

# **PAL16R8**

## 20-Pin TTL Programmable Array Logic

The PAL16R8 Family (PAL16L8, PAL16R8, PAL 16R6, PAL 16R4) is AMD's standard 20-pin PAL device family. The devices provide user-programmable logic for replacing conventional SSI/MSI gates and flip-flops at a reduced chip count.

The family allows the systems engineer to implement the design on-chip, by opening fuse links to configure AND and OR gates within the device, according to the desired logic function. Complex interconnections between gates, which previously required time-consuming layout, are lifted from the PC board and placed on silicon, where they can be easily modified during prototyping or production.

The PAL device implements the familiar Boolean logic transfer function, the sum of products. The PAL device is a programmable AND array driving a fixed OR array. The AND array is programmed to create custom product terms, while the OR array sums selected terms at the outputs.

<b>Rochester Electronics</b>
Manufactured Components

Rochester branded components are manufactured using either die/wafers purchased from the original suppliers or Rochester wafers recreated from the original IP. All re-creations are done with the approval of the Original Component Manufacturer (OCM).

Parts are tested using original factory test programs or Rochester developed test solutions to guarantee product meets or exceeds the OCM data sheet.

## **Quality Overview**

- ISO-9001
- AS9120 certification
- Qualified Manufacturers List (QML) MIL-PRF-35835
  - Class Q Military
  - Class V Space Level
- Qualified Suppliers List of Distributors (QSLD)
  - Rochester is a critical supplier to DLA and meets all industry and DLA standards.

Rochester Electronics, LLC is committed to supplying products that satisfy customer expectations for quality and are equal to those originally supplied by industry manufacturers.

The original manufacturer's datasheet accompanying this document reflects the performance and specifications of the Rochester manufactured version of this device. Rochester Electronics guarantees the performance of its semiconductor products to the original OCM specifications. 'Typical' values are for reference purposes only. Certain minimum or maximum ratings may be based on product characterization, design, simulation, or sample testing.

FOR REFERENCE ONLY

# PAL16R8 Family

20-pin TTL Programmable Array Logic

#### **DISTINCTIVE CHARACTERISTICS**

- As fast as 7.5 ns maximum propagation delay
- Popular 20-pin architectures: 16L8, 16R8, 16R6, 16R4
- Programmable replacement for high-speed TTL logic
- Power-up reset for initialization on most devices

#### **GENERAL DESCRIPTION**

The PAL16R8 Family (PAL16L8, PAL16R8, PAL16R6, PAL16R4) is AMD's standard 20-pin PAL device family. The devices provide user-programmable logic for replacing conventional SSI/MSI gates and flip-flops at a reduced chip count.

The family allows the systems engineer to implement the design on-chip, by opening fuse links to configure AND and OR gates within the device, according to the desired logic function. Complex interconnections between gates, which previously required time-consuming layout, are lifted from the PC board and placed on silicon, where they can be easily modified during prototyping or production.

The PAL device implements the familiar Boolean logic transfer function, the sum of products. The PAL device is a programmable AND array driving a fixed OR array. The AND array is programmed to create custom product terms, while the OR array sums selected terms at the outputs.



- Easy design with PALASM<sup>®</sup> software
- Programmable on standard PAL<sup>®</sup> device programmers
- 20-pin DIP and PLCC packages save space

In addition, the PAL device provides the following options:

- Variable input/output pin ratio
- Programmable three-state outputs
- Registers with feedback

Product terms with all connections opened assume the logical HIGH state; product terms connected to both true and complement of any single input assume the logical LOW state. Registers consist of D-type flip-flops that are loaded on the LOW-to-HIGH transition of the clock. Unused input pins should be tied to V<sub>CC</sub> or GND.

The entire PAL device family is supported by the PALASM software package. The PAL family is programmed on conventional PAL device programmers with appropriate personality and socket adapter modules. See the Programmer Reference Guide for approved programmers. Once the PAL device is programmed and verified an additional connection may be opened to prevent pattern readout. This feature secures proprietary circuits.

DEVICE	DEDICATED INPUTS	OUTPUTS	PRODUCT TERMS/ OUTPUT	FEEDBACK	ENABLE
PAL16L8	10	6 comb. 2 comb.	7 7	1/O _	prog. prog.
PAL16R8	8	8 reg.	8	reg.	pin
PAL16R6	8	6 reg. 2 comb.	8 7	reg. I/Ö	pin prog.
PAL16R4	8	4 reg. 4 comb.	8 7	reg. I/O	pin prog.

