

## 256K x 16 (4-MBIT) DYNAMIC RAM WITH FAST PAGE MODE

APRIL 2005

### FEATURES

- Fast access and cycle time
- TTL compatible inputs and outputs
- Refresh Interval: 512 cycles/8 ms
- Refresh Mode:  $\overline{\text{RAS}}$ -Only,  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  (CBR), and Hidden
- JEDEC standard pinout
- Single power supply:
  - 5V  $\pm$  10% (IS41C16257A)
  - 3.3V  $\pm$  10% (IS41LV16257A)
- Byte Write and Byte Read operation via two  $\overline{\text{CAS}}$
- Lead-free available

### DESCRIPTION

The *ISSI* IS41C16257A and the IS41LV16257A are 262,144 x 16-bit high-performance CMOS Dynamic Random Access Memories. Fast Page Mode allows 512 random accesses within a single row with access cycle time as short as 12 ns per 16-bit word. The Byte Write control, of upper and lower byte, makes these devices ideal for use in 16- and 32-bit wide data bus systems.

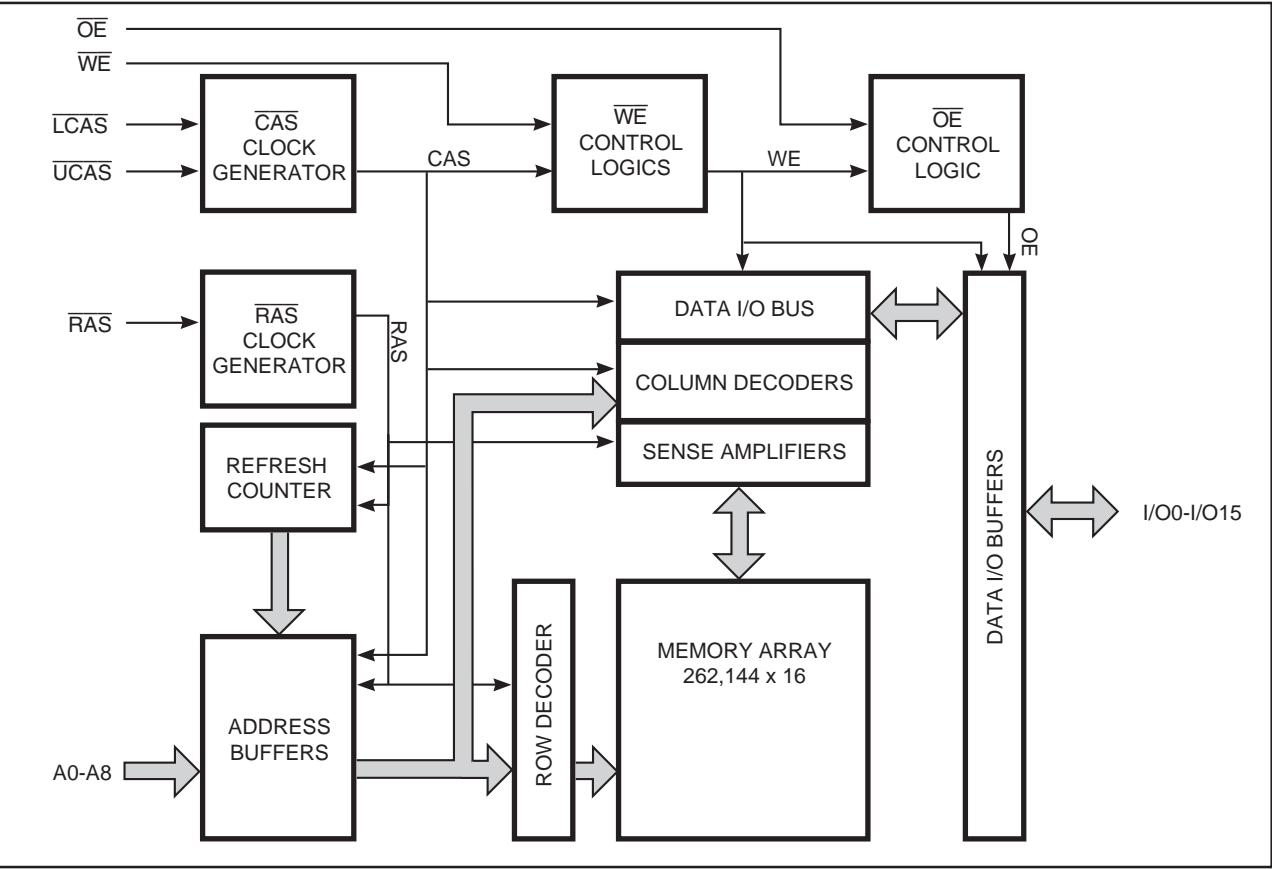
These features make the IS41C16257A and the IS41LV16257A ideally suited for high band-width graphics, digital signal processing, high-performance computing systems, and peripheral applications.

The IS41C16257A and the IS41LV16257A are packaged in a 40-pin, 400-mil SOJ and TSOP (Type II).

### KEY TIMING PARAMETERS

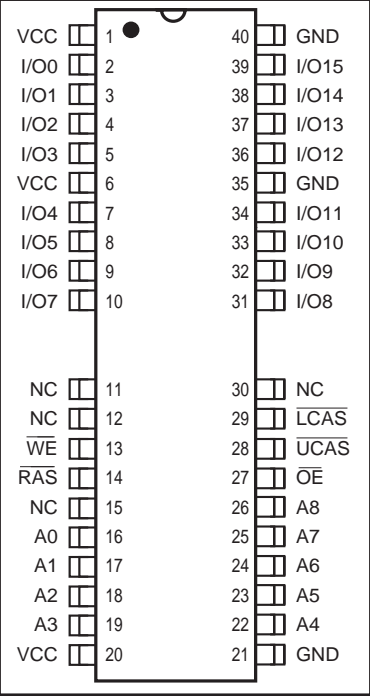
Parameter	-35	-60	Unit
Max. $\overline{\text{RAS}}$ Access Time ( $t_{\text{RAC}}$ )	35	60	ns
Max. $\overline{\text{CAS}}$ Access Time ( $t_{\text{CAC}}$ )	11	15	ns
Max. Column Address Access Time ( $t_{\text{AA}}$ )	18	30	ns
Min. Fast Page Mode Cycle Time ( $t_{\text{PC}}$ )	14	25	ns
Min. Read/Write Cycle Time ( $t_{\text{RC}}$ )	60	110	ns

FUNCTIONAL BLOCK DIAGRAM

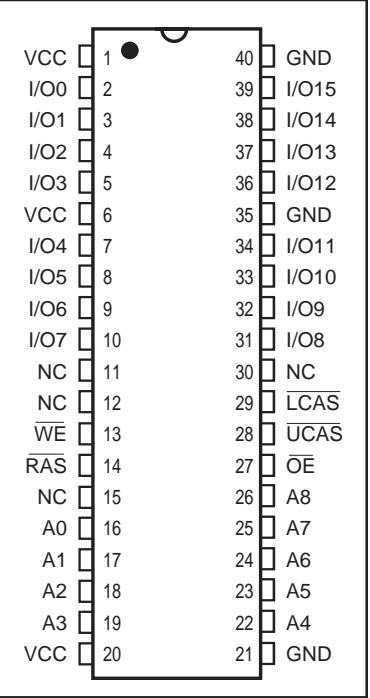


PIN CONFIGURATIONS

40-Pin TSOP (Type II)



40-Pin SOJ



PIN DESCRIPTIONS

A0-A8	Address Inputs
I/O0-I/O15	Data Inputs/Outputs
$\overline{WE}$	Write Enable
$\overline{OE}$	Output Enable
$\overline{RAS}$	Row Address Strobe
UCAS	Upper Column Address Strobe
$\overline{LCAS}$	Lower Column Address Strobe
Vcc	Power
GND	Ground
NC	No Connection

## TRUTH TABLE

Function	$\overline{\text{RAS}}$	$\overline{\text{LCAS}}$	$\overline{\text{UCAS}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	Address tr/tc	I/O
Standby	H	H	H	X	X	X	High-Z
Read: Word	L	L	L	H	L	ROW/COL	DOUT
Read: Lower Byte	L	L	H	H	L	ROW/COL	Lower Byte, DOUT Upper Byte, High-Z
Read: Upper Byte	L	H	L	H	L	ROW/COL	Lower Byte, High-Z Upper Byte, DOUT
Write: Word (Early Write)	L	L	L	L	X	ROW/COL	DIN
Write: Lower Byte (Early Write)	L	L	H	L	X	ROW/COL	Lower Byte, DIN Upper Byte, High-Z
Write: Upper Byte (Early Write)	L	H	L	L	X	ROW/COL	Lower Byte, High-Z Upper Byte, DIN
Read-Write <sup>(1,2)</sup>	L	L	L	HØL	LØH	ROW/COL	DOUT, DIN
Hidden Refresh <sup>2)</sup>	Read LØHØL	L	L	H	L	ROW/COL	DOUT
	Write LØHØL	L	L	L	X	ROW/COL	DOUT
$\overline{\text{RAS}}$ -Only Refresh	L	H	H	X	X	ROW/NA	High-Z
CBR Refresh <sup>(3)</sup>	HØL	L	L	X	X	X	High-Z

### Notes:

1. These WRITE cycles may also be BYTE WRITE cycles (either  $\overline{\text{LCAS}}$  or  $\overline{\text{UCAS}}$  active).
2. These READ cycles may also be BYTE READ cycles (either  $\overline{\text{LCAS}}$  or  $\overline{\text{UCAS}}$  active).
3. At least one of the two CAS signals must be active ( $\overline{\text{LCAS}}$  or  $\overline{\text{UCAS}}$ ).

