HM5116100 Series

Preliminary

T-46-23-15

16,777,216-Word x 1-Bit Dynamic Random Access Memory

■ DESCRIPTION

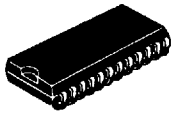
HITACHI/ LOGIC/ARRAYS/MEM

The Hitachi HM5116100 is a CMOS dynamic RAM organized 16,777,216-word x 1-bit. It employs the most advanced CMOS technology for high performance and low power. The HM5116100 offers Fast Page Mode as a high speed access mode.

■ FEATURES

- Single 5V (±10%)
- High Speed
  - Access Time .....60 ns/70 ns/80 ns/100 ns (max)
- Low Power Dissipation
  - Active Mode .....495 mW/440 mW/385 mW/330 mW (max)
  - Standby Mode .....11 mW (max)
- Fast Page Mode Capability
- Long Refresh Period
- 4096 Refresh Cycles .....(64 ms)
- 3 Variations of Refresh
  - $\overline{RAS}$ Only Refresh
  - $\overline{CAS}$ Before $\overline{RAS}$ Refresh
  - Hidden Refresh

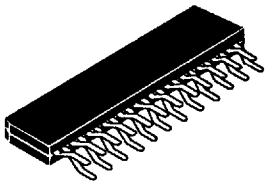
HM5116100J Series



3DCP24D

(CP-24D)

HM5116100Z Series



3DZP24

(ZP-24)

■ ORDERING INFORMATION

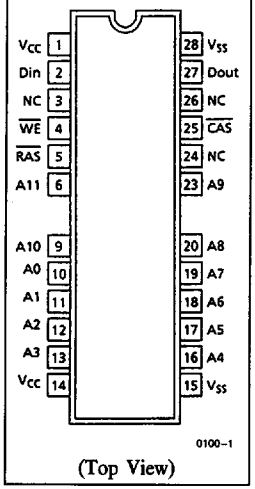
Part No.	Access Time	Package
HM5116100J-6 HM5116100J-7 HM5116100J-8 HM5116100J-10	60 ns 70 ns 80 ns 100 ns	400 mil 24-pin Plastic SOJ (CP-24D)
HM5116100Z-6 HM5116100Z-7 HM5116100Z-8 HM5116100Z-10	60 ns 70 ns 80 ns 100 ns	475 mil 24-pin Plastic ZIP (ZP-24)

■ PIN DESCRIPTION

Pin Name	Function
A_0–A_{11}	Address Input
A_0–A_{11}	Refresh Address Input
D_{in}	Data Input
D_{out}	Data Output
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
$\overline{WE}$	Read/Write Enable
V_{CC}	Power Supply (+ 5V)
V_{SS}	Ground
NC	No Connection

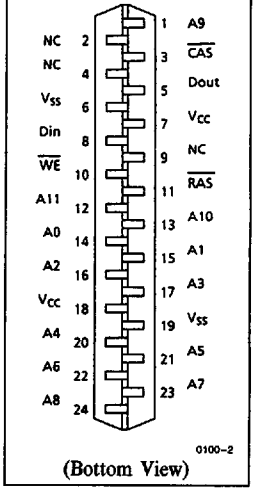
■ PIN OUT

HM5116100J Series



(Top View)

HM5116100Z Series

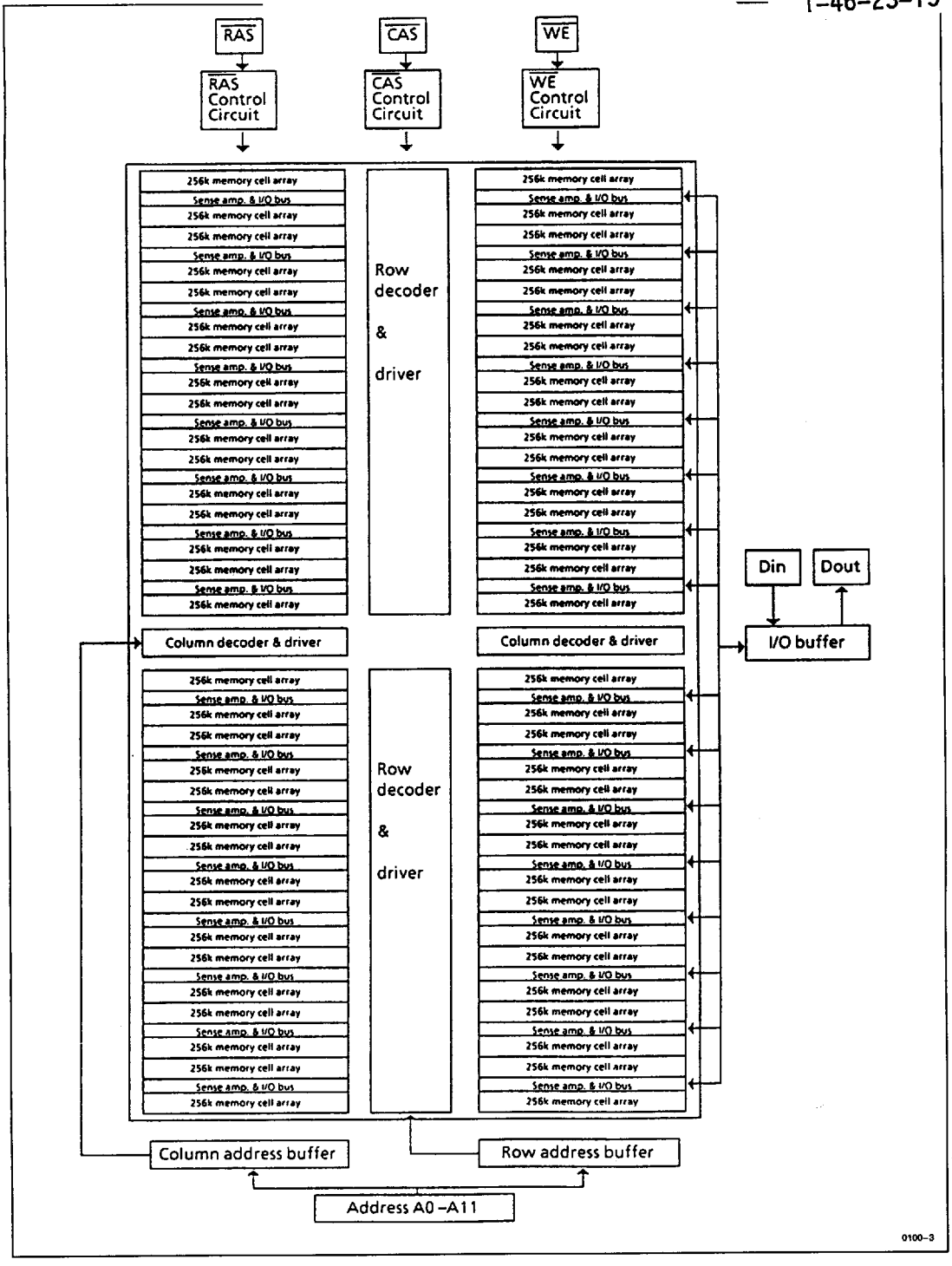


(Bottom View)

This specification is fully compatible with the preliminary 16MB DRAM specifications from TEXAS INSTRUMENTS.

■ BLOCK DIAGRAM

HITACHI/ LOGIC/ARRAYS/MEM — T-46-23-15



■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on Any Pin Relative to V_{SS}	V_T	−1.0 to +7.0	V
Supply Voltage Relative to V_{SS}	V_{CC}	−1.0 to +7.0	V
Short Circuit Output Current	I_{out}	50	mA
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C

■ ELECTRICAL CHARACTERISTICS

• Recommended DC Operating Conditions (T_A = 0 to +70°C)

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

Note: 1. All voltage referenced to V_{SS}.

• DC Electrical Characteristics (T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V)

Parameter	Symbol	HM5116100J/Z								Unit	Test Conditions	Note
		-6		-7		-8		-10				
		Min	Max	Min	Max	Min	Max	Min	Max			
Operating Current	I_{CC1}	—	90	—	80	—	70	—	60	mA	t_{RC} = Min	1, 2
Standby Current	I_{CC2}	—	2	—	2	—	2	—	2	mA	TTL Interface $\overline{RAS}$, $\overline{CAS}$ = V_{IH} D_{out} = High Z	
		—	1	—	1	—	1	—	1	mA	CMOS Interface $\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} − 0.2V D_{out} = High-Z	
$\overline{RAS}$ Only Refresh Current	I_{CC3}	—	90	—	80	—	70	—	60	mA	t_{RC} = Min	2
Standby Current	I_{CC5}	—	5	—	5	—	5	—	5	mA	$\overline{RAS}$ = V_{IH} $\overline{CAS}$ = V_{IL} D_{out} = Enable	1, 4
$\overline{CAS}$ Before $\overline{RAS}$ Refresh Current	I_{CC6}	—	90	—	80	—	70	—	60	mA	t_{RC} = Min	4
Fast Page Mode Current	I_{CC7}	—	70	—	60	—	50	—	45	mA	t_{PC} = Min	1, 3
Input Leakage Current	I_{LI}	−10	10	−10	10	−10	10	−10	10	μA	0V ≤ V_{in} ≤ 7V	
Output Leakage Current	I_{LO}	−10	10	−10	10	−10	10	−10	10	μA	0V ≤ V_{out} ≤ 7V D_{out} = Disable	
Output High Voltage	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	High I_{out} = −5 mA	
Output Low Voltage	V_{OL}	0	0.4	0	0.4	0	0.4	0	0.4	V	Low I_{out} = 4.2 mA	

Notes: 1. I_{CC} depends on output load condition when the device is selected, I_{CC} max is specified at the output open condition.
2. Address can be changed once or less while $\overline{RAS}$ = V_{IL}.
3. Address can be changed once or less while $\overline{CAS}$ = V_{IH}.
4. Clock voltages ($\overline{RAS}$ and $\overline{CAS}$) must be applied simultaneously with or prior to applying supply voltage.

• **Capacitance** (T_A = 25°C, V_{CC} = 5V ±10%)

Parameter	Symbol	Typ	Max	Unit	Note
Input Capacitance (Address, Data-in)	C_{I1}	—	5	pF	1
Input Capacitance (Clocks)	C_{I2}	—	7	pF	1
Output Capacitance (Data-out)	C_O	—	7	pF	1, 2

Notes: 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$ = V_{IH} to disable D_{out}.

