

SECTION 23. ELECTRICAL CHARACTERISTICS

23.1 Absolute Maximum Ratings

Item	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to +7.0	V
Input Voltage	V_{in}	-0.3 to $V_{CC}+0.3$	V
Operating Temperature	T_{opr}	-20 to +75	°C
Storage Temperature	T_{stg}	-55 to +150	°C

Note: Permanent LSI damage may occur if maximum ratings are exceeded. Normal operation should be under recommended operating conditions. If these conditions are exceeded, it could affect reliability of LSI.

23.2 DC Characteristics

$(V_{CC} = 5\text{ V} \pm 10\%, V_{SS} = 0\text{ V}, T_a = -20\text{ to }+75^\circ\text{C}, \text{ unless otherwise noted})$

Symbol	Item	Min	Typ	Max	Unit	Condition
V_{IH1}	Input High Voltage RESET, EXTAL, $\overline{\text{NMI}}$	$V_{CC}-0.6$	—	$V_{CC}+0.3$	V	
V_{IH2}	Input High Voltage Except RESET, EXTAL, $\overline{\text{NMI}}$	2.0	—	$V_{CC}+0.3$	V	
V_{IL1}	Input Low Voltage RESET, EXTAL, $\overline{\text{NMI}}$	-0.3	—	0.6	V	
V_{IL2}	Input Low Voltage Except RESET, EXTAL, $\overline{\text{NMI}}$	-0.3	—	0.8	V	
V_{OH}	Output High Voltage All outputs	2.4 $V_{CC}-1.2$	—	—	V	$I_{OH} = -200\ \mu\text{A}$ $I_{OH} = -20\ \mu\text{A}$
V_{OL}	Output Low Voltage All Outputs	—	—	0.45	V	$I_{OL} = 2.2\ \text{mA}$
I_L	Input Leakage Current All Inputs Except XTAL, EXTAL, RESET	—	—	1.0	μA	$V_{in} = 0.5\text{ to }V_{CC} - 0.5\text{ V}$
I_{TL}	Three State Leakage Current	—	—	1.0	μA	$V_{in} = 0.5\text{ to }V_{CC} - 0.5\text{ V}$
I_{CC} (Note)	Power Dissipation (Normal Operation)	—	20	40	mA	$f = 4\ \text{MHz}$
		—	25	50		$f = 6\ \text{MHz}$
		—	30	60		$f = 8\ \text{MHz}$
	Power Dissipation (System Stop Mode)	—	5	10	mA	$f = 4\ \text{MHz}$
		—	6.3	12.5		$f = 6\ \text{MHz}$
		—	7.5	15		$f = 8\ \text{MHz}$
C_p	Pin	RESET	—	120	pF	$V_{in} = 0\text{V}, f = 1\ \text{MHz}$
	Capacitance	Except RESET	—	20		$T_a = 25^\circ\text{C}$

Note: $V_{IHmin} = V_{CC} - 1.0\text{ V}, V_{ILmax} = 0.8\text{ V}$ (all output terminals are at no load.)

Symbol	Item		Min	Typ	Max	Unit	Condition
V_{IHP}	Input High-Level Voltage		2.2	—	$V_{CC} + 0.3$	V	
V_{ILP}	Input Low-Level Voltage		-0.3	—	0.8	V	
V_{OHP}	Output High-Level Voltage		2.4	—	—	V	$I_{OH} = -200 \mu A$
			$V_{CC} - 1.2$	—	—		$I_{OH} = -20 \mu A$
V_{OLP}	Output Low-Level Voltage		—	—	0.45	V	* $I_{OL} = 2.2 \text{ mA}$
			—	—	1.0		** $I_{OL} = 10 \text{ mA}$
V_{in}	Analog Comparator Input Level	High level	$V_{ref} + 0.1$	—	—	V	
		Low level	—	—	$V_{ref} - 0.1$		
V_{ref}	Input Level Voltage	V_{TH}	0	—	$V_{CC} \times 0.8$	V	
I_{LP}	Input Leak Current		—	—	1.0	μA	$V_{in} = 0.5$ to $V_{CC} - 0.5$

Note: *: Port A-F
 **: Port F only

23.3 AC Characteristics

($V_{CC} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $T_a = -20$ to $+75^\circ\text{C}$, unless otherwise noted)

Symbol	Item	HD647180X-4		HD647180X-6		HD647180X-8		Unit	
		Min	Max	Min	Max	Min	Max		
t_{cyc}	Clock Cycle Time	250	2000	162	2000	125	2000	ns	
t_{CHW}	Clock High Pulse Width	110	—	65	—	50	—	ns	
t_{CLW}	Clock Low Pulse Width	110	—	65	—	50	—	ns	
t_{cf}	Clock Fall Time	—	15	—	15	—	15	ns	
t_{cr}	Clock Rise Time	—	15	—	15	—	15	ns	
t_{AD}	Address Delay Time	—	110	—	90	—	80	ns	
t_{AS}	Address Set-up Time (\overline{ME} or \overline{IOE} ↓)	50	—	30	—	20	—	ns	
t_{MED1}	\overline{ME} Delay Time 1	—	85	—	60	—	50	ns	
t_{RDD1}	\overline{RD} Delay Time 1	$\overline{IOC}=1$	—	85	—	60	—	50	ns
		$\overline{IOC}=0$	—	85	—	65	—	60	ns
t_{LD1}	\overline{LIR} Delay Time 1	—	100	—	80	—	70 ^(Note)	ns	
t_{AH}	Address Hold Time 1 (\overline{ME} , \overline{IOE} , \overline{RD} or \overline{WR} ↓)	80	—	35	—	20	—	ns	
t_{MED2}	\overline{ME} Delay Time 2	—	85	—	60	—	50	ns	
t_{RDD2}	\overline{RD} Delay Time 2	—	85	—	60	—	50	ns	
t_{LD2}	\overline{LIR} Delay Time 2	—	100	—	80	—	70 ^(Note)	ns	
t_{DRS}	Data Read Set-up Time	50	—	40	—	30	—	ns	
t_{DRH}	Data Read Hold Time	0	—	0	—	0	—	ns	
t_{STD1}	ST Delay Time 1	—	110	—	90	—	70	ns	
t_{STD2}	ST Delay Time 2	—	110	—	90	—	70	ns	
t_{WS}	\overline{WAIT} Set-up Time	80	—	40	—	40	—	ns	
t_{WH}	\overline{WAIT} Hold Time	70	—	40	—	40	—	ns	
t_{WDZ}	Write Data Floating Delay Time	—	100	—	95	—	70	ns	
t_{WRD1}	\overline{WR} Delay Time 1	—	90	—	65	—	60	ns	
t_{WDD}	Write Data Delay Time	—	110	—	90	—	80	ns	
t_{WDS}	Write Data Set-up Time (\overline{WR} ↓)	60	—	40	—	20	—	ns	
t_{WRD2}	\overline{WR} Delay Time 2	—	90	—	80	—	60	ns	
t_{WRP}	\overline{WR} Pulse Width	280	—	170	—	130	—	ns	

