PRELIMINARY

KM428C256 CMOS VIDEO RAM

256K×8 Bit CMOS Video RAM

FEATURES

- **Dual Port Architecture**
  256K x 8 bits RAM port
  512 x 8 bits SAM port
- **Performance range:**

Parameter \ Speed	-6	-8	-10
RAM access time (t_{RAC})	60ns	80ns	100ns
RAM access time (t_{CAC})	20ns	20ns	25ns
RAM cycle time (t_{RC})	120ns	150ns	180ns
RAM page mode cycle (t_{PC})	40ns	50ns	60ns
SAM access time (t_{SCA})	15ns	20ns	25ns
SAM cycle time (t_{SCC})	18ns	25ns	30ns
RAM active current	100mA	80mA	70mA
SAM active current	50mA	40mA	35mA

- **Fast Page Mode**
- **RAM Read, Write, Read-Modify-Write**
- **Serial Read and Serial Write**
- **Read Real Time Read and Split Read Transfer (RAM→SAM)**
- **Write, Split Write Transfer with Masking operation (NEW MASK)**
- **Block Write, Flash Write and Write per bit with Masking operation (NEW MASK)**
- **$\overline{CAS}$-before-$\overline{RAS}$, $\overline{RAS}$-only and Hidden Refresh**
- **Common Data I/O Using three state RAM Output Control**
- **All Inputs and Outputs TTL and CMOS Compatible**
- **Refresh: 512 Cycles/8ms**
- **Single +5V ± 10% Supply Voltage**
- **Plastic 40-Pin 400 mil SOJ and 475 mil ZIP**
  40/44-Pin Plastic TSOP (Type II)

GENERAL DESCRIPTION

The Samsung KM428C256 is a CMOS 256K x 8 bit Dual Port DRAM. It consists of a 256K x 8 dynamic random access memory (RAM) port and 512 x 8 static serial access memory (SAM) port. The RAM and SAM ports operate asynchronously except during data transfer between the ports.

The RAM array consists of 512 bit rows of 4096 bits. It operates like a conventional 256K x 8 CMOS DRAM. The RAM port has a write per bit mask capability.

The SAM port consists of eight 512 bit high speed shift registers that are connected to the RAM array through a 4096 bit data transfer gate. The SAM port has serial read and write capabilities.

Data may be internally transferred bi-directionally between the RAM and SAM ports using read or write transfers.

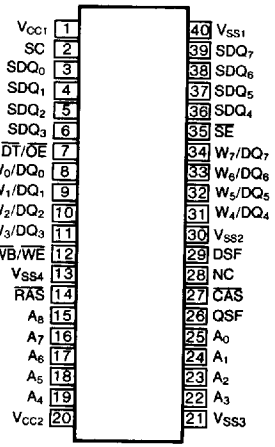
Refresh is accomplished by familiar DRAM refresh modes. The KM428C256 supports $\overline{RAS}$-only, Hidden, and $\overline{CAS}$-before-$\overline{RAS}$ refresh for the RAM port. The SAM port does not require refresh.

All inputs and I/O's are TTL and CMOS level compatible. All address lines and Data Inputs are latched on chip to simplify system design. The outputs are unlatched to allow greater system flexibiliy.

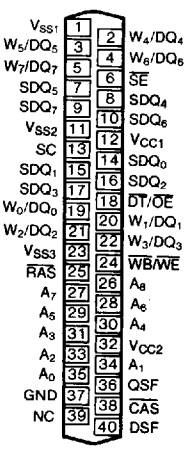
Pin Name	Pin Function
SC	Serial Clock
SDQ_0-SDQ_7	Serial Data Input/Output
$\overline{DT}/\overline{OE}$	Data Transfer/Output Enable
$\overline{WB}/\overline{WE}$	Write Per Bit/Write Enable
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
DSF	Special Function Control
W_0/DQ_0 – W_7/DQ_7	Data Write Mask/Input/Output
$\overline{SE}$	Serial Enable
A_0-A_8	Address Inputs
QSF	Special Flag Output
V_{CC}	Power (+5V)
V_{SS}	Ground
N.C.	No Connection

PIN CONFIGURATION (Top Views)

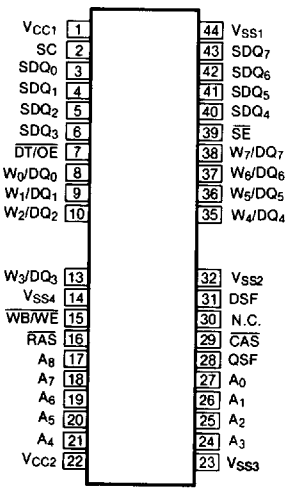
40 Pin 400 mil SOJ



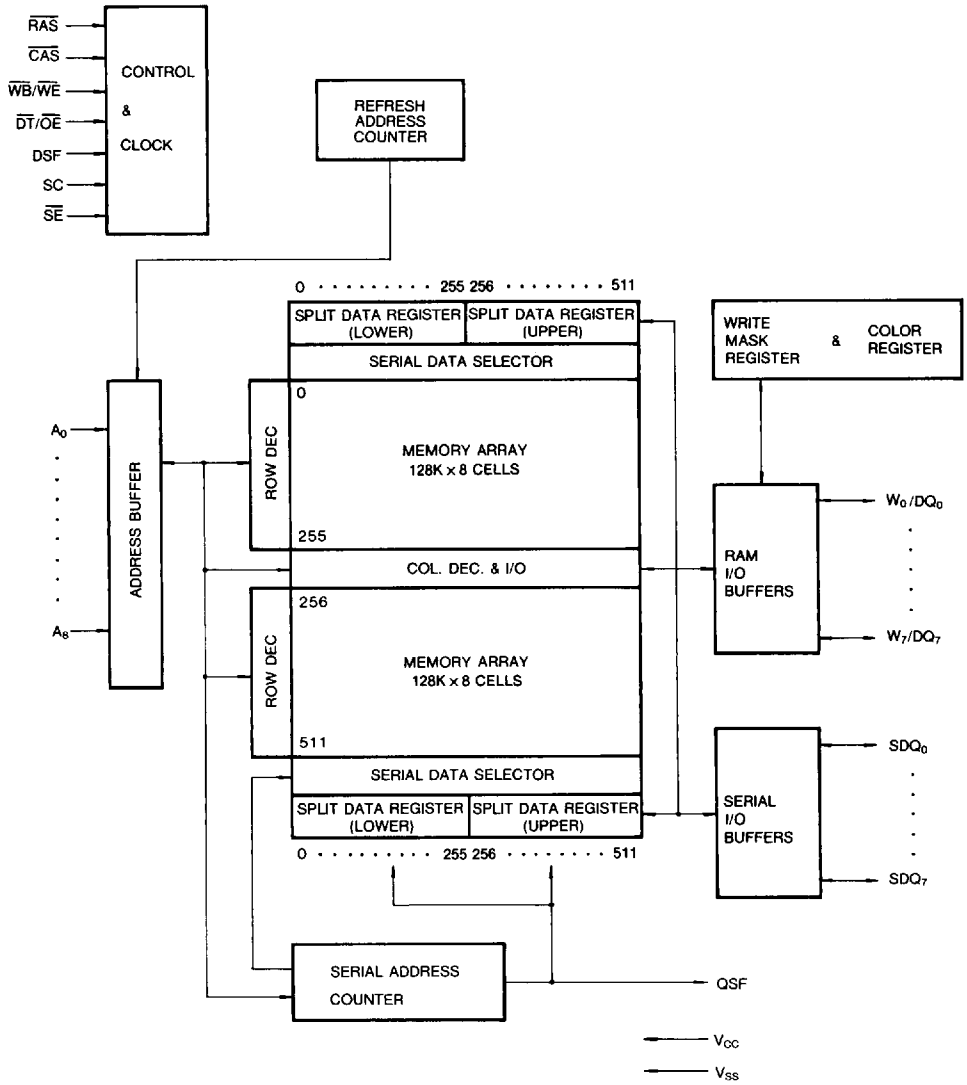
40 Pin 475 mil ZIP



40/44 Pin 400 mil TSOP II



FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS*

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to V_{SS}	V_{IN}, V_{OUT}	−1 to +7.0	V
Voltage on V_{CC} Supply Relative to V_{SS}	V_{CC}	−1 to +7.0	V
Storage Temperature	T_{stg}	−55 to +150	°C
Power Dissipation	P_D	1	W
Short Circuit Output Current	I_{OS}	50	mA

* Permanent device damage may occur if "ABSOLUTE MAXIMUM RATINGS" are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS (Voltage reference to V_{SS}, T_A = 0 to 70°C)

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
Ground	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.4	—	6.5	V
Input Low Voltage	V_{IL}	−1.0	—	0.8	V

DC AND OPERATING CHARACTERISTICS

(Recommended operating conditions unless otherwise noted)

Parameter (RAM Port)	SAM Port	Symbol	KM428C256			Unit
			−6	−8	−10	
Operating Current* ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC1}	100	80	70	mA
	Active	I_{CC1} A	130	120	110	mA
Standby Current ($\overline{RAS}$ = $\overline{CAS}$ = V_{IH})	Standby	I_{CC2}	10	10	10	mA
	Active	I_{CC2} A	50	40	35	mA
$\overline{RAS}$ Only Refresh Current* ($\overline{CAS}$ = V_{IH}, $\overline{RAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC3}	90	80	70	mA
	Active	I_{CC3} A	130	120	110	mA
Fast Page Mode Current* ($\overline{RAS}$ = V_{IL}, $\overline{CAS}$ Cycling @t_{PC} = min.)	Standby	I_{CC4}	70	60	50	mA
	Active	I_{CC4} A	110	100	90	mA
$\overline{CAS}$-Before-$\overline{RAS}$ Refresh Current* ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC5}	90	80	70	mA
	Active	I_{CC5} A	130	120	110	mA
Data Transfer Current* ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC6}	120	110	100	mA
	Active	I_{CC6} A	160	150	140	mA
Flash Write Cycle ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC7}	90	80	70	mA
	Active	I_{CC7} A	130	120	110	mA
Block Write Cycle ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC8}	100	90	80	mA
	Active	I_{CC8} A	140	130	120	mA
Color Register Load or Read Cycle ($\overline{RAS}$ and $\overline{CAS}$ Cycling @t_{RC} = min.)	Standby	I_{CC9}	90	80	70	mA
	Active	I_{CC9} A	130	120	110	mA

* NOTE: Real values are dependent on output loading and cycle rates. Specified values are obtained with the output open. I_{CC} is specified as average current.

INPUT/OUTPUT CURRENT (Recommended operating conditions unless otherwise noted.)

Item	Symbol	Min	Max	Unit
Input Leakage Current (Any Input $0 \leq V_{IN} \leq 6.5V$, all other pins not under test = 0 volts.)	I_{IL}	−10	10	μA
Output Leakage Current (Data out is disabled, $0V \leq V_{OUT} \leq 6.5V$)	I_{OL}	−10	10	μA
Output High Voltage Level (RAM $I_{OH} = -2mA$, SAM $I_{OH} = -2mA$)	V_{OH}	2.4	—	V
Output Low Voltage Level (RAM $I_{OL} = 2mA$, SAM $I_{OL} = 2mA$)	V_{OL}	—	0.4	V

CAPACITANCE ($T_A = 25°C$)

Item	Symbol	Min	Max	Unit
Input Capacitance (A_0-A_8)	C_{IN1}	—	6	pF
Input Capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WB/WE}$, $\overline{DT/OE}$, $\overline{SE}$, SC, DSF)	C_{IN2}	—	7	pF
Input/Output Capacitance (W_0/DQ_0-W_7/DQ_7)	C_{DQ}	—	7	pF
Input/Output Capacitance (SDQ_0-SDQ_7)	C_{SDQ}	—	7	pF
Output Capacitance (QSF)	C_{OSF}	—	7	pF

AC CHARACTERISTICS ($0°C \leq T_A \leq 70°C$, $V_{CC} = 5.0V \pm 10\%$. See notes 1, 2)

Parameter	Symbol	KM428C256-6		KM428C256-8		KM428C256-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	120		150		180		ns	
Read-modify-write cycle time	t_{RWC}	170		205		245		ns	
Fast page mode cycle time	t_{PC}	40		50		60		ns	
Fast page mode read-modify-write	t_{PRWC}	95		105		125		ns	
Access time from $\overline{RAS}$	t_{RAC}		60		80		100	ns	3,4
Access time from $\overline{CAS}$	t_{CAC}		20		20		25	ns	4
Access time from column address	t_{AA}		30		40		50	ns	3,11
Access time from $\overline{CAS}$ precharge	t_{CPA}		35		45		55	ns	3
$\overline{CAS}$ to output in Low-Z	t_{CLZ}	5		5		5		ns	3
Output buffer turn-off delay	t_{OFF}	0	25	0	25	0	30	ns	7
Transition time (rise and fall)	t_T	3	50	3	50	3	50	ns	2
$\overline{RAS}$ precharge time	t_{RP}	50		60		70		ns	
$\overline{RAS}$ pulse width	t_{RAS}	60	10,000	80	10,000	100	10,000	ns	
$\overline{RAS}$ pulse width (Fast page mode)	t_{RASP}	60	100,000	80	100,000	100	100,000	ns	
$\overline{RAS}$ hold time	t_{RSH}	20		20		25		ns	
$\overline{CAS}$ hold time	t_{CSH}	60		80		100		ns	
$\overline{CAS}$ pulse width	t_{CAS}	20	10,000	20	10,000	25	10,000	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	20	40	25	55	25	75	ns	5,6
$\overline{RAS}$ to column address delay time	t_{RAD}	15	30	20	40	20	50	ns	11

AC CHARACTERISTICS (Continued)

