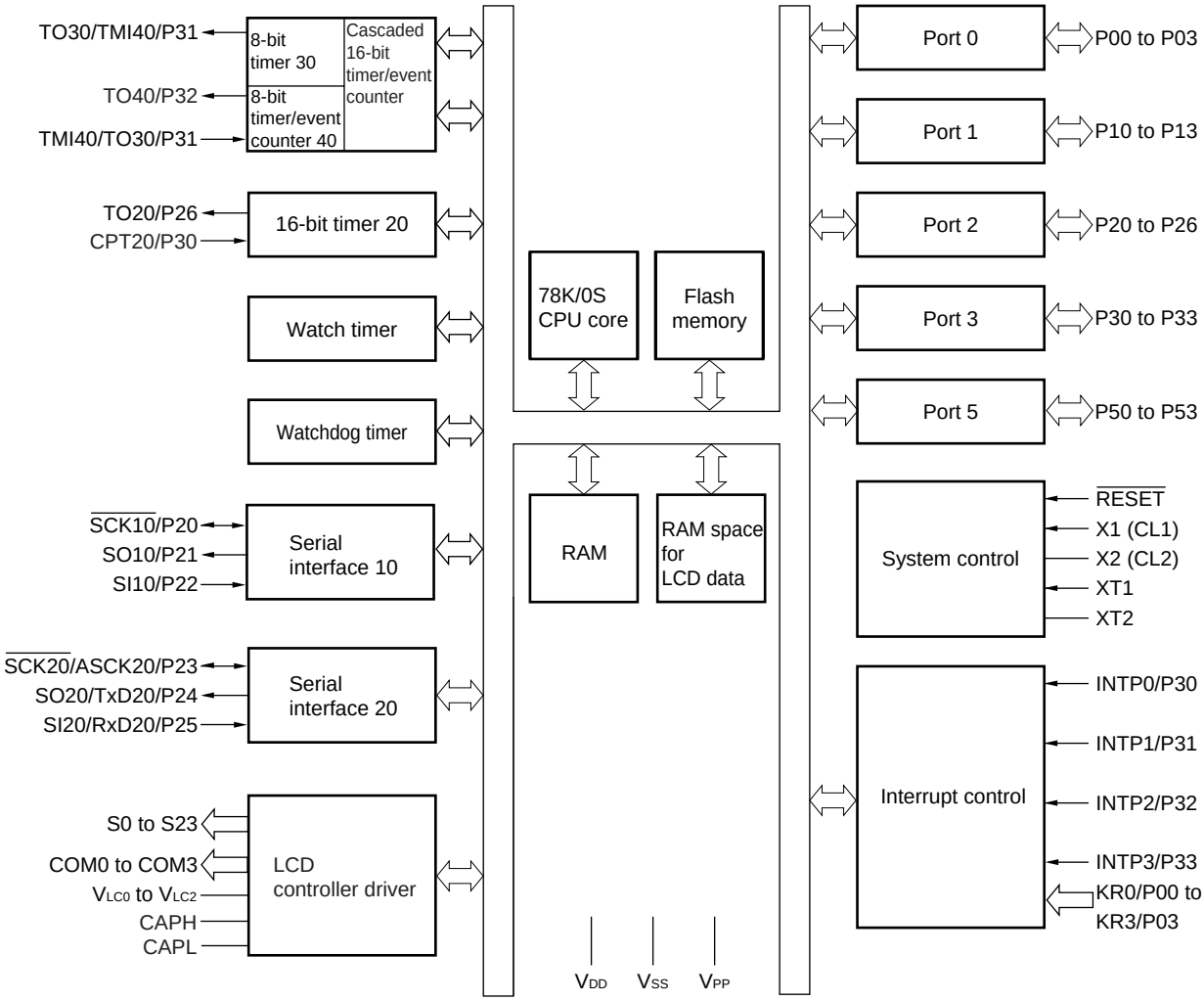


Caution Connect the V_{PP} pin directly to the V_{SS} pin in normal operation mode.

Remark Pin names enclosed in parentheses apply when using the μPD78F9316.

ASCK20:	Asynchronous serial input	S0 to S23:	Segment output
CAPH, CAPL:	LCD power supply capacitance control	$\overline{SCK10}$, $\overline{SCK20}$:	Serial clock
CL1, CL2:	RC oscillator	SI10, SI20:	Serial input
COM0 to COM3:	Common output	SO10, SO20:	Serial output
CPT20:	Capture trigger input	TMI40:	Timer input
INTP0 to INTP3:	External interrupt input	TO20, TO30, TO40:	Timer output
KR0 to KR3:	Key return	TxD20:	Transmit data
P00 to P03:	Port 0	V_{DD}:	Power supply
P10 to P13:	Port 1	V_{LC0} to V_{LC2}:	LCD power supply
P20 to P26:	Port 2	V_{PP}:	Programming power supply
P30 to P33:	Port 3	V_{SS}:	Ground
P50 to P53:	Port 5	X1, X2:	Crystal/ceramic oscillator
$\overline{RESET}$:	Reset	XT1, XT2:	Crystal oscillator
RxD20:	Receive data		

2. BLOCK DIAGRAM



Remark Pin names enclosed in parentheses apply when using the μPD78F9316.

3. PIN FUNCTIONS

3.1 Port Pins

Pin Name	I/O	Function	After Reset	Alternate Function
P00 to P03	I/O	Port 0. 4-bit I/O port. Input/output can be specified in 1-bit units. When used as an input port, use of an on-chip pull-up resistor can be specified in port units by pull-up resistor option register 0 (PU0) or key return mode register 00 (KRM00).	Input	KR0 to KR3
P10 to P13	I/O	Port 1. 4-bit I/O port. Input/output can be specified in 1-bit units. When used as an input port, use of an on-chip pull-up resistor can be specified in port units by pull-up resistor option register 0 (PU0).	Input	–
P20	I/O	Port 2. 7-bit I/O port. Input/output can be specified in 1-bit units. When used as an input port, use of an on-chip pull-up resistor can be specified in bit units by pull-up resistor option register B2 (PUB2).	Input	$\overline{\text{SCK10}}$
P21				SO10
P22				SI10
P23				$\overline{\text{SCK20}}$/ASCK20
P24				SO20/TxD20
P25				SI20/RxD20
P26				TO20
P30	I/O	Port 3. 4-bit I/O port. Input/output can be specified in 1-bit units. When used as an input port, use of an on-chip pull-up resistor can be specified in bit units by pull-up resistor option register B3 (PUB3).	Input	INTP0/CPT20
P31				INTP1/TO30/TMI40
P32				INTP2/TO40
P33				INTP3
P50 to P53	I/O	Port 5. 4-bit I/O port. Input/output can be specified in 1-bit units.	Input	–

3.2 Non-Port Pins

Pin Name	I/O	Function	After Reset	Alternate Function
INTP0	Input	External interrupt input for which the valid edge (rising edge, falling edge, or both rising and falling edges) can be specified	Input	P30/CPT20
INTP1				P31/TO30/TMI40
INTP2				P32/TO40
INTP3				P33
KR0 to KR3	Input	Key return signal detection	Input	P00 to P03
$\overline{SCK10}$	Input/ output	Serial clock input/output for serial interface 10 (SIO10)	Input	P20
$\overline{SCK20}$		Serial clock input/output for serial interface 20 (SIO20)		P23/ASCK20
SI10	Input	Serial data input for serial interface 10 (SIO10)	Input	P22
SI20		Serial data input for serial interface 20 (SIO20)		P25/RxD20
SO10	Output	Serial data output for serial interface 10 (SIO10)	Input	P21
SO20		Serial data output for serial interface 20 (SIO20)		P24/TxD20
ASCK20	Input	Serial clock input for asynchronous serial interface	Input	P23/$\overline{SCK20}$
RxD20	Input	Serial data input for asynchronous serial interface	Input	P25/SI20
TxD20	Output	Serial data output for asynchronous serial interface	Input	P24/SO20
TO20	Output	16-bit timer 20 (TM20) output	Input	P26
CPT20	Input	Capture edge input	Input	P30/INTP0
TO30	Output	8-bit timer 30 (TM30) output	Input	P31/INTP1/TMI40
TO40	Output	8-bit timer 40 (TM40) output	Input	P32/INTP2
TMI40	Input	External count clock input to 8-bit timer 40 (TM40)	Input	P31/INTP1/TO30
S0 to S23	Output	Segment signal output for LCD controller/driver	Low-level output	–
COM0 to COM3	Output	Common signal output for LCD controller/driver	Low-level output	–
V_{LC0} to V_{LC2}	–	LCD drive voltage	–	–
CAPH	–	Connection pin for LCD driver's capacitor	–	–
CAPL	–		–	–
X1[Note 1]	Input	Connecting crystal resonator for main system clock oscillation	–	–
X2[Note 1]	–		–	–
CL1[Note 2]	Input	Connections to resistor (R) and capacitor (C) for main system clock oscillation	–	–
CL2[Note 2]	–		–	–
XT1	Input	Connecting crystal resonator for subsystem clock oscillation	–	–
XT2	–		–	–
$\overline{RESET}$	Input	System reset input	Input	–
V_{DD}	–	Positive power supply	–	–
V_{SS}	–	Ground potential	–	–
V_{PP}	–	Flash memory programming mode setting. High-voltage application for program write/verify. In normal operation mode, connect directly to V_{SS}.	–	–

Notes 1. μPD78F9306 only

2. μPD78F9316 only

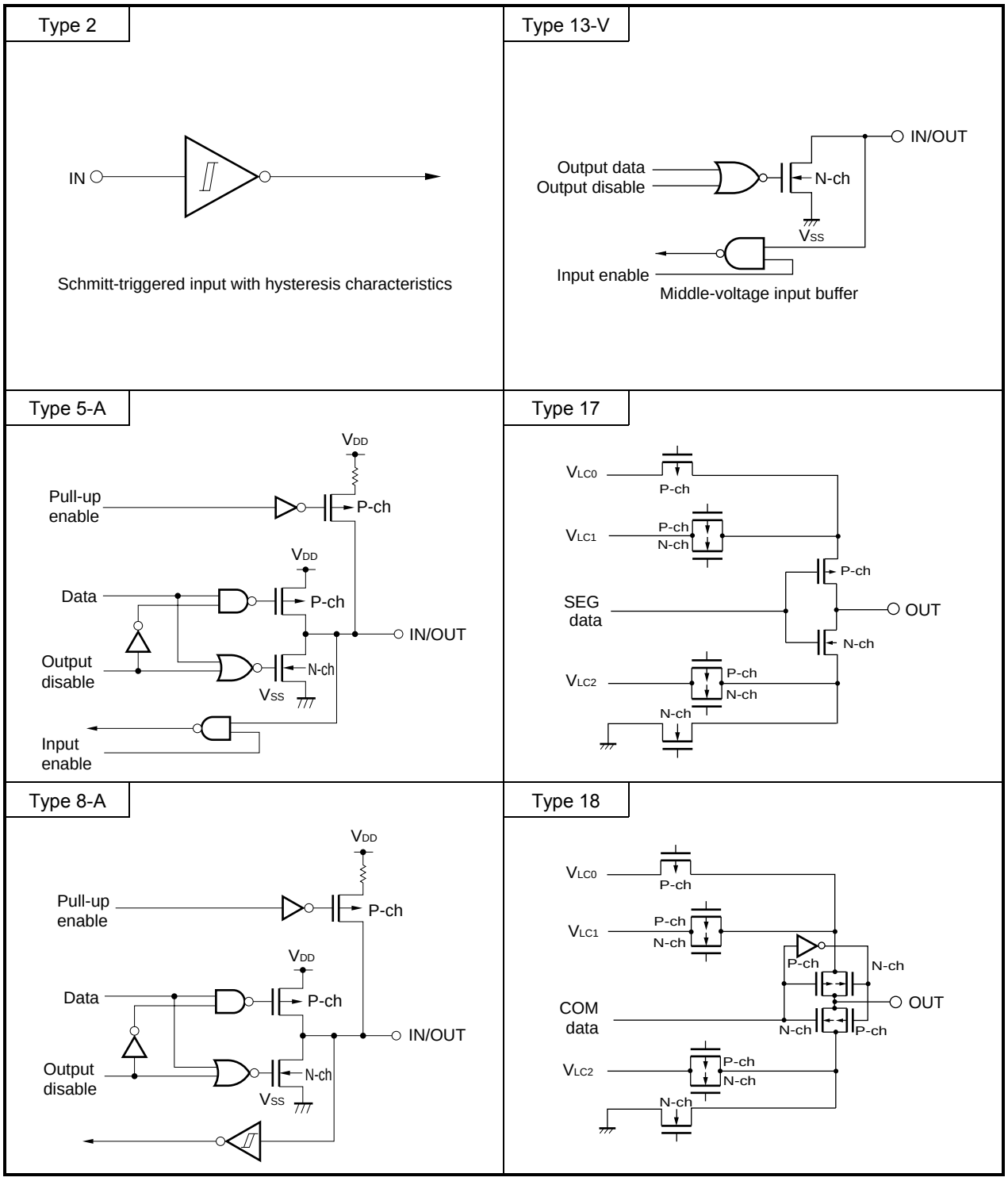
3.3 Pin I/O Circuits and Recommended Connection of Unused Pins

The I/O circuit type of each pin and recommended connection of unused pins are shown in Table 3-1.
For the I/O circuit configuration of each type, refer to Figure 3-1.

