

## CMOS 16-Bit Microcontrollers

## TMP95PS54F

## 1. Outline and Features

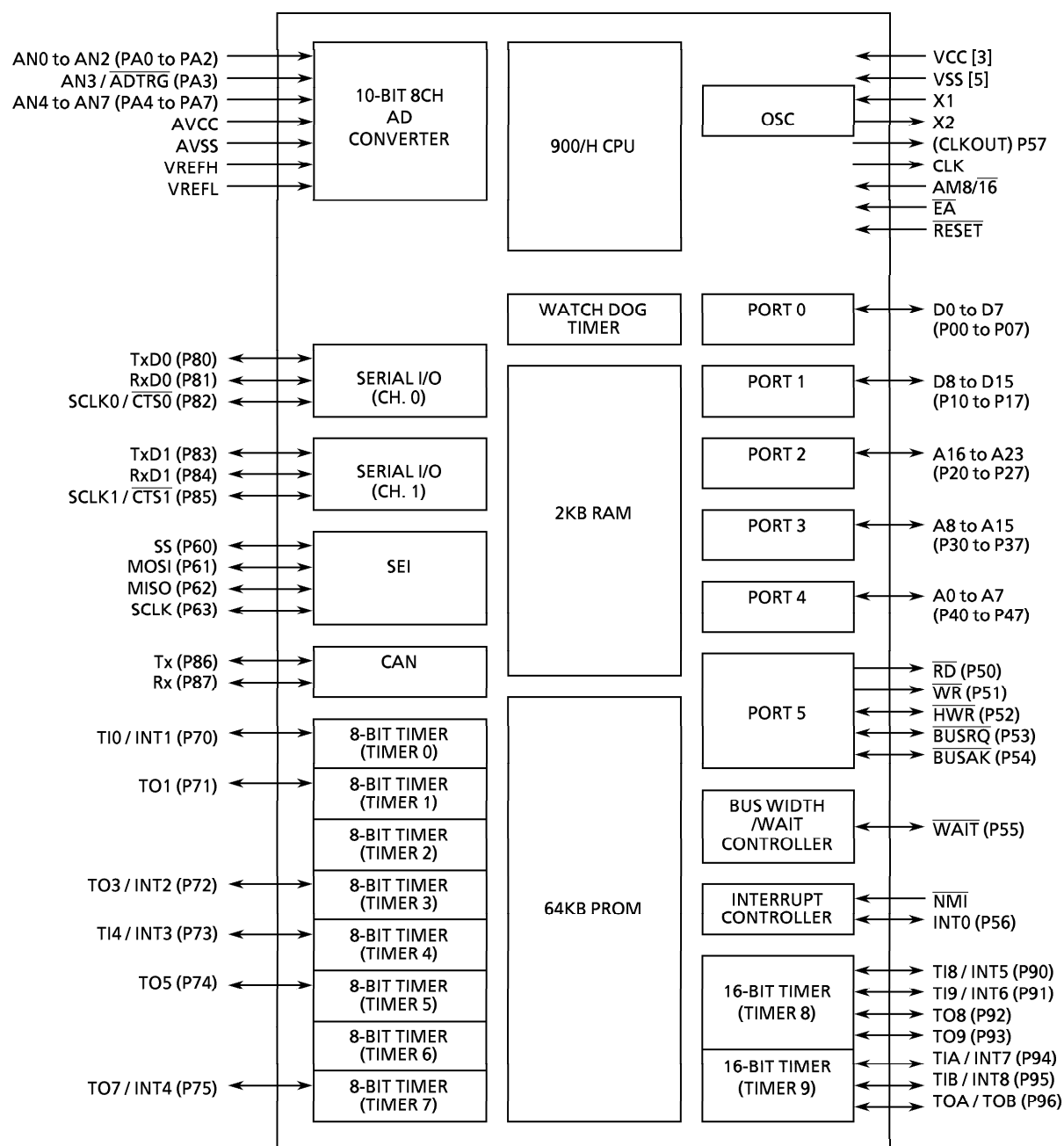
TMP95PS54 is an LSI for TMP95CS54 system evaluation. TMP95PS54 incorporates a 64 Kbyte one-time PROM. With an adapter socket, the user can write/verify data in the TMP95PS54's PROM using a general-purpose EPROM writer.

TMP95PS54 is pin-compatible with TMP95CS54, which incorporates a mask ROM. To achieve the same operations as TMP95CS54, write program data to the internal PROM.

Product Name	ROM	RAM	Package	Adapter Socket
TMP95PS54F	OTP 64 Kbyte	2 Kbyte	P-LQFP100-1414-0.50D	BM11129

000707EBP1

- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.



Note: After reset, functions in parentheses ( ) are selected for the shared pins.

Figure 1.1 TMP95PS54 Block Diagram

## 2. Pin Assignment and Pin Functions

This section shows the TMP95PS54F pin assignment, and the names and an outline of the functions of the input/output pins.

### 2.1 Pin Assignment Diagram

Figure 2.1.1 is a pin assignment diagram for TMP95PS54F.