Parameter	Symbol	KM428C256-6		KM428C256-8		KM428C256-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	5		5		5		ns	
$\overline{CAS}$ precharge time	t_{CPN}	10		10		15		ns	
$\overline{CAS}$ precharge time (Fast page)	t_{CP}	10		10		15		ns	
Row address set-up time	t_{ASR}	0		0		0		ns	
Row address hold time	t_{RAH}	10		15		15		ns	
Column address set-up time	t_{ASC}	0		0		0		ns	
Column address hold time	t_{CAH}	15		15		20		ns	
Column address hold referenced to $\overline{RAS}$	t_{AR}	55		65		75		ns	
Column address to $\overline{RAS}$ lead time	t_{RAL}	30		40		50		ns	
Read command set-up time	t_{RCS}	0		0		0		ns	
Read command hold referenced to $\overline{CAS}$	t_{RCH}	0		0		0		ns	9
Read command hold referenced to $\overline{RAS}$	t_{RRH}	0		0		0		ns	9
Write command hold time	t_{WCH}	15		15		20		ns	
Write command hold referenced to $\overline{RAS}$	t_{WCR}	55		65		75		ns	
Write command pulse width	t_{WP}	15		15		20		ns	
Write command to $\overline{RAS}$ lead time	t_{RWL}	20		20		25		ns	
Write command to $\overline{CAS}$ lead time	t_{CWL}	20		20		25		ns	
Data-in set-up time	t_{DS}	0		0		0		ns	10
Data hold time	t_{DH}	15		15		20		ns	10
Data hold referenced to $\overline{RAS}$	t_{DHR}	55		65		75		ns	
Write command set-up time	t_{WCS}	0		0		0		ns	8
$\overline{CAS}$ to $\overline{WE}$ delay	t_{CWD}	50		50		60		ns	8
$\overline{RAS}$ to $\overline{WE}$ delay	t_{RWD}	90		110		135		ns	8
Column address to $\overline{WE}$ delay time	t_{AWD}	60		70		85		ns	8
$\overline{CAS}$ set-up time ($\overline{C}$-B-$\overline{R}$ refresh)	t_{CSR}	10		10		10		ns	
$\overline{CAS}$ hold time ($\overline{C}$-B-$\overline{R}$ refresh)	t_{CHR}	15		15		20		ns	
$\overline{RAS}$ precharge to $\overline{CAS}$ hold time	t_{RPC}	0		0		0		ns	
$\overline{RAS}$ hold time referenced to $\overline{OE}$	t_{ROH}	20		20		20		ns	
Access time from output enable	t_{OEA}		20		20		25	ns	
Output enable to data input delay	t_{OED}	15		15		20		ns	
Output buffer turnoff delay from $\overline{OE}$	t_{OEZ}	0	20	0	20	0	25	ns	7
Output enable command hold time	t_{OEH}	20		20		25		ns	
Data to $\overline{CAS}$ delay	t_{DZC}	0		0		0		ns	
Data to output enable delay	t_{DZO}	0		0		0		ns	
Refresh period (512 cycles)	t_{REF}		8		8		8	ms	
$\overline{WB}$ Set-up time	t_{WSR}	0		0		0		ns	
$\overline{WB}$ hold time	t_{RWH}	15		15		20		ns	
DSF set-up time referenced to $\overline{RAS}$ (I)	t_{FSR}	0		0		0		ns	

AC CHARACTERISTICS (Continued)

Parameter	Symbol	KM428C256-6		KM428C256-8		KM428C256-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
DSF hold time referenced to $\overline{RAS}$ (II)	t_{FHR}	55		65		75		ns	
DSF hold time referenced to $\overline{RAS}$	t_{RFH}	15		15		15		ns	
DSF set-up time referenced to $\overline{CAS}$	t_{FSC}	10		10		10		ns	
DSF hold time referenced to $\overline{CAS}$	t_{CFH}	15		15		15		ns	
Write per bit mask data set-up	t_{MS}	0		0		0		ns	
Write per bit mask data hold	t_{MH}	15		15		20		ns	
$\overline{DT}$ high set-up time	t_{THS}	0		0		0		ns	
$\overline{DT}$ high hold time	t_{THH}	15		15		15		ns	
$\overline{DT}$ low set-up time	t_{TLS}	0		0		0		ns	
$\overline{DT}$ low hold time	t_{TLH}	15		15		15		ns	
$\overline{DT}$ low hold ref to $\overline{RAS}$ (real time read transfer)	t_{RTH}	60		70		80		ns	
$\overline{DT}$ low hold ref to $\overline{CAS}$ (real time read transfer)	t_{CTH}	18		25		30		ns	
$\overline{DT}$ low hold ref to Col. Address (Real time read transfer)	t_{ATH}	25		30		35		ns	
$\overline{SE}$ set-up referenced to $\overline{RAS}$	t_{ESR}	0		0		0		ns	
$\overline{SE}$ hold time referenced to $\overline{RAS}$	t_{REH}	10		10		15		ns	
$\overline{DT}$ high to $\overline{RAS}$ precharge time	t_{TRP}	50		60		70		ns	
$\overline{DT}$ precharge time	t_{TP}	18		25		30		ns	
$\overline{RAS}$ to first SC delay (read transfer)	t_{RSD}	60		80		100		ns	
$\overline{CAS}$ to first SC delay (read transfer)	t_{CSD}	30		40		50		ns	
Col. Addr. to first SC delay (read transfer)	t_{ASD}	35		45		55		ns	
Last SC to $\overline{DT}$ lead time	t_{TSL}	5		5		5		ns	
$\overline{DT}$ to first SC delay (read transfer)	t_{TSD}	10		10		15		ns	
Last SC to $\overline{RAS}$ set-up (serial input)	t_{SRS}	18		25		30		ns	
$\overline{RAS}$ to first SC delay time (serial input)	t_{SRD}	18		25		30		ns	
$\overline{RAS}$ to serial input delay	t_{SDD}	30		40		50		ns	
Serial out buffer turn-off delay from $\overline{RAS}$ (pseudo write transfer)	t_{SDZ}	10	30	10	40	10	50	ns	7
Serial input to first SC delay	t_{SZS}	0		0		0		ns	
SC cycle time	t_{SCC}	18		25		30		ns	
SC pulse width (SC high time)	t_{SC}	7		10		10		ns	
SC precharge (SC low time)	t_{SCP}	7		10		10		ns	
Access time from SC	t_{SCA}		15		20		25	ns	4
Serial output hold time from SC	t_{SOH}	5		5		5		ns	
Serial input set-up time	t_{SDS}	0		0		0		ns	
Serial input hold time	t_{SDH}	15		15		20		ns	
Access time from $\overline{SE}$	t_{SEA}		15		20		25	ns	4

AC CHARACTERISTICS (Continued)

Parameter	Symbol	KM428C256-6		KM428C256-8		KM428C256-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
$\overline{SE}$ pulse width	t_{SE}	15		20		25		ns	
$\overline{SE}$ precharge time	t_{SEP}	15		20		25		ns	
Serial out buffer turn-off from $\overline{SE}$	t_{SEZ}	0	15	0	15	0	20	ns	7
Serial input to $\overline{SE}$ delay time	t_{SZE}	0		0		0		ns	
Serial write enable set-up	t_{SWS}	5		5		5		ns	
Serial write enable hold time	t_{SWH}	15		15		15		ns	
Serial write disable set-up time	t_{SWIS}	5		5		5		ns	
Serial write disable hold time	t_{SWIH}	15		15		15		ns	
Split transfer set-up time	t_{STS}	18		25		30		ns	
Split transfer hold time	t_{STH}	18		25		30		ns	
SC-QSF delay time	t_{SQD}		16		20		25	ns	
$\overline{DT}$-QSF delay time	t_{TQD}		16		20		25	ns	
$\overline{CAS}$-QSF delay time	t_{CQD}		35		40		50	ns	
$\overline{RAS}$-QSF delay time	t_{RQD}		60		80		100	ns	

NOTES

1. An initial pause of 200μs is required after power-up followed by any 8 $\overline{RAS}$, 8 SC cycles before proper device operation is achieved ($\overline{DT}/\overline{OE}$ = HIGH). If the internal refresh counter is used a minimum of 8 $\overline{CAS}$-before-$\overline{RAS}$ initialization cycles are required instead of 8 $\overline{RAS}$ cycles.
2. V_{IH}(min) and V_{IL}(max) are reference levels for measuring timing of input signals. Transition times are measured between V_{IH}(min) and V_{IL}(max) and are assumed to be 5ns for all inputs.
3. RAM port outputs are measured with a load equivalent to 2 TTL loads and 100pF.
4. SAM port outputs are measured with a load equivalent to 2 TTL loads and 30pF. D_{OUT} comparator level: V_{OH}/V_{OL} = 2.0/0.8V.
5. Operation within the t_{RCD}(max) limit insures 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, then access time is controlled exclusively by t_{CAC}.
6. Assumes that $t_{RCD} \geq t_{RCD}$(max).
7. The parameters, t_{OFF}(max), t_{OEZ}(max), t_{SDZ}(max) and t_{SEZ}(max), define the time at which the output achieves the open circuit condition and is not referenced to V_{OH} or V_{OL}.
8. t_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are non 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 output will remain high impedance for the duration of the cycle. If $t_{CWD} \geq t_{CWD}$(min) and $t_{RWD} \geq t_{RWD}$(min) and $t_{AWD} \geq t_{AWD}$(min), then the cycle is a read-write cycle and the data output will contain the data read from the selected address. If neither of the above conditions are satisfied, the condition of the data out is indeterminate.
9. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
10. These parameters are referenced to the $\overline{CAS}$ leading edge in early write cycles and to the $\overline{WE}$ leading edge in read-write cycles.
11. Operation within the t_{RAD}(max) limit insures that t_{RCD}(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, then access time is controlled by t_{AA}.

DEVICE OPERATIONS

The KM428C256 contains 2,097,152 memory locations. Eighteen address bits are required to address a particular 4-bit word in the memory array. Since the KM428C256 has only 9 address input pins, time multiplexed addressing is used to input 9 row and 9 column addresses. The multiplexing is controlled by the timing relationship between the row address strobe ($\overline{RAS}$), the column address strobe ($\overline{CAS}$) and the valid row and column address inputs.

Operation of the KM428C256 begins by strobing in a valid row address with $\overline{RAS}$ while $\overline{CAS}$ remains high. Then the address on the 9 address input pins is changed from a row address to a column address and is strobed in by $\overline{CAS}$. This is the beginning of any KM428C256 cycle in which a memory location is accessed. The specific type of cycle is determined by the state of the write enable pin and various timing relationships. The cycle is terminated when both $\overline{RAS}$ and $\overline{CAS}$ have returned to the high state. Another cycle can be initiated after $\overline{RAS}$ remains high long enough to satisfy the $\overline{RAS}$ precharge time (t_{RP}) requirement.

$\overline{RAS}$ and $\overline{CAS}$ Timing

The minimum $\overline{RAS}$ and $\overline{CAS}$ pulse widths are specified by t_{RAS}(min) and t_{CAS}(min) respectively. These minimum pulse widths must be satisfied for proper device operation and data integrity. Once a cycle is initiated by bringing $\overline{RAS}$ low, it must not be aborted prior to satisfying the minimum $\overline{RAS}$ and $\overline{CAS}$ pulse widths. In addition, a new cycle must not begin until the minimum $\overline{RAS}$ precharge time, t_{RP}, has been satisfied. Once a cycle begins, internal clocks and other circuits within the KM428C256 begin a complex sequence of events. If the sequence is broken by violating minimum timing requirements, loss of data integrity can occur.

Read

A read cycle is achieved by maintaining $\overline{WB/WE}$ high during a $\overline{RAS}/\overline{CAS}$ cycle. The access time is normally specified with respect to the falling edge of $\overline{RAS}$. But the access time also depends on the falling edge of $\overline{CAS}$ and on the valid column address transition. If $\overline{CAS}$ goes low before t_{RCD}(max) and if the column address is valid before t_{RAD}(max) then the access time to valid data is specified by t_{RAC}(min). However, if $\overline{CAS}$ goes low after t_{RCD}(max) or if the column address becomes valid after t_{RAD}(max), access is specified by t_{CAC} or t_{AA}.

The KM428C256 has common data I/O pins. The $\overline{DT/OE}$ has been provided so the output buffer can be precisely controlled. For data to appear at the outputs, $\overline{DT/OE}$ must be low for the period of time defined by t_{OEA}.

Write

The KM428C256 can perform early write and read-modify-write cycles. The differece between these cycles is in the state of data-out and is determined by the timing relationship between $\overline{WB/WE}$, $\overline{DT/OE}$ and $\overline{CAS}$. In any type of write cycle Data-in must be valid at or before the falling edge of $\overline{WB/WE}$ whichever is later.

Fast Page Mode

Fast page mode provides high speed read, write or read-modify-write access to all memory cells within a selected row. These cycles may be mixed in any order. A fast page mode cycle begins with a normal cycle. Then, while $\overline{RAS}$ is kept low to maintain the row address, $\overline{CAS}$ is cycled to strobe in additional column addresses. This eliminates the time required to set up and strobe sequential row addresses for the same page.

Write-Per-Bit

The write-per-bit function selectively controls the internal write-enable circuits of the RAM port. When $\overline{WB/WE}$ is held 'low' at the falling edge of $\overline{RAS}$, during a random access operation, the write-mask is enabled. At the same time, the mask data on the Wi/DQi pins is latched onto the write-mask register (WM1). When a '0' is sensed on any of the Wi/DQi pins, their corresponding write circuits are disabled and new data will not be written.

When a '1' is sensed on any of the Wi/DQi pins, their corresponding write circuits will remain enabled so that new data is written. The write mask data is valid for only one cycle the truth table of the write-per-bit function are shown in Table 2.

Table 2. Truth Table for Write-per-bit Function

$\overline{RAS}$	$\overline{CAS}$	$\overline{DT/OE}$	$\overline{WB/WE}$	Wi/DQi	FUNCTION
	H	H	H	*	WRITE ENABLE
	H	H	L	1	WRITE ENABLE
				0	WRITE MASK

DEVICE OPERATIONS (Continued)

Block Write

A block write cycle is performed by holding $\overline{CAS}$, $\overline{DT}$, $\overline{OE}$ "high" and DSF "Low" at the falling edge of $\overline{RAS}$ and by holding DSF "high" at the falling edge of $\overline{CAS}$. The state of the $\overline{WB}/\overline{WE}$ at the falling edge of $\overline{RAS}$ determines whether or not the I/O data mask is enabled as write perbit function. At the falling edge of $\overline{CAS}$, the starting column address pointer and column mask data must be provided. During a block write cycle, the 2 least significant column address (A0 and A1) are internally controlled and only the seven most significant column address (A2-A8) are latched at the falling edge of $\overline{CAS}$.

Flash Write

Flash write is mainly used for fast clear operations in frame buffer applications. A flash write cycle is performed by holding $\overline{CAS}$ "high," $\overline{WB}/\overline{WE}$ "low" and DSF "high" at the falling edge of $\overline{RAS}$. The mask data must also be provided on the Wi/DQi lines at the falling edge of $\overline{RAS}$ in order to enable the flash write operation for selected I/O blocks.