Table 3-1. Types of Pin I/O Circuits and Recommended Connection of Unused Pins

Pin Name	I/O Circuit Type	I/O	Recommended Connection of Unused Pins
P00/KR0 to P03/KR3	8-A	I/O	Input mode: Independently connect to V_{DD} or V_{SS} via a resistor. Output mode: Leave open.
P10 to P13	5-A		
P20/$\overline{SCK10}$	8-A		
P21/SO10			
P22/SI10			
P23/$\overline{SCK20}$/ASCK20			
P24/SO20/TxD20			
P25/SI20/RxD20			
P26/TO20			
P30/INTP0/CPT20			Input mode: Independently connect to V_{SS} via a resistor. Output mode: Leave open.
P31/INTP1/TO30/ TMI40			
P32/INTP2/TO40			
P33/INTP3			
P50 to P53	13-V		Input mode: Independently connect to V_{DD} via a resistor. Output mode: Leave open.
S0 to S23	17	Output	Leave open.
COM0 to COM3	18		
V_{LC0} to V_{LC2}	–	–	
CAPH, CAPL	–		
XT1	–	Input	Connect to V_{SS}.
XT2		–	Leave open.
$\overline{RESET}$	2	Input	–
V_{PP}	–	–	Connect directly to V_{SS}.

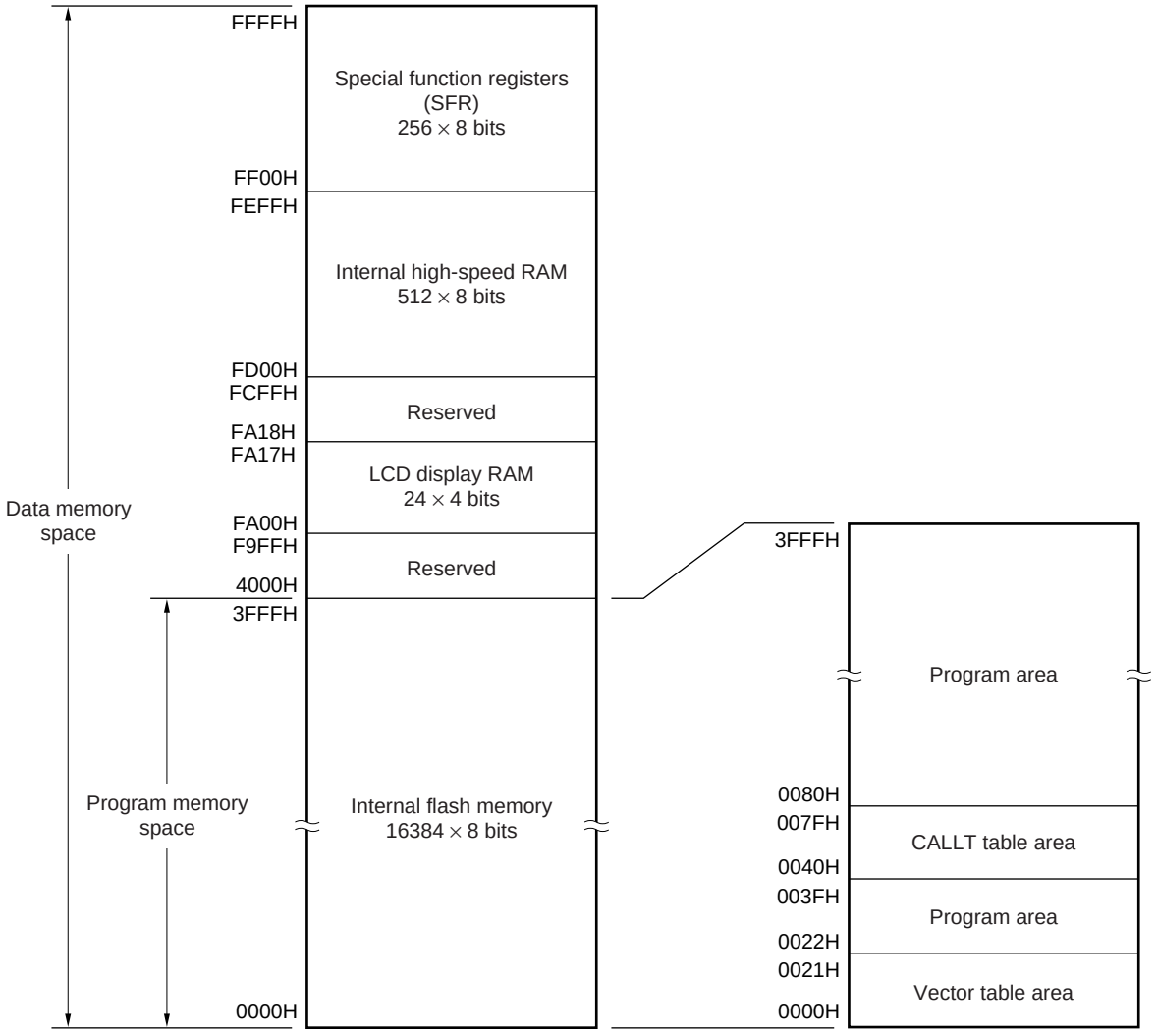
Figure 3-1. Pin I/O Circuits



4. MEMORY SPACE

Figure 4-1 shows the memory map.

Figure 4-1. Memory Map



5. FLASH MEMORY PROGRAMMING

The program memory that is incorporated in the μPD78F9306 and 78F9316 is flash memory.

With flash memory, it is possible to write programs on-board. Writing is performed by connecting a dedicated flash programmer (Flashpro III (Part No. FL-PR3, PG-FP3)) to the host machine and the target system.

Remark FL-PR3 is a product of Naito Densei Machida Mfg. Co., Ltd.

5.1 Selecting Communication Mode

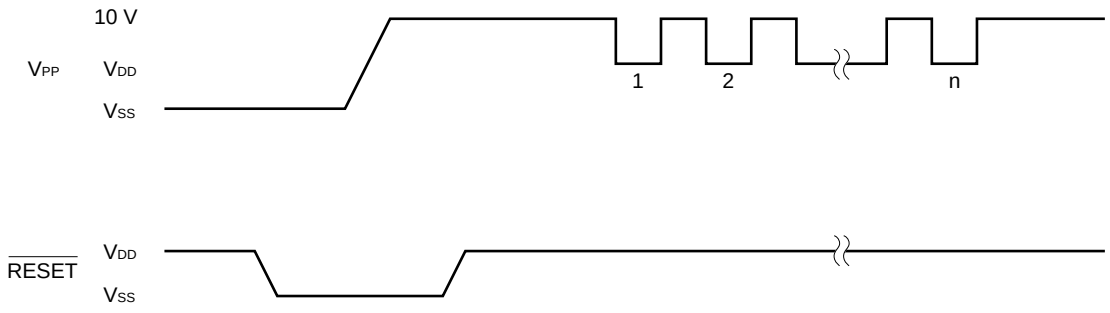
Writing to flash memory is performed using the Flashpro III in a serial communication mode. Select one of the communication modes in Table 5-1. The selection of the communication mode is made by using the format shown in Figure 5-1. Each communication mode is selected using the number of V_{PP} pulses shown in Table 5-1.

★ **Table 5-1. List of Communication Mode**

Communication Mode	Pins	V_{PP} Pulses
3-wire serial I/O	$\overline{SCK10}$/P20 SO10/P21 SI10/P22	0
	P00/KR0 (serial clock input) P01/KR1 (serial data output) P02/KR2 (serial data input)	1
UART	TxD20/SO20/P24 RxD20/SI20/P25	8

Caution Be sure to select a communication mode using the number of V_{PP} pulses shown in Table 5-1.

Figure 5-1. Format of Communication Mode Selection



5.2 Function of Flash Memory Programming

Operations such as writing to flash memory are performed by various command/data transmission and reception operations according to the selected communication mode. Table 5-2 shows the major functions of flash memory programming.

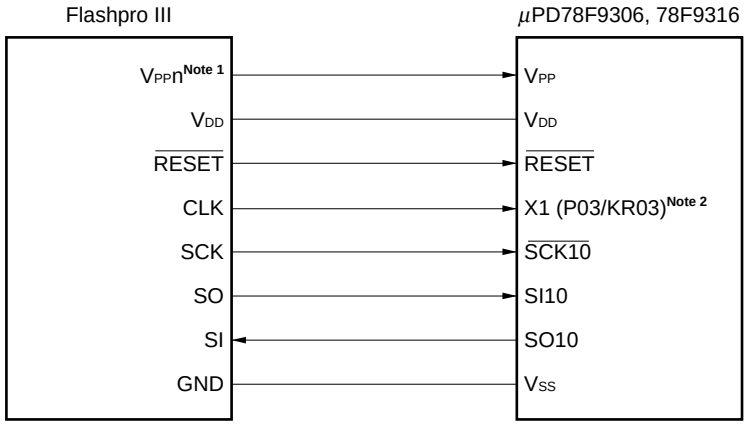
Table 5-2. Major Function of Flash Memory Programming

Function	Description
Batch erase	Deletes the entire memory contents.
Batch blank check	Checks the deletion status of the entire memory.
Data write	Performs a write operation to the flash memory based on the write start address and the number of data to be written (number of bytes).
Batch verify	Compares the entire memory contents with the input data.

5.3 Connecting Flashpro III

The connection of the Flashpro III and the μPD78F9306 and 78F9316 differs according to the communication mode (3-wire serial I/O or UART). The connections for each communication mode are shown in Figures 5-2 and 5-3, respectively.

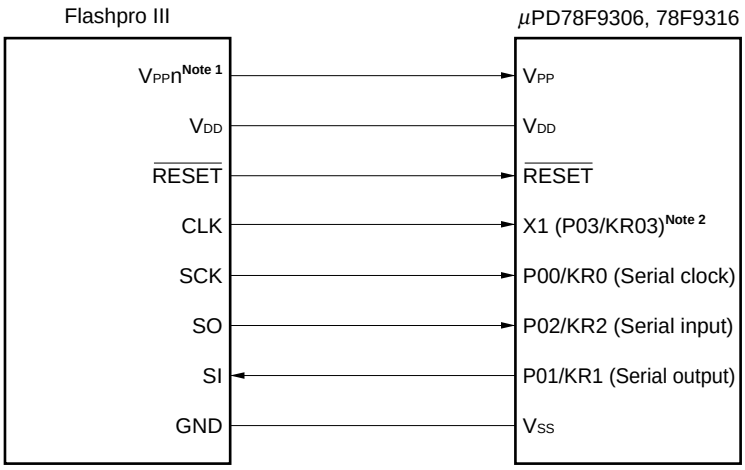
Figure 5-2. Connection Example of Flashpro III When Using 3-Wire Serial I/O Mode (1/2)



Notes 1. n = 1, 2

2. Pin names enclosed in parentheses apply when using the μPD78F9316.

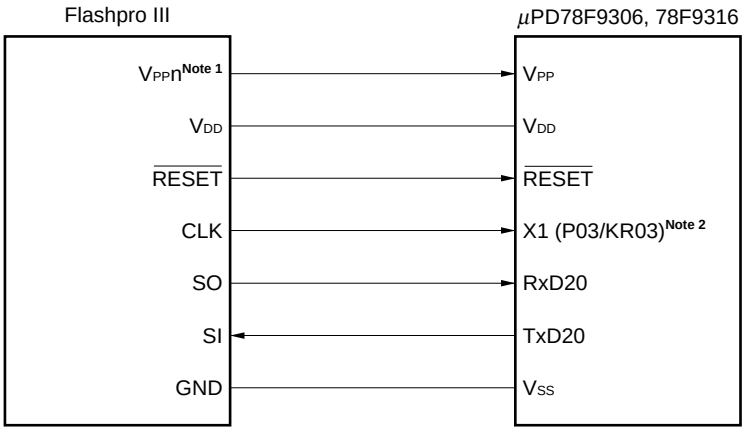
★ **Figure 5-2. Connection Example of Flashpro III When Using 3-Wire Serial I/O Mode (2/2)**



Notes 1. n = 1, 2

2. Pin names enclosed in parentheses apply when using the μPD78F9316.

Figure 5-3. Connection Example of Flashpro III When Using UART Mode



Notes 1. n = 1, 2

2. Pin names enclosed in parentheses apply when using the μPD78F9316.

5.4 Example of Settings for Flashpro III (PG-FP3)

When writing to flash memory using Flashpro III (PG-FP3), make the following settings.

