

OKI Semiconductor

MSM51V4400/L/SL

1,048,576-Word × 4-Bit DYNAMIC RAM : FAST PAGE MODE TYPE

DESCRIPTION

The MSM51V4400/L/SL is a 1,048,576-word × 4-bit dynamic RAM fabricated in OKI's CMOS silicon gate technology. The MSM51V4400/L/SL achieves high integration, high-speed operation, and low-power consumption due to quadruple polysilicon single metal CMOS. The MSM51V4400/L/SL is available in a 26/20-pin plastic SOJ or 26/20-pin plastic TSOP. The MSM51V4400L (the low-power version) and the MSM51V4400SL (the self-refresh version) are specially designed for lower-power applications.

FEATURES

- 1,048,576-word × 4-bit configuration
- Single 3.3 V power supply, ± 0.3 V tolerance
- Input : LVTTTL compatible, low input capacitance
- Output : LVTTTL compatible, 3-state
- Refresh : 1024 cycles/16 ms, 1024 cycles/128 ms (L/SL version)
- Fast page mode, read modify write capability
- $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh, hidden refresh, $\overline{\text{RAS}}$ -only refresh capability
- Multi-bit test mode capability
- $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ self-refresh capability (SL version)
- Package options:

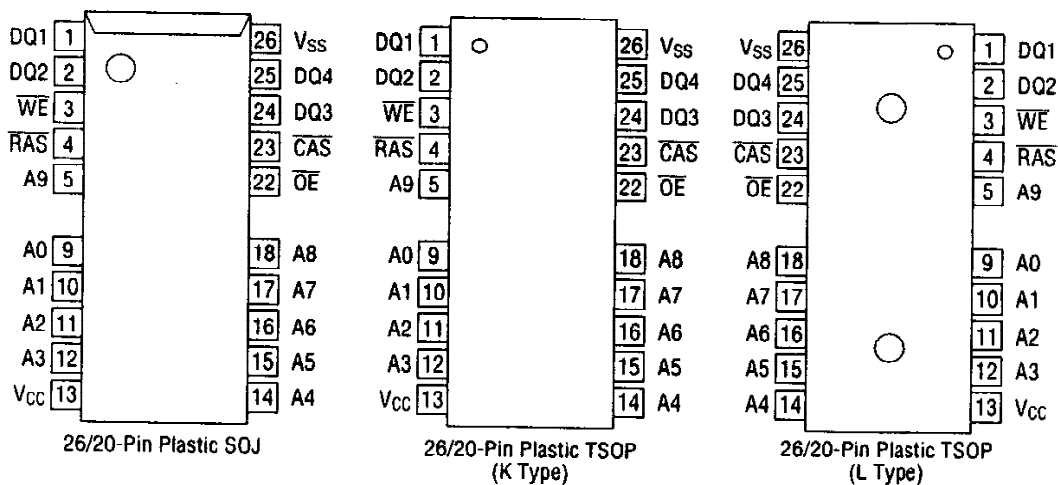
26/20-Pin 300 mil plastic SOJ	(SOJ26/20-P-300)	(Product : MSM51V4400/L/SL-xxSJ)
26/20-Pin 300 mil plastic TSOP	(TSOP26/20-P-300-K)	(Product : MSM51V4400/L/SL-xxTS-K)
	(TSOP26/20-P-300-L)	(Product : MSM51V4400/L/SL-xxTS-L)

 xx indicates speed rank.