#### **PRODUCT SELECTOR GUIDE**

PAL and PALASM are registered trademarks of Advanced Micro Devices. This part is covered by various U.S. and toreign patents owned by Advanced Micro Devices.

## PERFORMANCE OPTIONS



Power (Icc, mA)

#### Note:

For low power and high speed, the EE CMOS PALCE16V8 can directly replace the PAL16R8 Family.

Commercial	Military
-7	-12
D (10 ns)	D (15 ns)
H-15	
B (15 ns)	B (20 ns)
B-2 (25 ns)	B-2 (30 ns)
A (25 ns)	A (30 ns)
B-4 (35 ns)	B-4 (50 ns)
A-2 (35 ns)	A-2 (50 ns)

## **OPERATING RANGES**

## **BLOCK DIAGRAMS**





## BLOCK DIAGRAMS





12468-003A

2

## CONNECTION DIAGRAMS Top View



12468-005A

/	F = 1 00 F = 1 00 F = 1 20 F = 1 20	
I3 🗖 4	•	18 🔲 (NOTE 9)
I₄ 🗖 5		17 🔲 (NOTE 8)
I <sub>5</sub>		16 🔲 (NOTE 7)
l6 🗖 7		15 🔲 (NOTE 6)
17 🗖 8		14 🔲 (NOTE 5)
	9 10 11 12	13
	I <sub>8</sub> [ GND [ NOTE 2) [ NOTE 3) [	☐ ( <del>{</del> Ⅲ 12468-006A ☑

PLCC/LCC

Note	16L8	16R8	16R6	16R4
1	lo	CLK	CLK	CLK
2	lg	ŌE	ŌĒ	ŌE
3	O1	O1	I/O1	I/O1
4	I/O2	O2	O <sub>2</sub>	I/O2
5	I/O <sub>3</sub>	O <sub>3</sub>	O3	O <sub>3</sub>
6	I/O₄	O4	O4	O₄
7	I/O₅	O <sub>5</sub>	O <sub>5</sub>	O <sub>5</sub>
8	I/O6	O6	O6	O <sub>6</sub>
9	I/O7	07	07	1/07
10	O <sub>8</sub>	O <sub>8</sub>	1/O <sub>8</sub>	I/O8

**PIN DESIGNATIONS** 

CLK	Clock
GND	Ground
I	Input
1/O	Input/Output
0	Output
ŌĒ	Output Enable
Vcc	Supply Voltage

### **ORDERING INFORMATION**

#### Commercial Products (AMD Marking Only)

AMD programmable logic products for commercial applications are available with several ordering options. The order number (Valid Combination) is formed by a combination of: **a. Family Type** 

- b. Number of Array Inputs
- c. Output Type
- d. Number of Outputs
- e. Power
- f. Speed
- g. Package Type
- h. Operating Conditions
- i. Optional Processing



-15 = 15 ns tpp

Val	id Combin	ations
PAL16L8		
PAL16R8	7 11 15	
PAL16R6	]-', 1-'5	F0, 00, D0
PAL16R4	1	

#### Valid Combinations

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

Note: Marked with AMD logo.

## ORDERING INFORMATION Commercial Products (MMI Marking Only)

AMD programmable logic products for commercial applications are available with several ordering options. The order number (Valid Combination) is formed by a combination of: **a. Family Type** 

- b. Number of Array Inputs
- c. Output Type
- d. Number of Outputs
- e. Speed
- f. Power
- g. Operating Conditions
- h. Package Type
- I Optional Processing



- f. POWER
  - Blank = Full Power (155-180 mA lcc)
  - -2 = Half Power (80-90 mA lcc)
  - -4 = Quarter Power (55 mA Icc)

Valid Combinations			
PAL16L8	D, B	CN, CNL, CJ	
PAL16R8	B-2, A		
PAL16R6	B-4, A-2		
PAL16R4			

#### Valid Combinations

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

Note: Marked with MMI logo.