<1> Load a parameter file.
<2> Select the mode of serial communication and serial clock with a type command.
<3> Make the settings according to the example of settings for PG-FP3 shown below.

Table 5-3. Example of Settings for PG-FP3

Communication Mode	Example of Settings for PG-FP3		V_{PP} Pulse Number[Note 1]
3-wire serial I/O	COMM PORT	SIO-ch0	0
	CPU CLK	On Target Board	
		In Flashpro	
	On Target Board	4.1943 MHz	
	SIO CLK	1.0 MHz	
	In Flashpro	4.0 MHz	
	SIO CLK	1.0 MHz	
★	COMM PORT	SIO-ch1	1
	CPU CLK	On Target Board	
		In Flashpro	
	On Target Board	4.1943 MHz	
	SIO CLK	1.0 MHz	
	In Flashpro	4.0 MHz	
	SIO CLK	1.0 MHz	
UART	COMM PORT	UART-ch0	8
	CPU CLK	On Target Board	
	On Target Board	4.1943 MHz	
	UART BPS	9600 bps[Note 2]	

Notes 1. This is the number of V_{PP} pulses that are supplied by the Flashpro III at serial communication initialization. The pins that will be used for communication are determined according to this number.

2. Select one of 9600 bps, 19200 bps, 38400 bps, or 76800 bps.

Remark COMM PORT: Serial port selection
SIO CLK: Serial clock frequency selection
CPU CLK: Input CPU clock source selection

6. OVERVIEW OF INSTRUCTION SET

This section lists the instruction set for the μPD78F9306 and 78F9316.

6.1 Conventions

6.1.1 Operand expressions and description methods

Operands are described in "Operand" column of each instruction in accordance with the description method of the instruction operand expression (see the assembler specifications for details). When there are two or more description methods, select one of them. Uppercase letters and symbols, #, !, $, and [ ] are key words and are described as they are. The meaning of each symbol is described below.

- # : Immediate data specification
- ! : Absolute address specification
- $: Relative address specification
- [ ] : Indirect address specification

For immediate data, enter an appropriate numeric value or a label. When using a label, be sure to enter the #, !, $ and [ ] symbols.

For operand register expressions, r and rp, either function names (X, A, C, etc.) or absolute names (names in parenthesis in the table below, R0, R1, R2, etc.) can be used for the description.

Table 6-1. Operand Expressions and Description Methods

Expression	Description Method
r rp sfr	X (R0), A (R1), C (R2), B (R3), E (R4), D (R5), L (R6), H (R7) AX (RP0), BC (RP1), DE (RP2), HL (RP3) Special function register symbol
saddr saddrp	FE20H to FF1FH: immediate data or label FE20H to FF1FH: immediate data or label (even addresses only)
addr16 addr5	0000H to FFFFH: immediate data or label (even addresses only for 16-bit data transfer instruction) 0040H to 007FH: immediate data or label (even addresses only)
word byte bit	16-bit immediate data or label 8-bit immediate data or label 3-bit immediate data or label

6.1.2 Description of “Operation” column

A:	A register; 8-bit accumulator
X:	X register
B:	B register
C:	C register
D:	D register
E:	E register
H:	H register
L:	L register
AX:	AX register pair; 16-bit accumulator
BC:	BC register pair
DE:	DE register pair
HL:	HL register pair
PC:	Program counter
SP:	Stack pointer
PSW:	Program status word
CY:	Carry flag
AC:	Auxiliary carry flag
Z:	Zero flag
IE:	Interrupt request enable flag
NMIS:	Flag indicating non-maskable interrupt servicing in progress
( ):	Memory contents indicated by address or register contents in parenthesis
X_H, X_L:	Higher 8 bits and lower 8 bits of 16-bit register
∧:	Logical product (AND)
∨:	Logical sum (OR)
$\overline{\vee}$:	Exclusive logical sum (exclusive OR)
$\overline{\ }$:	Inverted data
addr16:	16-bit immediate data or label
jdisp8:	Signed 8-bit data (displacement value)

6.1.3 Description of “Flag” column

(Blank):	Unchanged
0:	Cleared to 0
1:	Set to 1
×:	Set/cleared according to the result
R:	Previously saved value is restored

6.2 List of Operations

Mnemonic	Operand	Bytes	Clocks	Operation	Flags
					Z AC CY
MOV	r, #byte	3	6	r ← byte	
	saddr, #byte	3	6	(saddr) ← byte	
	sfr, #byte	3	6	sfr ← byte	
	A, r Note 1	2	4	A ← r	
	r, A Note 1	2	4	r ← A	
	A, saddr	2	4	A ← (saddr)	
	saddr, A	2	4	(saddr) ← A	
	A, sfr	2	4	A ← sfr	
	sfr, A	2	4	sfr ← A	
	A, !addr16	3	8	A ← (addr16)	
	!addr16, A	3	8	(addr16) ← A	
	PSW, #byte	3	6	PSW ← byte	× × ×
	A, PSW	2	4	A ← PSW	
	PSW, A	2	4	PSW ← A	× × ×
	A, [DE]	1	6	A ← (DE)	
	[DE], A	1	6	(DE) ← A	
	A, [HL]	1	6	A ← (HL)	
	[HL], A	1	6	(HL) ← A	
	A, [HL + byte]	2	6	A ← (HL + byte)	
	[HL + byte], A	2	6	(HL + byte) ← A	
XCH	A, X	1	4	A ↔ X	
	A, r Note 2	2	6	A ↔ r	
	A, saddr	2	6	A ↔ (saddr)	
	A, sfr	2	6	A ↔ (sfr)	
	A, [DE]	1	8	A ↔ (DE)	
	A, [HL]	1	8	A ↔ (HL)	
	A, [HL + byte]	2	8	A ↔ (HL + byte)	
MOVW	rp, #word	3	6	rp ← word	
	AX, saddrp	2	6	AX ← (saddrp)	
	saddrp, AX	2	8	(saddrp) ← AX	
	AX, rp Note 3	1	4	AX ← rp	
	rp, AX Note 3	1	4	rp ← AX	
XCHW	AX, rp Note 3	1	8	AX ↔ rp	

Notes 1. Except r = A

2. Except r = A, X

3. rp = BC, DE and HL only

Remark One instruction clock cycle is one CPU clock cycle (f_{CPU}) selected via the processor clock control register (PCC).

Mnemonic	Operand	Bytes	Clocks	Operation	Flags		
					Z	AC	CY
ADD	A, #byte	2	4	A, CY ← A + byte	×	×	×
	saddr, #byte	3	6	(saddr), CY ← (saddr) + byte	×	×	×
	A, r	2	4	A, CY ← A + r	×	×	×
	A, saddr	2	4	A, CY ← A + (saddr)	×	×	×
	A, !addr16	3	8	A, CY ← A + (addr16)	×	×	×
	A, [HL]	1	6	A, CY ← A + (HL)	×	×	×
	A, [HL + byte]	2	6	A, CY ← A + (HL + byte)	×	×	×
ADDC	A, #byte	2	4	A, CY ← A + byte + CY	×	×	×
	saddr, #byte	3	6	(saddr), CY ← (saddr) + byte + CY	×	×	×
	A, r	2	4	A, CY ← A + r + CY	×	×	×
	A, saddr	2	4	A, CY ← A + (saddr) + CY	×	×	×
	A, !addr16	3	8	A, CY ← A + (addr16) + CY	×	×	×
	A, [HL]	1	6	A, CY ← A + (HL) + CY	×	×	×
	A, [HL + byte]	2	6	A, CY ← A + (HL + byte) + CY	×	×	×
SUB	A, #byte	2	4	A, CY ← A – byte	×	×	×
	saddr, #byte	3	6	(saddr), CY ← (saddr) – byte	×	×	×
	A, r	2	4	A, CY ← A – r	×	×	×
	A, saddr	2	4	A, CY ← A – (saddr)	×	×	×
	A, !addr16	3	8	A, CY ← A – (addr16)	×	×	×
	A, [HL]	1	6	A, CY ← A – (HL)	×	×	×
	A, [HL + byte]	2	6	A, CY ← A – (HL + byte)	×	×	×
SUBC	A, #byte	2	4	A, CY ← A – byte – CY	×	×	×
	saddr, #byte	3	6	(saddr), CY ← (saddr) – byte – CY	×	×	×
	A, r	2	4	A, CY ← A – r – CY	×	×	×
	A, saddr	2	4	A, CY ← A – (saddr) – CY	×	×	×
	A, !addr16	3	8	A, CY ← A – (addr16) – CY	×	×	×
	A, [HL]	1	6	A, CY ← A – (HL) – CY	×	×	×
	A, [HL + byte]	2	6	A, CY ← A – (HL + byte) – CY	×	×	×
AND	A, #byte	2	4	A ← A ∧ byte	×		
	saddr, #byte	3	6	(saddr) ← (saddr) ∧ byte	×		
	A, r	2	4	A ← A ∧ r	×		
	A, saddr	2	4	A ← A ∧ (saddr)	×		
	A, !addr16	3	8	A ← A ∧ (addr16)	×		
	A, [HL]	1	6	A ← A ∧ (HL)	×		
	A, [HL + byte]	2	6	A ← A ∧ (HL + byte)	×		

Remark One instruction clock cycle is one CPU clock cycle (f_{CPU}) selected via the processor clock control register (PCC).

Mnemonic	Operand	Bytes	Clocks	Operation	Flags
					Z AC CY
OR	A, #byte	2	4	A ← A ∨ byte	×
	saddr, #byte	3	6	(saddr) ← (saddr) ∨ byte	×
	A, r	2	4	A ← A ∨ r	×
	A, saddr	2	4	A ← A ∨ (saddr)	×
	A, !addr16	3	8	A ← A ∨ (addr16)	×
	A, [HL]	1	6	A ← A ∨ (HL)	×
	A, [HL + byte]	2	6	A ← A ∨ (HL + byte)	×
XOR	A, #byte	2	4	A ← A ∨̄ byte	×
	saddr, #byte	3	6	(saddr) ← (saddr) ∨̄ byte	×
	A, r	2	4	A ← A ∨̄ r	×
	A, saddr	2	4	A ← A ∨̄ (saddr)	×
	A, !addr16	3	8	A ← A ∨̄ (addr16)	×
	A, [HL]	1	6	A ← A ∨̄ (HL)	×
	A, [HL + byte]	2	6	A ← A ∨̄ (HL + byte)	×
CMP	A, #byte	2	4	A – byte	× × ×
	saddr, #byte	3	6	(saddr) – byte	× × ×
	A, r	2	4	A – r	× × ×
	A, saddr	2	4	A – (saddr)	× × ×
	A, !addr16	3	8	A – (addr16)	× × ×
	A, [HL]	1	6	A – (HL)	× × ×
	A, [HL + byte]	2	6	A – (HL + byte)	× × ×
ADDW	AX, #word	3	6	AX, CY ← AX + word	× × ×
SUBW	AX, #word	3	6	AX, CY ← AX – word	× × ×
CMPW	AX, #word	3	6	AX – word	× × ×
INC	r	2	4	r ← r + 1	× ×
	saddr	2	4	(saddr) ← (saddr) + 1	× ×
DEC	r	2	4	r ← r – 1	× ×
	saddr	2	4	(saddr) ← (saddr) – 1	× ×
INCW	rp	1	4	rp ← rp + 1	
DECW	rp	1	4	rp ← rp – 1	
ROR	A, 1	1	2	(CY, A_7 ← A_0, A_{m-1} ← A_m) × 1 time	×
ROL	A, 1	1	2	(CY, A_0 ← A_7, A_{m+1} ← A_m) × 1 time	×
RORC	A, 1	1	2	(CY ← A_0, A_7 ← CY, A_{m-1} ← A_m) × 1 time	×
ROLC	A, 1	1	2	(CY ← A_7, A_0 ← CY, A_{m+1} ← A_m) × 1 time	×

Remark One instruction clock cycle is one CPU clock cycle (f_{CPU}) selected via the processor clock control register (PCC).