• **AC Characteristics** (T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V)[1, 2, 16]

Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters)

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Random Read or Write Cycle Time	t_{RC}	110	—	130	—	150	—	180	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	40	—	50	—	60	—	70	—	ns	
$\overline{CAS}$ Precharge Time	t_{CP}	10	—	10	—	10	—	10	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	60	10000	70	10000	80	10000	100	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	15	10000	18	10000	20	10000	25	10000	ns	
Row Address Setup Time	t_{ASR}	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	10	—	10	—	10	—	10	—	ns	
Column Address Setup Time	t_{ASC}	0	—	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	15	—	15	—	15	—	15	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	45	20	52	20	60	20	75	ns	3
$\overline{RAS}$ to Column Address Delay Time	t_{RAD}	15	30	15	35	15	40	20	55	ns	4
$\overline{RAS}$ Hold Time	t_{RSH}	15	—	18	—	20	—	25	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	60	—	70	—	80	—	100	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	5	—	5	—	5	—	5	—	ns	
Transition Time (Rise and Fall)	t_T	3	30	3	30	3	30	3	30	ns	5

Read Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Access Time from $\overline{RAS}$	t_{RAC}	—	60	—	70	—	80	—	100	ns	6, 7, 17
Access Time from $\overline{CAS}$	t_{CAC}	—	15	—	18	—	20	—	25	ns	7, 8, 17
Access Time from Address	t_{AA}	—	30	—	35	—	40	—	45	ns	7, 9, 17
Read Command Setup Time	t_{RCS}	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	0	—	ns	10
Read Command Hold Time to $\overline{RAS}$	t_{RRH}	5	—	5	—	5	—	5	—	ns	10
Column Address to $\overline{RAS}$ Lead Time	t_{RAL}	30	—	35	—	40	—	45	—	ns	
Column Address to $\overline{CAS}$ Lead Time	t_{CAL}	30	—	35	—	40	—	45	—	ns	
$\overline{CAS}$ to Output in Low-Z	t_{CLZ}	0	—	0	—	0	—	0	—	ns	
Output Data Hold Time	t_{OH}	3	—	3	—	3	—	3	—	ns	
Output Buffer Turn-off Time	t_{OFF}	—	15	—	18	—	20	—	25	ns	11

Write Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Write Command Setup Time	t_{WCS}	0	—	0	—	0	—	0	—	ns	12
Write Command Hold Time	t_{WCH}	15	—	15	—	15	—	15	—	ns	
Write Command Pulse Width	t_{WP}	15	—	15	—	15	—	15	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	15	—	18	—	20	—	25	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	15	—	18	—	20	—	25	—	ns	
Data-in Setup Time	t_{DS}	0	—	0	—	0	—	0	—	ns	13
Data-in Hold Time	t_{DH}	15	—	15	—	15	—	15	—	ns	13

Read-Modify-Write Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Read-Modify-Write Cycle Time	t_{RWC}	130	—	153	—	175	—	210	—	ns	
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	60	—	70	—	80	—	100	—	ns	12
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	15	—	18	—	20	—	25	—	ns	12
Column Address to $\overline{WE}$ Delay Time	t_{AWD}	30	—	35	—	40	—	45	—	ns	12

Refresh Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{CAS}$ Setup Time (CBR Refresh Cycle)	t_{CSR}	10	—	10	—	10	—	10	—	ns	
$\overline{CAS}$ Hold Time (CBR Refresh Cycle)	t_{CHR}	20	—	20	—	20	—	20	—	ns	
$\overline{WE}$ Setup Time (CBR Refresh Cycle)	t_{WRP}	10	—	10	—	10	—	10	—	ns	
$\overline{WE}$ Hold Time (CBR Refresh Cycle)	t_{WRH}	10	—	10	—	10	—	10	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	0	—	ns	

Fast Page Mode Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Fast Page Mode Cycle Time	t_{PC}	40	—	45	—	50	—	55	—	ns	
Fast Page Mode $\overline{RAS}$ Pulse Width	t_{RASP}	—	100000	—	100000	—	100000	—	100000	ns	14
Access Time from $\overline{CAS}$ Precharge	t_{CPA}	—	35	—	40	—	45	—	50	ns	15, 17
$\overline{WE}$ Delay Time from $\overline{CAS}$ Precharge	t_{CPW}	35	—	40	—	45	—	50	—	ns	
$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge	t_{CPRH}	35	—	40	—	45	—	50	—	ns	

Fast Page Mode Read-Modify-Write Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Fast Page Mode Read-Modify-Write Cycle Time	t_{PRWC}	60	—	68	—	75	—	85	—	ns	

Test Mode Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
Test Mode $\overline{WE}$ Setup Time	t_{WTS}	10	—	10	—	10	—	10	—	ns	
Test Mode $\overline{WE}$ Hold Time	t_{WTH}	10	—	10	—	10	—	10	—	ns	

Counter Test Cycle

Parameter	Symbol	HM5116100J/Z								Unit	Note
		-6		-7		-8		-10			
		Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{CAS}$ Precharge Time in Counter Test Cycle	t_{CPT}	TBD	—	TBD	—	TBD	—	TBD	ns		

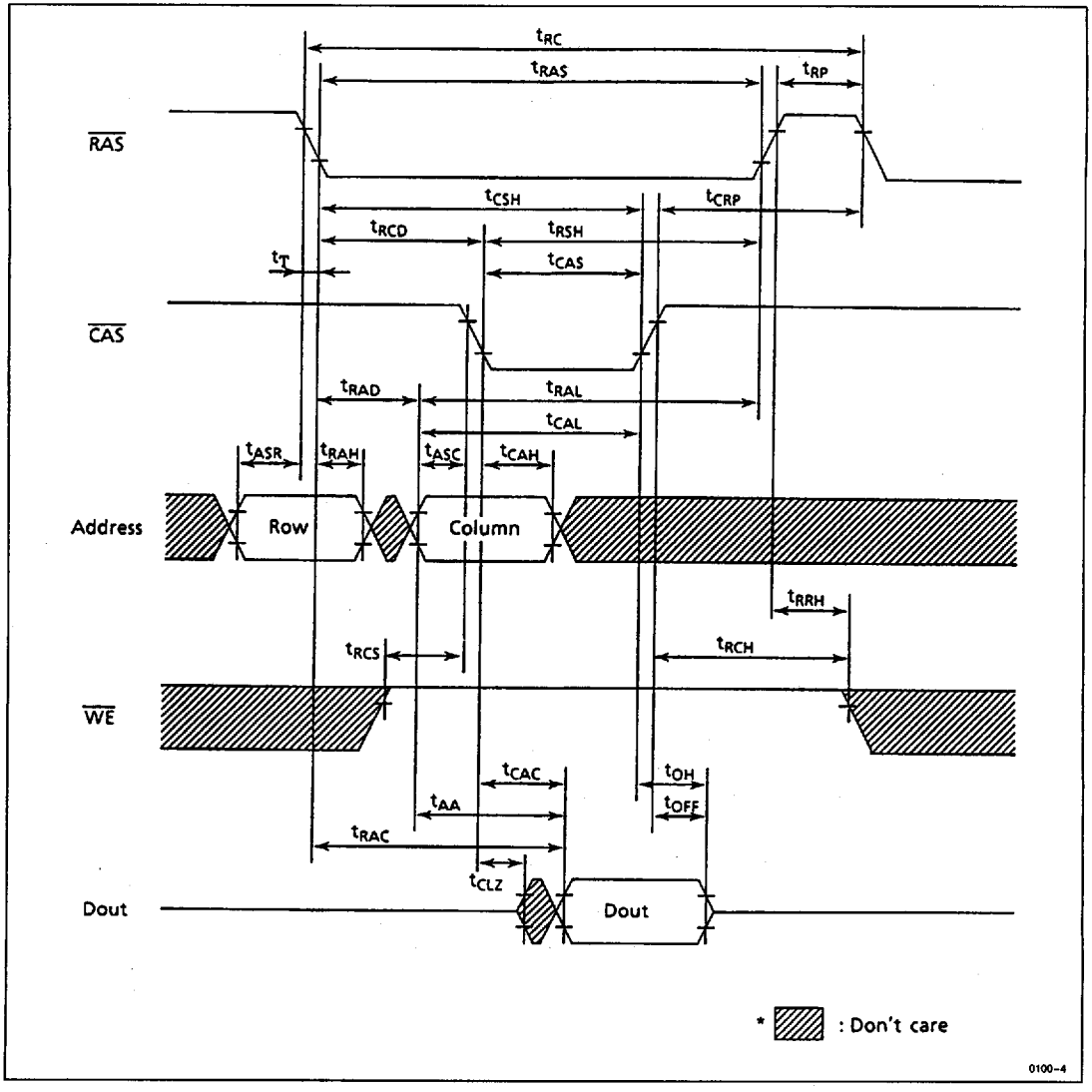
Refresh (T_J = 85°C, V_{CC} = 5V ±10%)

Parameter	Symbol	Max	Unit	Note
Refresh Period	t_{REF}	64	ms	4096 Cycles

Notes:
1. AC measurements assume t_T = 5 ns.
2. An initial pause of 100 µs is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing $\overline{RAS}$ only Refresh or $\overline{CAS}$ before $\overline{RAS}$ Refresh). If the internal refresh counter is used, a minimum of eight $\overline{CAS}$ before $\overline{RAS}$ refresh cycles are required.
3. Operation with 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}.
4. Operation with the t_{RAD} (max) limit insures 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, then access time is controlled exclusively by t_{AA}.
5. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} (min) and V_{IL} (max).
6. Assumes that $t_{RCD} < t_{RCD}$ (max) and $t_{RAD} < t_{RAD}$ (max). If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
7. Measured with a load circuit equivalent to 2 TTL loads and 100 pF.
8. Assumes that $t_{RCD} \geq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max).
9. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \geq t_{RAD}$ (max).
10. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
11. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
12. t_{WCS}, t_{RWD}, t_{CWD}, t_{AWD} and t_{CPW} 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 pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}$ (min), $t_{CWD} \geq t_{CWD}$ (min) and $t_{AWD} \geq t_{AWD}$ (min), or $t_{CWD} \geq t_{CWD}$ (min), $t_{AWD} \geq t_{AWD}$ (min) and $t_{CPW} \geq t_{CPW}$ (min), the cycle is a read-modify-write and the data output 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.
13. These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to WE leading edge in delayed write or read-modify-write cycles.
14. t_{RASP} defines $\overline{RAS}$ pulse width in fast page mode cycles.
15. Access time is determined by the longer of t_{AA} or t_{CAC} or t_{CPA}.
16. Test mode operation specified in this data sheet is 16-bits test function controlled by compression addresses . . . CA0, CA1, CA10 and CA11. This test mode operation can be performed by $\overline{WE}$ and $\overline{CAS}$ before $\overline{RAS}$ (WCBR) refresh cycle. Refresh during test mode operation will be performed by normal read cycles or by WCBR refresh cycles. When the state of sixteen test bits accord with each other, the state of the output data is high level. When the state of test bits do not accord with each other, the state of the output data is low level. Data output pin is D_{out} and data input in is D_{in}. If any refresh cycle has occurred, the test mode is reset.
17. In a test mode read cycle, the value of t_{RAC}, t_{AA}, t_{CAC} and t_{CPA} is delayed by 2 ns to 5 ns for the specified value. These parameters should be specified in test mode cycles by adding the above value to the specified value in this data sheet.