## ORDERING INFORMATION APL Products (AMD Marking Only)

AMD programmable logic products for Aerospace and Defense applications are available with several ordering options. APL (Approved Products List) products are fully compliant with MIL-STD-883 requirements. The order number (Valid Combination) is formed by a combination of: **a.** Family Type

b. Number of Array Inputs c. Output Type d. Number of Outputs e. Speed f. **Device Class** g. Package Type h. Lead Finish PAL 16 R 8 -12 /B R FAMILY TYPE а PAL = Programmable Array Logic NUMBER OF LEAD FINISH b. **ARRAY INPUTS** A = Hot Solder Dip PACKAGE TYPE c. OUTPUT TYPE g. R = 20-Pin Ceramic DIP R = Registered L = Active-Low Combinate (CD 020) 20-Pin Ceramic 2 d. NUMBER OF OUTPU Leadless Chip Carrier (CL 020) SPEED e. -12 f. DEVICE C /B = Class

Valid Combinations		
PAL16L8		
PAL16R8	10	
PAL16R6	-12	/DNA, /02A
PAI 16B4	1	

#### Valid Combinations

The Valid Combinations table lists 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, and to obtain additional data on AMD's standard military grade products.

Note: Marked with AMD logo.

#### **Group A Tests**

Group A Tests consist of Subgroups: 1, 2, 3, 7, 8, 9, 10, 11.

#### **Military Burn-In**

Military burn-in is in accordance with the current revision of MIL-STD-883, Test Methods 1015, Conditions A through E. Test conditions are selected at AMD's option.

## **ORDERING INFORMATION** APL Products (MMI Marking Only)

AMD programmable logic products for Aerospace and Defense applications are available with several ordering options. APL (Approved Products List) products are fully compliant with MIL-STD-883 requirements. The order number (Valid Combination) is formed by a combination of: a. Family Type

- b. Number of Array Inputs
- c. Output Type
- d. Number of Outputs
- e. Speed
- 1. Power
- g. Operating Conditions
- h. Package Type
- I. Optional Processing



- f. POWER
  - Blank = Full Power (180 mA Icc)
  - -2 = Half Power (90 mA lcc)
  - -4 = Quarter Power (55 mA Icc)

Valid Combinations			
PAL16L8	D, B,	MJ/883B,	
PAL16R8	B-2, A,	MW/883B,	
PAL16R6	B-4, A-2	ML/883B	
PAL16R4		2	

#### **Group A Tests**

Group A Tests consist of Subgroups: 1, 2, 3, 7, 8, 9, 10, 11.

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#### Valid Combinations

The Valid Combinations table lists 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, and to obtain additional information on AMD's Standard Military grade products.

Note: Marked with MMI logo.

## FUNCTIONAL DESCRIPTION Standard 20-pin PAL Family

The standard bipolar 20-pin PAL family devices have common electrical characteristics and programming procedures. Four different devices are available, including both registered and combinatorial devices. All parts are produced with a fuse link at each input to the AND gate array, and connections may be selectively removed by applying appropriate voltages to the circuit. Utilizing an easily-implemented programming algorithm, these products can be rapidly programmed to any customized pattern. Information on approved programmers can be found in the Programmer Reference Guide. Extra test words are pre-programmed during manufacturing to ensure extremely high field programming yields, and provide extra test paths to achieve excellent parametric correlation.

#### Variable Input/Output Pin Ratio

The registered devices have eight dedicated input lines, and each combinatorial output is an I/O pin. The PAL16L8 has ten dedicated input lines and six of the eight combinatorial outputs are I/O pins. Buffers for device inputs have complementary outputs to provide user-programmable input signal polarity. Unused input pins should be tied to  $V_{CC}$  or GND.

#### **Programmable Three-State Outputs**

Each output has a three-state output buffer with threestate control. On combinatorial outputs, a product term controls the buffer, allowing enable and disable to be a function of any product of device inputs or output feedback. The combinatorial output provides a bidirectional I/O pin and may be configured as a dedicated input if the output buffer is always disabled. On registered outputs, an input pin controls the enabling of the three-state outputs.

#### **Registers with Feedback**

Registered outputs are provided for data storage and synchronization. Registers are composed of D-type flip-flops that are loaded on the LOW-to-HIGH transition of the clock input.

#### **Power-Up Reset**

#### Applies to -7 (-12 Mil), H-15, B, B-2, A, A-2 Series Only

All flip-flops power-up to a logic LOW for predictable system initialization. Outputs of the listed Series will be

HIGH due to the active-low outputs. The  $V_{CC}$  rise must be monotonic and the reset delay time is 1000 ns maximum.

#### **Register Preload**

#### Applies to -7 (-12 Mil), H-15 Series Only

The register on the listed Series can be preloaded from the output pins to facilitate functional testing of complex state machine designs. This feature allows direct loading of arbitrary states, making it unnecessary to cycle through long test vector sequences to reach a desired state. In addition, transitions from illegal states can be verified by loading illegal states and observing proper recovery.