Note: For a loading capacitance of less than or equal to 40 picofarads and operating temperature from 0 to 50 degrees, subtract 10 nanoseconds from the value given in the maximum columns.

Symbol	Item	HD647180X-4		HD647180X-6		HD647180X-8		Unit	
		Min	Max	Min	Max	Min	Max		
t_{WDH}	Write Data Hold Time (\overline{WR} ↓)	60	—	40	—	15	—	ns	
t_{OD1}	\overline{IOE} Delay Time 1	$\overline{IOC}=1$	—	85	—	60	—	50	ns
		$\overline{IOC}=0$	—	85	—	65	—	60	
t_{OD2}	\overline{IOE} Delay Time 2	—	85	—	60	—	50	ns	
t_{OD3}	\overline{IOE} Delay Time 3 (LIR ↓)	540	—	340	—	250	—	ns	
t_{INTS}	\overline{INT} Set-up Time (ϕ ↓)	80	—	40	—	40	—	ns	
t_{INTH}	\overline{INT} Hold Time (ϕ ↓)	70	—	40	—	40	—	ns	
t_{NMIW}	\overline{NMI} Pulse Width	120	—	120	—	100	—	ns	
t_{BRS}	\overline{BUSREQ} Set-up Time (ϕ ↓)	80	—	40	—	40	—	ns	
t_{BRH}	\overline{BUSREQ} Hold Time (ϕ ↓)	70	—	40	—	40	—	ns	
t_{BAD1}	\overline{BUSACK} Delay Time 1	—	100	—	95	—	70	ns	
t_{BAD2}	\overline{BUSACK} Delay Time 2	—	100	—	95	—	70	ns	
t_{BZD}	Bus Floating Delay Time	—	130	—	125	—	90	ns	
t_{MEWH}	\overline{ME} Pulse Width (HIGH)	200	—	110	—	90	—	ns	
t_{MEWL}	\overline{ME} Pulse Width (LOW)	210	—	125	—	100	—	ns	
t_{RFD1}	\overline{REF} Delay Time 1	—	110	—	90	—	80	ns	
t_{RFD2}	\overline{REF} Delay Time 2	—	110	—	90	—	80	ns	
t_{HAD1}	\overline{HALT} Delay Time 1	—	110	—	90	—	80	ns	
t_{HAD2}	\overline{HALT} Delay Time 2	—	110	—	90	—	80	ns	
t_{DRQS}	\overline{DREQi} Set-up Time	80	—	40	—	40	—	ns	
t_{DRQH}	\overline{DREQi} Hold Time	70	—	40	—	40	—	ns	
t_{TED1}	\overline{TENDi} Delay Time 1	—	85	—	70	—	60	ns	
t_{TED2}	\overline{TENDi} Delay Time 2	—	85	—	70	—	60	ns	
t_{ED1}	Enable Delay Time 1	—	100	—	95	—	70	ns	
t_{ED2}	Enable Delay Time 2	—	100	—	95	—	70	ns	
P_{WEH}	E Pulse Width (HIGH)	150	—	75	—	65	—	ns	
P_{WEL}	E Pulse Width (LOW)	300	—	180	—	130	—	ns	

Symbol	Item	HD647180X-4		HD647180X-6		HD647180X-8		Unit
		Min	Max	Min	Max	Min	Max	
t_{Er}	Enable Rise Time	–	25	–	20	–	20	ns
t_{Ef}	Enable Fall Time	–	25	–	20	–	20	ns
t_{TOD}	Timer Output Delay Time	–	300	–	300	–	200	ns
t_{STDI}	CSI/O Transmit Data Delay Time (Internal Clock Operation)	–	200	–	200	–	200	ns
t_{STDE}	CSI/O Transmit Data Delay Time (External Clock Operation)	–	7.5tcyc + 300	–	7.5tcyc + 300	–	7.5tcyc + 200	ns
t_{SRSI}	CSI/O Receive Data Set-up Time (Internal Clock Operation)	1	–	1	–	1	–	tcyc
t_{SRHI}	CSI/O Receive Data Hold Time (Internal Clock Operation)	1	–	1	–	1	–	tcyc
t_{SRSE}	CSI/O Receive Data Set-up Time (External Clock Operation)	1	–	1	–	1	–	tcyc
t_{SRHE}	CSI/O Receive Data Hold Time (External Clock Operation)	1	–	1	–	1	–	tcyc
t_{RES}	$\overline{\text{RESET}}$ Set-up Time	120	–	120	–	100	–	ns
t_{REH}	$\overline{\text{RESET}}$ Hold Time	80	–	80	–	70	–	ns
t_{OSC}	Oscillator Stabilization Time	–	20	–	20	–	20	ms
t_{EXr}	External Clock Rise Time (EXTAL)	–	25	–	25	–	25	ns
t_{EXf}	External Clock Fall Time (EXTAL)	–	25	–	25	–	25	ns
t_{Rr}	$\overline{\text{RESET}}$ Rise Time	–	50	–	50	–	50	ms
t_{Rf}	$\overline{\text{RESET}}$ Fall Time	–	50	–	50	–	50	ms
t_{ir}	Input Rise Time (except EXTAL, $\overline{\text{RESET}}$)	–	100	–	100	–	100	ns
t_{if}	Input Fall Time (except EXTAL, $\overline{\text{RESET}}$)	–	100	–	100	–	100	ns
t_{PWD}	Port Data Output Delay Time	–	110	–	90	–	80	ns
t_{PDSU}	Port Data Input Setup Time	80	–	50	–	50	–	ns
t_{PDH}	Port Data Input Hold Time	60	–	40	–	40	–	ns

