

# Am2965/Am2966

## Octal Dynamic Memory Drivers with Three-State Outputs



Advanced  
Micro  
Devices

### DISTINCTIVE CHARACTERISTICS

- **Controlled rise and fall characteristics**  
Internal resistors provide symmetrical drive to HIGH and LOW states, eliminating need for external series resistor.
- **Output swings designed to drive 16K and 64K RAMs**  
 $V_{OH}$  guaranteed at  $V_{CC} - 1.15V$ . Undershoot going LOW guaranteed at less than 0.5V.
- **Large capacitive drive capability**  
35mA min source or sink current at 2.0V. Propagation delays specified for 50pF and 500pF loads.
- **Pin-compatible with 'S240 and 'S244**  
Non-inverting Am2966 replaces 74S244; inverting Am2965 replaces 74S240. Faster than 'S240/244 under equivalent load.
- **No-glitch outputs**  
Outputs forced into OFF state during power up and down. No glitch coming out of three-state.

### GENERAL DESCRIPTION

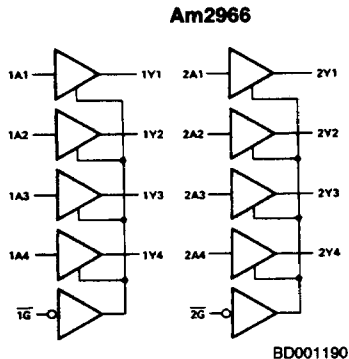
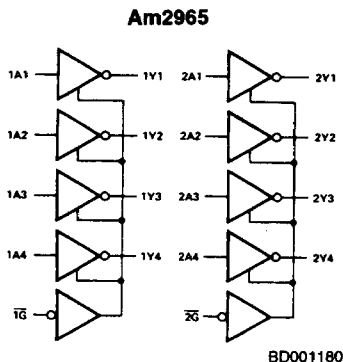
The Am2965 and Am2966 are designed and specified to drive the capacitive input characteristics of the address and control lines of MOS dynamic RAMs. The unique design of the lower output driver includes a collector resistor to control undershoot on the HIGH-to-LOW transition. The upper output driver pulls up to  $V_{CC} - 1.15V$  to be compatible with MOS memory and is designed to have a rise time symmetrical with the lower output's controlled fall time. This allows optimization of Dynamic RAM performance.

The Am2965 and Am2966 are pin-compatible with the popular 'S240 and 'S244 with identical 3-state output enable controls. The Am2965 has inverting drivers and the Am2966 has non-inverting drivers.

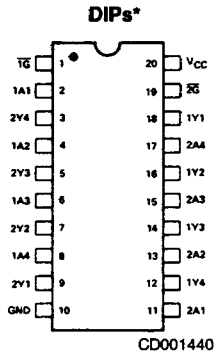
The inclusion of an internal resistor in the lower output driver eliminates the requirement for an external series resistor, therefore reducing package count and the board area required. The internal resistor controls the output fall and undershoot without slowing the output rise.

These devices are designed for use with the Am2964 Dynamic Memory Controller where large dynamic memories with highly capacitive input lines require additional buffering. Driving eight address lines or four RAS and four CAS lines with drivers on the same silicon chip also provides a significant performance advantage by minimizing skew between drivers. Each device has specified skew between drivers to improve the memory access worst case timing over the min and max  $t_{PD}$  difference of unspecified devices.

### BLOCK DIAGRAM



### CONNECTION DIAGRAM Top View



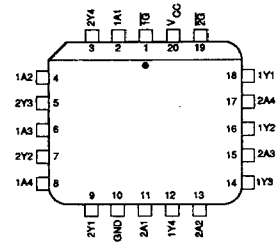
**Am2965**

Inputs		Outputs
$\bar{G}$	A	Y
H	X	Z
L	H	L
L	L	H

**Am2966**

Inputs		Outputs
$\bar{G}$	A	Y
H	X	Z
L	L	L
L	H	H

**Plastic Leaded Chip Carrier**



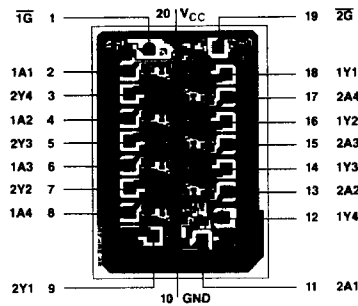
05409-001A  
CD012030

Note: Pin 1 is marked for orientation

\*Also available in 20-Pin Small Outline package for Am2966 only; pinout identical to DIPs.