## FUNCTIONAL DESCRIPTION

The IS41C16257A and the IS41LV16257A are CMOS DRAMs optimized for high-speed bandwidth, low-power applications. During READ or WRITE cycles, each bit is uniquely addressed through the 18 address bits. These are entered nine bits (A0-A8) at a time. The row address is latched by the Row Address Strobe ( $\overline{\text{RAS}}$ ). The column address is latched by the Column Address Strobe ( $\overline{\text{CAS}}$ ).  $\overline{\text{RAS}}$  is used to latch the first nine bits and  $\overline{\text{CAS}}$  is used to latch the latter nine bits.

The IS41C16257A and the IS41LV16257A has two  $\overline{\text{CAS}}$  controls,  $\overline{\text{LCAS}}$  and  $\overline{\text{UCAS}}$ . The  $\overline{\text{LCAS}}$  and  $\overline{\text{UCAS}}$  inputs internally generate a  $\overline{\text{CAS}}$  signal functioning in an identical manner to the single  $\overline{\text{CAS}}$  input on the other 256K x 16 DRAMs. The key difference is that each  $\overline{\text{CAS}}$  controls its corresponding I/O tristate logic (in conjunction with  $\overline{\text{OE}}$  and  $\overline{\text{WE}}$  and  $\overline{\text{RAS}}$ ).  $\overline{\text{LCAS}}$  controls I/O0 - I/O7 and  $\overline{\text{UCAS}}$  controls I/O8 - I/O15.

The IS41C16257A and the IS41LV16257A  $\overline{\text{CAS}}$  function is determined by the first  $\overline{\text{CAS}}$  ( $\overline{\text{LCAS}}$  or  $\overline{\text{UCAS}}$ ) transitioning LOW and the last transitioning back HIGH. The two  $\overline{\text{CAS}}$  controls give the IS41C16257A both BYTE READ and BYTE WRITE cycle capabilities.

### Memory Cycle

A memory cycle is initiated by bringing  $\overline{\text{RAS}}$  LOW and it is terminated by returning both  $\overline{\text{RAS}}$  and  $\overline{\text{CAS}}$  HIGH. To ensure proper device operation and data integrity any memory cycle, once initiated, must not be ended or aborted before the minimum  $t_{\text{RAS}}$  time has expired. A new cycle must not be initiated until the minimum precharge time  $t_{\text{RP}}$ ,  $t_{\text{CP}}$  has elapsed.

### Read Cycle

A read cycle is initiated by the falling edge of  $\overline{\text{CAS}}$  or  $\overline{\text{OE}}$ , whichever occurs last, while holding  $\overline{\text{WE}}$  HIGH. The column address must be held for a minimum time specified by  $t_{\text{AR}}$ . Data Out becomes valid only when  $t_{\text{RAC}}$ ,  $t_{\text{AA}}$ ,  $t_{\text{CAC}}$  and  $t_{\text{OEA}}$  are all satisfied. As a result, the access time is dependent

on the timing relationships between these parameters.

### Write Cycle

A write cycle is initiated by the falling edge of  $\overline{\text{CAS}}$  and  $\overline{\text{WE}}$ , whichever occurs last. The input data must be valid at or before the falling edge of  $\overline{\text{CAS}}$  or  $\overline{\text{WE}}$ , whichever occurs last.

### Refresh Cycle

To retain data, 512 refresh cycles are required in each 8 ms period. There are two ways to refresh the memory:

1. By clocking each of the 512 row addresses (A0 through A8) with  $\overline{\text{RAS}}$  at least once every 8 ms. Any read, write, read-modify-write or  $\overline{\text{RAS}}$ -only cycle refreshes the addressed row.
2. Using a  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycle.  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh is activated by the falling edge of  $\overline{\text{RAS}}$ , while holding  $\overline{\text{CAS}}$  LOW. In  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycle, an internal 9-bit counter provides the row addresses and the external address inputs are ignored.

$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  is a refresh-only mode and no data access or device selection is allowed. Thus, the output remains in the High-Z state during the cycle.

### Power-On

After application of the  $V_{\text{CC}}$  supply, an initial pause of 200  $\mu\text{s}$  is required followed by a minimum of eight initialization cycles (any combination of cycles containing a  $\overline{\text{RAS}}$  signal).

During power-on, it is recommended that  $\overline{\text{RAS}}$  track with  $V_{\text{CC}}$  or be held at a valid  $V_{\text{IH}}$  to avoid current surges.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

Symbol	Parameters		Rating	Unit
V <sub>T</sub>	Voltage on Any Pin Relative to GND	5V 3.3V	–1.0 to +7.0 –0.5 to +4.6	V
V <sub>CC</sub>	Supply Voltage	5V 3.3V	–1.0 to +7.0 –0.5 to +4.6	V
I <sub>OUT</sub>	Output Current		50	mA
P <sub>D</sub>	Power Dissipation		1	W
T <sub>A</sub>	Operation Temperature	Com.	0 to +70	°C
T <sub>STG</sub>	Storage Temperature		–55 to +125	°C

**Note:**

1. Stress greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**RECOMMENDED OPERATING CONDITIONS** (Voltages are referenced to GND)

Symbol	Parameter	Voltage	Min.	Typ.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	5V	4.5	5.0	5.5	V
V <sub>CC</sub>	Supply Voltage	3.3V	3.0	3.3	3.6	V
V <sub>IH</sub>	Input High Voltage	5V	2.4	—	V <sub>CC</sub> + 1.0	V
V <sub>IH</sub>	Input High Voltage	3.3V	2.0	—	V <sub>CC</sub> + 0.3	V
V <sub>IL</sub>	Input Low Voltage	5V	–1.0	—	0.8	V
V <sub>IL</sub>	Input Low Voltage	3.3V	–0.3	—	0.8	V
T <sub>A</sub>	Ambient Temperature	Com.	0	—	70	°C

**CAPACITANCE<sup>(1,2)</sup>**

Symbol	Parameter	Max.	Unit
C <sub>IN1</sub>	Input Capacitance: A0-A8	5	pF
C <sub>IN2</sub>	Input Capacitance: $\overline{RAS}$ , $\overline{UCAS}$ , $\overline{LCAS}$ , $\overline{WE}$ , $\overline{OE}$	7	pF
C <sub>IO</sub>	Data Input/Output Capacitance: I/O0-I/O15	7	pF

**Notes:**

1. Tested initially and after any design or process changes that may affect these parameters.
2. Test conditions: T<sub>A</sub> = 25°C, f = 1 MHz, V<sub>CC</sub> = 5.0V ± 10% or V<sub>CC</sub> = 3.3V ± 10%.

**ELECTRICAL CHARACTERISTICS<sup>(1)</sup>** (Recommended Operation Conditions unless otherwise noted.)

Symbol	Parameter	Test Condition	Speed	Min.	Max.	Unit
I <sub>IL</sub>	Input Leakage Current	Any input $0V \leq V_{IN} \leq V_{CC}$ Other inputs not under test = 0V		-10	10	μA
I <sub>IO</sub>	Output Leakage Current	Output is disabled (Hi-Z) $0V \leq V_{OUT} \leq V_{CC}$		-10	10	μA
V <sub>OH</sub>	Output High Voltage Level	I <sub>OH</sub> = -2 mA		2.4	—	V
V <sub>OL</sub>	Output Low Voltage Level	I <sub>OL</sub> = +2 mA		—	0.4	V
I <sub>CC1</sub>	Stand-by Current: TTL	$\overline{RAS}, \overline{LCAS}, \overline{UCAS} \geq V_{IH}$	Com. 5V	—	4	mA
I <sub>CC1</sub>	Stand-by Current: TTL	$\overline{RAS}, \overline{LCAS}, \overline{UCAS} \geq V_{IH}$	Com. 3.3V	—	4	mA
I <sub>CC2</sub>	Stand-by Current: CMOS	$\overline{RAS}, \overline{LCAS}, \overline{UCAS} \geq V_{CC} - 0.2V$	5V	—	2	mA
I <sub>CC2</sub>	Stand-by Current: CMOS	$\overline{RAS}, \overline{LCAS}, \overline{UCAS} \geq V_{CC} - 0.2V$	3.3V	—	1	mA
I <sub>CC3</sub>	Operating Current: Random Read/Write <sup>(2,3,4)</sup> Average Power Supply Current	$\overline{RAS}, \overline{LCAS}, \overline{UCAS}$ , Address Cycling, t <sub>RC</sub> = t <sub>RC</sub> (min.)	-35 -60	— —	230 170	mA
I <sub>CC4</sub>	Operating Current: Fast Page Mode <sup>(2,3,4)</sup> Average Power Supply Current	$\overline{RAS} = V_{IL}, \overline{LCAS}, \overline{UCAS}$ , Cycling t <sub>PC</sub> = t <sub>PC</sub> (min.)	-35 -60	— —	220 160	mA
I <sub>CC5</sub>	Refresh Current: $\overline{RAS}$ -Only <sup>(2,3)</sup> Average Power Supply Current	$\overline{RAS}$ Cycling, $\overline{LCAS}, \overline{UCAS} \geq V_{IH}$ t <sub>RC</sub> = t <sub>RC</sub> (min.)	-35 -60	— —	230 170	mA
I <sub>CC6</sub>	Refresh Current: CBR <sup>(2,3,5)</sup> Average Power Supply Current	$\overline{RAS}, \overline{LCAS}, \overline{UCAS}$ Cycling t <sub>RC</sub> = t <sub>RC</sub> (min.)	-35 -60	— —	230 170	mA

**Notes:**

1. An initial pause of 200 μs is required after power-up followed by eight  $\overline{RAS}$  refresh cycles ( $\overline{RAS}$ -Only or CBR) before proper device operation is assured. The eight  $\overline{RAS}$  cycles wake-up should be repeated any time the t<sub>REF</sub> refresh requirement is exceeded.
2. Dependent on cycle rates.
3. Specified values are obtained with minimum cycle time and the output open.
4. Column-address is changed once each fast page cycle.
5. Enables on-chip refresh and address counters.