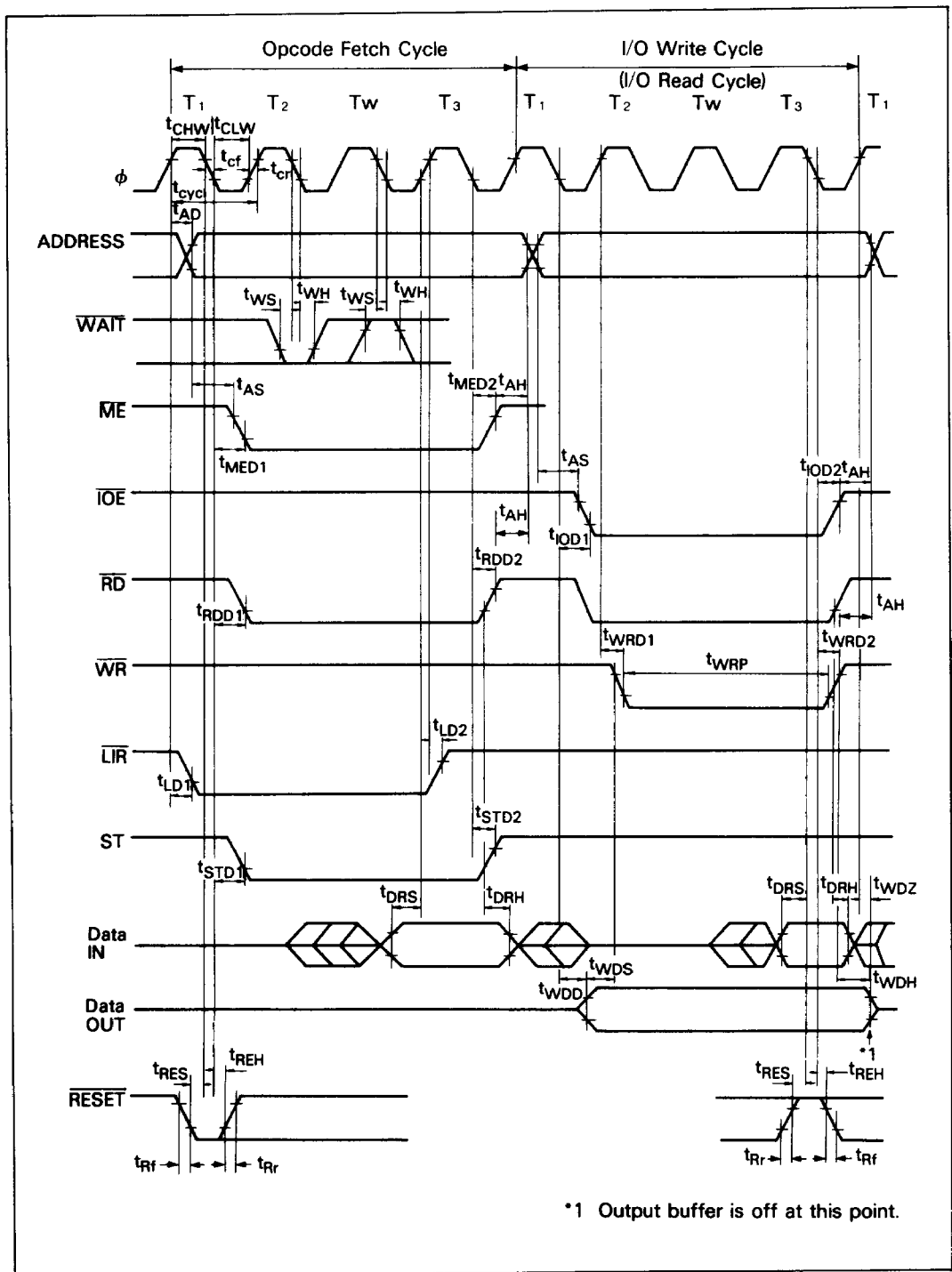


Figure 23-1. CPU Timing (Opcode Fetch Cycle, I/O Write Cycle, I/O Read Cycle)