PRODUCT FAMILY

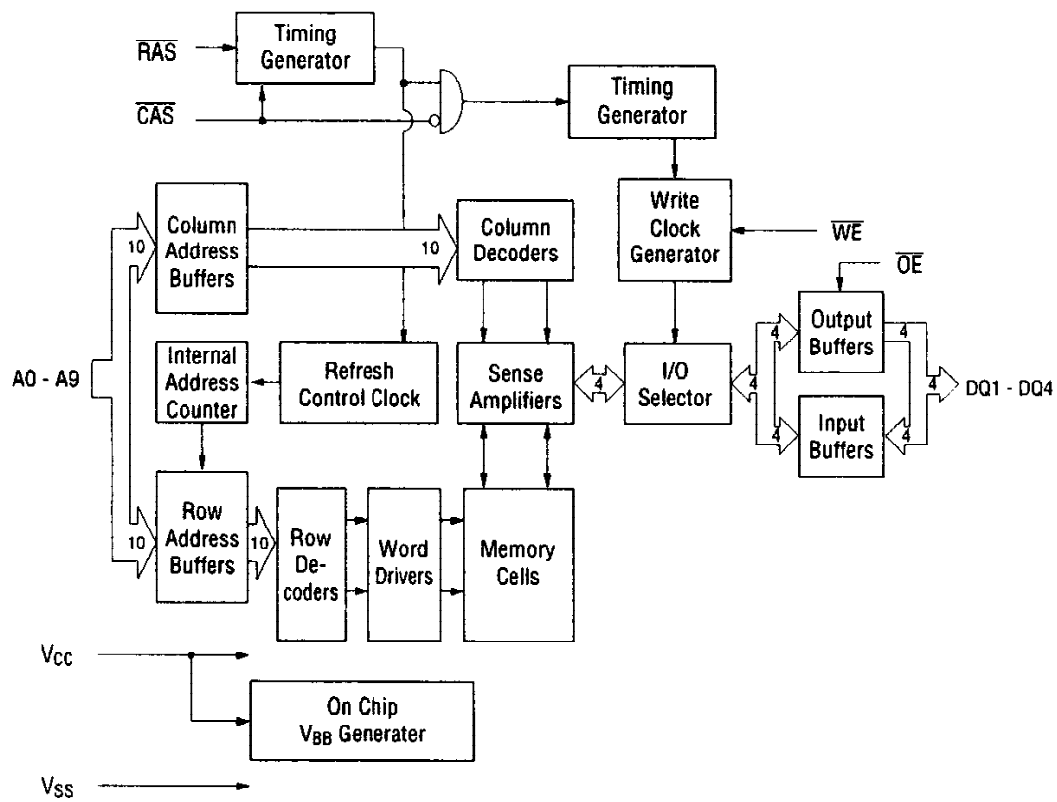
Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t_{RAC}	t_{AA}	t_{CAC}	t_{OEA}		Operating (Max.)	Standby (Max.)
MSM51V4400/L/SL-60	60 ns	30 ns	15 ns	15 ns	110 ns	252 mW	1.8 mW/ 0.54 mW (L/SL version)
MSM51V4400/L/SL-70	70 ns	35 ns	20 ns	20 ns	130 ns	234 mW	
MSM51V4400/L/SL-80	80 ns	40 ns	20 ns	20 ns	150 ns	216 mW	
MSM51V4400/L/SL-10	100 ns	50 ns	25 ns	25 ns	180 ns	198 mW	

PIN CONFIGURATION (TOP VIEW)



Pin Name	Function
A0 - A9	Address Input
RAS	Row Address Strobe
CAS	Column Address Strobe
DQ1 - DQ4	Data Input/Data Output
OE	Output Enable
WE	Write Enable
Vcc	Power Supply (3.3 V)
Vss	Ground (0 V)

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS**Absolute Maximum Ratings**

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to V_{SS}	V_I	-0.5 to 4.6	V
Short Circuit Output Current	I_{OS}	50	mA
Power Dissipation	P_D^*	1	W
Operating Temperature	T_{opr}	0 to 70	°C
Storage Temperature	T_{stg}	-55 to 150	°C

*: $T_a = 25^\circ\text{C}$ **Recommended Operating Conditions** $(T_a = 0^\circ\text{C to } 70^\circ\text{C})$

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	3.0	3.3	3.6	V
	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.0	—	$V_{CC} + 0.3$	V
Input Low Voltage	V_{IL}	-0.3	—	0.8	V

Capacitance $(V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, T_a = 25^\circ\text{C}, f = 1 \text{ MHz})$

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 - A9)	C_{IN1}	—	6	pF
Input Capacitance (RAS, CAS, WE, OE)	C_{IN2}	—	7	pF
Output Capacitance (DQ1 - DQ4)	$C_{I/O}$	—	7	pF

DC Characteristics

($V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$, $T_a = 0^\circ\text{C}$ to 70°C)

