

**HYB 511000AL-60/-70**  
**1M x 1-Bit Dynamic RAM**

(Low Power Version)

## Advance Information

- 1 048 576 x 1-bit organization
- Fast access and cycle time  
60 ns access time  
110 ns cycle time (HYB 511000AL-60)  
70 ns access time  
130 ns cycle time (HYB 511000AL-70)
- Fast page mode cycle time  
40 ns (HYB 511000AL-60)  
40 ns (HYB 511000AL-70)
- Single +5 V ( $\pm 10\%$ ) supply with a built-in  $V_{BB}$  generator
- Output unlatched at cycle end allows two-dimensional chip selection
- Common I/O capability using "early write" operation
- Low power dissipation  
max. 495 mW (HYB 511000AL-60)  
max. 440 mW (HYB 511000AL-70)  
max. 1.1 mW standby
- Read-modify-write,  $\overline{CAS}$ -before- $\overline{RAS}$  refresh,  $\overline{RAS}$ -only refresh, hidden-refresh, fast page mode capability and test mode capability
- All inputs, outputs and clocks fully TTL-compatible
- 512 refresh cycles/64 ms
- Plastic Packages:  
P-DIP-18-T HYB 511000AL  
P-SOJ-26/20 HYB 511000AJL  
P-ZIP-20/19 HYB 511000AZL

The HYB 511000AL-60/-70 is the new generation dynamic RAM organized as 1 048 576 words by 1-bit. The HYB 511000AL-60/-70 utilizes CMOS silicon gate process technology as well as advanced circuit techniques to provide wide operation margins, both internally and for the system user. Multiplexed address inputs permit the HYB 511000AL-60/-70 to be packaged in a standard 18-pin plastic DIP, 26/20 pin plastic SOJ and 20/19 pin plastic ZIP. This package size provides high system bit densities and is compatible with commonly used automatic testing and insertion equipment. System oriented features include single +5 V ( $\pm 10\%$ ) power supply, direct interfacing with high-performance logic device families such as Schottky TTL. These HYB 511000AL-60/-70 1M x 1 DRAMs are specially selected for battery backup applications. "Test Mode" function is implemented.

T-46-23-15

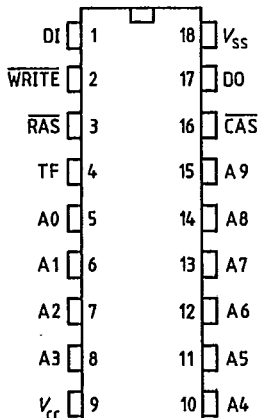
Ordering Information

Type	Ordering code	Package	Description
HYB 511000AL-60	Q67100-Q485	P-DIP-18-T	DRAM (access time 60 ns)
HYB 511000AL-70	Q67100-Q486	P-DIP-18-T	DRAM (access time 70 ns)
HYB 511000AJL-60	Q67100-Q487	P-SOJ-26/20	DRAM (access time 60 ns)
HYB 511000AJL-70	Q67100-Q488	P-SOJ-26/20	DRAM (access time 70 ns)
HYB 511000AZL-60	Q67100-Q493	P-ZIP-20/19	DRAM (access time 60 ns)
HYB 511000AZL-70	Q67100-Q494	P-ZIP-20/19	DRAM (access time 70 ns)

Pin Names

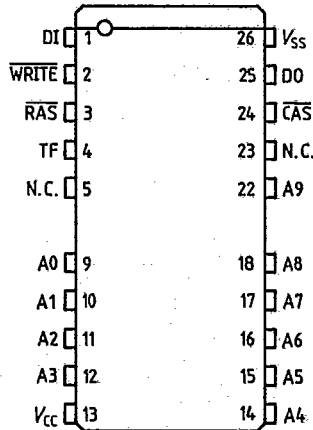
A0-A9	Address Inputs
$\overline{RAS}$	Row Address Strobe
DI	Data Input
DO	Data Output
$\overline{CAS}$	Column Address Strobe
$\overline{WRITE}$	Read/Write Input
$V_{CC}$	Power Supply (+5 V)
$V_{SS}$	Ground (0 V)
TF	Test Function
N.C.	No Connection