#### **Security Fuse**

After programming and verification, a PAL16R8 Family design can be secured by programming the security fuse. Once programmed, this fuse defeats readback of the internal programmed pattern by a device programmer, securing proprietary designs from competitors. When the security fuse is programmed, the array will read as if every fuse is intact. Exceptions are the -7 (-12 Mil) Series, where the array will read as if every fuse is programmed.

#### **Quality and Testability**

The PAL16R8 Family offers a very high level of built-in quality. Extra programmable fuses provide a means of verifying performance of all AC and DC parameters. In addition, this verifies complete programmability and functionality of the device to provide the highest programming yields and post-programming functional yields in the industry.

#### Technology

The high-speed -7 (-12 Mil), D, and H-15 Series are fabricated with AMD's advanced oxide-isolated bipolar process. This process reduces parasitic capacitances and minimum geometries to provide higher performance. The array connections are formed with proven PtSi fuses for the -7 Series and TiW fuses for the D and H-15 Series. The remaining Series are fabricated with AMD's junction-isolated process, utilizing TiW fuses.

## LOGIC DIAGRAM



12468-012A

16R8



## LOGIC DIAGRAM



12468-014A

LOGIC DIAGRAM

16R4



12468-015A

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	–0.5 V to +7.0 V
DC Input Voltage	-1.2 V to +7.0 V
DC Input Current	-30 mA to +5 mA
DC Output or I/O Pin Voltage	-0.5 V to V <sub>CC</sub> + 0.5 V
Static Discharge Voltage	2001 V

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. Programming conditions may differ.

## OPERATING RANGES

### **Commercial (C) Devices**

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (V <sub>CC</sub> )	
with Respect to Ground	+4.75 V to +5.25 V

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

# DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	$I_{OH} = -3.2 \text{ mA}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{CC} = \text{Min.}$	2.4		V
Vol	Output LOW Voltage	$  I_{OL} = 24 \text{ mA} \qquad V_{IN} = V_{IH} \text{ or } V_{IL} \\ V_{CC} = Min. $		0.5	V
ViH	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
VIL	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
Vi	Input Clamp Voltage	$I_{IN} = -18 \text{ mA}, V_{CC} = \text{Min}.$		-1.2	v
lн	Input HIGH Current	V <sub>IN</sub> = 2.7 V, V <sub>CC</sub> = Max. (Note 2)		25	μA
h.	Input LOW Current	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 2)		250	μA
li li	Maximum Input Current	$V_{IN} = 5.5 V, V_{CC} = Max.$		1	mA
Іогн	Off-State Output Leakage Current HIGH	$V_{OUT} = 2.7 \text{ V}, V_{CC} = \text{Max}.$ $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 2)}$		100	μA
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 2)}$		-100	μA
Isc	Output Short-Circuit Current	Vour = 0.5 V, Vcc = Max. (Note 3)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0$ V, Outputs Open ( $I_{OUT} = 0$ mA) $V_{CC} = Max$ .		180	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

2. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).

Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
CiN	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	5	
Cour	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	8	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

### SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Des	arameter Description				Min. (Note 3)	Max.	Unit
t <sub>PD</sub>	Input or Feedba Combinatorial C	ack to Output1	k to		16L8, 16R6 16R4	3 3	7.5 7	ns
ts	Setup Time from Input or Feedback to Clock			7		ns		
tн	Hold Time				0		ns	
tco	Clock to Output	t				3	6.5	ns
tor	Clock to Feedb	ock to Feedback (Note 4)					3	ns
tskew	Skew Between	en Registered Outputs (Note 5)		16R8, 16R6		1	ns	
tw.	Clock Width	LOW	LOW		16R4	5		ns
twн	1	HIGH				5		ns
	Maximum	External F	eedback	1/(ts + tco)		74		MHz
fмах	Frequency	Internal Fe	edback	$1/(t_{S} + t_{CF})$		100		MHz
	(Note 6)	No Feedba	ack	1/(twn + tw∟)		100		MHz
tezx	OE to Output Enable			3	8	ns		
tpxz	OE to Output Disable			3	8	ns		
<b>t</b> EA	Input to Output Enable Using Product Term Control			16L8, 16R6	3	10	ns	
ter	Input to Output	Disable Using	Product	Term Control	16R4	3	10	ns