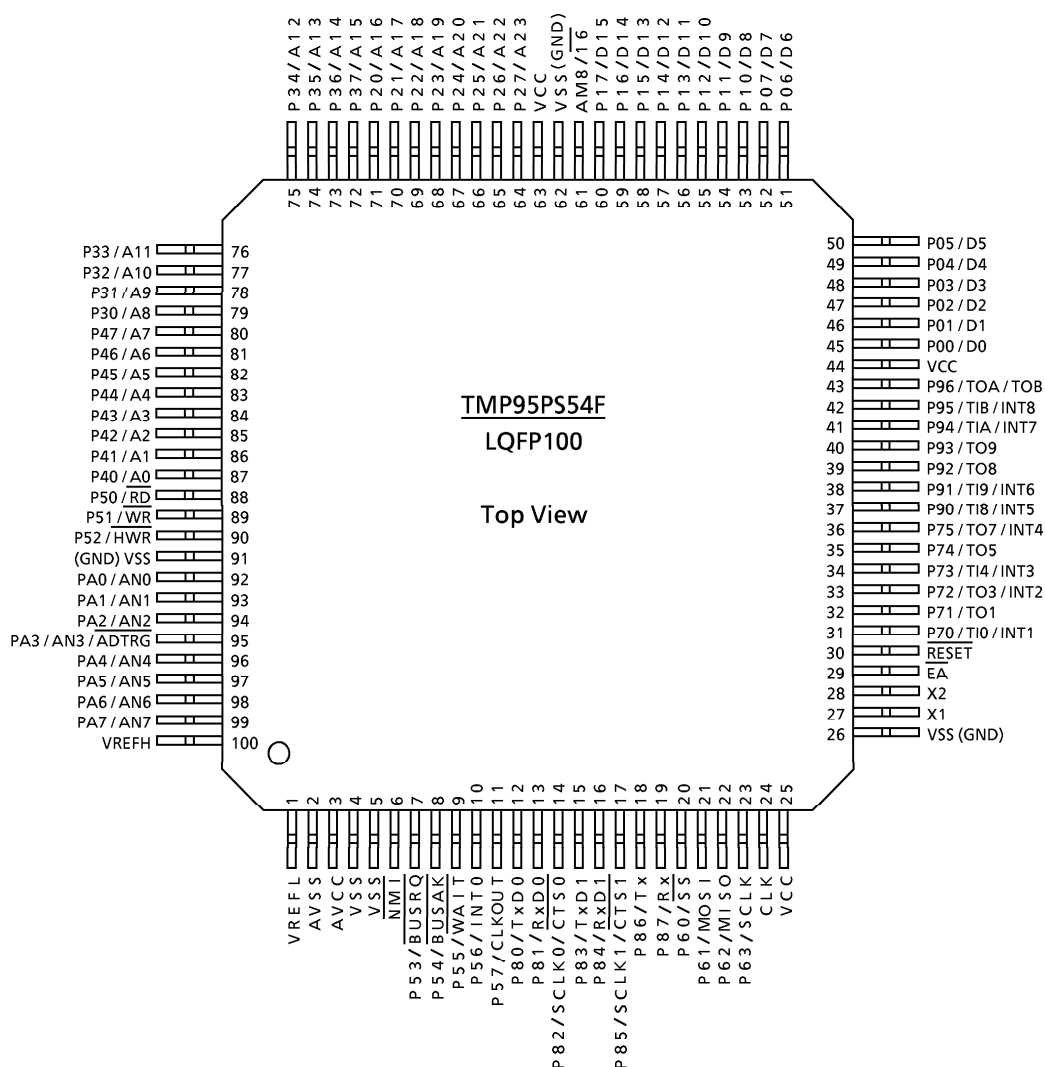


Figure 2.1.1 Pin Allocation Diagram (100-Pin LQFP)

## 2.2 Pin Names and Functions

TMP95PS54 has an MCU mode and a PROM mode.

### (1) Pin Names and Functions in MCU Mode

Table 2.2.1 lists the names and functions of the input/output pins.

Table 2.2.1 Pin Names and Functions (1/4)

Pin Name	Number of Pins	Input/Output	Function
P00 to P07 / D0 to D7	8	Input/output	Port 0: I/O port. Input or output specifiable in units of bits
		Input/output	Data: Data bus 0 to 7
P10 to P17 / D8 to D15	8	Input/output	Port 1: I/O port. Input or output specifiable in units of bits
		Input/output	Data: Data bus 8 to 15
P20 to P27 / A16 to A23	8	Input/output	Port 2: I/O port. Input or output specifiable in units of bits
		Output	Address: Address bus 16 to 23
P30 to P37 / A8 to A15	8	Input/output	Port 3: I/O port. Input or output specifiable in units of bits
		Output	Address: Address bus 8 to 15
P40 to P47 / A0 to A7	8	Input/output	Port 4: I/O port. Input or output specifiable in units of bits
		Output	Address: Address bus 0 to 7
P50 / $\overline{RD}$	1	Output	Port 50: Output-only port
		Output	Read: Outputs strobe signal to read external memory (setting P5 <P50> = 0 and P5FC <P50F> = 1 outputs strobe signal at all read timings)
P51 / $\overline{WR}$	1	Output	Port 51: Output-only port.
		Output	Write: Outputs strobe signal to write data on pins D0 to D7
P52 / $\overline{HWR}$	1	Input/output	Port 52: I/O port (with built-in pull-up resistor)
		Output	Upper write: Outputs strobe signal to write data on pins D8 to D15
P53 / $\overline{BUSRQ}$	1	Input/output	Port 53: I/O port (with built-in pull-up resistor)
		Input	Bus request: Input pin to request external bus release
P54 / $\overline{BUSAK}$	1	Input/output	Port 54: I/O port (with built-in pull-up resistor)
		Output	Bus acknowledge: Output pin to acknowledge that CPU received $\overline{BUSRQ}$ and released external bus.
P55 / $\overline{WAIT}$	1	Input/output	Port 55: I/O port (with built-in pull up resistor)
		Input	Wait: Buswait request pin for CPU (Effective when 1 WAIT + N mode, or 0 + N WAIT mode. Set using bus width/wait control register.)
P56 / INT0	1	Input/output	Port 56: I/O port (with built-in pull-up resistor)
		Input	Interrupt request pin 0: Interrupt request pin with programmable level/rising edge.

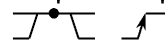


Table 2.2.1 Pin Names and Functions (2/4)





Pin Name	Number of Pins	Input/Output	Function
P57 / CLKOUT	1	Output	Port 57: Output-only port (with built-in pull-up resistor)
		Output	CLKOUT output: Outputs external clock divided by 6. Pulled up during reset.
P60 / $\overline{SS}$	1	Input/output	Port 60: I/O port
		Input	SEI slave select input
P61 / MOSI	1	Input/output	Port 61: I/O port
		Input/output	SEI master output, slave input
P62 / MISO	1	Input/output	Port 62: I/O port
		Input/output	SEI master input, slave output
P63 / SCLK	1	Input/output	Port 63: I/O port
		Input/output	SEI clock input/output
P70 / TI0 / INT1	1	Input/output	Port 70: I/O port
		Input	Timer input 0: Input pin for timer 0
		Input	Interrupt request pin 1: Rising-edge interrupt request pin 
P71 / TO1	1	Input/output	Port 71: I/O port.
		Output	Timer output 1: Output pin for timer 0 or 1
P72 / TO3 / INT2	1	Input/output	Port 72: I/O port
		Output	Timer output 3: Output pin for timer 2 or 3
		Input	Interrupt request pin 2: Rising-edge interrupt request pin 
P73 / TI4 / INT3	1	Input/output	Port 73: I/O port
		Input	Timer input 4: Input pin for timer 4
		Input	Interrupt request pin 3: Rising-edge interrupt request pin 
P74 / TO5	1	Input/output	Port 74: I/O port
		Output	Timer output 5: Output pin for timer 4 or 5
P75 / TO7 / INT4	1	Input/output	Port 75: I/O port
		Output	Timer output 7: Output pin for timer 6 or 7
		Input	Interrupt request pin 4: Rising-edge interrupt request pin 
P80 / TxD0	1	Input/output	Port 80: I/O port (with built-in pull-up resistor)
		Output	Serial transmission data 0
P81 / RxD0	1	Input/output	Port 81: I/O port (with built-in pull-up resistor)
		Input	Serial receive data 0
P82 / SCLK0 / $\overline{CTS0}$	1	Input/output	Port 82: I/O port (with built-in pull-up resistor)
		Input/output	Serial clock input/output 0
		Input	Serial data ready to send 0 (Clear-to-send)

Table 2.2.1 Pin Names and Functions (3/4)