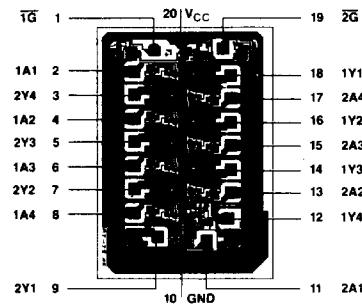
### METALLIZATION AND PAD LAYOUT

**Am2965**



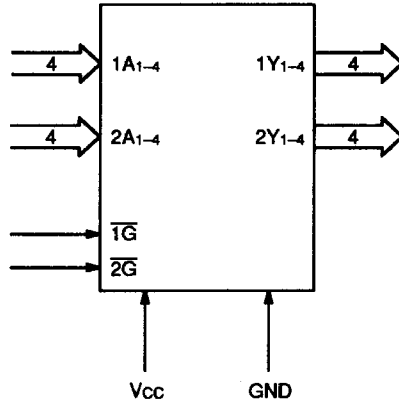
DIE SIZE 0.094" x 0.060"

**Am2966**



DIE SIZE 0.094" x 0.066"

LOGIC SYMBOL



05409-002A

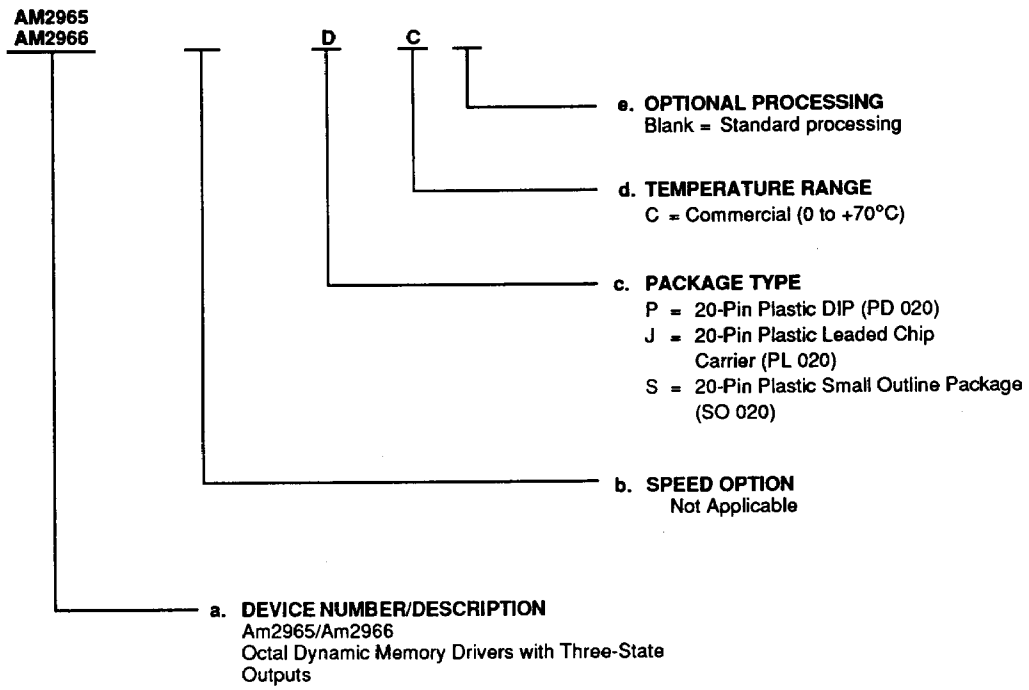
Parameter	PD	PLCC	SOIC	Units
$\theta_{JA}$	71	72	75	°C/Watt
$\theta_{JC}$	22	18	16	

## ORDERING INFORMATION

### Standard Products

AMD standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of:

- a. **Device Number**
- b. **Speed Option (if applicable)**
- c. **Package Type**
- d. **Temperature Range**
- e. **Optional Processing**