- 2. See Switching Test Circuit for test conditions.
- 3. Output delay minimums are measured under best-case conditions.
- 4. Calculated from measured fMAX internal.
- 5. Skew is measured with all outputs switching in the same direction.
- 6. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-0.5 V to +5.5 V
DC Input Current	-30 mA to +5 mA
DC Output or I/O Pin Voltage	-0.5 V to Vcc + 0.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## **OPERATING RANGES**

## Military (M) Devices (Note 1)

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	–55°C Min.
Operating Case (T <sub>C</sub> )	
Temperature	125°C Max.
Supply Voltage (Vcc)	
with Respect to Ground	+4.50 V to +5.50 V

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

#### Note:

1. Military products are tested t T = +25°C, +125°C, and -55°C, per MIL

# DC CHARACTERISTICS over MILITARY operating and s and s wherwise specified (Note 2)

Parameter Symbol	Parameter Description		Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	$V_{\rm IN} = V_{\rm IH} \text{ or } V_{\rm IL}$ $V_{\rm CC} = Min.$	2.4		V
VoL	Output LOW Votinge	$V_{IN} = 12 \text{ mA} \qquad V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{CC} = Min.$		0.5	V
VIH	Input NG Wage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		v
VIL	Inper LOW Volage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	v
VI	Input Člamp Voltage	$I_{IN} = -18$ mA, $V_{CC} = Min$ .		-1.2	v
lін	Input HIGH Current	V <sub>IN</sub> = 2.7 V, V <sub>CC</sub> = Max. (Note 4)		25	μA
11	Input LOW Current	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 4)		-250	μA
4	Maximum Input Current	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
Іогн	Off-State Output Leakage Current HIGH	V <sub>OUT</sub> ≈ 2.7 V, V <sub>CC</sub> = Max. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> (Note 4)		100	μA
lozl	Off-State Output Leakage Current LOW	V <sub>OUT</sub> ≠ 0.4 V, V <sub>CC</sub> = Max. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> (Note 4)		-100	μÂ
Isc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 5)	-30	-130	mA
Icc	Supply Current	$V_{IN} = 0$ V, Outputs Open ( $I_{OUT} = 0$ mA) $V_{CC} = Max$ .		180	mA

- 2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. Vour = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	5	
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	8	p⊦

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

### SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description			MI ()	Max.	Unit	
teo	Input or Feedback to Combinatorial Output	1 Output S	witching	16L8, 16 R4	3	12.5 12	ns
ts	Setup Time from Input or Feedback to Clock			2		ns	
tн	Hold Time			0		ns	
tco	Clock to Output	Clock to Output			3	11	ns
tcF	Clock to Feedback (Note 4)			<b>N</b>		6.5	ns
tskew	Skew Between Registered	J Out				1	ns
twL	Clock Width			16R8, 16R6	10		ns
twн	लिग			16R4	8		ns
	Maxin A	Fullback	$1/(t_{\rm S} + t_{\rm CO})$		43.4		MHz
fmax	Frs en Tis a	Feedback	$1/(t_{S} + t_{CF})$		54		MHz
	(No Fee	dback	1/(twn + twL)		55.5		MHz
tezx	OE to put Enable (Not	e 7)		]	3	10	ns
t <sub>PXZ</sub>	OE to Output Disable (Not	te 7)			3	10	ns
tea	Input to Output Enable Us Term Control (Note 7)	ing Product		16L8, 16R6	3	15	กร
ter	Input to Output Disable Us Term Control (Note 7)	sing Product		16R4	3	12	ns

- See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 3. Minimum value for tpp, tco, tpzx, tpxz, tEA, and tER parameters should be used for simulation purposes only and are not tested.
- 4. Calculated from measured fMAX internal.
- 5. Skew is measured with all outputs switching in the same direction.
- 6. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 7. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

## **MEASURED SWITCHING CHARACTERISTICS**

V<sub>CC</sub> = 4.75 V, T<sub>A</sub> = 75°C (Note 1)





10240-001A



tpp vs. Load Capacitance

10240-002A

#### Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where tpD may be affected.

# CURRENT VS. VOLTAGE (I-V) CHARACTERISTICS $V_{CC} = 5.0 \text{ V}, T_A = 25^{\circ}\text{C}$







10240-004A

10240-003A

1



PAL16R8-7/12 Series (Com'i/Mil)

10240-005A

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	-0.5 V to +5.5 V
Static Discharge Voltage	2001 V

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. Programming conditions may differ.