■ TIMING WAVEFORMS

• Read Cycle



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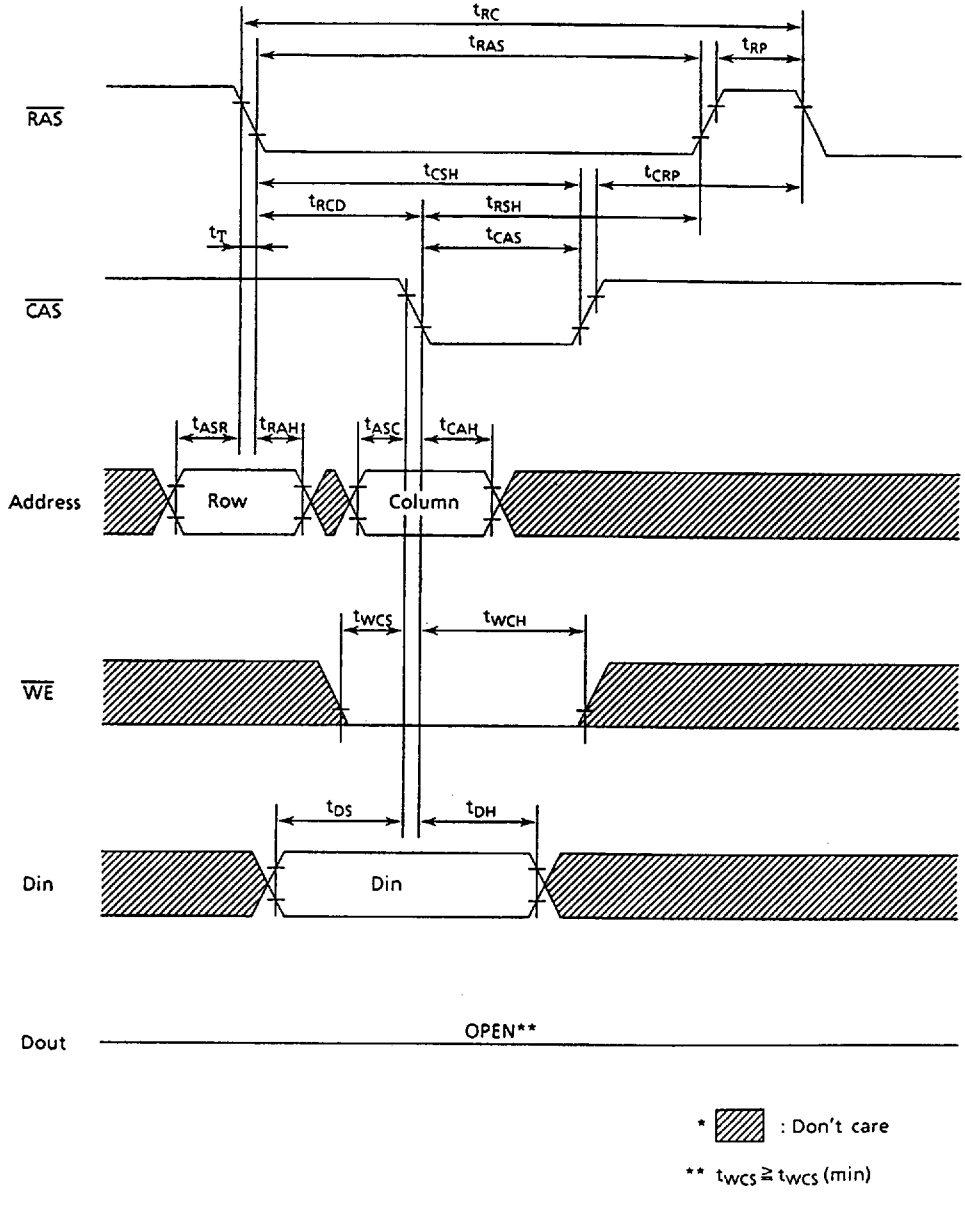
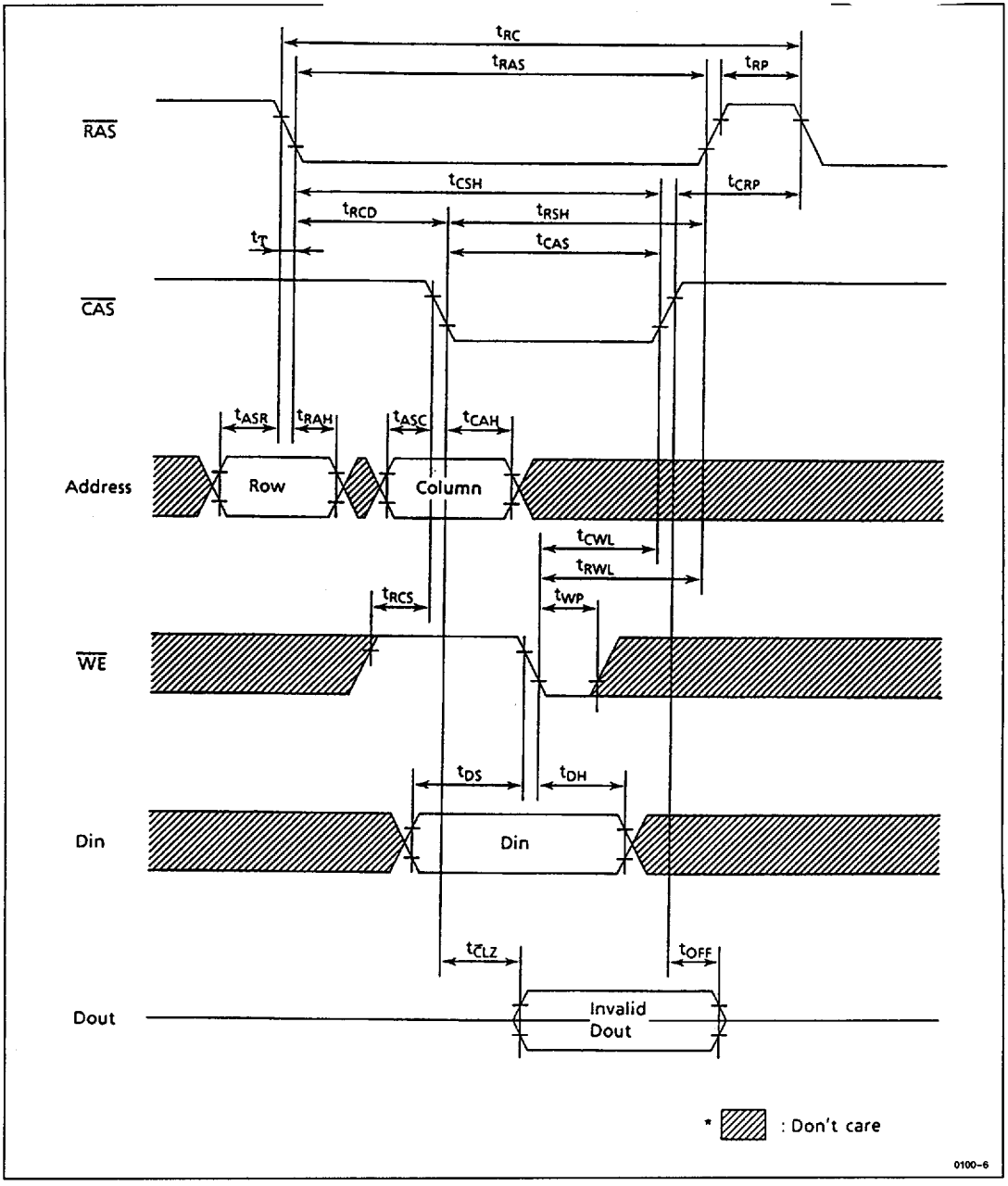
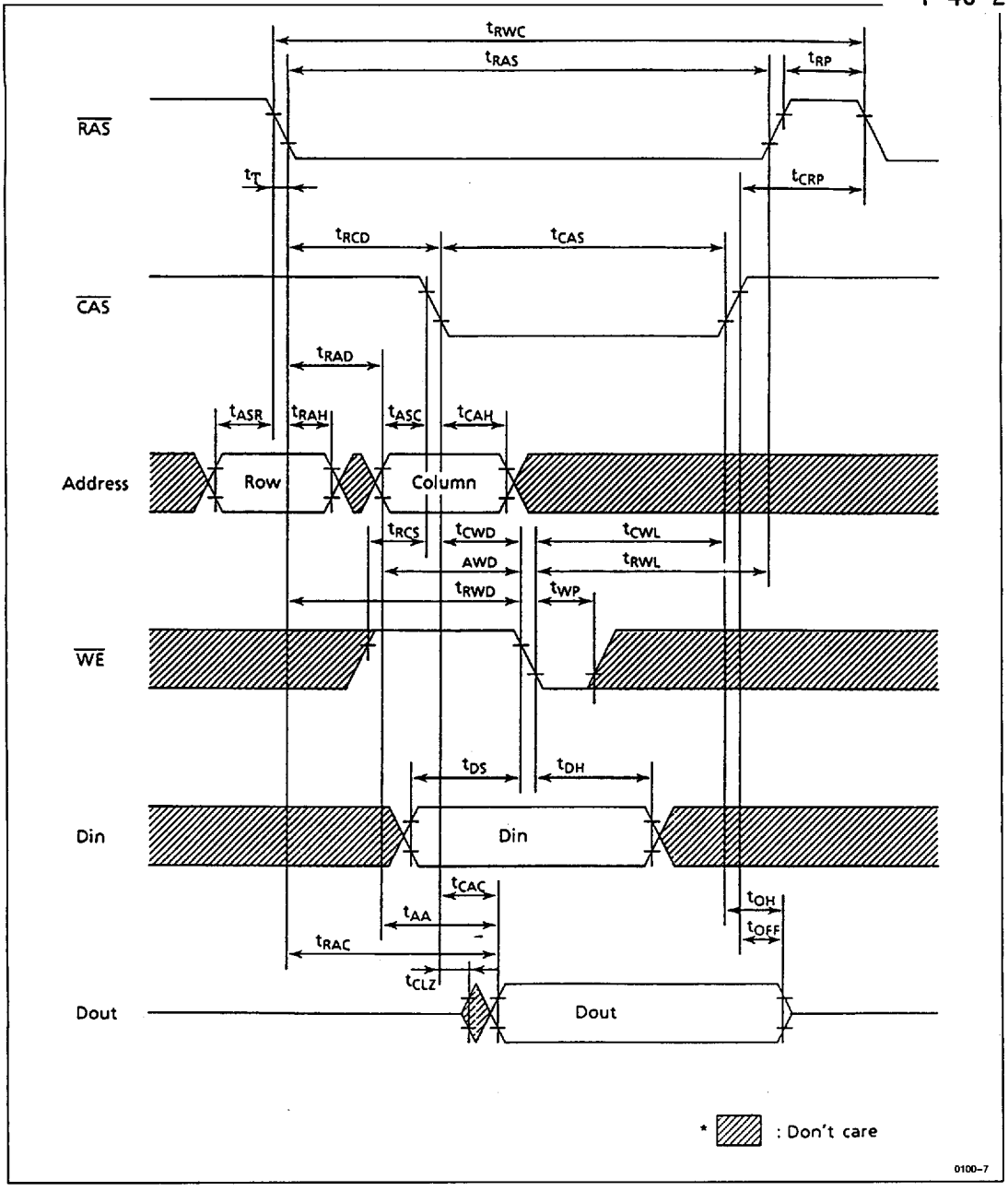
• **Early Write Cycle**




tRC
tRAS
tRP
RAS
tCSH
tCRP
tRCD
tRSH
tT
tCAS
CAS
tASR
tRAH
tASC
tCAH
Address
Row
Column
tCWL
tRWL
tRCS
tWP
WE
tDS
tDH
Din
Din
tCLZ
tOFF
Dout
Invalid
Dout
* : Don't care
0100-6