Data Output

The KM428C256 has a three-state output buffers which are controlled by $\overline{CAS}$ and $\overline{DT}/\overline{OE}$. When either $\overline{CAS}$ or $\overline{DT}/\overline{OE}$ is high (V_{IH}) the output is in the high impedance (Hi-Z) state. In any cycle in which valid data appears at the output the output goes into the low impedance state in a time specified by t_{CLZ} after the falling edge of $\overline{CAS}$. Invalid data may be presented at the output during the time after t_{CLZ} and before the valid data appears at the output. The timing parameters t_{CAC}, t_{RAC} and t_{AA} specify when the valid data will be present at the output. The valid data remains at the output until $\overline{CAS}$ returns high. This is true even if a new $\overline{RAS}$ cycle occurs (as in hidden refresh). Each of the KM428C256 operating cycles is listed below after the corresponding output state produced by the cycle.

Valid Output Data: Read, Read-Modify-Write, Hidden Refresh, Fast Page Mode Read, Fast Page Mode Read-Modify-Write, Read Color Register.

Refresh

The data in the KM428C256 is stored on a tiny capacitor within each memory cell. Due to leakage the data may leak off after a period of time. To maintain data integrity it is necessary to refresh each of the 512 rows every 8ms. Any operation cycle performed in the RAM port refreshes the 2048 bits selected by the row addresses or an on-chip refresh address counter. Either a burst refresh or distributed refresh may be used. There are several ways to accomplish this.

$\overline{RAS}$-Only Refresh: This is the most common method for performing refresh. It is performed by strobing in a row address with $\overline{RAS}$ while $\overline{CAS}$ remains high. This cycle must be repeated for each of the 512 row addresses, (A_0-A_8).

$\overline{CAS}$-before-$\overline{RAS}$ Refresh: The KM428C256 has $\overline{CAS}$-before-$\overline{RAS}$ on-chip refresh capability that eliminates the need for external refresh addresses. If $\overline{CAS}$ is held low for the specified set up time (t_{CSR}) before $\overline{RAS}$ goes low, the on-chip refresh circuitry is enabled. An internal refresh operation automatically occurs. The refresh address is supplied by the on-chip refresh address counter which is then internally incremented in preparation for the next $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle.

Hidden Refresh: A hidden refresh cycle may be performed while maintaining the latest valid data at the output by extending the $\overline{CAS}$ active time and cycling $\overline{RAS}$. The KM428C256 hidden refresh cycle is actually a $\overline{CAS}$-before-$\overline{RAS}$ refresh cycle within an extended read cycle. The refresh row address is provided by the on-chip refresh address counter.

Other Refresh Methods: It is also possible to refresh the KM428C256 by using read, write or read-modify-write cycles. Whenever a row is accessed, all the cells in that row are automatically refreshed. There are certain applications in which it might be advantageous to perform refresh in this manner but in general $\overline{RAS}$-only or $\overline{CAS}$-before-$\overline{RAS}$ refresh is the preferred method.

Transfer Operation

1. Normal Write/Read Transfer (SAM→RAM/RAM→SAM.)
2. Pseudo Write Transfer (Switches serial port from serial Read to serial Write. No actual data transfer takes place between the RAM and the SAM.)
3. Real Time Read Transfer (On the fly Read Transfer operation).
4. Split Write/Read Transfer (Divides the SAM into a high and a low half. Only one half is transferred from to the SAM while the other half is write to/read from the SDQ pins.)

Read-Transfer Cycle

A read-transfer consists of loading a selected row of data from the RAM array into the SAM register. A read-transfer is accomplished by holding $\overline{CAS}$ high, $\overline{DT}/\overline{OE}$ low and $\overline{WB}/\overline{WE}$ high at the falling edge of $\overline{RAS}$. The row address selected at the falling edge of $\overline{RAS}$ determines the RAM row to be transferred into the SAM.

DEVICE OPERATIONS (Continued)

The actual data transfer completed at the rising edge of $\overline{DT}/\overline{OE}$. When the transfer is completed, the SDQ lines are set into the output mode. In a read/real-time read-transfer cycle, the transfer of a new row of data is completed at the rising edge of $\overline{DT}/\overline{OE}$ and becomes valid on the SDQ lines after the specified access time t_{SCA} from the rising edge of the subsequent serial clock(SC) cycle. The start address of the serial pointer of the SAM is determined by the column address selected at the falling edge of $\overline{CAS}$.

Table 3. Truth Table for Transfer Operation

RAS Falling Edge					Function	Transfer Direction	Transfer Data Bits	SAM Port Mode
$\overline{CAS}$	$\overline{DT}/\overline{OE}$	$\overline{WB}/\overline{WE}$	$\overline{SE}$	DSF				
H	L	H	*	L	Read Transfer	RAM→SAM	512×8	Input→Output
H	L	L	L	L	Masked Write Transfer	SAM→RAM	512×8	Output→Input
H	L	L	H	L	Pseudo Write Transfer	—	—	Output→Input
H	L	H	*	H	Split Read Transfer	RAM→SAM	256×8	Not Changed
H	L	L	*	H	Split Write Transfer	SAM→RAM	256×8	Not Changed

*: Don't Care

Write Transfer Cycle

A write transfer cycle consists of loading the content of the SAM data register into a selected row or RAM array. A write transfer is accomplished by $\overline{CAS}$ high, $\overline{DT}/\overline{OE}$ low, $\overline{WB}/\overline{WE}$ low and $\overline{SE}$ low at the falling edge of $\overline{RAS}$. The row address selected at the falling edge of $\overline{RAS}$ determines the RAM row address into which the data will be transfered. The column address selected at the falling edge of $\overline{CAS}$ determines the start address of the serial pointer of the SAM. After the write transfer is completed, the SDQ lines are in the input mode so that serial data synchronized with SC can be loaded. When two consecutive write transfer operations are performed, there is a delay in availability between the last bit of the previous row and the first bit of the new row. Consequently the SC clock must be held at a constant V_{IL} or V_{IH} after the SC precharge time t_{SCP} has been satisfied, a rising edge of the SC clock until after a specified delay t_{RSD} from the falling edge of $\overline{RAS}$.

Pseudo Write Transfer Cycle

The pseudo write transfer cycle switches SDQ lines from serial read mode to serial write mode. It doesn't perform data trnasfer. A pseudo write transfer is accomplished by holding $\overline{CAS}$ high, $\overline{DT}/\overline{OE}$ low, $\overline{WB}/\overline{WE}$ low and $\overline{SE}$ high at the falling edge of $\overline{RAS}$. The pseudo write transfer cycle must be performed after a read transfer cycle if the subsequent operation is a write transfer cycle. There is a timing delay associated with the switching of the SDQ lines from serial output mode to serial input mode. During this period, the SC clock must be held at a constant V_{IL} or V_{IH} after the t_{SC} precharge time has been satisfied. A rising edge of the SC clock must not occur until after the specified delay t_{RSD} from the falling edge of $\overline{RAS}$.

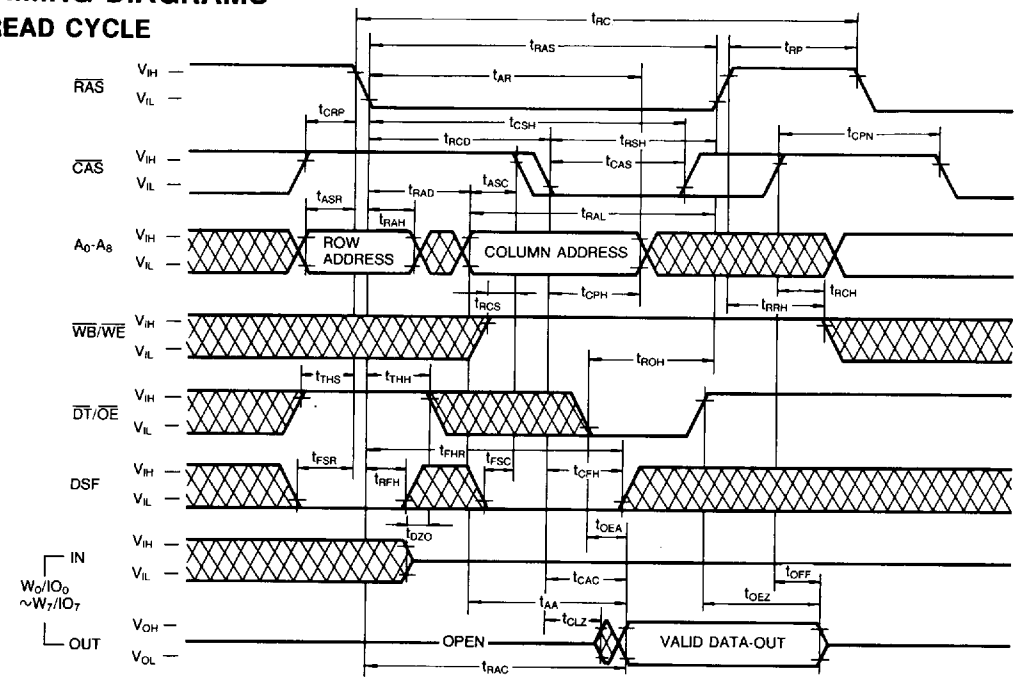
Special Function Input (DSF)

In read transfer mode, holding DSF high on the falling edge of $\overline{RAS}$ selects the split register mode read transfer operation. This mode divides the serial data register into a high order half and a low order half, one active, and one inactive. When the cycle is initialed, a transfer occurs between the memory array and either the high half or the low half register, depending on the state of most significant column address bit (A8) that is strobed in on the falling edge of $\overline{CAS}$. If A8 is high, the transfer is to the high half of the register. If A8 is low, the transfer is to the low half of the register. Use of the split register mode read transfer feature allows on-the-fly read transfer operation without synchronizing $\overline{DT}/\overline{OE}$ to the serial clock. The transfer can be to either the active half or the inactive half register. If the transfer is to the active register, with an uninterrupted serial data stream, then the timings t_{TSL} and t_{TSD} must be met.

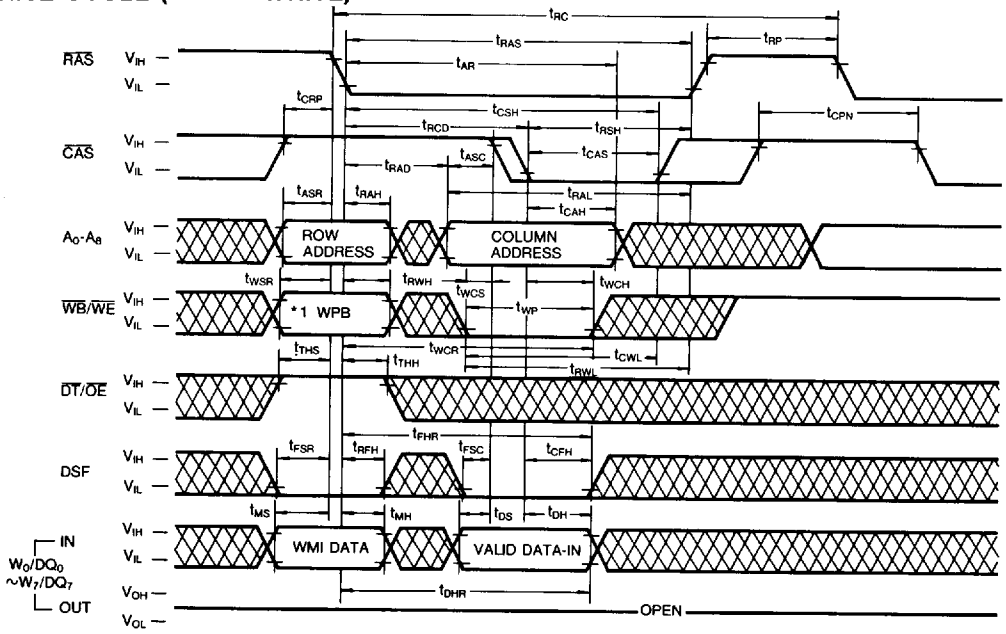
In write transfer mode, holding DSF high on the falling edge of $\overline{RAS}$ permits use of a Split Register mode of transfer write. This mode allows $\overline{SE}$ to be high on the falling edge of $\overline{RAS}$ without performing a pseudo write transfer, with the serial port disabled during the entire transfer write cycle.