**AC CHARACTERISTICS**<sup>(1,2,3,4,5,6)</sup> (Recommended Operating Conditions unless otherwise noted.)

Symbol	Parameter	-35		-60		Units
		Min.	Max.	Min.	Max.	
t <sub>RC</sub>	Random READ or WRITE Cycle Time	70	—	110	—	ns
t <sub>RAC</sub>	Access Time from $\overline{\text{RAS}}$ <sup>(6, 7)</sup>	—	35	—	60	ns
t <sub>CAC</sub>	Access Time from $\overline{\text{CAS}}$ <sup>(6, 8, 15)</sup>	—	11	—	15	ns
t <sub>AA</sub>	Access Time from Column-Address <sup>(6)</sup>	—	18	—	30	ns
t <sub>RAS</sub>	$\overline{\text{RAS}}$ Pulse Width	35	10K	60	10K	ns
t <sub>RP</sub>	$\overline{\text{RAS}}$ Precharge Time	25	—	40	—	ns
t <sub>CAS</sub>	$\overline{\text{CAS}}$ Pulse Width <sup>(26)</sup>	6	10K	10	10K	ns
t <sub>CP</sub>	$\overline{\text{CAS}}$ Precharge Time <sup>(9, 25)</sup>	6	—	10	—	ns
t <sub>CSH</sub>	$\overline{\text{CAS}}$ Hold Time <sup>(21)</sup>	35	—	60	—	ns
t <sub>RCD</sub>	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time <sup>(10, 20)</sup>	13	24	20	45	ns
t <sub>ASR</sub>	Row-Address Setup Time	0	—	0	—	ns
t <sub>RAH</sub>	Row-Address Hold Time	6	—	10	—	ns
t <sub>ASC</sub>	Column-Address Setup Time <sup>(20)</sup>	0	—	0	—	ns
t <sub>CAH</sub>	Column-Address Hold Time <sup>(20)</sup>	6	—	10	—	ns
t <sub>AR</sub>	Column-Address Hold Time (referenced to $\overline{\text{RAS}}$ )	30	—	45	—	ns
t <sub>RAD</sub>	$\overline{\text{RAS}}$ to Column-Address Delay Time <sup>(11)</sup>	12	20	15	30	ns
t <sub>RAL</sub>	Column-Address to $\overline{\text{RAS}}$ Lead Time	18	—	30	—	ns
t <sub>RPC</sub>	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Precharge Time	0	—	0	—	ns
t <sub>RSH</sub>	$\overline{\text{RAS}}$ Hold Time <sup>(27)</sup>	10	—	15	—	ns
t <sub>CLZ</sub>	$\overline{\text{CAS}}$ to Output in Low-Z <sup>(15, 29)</sup>	3	—	3	—	ns
t <sub>CRP</sub>	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time <sup>(21)</sup>	5	—	5	—	ns
t <sub>OD</sub>	Output Disable Time <sup>(19, 28, 29)</sup>	3	15	3	15	ns
t <sub>OE</sub>	Output Enable Time <sup>(15, 16)</sup>	—	11	—	15	ns
t <sub>OEHC</sub>	$\overline{\text{OE}}$ HIGH Hold Time from $\overline{\text{CAS}}$ HIGH	8	—	8	—	ns
t <sub>OEP</sub>	$\overline{\text{OE}}$ HIGH Pulse Width	8	—	8	—	ns
t <sub>OES</sub>	$\overline{\text{OE}}$ LOW to $\overline{\text{CAS}}$ HIGH Setup Time	5	—	7	—	ns
t <sub>RCS</sub>	Read Command Setup Time <sup>(17, 20)</sup>	0	—	0	—	ns
t <sub>RRH</sub>	Read Command Hold Time (referenced to $\overline{\text{RAS}}$ ) <sup>(12)</sup>	0	—	0	—	ns
t <sub>RCH</sub>	Read Command Hold Time (referenced to $\overline{\text{CAS}}$ ) <sup>(12, 17, 21)</sup>	0	—	0	—	ns
t <sub>WCH</sub>	Write Command Hold Time <sup>(17, 27)</sup>	5	—	10	—	ns
t <sub>WCR</sub>	Write Command Hold Time (referenced to $\overline{\text{RAS}}$ ) <sup>(17)</sup>	30	—	50	—	ns
t <sub>WP</sub>	Write Command Pulse Width <sup>(17)</sup>	5	—	10	—	ns
t <sub>WPZ</sub>	$\overline{\text{WE}}$ Pulse Widths to Disable Outputs	10	—	10	—	ns
t <sub>RWL</sub>	Write Command to $\overline{\text{RAS}}$ Lead Time <sup>(17)</sup>	10	—	15	—	ns
t <sub>CWL</sub>	Write Command to $\overline{\text{CAS}}$ Lead Time <sup>(17, 21)</sup>	8	—	15	—	ns
t <sub>WCS</sub>	Write Command Setup Time <sup>(14, 17, 20)</sup>	0	—	0	—	ns
t <sub>DHR</sub>	Data-in Hold Time (referenced to $\overline{\text{RAS}}$ )	30	—	46	—	ns

(Continued)

**AC CHARACTERISTICS**<sup>(1,2,3,4,5,6)</sup> (Recommended Operating Conditions unless otherwise noted.)

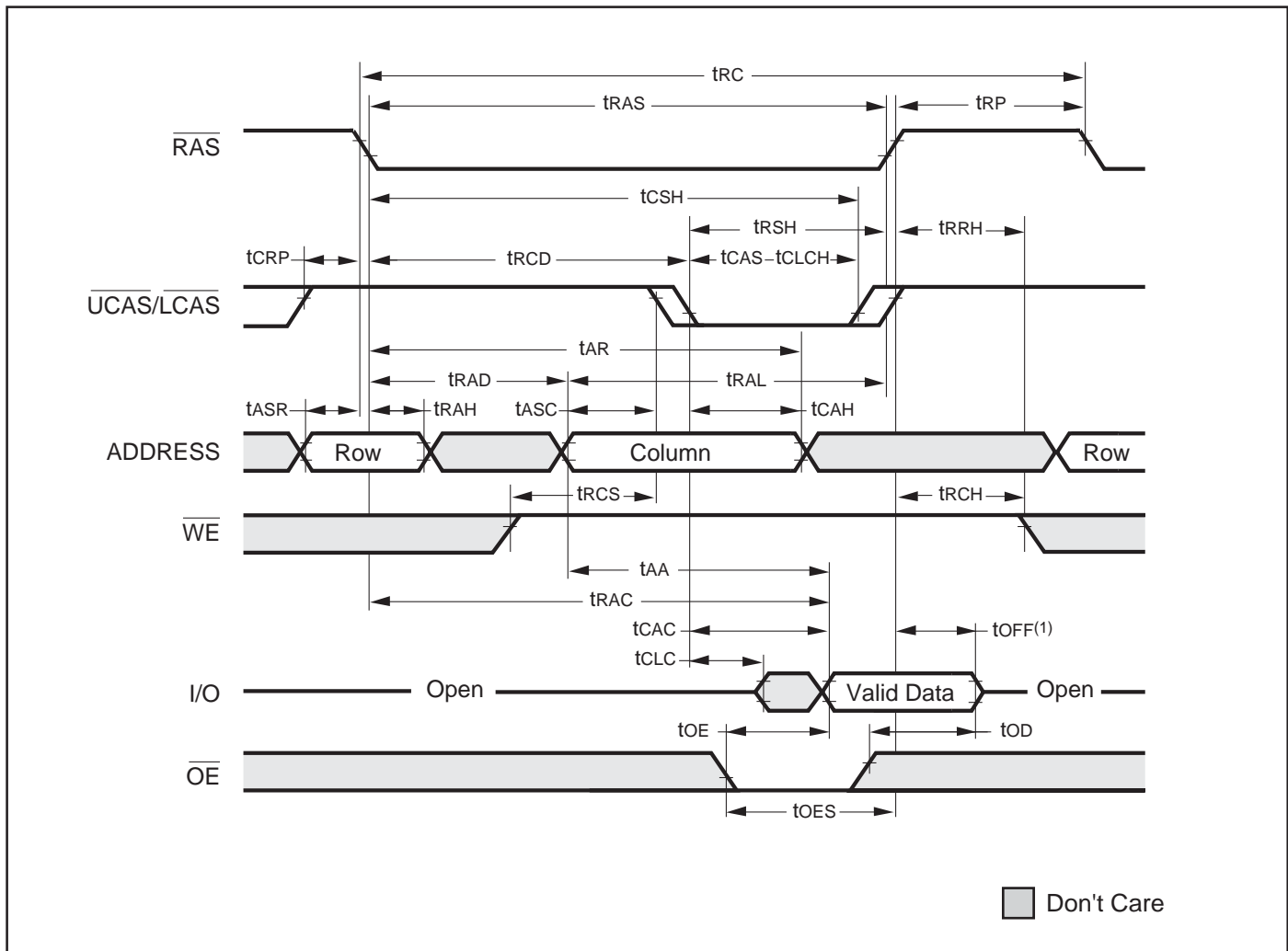
Symbol	Parameter	-35		-60		Units
		Min.	Max.	Min.	Max.	
t <sub>ACH</sub>	Column-Address Setup Time to $\overline{\text{CAS}}$ Precharge during WRITE Cycle	15	—	15	—	ns
t <sub>OEH</sub>	$\overline{\text{OE}}$ Hold Time from $\overline{\text{WE}}$ during READ-MODIFY-WRITE cycle <sup>(18)</sup>	8	—	15	—	ns
t <sub>DS</sub>	Data-In Setup Time <sup>(15, 22)</sup>	0	—	0	—	ns
t <sub>DH</sub>	Data-In Hold Time <sup>(15, 22)</sup>	6	—	10	—	ns
t <sub>RWC</sub>	READ-MODIFY-WRITE Cycle Time	80	—	140	—	ns
t <sub>RWD</sub>	$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time during READ-MODIFY-WRITE Cycle <sup>(14)</sup>	46	—	80	—	ns
t <sub>CWD</sub>	$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time <sup>(14, 20)</sup>	25	—	36	—	ns
t <sub>AWD</sub>	Column-Address to $\overline{\text{WE}}$ Delay Time <sup>(14)</sup>	30	—	49	—	ns
t <sub>PC</sub>	Fast Page Mode READ or WRITE Cycle Time <sup>(24)</sup>	14	—	25	—	ns
t <sub>RASP</sub>	$\overline{\text{RAS}}$ Pulse Width	35	100K	60	100K	ns
t <sub>CPA</sub>	Access Time from $\overline{\text{CAS}}$ Precharge <sup>(15)</sup>	—	20	—	35	ns
t <sub>PRWC</sub>	READ-WRITE Cycle Time <sup>(24)</sup>	45	—	60	—	ns
t <sub>OFF</sub>	Output Buffer Turn-Off Delay from $\overline{\text{CAS}}$ or $\overline{\text{RAS}}$ <sup>(13,15,19, 29)</sup>	3	10	3	15	ns
t <sub>WHZ</sub>	Output Disable Delay from $\overline{\text{WE}}$	3	10	3	15	ns
t <sub>CLCH</sub>	Last $\overline{\text{CAS}}$ going LOW to First $\overline{\text{CAS}}$ returning HIGH <sup>(23)</sup>	10	—	10	—	ns
t <sub>CSR</sub>	$\overline{\text{CAS}}$ Setup Time (CBR REFRESH) <sup>(30, 20)</sup>	8	—	10	—	ns
t <sub>CHR</sub>	$\overline{\text{CAS}}$ Hold Time (CBR REFRESH) <sup>(30, 21)</sup>	8	—	10	—	ns
t <sub>ORD</sub>	$\overline{\text{OE}}$ Setup Time prior to $\overline{\text{RAS}}$ during HIDDEN REFRESH Cycle	0	—	0	—	ns
t <sub>REF</sub>	Refresh Period (512 Cycles)	—	8	—	8	ms
t <sub>tr</sub>	Transition Time (Rise or Fall) <sup>(2, 3)</sup>	2	50	2	50	ns