**Pin Configuration**  
**P-DIP-18-T**



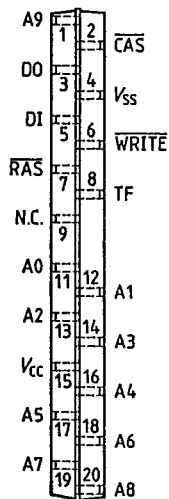
SPP00865

**P-SOJ-26/20**



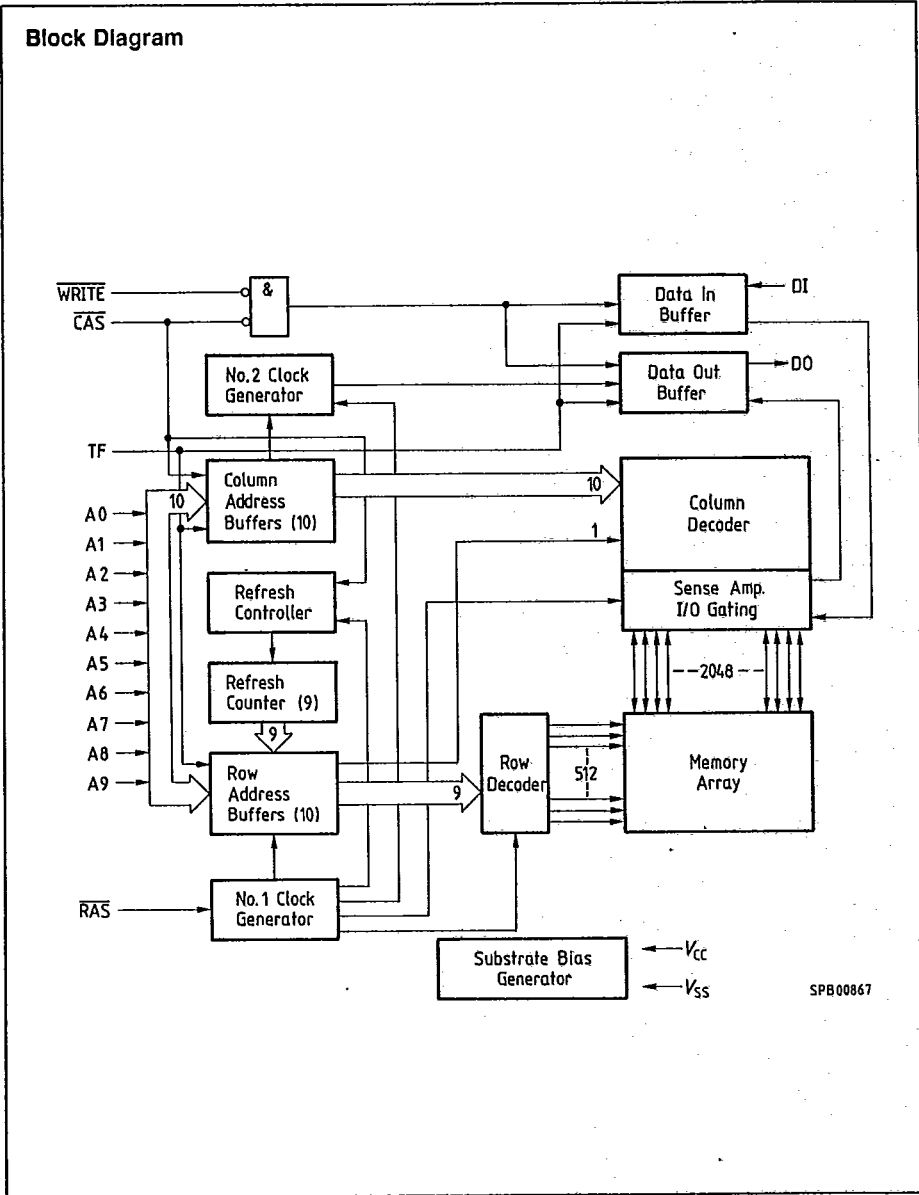
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**P-ZIP-20:19**



SPP00998

Block Diagram



SPB00867

**Absolute Maximum Ratings**

Operating temperature range	0 to +70 °C
Storage temperature range	- 55 to +150 °C
Soldering temperature	260 °C
Soldering time	10 s
Input/output voltage	- 1 to +7 V
Power supply voltage	- 1 to +7 V
Power dissipation	0.6 W
Data out current (short circuit)	50 mA

**Note:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**DC Characteristics**

$T_A = 0$  to  $70$  °C,  $V_{SS} = 0$  V,  $V_{CC} = 5$  V  $\pm 10$  %

Parameter	Symbol	Limit values		Unit	Test condition
		min.	max.		
Input high voltage	$V_{IH}$	2.4	6.5	-	1)
Input low voltage	$V_{IL}$	-1.0	0.8	V	1)
Test enable input high voltage	$V_{IH(TF)}$	$V_{CC} + 4.5$ V	10.5	V	-
Test disable input low voltage	$V_{IL(TF)}$	-1.0	$V_{CC} + 1$	V	-
Output high voltage ( $I_{OUT} = -5$ mA)	$V_{OH}$	2.4	-	V	-
Output low voltage ( $I_{OUT} = 4.2$ mA)	$V_{OL}$	-	0.4	V	-
Input leakage current ( $0$ V $\leq V_{IN} \leq 6.5$ V, all other pins = $0$ V)	$I_{I(L)}$	-10	10	$\mu$ A	-
Output leakage current (DO is disabled, $0$ V $\leq V_{OUT} \leq 5.5$ V)	$I_{O(L)}$	-10	10	$\mu$ A	-
Average $V_{CC}$ supply current: HYB 511000AL-60 HYB 511000AL-70 (RAS, CAS, address cycling: $t_{RC} = t_{RC\ min.}$ )	$I_{CC1}$	-	90 80	mA mA	2) 3) 2) 3)

For notes see page 6.

## DC Characteristics (cont'd)

Parameter	Symbol	Limit values		Unit	Test condition
		min.	max.		
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{IH}$ )	$I_{CC2}$	-	2	mA	-
Average $V_{CC}$ supply current, during $\overline{RAS}$ only refresh cycles: HYB 511000AL-60 HYB 511000AL-70 ( $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$ , $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC3}$	-	90 80	mA mA	2) 2)
Average $V_{CC}$ supply current, during fast page mode: HYB 511000AL-60 HYB 511000AL-70 ( $\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling, $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC4}$	-	70 60	mA mA	2) 3) 2) 3)
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{CC} - 0.2 \text{ V}$ )	$I_{CC5}$	-	1	mA	-
Average $V_{CC}$ supply current, during $\overline{CAS}$ -before- $\overline{RAS}$ refresh mode: HYB 511000AL-60 HYB 511000AL-70 ( $\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC6}$	-	90 80	mA mA	2) 2)
Battery backup current average power supply current battery backup mode: ( $\overline{CAS} = \overline{CAS}$ before $\overline{RAS}$ cycling or 0.2 V, $\overline{WRITE} = V_{CC} - 0.2 \text{ V}$ or 0.2 V, A0 to A9 = $V_{CC} - 0.2 \text{ V}$ or 0.2 V, DI = $V_{CC} - 0.2 \text{ V}$ or 0.2 V or open, $t_{RC} = 125 \mu\text{s}$ , $t_{RAS} = t_{RAS \text{ min.}} \sim 1 \mu\text{s}$ )	$I_{CC7}$	-	300	$\mu\text{A}$	2) 13)

- 1) All voltages are referenced to  $V_{SS}$ .
- 2)  $I_{CC1}$ ,  $I_{CC3}$ ,  $I_{CC4}$  and  $I_{CC6}$  depend on cycle rate.
- 3)  $I_{CC1}$  and  $I_{CC4}$  depend on output loading. Specified values are measured with the output open.
- 13)  $t_{RAS} \text{ (max.)} = 1 \mu\text{s}$  is only applied to refresh of battery-backup.  
 $t_{RAS} \text{ (max.)} = 10 \mu\text{s}$  is applied to functional operating.