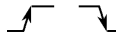

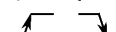

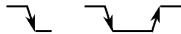
Pin Name	Number of Pins	Input/Output	Function
P83 / TxD1	1	Input/output	Port 83: I/O port (with built-in pull-up resistor)
		Output	Serial transmission data 1
P84 / RxD1	1	Input/output	Port 84: I/O port (with built-in pull-up resistor)
		Input	Serial receive data 1
P85 / SCLK1 / $\overline{\text{CTS1}}$	1	Input/output	Port 85: I/O port (with built-in pull-up resistor)
		Input/output	Serial clock input/output 1
		Input	Serial data ready to send 1 (Clear-to-send)
P86 / Tx	1	Input/output	Port 86: I/O port (with built-in pull-up resistor)
		Output	CAN transmission data
P87 / Rx	1	Input/output	Port 87: I/O port (with built-in pull-up resistor)
		Input	CAN receive data
P90 / TI8 / INT5	1	Input/output	Port 90: I/O port
		Input	Timer input 8: Input pin for timer 8
		Input	Interrupt request pin 5: Interrupt request pin with programmable rising/falling edge 
P91 / TI9 / INT6	1	Input/output	Port 91: I/O port
		Input	Timer input 9: Input pin for timer 8
		Input	Interrupt request pin 6: Rising edge interrupt request pin 
P92 / TO8	1	Input/output	Port 92: I/O port
		Output	Timer output 8: Output pin for timer 8
P93 / TO9	1	Input/output	Port 93: I/O port
		Output	Timer output 9: Output pin for timer 8
P94 / TIA / INT7	1	Input/output	Port 94: I/O port
		Input	Timer input A: Input pin for timer 9
		Input	Interrupt request pin 7: Interrupt request pin with programmable rising/falling edge 
P95 / TIB / INT8	1	Input/output	Port 95: I/O port
		Input	Timer input B: Input pin for timer 9
		Input	Interrupt request pin 8: Rising edge interrupt request pin 
P96 / TOA / TOB	1	Input/output	Port 96: I/O port
		Output	Timer output A: Output pin for timer 9
		Output	Timer output B: Output pin for timer 9
PA0 to PA2 / AN0 to AN2	3	Input	Port A0 to A2: Input-only port
		Input	Analog input 0 to 2: AD converter input pins
PA3 / AN3 / $\overline{\text{ADTRG}}$	1	Input	Port A3: Input-only port
		Input	Analog input 3: AD converter input pin
		Input	External start trigger

Table 2.2.1 Pin Names and Functions (4/4)

Pin Name	Number of Pins	Input/Output	Function
PA4 to PA7 / AN4 to AN7	4	Input	Port A4 to A7: Input-only port
		Input	Analog input 4 to 7: AD converter input pins
$\overline{\text{NMI}}$	1	Input	Non-maskable interrupt request pin: Interrupt request pin with programmable falling edge or both falling and rising edge 
CLK	1	Output	Clock output: Outputs external clock divided by 4. Pulled up during reset.
$\overline{\text{EA}}$	1	Input	External access: Connect to VCC.
AM8 / $\overline{16}$	1	Input	Address mode: External data bus width select pin Connect this pin to VCC. Data bus width at external access can be set by bus width / wait control register.
$\overline{\text{RESET}}$	1	Input	Reset: Initializes TMP95PS54 (with built-in pull-up resistor)
VREFH	1	Input	Reference voltage input pin for AD converter (high)
VREFL	1	Input	Reference voltage input pin for AD converter (low)
AVCC	1		Power supply pin for AD converter: Connect to power supply
AVSS	1		GND pin for AD converter: Connect to GND
X1 / X2	2	Input/output	Oscillator connecting pin
VCC	3		Power supply pin: Connect all VCC pins to power supply
VSS	5		GND pin: Connect all VSS pins to GND (0 V)

Note: Software can be used to turn off the resistance of pull-up pins with resistors (except for the  $\overline{\text{RESET}}$  pin).

P57 and CLK pin are pulled-up only during reset.

## (2) PROM Mode Pin Functions and Pin Processing

Tables 2.2.2 and 2.2.3 show the names and functions of the input/output pins, and the pin processing.

Table 2.2.2 Pin Names and Functions

Pin Function Name	Number of Pins	Input/Output	Function	Pin Name (In MCU Mode)
A7 to A0	8	Input	Program memory address input	P20 to P27
A15 to A8	8			P17 to P10
A16	1			P34
D7 to D0	8	Input/output	Program memory data input/output	P07 to P00
$\overline{\text{CE}}$	1	Input	Chip enable input	P35
$\overline{\text{OE}}$	1	Input	Output control input	P37
$\overline{\text{PGM}}$	1	Input	Program control input	P36
VPP	1	Power supply	12.75 V / 5 V (program power supply)	$\overline{\text{EA}}$
VCC	4	Power supply	6.25 V / 5 V	VCC, AVCC
VSS	6	Power supply	0 V	VSS, AVSS

Table 2.2.3 Pin Names and Pin Processing

Pin Name	Number of Pins	Input/ Output	Pin Processing
P33	1	Input	Fixed to low level (SECURITY pin)
RESET	1	Input	Fixed to low level (set to PROM mode)
CLK	1	Input	
X1	1	Input	Connect oscillator and set to self-oscillation
X2	1	Output	
P32 to P30 P47 to P40 P56 to P52 P63 to P60 P75 to P70 P87 to P80 P96 to P90 PA7 to PA0 AM8/16 NMI	51	Input	Fixed to high level
P57, P51, P50	3	Output	Open
VREFH	1	Input	
VREFL	1		

### 3. Operation

The following describes the structure and operation of the TMP95PS54 hardware.

In TMP95PS54, the internal ROM of TMP95CS54 is replaced by an internal PROM. Otherwise, TMP95PS54 is structurally and operationally identical to TMP95CS54. Accordingly, for functions not described here, see the TMP95CS54 section of the manual. TMP95PS54 supports MCU operating mode and PROM operating mode.

#### 3.1 MCU Mode

##### (1) Setting and function

Opening the CLK pin (setting to output) sets MCU mode.

In MCU mode, TMP95PS54 operates the same as TMP95CS54.

##### (2) Memory map

Figure 3.1.1 shows the memory map in MCU mode and the CPU access area in each addressing mode.