**Notes:**

1. An initial pause of 200  $\mu$ s is required after power-up followed by eight  $\overline{\text{RAS}}$  refresh cycle ( $\overline{\text{RAS}}$ -Only or CBR) before proper device operation is assured. The eight  $\overline{\text{RAS}}$  cycles wake-up should be repeated any time the  $t_{\text{REF}}$  refresh requirement is exceeded.
2.  $V_{\text{IH}}$  (MIN) and  $V_{\text{IL}}$  (MAX) are reference levels for measuring timing of input signals. Transition times, are measured between  $V_{\text{IH}}$  and  $V_{\text{IL}}$  (or between  $V_{\text{IL}}$  and  $V_{\text{IH}}$ ) and assume to be 1 ns for all inputs.
3. In addition to meeting the transition rate specification, all input signals must transit between  $V_{\text{IH}}$  and  $V_{\text{IL}}$  (or between  $V_{\text{IL}}$  and  $V_{\text{IH}}$ ) in a monotonic manner.
4. If  $\overline{\text{CAS}}$  and  $\overline{\text{RAS}} = V_{\text{IH}}$ , data output is High-Z.
5. If  $\overline{\text{CAS}} = V_{\text{IL}}$ , data output may contain data from the last valid READ cycle.
6. Measured with a load equivalent to one TTL gate and 50 pF.
7. Assumes that  $t_{\text{RCD}} \leq t_{\text{RCD}}(\text{MAX})$ . If  $t_{\text{RCD}}$  is greater than the maximum recommended value shown in this table,  $t_{\text{RAC}}$  will increase by the amount that  $t_{\text{RCD}}$  exceeds the value shown.
8. Assumes that  $t_{\text{RCD}} \geq t_{\text{RCD}}(\text{MAX})$ .
9. If  $\overline{\text{CAS}}$  is LOW at the falling edge of  $\overline{\text{RAS}}$ , data out will be maintained from the previous cycle. To initiate a new cycle and clear the data output buffer,  $\overline{\text{CAS}}$  and  $\overline{\text{RAS}}$  must be pulsed for  $t_{\text{CP}}$ .
10. Operation with the  $t_{\text{RCD}}(\text{MAX})$  limit ensures that  $t_{\text{RAC}}(\text{MAX})$  can be met.  $t_{\text{RCD}}(\text{MAX})$  is specified as a reference point only; if  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}(\text{MAX})$  limit, access time is controlled exclusively by  $t_{\text{CAC}}$ .
11. Operation within the  $t_{\text{RAD}}(\text{MAX})$  limit ensures that  $t_{\text{RCD}}(\text{MAX})$  can be met.  $t_{\text{RAD}}(\text{MAX})$  is specified as a reference point only; if  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}(\text{MAX})$  limit, access time is controlled exclusively by  $t_{\text{AA}}$ .
12. Either  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a READ cycle.
13.  $t_{\text{OFF}}(\text{MAX})$  defines the time at which the output achieves the open circuit condition; it is not a reference to  $V_{\text{OH}}$  or  $V_{\text{OL}}$ .
14.  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{AWD}}$  and  $t_{\text{CWD}}$  are restrictive operating parameters in LATE WRITE and READ-MODIFY-WRITE cycle only. If  $t_{\text{WCS}} \geq t_{\text{WCS}}(\text{MIN})$ , the cycle is an EARLY WRITE cycle and the data output will remain open circuit throughout the entire cycle. If  $t_{\text{RWD}} \geq t_{\text{RWD}}(\text{MIN})$ ,  $t_{\text{AWD}} \geq t_{\text{AWD}}(\text{MIN})$  and  $t_{\text{CWD}} \geq t_{\text{CWD}}(\text{MIN})$ , the cycle is a READ-WRITE cycle and the data output will contain data read from the selected cell. If neither of the above conditions is met, the state of I/O (at access time and until  $\overline{\text{CAS}}$  and  $\overline{\text{RAS}}$  or  $\overline{\text{OE}}$  go back to  $V_{\text{IH}}$ ) is indeterminate.  $\overline{\text{OE}}$  held HIGH and  $\overline{\text{WE}}$  taken LOW after  $\overline{\text{CAS}}$  goes LOW result in a LATE WRITE ( $\overline{\text{OE}}$ -controlled) cycle.
15. Output parameter (I/O) is referenced to corresponding  $\overline{\text{CAS}}$  input, I/O0-I/O7 by  $\overline{\text{LCAS}}$  and I/O8-I/O15 by  $\overline{\text{UCAS}}$ .
16. During a READ cycle, if  $\overline{\text{OE}}$  is LOW then taken HIGH before  $\overline{\text{CAS}}$  goes HIGH, I/O goes open. If  $\overline{\text{OE}}$  is tied permanently LOW, a LATE WRITE or READ-MODIFY-WRITE is not possible.
17. Write command is defined as  $\overline{\text{WE}}$  going low.
18. LATE WRITE and READ-MODIFY-WRITE cycles must have both  $t_{\text{OD}}$  and  $t_{\text{OE}}(\text{H})$  met ( $\overline{\text{OE}}$  HIGH during WRITE cycle) in order to ensure that the output buffers will be open during the WRITE cycle. The I/Os will provide the previously written data if  $\overline{\text{CAS}}$  remains LOW and  $\overline{\text{OE}}$  is taken back to LOW after  $t_{\text{OE}}(\text{H})$  is met.
19. The I/Os are in open during READ cycles once  $t_{\text{OD}}$  or  $t_{\text{OFF}}$  occur.
20. The first  $\chi\overline{\text{CAS}}$  edge to transition LOW.
21. The last  $\chi\overline{\text{CAS}}$  edge to transition HIGH.
22. These parameters are referenced to  $\overline{\text{CAS}}$  leading edge in EARLY WRITE cycles and  $\overline{\text{WE}}$  leading edge in LATE WRITE or READ-MODIFY-WRITE cycles.
23. Last falling  $\chi\overline{\text{CAS}}$  edge to first rising  $\chi\overline{\text{CAS}}$  edge.
24. Last rising  $\chi\overline{\text{CAS}}$  edge to next cycle's last rising  $\chi\overline{\text{CAS}}$  edge.
25. Last rising  $\chi\overline{\text{CAS}}$  edge to first falling  $\chi\overline{\text{CAS}}$  edge.
26. Each  $\chi\overline{\text{CAS}}$  must meet minimum pulse width.
27. Last  $\chi\overline{\text{CAS}}$  to go LOW.
28. I/Os controlled, regardless  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ .
29. The 3 ns minimum is a parameter guaranteed by design.
30. Enables on-chip refresh and address counters.