AC Characteristics <sup>4) 5)</sup> $T_A = 0$  to  $70$  °C,  $V_{CC} = 5 V \pm 10 \%$ ,  $t_T = 5$  ns

Parameter	Symbol	Limit values				Unit
		HYB 511000AL-60		HYB 511000AL-70		
		min.	max.	min.	max.	
Random read or write cycle time	$t_{RC}$	110	-	130	-	ns
Read modify write cycle time	$t_{RMW}$	135	-	155	-	ns
Fast page mode cycle time	$t_{PC}$	40	-	40	-	ns
Fast page mode RMW cycle time	$t_{PRMW}$	65	-	65	-	ns
Access time from $\overline{RAS}$ <sup>6) 11)</sup>	$t_{RAC}$	-	60	-	70	ns
Access time from $\overline{CAS}$ <sup>6) 11)</sup>	$t_{CAC}$	-	20	-	20	ns
Access time from column address <sup>6) 12)</sup>	$t_{AA}$	-	30	-	35	ns
Access time from $\overline{CAS}$ precharge <sup>6) 12)</sup>	$t_{CPA}$	-	30	-	35	ns
$\overline{CAS}$ to output in low-Z <sup>4)</sup>	$t_{CLZ}$	0	-	0	-	ns
Output buffer turn-off delay <sup>7)</sup>	$t_{OFF}$	0	20	0	20	ns
Transition time (rise and fall) <sup>5)</sup>	$T_T$	3	50	3	50	ns
$\overline{RAS}$ precharge time	$t_{RP}$	40	-	50	-	ns
$\overline{RAS}$ pulse width	$t_{RAS}$	60	10000	70	10000	ns
$\overline{RAS}$ pulse width (fast page mode)	$t_{RASP}$	60	100000	70	100000	ns
$\overline{RAS}$ hold time	$t_{RSH}$	20	-	20	-	ns
$\overline{CAS}$ hold time	$t_{CSH}$	60	-	70	-	ns
$\overline{CAS}$ pulse width	$t_{CAS}$	20	10000	20	10000	ns
$\overline{RAS}$ to $\overline{CAS}$ delay time <sup>11)</sup>	$t_{RCD}$	20	40	20	50	ns
$\overline{RAS}$ to column address delay time <sup>12)</sup>	$t_{RAD}$	15	30	15	35	ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time	$t_{CRP}$	5	-	5	-	ns
$\overline{CAS}$ precharge time	$t_{CPN}$	10	-	10	-	ns
$\overline{CAS}$ precharge time (fast page mode)	$t_{CP}$	10	-	10	-	ns
Row address setup time	$t_{ASR}$	0	-	0	-	ns
Row address hold time	$t_{RAH}$	10	-	10	-	ns
Column address setup time	$t_{ASC}$	0	-	0	-	ns
Column address hold time	$t_{CAH}$	15	-	15	-	ns
Column address hold time referenced to $\overline{RAS}$	$t_{AR}$	50	-	55	-	ns

For notes see page 9.

AC Characteristics (cont'd) <sup>4) 5)</sup>

Parameter	Symbol	Limit values				Unit
		HYB 511000AL-60		HYB 511000AL-70		
		min.	max.	min.	max.	
Column address to $\overline{\text{RAS}}$ lead time	$t_{\text{RAL}}$	30	-	35	-	ns
Read command setup time	$t_{\text{RCS}}$	0	-	0	-	ns
Read command hold time	<sup>8)</sup> $t_{\text{RCH}}$	0	-	0	-	ns
Read command hold time referenced to $\overline{\text{RAS}}$	<sup>8)</sup> $t_{\text{RRH}}$	0	-	0	-	ns
Write command hold time	$t_{\text{WCH}}$	15	-	15	-	ns
Write command hold time referenced to $\overline{\text{RAS}}$	$t_{\text{WCR}}$	60	-	55	-	ns
Write command pulse width	$t_{\text{WP}}$	15	-	15	-	ns
Write command to $\overline{\text{RAS}}$ lead time	$t_{\text{RWL}}$	20	-	20	-	ns
Write command to $\overline{\text{CAS}}$ lead time	$t_{\text{CWL}}$	20	-	20	-	ns
Data setup time	<sup>9)</sup> $t_{\text{DS}}$	0	-	0	-	ns
Data hold time	<sup>9)</sup> $t_{\text{DH}}$	15	-	15	-	ns
Data hold time referenced to $\overline{\text{RAS}}$	$t_{\text{DHR}}$	50	-	55	-	ns
Refresh period	$t_{\text{REF}}$	-	64	-	64	ms
Write command setup time	<sup>10)</sup> $t_{\text{WCS}}$	0	-	0	-	ns
$\overline{\text{CAS}}$ to $\overline{\text{WRITE}}$ delay time	<sup>10)</sup> $t_{\text{CWD}}$	50	-	50	-	ns
$\overline{\text{RAS}}$ to $\overline{\text{WRITE}}$ delay time	<sup>10)</sup> $t_{\text{RWD}}$	90	-	100	-	ns
Column address to $\overline{\text{WRITE}}$ delay time	<sup>10)</sup> $t_{\text{AWD}}$	60	-	65	-	ns
$\overline{\text{CAS}}$ setup time (CBR cycle)	$t_{\text{CSR}}$	10	-	10	-	ns
$\overline{\text{CAS}}$ hold time (CBR cycle)	$t_{\text{CHR}}$	30	-	30	-	ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	$t_{\text{RPC}}$	0	-	0	-	ns
$\overline{\text{CAS}}$ precharge time ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ counter test cycle)	$t_{\text{CPN}}$	40	-	40	-	ns
Test mode enable setup time referenced to $\overline{\text{RAS}}$	$t_{\text{TES}}$	0	-	0	-	ns
Test mode enable hold time referenced to $\overline{\text{RAS}}$	$t_{\text{TEHR}}$	0	-	0	-	ns
Test mode enable hold time referenced to $\overline{\text{CAS}}$	$t_{\text{TEHC}}$	0	-	0	-	ns

For notes see page 9.