## **OPERATING RANGES**

#### Commerciai (C) Devices

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (Vcc)	
with Respect to Ground	+4.75 V to +5.25 V

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

# DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	$I_{OH} = -3.2 \text{ mA}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{CC} = \text{Min.}$	2.4		V
Vol	Output LOW Voltage	$l_{OL} = 24 \text{ mA}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{CC} = \text{Min.}$		0.5	V
ViH	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
VIL	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
Vi	Input Clamp Voltage	$I_{IN} = -18$ mA, $V_{CC} = Min$ .		-1.5	V _
lін	Input HIGH Current	V <sub>IN</sub> = 2.4 V, V <sub>CC</sub> = Max. (Note 2)		25	μA
1 <sub>1L</sub>	Input LOW Current	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 2)		-250	μΑ
li li	Maximum Input Current	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		100	μA
ЮZH	Off-State Output Leakage Current HIGH			100	μA
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μΑ
lsc	Output Short-Circuit Current	$V_{OUT} = 0.5 V$ , $V_{CC} = Max$ . (Note 3)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0$ V, Outputs Open ( $I_{OUT} \approx 0$ mA) $V_{CC} = Max$ .		180	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

2. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).

Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second.
 V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditio	ns		Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	V <sub>CC</sub> = 5.0 V	CLK, OE	9	
			T <sub>A</sub> = 25°C	Other Inputs	2	рF
Соит	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	Outputs	4	P.,

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min. (Note 3)	Max.	Unit
tPD	Input or Feedback to Combinatorial Output		16L8, 16R6 16R4	3	10	ns	
ts	Setup Time from	n Input or Feedback to	Clock		10		ns
tн	Hold Time				0		ns
tco	Clock to Output				2	7	ns
tc⊧	Clock to Feedba	back (Note 4)		16R8, 16R6	2	6.5	ns
tw⊾	Clock Width	LOW		16R4	8		ns
twн	]	HIGH			8		ns
	Maximum	External Feedback	1/(ts + tco)		58.8		MHz
fmax	Frequency	Internal Feedback	1/(ts + tcr)		60		MHz
	(Note 5)	No Feedback	1/(t <sub>WH</sub> + t <sub>WL</sub> )		62.5		MHz
tezx	OE to Output Enable			3	10	ns	
texz	OE to Output Disable			3	10	ns	
tea	Input to Output Enable Using Product Term Control		16L8, 16R6	1	10	ns	
t <sub>ER</sub>	Input to Output	Disable Using Product	Term Control	16R4	1	10	ns

- 2. See Switching Test Circuit for test conditions.
- 3. Output delay minimums are measured under best-case conditions.
- 4. Calculated from measured fMAX internal.
- 5. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	–1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V
Static Discharge Voltage	2001 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## **OPERATING RANGES**

#### Military (M) Devices (Note 1)

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	–55°C Min.
Operating Case (Tc)	
Temperature	125°C Max.
Supply Voltage (Vcc)	
with Respect to Ground	+4.50 V to +5.50

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

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#### Note:

1. Military products are tested at  $T_C = +25^{\circ}C$ ,  $+125^{\circ}C$ , and  $-55^{\circ}C$ , per MIL-STD-883.

#### Parameter Max. Symbol **Parameter Description Test Conditions** Min. Unit Vон **Output HIGH Voltage** $l_{OH} = -2 \text{ mA}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$ 24 v $V_{CC} = Min.$ $V_{IN} = V_{IH} \text{ or } V_{IL}$ Output LOW Voltage v Voi $I_{OL} = 12 \text{ mA}$ 0.5 Vcc = Min. Input HIGH Voltage Guaranteed Input Logical HIGH v Ин 20 Voltage for all inputs (Note 3) Input LOW Voltage Guaranteed Input Logical LOW 0.8 v Va Voltage for all Inputs (Note 3) V Input Clamp Voltage $I_{IN} = -18 \text{ mA}, V_{CC} = \text{Min}.$ -1.5v V<sub>IN</sub> = 2.4 V, V<sub>CC</sub> = Max. (Note 4) 25 uА łн Input HIGH Current ŧĿ. Input LOW Current VIN = 0.4 V, Vcc = Max. (Note 4) -250 uА h Maximum Input Current $V_{IN} = 5.5 V, V_{CC} = Max.$ mΑ 1 Off-State Output Leakage $V_{OUT} \approx 2.4 V. V_{CC} = Max.$ 100 μА lozн Current HIGH $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 4)}$ lozL Off-State Output Leakage $V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . -100 uА Current LOW $V_{iN} = V_{iH}$ or $V_{iL}$ (Note 4) -30 Vour = 0.5 V, Vcc = Max. (Note 5) -130Isc Output Short-Circuit Current mA V<sub>IN</sub> = 0 V, Outputs Open (I<sub>OUT</sub> = 0 mA) 180 lcc Supply Current mA V<sub>cc</sub> = Max.

# DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

- 2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- VIL and VIH are input conditions of output tests and are not themselves directly tested. VIL and VIH are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. Vour = 0.5 V
  has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditio	ns		Тур.	Unit
Cin	Input Capacitance	V <sub>IN</sub> = 2.0 V	V <sub>CC</sub> = 5.0 V	CLK, OE	9	
			T <sub>A</sub> = 25°C	Other Inputs	2	DF
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	Outputs	4	

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description			Min. (Note 3)	Max.	Unit	
t <sub>PD</sub>	Input or Feedback Combinatorial Out	k to itput		16L8, 16R6 16R4	3	15	ns
ts	Setup Time from	Input or Feedback to	Clock		15		ns
tн	Hold Time				0		ns
tco	Clock to Output o	r Feedback			2	12	ns
twL	Clock Width	LOW		16R8, 16R6	12		ns
twн		HIGH		16R4	8		ns
	Max. Frequency	External Feedback	1/(ts + tco)		37		MHz
	(Note 4)	No Feedback	1/(t <sub>WH</sub> + t <sub>WL</sub> )		50		MHz
tpzx	OE to Output Ena	able (Note 5)			3	12	ns
lpxz	OE to Output Dis	output Disable (Note 5)			3	10	ns
tea	Input to Output E Term Control (No	nable Using Product ote 5)		 16L8, 16R6	1	17	ns
t <sub>ER</sub>	Input to Output D Term Control (No	Disable Using Product Note 5)		16R4	1	13	ns

- See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 3. Minimum value for tPD, tCO, tPZX, tPXZ, tEA, and tER parameters should be used for simulation purposes only and are not tested.
- 4. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 5. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	–0.5 V to +7.0 V
DC Input Voltage	$-1.5$ V to V_{CC} + 0.5 V
DC Output or I/O Pin Voltage	–0.5 V to V <sub>CC</sub> + 0.5 V
DC Output Current	16 mA
Static Discharge Voltage	2001 V

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. Programming conditions may differ.

## OPERATING RANGES

## Commercial (C) Devices

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (V <sub>CC</sub> )	
with Respect to Ground	+4.75 V to +5.25 V

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

# DC CHARACTERISTICS over COMMERCIAL operating range the service specified

Parameter Symbol	Parameter Description	Test Concepts	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	$V_{\rm CC} = Min.$	2.4		۷
VoL	Output LOW Voltage	$V_{IN} = V_{IL} V_{IL}$		0.5	V
ViH	Input HIC Lage	Guarantee pur pur price Hit Voltace (c. ull inputs col.	2.0		V
V <sub>IL</sub>	V dt W on e	Guerafiteed, but Logical LOW Voltine for all courts (Note 1)		0.8	V
Vi	Inplant of Voltage	$I_{\rm IN} = -$ , $V_{\rm CC} = Min$ .		-1.5	V
l <sub>iH</sub>	Input HIGH Current	2.4 V, Vcc = Max. (Note 2)		25	μA
ار	Input LOW Cure at 2	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 2)		-250	μA
4	Maximum Input Overent	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		100	μA
lozh	Off-State Output Lettage Current HIGH	$V_{OUT} = 2.4 \text{ V}, V_{CC} = \text{Max}.$ $V_{IN} = V_{IH} \text{ or } V_{IL} (\text{Note } 2)$		100	μA
lozl	Off-State Output Leakage Current LOW	$V_{DUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA
Isc	Output Short-Circuit Current	Vout = 0.5 V, Vcc = Max. (Note 3)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		100	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

2. I/O pin leakage is the worst case of  $I_{IL}$  and  $I_{OZL}$  (or  $I_{IH}$  and  $I_{OZH}$ ).

Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditio	ns		Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	V <sub>CC</sub> = 5.0 V	CLK, OE	9	
			T <sub>A</sub> = 25°C	Other Inputs	2	DF
Сол	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	Outputs	4	