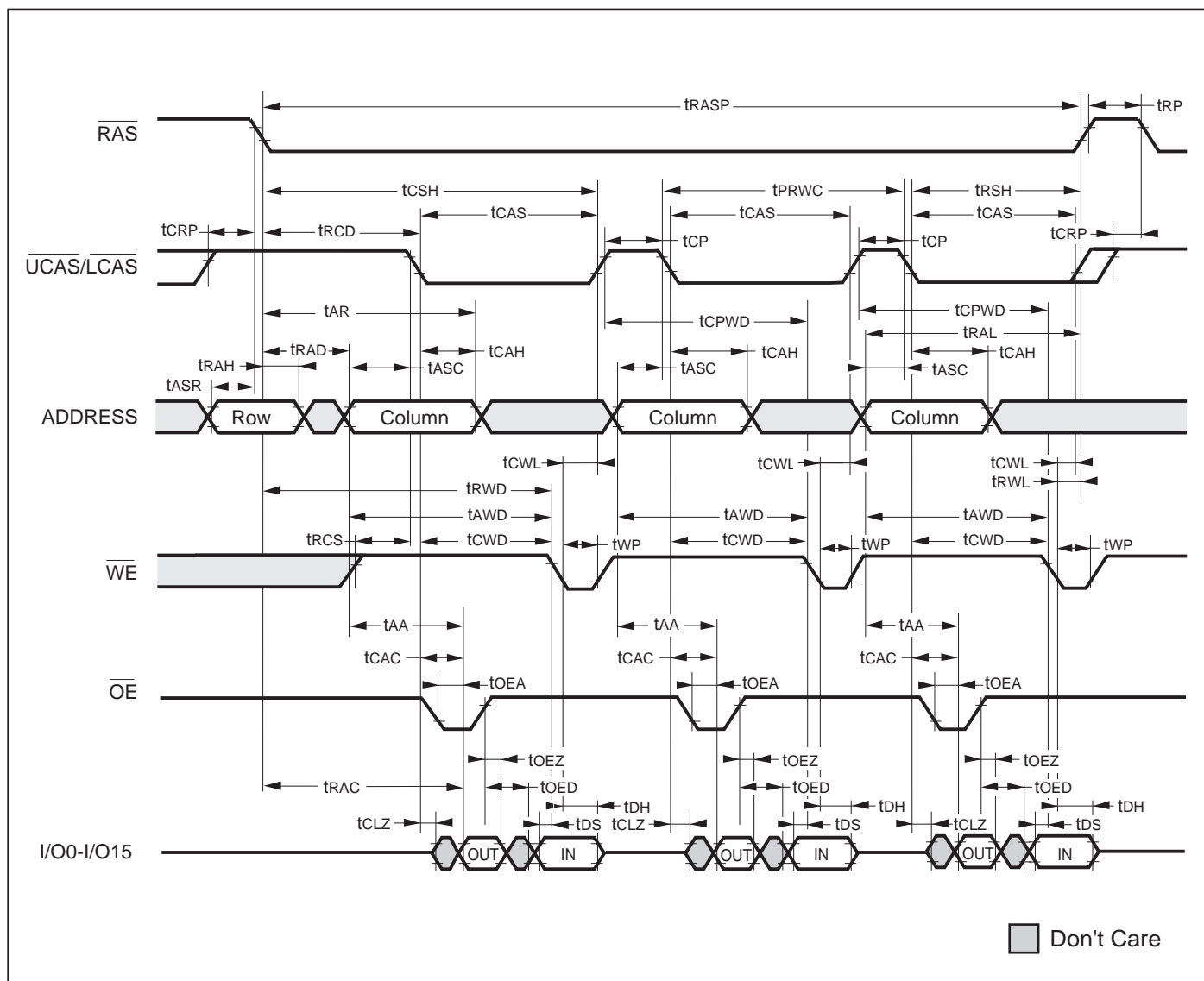
## FAST-PAGE-MODE READ CYCLE



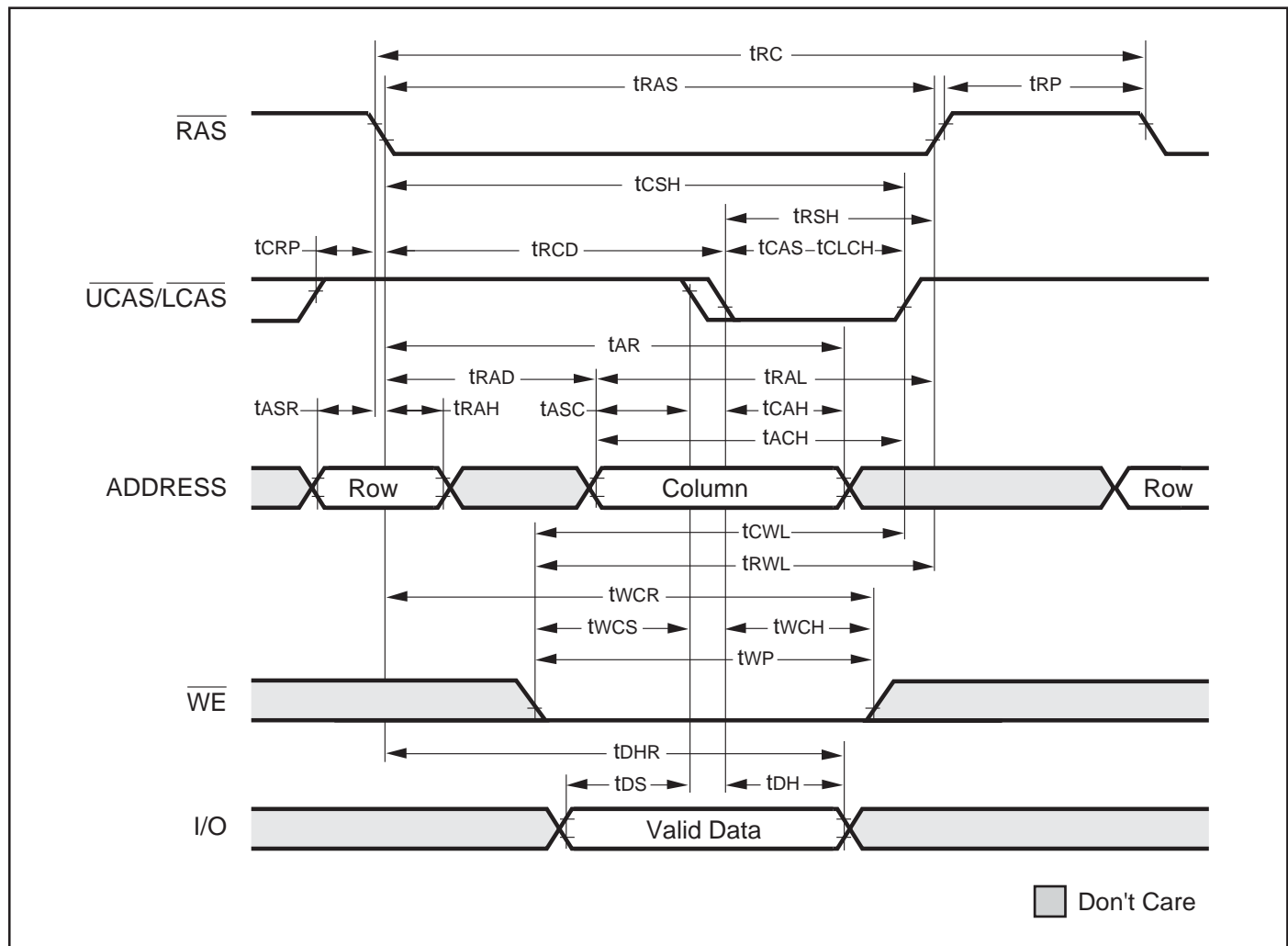
**Note:**

1.  $t_{OFF}$  is referenced from rising edge of  $\overline{CAS}$ .