**Capacitance** $T_A = 0$  to  $70$  °C,  $V_{CC} = 5$  V  $\pm$  10 %,  $f = 1$  MHz

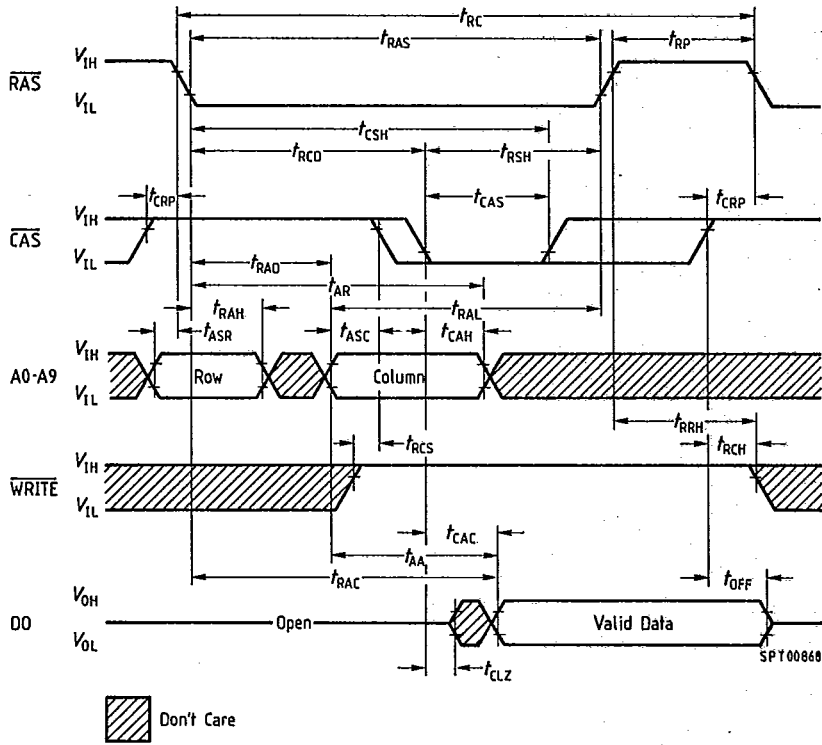
Parameter	Symbol	Limit values		Unit	Test condition
		min.	max.		
Input capacitance (A0 to A9, DI)	$C_{I1}$	-	6	pF	-
Input capacitance ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ , TF)	$C_{I2}$	-	7	pF	-
Output capacitance	$C_O$	-	7	pF	-

**Notes for pages 7 and 8**

- 4) An initial pause of 200  $\mu$ s is required after power-up followed by 8  $\overline{\text{RAS}}$  cycles before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  initialization cycles instead of 8  $\overline{\text{RAS}}$  cycles are required.
- 5)  $V_{IH}$  (min.) and  $V_{IL}$  (max.) are reference levels for measuring timing of input signals. Transition times are also measured between  $V_{IH}$  and  $V_{IL}$ .
- 6) Measured with a load equivalent of 2 TTL loads and 100 pF.
- 7)  $t_{OFF}$  (max.) defines the time at which the output achieves the open-circuit conditions and is not referenced to output voltage levels.
- 8) Either  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.
- 9) These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in early write cycles and the  $\overline{\text{WRITE}}$  leading edge in read-write cycles.
- 10)  $t_{WCS}$ ,  $t_{RWD}$ ,  $t_{CWD}$  and  $t_{AWD}$  are not restricted operation 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 data out pin will remain open-circuit (high impedance) through the entire cycle. If  $t_{RWD} \geq t_{RWD}$  (min.),  $t_{CWD} \geq t_{CWD}$  (min.), and  $t_{AWD} \geq t_{AWD}$  (min.) the cycle is a read-modify-write cycle and data out will contain data read from the selected cell. If neither of the above sets of conditions is satisfied, the condition of data out (at access time) is indeterminate.
- 11) Operation within the  $t_{RCD}$  (max.) limit ensures that  $t_{RAC}$  (max.) can be met.  $t_{RAD}$  (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 by  $t_{CAC}$ .
- 12) Operation within the  $t_{RAD}$  (max.) limit ensures that  $t_{RAC}$  (max.) can be met.  $t_{RAD}$  (max.) is specified as a reference point only. If  $t_{RAD}$  is greater than the specified  $t_{RAD}$  (max.) limit, then access time is controlled by  $t_{AA}$ .