Valid Combinations	
AM2965	JC, PC
AM2966	JC, PC, SC

#### Valid Combinations

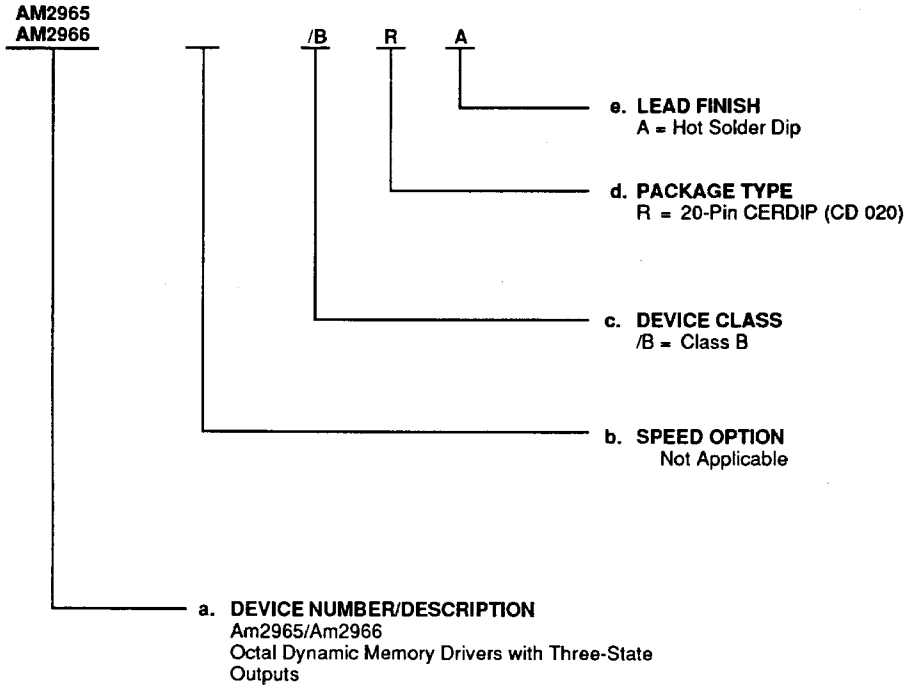
Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check on newly released combinations, and to obtain additional data on AMD's standard military grade products.

## MILITARY ORDERING INFORMATION

### APL Products

AMD products for Aerospace and Defense applications are available in several packages and operating ranges. APL (Approved Products List) products are fully compliant with MIL-STD-883C requirements. The order number (Valid Combination) is formed by a combination of:

- a. Device Number
- b. Speed Option (if applicable)
- c. Package Type
- d. Temperature Range
- e. Optional Processing



Valid Combinations	
AM2965	/BRA
AM2966	

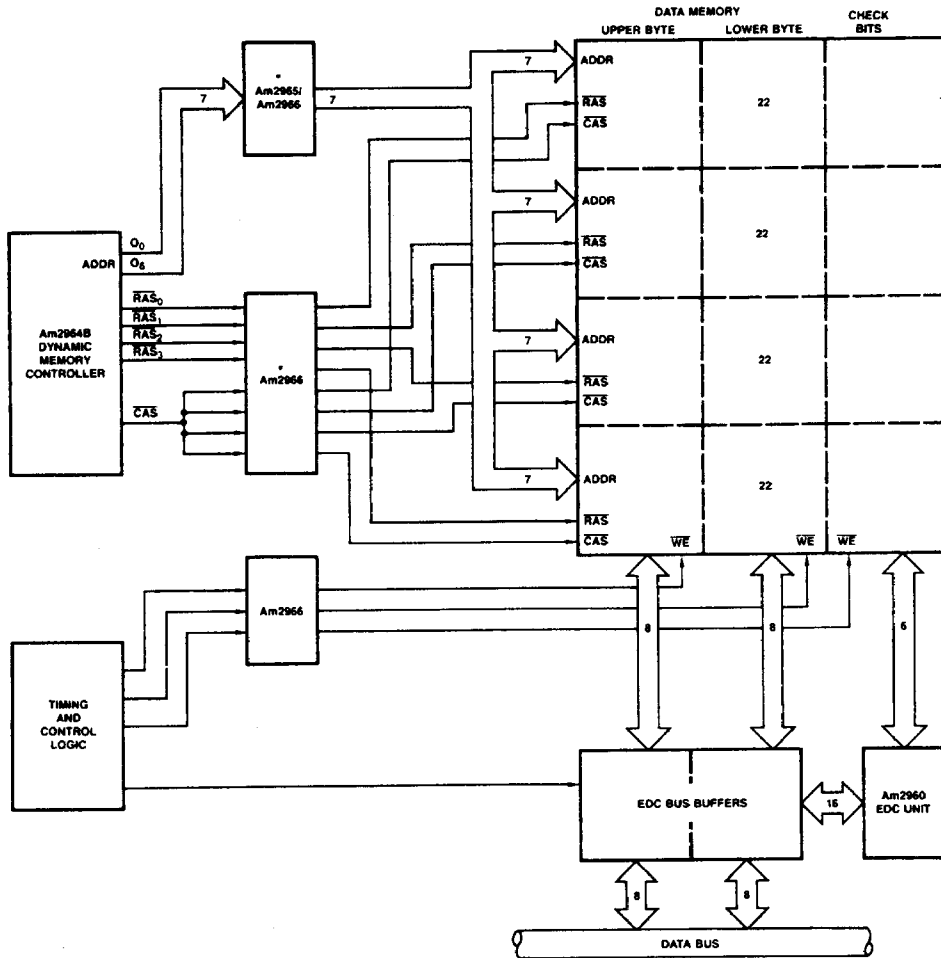
#### Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations, to check on newly released combinations.