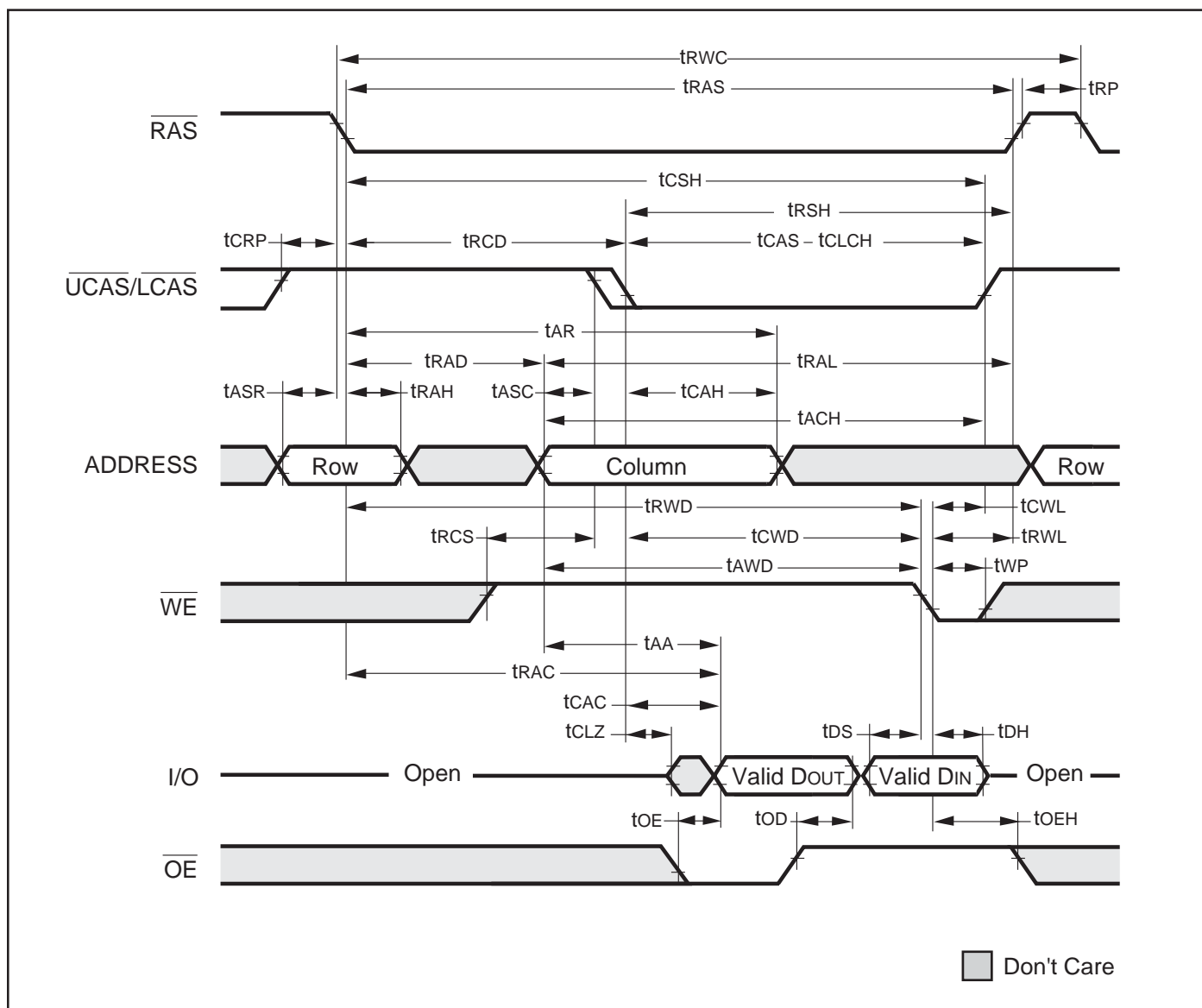
# FAST PAGE MODE READ-MODIFY-WRITE CYCLE



**FAST-PAGE-MODE EARLY WRITE CYCLE** ( $\overline{OE}$  = DON'T CARE)



**FAST-PAGE-MODE READ WRITE CYCLE (LATE WRITE and READ-MODIFY-WRITE Cycles)**



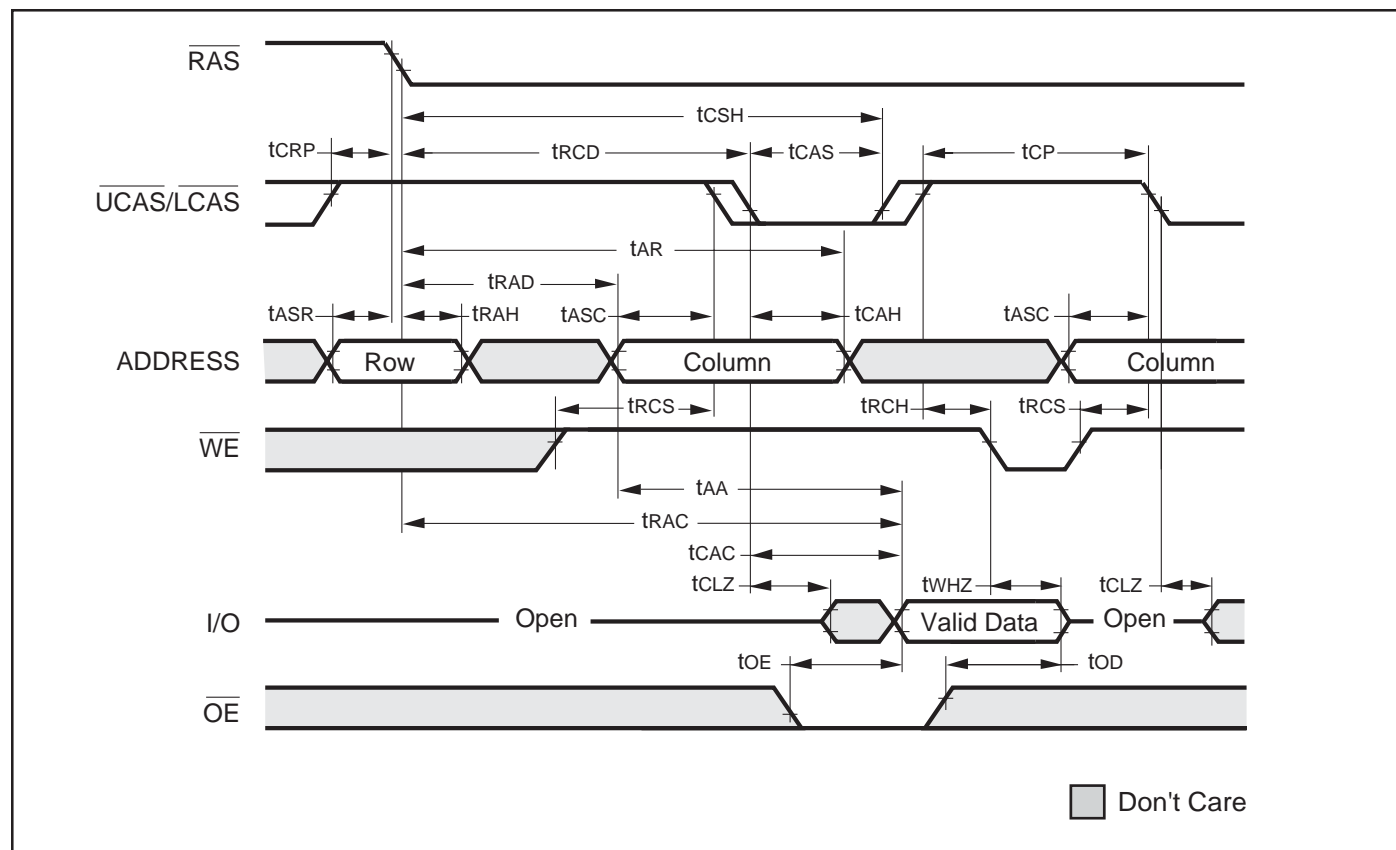
The diagram illustrates the timing relationships for the 28C02 EPROM. The signals shown are:

- RAS**: Row Address Strobe. Timing parameters include  $t_{CRP}$  (setup),  $t_{RCD}$  (delay to column strobe),  $t_{CAS}$  (column access time),  $t_{CP}$  (column pulse width),  $t_{PC}$  (pulse to next row strobe),  $t_{RSH}$  (setup to next row strobe),  $t_{RHCP}$  (hold), and  $t_{RP}$  (return to high).
- UCAS/LCAS**: Universal Column Address Strobe/Latch Enable. Timing parameters include  $t_{AR}$  (setup to row strobe),  $t_{RAH}$  (hold after row strobe),  $t_{ASR}$  (setup to row strobe),  $t_{AD}$  (delay to data),  $t_{ASC}$  (column access time),  $t_{CAH}$  (column access hold),  $t_{RAL}$  (setup to row strobe), and  $t_{CAH}$  (column access hold).
- ADDRESS**: Shows Row and Column address periods. Timing parameters include  $t_{CWL}$  (column write latency),  $tw_{CS}$  (column strobe width),  $tw_{CH}$  (column hold time), and  $tw_P$  (pulse width).
- WE**: Write Enable. Timing parameters include  $tw_{CR}$  (write enable pulse width).
- OE**: Output Enable. Timing parameter is  $t_{DHR}$  (output hold time).
- I/O0-I/O15**: Data bus. Timing parameters include  $t_{DS}$  (data setup time) and  $t_{DH}$  (data hold time).