Mnemonic	Operand	Bytes	Clocks	Operation	Flags
					Z AC CY
SET1	saddr. bit	3	6	(saddr. bit) ← 1	
	sfr. bit	3	6	sfr. bit ← 1	
	A. bit	2	4	A. bit ← 1	
	PSW. bit	3	6	PSW. bit ← 1	× × ×
	[HL]. bit	2	10	(HL). bit ← 1	
CLR1	saddr. bit	3	6	(saddr. bit) ← 0	
	sfr. bit	3	6	sfr. bit ← 0	
	A. bit	2	4	A. bit ← 0	
	PSW. bit	3	6	PSW. bit ← 0	× × ×
	[HL]. bit	2	10	(HL). bit ← 0	
SET1	CY	1	2	CY ← 1	1
CLR1	CY	1	2	CY ← 0	0
NOT1	CY	1	2	CY ← $\overline{CY}$	×
CALL	!addr16	3	6	(SP – 1) ← (PC + 3)$_H$, (SP – 2) ← (PC + 3)$_L$, PC ← addr16, SP ← SP – 2	
CALLT	[addr5]	1	8	(SP – 1) ← (PC + 1)$_H$, (SP – 2) ← (PC + 1)$_L$, PC$_H$ ← (00000000, addr5 + 1), PC$_L$ ← (00000000, addr5), SP ← SP – 2	
RET		1	6	PC$_H$ ← (SP + 1), PC$_L$ ← (SP), SP ← SP + 2	
RETI		1	8	PC$_H$ ← (SP + 1), PC$_L$ ← (SP), PSW ← (SP + 2), SP ← SP + 3, NMIS ← 0	R R R
PUSH	PSW	1	2	(SP – 1) ← PSW, SP ← SP – 1	
	rp	1	4	(SP – 1) ← rp$_H$, (SP – 2) ← rp$_L$, SP ← SP – 2	
POP	PSW	1	4	PSW ← (SP), SP ← SP + 1	R R R
	rp	1	6	rp$_H$ ← (SP + 1), rp$_L$ ← (SP), SP ← SP + 2	
MOVW	SP, AX	2	8	SP ← AX	
	AX, SP	2	6	AX ← SP	
BR	!addr16	3	6	PC ← addr16	
	$addr16	2	6	PC ← PC + 2 + jdisp8	
	AX	1	6	PC$_H$ ← A, PC$_L$ ← X	

Remark One instruction clock cycle is one CPU clock cycle (f_{CPU}) selected via the processor clock control register (PCC).

Mnemonic	Operand	Bytes	Clocks	Operation	Flags
					Z AC CY
BC	$addr16	2	6	PC ← PC + 2 + jdisp8 if CY = 1	
BNC	$addr16	2	6	PC ← PC + 2 + jdisp8 if CY = 0	
BZ	$addr16	2	6	PC ← PC + 2 + jdisp8 if Z = 1	
BNZ	$addr16	2	6	PC ← PC + 2 + jdisp8 if Z = 0	
BT	saddr. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if (saddr. bit) = 1	
	sfr. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if sfr. bit = 1	
	A. bit, $addr16	3	8	PC ← PC + 3 + jdisp8 if A. bit = 1	
	PSW. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if PSW. bit = 1	
BF	saddr. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if (saddr. bit) = 0	
	sfr. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if sfr. bit = 0	
	A. bit, $addr16	3	8	PC ← PC + 3 + jdisp8 if A. bit = 0	
	PSW. bit, $addr16	4	10	PC ← PC + 4 + jdisp8 if PSW. bit = 0	
DBNZ	B, $addr16	2	6	B ← B – 1, then PC ← PC + 2 + jdisp8 if B ≠ 0	
	C, $addr16	2	6	C ← C – 1, then PC ← PC + 2 + jdisp8 if C ≠ 0	
	saddr, $addr16	3	8	(saddr) ← (saddr) – 1, then PC ← PC + 3 + jdisp8 if (saddr) ≠ 0	
NOP		1	2	No Operation	
EI		3	6	IE ← 1 (Enable Interrupt)	
DI		3	6	IE ← 0 (Disable Interrupt)	
HALT		1	2	Set HALT Mode	
STOP		1	2	Set STOP Mode	

Remark One instruction clock cycle is one CPU clock cycle (f_{CPU}) selected via the processor clock control register (PCC).

7. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Symbol	Conditions		Ratings	Unit
Power supply voltage	V_{DD}			–0.3 to +6.5	V
	V_{PP}			–0.3 to +10.5	V
Input voltage	V_{I1}	P00 to P03, P10 to P13, P20 to P26, P30 to P33, X1 (CL1), X2 (CL2), XT1, XT2, $\overline{\text{RESET}}$		–0.3 to V_{DD} + 0.3[Note]	V
	V_{I2}	P50 to P53	N-ch open drain	–0.3 to +13	V
Output voltage	V_O			–0.3 to V_{DD} + 0.3[Note]	V
Output current, high	I_{OH}	1 pin		–10	mA
		Total for all pins		–30	mA
Output current, low	I_{OL}	1 pin		30	mA
		Total for all pins		160	mA
Operating ambient temperature	T_A	In normal operation mode		–40 to +85	°C
		During flash memory programming		10 to 40	°C
Storage temperature	T_{stg}			–40 to +125	°C

Note 6.5 V or less

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.

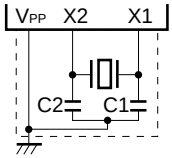
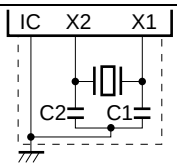
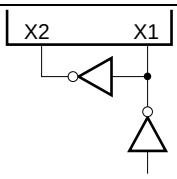
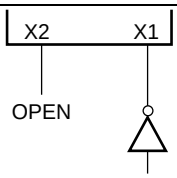
Remarks 1. Pin names enclosed in parentheses apply when using the μPD78F9316.

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

Main System Clock Oscillator Characteristics

Ceramic/crystal oscillation (μPD78F9306)

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

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Ceramic resonator		Oscillation frequency (f_X)[Note 1]		1.0		5.0	MHz
		Oscillation stabilization time[Note 2]	After V_{DD} reaches oscillation voltage range MIN.			4	ms
Crystal resonator		Oscillation frequency[Note 1]		1.0		5.0	MHz
		Oscillation stabilization time[Note 2]	V_{DD} = 4.5 to 5.5 V			10	ms
						30	ms
External clock		X1 input frequency (f_X)[Note 1]		1.0		5.0	MHz
		X1 input high-/low-level width (t_{XH}, t_{XL})		85		500	ns
★		X1 input frequency (f_X)[Note 1]	V_{DD} = 2.7 to 5.5 V	1.0		5.0	MHz
		X1 input high-/low-level width (t_{XH}, t_{XL})	V_{DD} = 2.7 to 5.5 V	85		500	ns

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

2. Time required to stabilize oscillation after reset or STOP mode release. Use a resonator whose oscillation stabilizes within the oscillation stabilization wait time.

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.

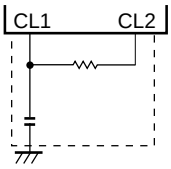
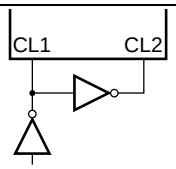
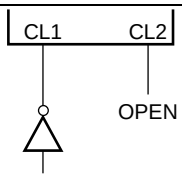
- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with the other signal lines.**
- **Do not route the wiring near a signal line through which a high fluctuating current flows.**
- **Always make the ground point of the oscillator capacitor the same potential as V_{SS}.**
- **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, customers are requested to either evaluate the oscillation themselves or apply to the resonator manufacturer for evaluation.

RC oscillation (μPD78F9316)

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

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
RC resonator		Oscillation frequency (f_{CC})[Note 1]		2.0		4.0	MHz
		Oscillation stabilization time[Note 2]	V_{DD} = 2.7 to 5.5 V	32			ms
				128			ms
External clock		CL1 input frequency (f_{CC})[Note 1]		1.0		4.0	MHz
		CL1 input high-/low-level width (t_{XH}, t_{XL})		100		500	ns
★		CL1 input frequency (f_{CC})[Note 1]	V_{DD} = 2.7 to 5.5 V	1.0		4.0	MHz
		CL1 input high-/low-level width (t_{XH}, t_{XL})	V_{DD} = 2.7 to 5.5 V	100		500	ns

Notes 1. Indicates only oscillator characteristics. Refer to **AC Characteristics** for instruction execution time. The error of capacitor (C) and resistor (R) is not included.

2. Time required to stabilize oscillation after reset or STOP mode release. Use a resonator whose oscillation stabilizes within the oscillation stabilization wait time.

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

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

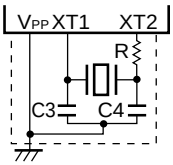
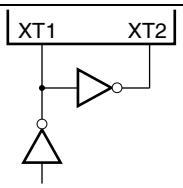
★ **RC Oscillation Frequency Characteristics (T_A = –40 to +85°C)**

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Oscillation frequency	f_{CC1}	R = 11.0 kΩ, C = 22 pF Target: 2 MHz	V_{DD} = 2.7 to 5.5 V	1.5	2.0	2.5	MHz
	f_{CC2}		V_{DD} = 1.8 to 3.6 V	0.5	2.0	2.5	MHz
	f_{CC3}		V_{DD} = 1.8 to 5.5 V	0.5	2.0	2.5	MHz
	f_{CC4}	R = 6.8 kΩ, C = 22 pF Target: 3 MHz	V_{DD} = 2.7 to 5.5 V	2.5	3.0	3.5	MHz
	f_{CC5}		V_{DD} = 1.8 to 3.6 V	0.75	3.0	3.5	MHz
	f_{CC6}		V_{DD} = 1.8 to 5.5 V	0.75	3.0	3.5	MHz
	f_{CC7}	R = 4.7 kΩ, C = 22 pF Target: 4 MHz	V_{DD} = 2.7 to 5.5 V	3.5	4.0	4.7	MHz
	f_{CC8}		V_{DD} = 1.8 to 3.6 V	1.0	4.0	4.7	MHz
	f_{CC9}		V_{DD} = 1.8 to 5.5 V	1.0	4.0	4.7	MHz

Remarks 1. Set RC to one of the above nine values so that the typical value of the oscillation frequency is within 2.0 to 4.0 MHz.

2. The resistor (R) and capacitor (C) error is not included.

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

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Crystal resonator		Oscillation frequency (f_{XT})[Note 1]		32	32.768	35	kHz
		Oscillation stabilization time[Note 2]	V_{DD} = 4.5 to 5.5 V		1.2	2	s
						10	
External clock		XT1 input frequency (f_{XT})[Note 1]		32		35	kHz
		XT1 input high-/low-level width (t_{XTH}, t_{XTL})		14.3		15.6	μs

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

2. Time required to stabilize oscillation after V_{DD} reaches oscillation voltage range MIN.

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

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

2. The subsystem clock oscillator is designed as a low-amplitude circuit for reducing current consumption, and is more prone to malfunction due to noise than the main system clock oscillator. Particular care is therefore required with the wiring method when the subsystem clock is used.