TIMING DIAGRAMS

READ CYCLE

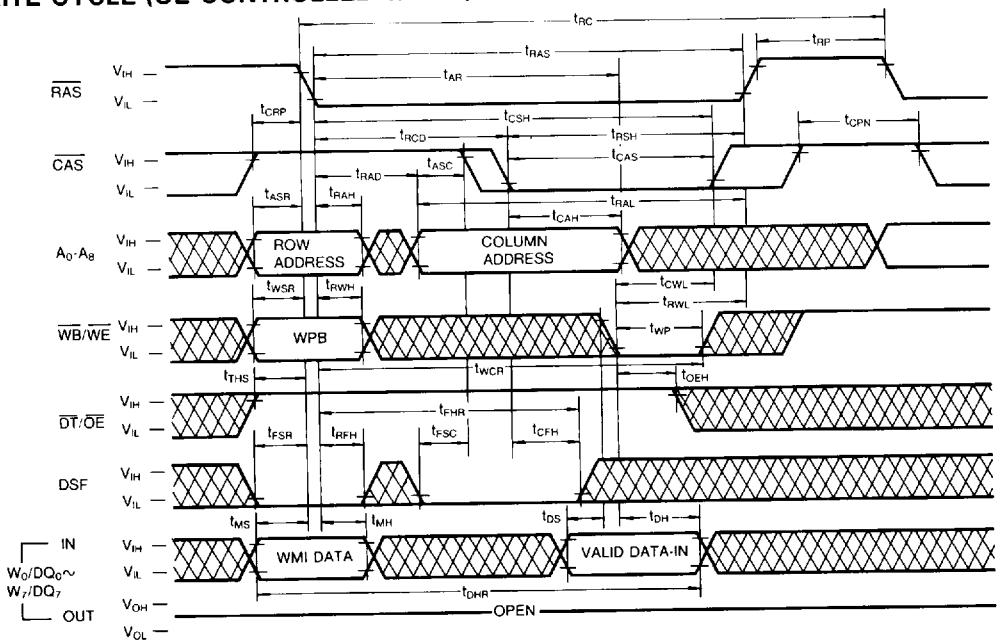


WRITE CYCLE (EARLY WRITE)

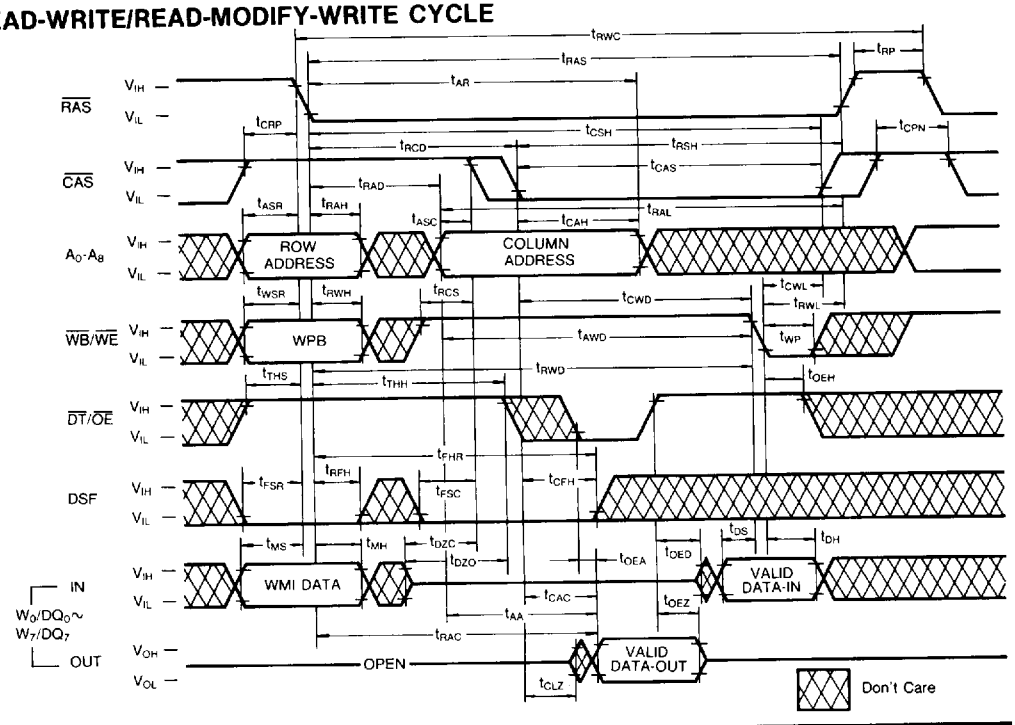


TIMING DIAGRAMS (Continued)

WRITE CYCLE ($\overline{OE}$ CONTROLLED WRITE)

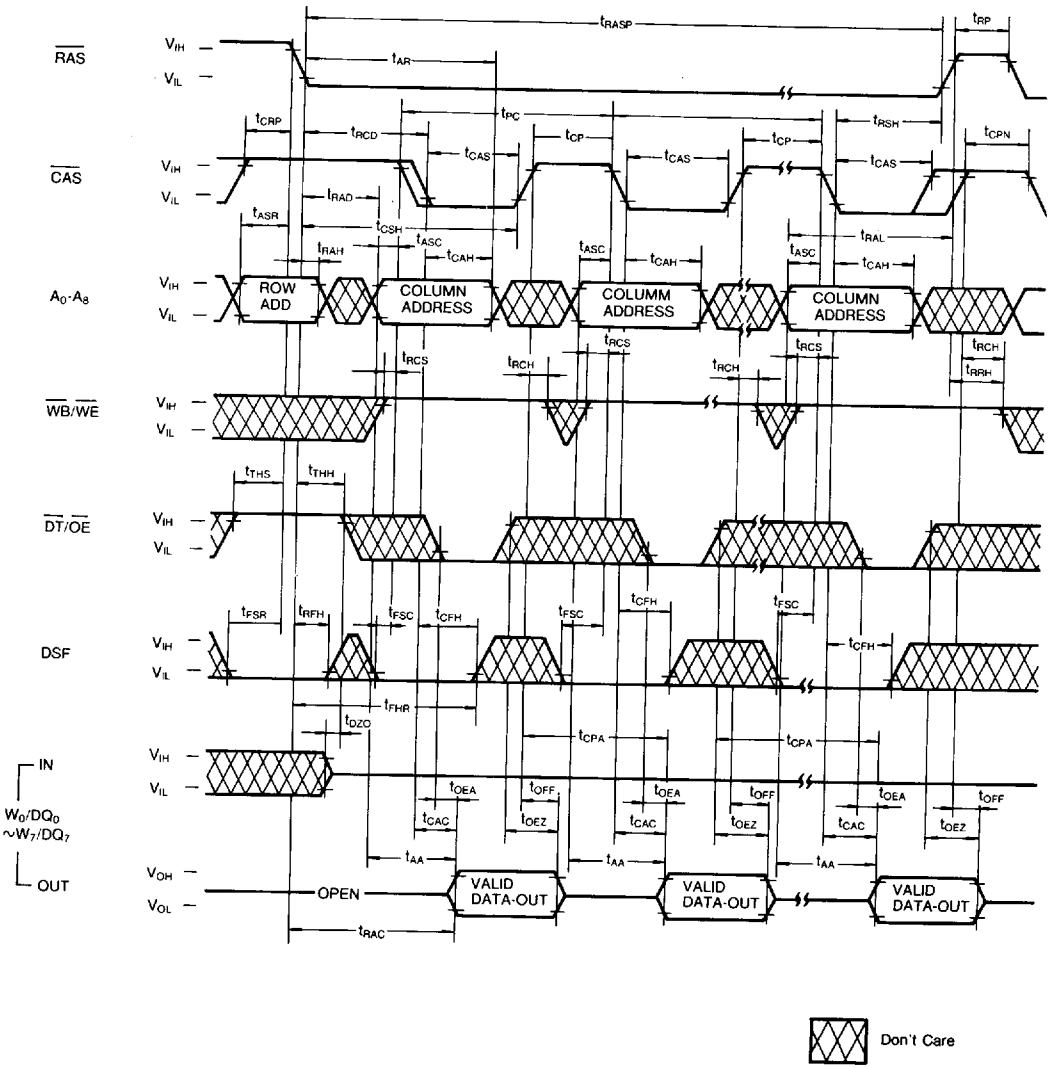


READ-WRITE/READ-MODIFY-WRITE CYCLE



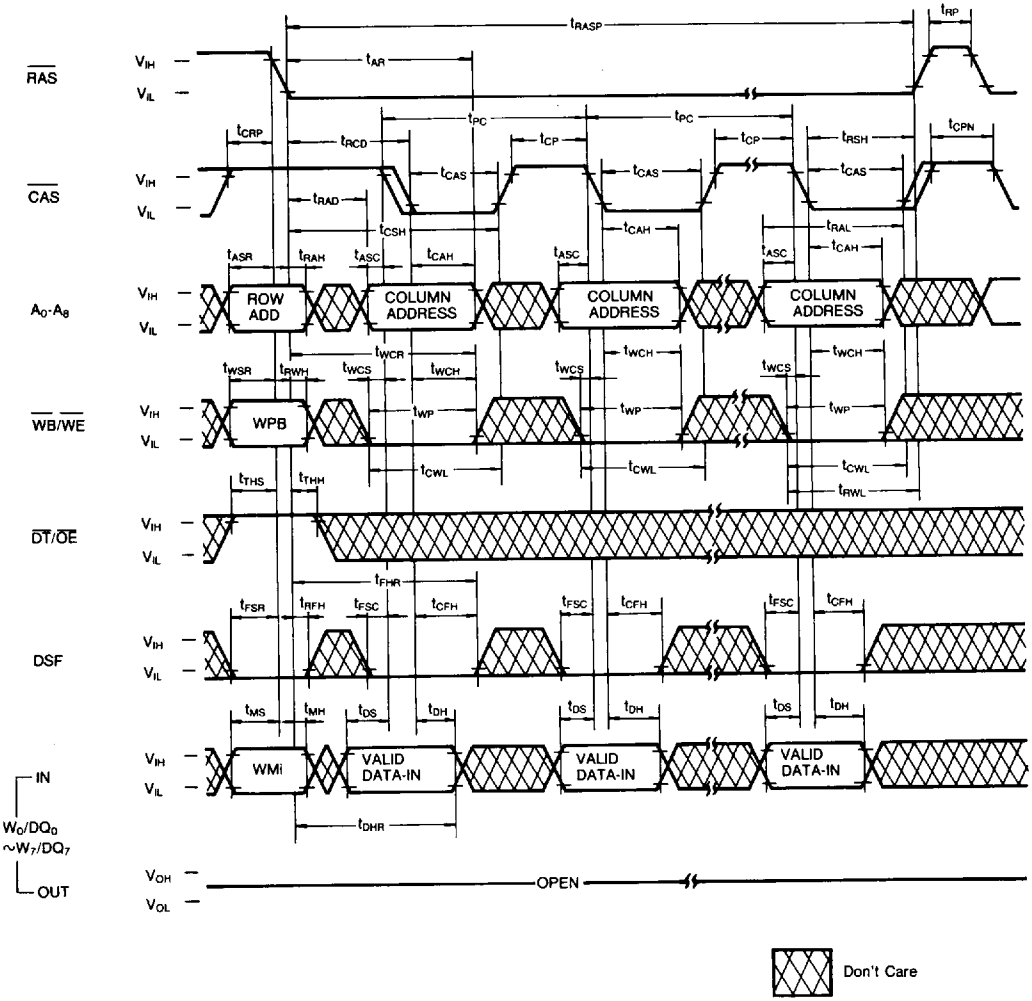
TIMING DIAGRAMS (Continued)

PAGE MODE READ CYCLE



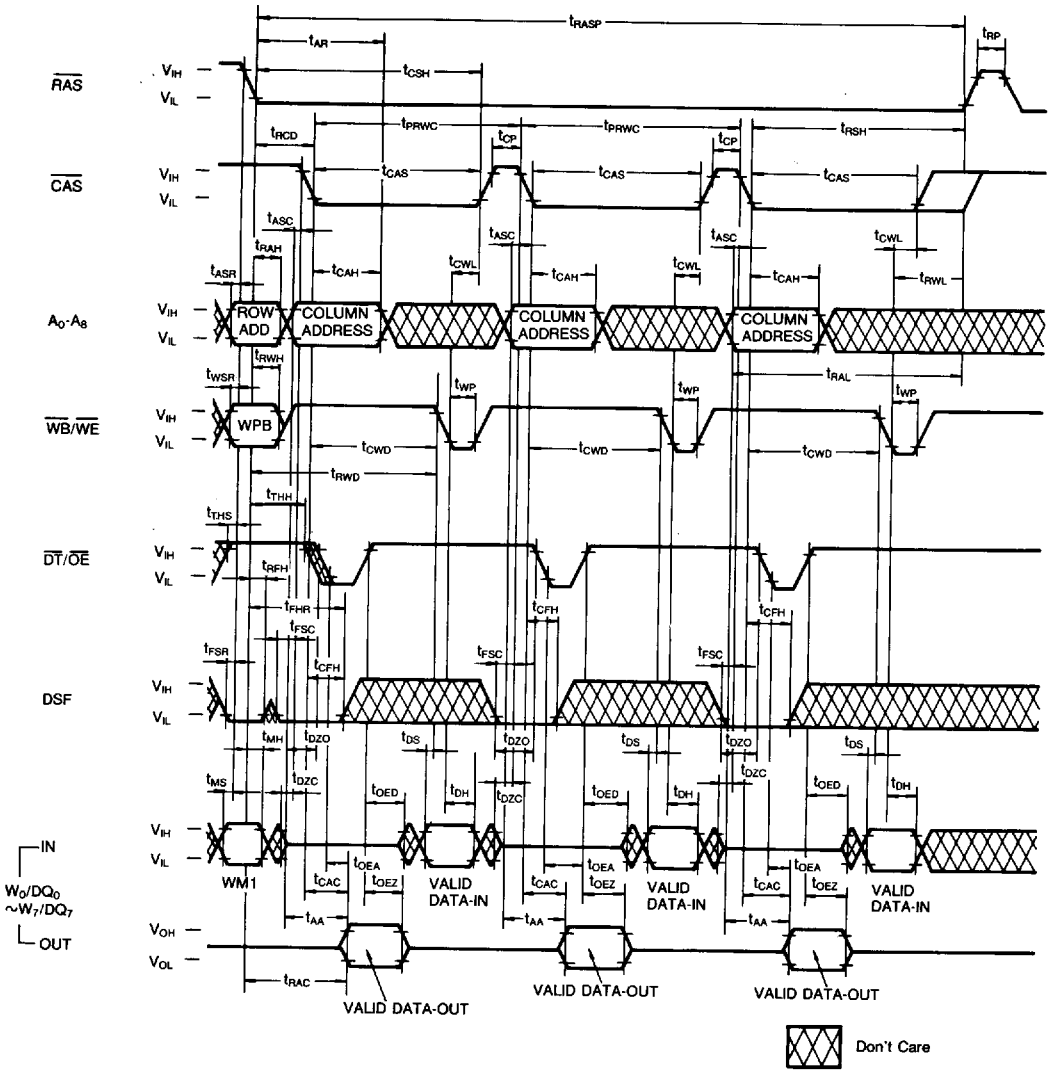
TIMING DIAGRAMS (Continued)

PAGE MODE WRITE CYCLE (EARLY WRITE)