Waveforms

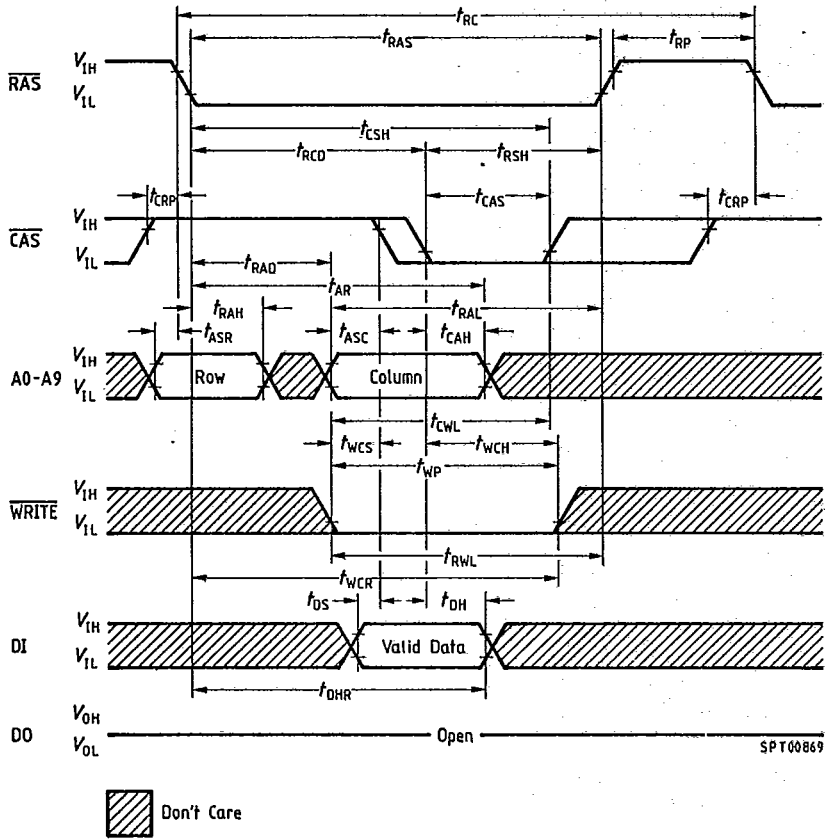
Read Cycle



Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

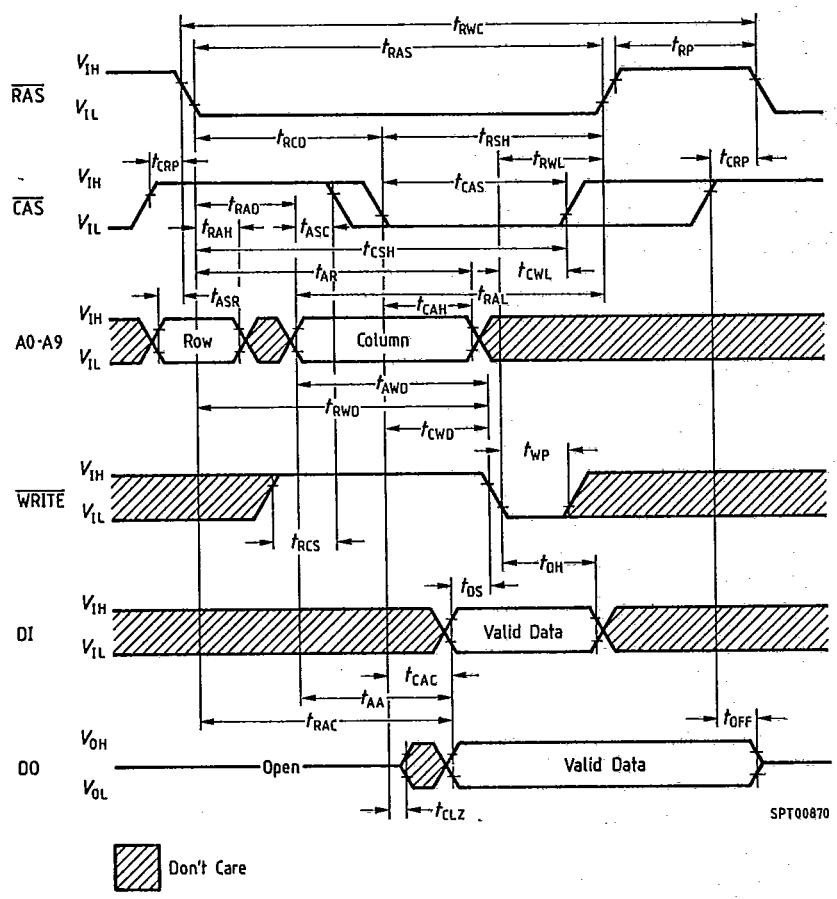
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Write Cycle (early write)



Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

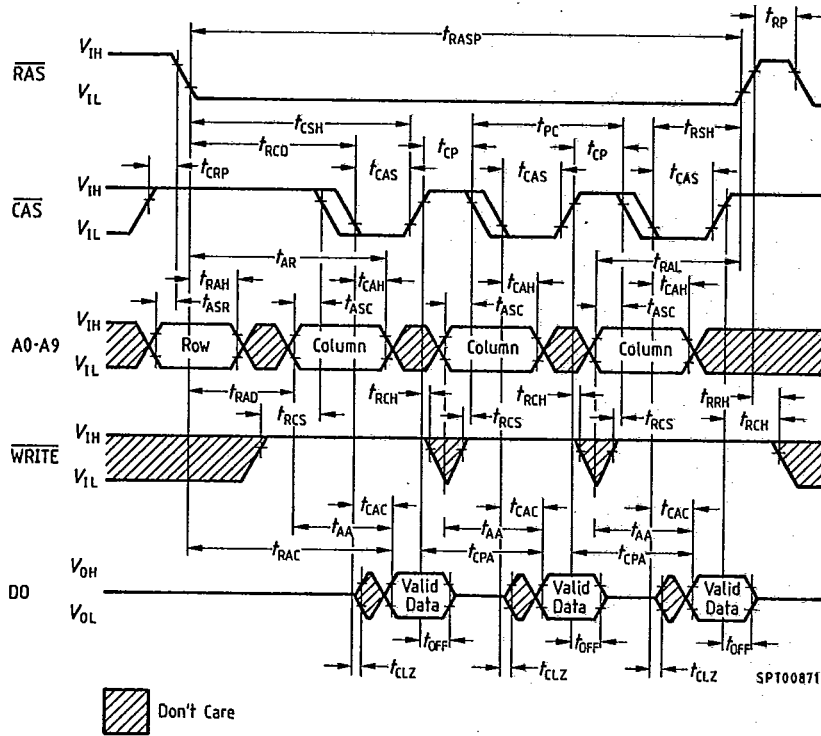
Read-Write Cycle



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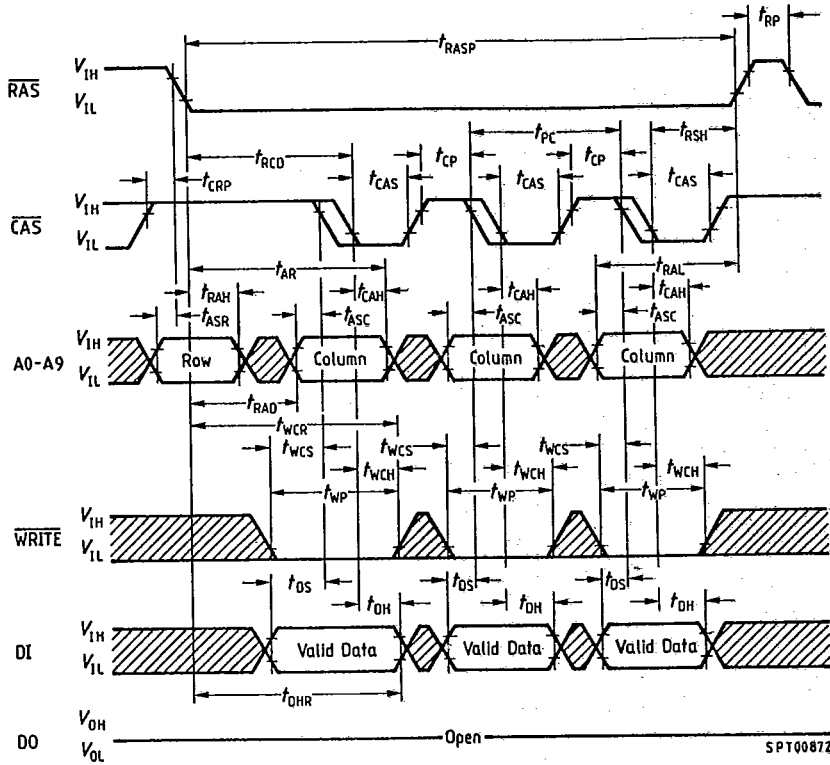
Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

Fast Page Mode Read Cycle



Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

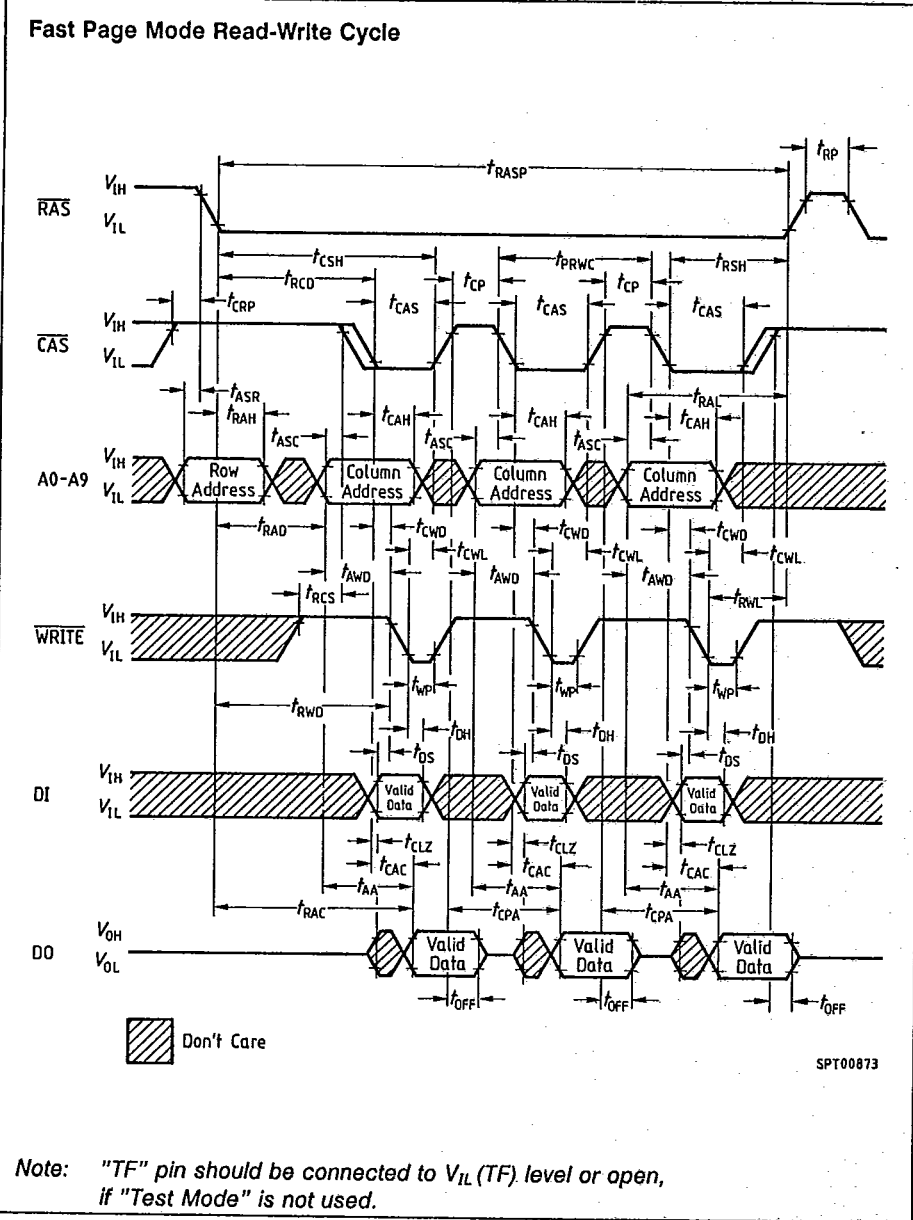
Fast Page Mode Write Cycle (early write)