#### Group A Tests

Group A tests consists of Subgroups  
1, 2, 3, 7, 8, 9, 10, 11

## APPLICATION



AF000401

\*Address and  $\overline{\text{RAS}}/\overline{\text{CAS}}$  drivers each drive 22 RAM inputs at each output. Timing skew is minimized by using one device for address lines and one device for  $\overline{\text{RAS}}/\overline{\text{CAS}}$ , spreading the  $\overline{\text{CAS}}$  loading over four drivers to equalize the capacitive load on each driver.

### DYNAMIC MEMORY CONTROL WITH ERROR DETECTION AND CORRECTION

## ABSOLUTE MAXIMUM RATINGS

Storage Temperature .....	-65°C to +150°C
Temperature (Case)	
Under Bias .....	-55°C to +125°C
Supply Voltage to Ground Potential	
Continuous .....	-0.5V to +7.0V
DC Voltage Applied to Outputs For	
High Output State .....	-0.5V to V <sub>CC</sub> Max
DC Input Voltage .....	-0.5V to +7.0V
DC Output Current, Into Outputs .....	200mA
DC Input Current .....	-30mA to +5.0mA

Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

## OPERATING RANGES

Commercial (C) Devices	
Temperature .....	0°C to +70°C
Supply Voltage .....	+4.75V to +5.25V
Military (M) Devices	
Temperature .....	-55°C to +125°C
Supply Voltage .....	+4.5V to +5.5V

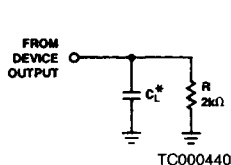
Operating ranges define those limits over which the functionality of the device is guaranteed.

## DC CHARACTERISTICS over operating ranges unless otherwise specified (for APL Products, Group A Subgroups 1, 2, 3, 7, and 8 are tested unless otherwise noted)

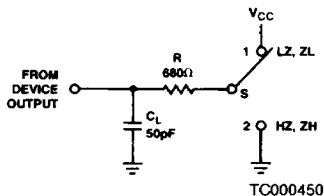
Parameters	Descriptions	Test Conditions (Note 1)		Min	Typ (Note 2)	Max	Units
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = MIN V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -1mA	V <sub>CC</sub> - 1.15	V <sub>CC</sub> - 0.7V		Volts
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = MIN V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 1mA I <sub>OL</sub> = 12mA			0.5 0.8	Volts
V <sub>IH</sub>	Input HIGH Level	Guaranteed input logical HIGH voltage for all inputs		2.0			Volts
V <sub>IL</sub>	Input LOW Level	Guaranteed input logical LOW voltage for all inputs				0.8	Volts
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = MIN, I <sub>IIN</sub> = -18mA				-1.2	Volts
I <sub>IL</sub>	Input LOW Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 0.4V	DATA TG, 2G			-200 -400	μA
I <sub>IH</sub>	Input HIGH Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 2.7V				20	μA
I <sub>I</sub>	Input HIGH Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 7.0V				0.1	mA
I <sub>OZH</sub>	Off-State Current	V <sub>O</sub> = 2.7V				100	μA
I <sub>OZL</sub>	Off-State Current	V <sub>O</sub> = 0.4V				-200	μA
I <sub>OL</sub>	Output Sink Current	V <sub>OL</sub> = 2.0V		50			mA
I <sub>OH</sub>	Output Source Current	V <sub>OH</sub> = 2.0V		-35			mA
I <sub>SC</sub>	Output Short Circuit Current (Note 3)	V <sub>CC</sub> = MAX		-60 (see I <sub>OH</sub> )		-200	mA
I <sub>CC</sub>	Supply Current	Am2965	All Outputs HIGH	V <sub>CC</sub> = MAX Outputs Open	24	50	mA
			All Outputs LOW		86	125	
			All Outputs Hi-Z		86	125	
		Am2966	All Outputs HIGH		53	75	
			All Outputs LOW		92	130	
			All Outputs Hi-Z		116	150	