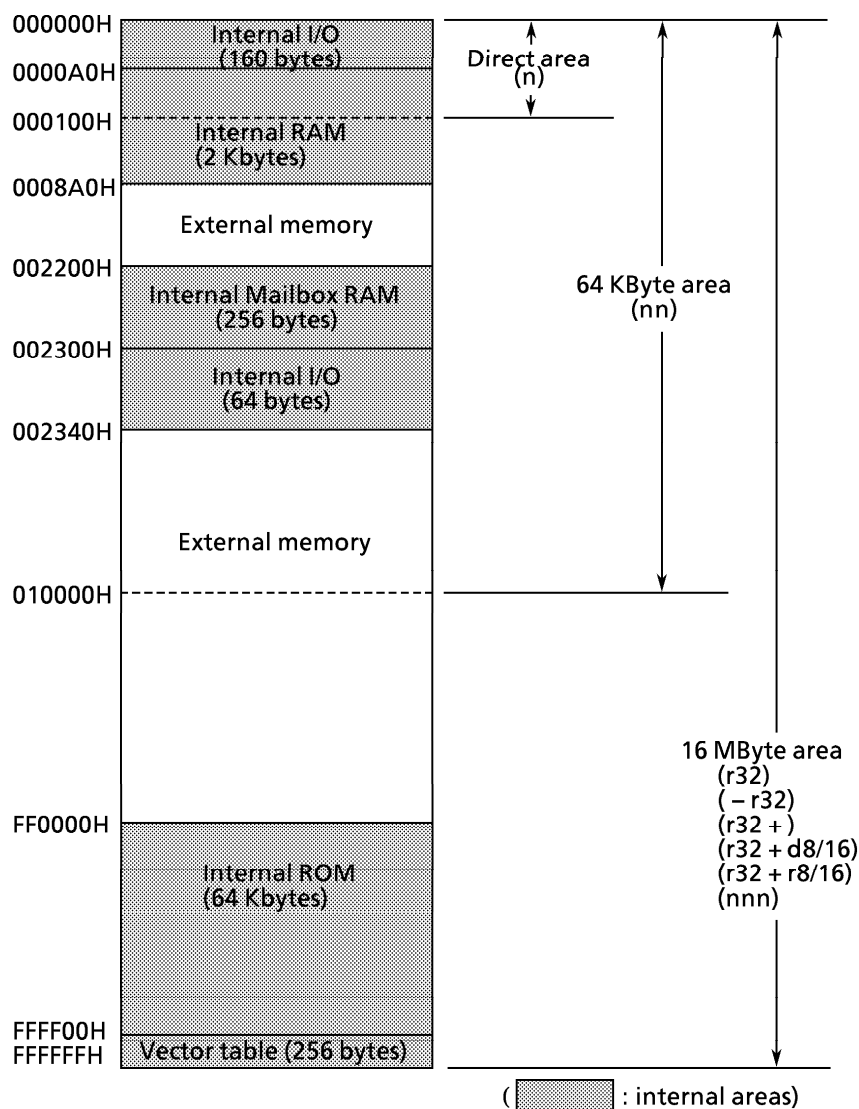


Figure 3.1.1 TMP95PS54 Memory Map

#### 4. Electrical Characteristics

##### 4.1 Absolute Maximum Ratings

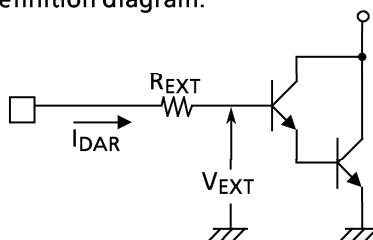
Parameter	Symbol	Rating		Unit
Power Supply Voltage	$V_{CC}$	– 0.5 to + 6.5		V
Input Voltage	$V_{IN}$	except for $\overline{EA}$ pin	– 0.5 to $V_{CC} + 0.5$	V
		$\overline{EA}$ pin	– 0.5 to 14.0	
Output current (total)	$\Sigma I_{OL}$	+ 120		mA
Output current (total)	$\Sigma I_{OH}$	– 120		mA
Power Dissipation ( $T_a = + 85^\circ\text{C}$ )	$P_D$	600		mW
Soldering Temperature (10 s)	$T_{SOLDER}$	+ 260		$^\circ\text{C}$
Storage Temperature	$T_{STG}$	– 65 to + 150		$^\circ\text{C}$
Operating Temperature	$T_{OPR}$	– 40 to + 85		$^\circ\text{C}$

Note: The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

## 4.2 DC Electrical Characteristics

 $V_{CC} = 4.7 \text{ to } 5.3 \text{ V}$ ,  $T_a = -40 \text{ to } +85 \text{ }^\circ\text{C}$  ( $f_c = 8 \text{ to } 24 \text{ MHz}$ )
(Typical values are for  $T_a = +25^\circ\text{C}$ ,  $V_{CC} = +5 \text{ V}$ .)

Parameter	Symbol	Test Condition	Min	Max	Unit
Input Low Voltage (D0 to 15)	$V_{IL}$		-0.3	0.8	V
Port 2 to A	$V_{IL1}$		-0.3	$0.3 V_{CC}$	V
(except P56, P70, P72, P73, P75)					
RESET, NMI, INT0 to 4	$V_{IL2}$		-0.3	$0.25 V_{CC}$	V
EA, AM8/16	$V_{IL3}$		-0.3	0.3	V
X1	$V_{IL4}$		-0.3	$0.2 V_{CC}$	V
Input High Voltage (D0 to 15)	$V_{IH}$		2.2	$V_{CC} + 0.3$	V
Port 2 to A	$V_{IH1}$		$0.7 V_{CC}$	$V_{CC} + 0.3$	V
(except P56, P70, P72, P73, P75)					
RESET, NMI, INT0 to 4	$V_{IH2}$		$0.75 V_{CC}$	$V_{CC} + 0.3$	V
EA, AM8/16	$V_{IH3}$		$V_{CC} - 0.3$	$V_{CC} + 0.3$	V
X1	$V_{IH4}$		$0.8 V_{CC}$	$V_{CC} + 0.3$	V
Output Low Voltage	$V_{OL}$	$I_{OL} = 1.6 \text{ mA}$		0.45	V
Output High Voltage	$V_{OH}$	$I_{OH} = -400 \text{ } \mu\text{A}$	2.4		V
	$V_{OH1}$	$I_{OH} = -100 \text{ } \mu\text{A}$	$0.75 V_{CC}$		V
	$V_{OH2}$	$I_{OH} = -20 \text{ } \mu\text{A}$	$0.9 V_{CC}$		V
Darlington Drive Current (8 Output Pins max.)	$I_{DAR}$	$V_{EXT} = 1.5 \text{ V}$ $R_{EXT} = 1.1 \text{ k}\Omega$	-1.0	-3.5	mA
Input Leakage Current	$I_{LI}$	$0.0 \leq V_{in} \leq V_{CC}$	0.02 (Typ)	$\pm 5$	$\mu\text{A}$
Output Leakage Current	$I_{LO}$	$0.2 \leq V_{in} \leq V_{CC} - 0.2$	0.05 (Typ)	$\pm 10$	$\mu\text{A}$
Operating Current (NORMAL)	$I_{CC}$	$f_c = 24 \text{ MHz}$	69 (Typ)	85	mA
RUN			35 (Typ)	50	mA
IDLE2			27 (Typ)	40	mA
IDLE1			5 (Typ)	10	mA
STOP ( $T_a = -40 \text{ to } +85 \text{ }^\circ\text{C}$ )		$0.2 \leq V_{in} \leq V_{CC} - 0.2$	0.5 (Typ)	100	$\mu\text{A}$
( $T_a = -20 \text{ to } +70 \text{ }^\circ\text{C}$ )				50	$\mu\text{A}$
Power Down Voltage (@STOP, RAM Back up)	$V_{STOP}$	$V_{IL2} = 0.2 V_{CC}$ , $V_{IH2} = 0.8 V_{CC}$	2.0	6.0	V
Pull Up Registance	$R_{RP}$		45	160	$\text{k}\Omega$
Pin Capacitance	$C_{IO}$	$f_c = 1 \text{ MHz}$		10	pF
Schmitt Width	$V_{TH}$		0.4	1.0 (Typ)	V
RESET, NMI, INT0 to 4					

Note:  $I_{DAR}$  guarantees up to eight pins from any output port.Refer:  $I_{DAR}$  definition diagram.