Parameter	Symbol	Condition	MSM51V4400 /L/SL-60		MSM51V4400 /L/SL-70		MSM51V4400 /L/SL-80		MSM51V4400 /L/SL-10		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Output High Voltage	V_{OH}	$I_{OH} = -2.0 \text{ mA}$	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Low Voltage	V_{OL}	$I_{OL} = 2.0 \text{ mA}$	0	0.4	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	I_{LI}	$0 \text{ V} \leq V_i \leq V_{CC} + 0.3 \text{ V}$, All other pins not under test = 0 V	-10	10	-10	10	-10	10	-10	10	μA	
Output Leakage Current	I_{LO}	DQ disable $0 \text{ V} \leq V_o \leq V_{CC}$	-10	10	-10	10	-10	10	-10	10	μA	
Average Power Supply Current (Operating)	I_{CC1}	$\overline{\text{RAS}}$, $\overline{\text{CAS}}$ cycling, $t_{RC} = \text{Min.}$	—	70	—	65	—	60	—	55	mA	1, 2
Power Supply Current (Standby)	I_{CC2}	$\overline{\text{RAS}}, \overline{\text{CAS}} = V_{IH}$	—	2	—	2	—	2	—	2	mA	1
		$\overline{\text{RAS}}, \overline{\text{CAS}}$ $\geq V_{CC} - 0.2 \text{ V}$	—	0.5	—	0.5	—	0.5	—	0.5	μA	1, 5
			—	150	—	150	—	150	—	150	μA	
Average Power Supply Current (RAS-only Refresh)	I_{CC3}	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}} = V_{IH}$, $t_{RC} = \text{Min.}$	—	70	—	65	—	60	—	55	mA	1, 2
Power Supply Current (Standby)	I_{CC5}	$\overline{\text{RAS}} = V_{IH}$, $\overline{\text{CAS}} = V_{IL}$, DQ = enable	—	2	—	2	—	2	—	2	mA	1
Average Power Supply Current (CAS before RAS Refresh)	I_{CC6}	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$	—	70	—	65	—	60	—	55	mA	1, 2
Average Power Supply Current (Fast Page Mode)	I_{CC7}	$\overline{\text{RAS}} = V_{IL}$, $\overline{\text{CAS}}$ cycling, $t_{PC} = \text{Min.}$	—	55	—	50	—	45	—	40	mA	1, 3
Average Power Supply Current (Battery Backup)	I_{CC10}	$t_{RC} = 125 \mu\text{s}$, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$, $t_{RAS} \leq 1 \mu\text{s}$	—	250	—	250	—	250	—	250	μA	1, 2, 4, 5
Average Power Supply Current (CAS before RAS Self-Refresh)	I_{CC5}	$\overline{\text{RAS}} \leq 0.2 \text{ V}$ $\overline{\text{CAS}} \leq 0.2 \text{ V}$	—	200	—	200	—	200	—	200	μA	1, 5

- Notes :
1. I_{CC} Max. is specified as I_{CC} for output open condition.
 2. Address can be changed once or less while $\overline{\text{RAS}} = V_{IL}$.
 3. Address can be changed once or less while $\overline{\text{CAS}} = V_{IH}$.
 4. $V_{CC} - 0.2 \text{ V} \leq V_{IH} \leq 4.6 \text{ V}$, $-0.3 \text{ V} \leq V_{IL} \leq 0.2 \text{ V}$.
 5. L/SL version.

AC Characteristics (1/2)