• **Read-Modify-Write Cycle**

T-46-23-15



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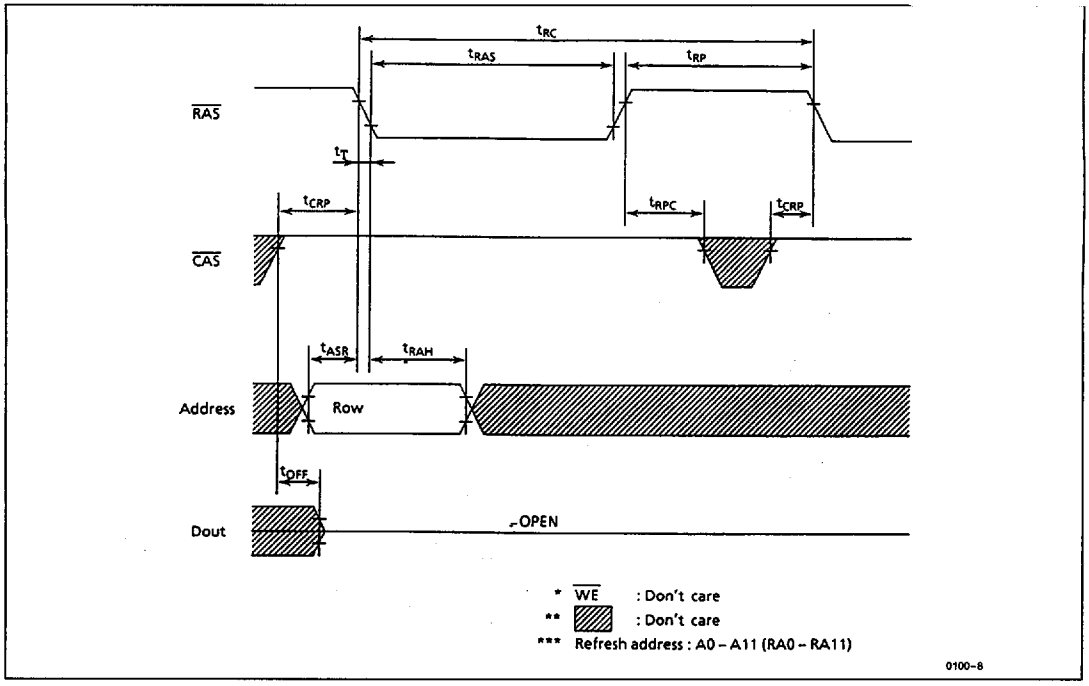
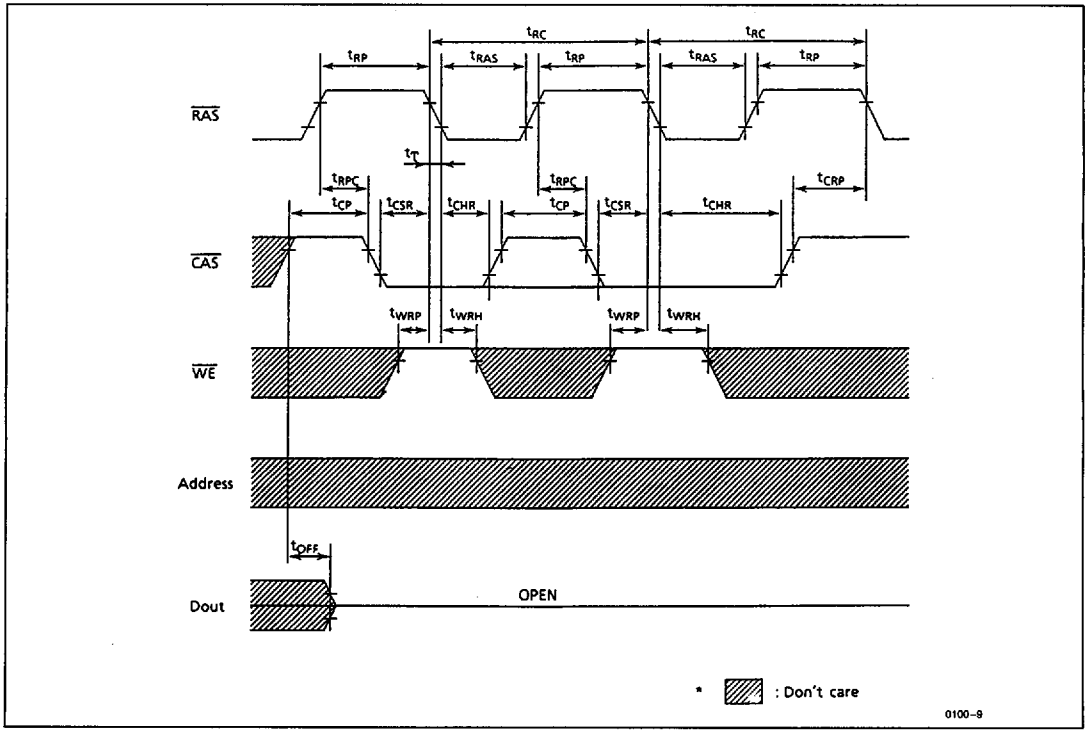
• $\overline{RAS}$ Only Refresh Cycle