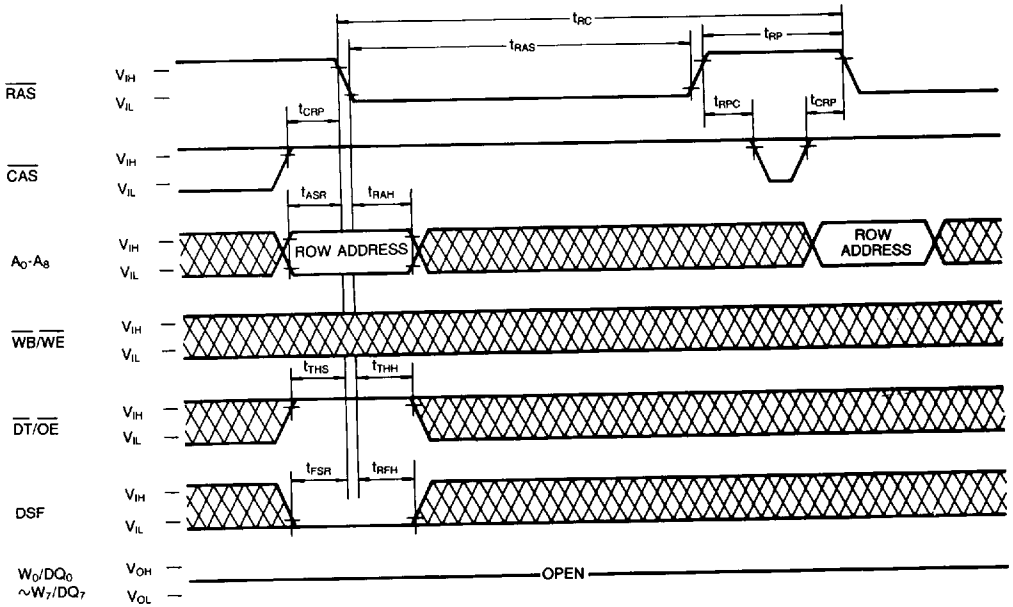
TIMING DIAGRAMS (Continued)

PAGE MODE READ-MODIFY-WRITY CYCLE

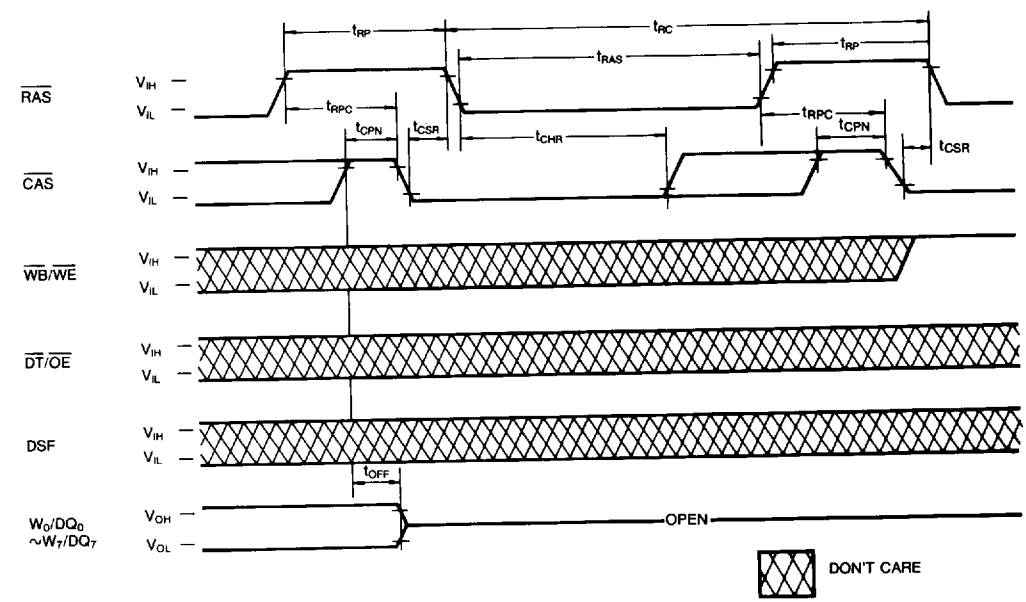


TIMING DIAGRAMS (Continued)

$\overline{RAS}$ ONLY REFRESH CYCLE

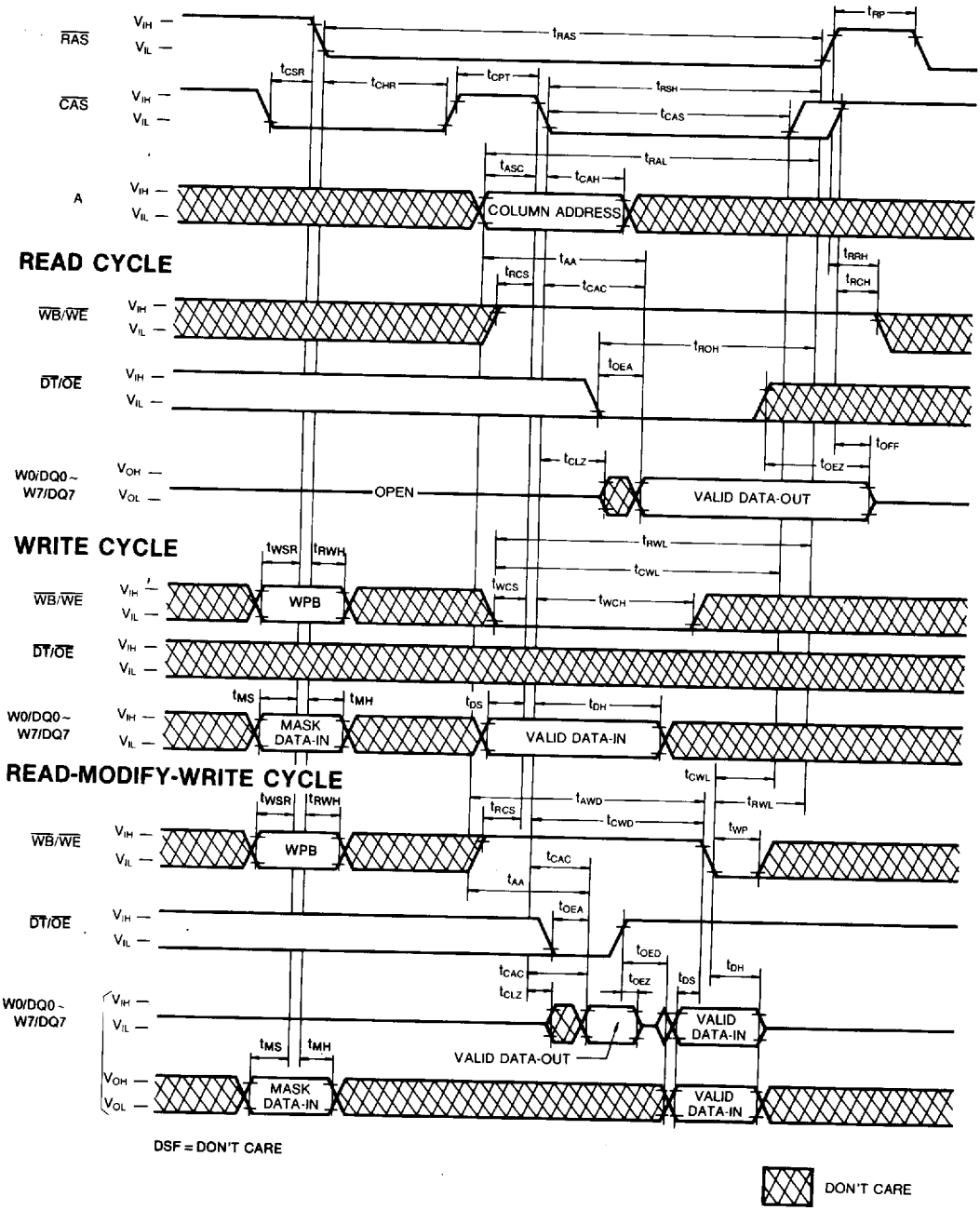


$\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH



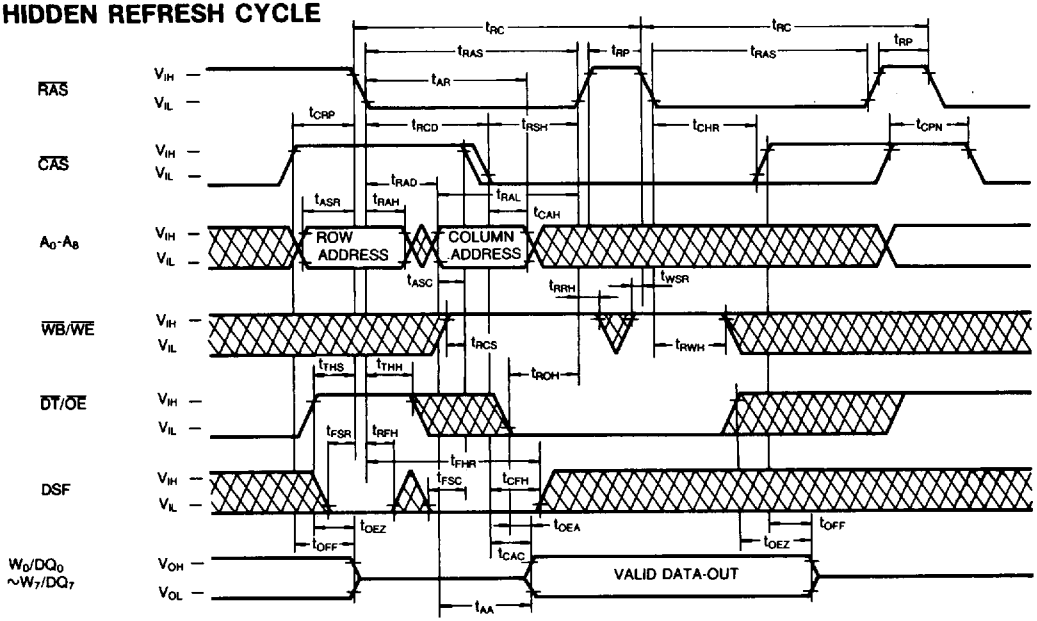
TIMING DIAGRAMS (Continued)

CAS-BEFORE-RAS REFRESH COUNTER TEST CYCLE

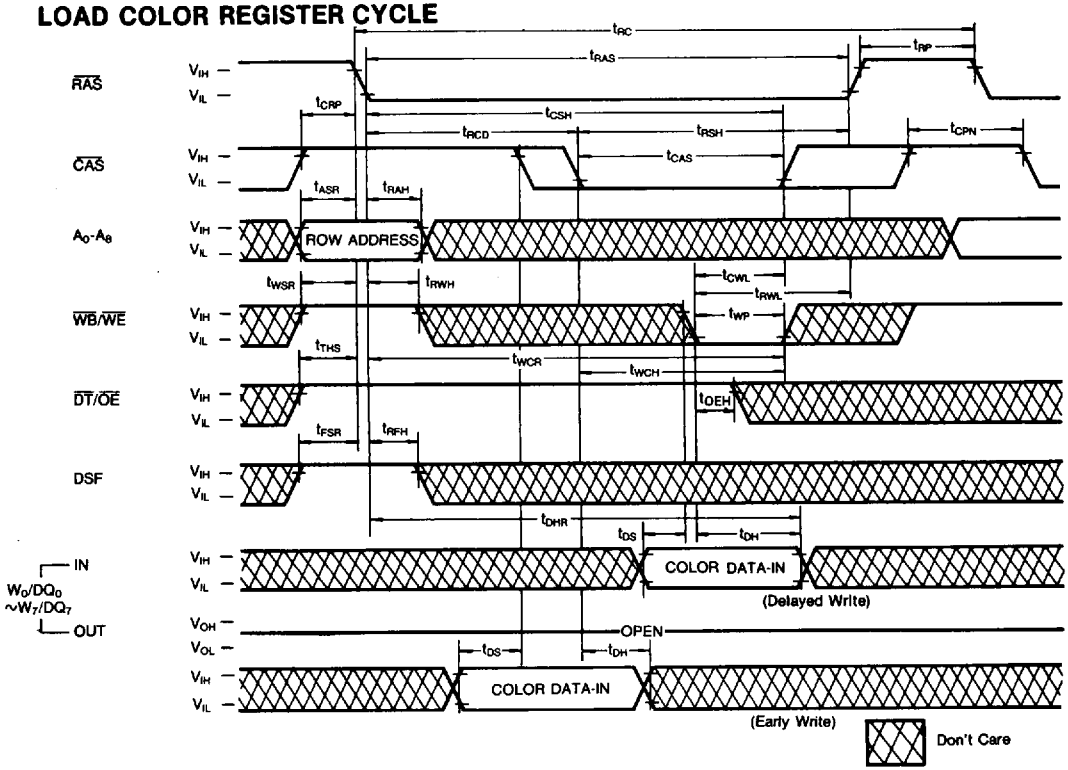


TIMING DIAGRAMS (Continued)

HIDDEN REFRESH CYCLE

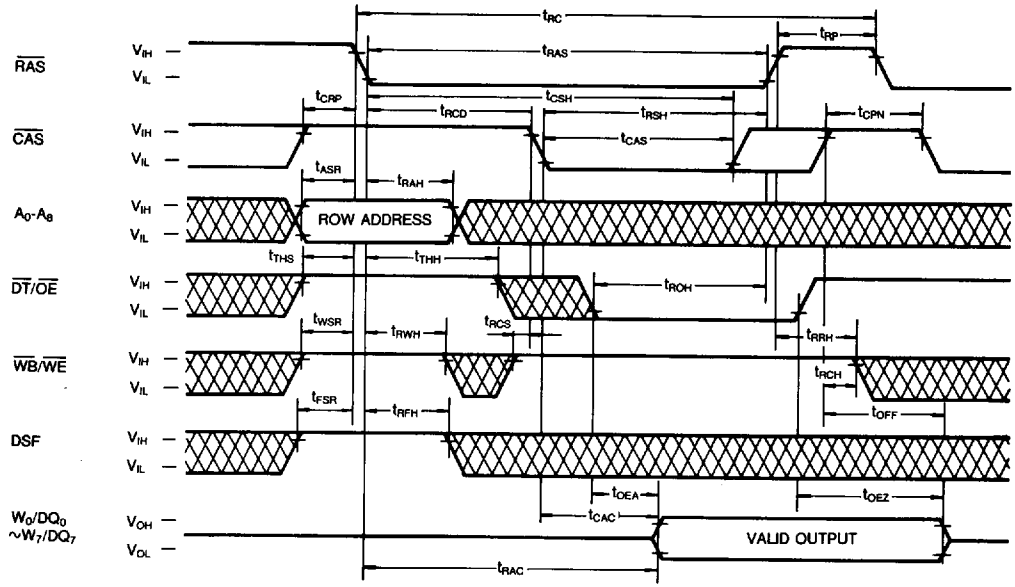


LOAD COLOR REGISTER CYCLE

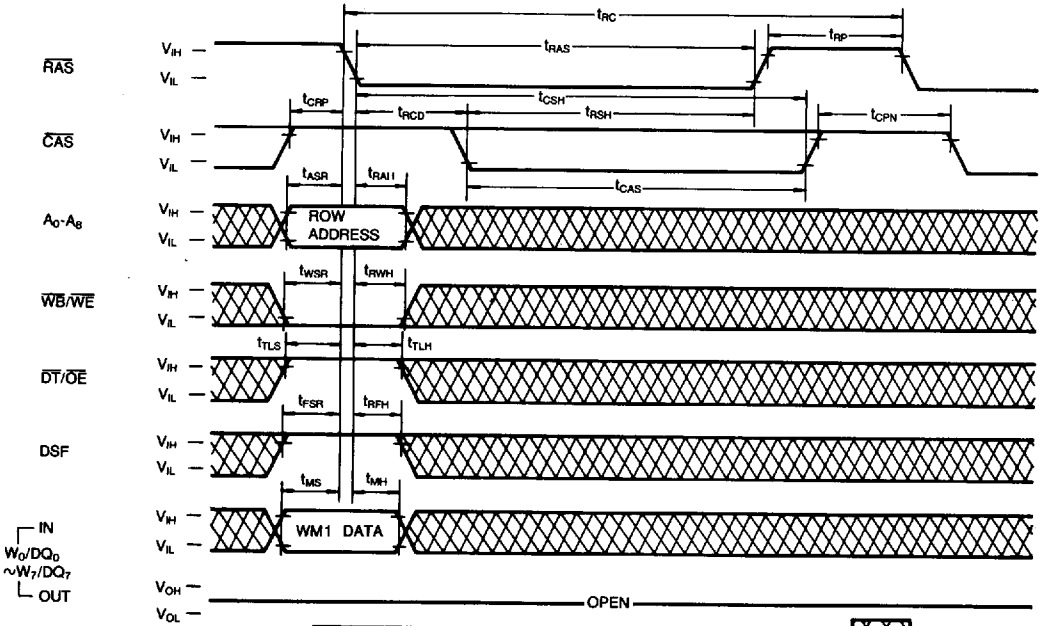


TIMING DIAGRAMS (Continued)