(V_{CC} = 3.3 V ± 0.3 V, T_a = 0°C to 70°C) Note 1, 2, 3, 11, 12

Parameter	Symbol	MSM51V4400 /L/SL-60		MSM51V4400 /L/SL-70		MSM51V4400 /L/SL-80		MSM51V4400 /L/SL-10		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t _{RC}	110	—	130	—	150	—	180	—	ns	
Read Modify Write Cycle Time	t _{RWC}	150	—	180	—	200	—	240	—	ns	
Fast Page Mode Cycle Time	t _{PC}	40	—	45	—	50	—	60	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t _{PRWC}	80	—	95	—	100	—	120	—	ns	
Access Time from RAS	t _{RAC}	—	60	—	70	—	80	—	100	ns	4, 5, 6
Access Time from $\overline{\text{CAS}}$	t _{CAC}	—	15	—	20	—	20	—	25	ns	4, 5
Access Time from Column Address	t _{AA}	—	30	—	35	—	40	—	50	ns	4, 6
Access Time from $\overline{\text{CAS}}$ Precharge	t _{CPA}	—	35	—	40	—	45	—	55	ns	4
Access Time from $\overline{\text{OE}}$	t _{OEa}	—	15	—	20	—	20	—	25	ns	4
Output Low Impedance Time from $\overline{\text{CAS}}$	t _{CLZ}	0	—	0	—	0	—	0	—	ns	4
$\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time	t _{OFF}	0	15	0	20	0	20	0	25	ns	7
$\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time	t _{OEZ}	0	15	0	20	0	20	0	25	ns	7
Transition Time	t _T	3	50	3	50	3	50	3	50	ns	3
Refresh Period	t _{REF}	—	16	—	16	—	16	—	16	ms	
Refresh Period (L/SL version)	t _{REF}	—	128	—	128	—	128	—	128	ms	
RAS Precharge Time	t _{RP}	40	—	50	—	60	—	70	—	ns	
RAS Pulse Width	t _{RAS}	60	10,000	70	10,000	80	10,000	100	10,000	ns	
RAS Pulse Width (Fast Page Mode)	t _{RASP}	60	100,000	70	100,000	80	100,000	100	100,000	ns	
RAS Hold Time	t _{RSH}	15	—	20	—	20	—	25	—	ns	
RAS Hold Time referenced to $\overline{\text{OE}}$	t _{ROH}	15	—	20	—	20	—	25	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Fast Page Mode)	t _{CP}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Pulse Width	t _{CAS}	15	10,000	20	10,000	20	10,000	25	10,000	ns	
$\overline{\text{CAS}}$ Hold Time	t _{CSH}	60	—	70	—	80	—	100	—	ns	
$\overline{\text{CAS}}$ to RAS Precharge Time	t _{CRP}	5	—	5	—	5	—	5	—	ns	
$\overline{\text{CAS}}$ to RAS Precharge Time	t _{RHCP}	35	—	40	—	45	—	50	—	ns	
RAS to $\overline{\text{CAS}}$ Delay Time	t _{RCD}	20	45	20	50	20	60	25	75	ns	5
RAS to Column Address Delay Time	t _{RAD}	15	30	15	35	15	40	20	50	ns	6
Row Address Set-up Time	t _{ASR}	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t _{RAH}	10	—	10	—	10	—	15	—	ns	
Column Address Set-up Time	t _{ASC}	0	—	0	—	0	—	0	—	ns	
Column Address Hold Time	t _{CAH}	15	—	15	—	15	—	20	—	ns	
Column Address Hold Time from RAS	t _{AR}	50	—	55	—	60	—	75	—	ns	
Column Address to RAS Lead Time	t _{RAL}	30	—	35	—	40	—	50	—	ns	

AC Characteristics (2/2)