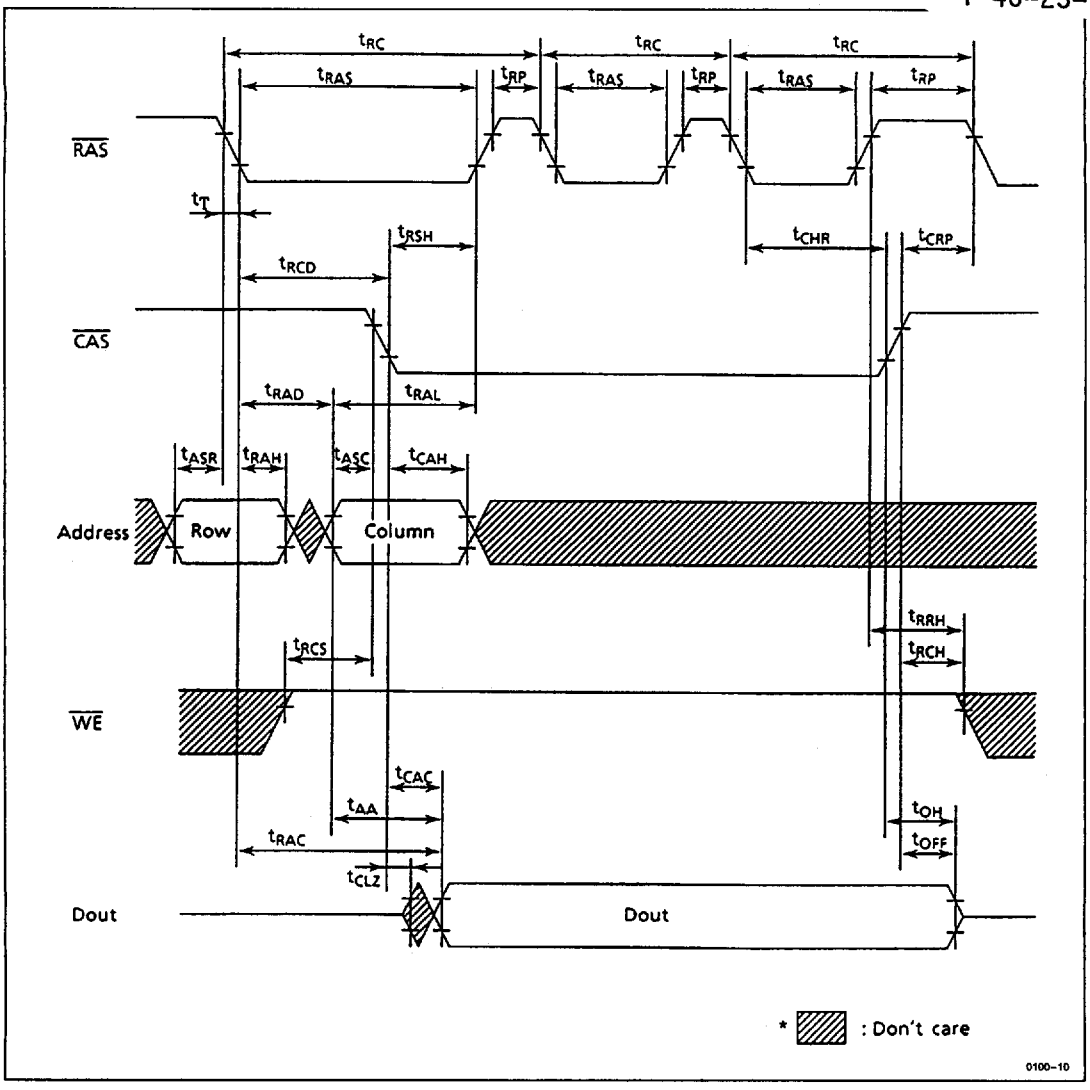


• $\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle



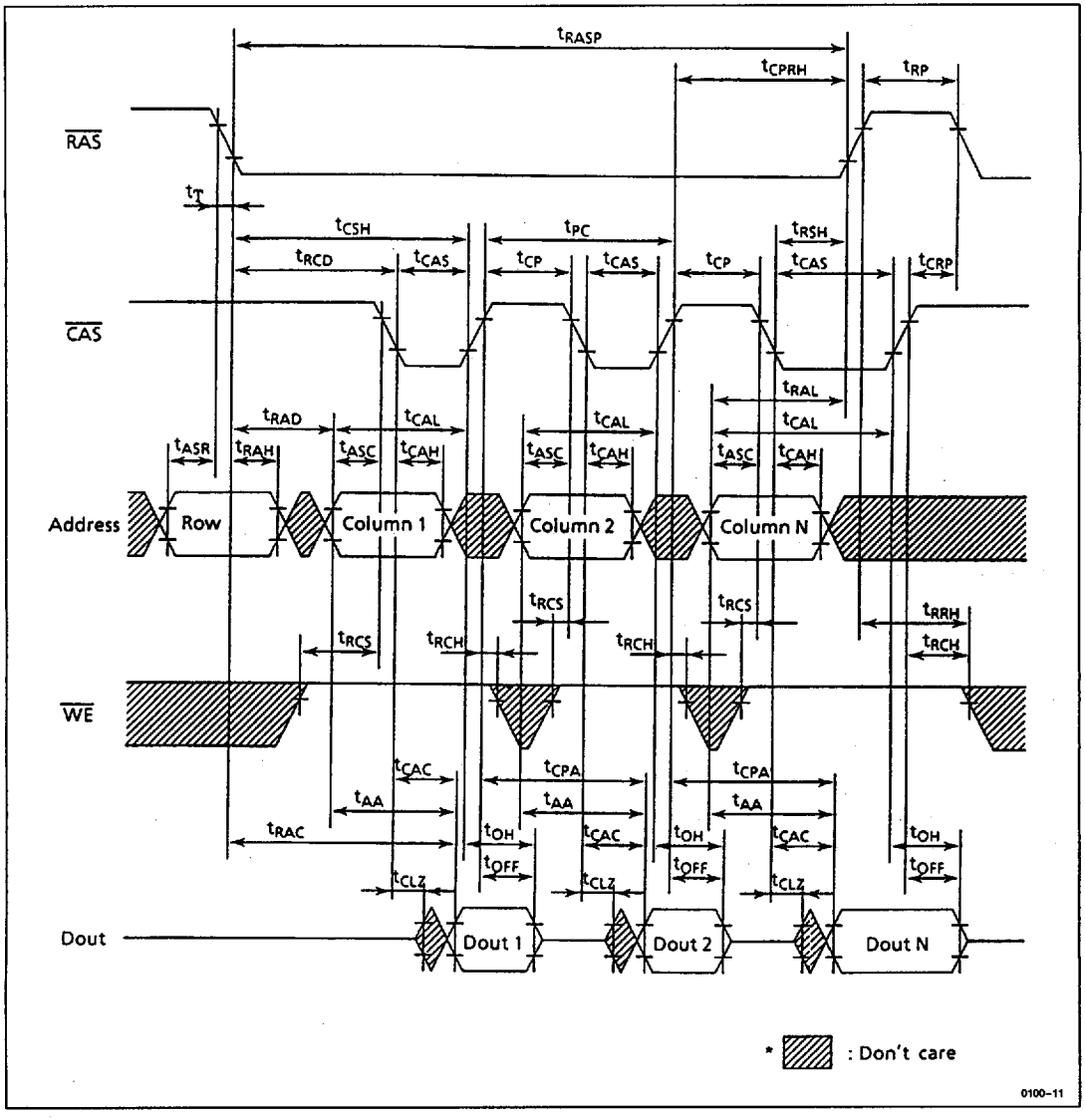
• **Hidden Refresh Cycle**

T-46-23-15



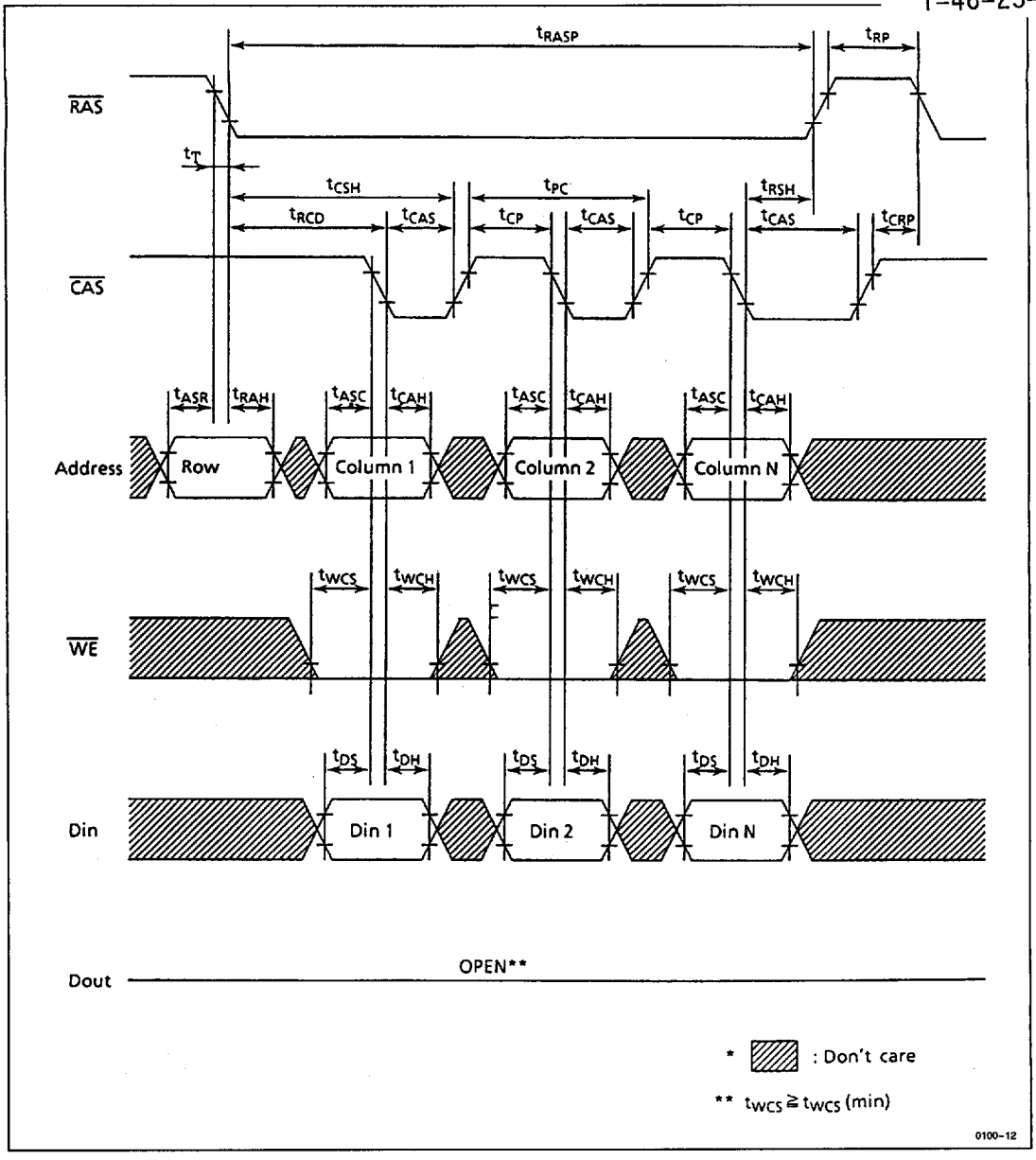
T-46-23-15

• **Fast Page Mode Read Cycle**



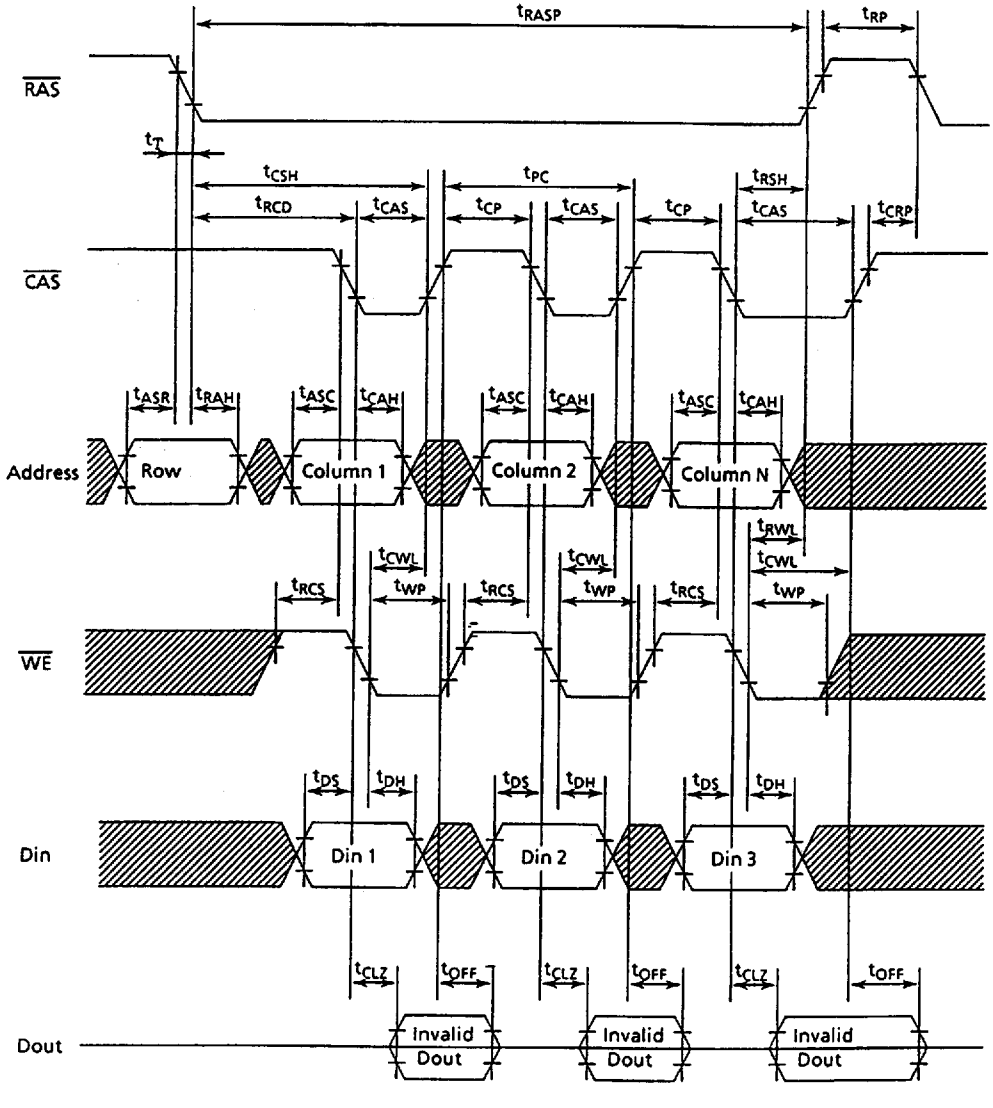
• **Fast Page Mode Early Write Cycle**

T-46-23-15



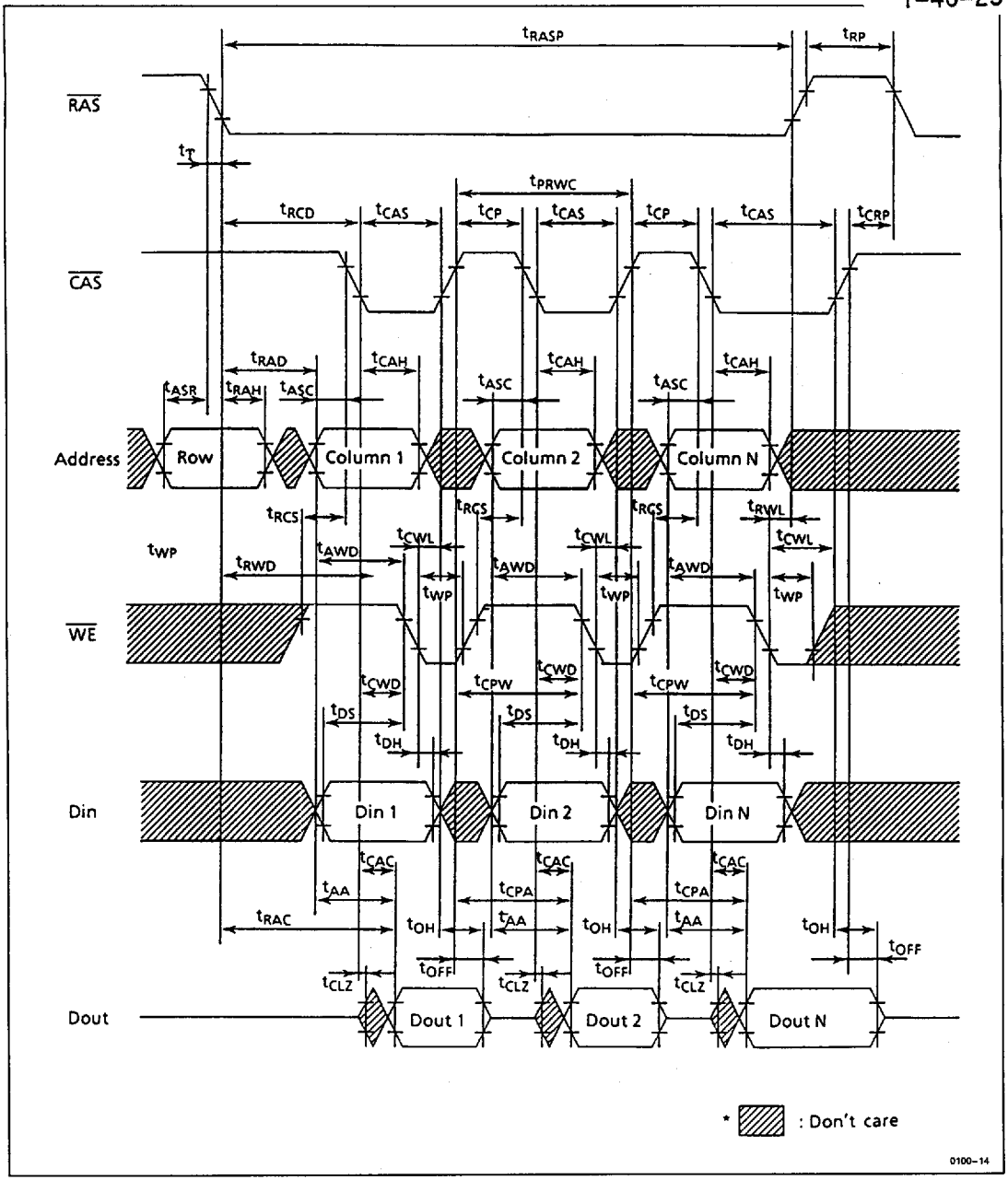
• **Fast Page Mode Delayed Write Cycle**

T-46-23-15



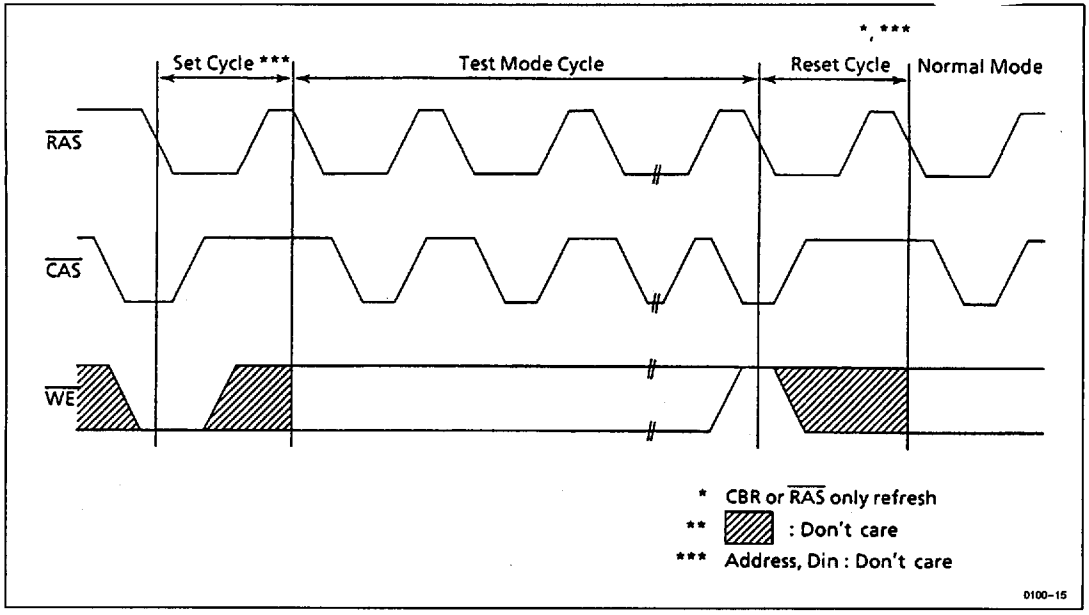
• **Fast Page Mode Read-Modify-Write Cycle**