READ COLOR REGISTER CYCLE



FLASH WRITE CYCLE

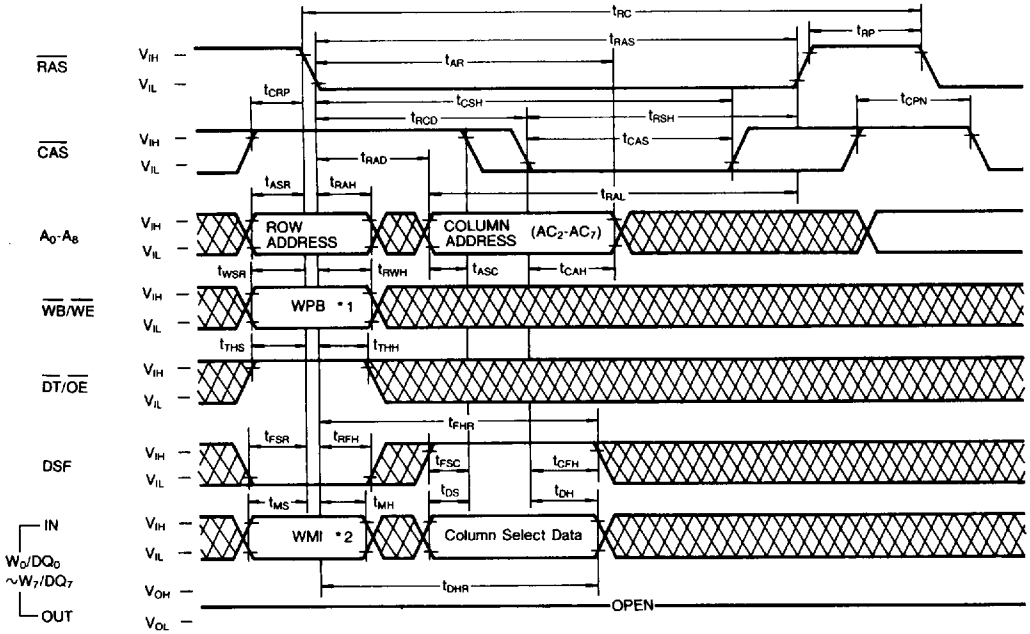


WM1 DATA	CYCLE
O	Flash write Disable
I	Flash write Enable

Don't Care

TIMING DIAGRAMS (Continued)

BLOCK WRITE CYCLE



*1 $\overline{WB}/\overline{WE}$	*2 W_0/DQ_0-W_3/DQ_3	CYCLE
0	WM1 Data	Masked Block Write
1	Don't Care	Block Write (Non Mask)

WM1 Data: 0: Write Disable
1: Write Enable

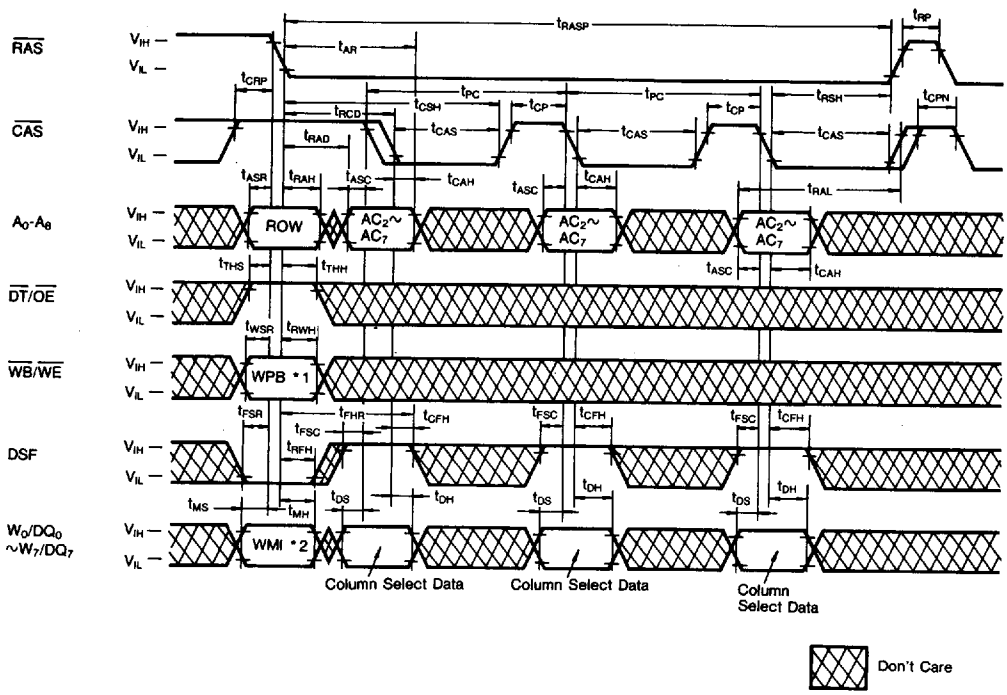
COLUMN SELECT DATA

W_0/DQ_0 — Column 0 (A_{IC}=0, A_{OC}=0)
W_1/DQ_1 — Column 1 (A_{IC}=0, A_{OC}=1)
W_2/DQ_2 — Column 2 (A_{IC}=1, A_{OC}=0)
W_3/DQ_3 — Column 3 (A_{IC}=1, A_{OC}=1)

Wn/DQn
= 0: Disable
= 1: Enable

TIMING DIAGRAMS (Continued)

PAGE MODE BLOCK WRITE CYCLE



*1 $\overline{WB}/\overline{WE}$	*2 W_0/DQ_0-W_3/DQ_3	CYCLE
0	WM1 Data	Masked Block Write
1	Don't Care	Block Write (Non Mask)

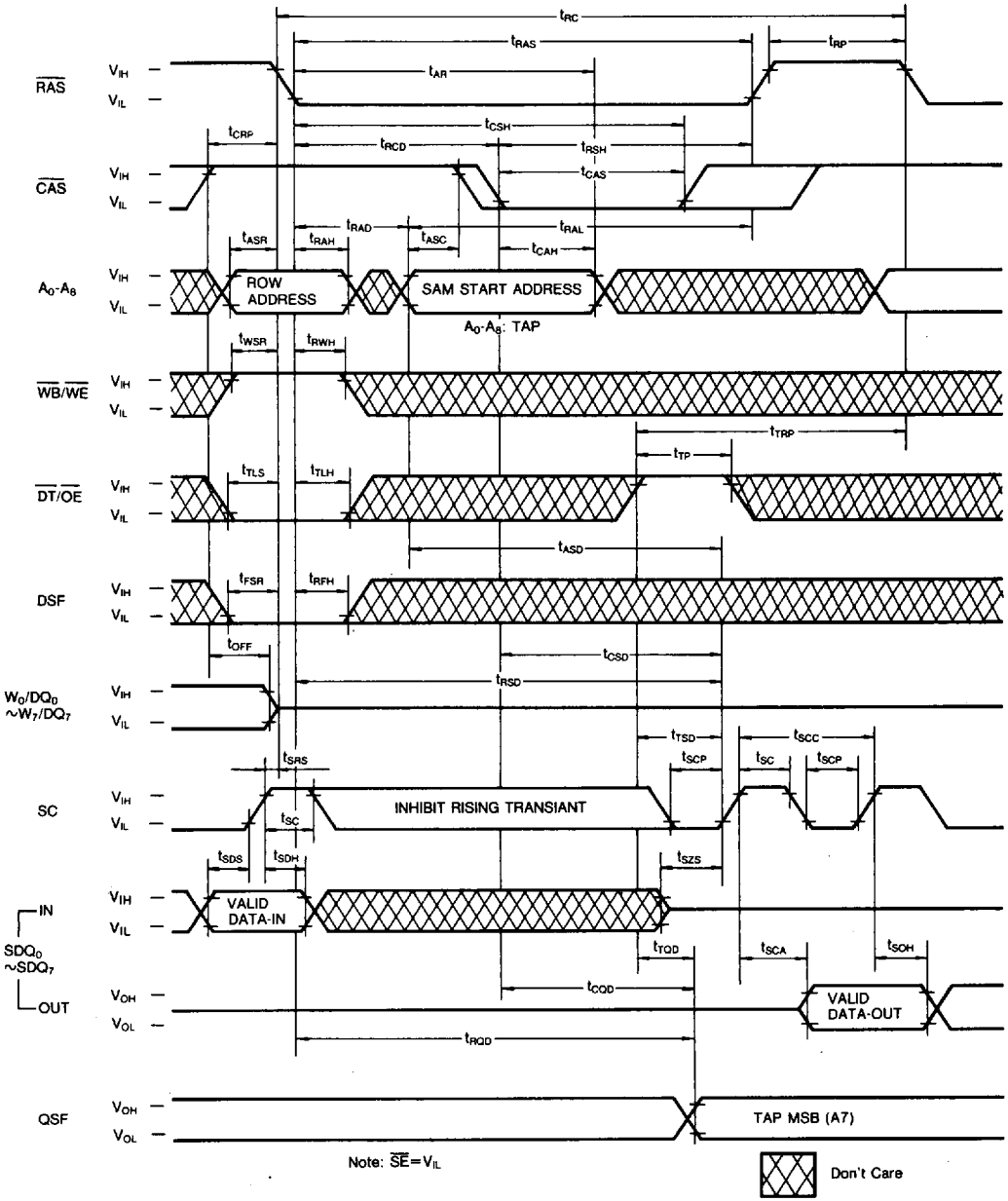
WM1 Data: 0: Write Disable
1: Write Enable

COLUMN SELECT DATA
W_0/DQ_0 — Column 0 (A_{IC}=0, A_{OC}=0)
W_1/DQ_1 — Column 1 (A_{IC}=0, A_{OC}=1)
W_2/DQ_2 — Column 2 (A_{IC}=1, A_{OC}=0)
W_3/DQ_3 — Column 3 (A_{IC}=1, A_{OC}=1)

Wn/DQn
= 0: Disable
= 1: Enable

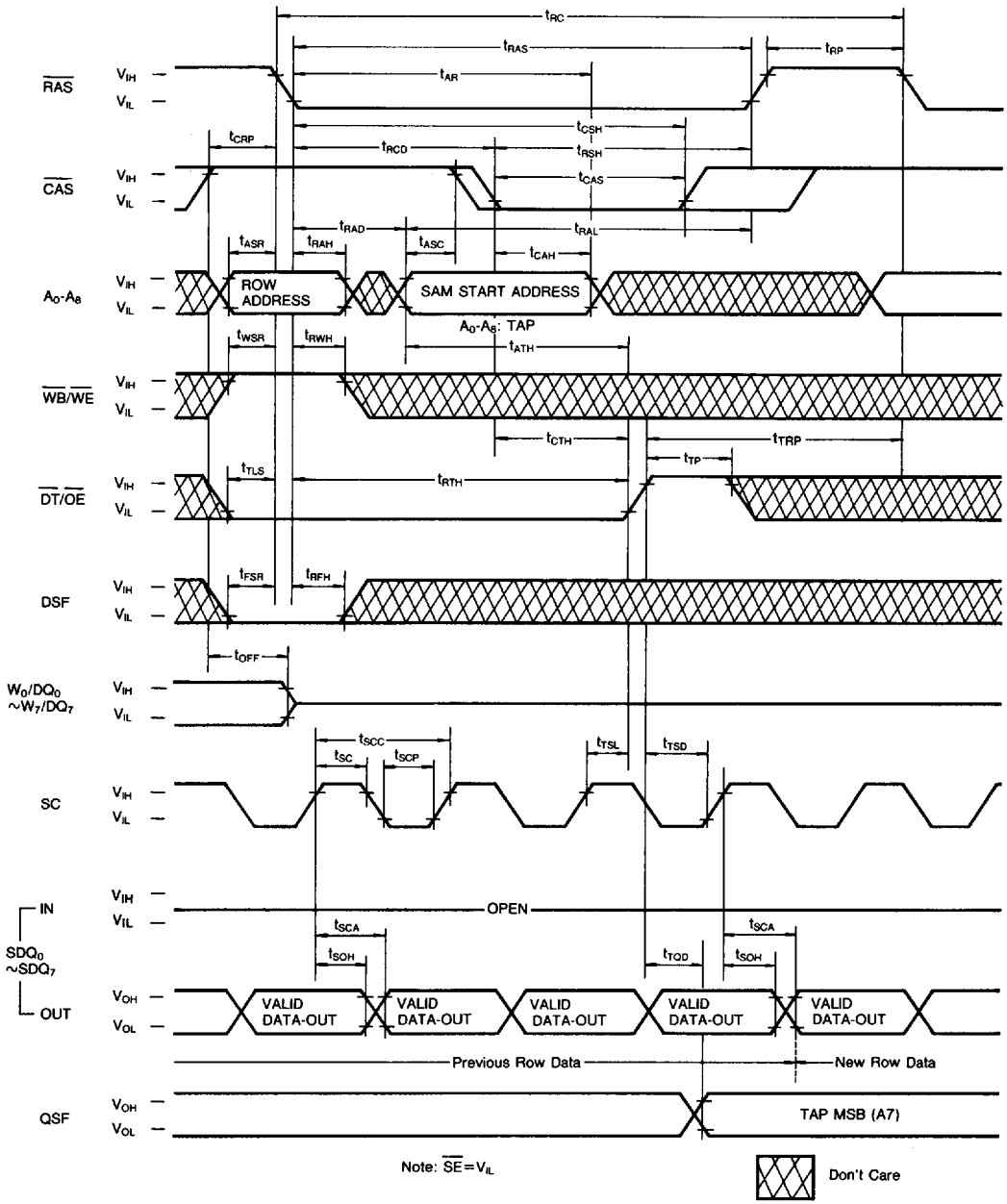
TIMING DIAGRAMS (Continued)