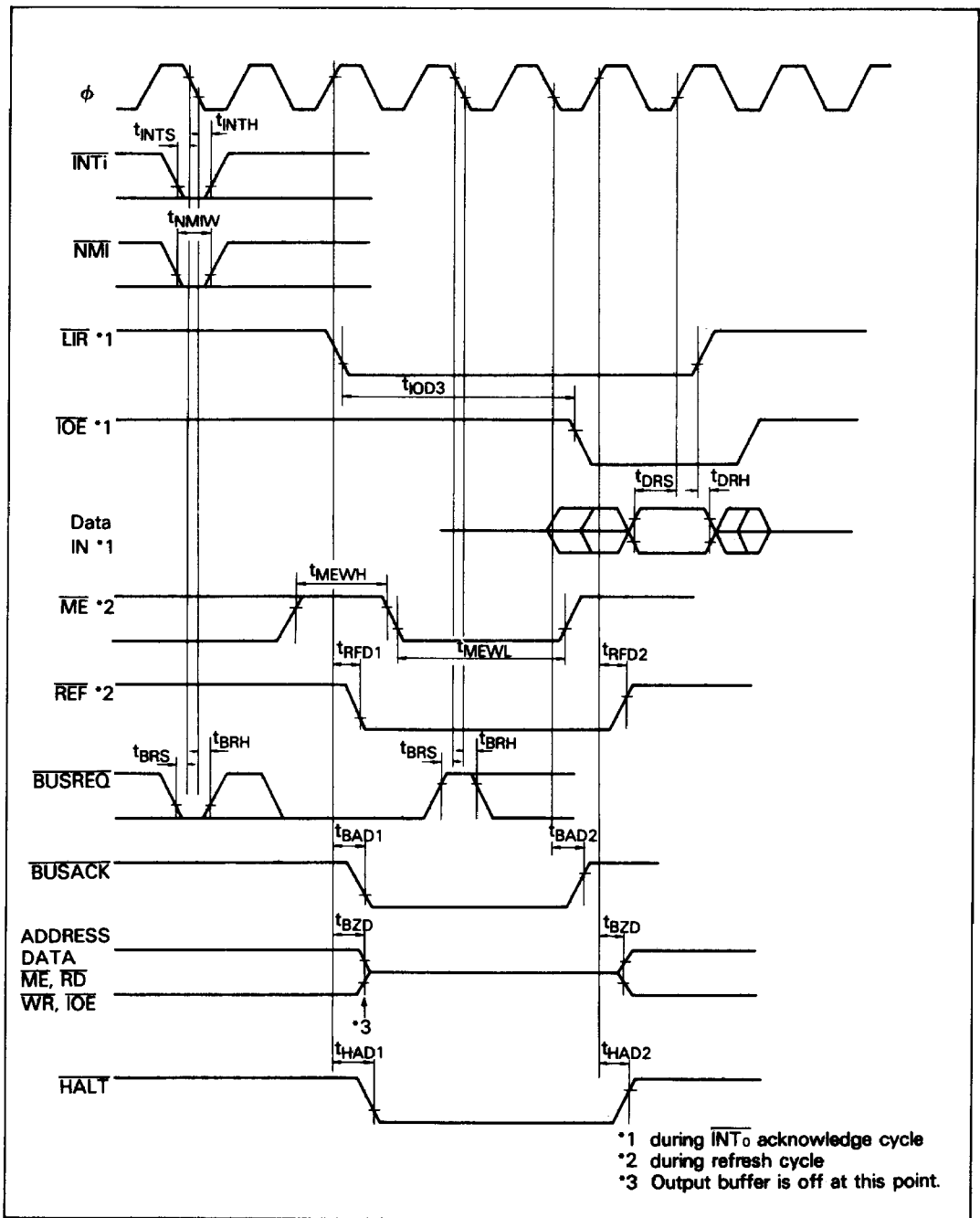


Figure 23-2. CPU Timing (\overline{INT}_0 Acknowledge Cycle, Refresh Cycle, Bus Release Mode, Halt Mode, Sleep Mode, System Stop Mode)

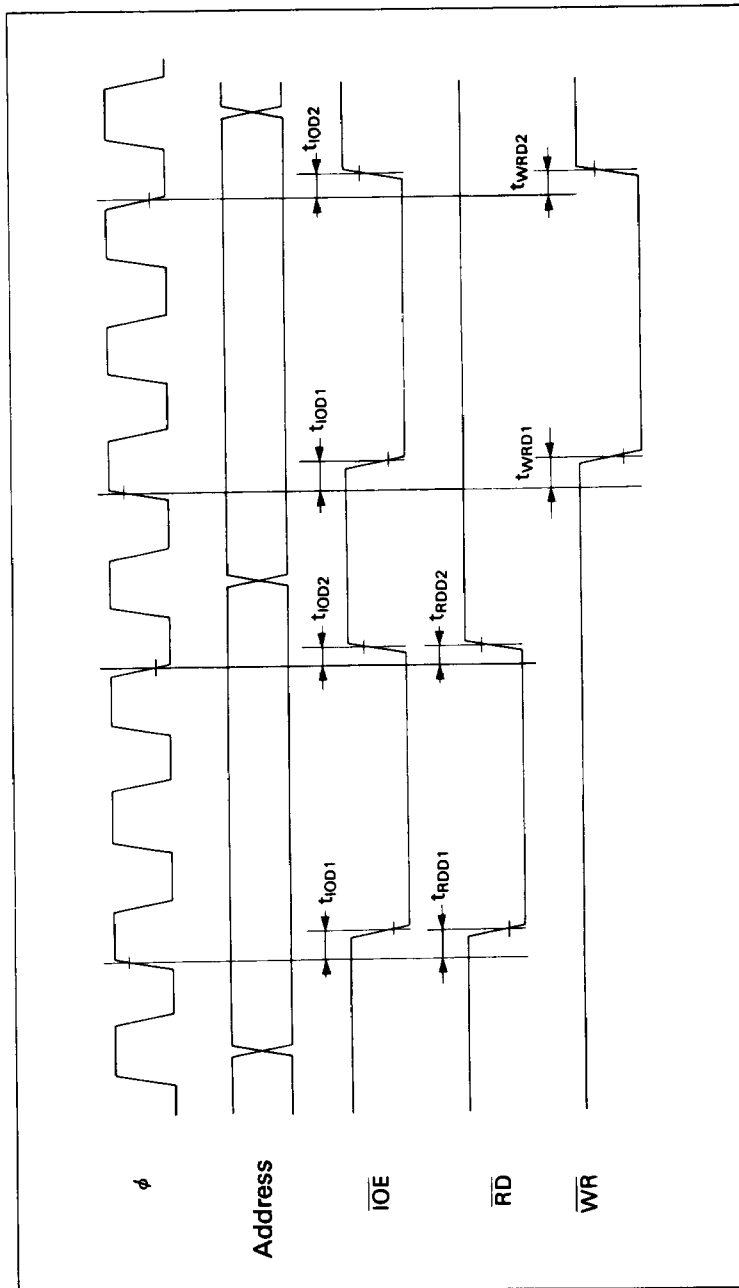
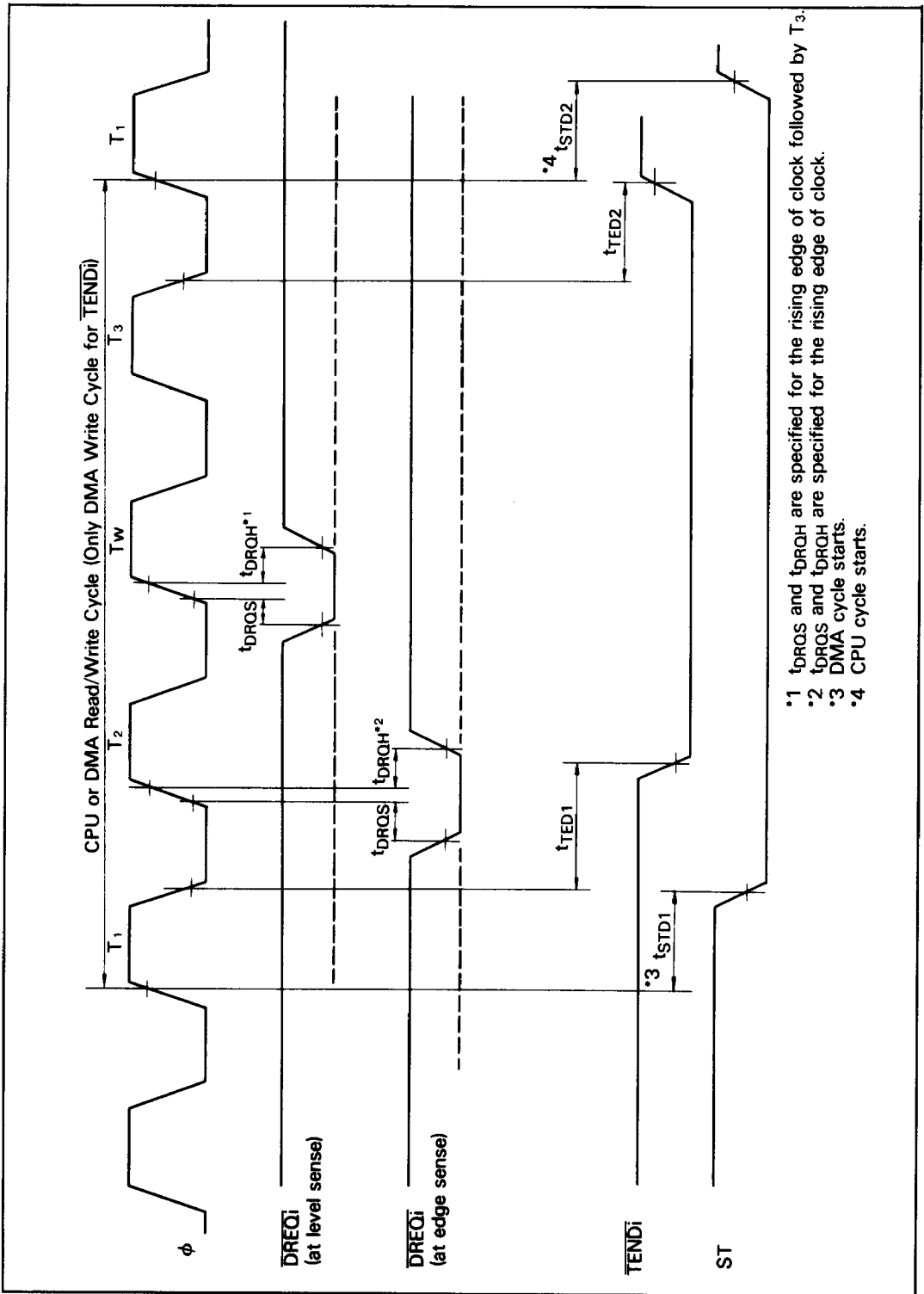