T-46-23-15

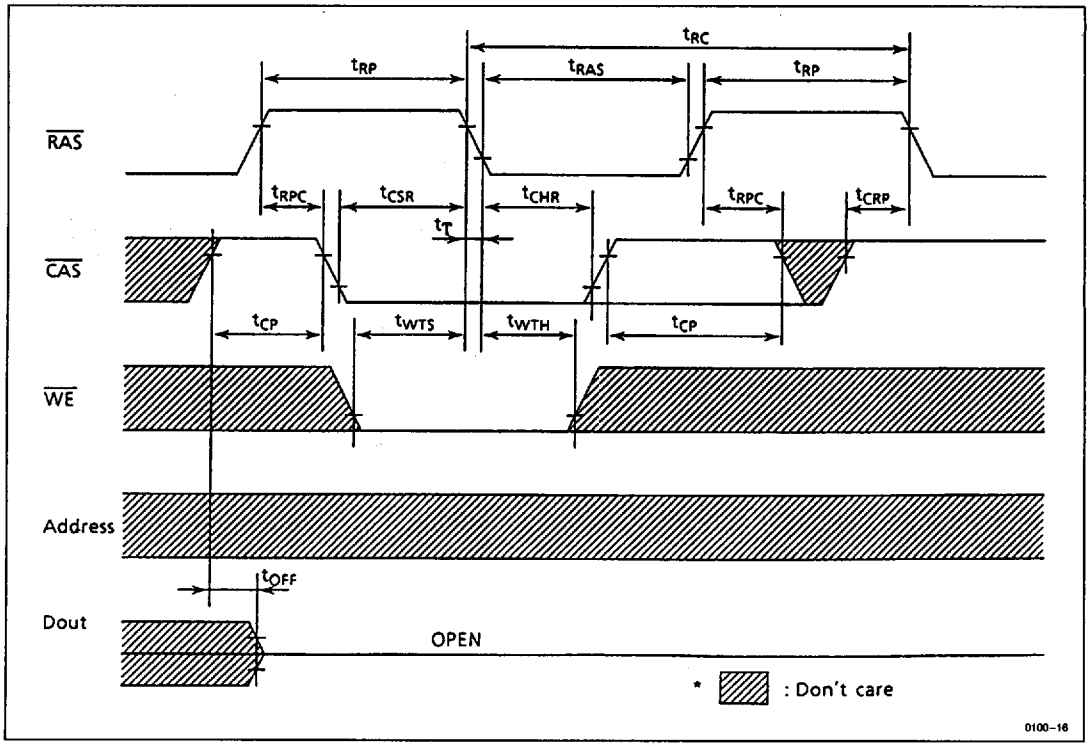


T-46-23-15

• **Test Mode Cycle**

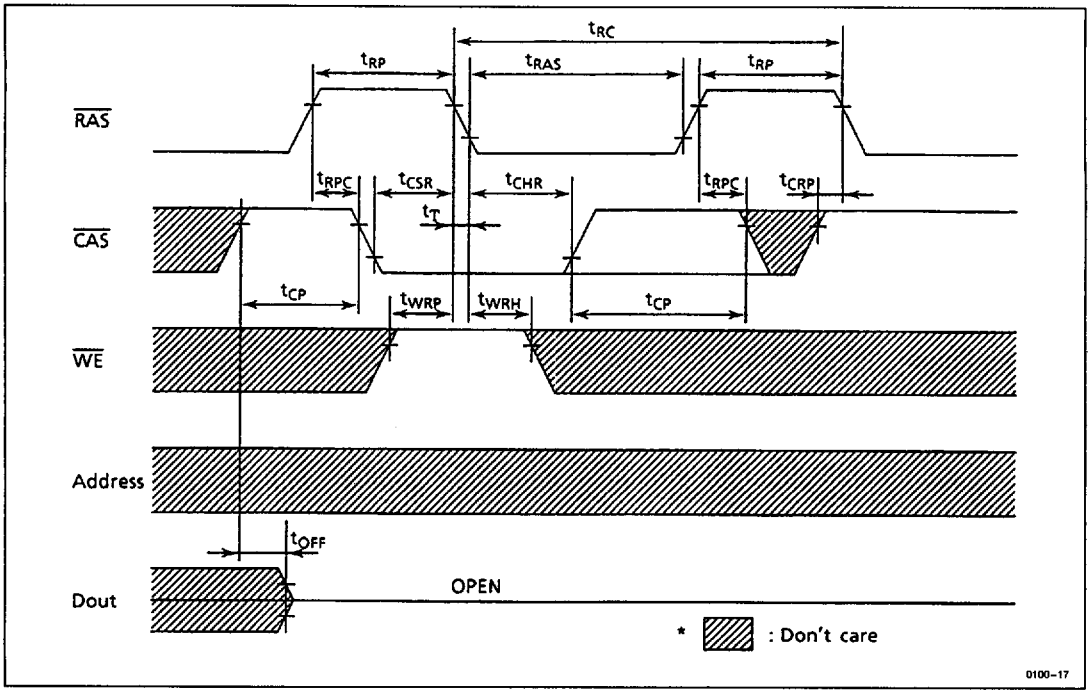


• **Test Mode Set Cycle**

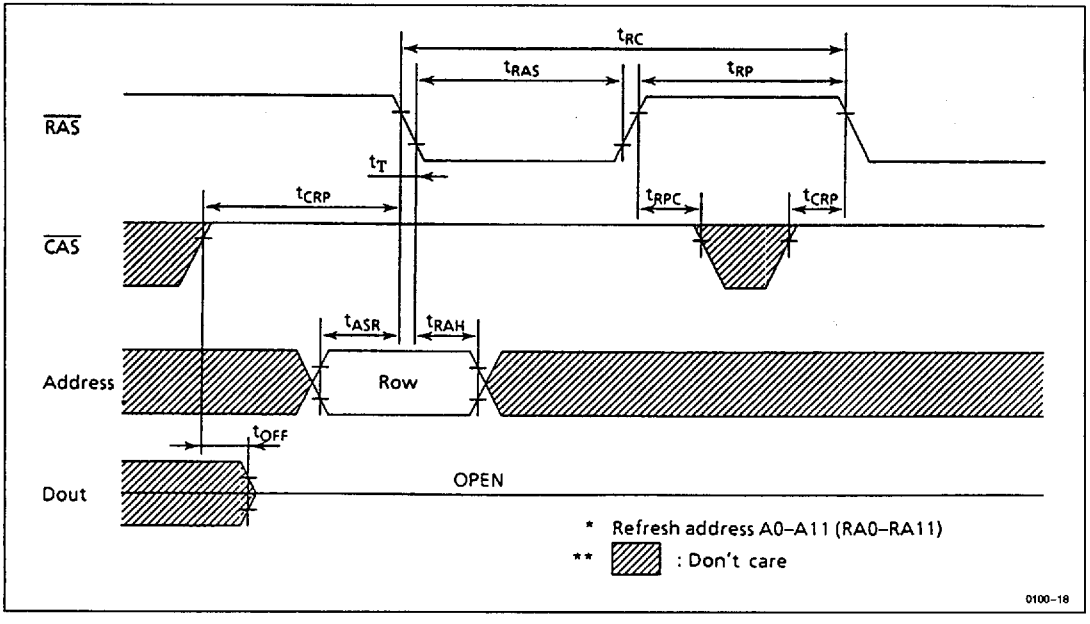


• Test Mode Reset Cycle
$\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle

T-46-23-15

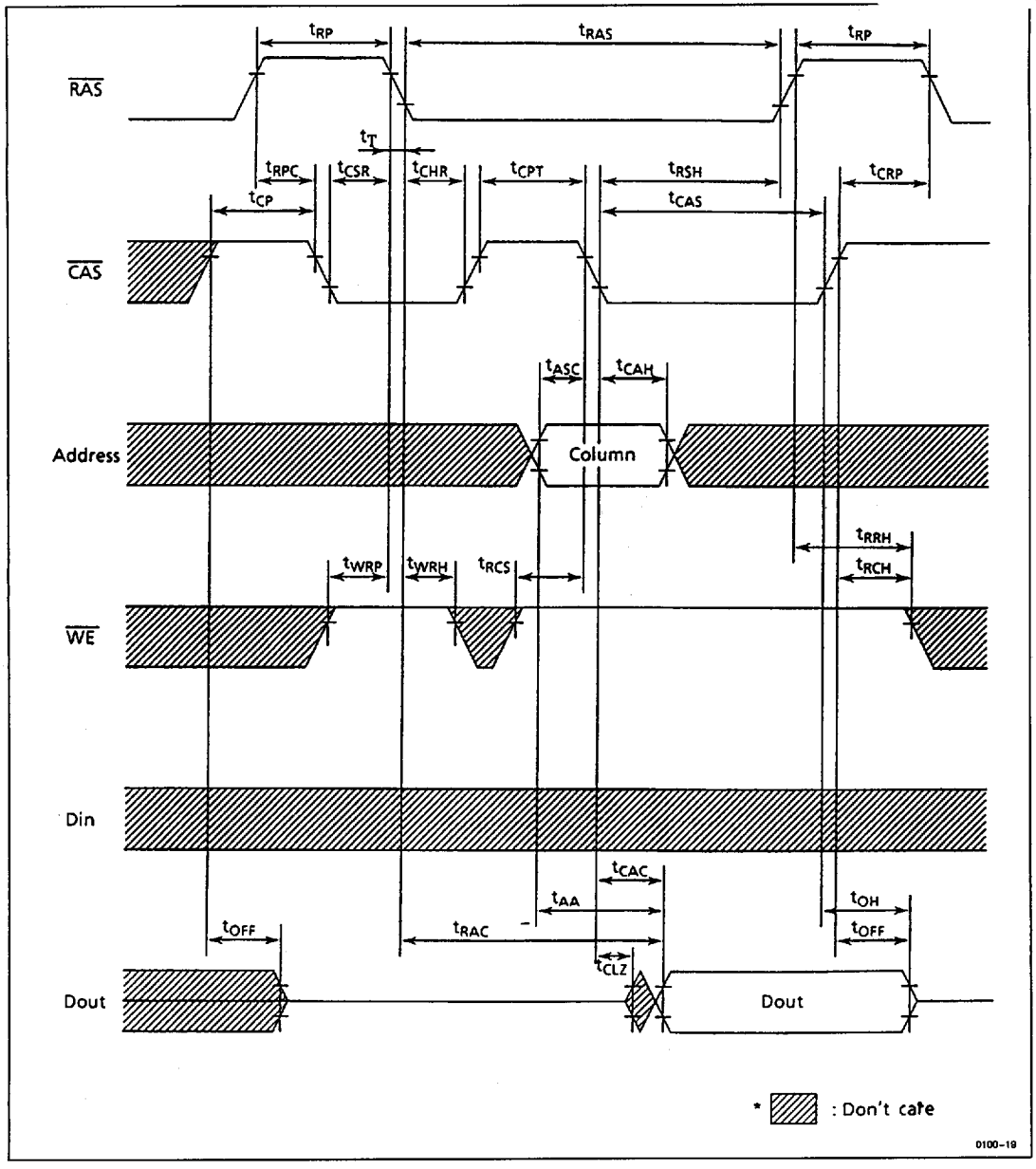


$\overline{RAS}$ Only Refresh Cycle



$\overline{CAS}$ Before $\overline{RAS}$ Refresh Counter Check Cycle (Read)