- Notes: 1. For conditions shown as MIN or MAX, use the appropriate value specified under Operating Range for the applicable device type.  
 2. Typical limits are at V<sub>CC</sub> = 5.0V, 25°C ambient and maximum loading.  
 3. Not more than one output should be shorted at a time. Duration of the short circuit test should not exceed one second.

### SWITCHING TEST CIRCUIT

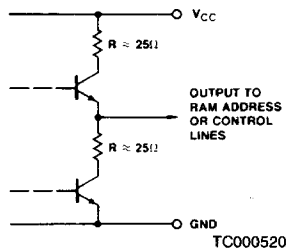


\*t<sub>pd</sub> specified at C = 50 and 500pF.  
**Figure 1. Capacitive Load Switching.**



**Figure 2. Three-State Enable/Disable.**

### TYPICAL OUTPUT DRIVER



### SWITCHING CHARACTERISTICS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5.0 V) for APL Products, Group A Subgroups 9, 10, and 11 are tested unless otherwise noted)

Parameters	Description	Test Conditions	Min	Typ	Max	Units	
t <sub>PLH</sub>	Propagation Delay Time from LOW-to-HIGH Output	Figure 1 Test Circuit Figure 3 Voltage Levels and Waveforms	C <sub>L</sub> = 0pF		6	(Note 4)	ns
			C <sub>L</sub> = 50pF	6	9	15	
			C <sub>L</sub> = 500pF	18	22	30	
t <sub>PHL</sub>	Propagation Delay Time from HIGH-to-LOW Output	Figure 1 Test Circuit Figure 3 Voltage Levels and Waveforms	C <sub>L</sub> = 0pF		4	(Note 4)	ns
			C <sub>L</sub> = 50pF	5	7	15	
			C <sub>L</sub> = 500pF	18	22	30	
t <sub>PLZ</sub>	Output Disable Time from LOW, HIGH	Figures 2 and 4, S = 1		11	20	ns	
t <sub>PHZ</sub>	Output Disable Time from LOW, HIGH	Figures 2 and 4, S = 2		6.5	12		
t <sub>PZL</sub>	Output Enable Time from LOW, HIGH	Figures 2 and 4, S = 1		12	20	ns	
t <sub>PZH</sub>	Output Enable Time from LOW, HIGH	Figures 2 and 4, S = 2		12	20		
t <sub>SKEW</sub>	Output-to-Output Skew	Figures 1 and 3, C <sub>L</sub> = 50pF		±0.5	±3.0 (Note 5)	ns	
V <sub>ONP</sub>	Output Voltage Undershoot	Figures 1 and 3, C <sub>L</sub> = 50pF		0	-0.5	Volts	

### SWITCHING CHARACTERISTICS over operating ranges unless otherwise specified (Note 6)

Parameters	Description	Test Conditions	COMMERCIAL		MILITARY		Units	
			Min	Max	Min	Max		
t <sub>PLH</sub>	Propagation Delay Time LOW-to-HIGH Output	Figures 1 and 3	C <sub>L</sub> = 50pF	4	17	4	20	ns
			C <sub>L</sub> = 500pF	18	35	18	40	
t <sub>PHL</sub>	Propagation Delay Time HIGH-to-LOW Output	Figures 1 and 3	C <sub>L</sub> = 50pF	4	17	4	20	ns
			C <sub>L</sub> = 500pF	18	35	18	40	
t <sub>PLZ</sub>	Output Disable Time from LOW, HIGH	Figures 2 and 4	S = 1		24		24	ns
t <sub>PHZ</sub>	Output Disable Time from LOW, HIGH		S = 2		16		16	
t <sub>PZL</sub>	Output Enable Time from LOW, HIGH	Figures 2 and 4	S = 1		28		28	ns
t <sub>PZH</sub>	Output Enable Time from LOW, HIGH		S = 2		28		28	
V <sub>ONP</sub>	Output Voltage Undershoot	Figures 1 and 3, C <sub>L</sub> = 50pF		-0.5			-0.5	Volts

Notes: 4. Typical time shown for reference only – not tested.