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

DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V) (1/4)

	Parameter	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
	Output current, low	I_{OL}	1 pin					10	mA
			All pins					80	mA
	Output current, high	I_{OH}	1 pin					–1	mA
			All pins					–15	mA
	Input voltage, high	V_{IH1}	P10 to P13		V_{DD} = 2.7 to 5.5 V	0.7V_{DD}		V_{DD}	V
						0.9V_{DD}		V_{DD}	V
		V_{IH2}	P50 to P53	N-ch open drain	V_{DD} = 2.7 to 5.5 V	0.7V_{DD}		12	V
						0.9V_{DD}		12	V
		V_{IH3}	$\overline{\text{RESET}}$, P00 to P03, P20 to P26, P30 to P33		V_{DD} = 2.7 to 5.5 V	0.8V_{DD}		V_{DD}	V
						0.9V_{DD}		V_{DD}	V
★		V_{IH4}	X1 (CL1), X2 (CL2), XT1, XT2		V_{DD} = 4.5 to 5.5 V	V_{DD} – 0.5		V_{DD}	V
						V_{DD} – 0.1		V_{DD}	V
	Input voltage, low	V_{IL1}	P10 to P13		V_{DD} = 2.7 to 5.5 V	0		0.3V_{DD}	V
						0		0.1V_{DD}	V
		V_{IL2}	P50 to P53		V_{DD} = 2.7 to 5.5 V	0		0.3V_{DD}	V
						0		0.1V_{DD}	V
		V_{IL3}	$\overline{\text{RESET}}$, P00 to P03, P20 to P26, P30 to P33		V_{DD} = 2.7 to 5.5 V	0		0.2V_{DD}	V
						0		0.1V_{DD}	V
★		V_{IL4}	X1 (CL1), X2 (CL2), XT1, XT2		V_{DD} = 4.5 to 5.5 V	0		0.4	V
						0		0.1	V
	Output voltage, high	V_{OH}	I_{OH} = –1 mA		V_{DD} = 4.5 to 5.5 V	V_{DD} – 1.0			V
			I_{OH} = –100 μA		V_{DD} = 1.8 to 5.5 V	V_{DD} – 0.5			V
	Output voltage, low	V_{OL1}	P00 to P03, P10 to P13, P20 to P26, P30 to P33		4.5 ≤ V_{DD} ≤ 5.5 V, I_{OL} = 10 mA			1.0	V
					1.8 ≤ V_{DD} < 4.5 V, I_{OL} = 400 μA			0.5	V
		V_{OL2}	P50 to P53		4.5 ≤ V_{DD} < 5.5 V, I_{OL} = 10 mA			1.0	V
					1.8 ≤ V_{DD} < 4.5 V, I_{OL} = 1.6 mA			0.4	V

Remarks 1. Pin names enclosed in parentheses apply when using the μPD78F9316.

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

DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V) (2/4)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input leakage current, high	I_{LIH1}	$V_{IN} = V_{DD}$	P00 to P03, P10 to P13, P20 to P26, P30 to P33, RESET			3	μA
	I_{LIH2}		X1 (CL1), X2 (CL2), XT1, XT2			20	μA
	I_{LIH3}	V_{IN} = 12 V	P50 to P53 (N-ch open drain)			20	μA
Input leakage current, low	I_{LIL1}	V_{IN} = 0 V	P00 to P03, P10 to P13, P20 to P26, P30 to P33, RESET			–3	μA
	I_{LIL2}		X1 (CL1), X2 (CL2), XT1, XT2			–20	μA
	I_{LIL3}		P50 to P53 (N-ch open drain)			–3 Note	μA
Output leakage current, high	I_{LOH}	$V_{OUT} = V_{DD}$				3	μA
Output leakage current, low	I_{LOL}	V_{OUT} = 0 V				–3	μA
Software pull-up resistor	R_1	V_{IN} = 0 V	P00 to P03, P10 to P13, P20 to P26, P30 to P33	50	100	200	kΩ

Note If P50 to P53 have been set to input mode when a read instruction is executed to read from P50 to P53, a low-level input leakage current of up to –30 μA flows during only one cycle. At all other times, the maximum leakage current is –3 μA.

Remarks 1. Pin names enclosed in parentheses apply when using the μPD78F9316.

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

★ **DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V) (3/4)**

Parameter	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Power supply current[Note 1] (Ceramic/crystal oscillation)	I_{DD1}	5.0 MHz crystal oscillation operation mode (C1 = C2 = 22 pF)		V_{DD} = 5.0 V ±10%[Note 2]		4.5	9	mA
				V_{DD} = 3.0 V ±10%[Note 3]		1	2	mA
				V_{DD} = 2.0 V ±10%[Note 3]		0.65	1.5	mA
	I_{DD2}	5.0 MHz crystal oscillation HALT mode (C1 = C2 = 22 pF)		V_{DD} = 5.0 V ±10%[Note 2]		1.4	2	mA
				V_{DD} = 3.0 V ±10%[Note 3]		0.4	0.8	mA
				V_{DD} = 2.0 V ±10%[Note 3]		0.19	0.42	mA
	I_{DD3}	32.768 kHz crystal oscillation operation mode[Note 4] (C3 = C4 = 22 pF, R1 = 220 kΩ)		V_{DD} = 5.0 V ±10%		100	230	μA
				V_{DD} = 3.0 V ±10%		70	160	μA
				V_{DD} = 2.0 V ±10%		58	120	μA
	I_{DD4}	32.768 kHz crystal oscillation HALT mode[Note 4] (C3 = C4 = 22 pF, R1 = 220 kΩ)	LCD not operating	V_{DD} = 5.0 V ±10%		25	65	μA
				V_{DD} = 3.0 V ±10%		7	29	μA
				V_{DD} = 2.0 V ±10%		4	20	μA
			LCD operating[Note 5]	V_{DD} = 5.0 V ±10%		28	70	μA
				V_{DD} = 3.0 V ±10%		9.6	34	μA
				V_{DD} = 2.0 V ±10%		6	25	μA
	I_{DD5}	STOP mode[Note 6]		V_{DD} = 5.0 V ±10%		0.1	17	μA
				V_{DD} = 3.0 V ±10%		0.05	5.5	μA
				V_{DD} = 2.0 V ±10%		0.05	3.5	μA

Notes 1. The port current (including the current that flows to the on-chip pull-up resistors) is not included.

2. High-speed mode operation (when processor clock control register (PCC) is set to 00H)

3. Low-speed mode operation (when PCC is set to 02H)

4. When the main system clock is stopped

5. This is the total current that flows when the LCD controller/driver is operating (LCDON0 = 1, VAON0 = 1, LIPS0 = 1). The power supply current when the LCD is not operating (LCDON0 = 0, VAON0 = 1, LIPS0 = 0) is included in I_{DD2}.

6. This is the current when the LCD booster circuit is stopped (LCDON0 = 0, VAON0 = 1).

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

★ **DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V) (4/4)**

Parameter	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Power supply current[Note 1] (RC oscillation)	I_{DD1}	4.0 MHz RC oscillation operation mode (R = 4.7 kΩ, C = 22 pF)		V_{DD} = 5.0 V ±10%[Note 2]		6	9	mA
				V_{DD} = 3.0 V ±10%[Note 3]		2.0	2.5	mA
				V_{DD} = 2.0 V ±10%[Note 3]		1.2	1.6	mA
	I_{DD2}	4.0 MHz RC oscillation HALT mode (R = 4.7 kΩ, C = 22 pF)		V_{DD} = 5.0 V ±10%[Note 2]		2.5	3.5	mA
				V_{DD} = 3.0 V ±10%[Note 3]		1.5	2	mA
				V_{DD} = 2.0 V ±10%[Note 3]		0.8	1.5	mA
	I_{DD3}	32.768 kHz crystal oscillation operation mode[Note 4] (C3 = C4 = 22 pF, R1 = 220 kΩ)		V_{DD} = 5.0 V ±10%		100	230	μA
				V_{DD} = 3.0 V ±10%		70	160	μA
				V_{DD} = 2.0 V ±10%		58	120	μA
	I_{DD4}	32.768 kHz crystal oscillation HALT mode[Note 4] (C3 = C4 = 22 pF, R1 = 220 kΩ)	LCD not operating	V_{DD} = 5.0 V ±10%		25	65	μA
				V_{DD} = 3.0 V ±10%		7	29	μA
				V_{DD} = 2.0 V ±10%		4	20	μA
			LCD operating[Note 5]	V_{DD} = 5.0 V ±10%		28	70	μA
				V_{DD} = 3.0 V ±10%		9.6	34	μA
				V_{DD} = 2.0 V ±10%		6	25	μA
	I_{DD5}	STOP mode[Note 6]		V_{DD} = 5.0 V ±10%		0.1	17	μA
				V_{DD} = 3.0 V ±10%		0.05	5.5	μA
				V_{DD} = 2.0 V ±10%		0.05	3.5	μA

Notes 1. The port current (including the current that flows to the on-chip pull-up resistors) is not included.

2. High-speed mode operation (when processor clock control register (PCC) is set to 00H)

3. Low-speed mode operation (when PCC is set to 02H)

4. When the main system clock is stopped

5. This is the total current that flows when the LCD controller/driver is operating (LCDON0 = 1, VAON0 = 1, LIPS0 = 1). The power supply current when the LCD is not operating (LCDON0 = 0, VAON0 = 1, LIPS0 = 0) is included in I_{DD2}.

6. This is the current when the LCD booster circuit is stopped (LCDON0 = 0, VAON0 = 1).

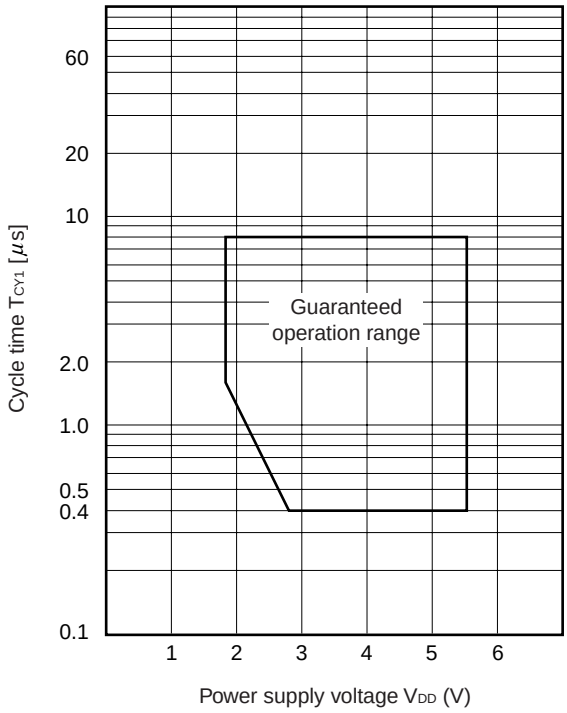
Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of port pins.

AC Characteristics

(1) Basic operation (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Cycle time (minimum instruction execution time)	T_{CY}	Operating with main system clock	V_{DD} = 2.7 to 5.5 V	0.4		8.0	μs
				1.6		8.0	μs
		Operating with subsystem clock		114	122	125	μs
TMI40 input frequency	f_{TMI}	V_{DD} = 2.7 to 5.5 V		0		4	MHz
				0		275	kHz
★ TMI40 input high-/low-level width	t_{TIMH}, t_{TIML}	V_{DD} = 2.7 to 5.5 V		0.1			μs
				1.8			μs
Interrupt input high-/low-level width	t_{INTH}, t_{INTL}	INTP0 to INTP3		10			μs
Key return input low-level width	t_{KRL}	KR00 to KR03		10			μs
$\overline{\text{RESET}}$ low-level width	t_{RSL}			10			μs
CPT20 input high-/low-level width	t_{CPH}, t_{CPL}			10			μs

T_{CY} vs V_{DD} (main system clock)



(2) Serial interface 10, 20 (SIO10, SIO20) (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

(a) 3-wire serial I/O mode (internal clock output)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCKn0}$ cycle time	t_{KCY1}	V_{DD} = 2.7 to 5.5 V		800			ns
				3200			ns
$\overline{SCKn0}$ high-/low-level width	t_{KH1}, t_{KL1}	V_{DD} = 2.7 to 5.5 V		t_{KCY1}/2–50			ns
				t_{KCY1}/2–150			ns
SIn0 setup time (to $\overline{SCKn0}$↑)	t_{SIK1}	V_{DD} = 2.7 to 5.5 V		150			ns
				500			ns
SIn0 hold time (from $\overline{SCKn0}$↑)	t_{KSI1}	V_{DD} = 2.7 to 5.5 V		400			ns
				600			ns
Delay time from $\overline{SCKn0}$↓ to SOn0 output	t_{KSO1}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 2.7 to 5.5 V	0		250	ns
				0		1000	ns

Note R and C are the load resistance and load capacitance of the SOn0 output lines.