Figure 23-3. CPU Timing ($\overline{IOC}=0$)



- *1 t_{DROS} and t_{DROH} are specified for the rising edge of clock followed by T_3 .
- *2 t_{DROS} and t_{DROH} are specified for the rising edge of clock.
- *3 DMA cycle starts.
- *4 CPU cycle starts.

Figure 23-4. DMA Control Signals

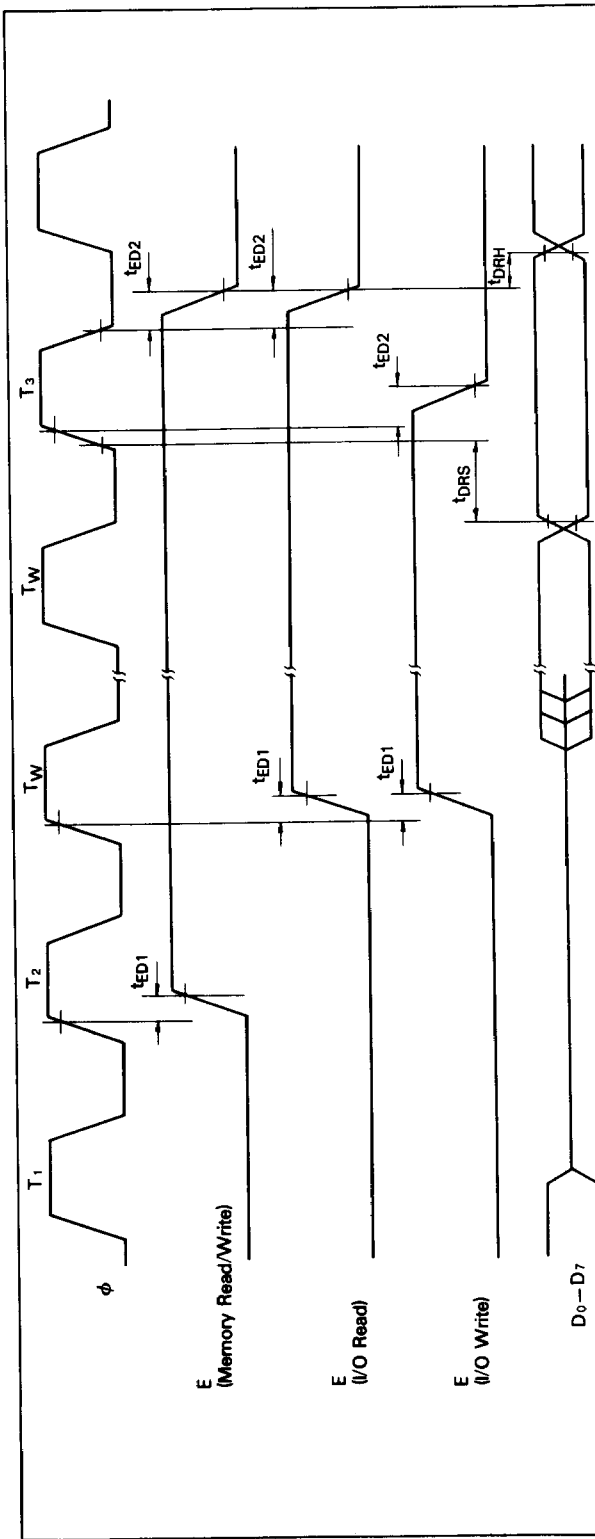


Figure 23-5. E Clock Timing (Memory Read/Write Cycle, I/O Read/Write Cycle)