Don't Care

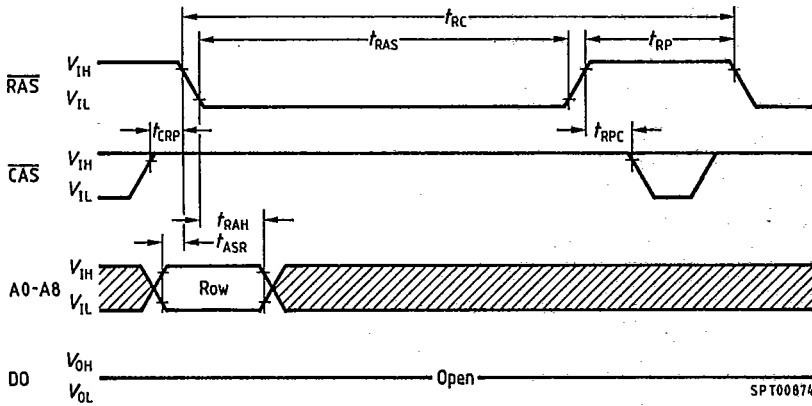
Note: "TF" pin should be connected to  $V_{IL}(TF)$  level or open, if "Test Mode" is not used.

Fast Page Mode Read-Write Cycle



Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

**RAS-Only Refresh Cycle**

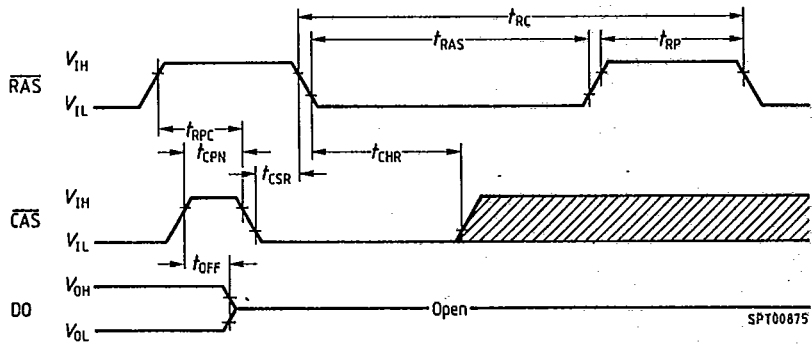


Note:  $\overline{WRITE}$ =Don't Care, A9=Don't Care Don't Care

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Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

**CAS-Before-RAS Refresh Cycle**



Note:  $\overline{WRITE}$  = Don't Care, A0-A9=Don't Care Don't Care

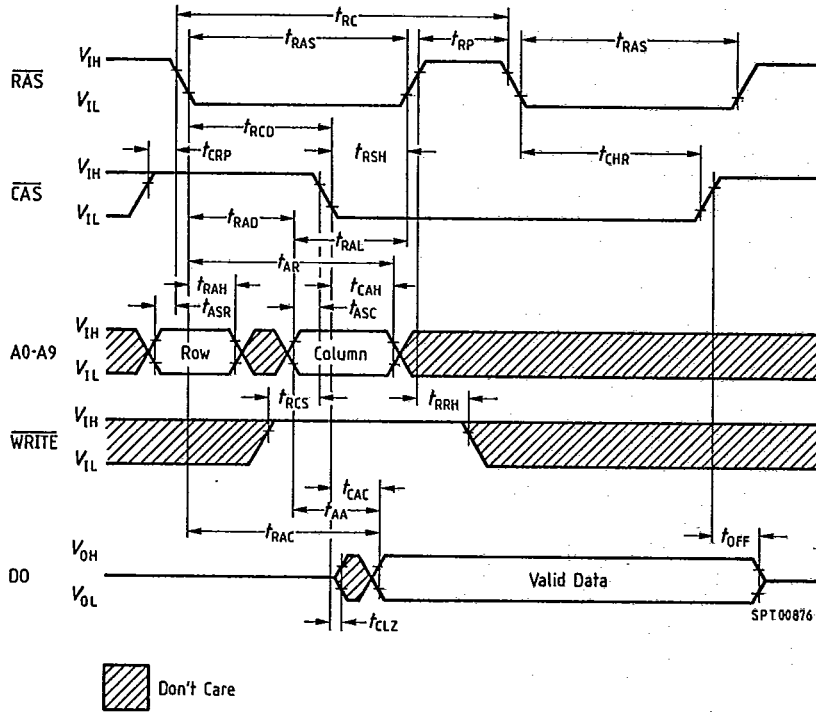
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Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.



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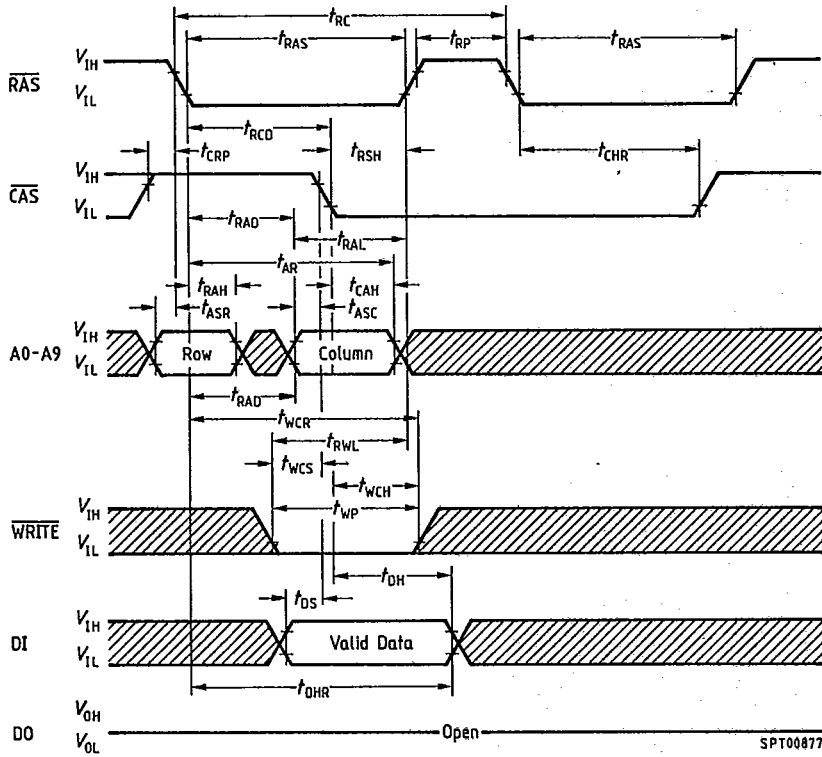
Hidden Refresh Cycle (read)



Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

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Hidden Refresh Cycle (write)

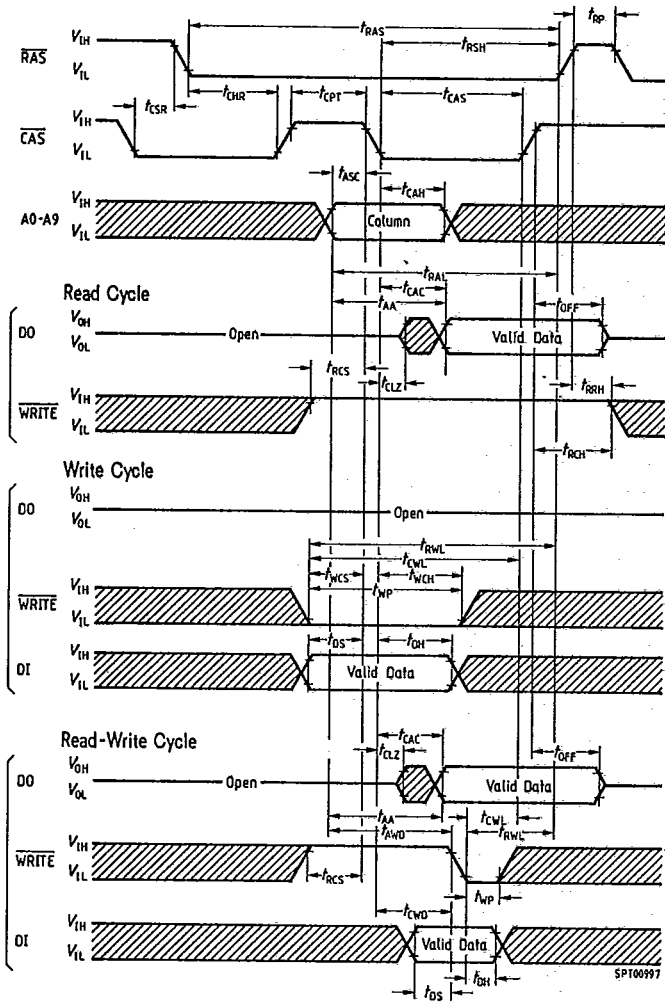


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Note: "TF" pin should be connected to  $V_{TL}$  (TF) level or open, if "Test Mode" is not used.

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CAS-Before-RAS Refresh Counter Test Cycle

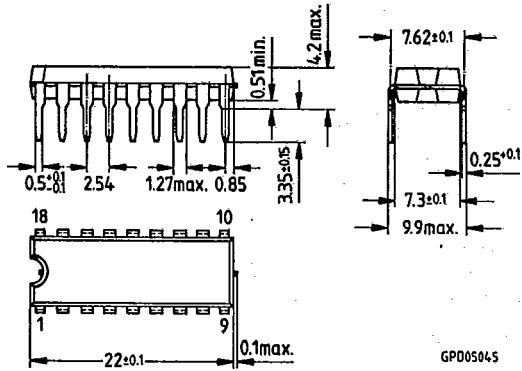


Note: "TF" pin should be connected to  $V_{IL}$  (TF) level or open, if "Test Mode" is not used.

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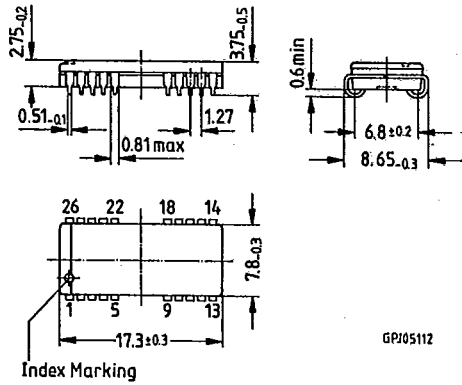
Package Outlines

Plastic Package, P-DIP-18-T  
(dual-in-line-package)  
20A18DIN41870T9



Dimensions in mm

Plastic Package, P-SOJ-26/20  
(Plastic small outline J-lead) - SMD

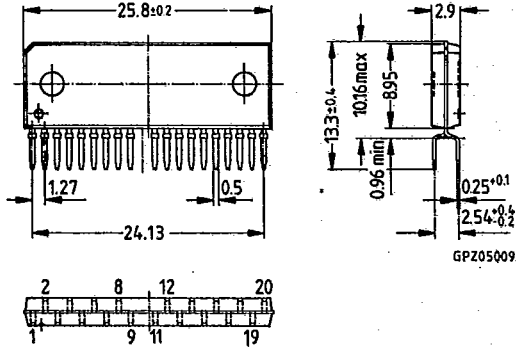


Dimensions in mm

T-46-23-15

Package Outlines (cont'd)

Plastic Package, P-ZIP-20/19  
(JEDEC-MO-072-AA)



Dimensions in mm