Remark n = 1, 2

(b) 3-wire serial I/O mode (external clock input)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCKn0}$ cycle time	t_{KCY2}	V_{DD} = 2.7 to 5.5 V		800			ns
				3200			ns
$\overline{SCKn0}$ high-/low-level width	t_{KH2}, t_{KL2}	V_{DD} = 2.7 to 5.5 V		400			ns
				1600			ns
SIn0 setup time (to $\overline{SCKn0}$↑)	t_{SIK2}	V_{DD} = 2.7 to 5.5 V		100			ns
				150			ns
SIn0 hold time (from $\overline{SCKn0}$↑)	t_{KSI2}	V_{DD} = 2.7 to 5.5 V		400			ns
				600			ns
Delay time from $\overline{SCKn0}$↓ to SOn0 output	t_{KSO2}	R = 1 kΩ, C = 100 pF[Note]	V_{DD} = 2.7 to 5.5 V	0		300	ns
				0		1000	ns

Note R and C are the load resistance and load capacitance of the SOn0 output lines.

Remark n = 1, 2

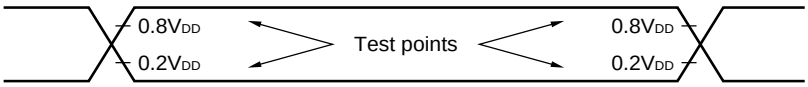
(c) UART mode (SIO20 only) (dedicated baud rate generator output)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate		V_{DD} = 2.7 to 5.5 V			78125	bps
					19531	bps

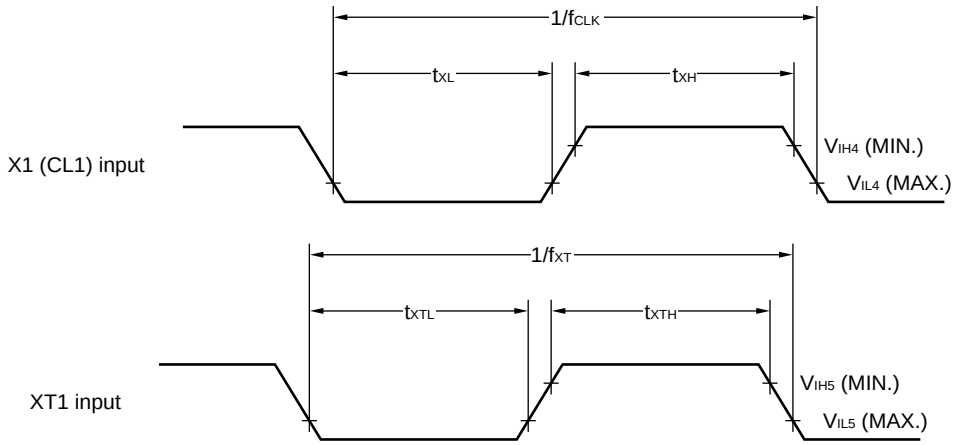
(d) UART mode (SIO20 only) (external clock input)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ASCK20 cycle time	t_{KCY3}	V_{DD} = 2.7 to 5.5 V	800			ns
			3200			ns
ASCK20 high-/low-level width	t_{KH3}, t_{KL3}	V_{DD} = 2.7 to 5.5 V	400			ns
			1600			ns
Transfer rate		V_{DD} = 2.7 to 5.5 V			39063	bps
					9766	bps
ASCK20 rise/fall time	t_R, t_F				1	μs

AC Timing Test Points (excluding X1 (CL1) and XT1 inputs)

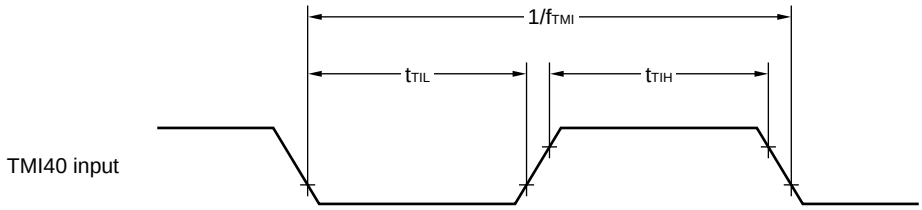


Clock Timing

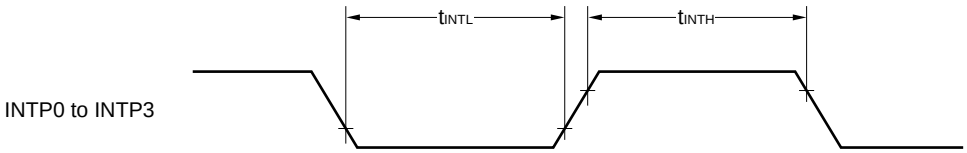


Remark f_{CLK}: fx or fCC

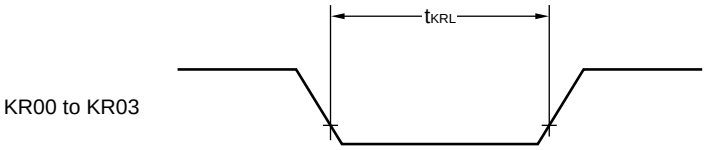
TMI Timing



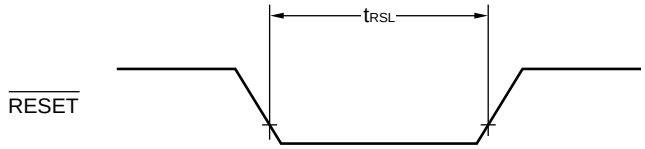
Interrupt Input Timing



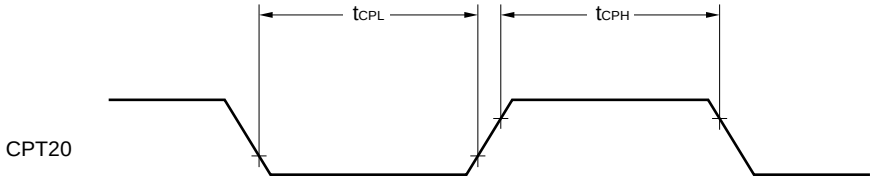
Key Return Input Timing



$\overline{\text{RESET}}$ Input Timing

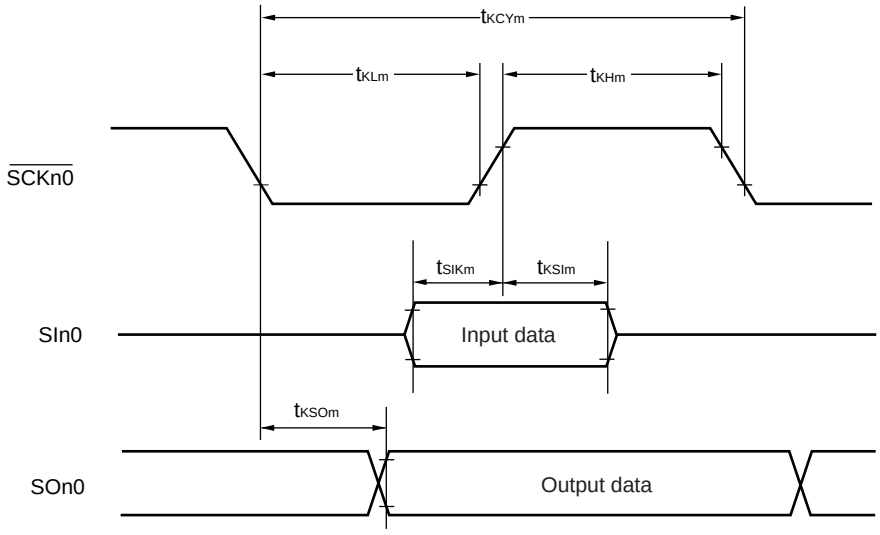


CPT20 Input Timing



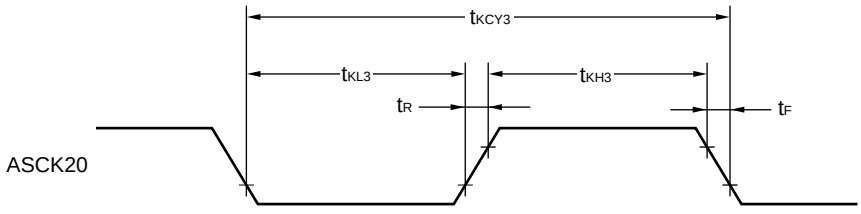
Serial Transfer Timing

3-wire serial I/O mode:



Remark n, m = 1, 2

UART mode (external clock input):



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

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
LCD output voltage variation range	V_{LCD2}	c1 to c4 = 0.47 μF	GAIN = 1	0.84	1.0	1.165	V
			GAIN = 0	1.26	1.5	1.74	V
Doubler output	V_{LCD1}	c1 to c4 = 0.47 μF		2 V_{LCD2} – 0.1	2.0 V_{LCD2}	2.0 V_{LCD2}	V
Tripler output	V_{LCD0}	c1 to c4 = 0.47 μF		3 V_{LCD2} – 0.15	3.0 V_{LCD2}	3.0 V_{LCD2}	V
Voltage boost wait time[Note 1]	t_{VAWAIT}	GAIN = 0		0.5			s
		GAIN = 1	5.0 ≤ V_{DD} ≤ 5.5 V	2.0			s
			4.5 ≤ V_{DD} < 5.0 V	1.0			s
			1.8 ≤ V_{DD} < 4.5 V	0.5			s
LCD output voltage differential[Note 2] (common)	V_{ODC}	I_O = ±5 μA		0		±0.2	V
LCD output voltage differential[Note 2] (segment)	V_{ODS}	I_O = ±1 μA		0		±0.2	V

Notes 1. This is the wait time from when voltage boost is started (VAON0 = 1) until display is enabled (LCDON0 = 0).

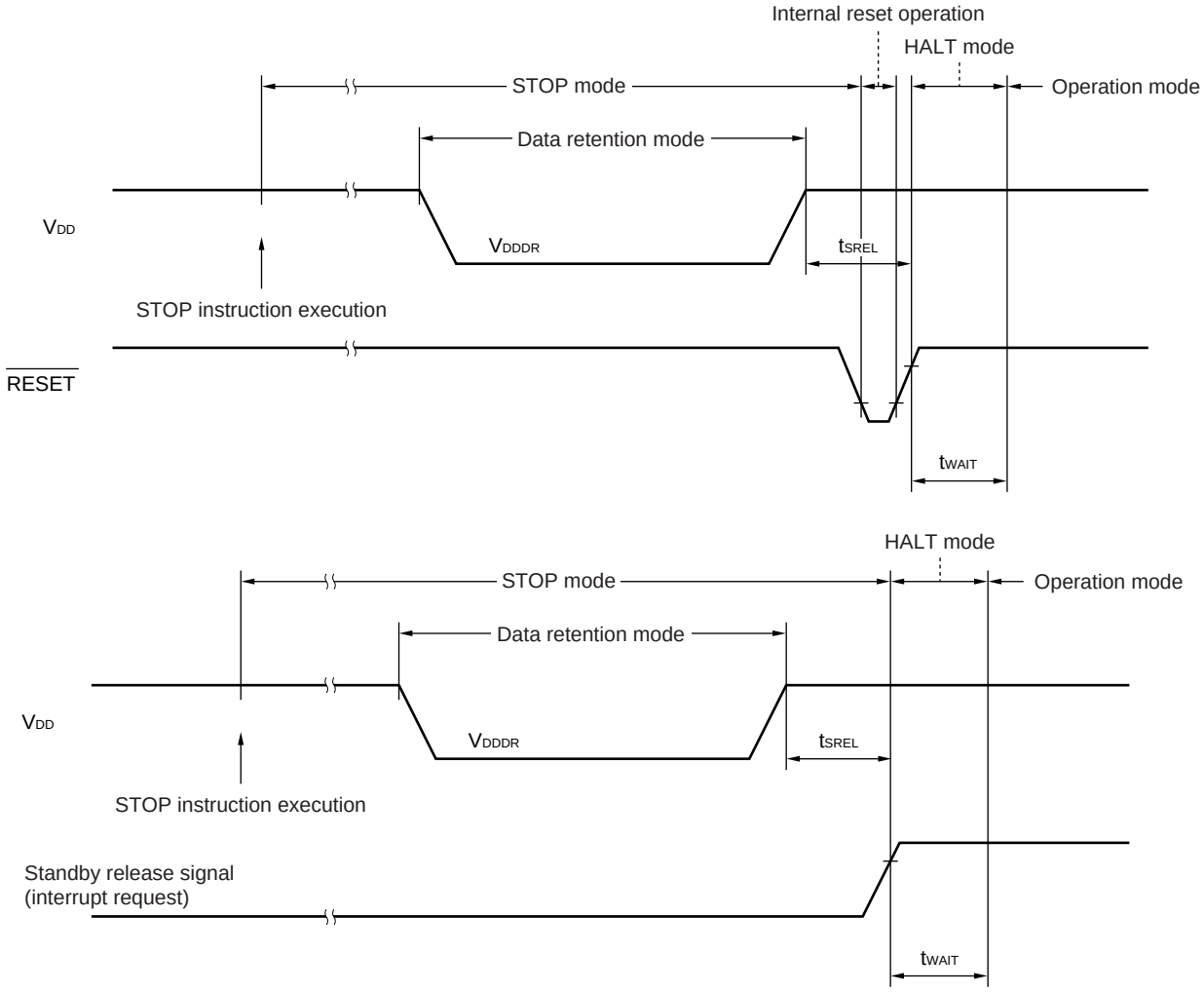
2. The voltage differential is the difference between the segment and common signal output's actual and ideal output voltages.