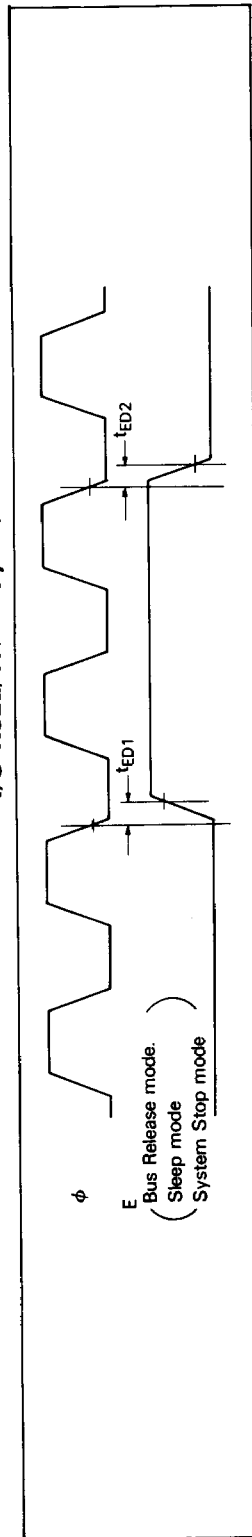


Figure 23-6. E Clock Timing (Bus Release Mode, Sleep Mode, System Stop Mode)

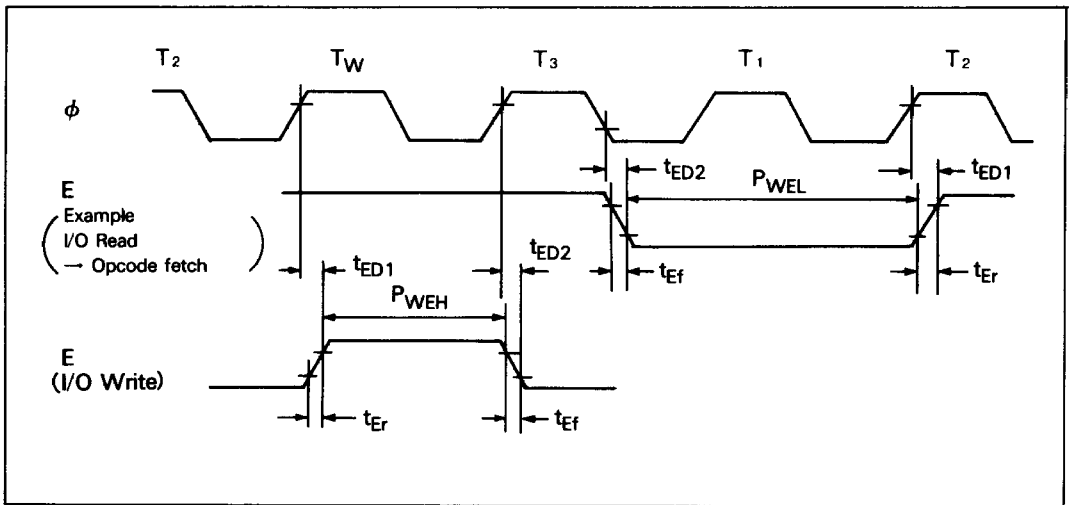


Figure 23-7. E Clock Timing (Minimum Timing Example of P_{WEL} and P_{WEH})