5. Time Skew specification is guaranteed by design but not tested.

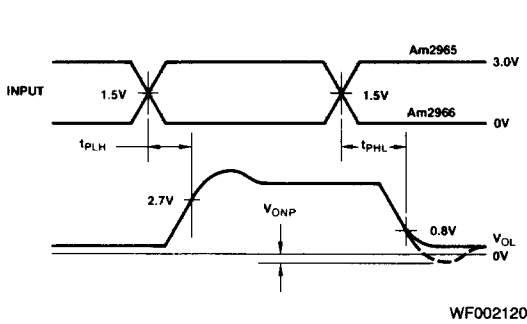
6. AC performance over the operating temperature range is guaranteed by testing defined in Group A, Subgroup 9.

7. T<sub>C</sub> = -55 to +125°C for Flatpak versions.



## TYPICAL SWITCHING CHARACTERISTICS

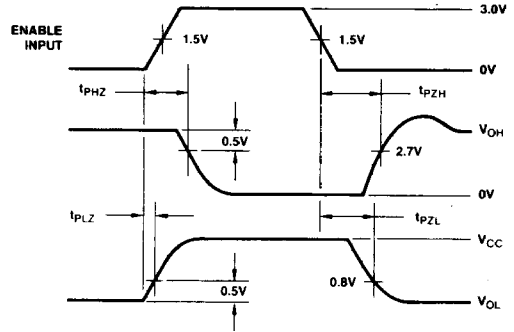
### SWITCHING TEST WAVEFORMS



t<sub>r</sub> = t<sub>f</sub> = 2.5ns  
 f = 2.5MHz  
 t<sub>pw</sub> = 200ns

Figure 3. Output Drive Levels.

The RAM Driver symmetrical output design offers significant improvement over a standard Schottky output by providing a balanced drive output impedance ( $\approx 25\Omega$  both HIGH and LOW), and by pulling up to MOS V<sub>OH</sub> levels (V<sub>CC</sub> - 1.5V). External resistors, not required with the RAM Driver, protect standard Schottky drivers from error causing undershoot but also slow the output rise by adding to the internal R.



t<sub>r</sub> = t<sub>f</sub> = 2.5ns  
 f = 1MHz  
 t<sub>pw</sub> = 800ns

Figure 4. Three-State Control Levels.

The RAM Driver is optimized to drive LOW at maximum speed based on safe undershoot control and to drive HIGH with a symmetrical speed characteristic. This is an optimum approach, because the dominant RAM loading characteristic is input capacitance.

The curves shown below provide performance characteristics typical of both the inverting (Am2965) and non-inverting (Am2966) RAM Drivers.

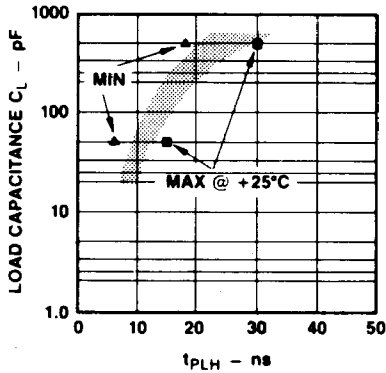


Figure 5. t<sub>PLH</sub> for V<sub>OH</sub> = 2.7 Vol vs. C<sub>L</sub>.

The curves above depict the typical t<sub>PLH</sub> and t<sub>PHL</sub> for the RAM Driver outputs as a function of load capacitance. The minimums and maximums are shown for worst case design. The typical band is provided as a guide for intermediate capacitive loads.

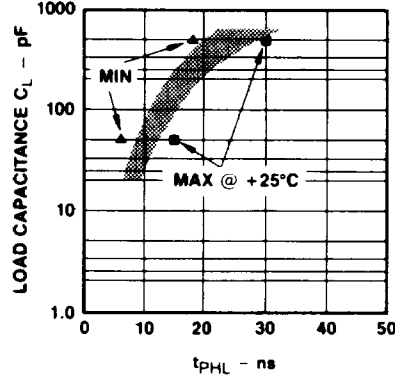


Figure 6. t<sub>PHL</sub> for V<sub>OL</sub> = 0.8 Volts vs. C<sub>L</sub>.