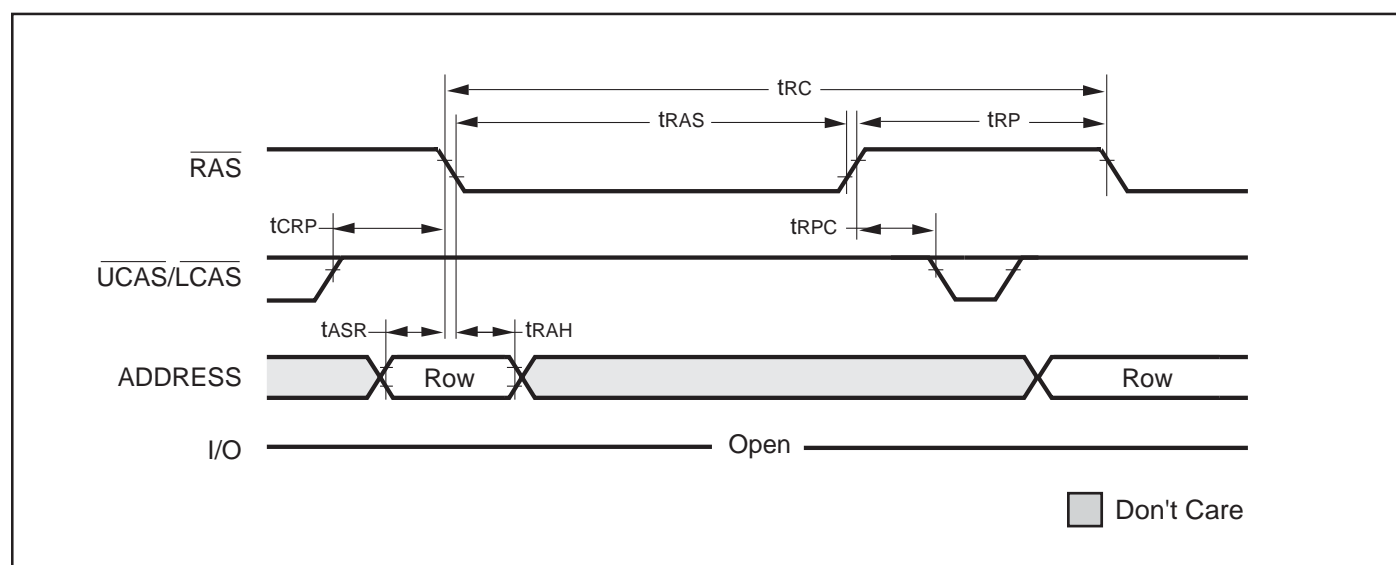
Legend:  Don't Care

## AC WAVEFORMS

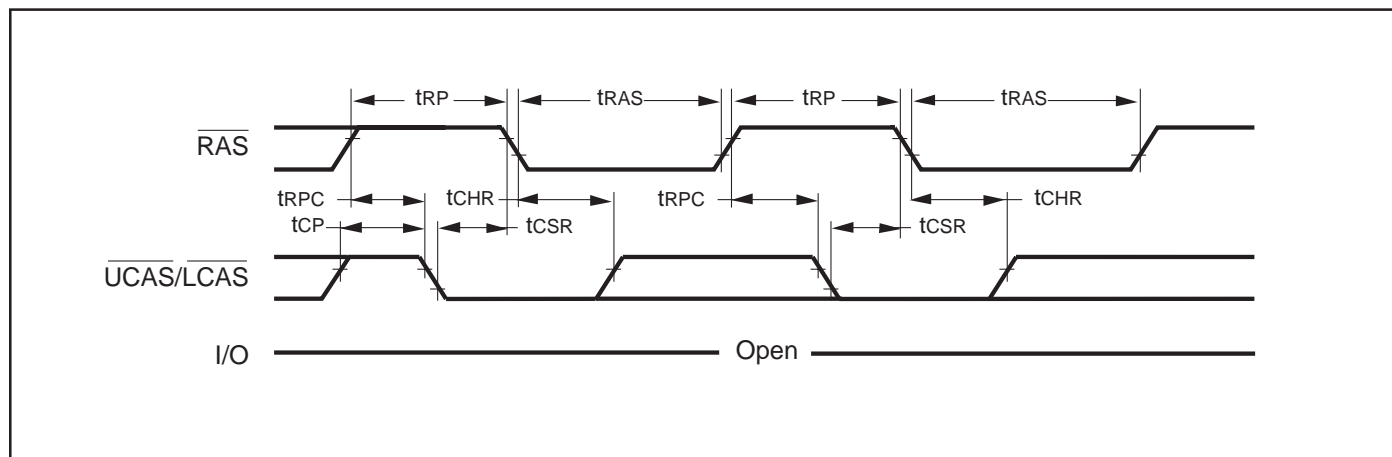
### READ CYCLE (With $\overline{WE}$ -Controlled Disable)



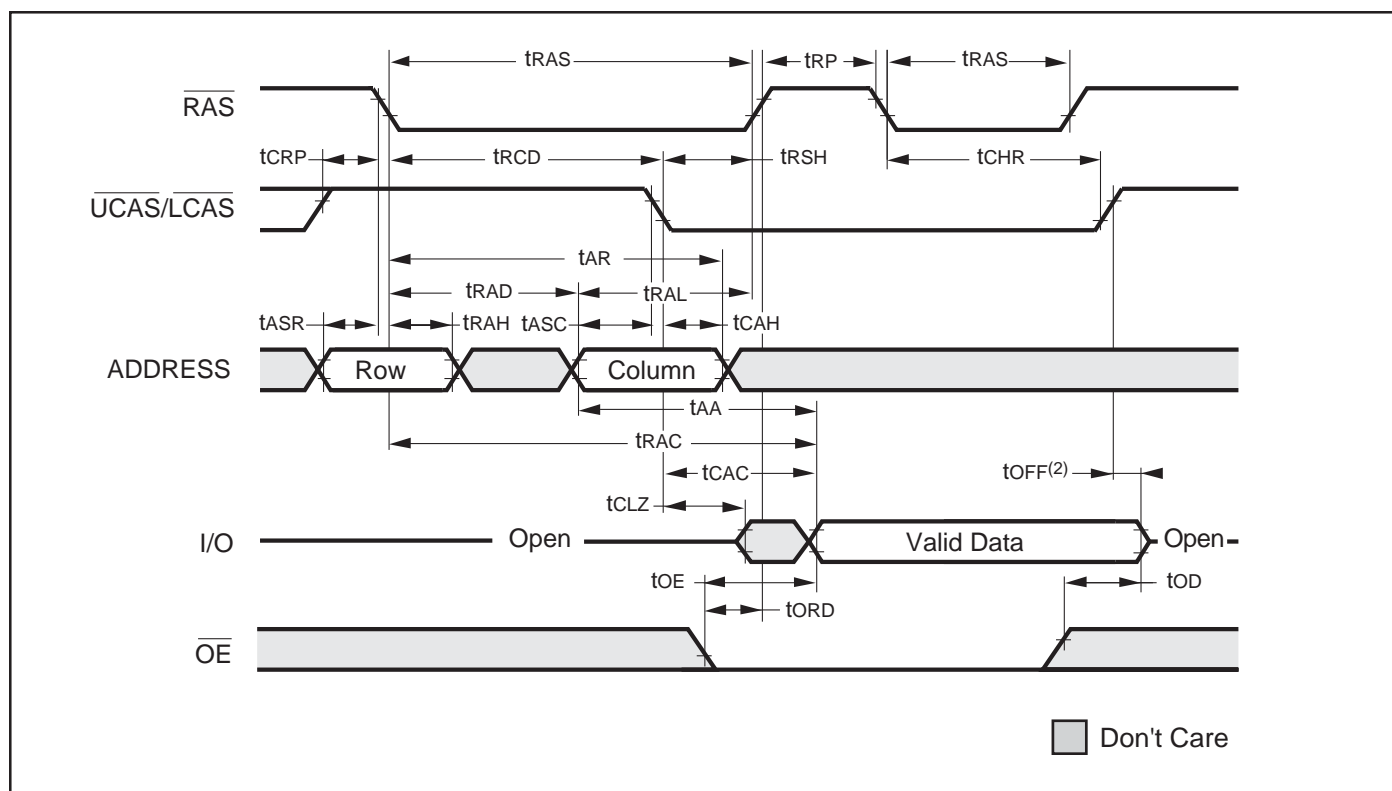
### $\overline{RAS}$ -ONLY REFRESH CYCLE ( $\overline{OE}$ , $\overline{WE}$ = DON'T CARE)



**$\overline{\text{CBR}}$  REFRESH CYCLE** (Addresses;  $\overline{\text{WE}}$ ,  $\overline{\text{OE}}$  = DON'T CARE)



**HIDDEN REFRESH CYCLE<sup>(1)</sup>** ( $\overline{\text{WE}}$  = HIGH;  $\overline{\text{OE}}$  = LOW)



**Notes:**

1. A Hidden Refresh may also be performed after a Write Cycle. In this case,  $\overline{\text{WE}}$  = LOW and  $\overline{\text{OE}}$  = HIGH.
2.  $t_{OFF}$  is referenced from rising edge of  $\overline{\text{RAS}}$  or  $\overline{\text{CAS}}$ , whichever occurs last.