## 4.3 AC Electrical Characteristics

$V_{CC} = 4.7$  to  $5.3V$ ,  $T_a = -40$  to  $+85\text{ }^{\circ}C$

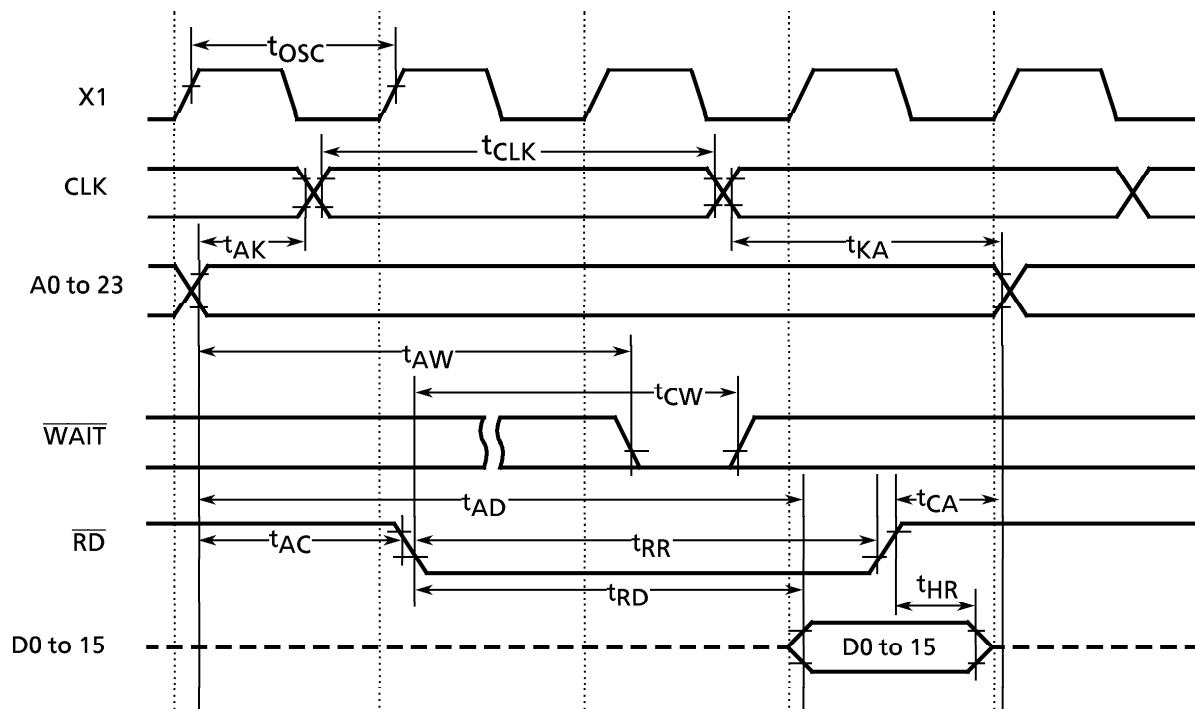
( $f_c = 8\text{ MHz}$  to  $24\text{ MHz}$ )

No.	Parameter	Symbol	Variable		24 MHz		Unit
			Min	Max	Min	Max	
1	Oscillation cycle (= x)	$t_{OSC}$	42	125	42		ns
2	Clock pulse width	$t_{CLK}$	$2.0x - 40$		44		ns
3	A0 to 23 valid $\rightarrow$ Clock hold	$t_{AK}$	$0.5x - 20$		1		ns
4	Clock valid $\rightarrow$ A0 to 23 hold	$t_{KA}$	$1.5x - 60$		3		ns
5	A0 to 23 valid $\rightarrow \overline{RD}/\overline{WR}$ fall	$t_{AC}$	$1.0x - 20$		22		ns
6	$\overline{RD}/\overline{WR}$ rise $\rightarrow$ A0 to 23 hold	$t_{CA}$	$0.5x - 20$		1		ns
7	A0 to 23 valid $\rightarrow$ D0 to 15 input	$t_{AD}$		$3.5x - 40$		107	ns
8	$\overline{RD}$ fall $\rightarrow$ D0 to 15 input	$t_{RD}$		$2.5x - 45$		60	ns
9	$\overline{RD}$ low pulse width	$t_{RR}$	$2.5x - 40$		65		ns
10	$\overline{RD}$ rise $\rightarrow$ D0 to 15 hold	$t_{HR}$	0		0		ns
11	$\overline{WR}$ low pulse width	$t_{WW}$	$2.5x - 40$		65		ns
12	D0 to 15 valid $\rightarrow \overline{WR}$ rise	$t_{DW}$	$2.0x - 40$		44		ns
13	$\overline{WR}$ rise $\rightarrow$ D0 to 15 hold	$t_{WD}$	$0.5x - 10$		11		ns
14	A0 to 23 valid $\rightarrow \overline{WAIT}$ input $\left( \begin{smallmatrix} 1 \\ +n \end{smallmatrix} \overline{WAIT}_{mode} \right)$	$t_{AW}$		$3.5x - 90$		57	ns
	A0 to 23 valid $\rightarrow \overline{WAIT}$ input $\left( \begin{smallmatrix} 0+n \\ mode \end{smallmatrix} \overline{WAIT} \right)$	$t_{AW}$		$1.5x - 40$		23	ns
15	$\overline{RD}/\overline{WR}$ fall $\rightarrow \overline{WAIT}$ hold $\left( \begin{smallmatrix} 1 \\ +n \end{smallmatrix} \overline{WAIT}_{mode} \right)$	$t_{CW}$	$2.5x + 0$		105		ns
	$\overline{RD}/\overline{WR}$ fall $\rightarrow \overline{WAIT}$ hold $\left( \begin{smallmatrix} 0+n \\ mode \end{smallmatrix} \overline{WAIT} \right)$	$t_{CW}$	$0.5x + 0$		21		ns
16	$\overline{WR}$ rise $\rightarrow$ PORT valid	$t_{CP}$		200		200	ns