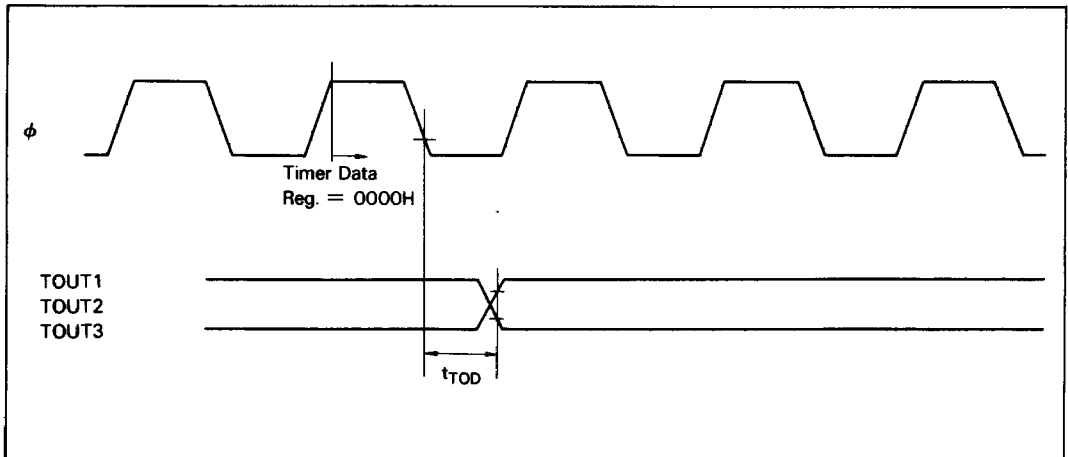


Figure 23-8. Timer Output Timing

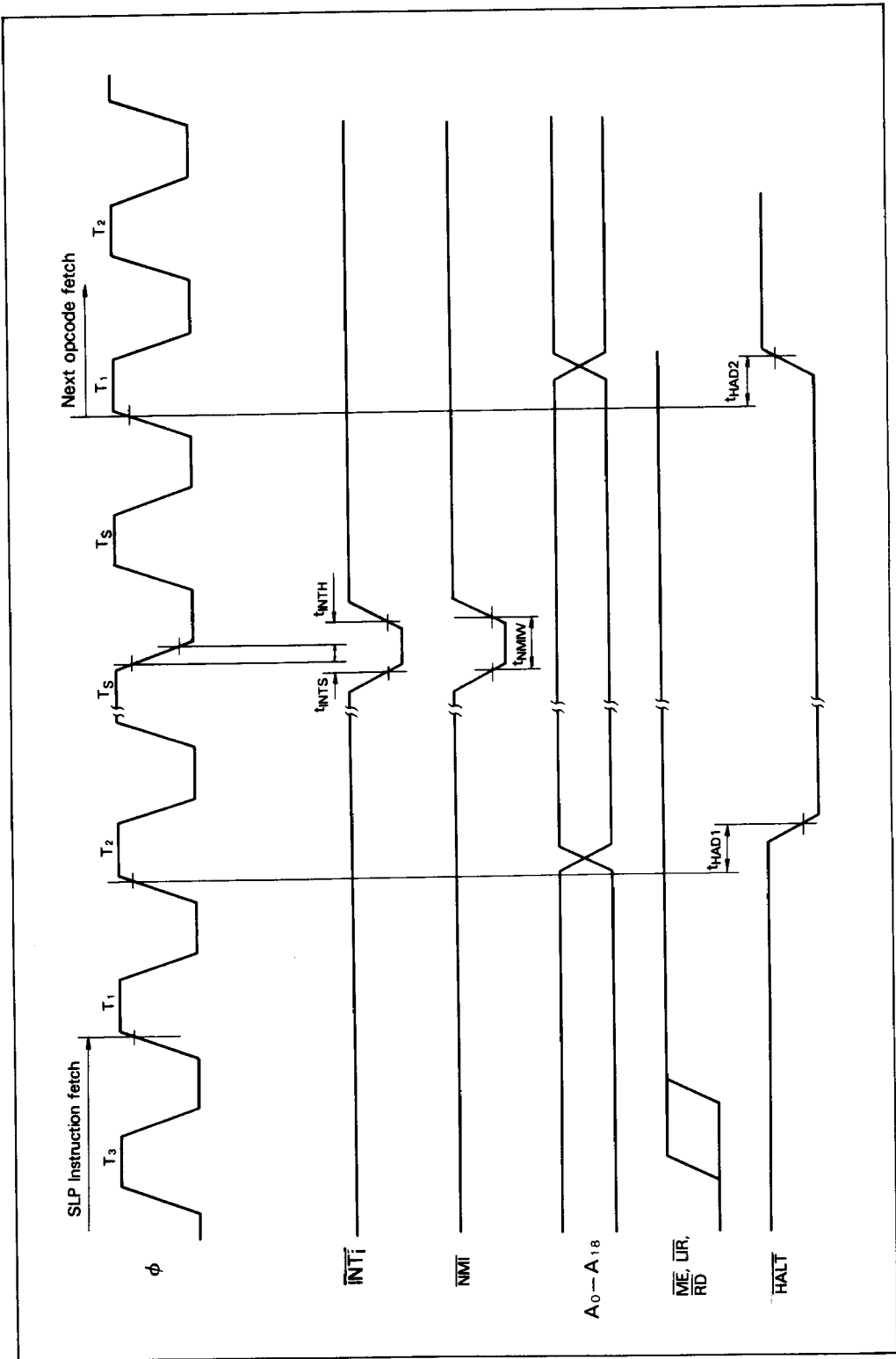


Figure 23-9. SLP Execution Cycle

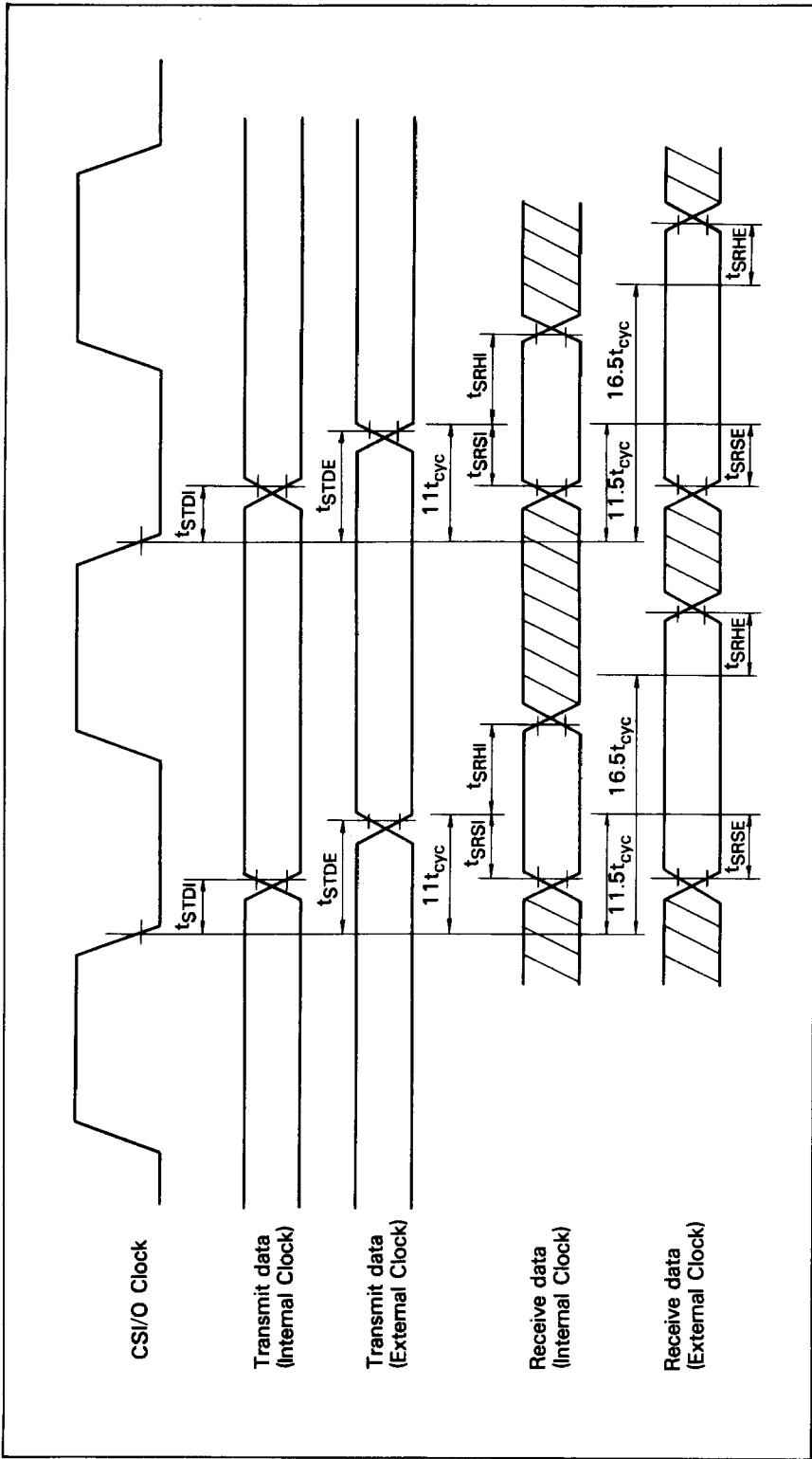


Figure 23-10. CSI/O Receive/Transmit Timing

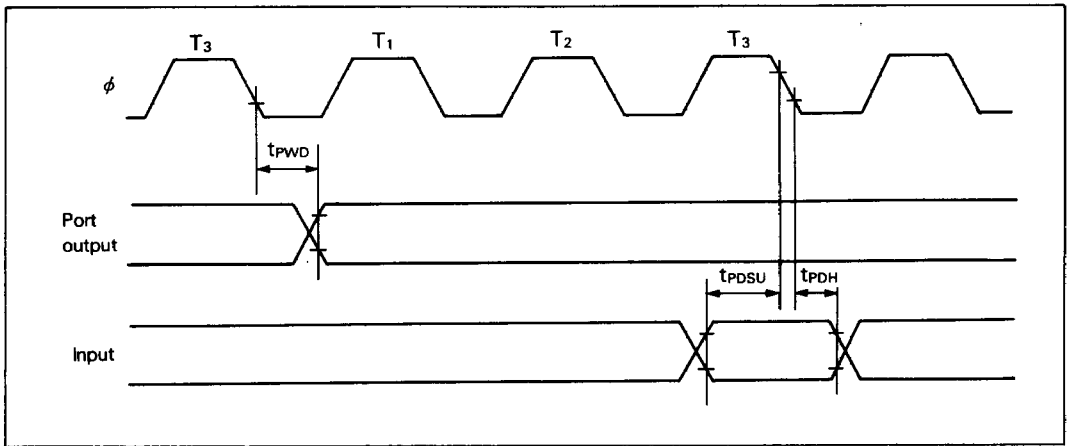


Figure 23-11. Port Input and Output Timing

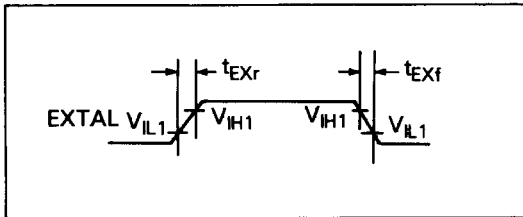