**ORDERING INFORMATION**

**IS41C16257A**

**Commercial Range: 0°C to +70°C**

Speed (ns)	Order Part No.	Package
35	IS41C16257A-35K	400-mil SOJ
	IS41C16257A-35T	400-mil TSOP (Type II)
60	IS41C16257A-60K	400-mil SOJ
	IS41C16257A-60T	400-mil TSOP (Type II)

**ORDERING INFORMATION**

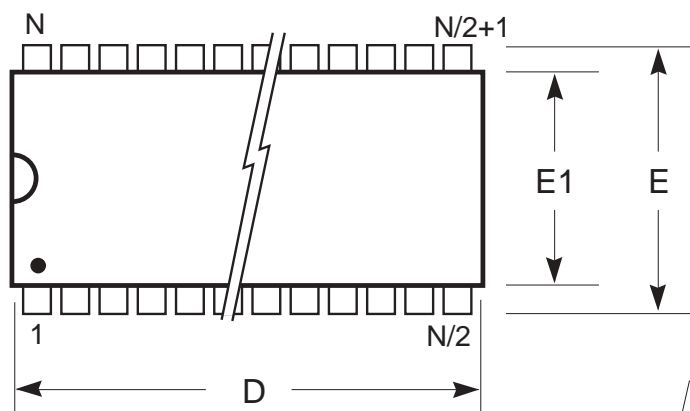
**IS41LV16257A**

**Commercial Range: 0°C to +70°C**

Speed (ns)	Order Part No.	Package
35	IS41LV16257A-35K	400-mil SOJ
	IS41LV16257A-35KL	400-mil SOJ, Lead-free
	IS41LV16257A-35T	400-mil TSOP (Type II)
	IS41LV16257A-35TL	400-mil TSOP (Type II), Lead-free
60	IS41LV16257A-60K	400-mil SOJ
	IS41LV16257A-60KL	400-mil SOJ, Lead-free
	IS41LV16257A-60T	400-mil TSOP (Type II)
	IS41LV16257A-60TL	400-mil TSOP (Type II), Lead-free

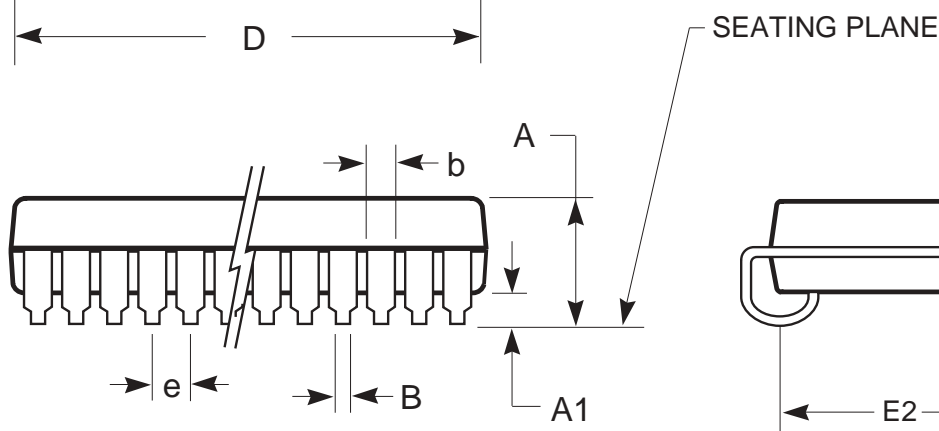
# PACKAGING INFORMATION

**400-mil Plastic SOJ**  
**Package Code: K**



**Notes:**

1. Controlling dimension: millimeters.
2. BSC = Basic lead spacing between centers.
3. Dimensions D and E1 do not include mold flash protrusions and should be measured from the bottom of the package.
4. Reference document: JEDEC MS-027.



Symbol	Millimeters		Inches		Millimeters		Inches		Millimeters		Inches	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
No. Leads (N)	28				32				36			
A	3.25	3.75	0.128	0.148	3.25	3.75	0.128	0.148	3.25	3.75	0.128	0.148
A1	0.64	—	0.025	—	0.64	—	0.025	—	0.64	—	0.025	—
A2	2.08	—	0.082	—	2.08	—	0.082	—	2.08	—	0.082	—
B	0.38	0.51	0.015	0.020	0.38	0.51	0.015	0.020	0.38	0.51	0.015	0.020
b	0.66	0.81	0.026	0.032	0.66	0.81	0.026	0.032	0.66	0.81	0.026	0.032
C	0.18	0.33	0.007	0.013	0.18	0.33	0.007	0.013	0.18	0.33	0.007	0.013
D	18.29	18.54	0.720	0.730	20.82	21.08	0.820	0.830	23.37	23.62	0.920	0.930
E	11.05	11.30	0.435	0.445	11.05	11.30	0.435	0.445	11.05	11.30	0.435	0.445
E1	10.03	10.29	0.395	0.405	10.03	10.29	0.395	0.405	10.03	10.29	0.395	0.405
E2	9.40 BSC		0.370 BSC		9.40 BSC		0.370 BSC		9.40 BSC		0.370 BSC	
e	1.27 BSC		0.050 BSC		1.27 BSC		0.050 BSC		1.27 BSC		0.050 BSC	

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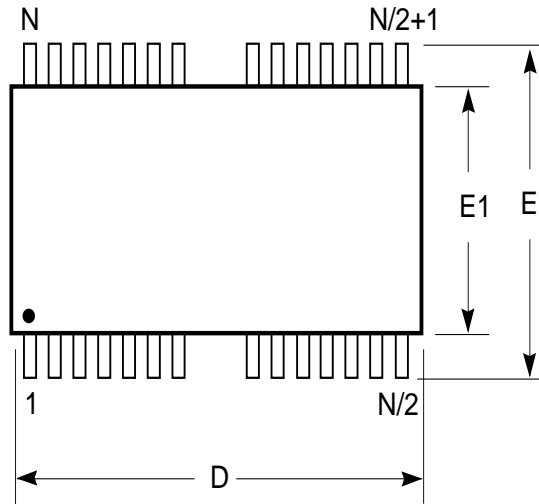
Rev. F  
10/29/03

Symbol	Millimeters		Inches		Millimeters		Inches		Millimeters		Inches	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
No. Leads (N)	<b>40</b>				<b>42</b>				<b>44</b>			
A	3.25	3.75	0.128	0.148	3.25	3.75	0.128	0.148	3.25	3.75	0.128	0.148
A1	0.64	—	0.025	—	0.64	—	0.025	—	0.64	—	0.025	—
A2	2.08	—	0.082	—	2.08	—	0.082	—	2.08	—	0.082	—
B	0.38	0.51	0.015	0.020	0.38	0.51	0.015	0.020	0.38	0.51	0.015	0.020
b	0.66	0.81	0.026	0.032	0.66	0.81	0.026	0.032	0.66	0.81	0.026	0.032
C	0.18	0.33	0.007	0.013	0.18	0.33	0.007	0.013	0.18	0.33	0.007	0.013
D	25.91	26.16	1.020	1.030	27.18	27.43	1.070	1.080	28.45	28.70	1.120	1.130
E	11.05	11.30	0.435	0.445	11.05	11.30	0.435	0.445	11.05	11.30	0.435	0.445
E1	10.03	10.29	0.395	0.405	10.03	10.29	0.395	0.405	10.03	10.29	0.395	0.405
E2	9.40 BSC		0.370 BSC		9.40 BSC		0.370 BSC		9.40 BSC		0.370 BSC	
e	1.27 BSC		0.050 BSC		1.27 BSC		0.050 BSC		1.27 BSC		0.050 BSC	

## PACKAGING INFORMATION

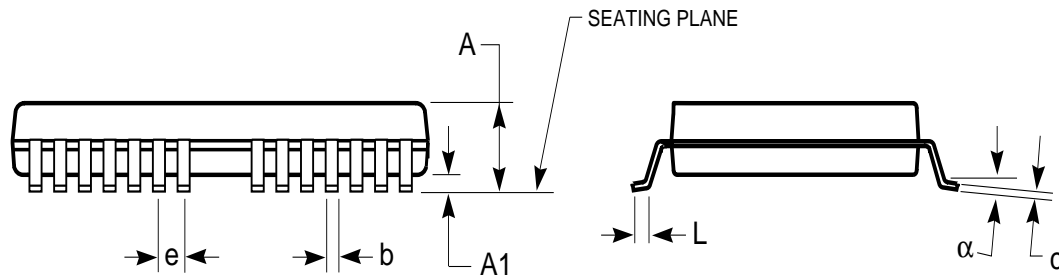
### Plastic TSOP

Package Code: T (Type II)



#### Notes:

1. Controlling dimension: millimeters, unless otherwise specified.
2. BSC = Basic lead spacing between centers.
3. Dimensions D1 and E do not include mold flash protrusions and should be measured from the bottom of the package.
4. Formed leads shall be planar with respect to one another within 0.004 inches at the seating plane.



Plastic TSOP (T - Type II) (MS 25)				
Millimeters		Inches		
Symbol	Min	Max	Min	Max
Ref. Std.				
N	24/26			
A		1.20		0.0472
A1	0.05	0.15	0.002	0.0059
b	0.30	0.51	0.012	0.0201
c	0.12	0.21	0.005	0.0083
D	17.01	17.27	0.670	0.6899
E <sub>1</sub>	7.49	7.75	0.295	0.3051
e	1.27 BSC		0.050 BSC	
E	9.02	9.42	0.462	0.4701
L	0.40	0.60	0.016	0.0236
α	0°	5°	0°	5°

Plastic TSOP (T - Type II) (MS 24)				
Millimeters		Inches		
Symbol	Min	Max	Min	Max
Ref. Std.				
N	40/44			
A		1.20		0.0472
A1	0.05	0.15	0.002	0.0059
b	0.30	0.45	0.012	0.0157
c	0.12	0.21	0.005	0.0083
D	18.31	18.51	0.721	0.7287
E <sub>1</sub>	10.06	10.26	0.396	0.4040
e	0.80 BSC		0.031 BSC	
E	11.56	11.96	0.455	0.4709
L	0.40	0.60	0.016	0.0236
α	0°	8°	0°	8°

Plastic TSOP (T - Type II) (MS 24)				
Millimeters		Inches		
Symbol	Min	Max	Min	Max
Ref. Std.				
N	44/50			
A		1.20		0.0472
A1	0.05	0.15	0.002	0.0059
b	0.30	0.45	0.012	0.0157
c	0.12	0.21	0.005	0.0083
D	20.85	21.05	0.821	0.8287
E <sub>1</sub>	10.06	10.26	0.396	0.4040
e	0.80 BSC		0.031 BSC	
E	11.56	11.96	0.455	0.4709
L	0.40	0.60	0.016	0.0236
α	0°	8°	0°	8°