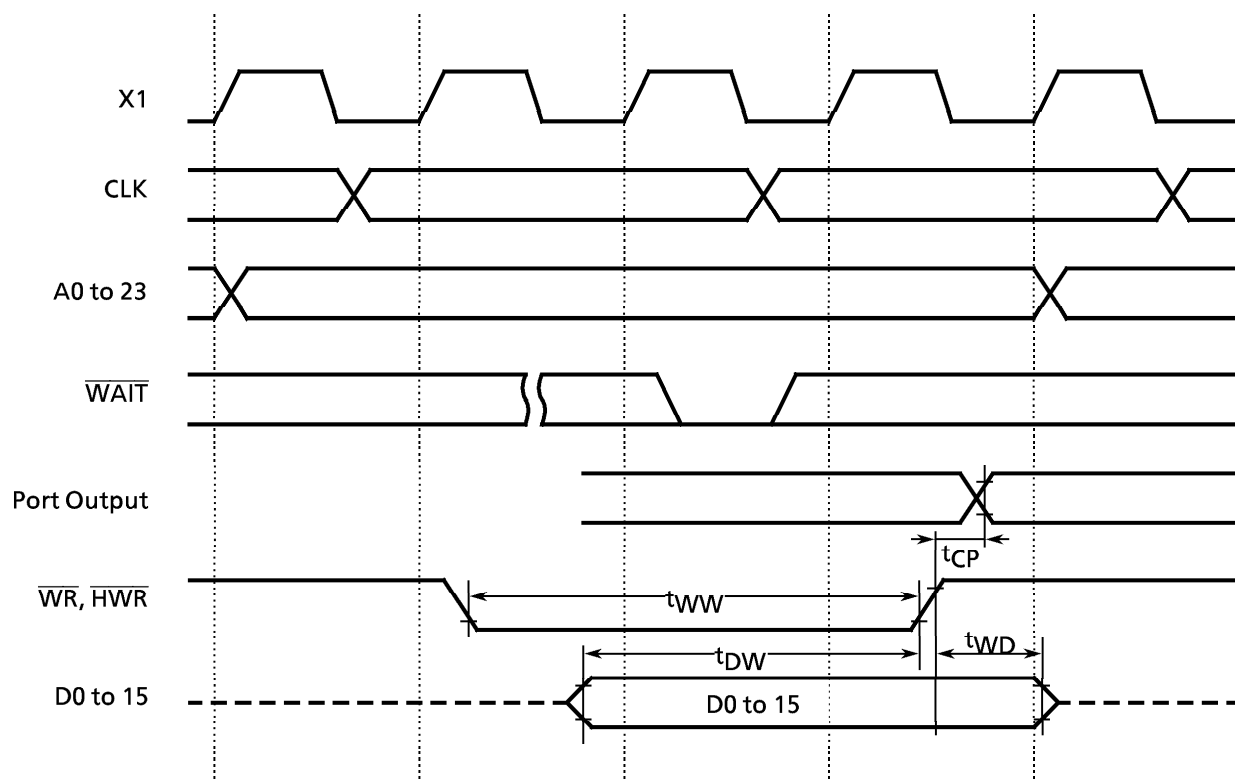
## AC measuring conditions

- Output level : High 2.2 V/Low 0.8 V ,  $CL = 50\text{ pF}$
- Input level : High 2.4 V / Low 0.45 V (D0 to D15)  
High  $0.8 \times V_{CC}$  / Low  $0.2 \times V_{CC}$  (except for D0 to D15)

## (1) Read cycle



## (2) Write cycle



#### 4.4 Serial Channel Timing

##### (1) I/O interface mode

###### ① SCLK input mode

$V_{CC} = 4.7$  to  $5.3$  V,  $T_a = -40$  to  $+85^\circ\text{C}$  ( $f_c = 8$  to  $24$  MHz)

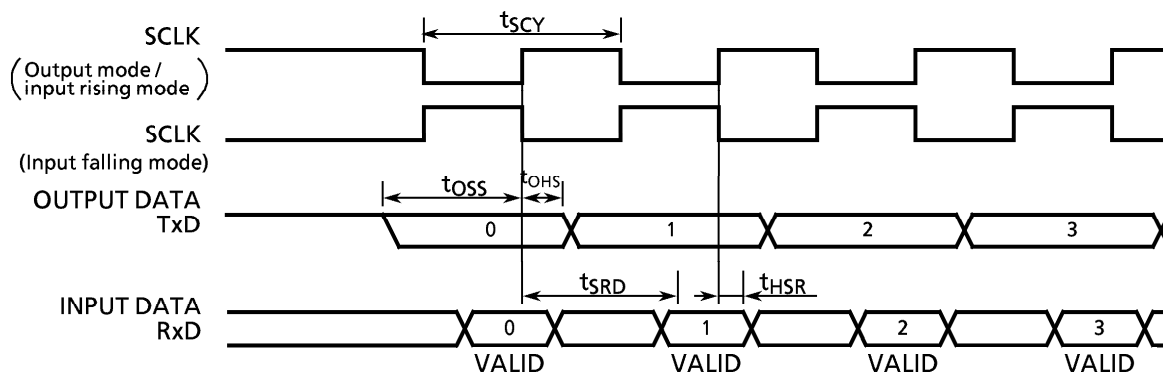
Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
SCLK cycle	$t_{SCY}$	16x		0.667		$\mu\text{s}$
Output Data $\rightarrow$ SCLK rise/fall*	$t_{OSS}$	$t_{SCY}/2 - 5x - 50$		75		ns
SCLK rise/fall* $\rightarrow$ Output Data hold	$t_{OHS}$	$5x - 100$		108		ns
SCLK rise/fall* $\rightarrow$ input data hold	$t_{HSR}$	0		0		ns
SCLK rise/fall* $\rightarrow$ valid data input	$t_{SRD}$		$t_{SCY} - 5x - 100$		358	ns

\*) SCLK rise/fall: In SCLK rising edge mode, SCLK rising edge timing; in SCLK falling edge mode, SCLK falling edge timing

###### ② SCLK output mode

$V_{CC} = 4.7$  to  $5.3$  V,  $T_a = -40$  to  $+85^\circ\text{C}$  ( $f_c = 8$  to  $24$  MHz)

Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
SCLK cycle (programmable)	$t_{SCY}$	16x	8192x	0.667	341.3	$\mu\text{s}$
Output Data $\rightarrow$ SCLK rising edge	$t_{OSS}$	$t_{SCY} - 2x - 150$		433		ns
SCLK rising edge $\rightarrow$ Output Data hold	$t_{OHS}$	$2x - 80$		3		ns
SCLK rising edge $\rightarrow$ Input Data hold	$t_{HSR}$	0		0		ns
SCLK rising edge $\rightarrow$ valid data input	$t_{SRD}$		$t_{SCY} - 2x - 150$		433	ns



##### (2) UART mode (SCLK0 to 1 External Input)

$V_{CC} = 4.7$  to  $5.3$  V,  $T_a = -40$  to  $+85^\circ\text{C}$  ( $f_c = 8$  to  $24$  MHz)

Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
SCLK cycle	$t_{SCY}$	$4x + 20$		187		ns
Low-level SCLK pulse width	$t_{SCYL}$	$2x + 5$		88		ns
High-level SCLK pulse width	$t_{SCYH}$	$2x + 5$		88		ns

## 4.5 AD Conversion Characteristics

Vcc = 4.7 to 5.3 V, Ta = -40 to +85 °C (fc = 8 to 24 MHz)