Remark c1: Capacitor connected between CAPH and CAPL
c2: Capacitor connected between V_{LC0} and ground
c3: Capacitor connected between V_{LC1} and ground
c4: Capacitor connected between V_{LC2} and ground

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

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Data retention power supply voltage	V_{DDDR}		1.8		5.5	V
Release signal set time	t_{SREL}		0			μs

Data Retention Timing



Oscillation Stabilization Wait Time (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Oscillation stabilization wait time[Note 1] (ceramic/crystal oscillation)	t_{WAIT}	Release by $\overline{\text{RESET}}$		$2^{15}/f_X$		s
		Release by interrupt		**Note 2**		s
Oscillation stabilization wait time (RC oscillation)	t_{WAIT}	Release by $\overline{\text{RESET}}$		$2^7/f_{CC}$		s
		Release by interrupt		$2^7/f_{CC}$		s

Notes 1. Use a resonator whose oscillation stabilizes within the oscillation stabilization wait time.

2. Selection of $2^{12}/f_X$, $2^{15}/f_X$, or $2^{17}/f_X$ is possible with bits 0 to 2 (OSTS0 to OSTS2) of the oscillation stabilization time select register (OSTS).

Remarks 1. f_X: Main system clock oscillation frequency (ceramic/crystal oscillation)

2. f_{CC}: Main system clock oscillation frequency (RC oscillation)

★ **Flash Memory Write/Erase Characteristics (T_A = 10 to 40°C, V_{DD} = 1.8 to 5.5 V)**

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Operating frequency	f_X, f_{CC}	V_{DD} = 2.7 to 5.5 V		1.0		5	MHz
				1.0		1.25	MHz
Write current[Note 1] (V_{DD} pin)	I_{DDW}	When V_{PP} supply voltage = V_{PP1}	RC oscillation During f_{CC} = 4.0 MHz operation[Note 2]			9	mA
			Ceramic oscillation During f_X = 5.0 MHz operation			7	mA
Write current[Note 1] (V_{PP} pin)	I_{PPW}	When V_{PP} supply voltage = V_{PP1}				12	mA
Erase current[Note 1] (V_{DD} pin)	I_{DDE}	When V_{PP} supply voltage = V_{PP1}	RC oscillation During f_{CC} = 4.0 MHz operation[Note 2]			9	mA
			Ceramic oscillation During f_X = 5.0 MHz operation			7	mA
Erase current[Note 1] (V_{PP} pin)	I_{PPE}	When V_{PP} supply voltage = V_{PP1}				100	mA
Unit erase time	t_{er}			0.5	1	1	s
Total erase time	t_{era}					20	s
Write count		Erase/write are regarded as 1 cycle				20	Times
V_{PP} supply voltage	V_{PP0}	In normal operation		0		$0.2V_{DD}$	V
	V_{PP1}	During flash memory programming		9.7	10.0	10.3	V

Notes 1. The port current (including the current that flows to the on-chip pull-up resistors) is not included.

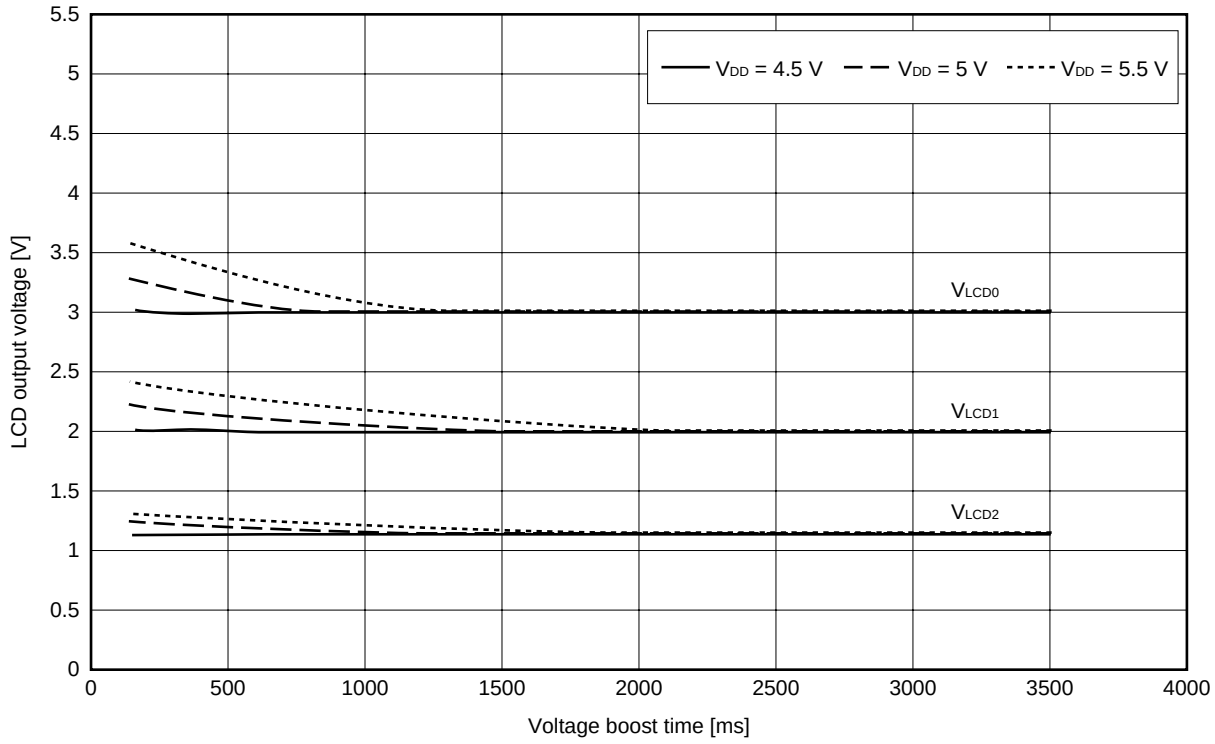
2. When an external clock is input

★ 8. CHARACTERISTICS CURVES OF LCD CONTROLLER/DRIVER (REFERENCE VALUES)

(1) Characteristics curves of voltage boost stabilization time

The following shows the characteristics curves of the time from the start of voltage boost (VAON0 = 1) and the changes in the LCD output voltage (when GAIN is set as 1 (using the 3 V display panel)).

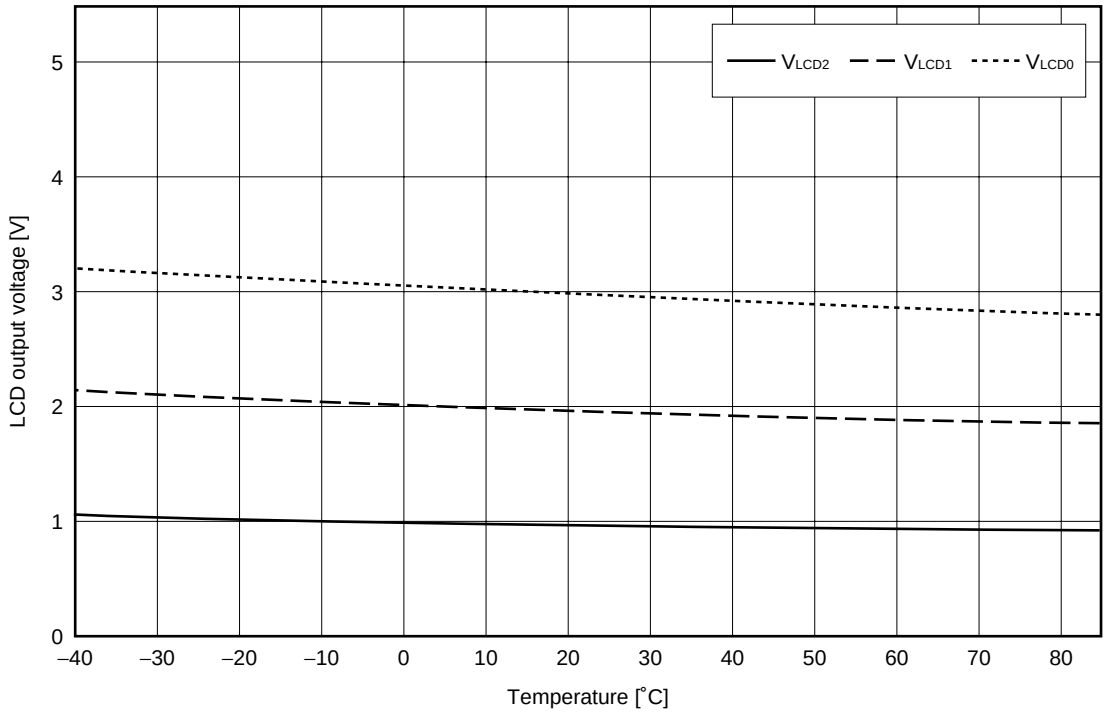
LCD Output Voltage/Voltage Boost Time



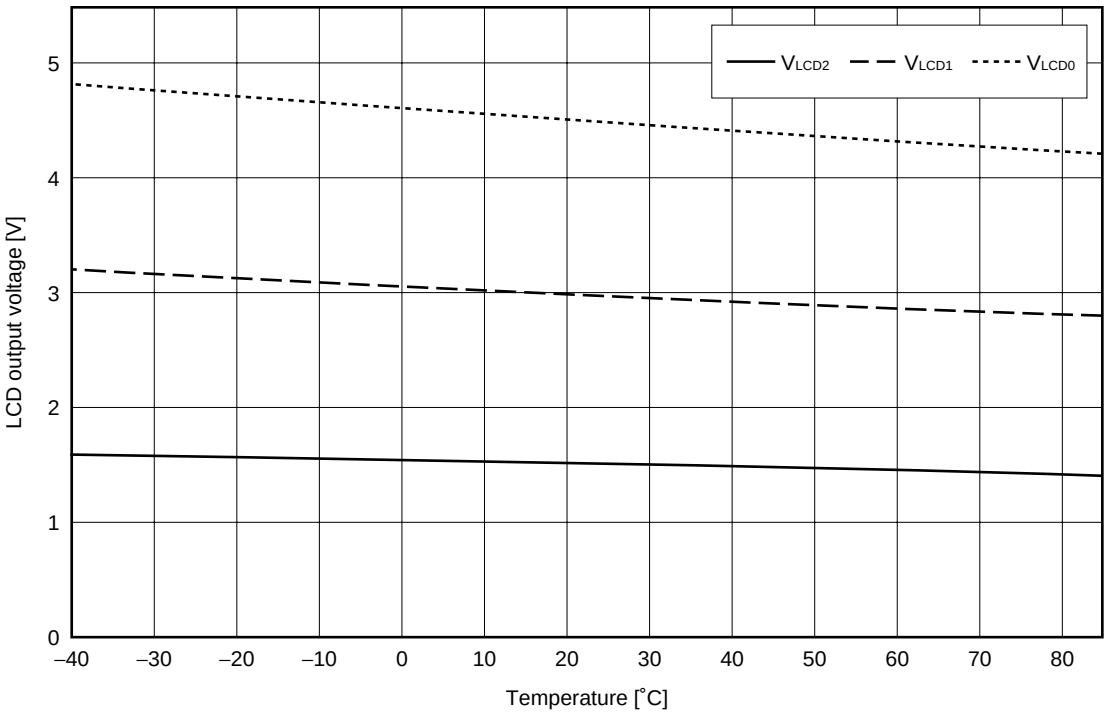
(2) Temperature characteristics of LCD output voltage

The following shows the temperature characteristics curves of LCD output voltage.