READ TRANSFER CYCLE



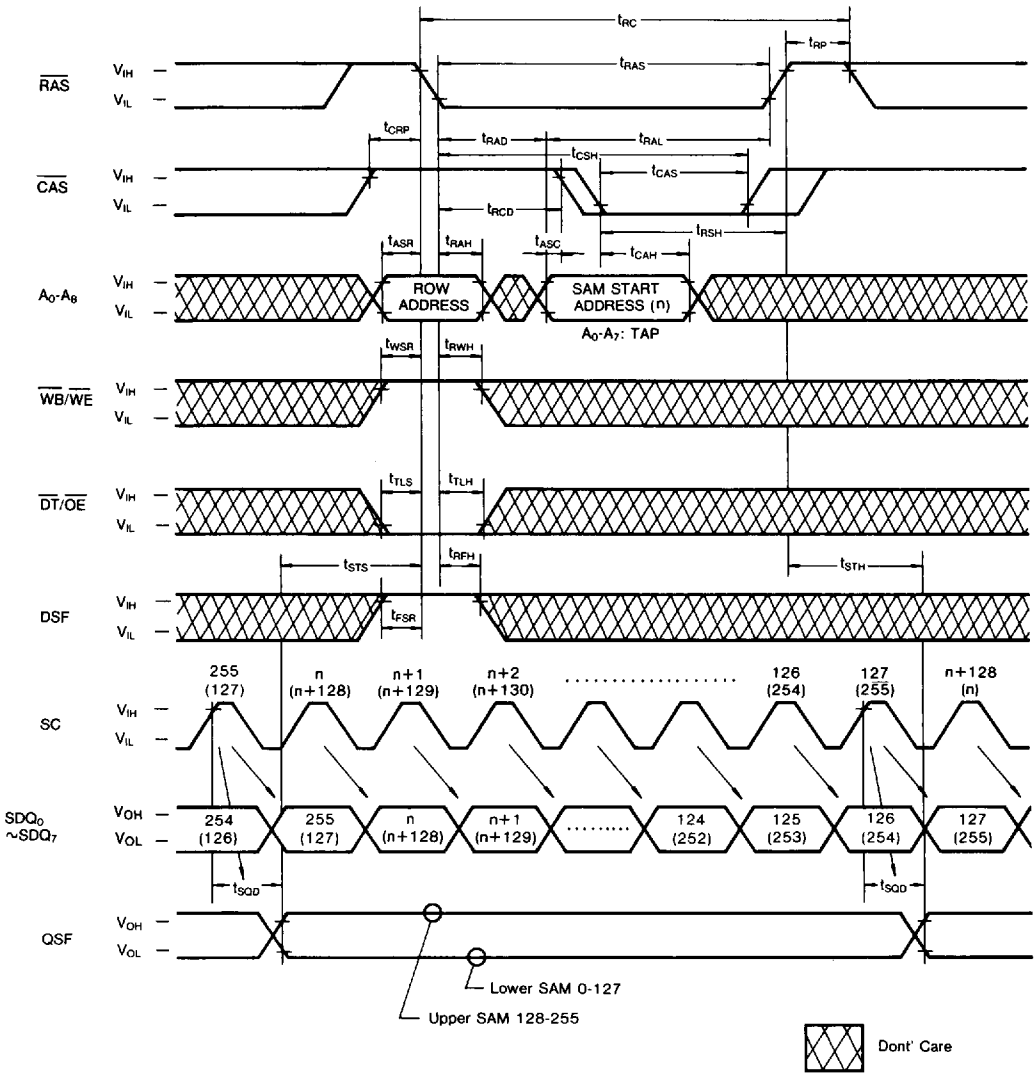
TIMING DIAGRAMS (Continued)

REAL TIME READ TRANSFER CYCLE



TIMING DIAGRAMS (Continued)

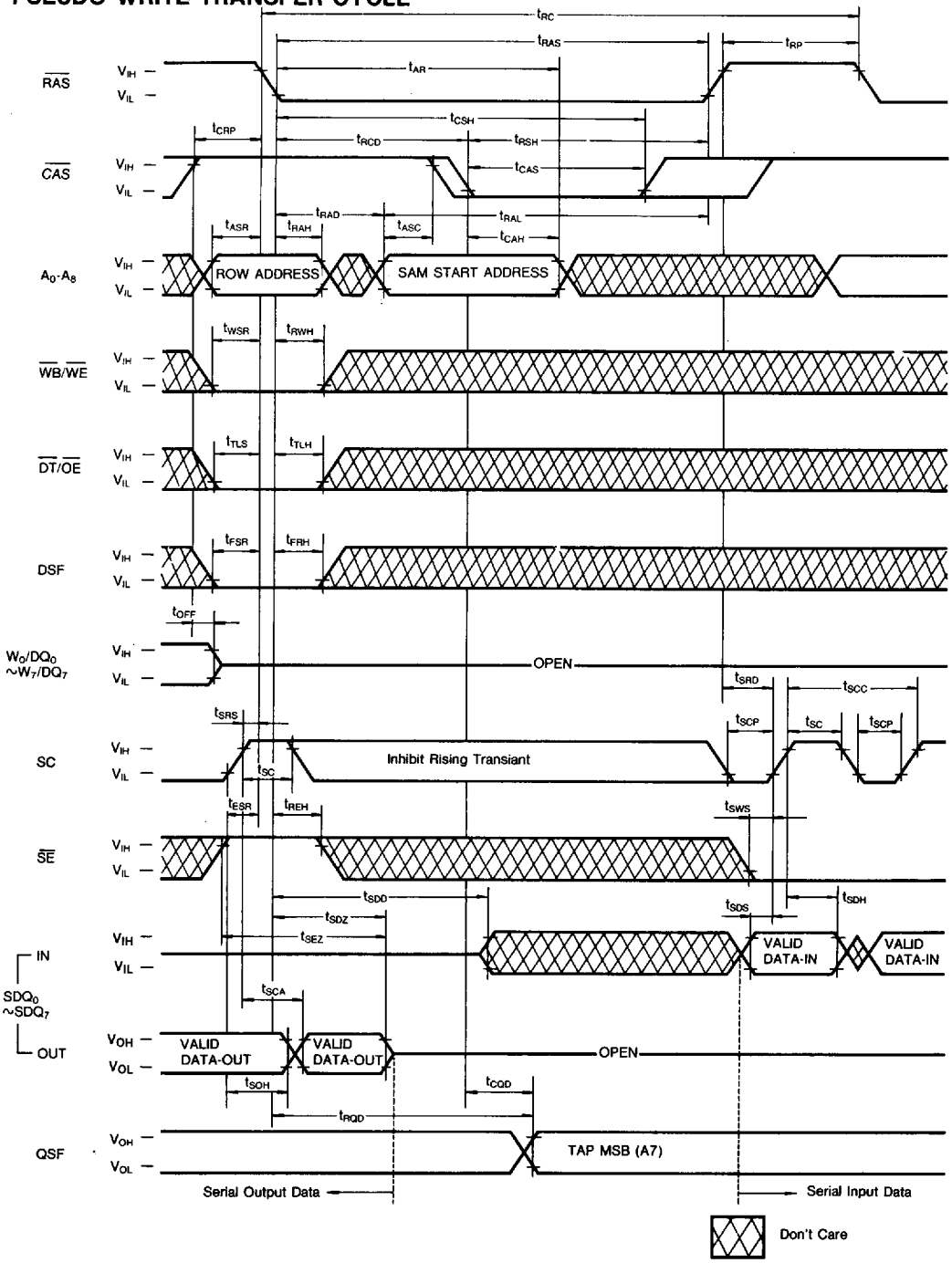
SPLIT READ TRANSFER CYCLE



Note: $\overline{SE}=V_{IL}$

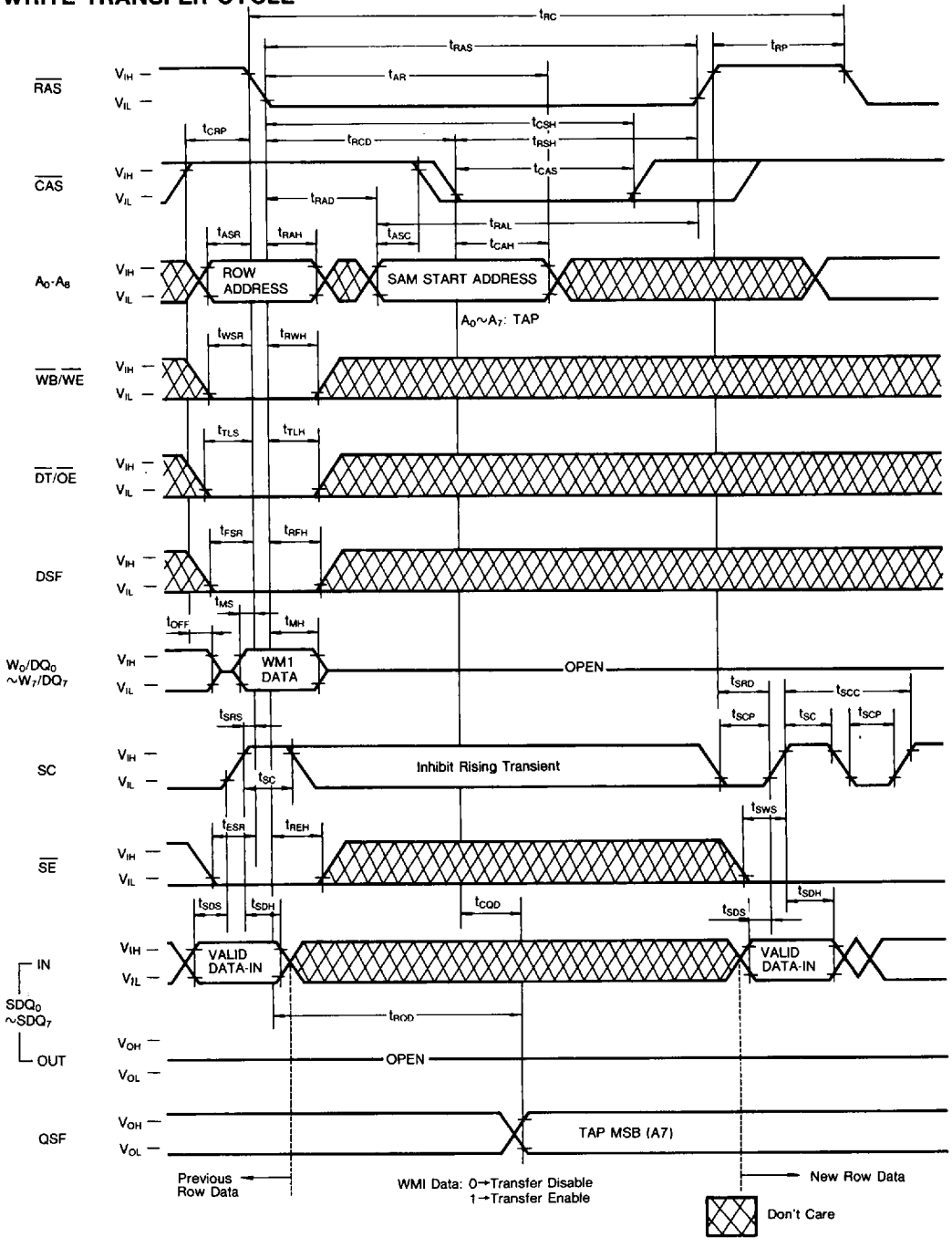
TIMING DIAGRAMS (Continued)