Parameter	Symbol	Test Conditions	Min	Typ.	Max	Unit
AD analog reference supply voltage ( + )	V <sub>REFH</sub>		Vcc - 0.2		Vcc	V
AD analog reference supply voltage ( - )	V <sub>REFL</sub>		Vss		Vss + 0.2	
Analog reference voltage	AV <sub>CC</sub>		Vcc - 0.2		Vcc	
Analog reference voltage	AV <sub>SS</sub>		Vss		Vss + 0.2	
Analog input voltage	V <sub>AIN</sub>		V <sub>REFL</sub>		V <sub>REFH</sub>	
Analog reference voltage supply current	<VREFON> = 1	I <sub>REF</sub>	Vcc = 4.7 to 5.3 V		3.7	mA
	<VREFON> = 0		Vcc = 4.7 to 5.3 V	0.02	5.0	μA
Total tolerance (excludes quantization error)	E <sub>T</sub>	Vcc = 4.7 to 5.3 V		± 1	± 3	LSB

Note 1 : 1LSB = (V<sub>REFH</sub> - V<sub>REFL</sub>) / 2<sup>10</sup> [V]Note 2 : Power supply current I<sub>CC</sub> from the VCC pin includes the power supply current from the AVCC pin.

## 4.6 Event Counter (External Input Clocks : TI0, TI4, TI8, TI9, TIA, TIB)

Vcc = 4.7 to 5.3 V, Ta = -40 to +85 °C (fc = 8 to 24 MHz)

Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
External input clock cycle	t <sub>VCK</sub>	8x + 100		433		ns
External low-level input clock pulse width	t <sub>VCKL</sub>	4x + 40		207		ns
External high-level input clock pulse width	t <sub>VCKH</sub>	4x + 40		207		ns

## 4.7 Interrupt Operation

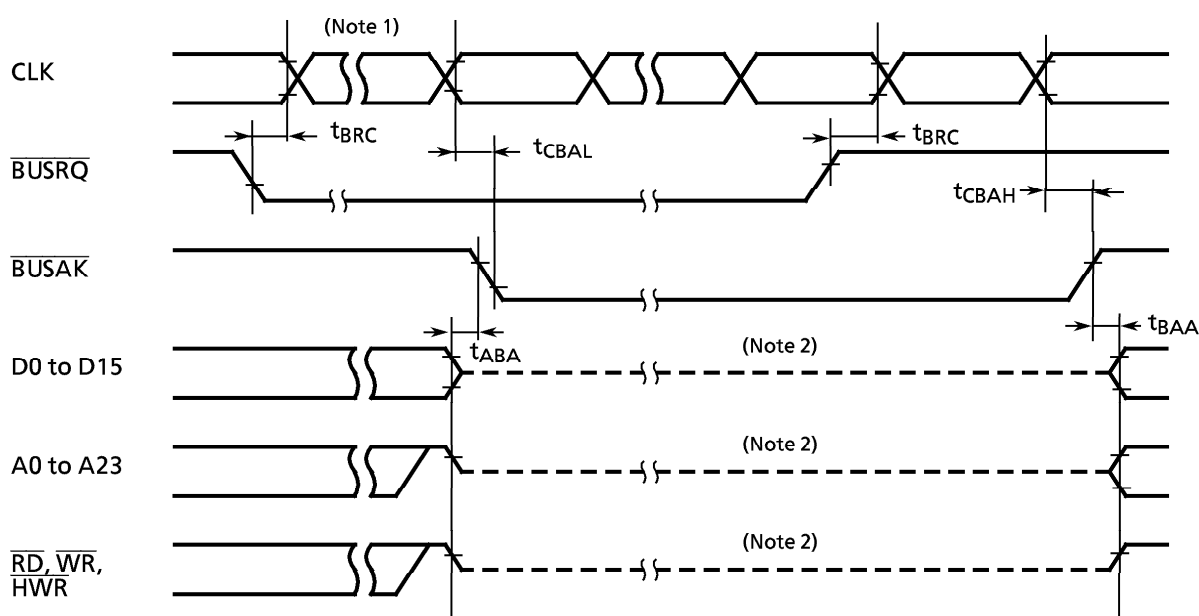
Vcc = 4.7 to 5.3 V, Ta = -40 to +85 °C (fc = 8 to 24 MHz)

Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
NMI, INT0 to 4 low-level pulse width	t <sub>INTAL</sub>	4x		167		ns
NMI, INT0 to 4 high-level pulse width	t <sub>INTAH</sub>	4x		167		ns
INT5 to INT8 low-level pulse width	t <sub>INTBL</sub>	8x + 100		433		ns
INT5 to INT8 high-level pulse width	t <sub>INTBH</sub>	8x + 100		433		ns

## 4.8 Bus Request/Bus Acknowledge Timing

V<sub>CC</sub> = 4.7 to 5.3V, T<sub>a</sub> = -40 to +85 °C (f<sub>c</sub> = 8 to 24 MHz)

Parameter	Symbol	Variable		24 MHz		Unit
		Min	Max	Min	Max	
$\overline{\text{BUSRQ}}$ setup time for CLK	t <sub>BRC</sub>	120		120		ns
CLK → $\overline{\text{BUSAK}}$ fall	t <sub>CBAL</sub>		2.0x + 120		203	ns
CLK → $\overline{\text{BUSAK}}$ rise	t <sub>CBAH</sub>		0.5x + 40		61	ns
Time from output buffer off until $\overline{\text{BUSAK}}$ falling edge	t <sub>ABA</sub>	0	80	0	80	ns
Time from $\overline{\text{BUSAK}}$ rising edge until output buffer on	t <sub>BAA</sub>	0	80	0	80	ns



Note 1: When  $\overline{\text{BUSRQ}}$  goes to low level to request bus release, if the current bus cycle is yet complete due to a wait, the bus is not released until the wait completes.

Note 2: The dotted line indicates only that the output buffer is off, not that the signal is at middle level. Immediately after bus release, the signal level prior to the bus release is held dynamically by the external load capacitance. Therefore, designs should allow for the fact that when using an external resistor or similar to fix the signal level while the bus is released, after bus release a delay occurs before the signal goes to its fixed level (due to the CR time constant). The internal programmable pull-up resistor continues to function in accordance with the internal signal level.