LCD Output Voltage/Temperature (When GAIN = 1)

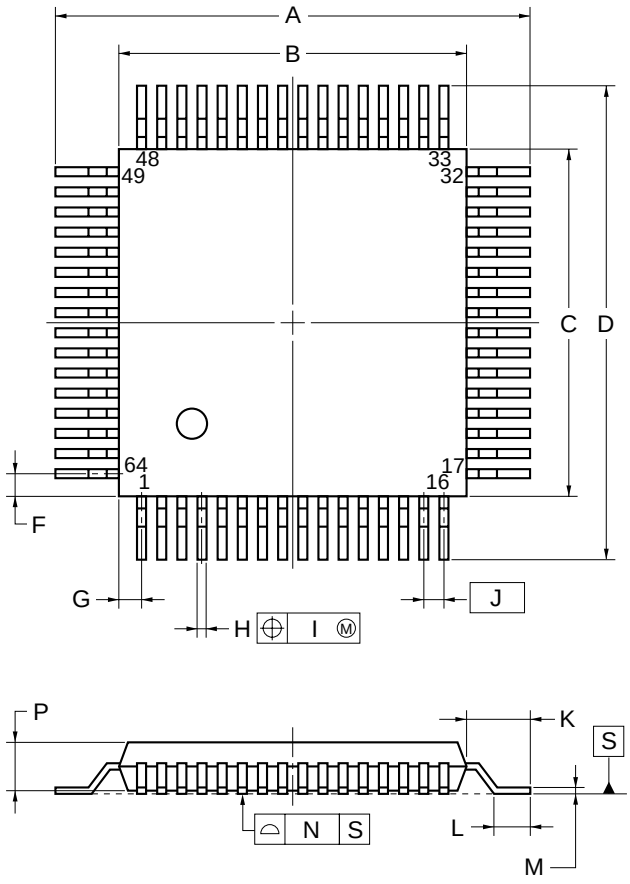


LCD Output Voltage/Temperature (When GAIN = 0)

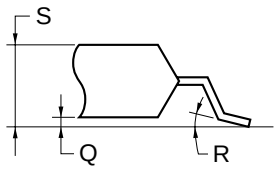


9. PACKAGE DRAWINGS

64-PIN PLASTIC QFP (14x14)



detail of lead end



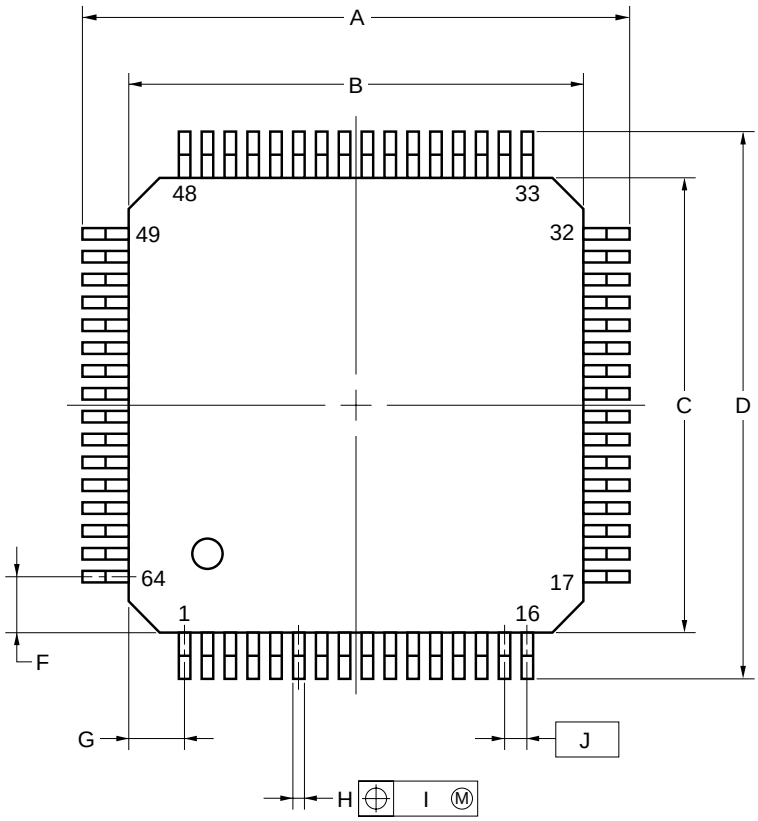
NOTE

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

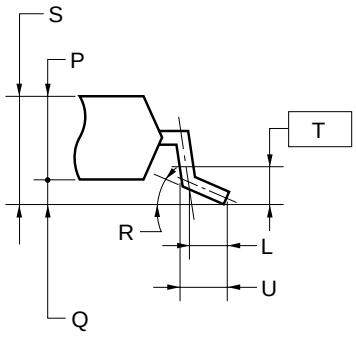
ITEM	MILLIMETERS
A	17.6±0.4
B	14.0±0.2
C	14.0±0.2
D	17.6±0.4
F	1.0
G	1.0
H	$0.37^{+0.08}_{-0.07}$
I	0.15
J	0.8 (T.P.)
K	1.8±0.2
L	0.8±0.2
M	$0.17^{+0.08}_{-0.07}$
N	0.10
P	2.55±0.1
Q	0.1±0.1
R	5°±5°
S	2.85 MAX.

P64GC-80-AB8-5

64-PIN PLASTIC TQFP (12x12)



detail of lead end



NOTE

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

ITEM	MILLIMETERS
A	14.0±0.2
B	12.0±0.2
C	12.0±0.2
D	14.0±0.2
F	1.125
G	1.125
H	$0.32^{+0.06}_{-0.10}$
I	0.13
J	0.65 (T.P.)
K	1.0±0.2
L	0.5
M	$0.17^{+0.03}_{-0.07}$
N	0.10
P	1.0
Q	0.1±0.05
R	$3^{\circ}{}^{+4^{\circ}}_{-3^{\circ}}$
S	1.1±0.1
T	0.25
U	0.6±0.15

P64GK-65-9ET-3

★ 10. RECOMMENDED SOLDERING CONDITIONS

The μPD78F9306 and 78F9316 should be soldered and mounted under the following recommended conditions.

For 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 10-1. Surface Mounting Type Soldering Conditions

μPD78F9306GC-AB8: 64-pin plastic QFP (14 × 14)
μPD78F9316GC-AB8: 64-pin plastic QFP (14 × 14)

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

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

μPD78F9306GK-9ET: 64-pin plastic TQFP (12 × 12)
μPD78F9316GK-9ET: 64-pin plastic TQFP (12 × 12)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: 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).

APPENDIX A. DIFFERENCES BETWEEN μPD78F9306, 78F9316 AND MASK ROM VERSIONS

The μPD78F9306 and 78F9316 have flash memory in place of the internal ROM of the mask ROM versions. Differences between the μPD78F9306 and 78F9316 and the mask ROM versions are shown in Table A-1.

Table A-1. Differences Between μPD78F9306, 78F9316 and Mask ROM Versions

Item \ Part Number		Flash Memory Versions		Mask ROM Versions			
		μPD78F9306	μPD78F9316	μPD789304	μPD789306	μPD789314	μPD789316
Internal memory	ROM	16 KB		8 KB	16 KB	8 KB	16 KB
	High-speed RAM	512 bytes					
	LCD display RAM	24 bytes					
Main system clock		Ceramic/ crystal oscillation	RC oscillation	Ceramic/crystal oscillation		RC oscillation	
IC pin		Not available		Available			
V_{PP} pin		Available		Not available			
Pull-up resistors		19 (software control: 19)		23 (software control: 19, mask option control: 4)			
Electrical specifications		Refer to the relevant data sheet.					

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 for the commercial samples (not engineering samples) of the mask ROM version.

APPENDIX B. DEVELOPMENT TOOLS

The following development tools are available for system development using the μPD78F9306 and 78F9316.

Language Processing Software

RA78K0S[Notes 1, 2, 3]	Assembler package common to 78K/0S Series
CC78K0S[Notes 1, 2, 3]	C compiler package common to 78K/0S Series
★ DF789306[Notes 1, 2, 3]	Device file for μPD789306, 789316 Subseries
CC78K0S-L[Notes 1, 2, 3]	C compiler library source file common to 78K/0S Series

Flash Memory Writing Tools

Flashpro III (Part No. FL-PR3[Note 4], PG-FP3)	Flash programmer dedicated to on-chip flash memory microcontroller
FA-64GC[Note 4]	Flash memory writing adapter for 64-pin plastic QFP (GC-AB8 type)
FA-64GK[Note 4]	Flash memory writing adapter for 64-pin plastic TQFP (GK-9ET type)

Debugging Tools

IE-78K0S-NS In-circuit emulator	This is an in-circuit emulator for debugging hardware and software of application system using the 78K/0S Series. It supports the integrated debugger (ID78K0S-NS) and is used with an AC adapter, emulation probe, and interface adapter for connecting the host machine.
IE-70000-MC-PS-B AC adapter	This is the adapter for supplying power from an AC-100 to 240 V outlet.
IE-70000-98-IF-C Interface adapter	This adapter is needed when a PC-9800 series PC (except notebook type) is used as the host machine for the IE-78K0S-NS (supports C bus).
IE-70000-CD-IF-A PC card interface	This PC card and interface cable are needed when a PC-9800 series notebook-type PC is used as the host machine for the IE-78K0S-NS (supports PCMCIA socket).
IE-70000-PC-IF-C Interface adapter	This adapter is needed when an IBM PC/AT™ or compatible PC is used as the host machine for the IE-78K0S-NS (supports ISA bus).
IE-70000-PCI-IF Interface adapter	This adapter is needed when a PC that includes a PCI bus is used as the host machine for the IE-78K0S-NS.
★ IE-789306-NS-EM1 Emulation board	This is an emulation board for emulating the peripheral hardware inherent to the device. It is used with an in-circuit emulator.
NP-64GC[Note 4]	This is a board that is used to connect an in-circuit emulator to the target system. It is for a 64-pin plastic QFP (GC-AB8 type).
NP-64GK[Note 4]	This is a board that is used to connect an in-circuit emulator to the target system. It is for a 64-pin plastic TQFP (GK-9ET type).
SM78K0S[Notes 1, 2]	System simulator common to 78K/0S Series
ID78K0S-NS[Notes 1, 2]	Integrated debugger common to 78K/0S Series
★ DF789306[Notes 1, 2]	Device file for μPD789306, 789316 Subseries

Real-Time OS

MX78K0S[Notes 1, 2]	OS for 78K/0S Series

Notes 1. Based on PC-9800 Series (Japanese Windows)

2. Based on IBM PC/AT compatibles (Japanese/English Windows)

3. Based on HP9000 Series 700™ (HP-UX™), SPARCstation™ (SunOS™, Solaris™), or NEWS™ (NEWS-OS™)

4. This product is manufactured by Naito Densei Machida Mfg. Co., Ltd. (TEL +81-44-822-3813).

Remark The RA78K0S, CC78K0S, and SM78K0S are used in combination with the DF789306.

APPENDIX C. RELATED DOCUMENTS

Documents Related to Devices

Document Name	Document No.
μPD789304, 789306, 789314, 789316 Data Sheet	To be prepared
μPD78F9306, 78F9316 Data Sheet	This document
μPD789306, 789316 Subseries User's Manual	U14800E
78K/0S Series User's Manual Instructions	U11047E
78K/0, 78K/0S Series Application Note Flash Memory Write	U14458E

Documents Related to Development Tools (User's Manuals)

Document Name		Document No.
RA78K0S Assembler Package	Operation	U11622E
	Language	U11599E
	Structured Assembly Language	U11623E
CC78K0S C Compiler	Operation	U11816E
	Language	U11817E
SM78K0S, SM78K0 System Simulator Ver.2.10 or Later Windows Based	Operation	U14611E
SM78K Series System Simulator Ver.2.10 or Later	External Part User Open Interface Specifications	U15006E
ID-78K0-NS, ID78K0S-NS Integrated Debugger Ver.2.20 or Later Windows Based	Operation	U14910E
IE-78K0S-NS In-circuit Emulator		U13549E
IE-789306-NS-EM1 Emulation Board		To be prepared

Documents Related to Embedded Software (User's Manuals)

Document Name		Document No.
78K/0S Series OS MX78K0S	Fundamental	U12938E

Other Related 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

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.

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- 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

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