(V_{CC} = 3.3 V ±0.3 V, T_a = 0°C to 70°C) Note 1, 2, 3, 11, 12

Parameter	Symbol	MSM51V4400 /L/SL-60		MSM51V4400 /L/SL-70		MSM51V4400 /L/SL-80		MSM51V4400 /L/SL-10		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Read Command Set-up Time	t _{RCS}	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time	t _{RCH}	0	—	0	—	0	—	0	—	ns	8
Read Command Hold Time referenced to $\overline{\text{RAS}}$	t _{RRH}	0	—	0	—	0	—	0	—	ns	8
Write Command Set-up Time	t _{WCS}	0	—	0	—	0	—	0	—	ns	9
Write Command Hold Time	t _{WCH}	10	—	10	—	10	—	15	—	ns	
Write Command Hold Time from $\overline{\text{RAS}}$	t _{WCR}	45	—	50	—	60	—	75	—	ns	
Write Command Pulse Width	t _{WP}	10	—	10	—	10	—	15	—	ns	
$\overline{\text{OE}}$ Command Hold Time	t _{OEH}	15	—	20	—	20	—	25	—	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t _{RWL}	15	—	20	—	20	—	25	—	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t _{CWL}	15	—	20	—	20	—	25	—	ns	
Data-in Set-up Time	t _{DS}	0	—	0	—	0	—	0	—	ns	10
Data-in Hold Time	t _{DH}	15	—	15	—	15	—	20	—	ns	10
Data-in Hold Time from $\overline{\text{RAS}}$	t _{DHR}	50	—	55	—	60	—	75	—	ns	
$\overline{\text{OE}}$ to Data-in Delay Time	t _{OED}	15	—	20	—	20	—	25	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{CWD}	35	—	45	—	45	—	55	—	ns	9
Column Address to $\overline{\text{WE}}$ Delay Time	t _{AWD}	50	—	60	—	65	—	80	—	ns	9
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{RWD}	80	—	95	—	105	—	130	—	ns	9
$\overline{\text{CAS}}$ Precharge $\overline{\text{WE}}$ Delay Time	t _{CPWD}	60	—	70	—	75	—	85	—	ns	9
$\overline{\text{CAS}}$ Active Delay Time from $\overline{\text{RAS}}$ Precharge	t _{RPC}	5	—	5	—	5	—	5	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Set-up Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CSR}	5	—	5	—	5	—	5	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Hold Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CHR}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Refresh Counter Test)	t _{CPT}	30	—	35	—	40	—	50	—	ns	
$\overline{\text{WE}}$ to $\overline{\text{RAS}}$ Precharge Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{WRP}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{WE}}$ Hold Time from $\overline{\text{RAS}}$ ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{WRH}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Set-up Time (Test Mode)	t _{WTS}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Hold Time (Test Mode)	t _{WTH}	10	—	10	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ Pulse Width ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)	t _{RASS}	100	—	100	—	100	—	100	—	μs	13
$\overline{\text{RAS}}$ Precharge Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)	t _{RPS}	110	—	130	—	150	—	180	—	ns	13
$\overline{\text{CAS}}$ Hold Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)	t _{CHS}	40	—	50	—	60	—	70	—	ns	13

- Notes:
1. A start-up delay of 200 μ s is required after power-up, followed by a minimum of eight initialization cycles ($\overline{\text{RAS}}$ -only refresh or $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh) before proper device operation is achieved.
 2. The AC characteristics assume $t_T = 5$ ns.
 3. V_{IH} (Min.) and V_{IL} (Max.) are reference levels for measuring input timing signals. Transition times (t_T) are measured between V_{IH} and V_{IL} .
 4. This parameter is measured with a load circuit equivalent to 1 TTL load and 100 pF. Output timing reference levels are $V_{OH} = 2.0$ V and $V_{OL} = 0.8$ V.
 5. Operation within the t_{RCD} (Max.) limit ensures that t_{RAC} (Max.) can be met. t_{RCD} (Max.) is specified as a reference point only. If t_{RCD} is greater than the specified t_{RCD} (Max.) limit, access time is controlled by t_{CAC} .
 6. Operation within the t_{RAD} (Max.) limit ensures that t_{RAC} (Max.) can be met. t_{RAD} (Max.) is specified as a reference point only. If t_{RAD} is greater than the specified t_{RAD} (Max.) limit, access time is controlled by t_{AA} .
 7. t_{OFF} (Max.) and t_{OEZ} (Max.) define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
 8. t_{RCH} or t_{RRH} must be satisfied for a read cycle.
 9. t_{WCS} , t_{CWD} , t_{RWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}$ (Min.), the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$ (Min.), $t_{RWD} \geq t_{RWD}$ (Min.), $t_{AWD} \geq t_{AWD}$ (Min.) and $t_{CPWD} \geq t_{CPWD}$ (Min.), the cycle is a read modify write cycle and data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
 10. These parameters are referenced to $\overline{\text{CAS}}$ leading edge in an early write cycle, and to $\overline{\text{WE}}$ leading edge in an $\overline{\text{OE}}$ control write cycle or a read modify write cycle.
 11. The test mode is initiated by performing a $\overline{\text{WE}}$ and $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycle. This mode is latched and remains in effect until the exit cycle is generated. The test mode specified in this data sheet is a 2-bit parallel test function. CA0 is not used. In a read cycle, if all internal bits are equal, the DQ pin will indicate a high level. If any internal bits are not equal, the DQ pin will indicate a low level. The test mode is cleared and the memory device returned to its normal operating state by performing a RAS-only refresh cycle or a $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycle.
 12. In a test mode read cycle, the value of access time parameters is delayed for 5 ns for the specified value. These parameters should be specified in test mode cycle by adding the above value to the specified value in this data sheet.
 13. Only SL version.

See ADDENDUM K for AC Timing Waveforms