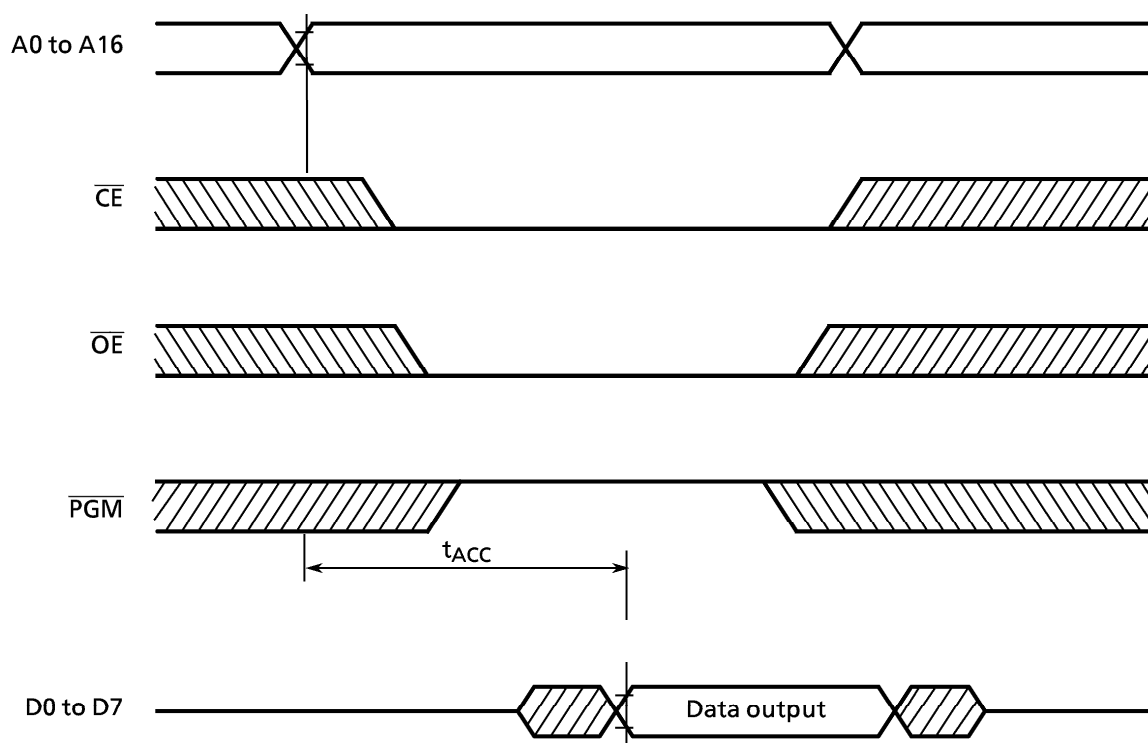
## 4.9 Read Operations in PROM Mode

## DC / AC Electrical Specifications

 $T_a = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$ 

Parameter	Symbol	Test Condition	Min	Max	Unit
$V_{PP}$ Read Voltage	$V_{PP}$		4.5	5.5	V
Input High Voltage (A0 to A16, $\overline{CE}$ , $\overline{OE}$ , $\overline{PGM}$ )	$V_{IH}$		2.2	$V_{CC} + 0.3$	V
Input Low Voltage (A0 to A16, $\overline{CE}$ , $\overline{OE}$ , $\overline{PGM}$ )	$V_{IL}$		-0.3	0.8	V
Address to Output Delay	$t_{ACC}$	$C_L = 50\text{ pF}$	-	$2.25T_{CYC} + \alpha$	ns

$T_{CYC} = 400\text{ ns}$  (10 MHz Clock)  
 $\alpha = 200\text{ ns}$

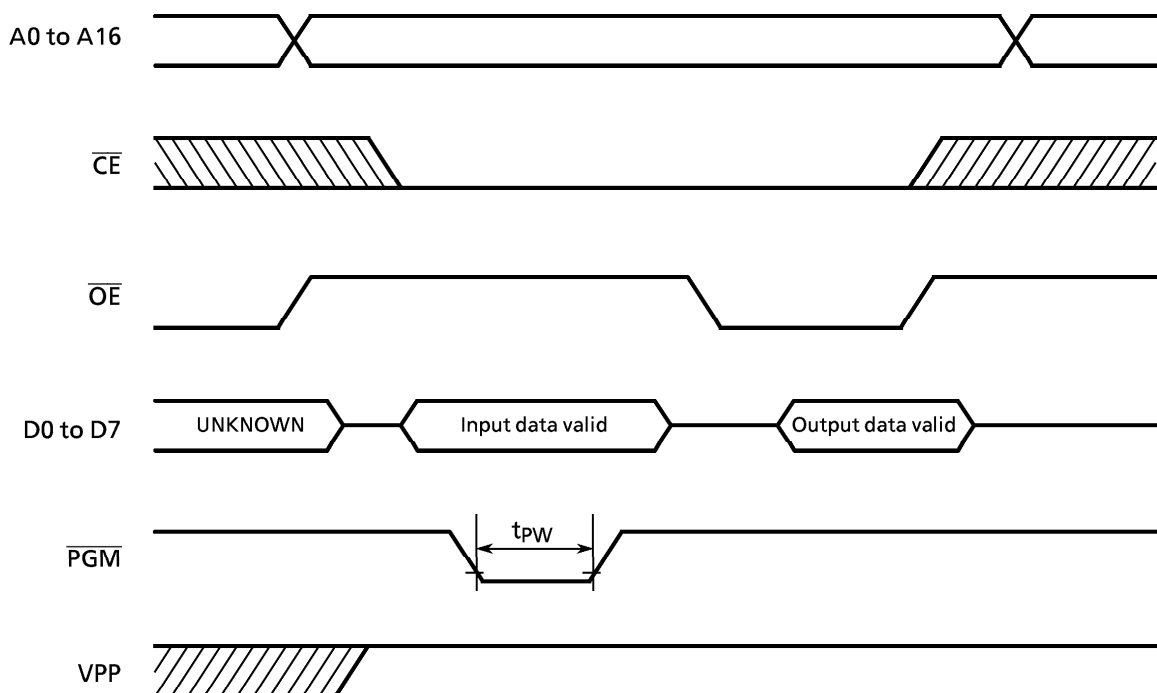


## 4.10 Program Operations in PROM Mode

## DC / AC Electrical Specifications

 $T_a = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 6.25\text{ V} \pm 0.25\text{ V}$ 

Parameter	Symbol	Test Condition	Min	Typ.	Max	Unit
Programing Supply Voltage	$V_{PP}$		12.50	12.75	13.00	V
Input High Voltage (D0 to D7, A0 to A16, $\overline{CE}$ , $\overline{OE}$ , $\overline{PGM}$ )	$V_{IH}$		2.6		$V_{CC} + 0.3$	V
Input Low Voltage (D0 to D7, A0 to A16, $\overline{CE}$ , $\overline{OE}$ , $\overline{PGM}$ )	$V_{IL}$		-0.3		0.8	V
$V_{CC}$ Supply Current	$I_{CC}$	$f_c = 10\text{ MHz}$	-		50	mA
$V_{PP}$ Supply Current	$I_{PP}$	$V_{PP} = 13.00\text{ V}$	-		50	mA
$\overline{PGM}$ Program Pulse Width	$t_{PW}$	$C_L = 50\text{ pF}$	0.095	0.1	0.105	ms



Note 1: When turning the  $V_{PP}$  (12.75 V) power supply off and on, ensure that  $V_{CC}$  is on.

Note 2: Do not plug in or unplug the device when the  $V_{PP}$  power (12.75 V) is on.  
(This can damage the device.)

Note 3: The  $V_{PP}$  pin maximum rating is 14 V. When the program is executed, the voltage applied, including overshoot, should not exceed 14 V.