PSEUDO WRITE TRANSFER CYCLE



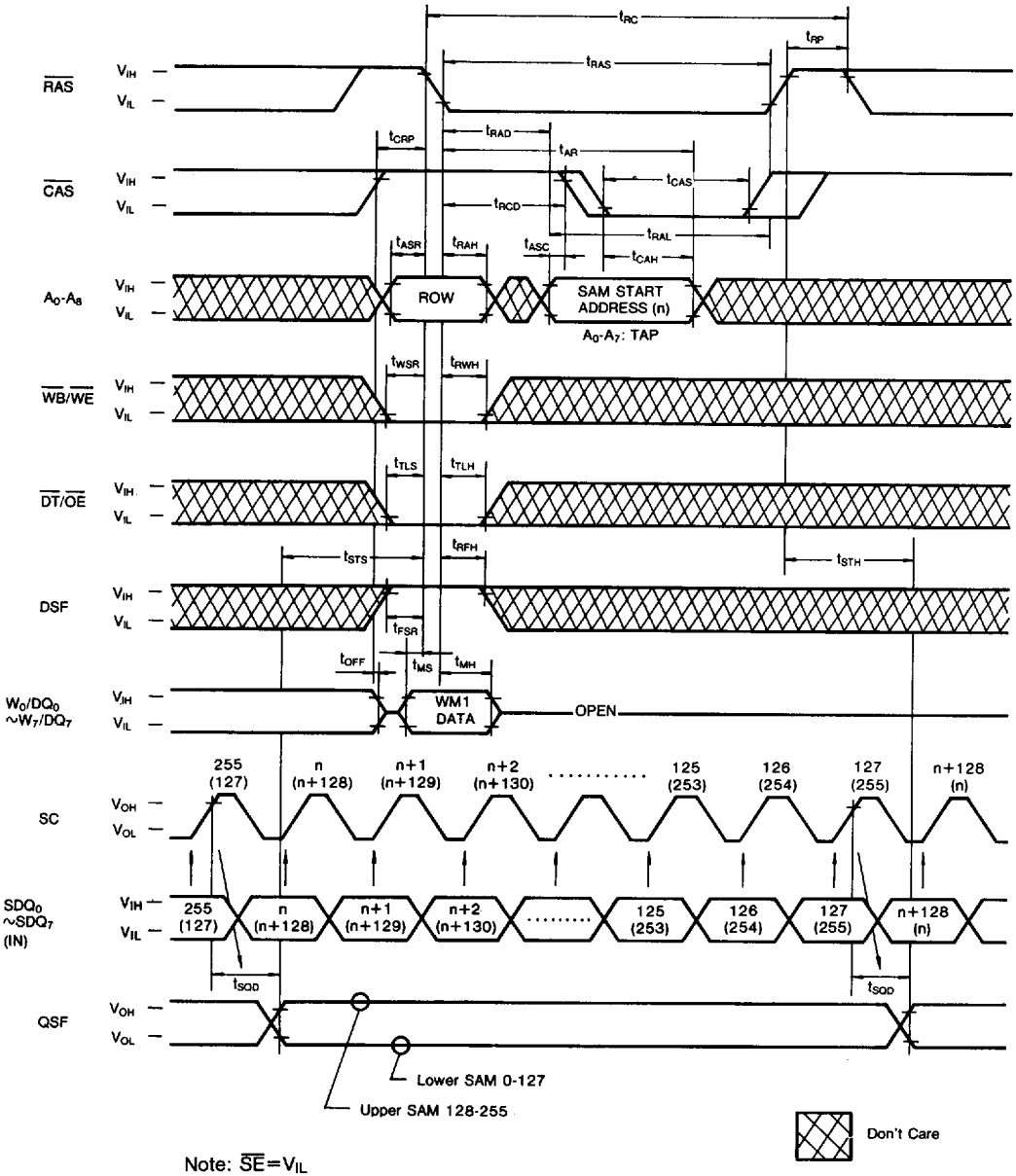
TIMING DIAGRAMS (Continued)

WRITE TRANSFER CYCLE



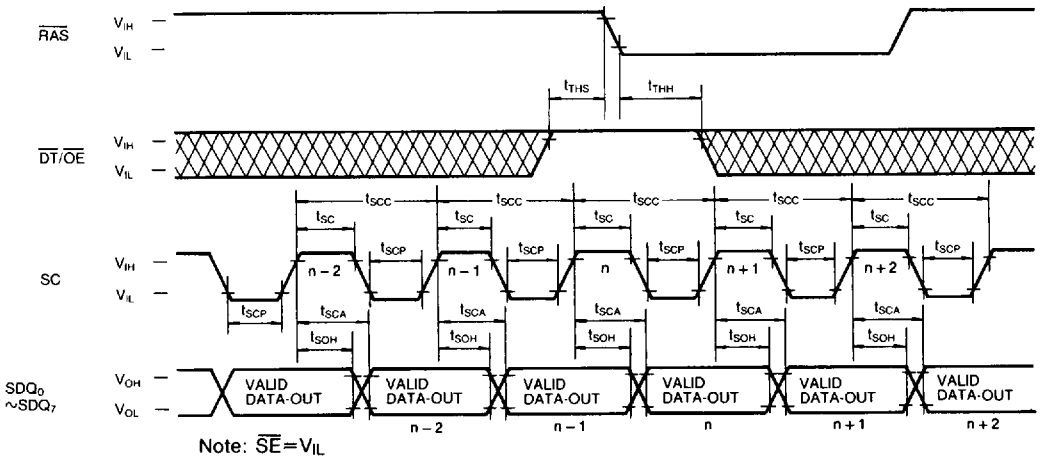
TIMING DIAGRAMS (Continued)

SPLIT WRITE TRANSFER CYCLE



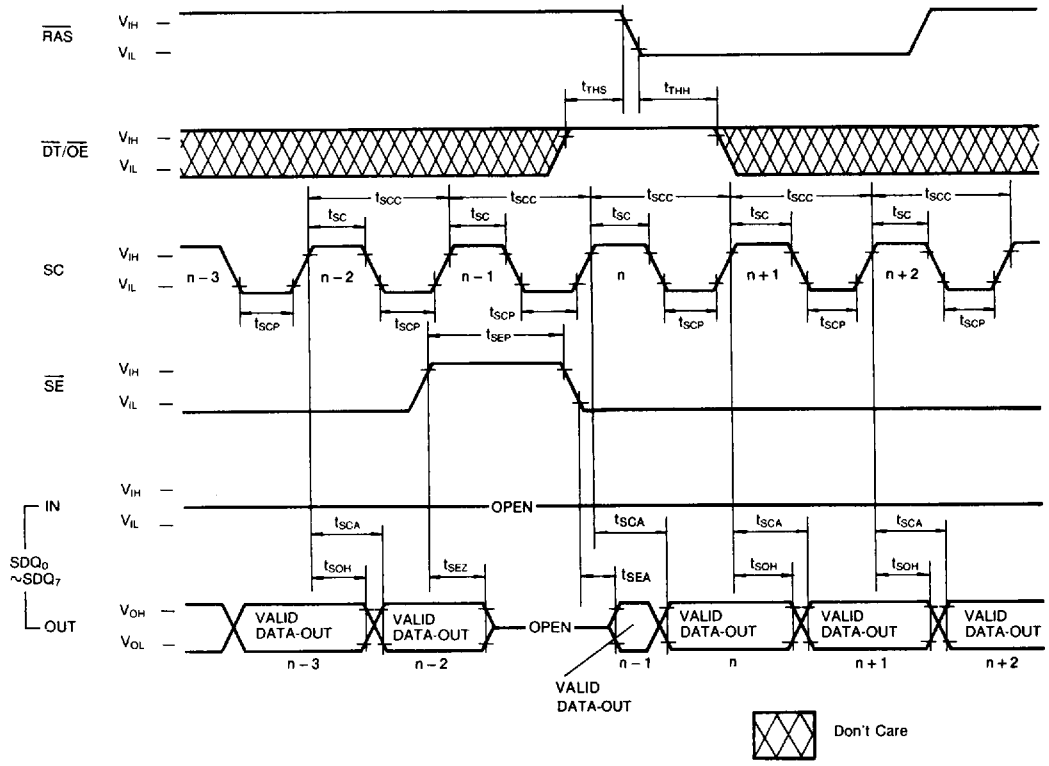
Note: $\overline{SE}=V_{IL}$

SERIAL READ CYCLE ($\overline{SE}$ = V_{IL})



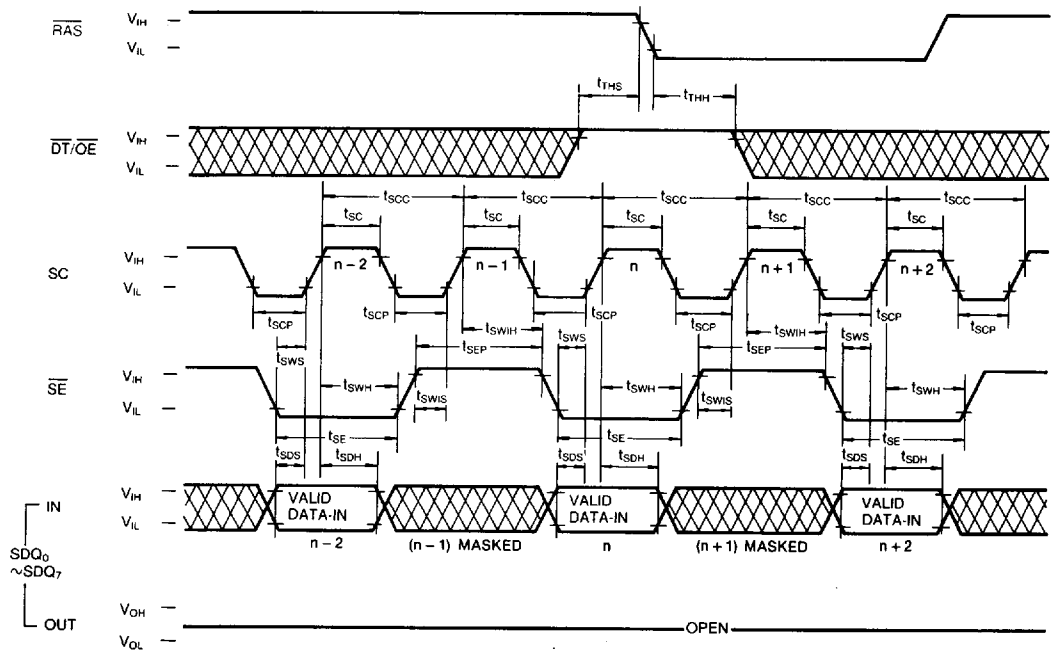
Note: $\overline{SE}$=V_{IL}

SERIAL READ CYCLE ($\overline{SE}$ Controlled Outputs)

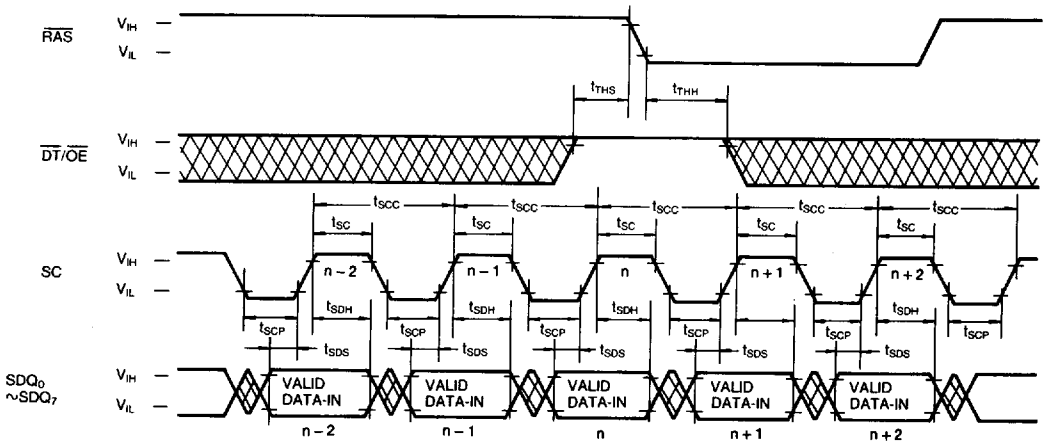


TIMING DIAGRAMS (Continued)

SERIAL WRITE CYCLE ($\overline{SE}$ Controlled Inputs)



SERIAL WRITE CYCLE ($\overline{SE} = V_{IL}$)



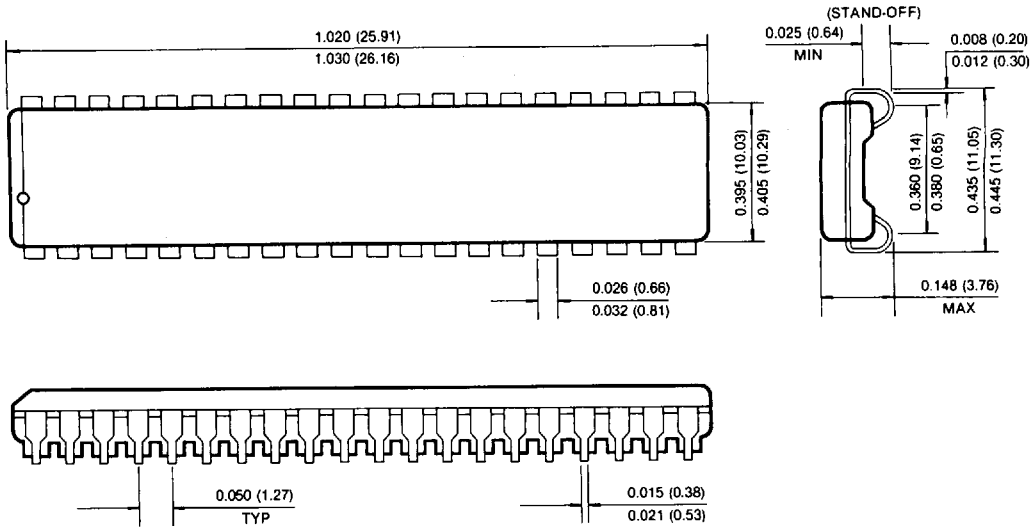
Note: $\overline{SE} = V_{IL}$

Don't Care

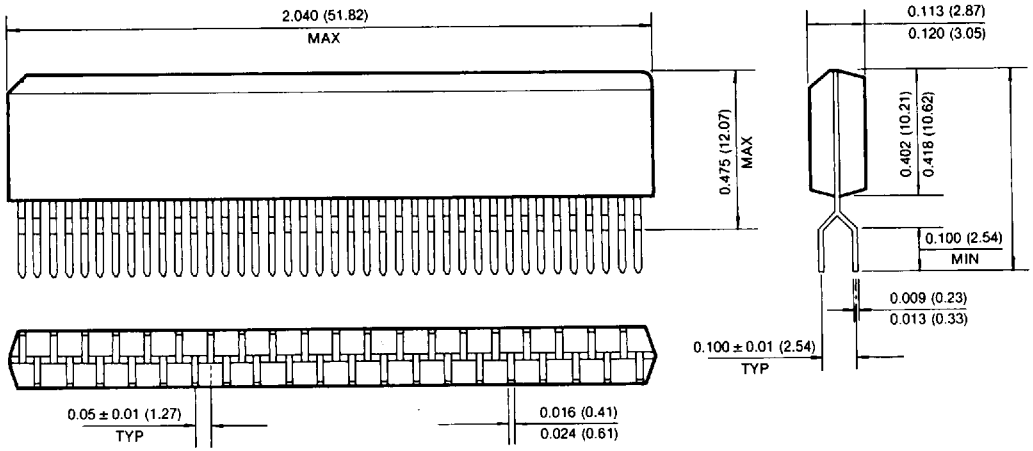
PACKAGE DIMENSIONS

40-PIN PLASTIC SOJ

Units: Inches (millimeters)



40-PIN PLASTIC ZIP



PACKAGE DIMENSIONS

40/44-PIN PLASTIC TSOP-II (Forward Type)

Units: Inches (millimeters)