T-46-23-15



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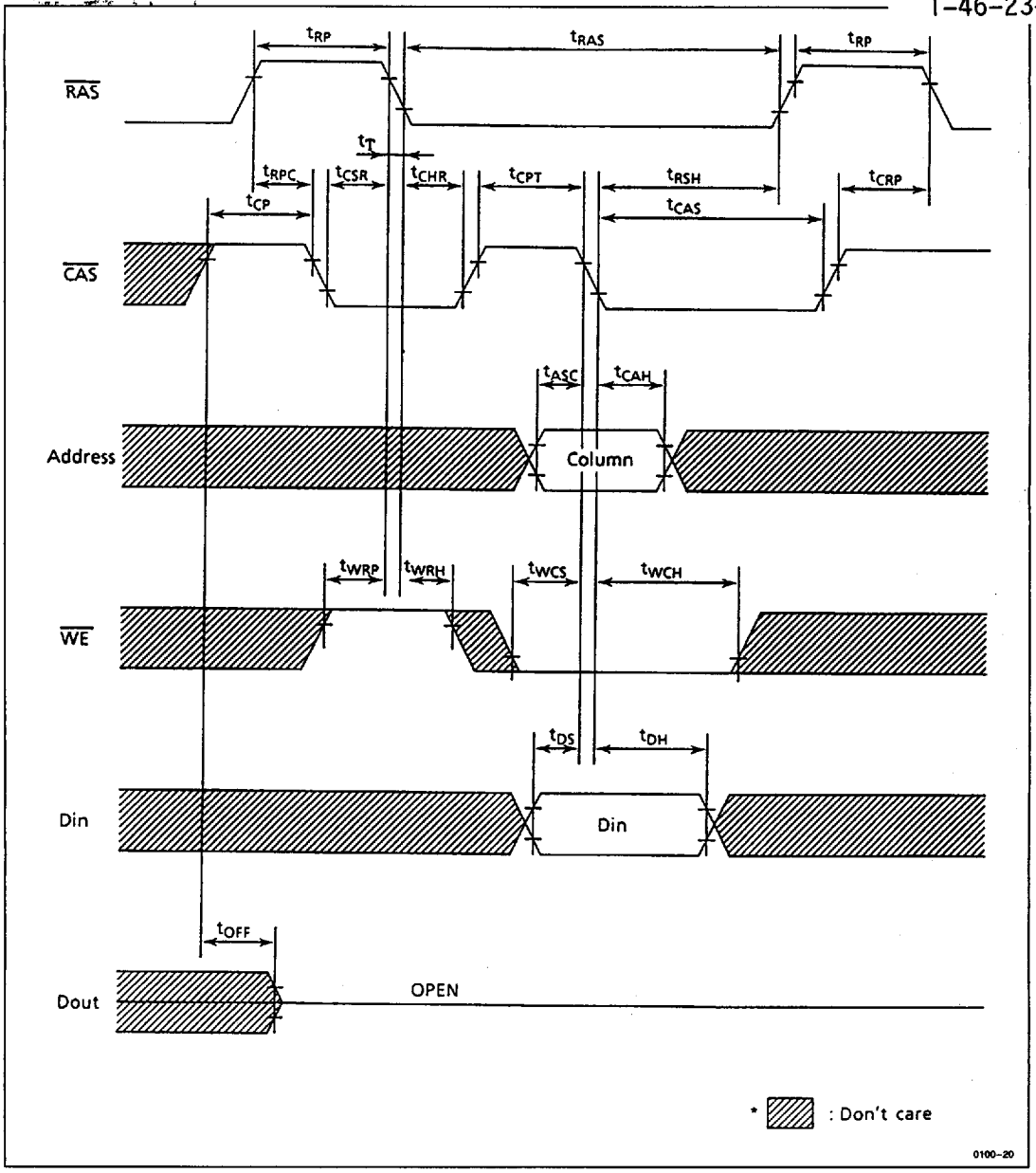
CAS Before RAS Refresh Counter Check Cycle (Write)