Figure 23-12. External Clock Rise Time and Fall Time

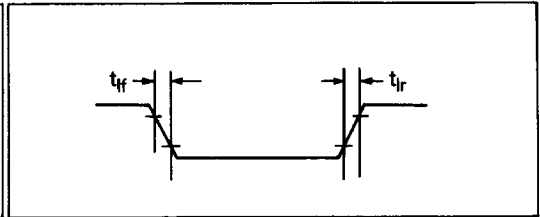


Figure 23-13. Input Rise Time and Fall Time (Except EXTAL, RESET)

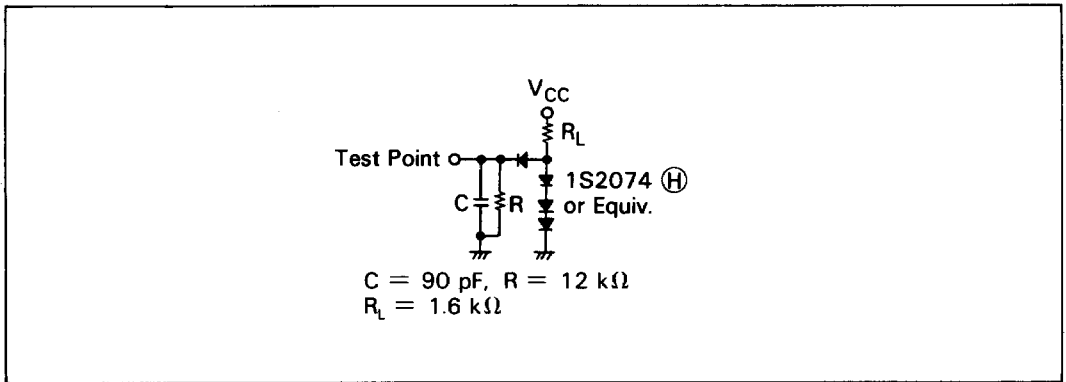


Figure 23-14. Bus Timing Test Load (TTL Load)

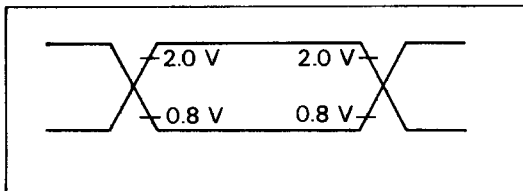


Figure 23-15. Reference Level (Input)

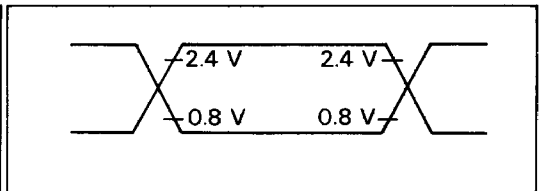


Figure 23-16. Reference Level (Output)