T-46-23-15



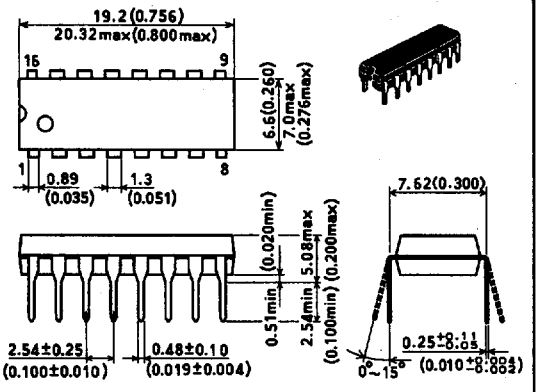
PACKAGE INFORMATION

T-90-20

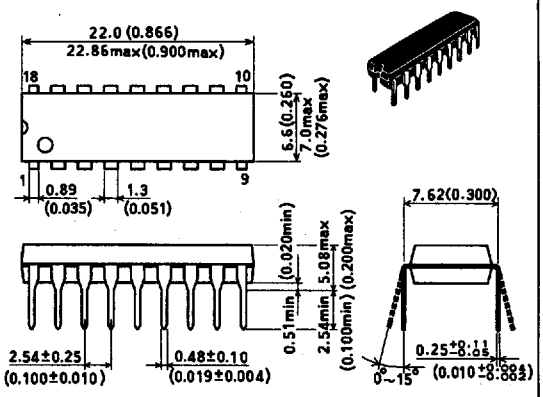
• Dual-in-line Plastic

Unit: mm (inch) Scale 3/2

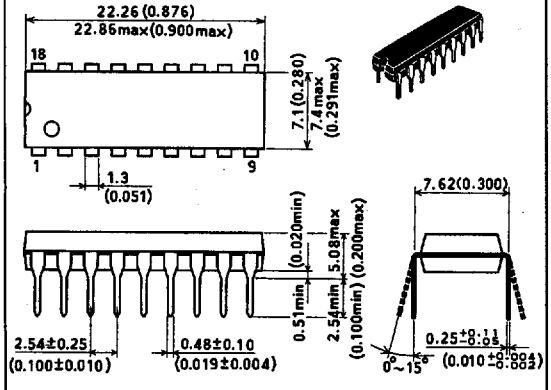
• DP-16B



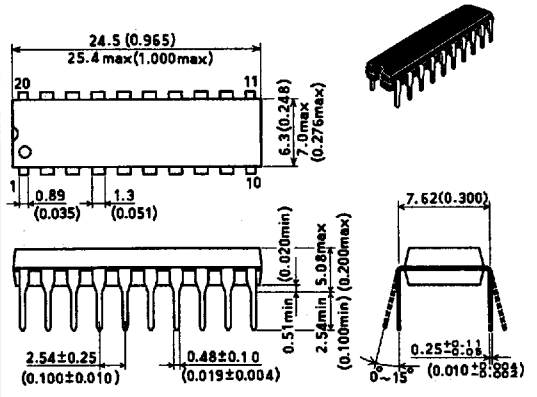
• DP-18B



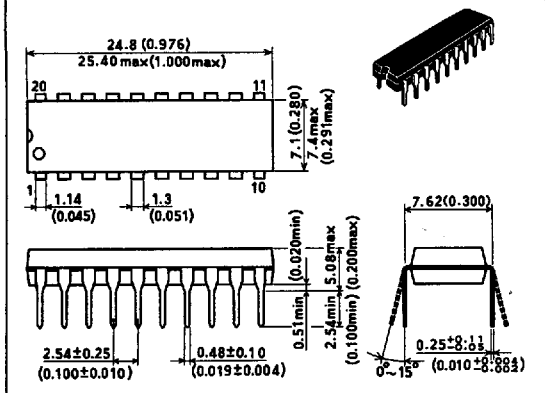
• DP-18C



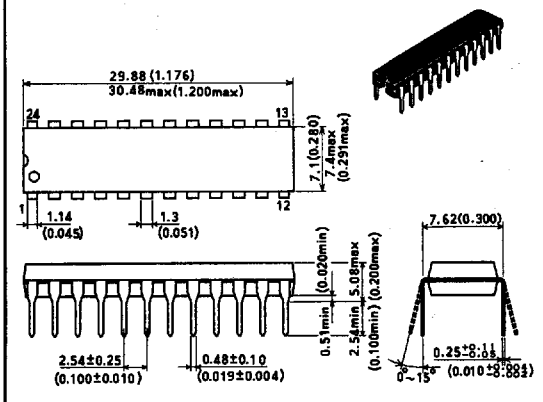
• DP-20N



• DP-20NA



• DP-20NC

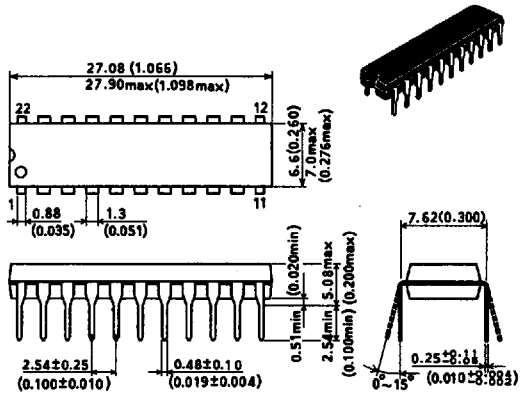


• Dual-in-line Plastic

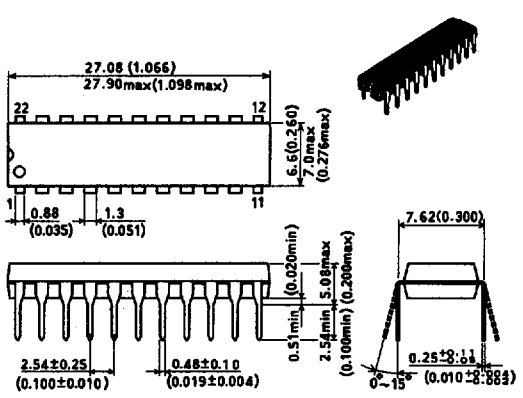
Unit: mm (inch) Scale 3/2

T-90-20

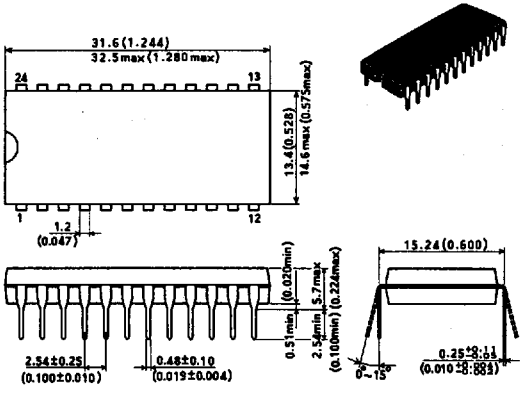
• DP-22N



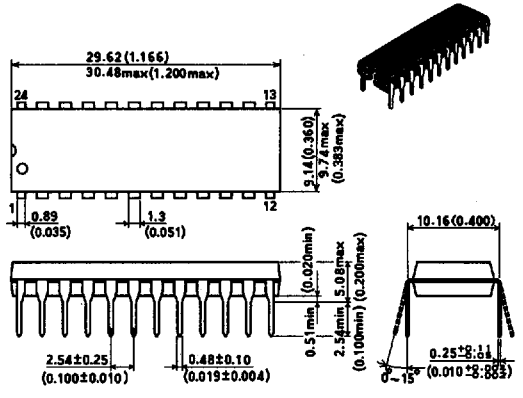
• DP-22NB



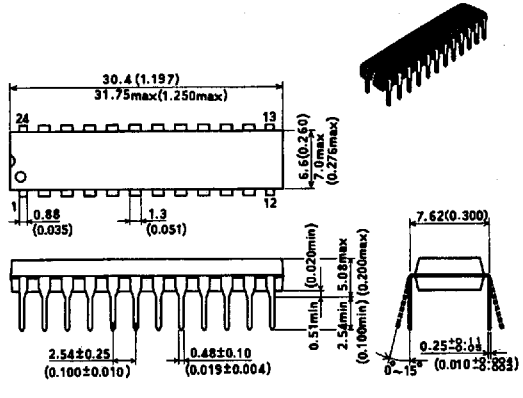
• DP-24



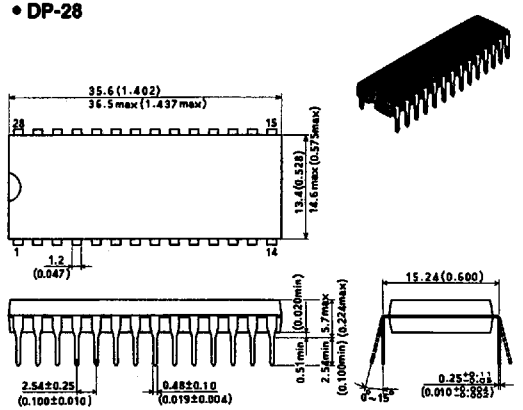
• DP-24A



• DP-24N



• DP-28



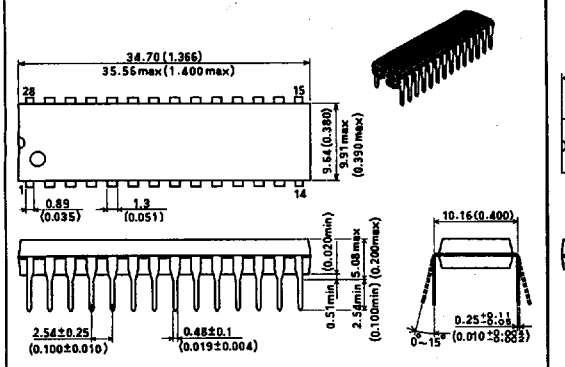
• Dual-in-line Plastic

HITACHI/ LOGIC/ARRAYS/MEM

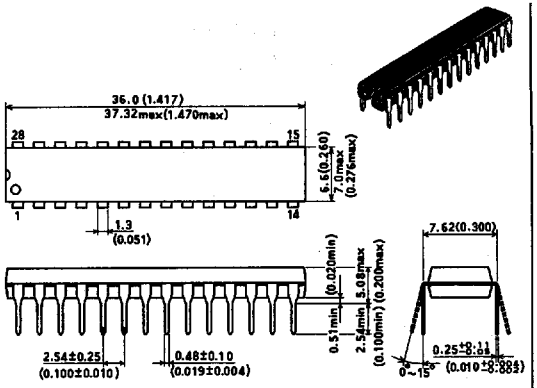
Unit: mm (inch) Scale 3/2

T-90-20

• DP-28C



• DP-28N

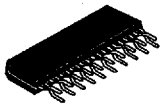


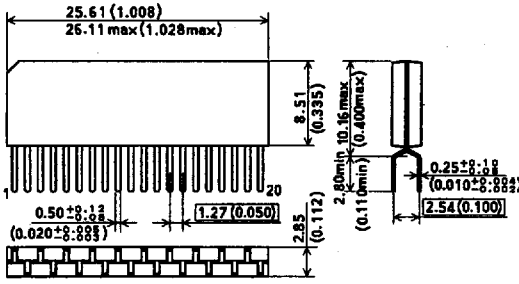
• Zigzag-in-line Plastic HITACHI/ LOGIC/ARRAYS/MEM

Unit: mm (inch) Scale 3/2

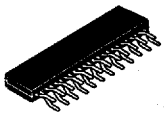
T-90-20

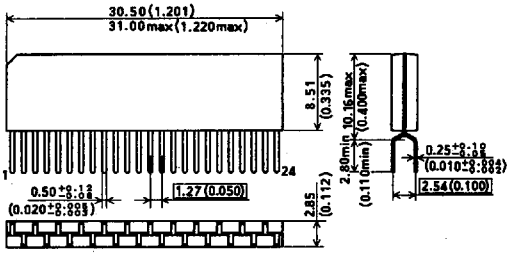
• ZP-20



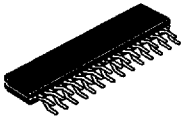


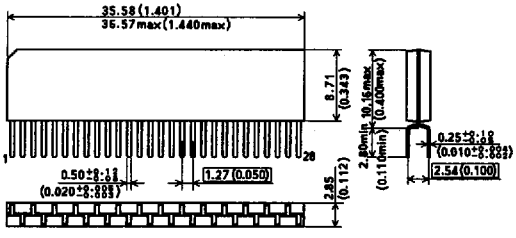
• ZP-24



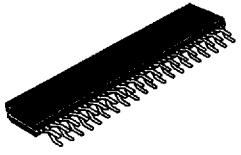


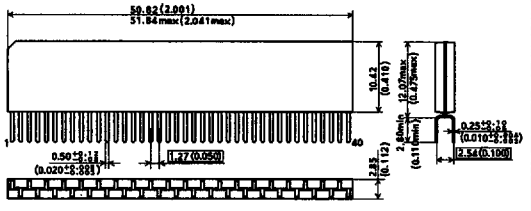
• ZP-28





• ZP-40





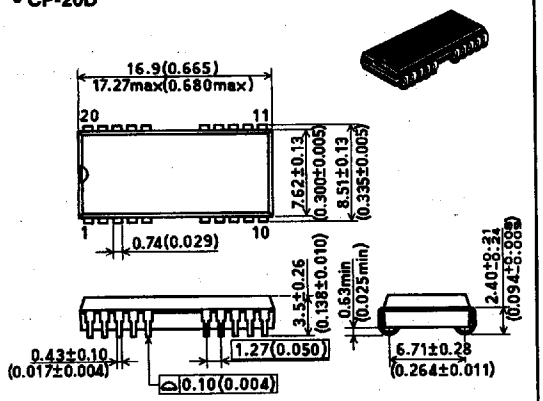
• Flat Package (J-bend Leads)

HITACHI/ LOGIC/ARRAYS/MEM

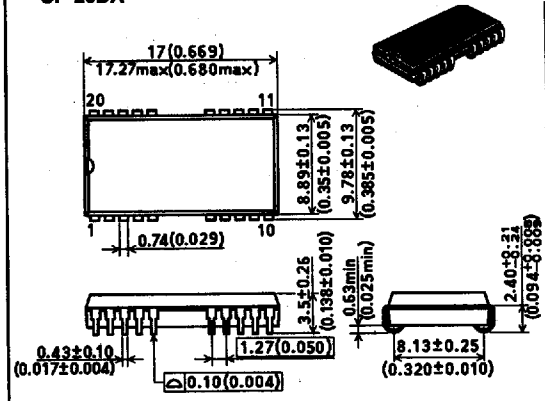
Unit: mm (inch) Scale 3/2

T-90-20

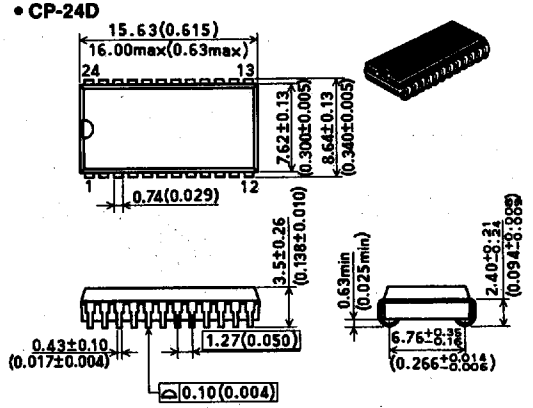
• CP-20D



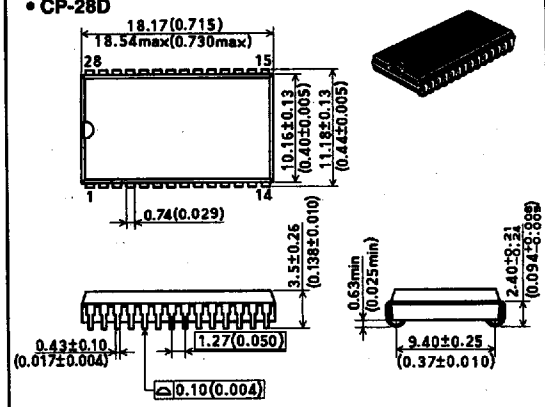
• CP-20DA



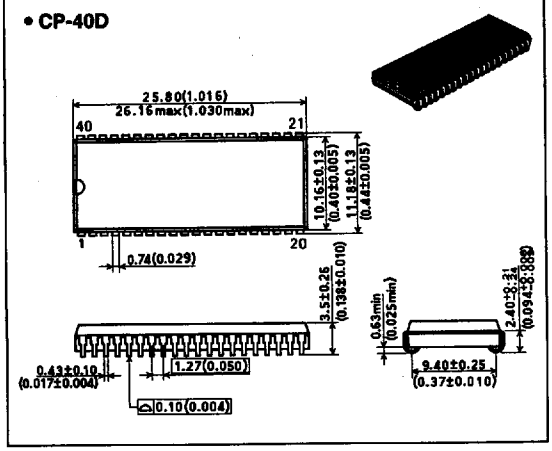
• CP-24D



• CP-28D



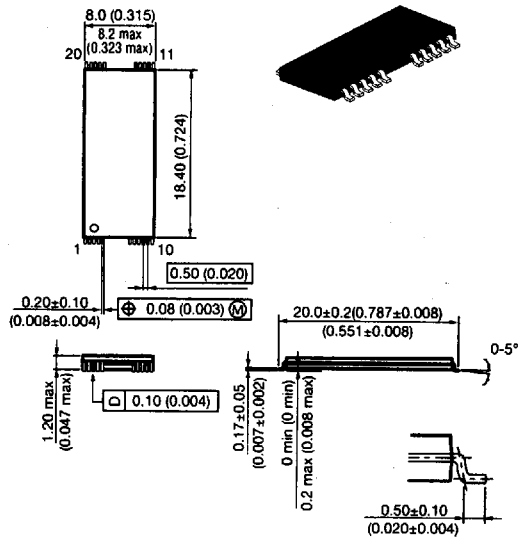
• CP-40D



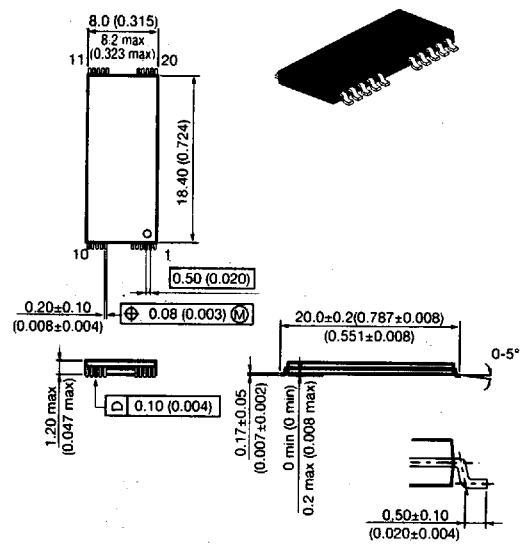
• TSOP (Thin Small Outline Package)

Unit: mm (inch) Scale 3/2

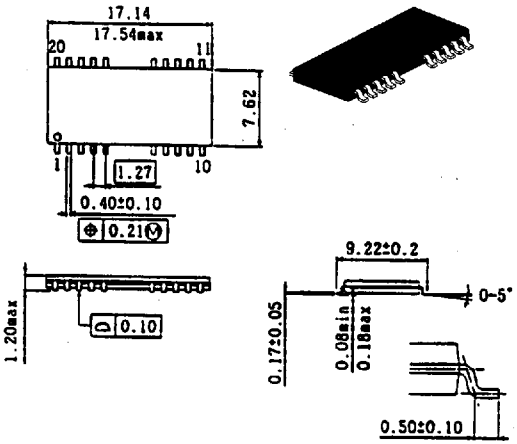
• TFP-20DA



• TFP-20DAR



• TTP-20D



• TTP-20DR