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Desc	cription				Max.	Unit
Input or Feedbac Combinatorial O	ck to utput		16L8, 16B6		15	ns
Setup Time from	Input or Feedback to	Clock		VOP-		ns
Hold Time				0		ns
Clock to Output					12	ns
Clock to Feedba	ck (Note 3)		6R8, 16R6,		11	ns
Clock Width	LOW		16 <b>P4</b>	N DAG		ns
	HIG				1	ns
Maximum	Extel    Feedback	1/(ts + tco)		37		MHz
Frequence	Internationaback	1/(t		38.4		MHz
(Notes and	No Feedback	With Mill		52.6		MHz
JE O IN	able		•		12	ns
E to at Dis	sable 📣 🚺	V.J.			10	ns
put to Output E		rm Control	16L8, 16R6		15	ns
Input to Output I	The Us Adduct	Term Control	16R4		15	ns
	Parameter Desc Input or Feedbac Combinatorial O Setup Time from Hold Time Clock to Output Clock to Feedba Clock Width Maximum Frequence (Note: DE Convint E to what Dis upput to Output for	Parameter Description         Input or Feedback to         Combinatorial Output         Setup Time from Input or Feedback to         Hold Time         Clock to Output         Clock to Output         Clock to Feedback (Note 3)         Clock Width         LOW         HIG         Maximum         Frequence         Frequence         International oback         No Feedback         Observe         Description         LOW         HIG         Maximum         Frequence         International oback         No Feedback         Description         International oback         No Feedback         Description         International oback         No Feedback         Description         Using troot         Input to Output Ender Using troot	Parameter Description         Input or Feedback to Combinatorial Output         Setup Time from Input or Feedback to Clock         Hold Time         Clock to Output         Clock to Feedback (Note 3)         Clock to Feedback (Note 3)         Clock Width         LOW         HIG         Maximum         Frequence         Frequence         Internationable         Volume         DE OLOUN able         DE to South Disable         Input to Output Ender Using Roome         Input to Output Lable	Parameter Description         Input or Feedback to Combinatorial Output       16L8, 16R6         Setup Time from Input or Feedback to Clock       11         Hold Time       Clock to Output         Clock to Output       6R8, 16R6, 16R4, 16R6, 16R4	Parameter Description         Input or Feedback to Combinatorial Output       16L8, 16B6         Setup Time from Input or Feedback to Clock       11         Hold Time       0         Clock to Output       0         Clock to Feedback (Note 3)       6R8, 16R6         Clock Width       LOW         HIG       16P1         Maximum       Extel 1 Feedback         Frequend       Internationaback         (Note)       No Feedback         DE to Output Lotsable       1/(tracf)         Extel 1 Feedback       38.4         (Note)       1/(tracf)         DE to Output End Us globach       16L8, 16R6         Input to Output End Us globach       16L8, 16R6         Input to Output Loth Us globach       16L8, 16R6	Parameter DescriptionMax.Input or Feedback to Combinatorial Output16L8, 16B6115Setup Time from Input or Feedback to Clock16L8, 16B60Hold Time012Clock to Output012Clock to Feedback (Note 3)6R8, 16R6, 16B611Clock WidthLOW16E416E4HIG3738.4Maximum FrequenceInternational oback1/(tricter)RegimentNo Feedback1/(tricter)No Feedback1/(tricter)Observe38.4JE to find Disable10Input to Output End Using Groot Function16L8, 16R6Input to Output Lint Using Groot Function16L8, 16R6Input to Output Lint Using Groot Function16R4Input to Output Lint Using Groot Function16R4

- 2. See Switching Test Circuit for test conditions.
- 3. Calculated from measured fMAX internal.
- 4. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-1.5 V to Vcc + 0.5 V
DC Output or I/O Pin Voltage	-0.5 V to V <sub>CC</sub> + 0.5 V

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. Programming conditions may differ.

#### **OPERATING RANGES** Commercial (C) Devices

## Ambient Temperature (T<sub>4</sub>)

Operating in Free Air	0°C to +75°C
Supply Voltage (Vcc)	
with Respect to Ground	+4.75 V to +5.25 V

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

mum Ratings for extended periods may affect device reliabil- ity. Programming conditions may differ.	
DC CHARACTERISTICS over COMMERCIAL operating r specified	anges un <b>te</b> ss o <b>n e</b> rwise

Parameter Symbol	Parameter Description	Test Condition	Min.	Max.	Unit
Vон	Output HIGH Voltage	$I_{OH} = -3.2 \text{ mA}$ $I_{HH} = V_{H} \text{ or } V_{H}^{*}$ $V_{ec} = M \text{ in.}$	2.4		V
Vol	Output LOW Voltage	$V_{\rm IC} = Min.$		0.5	V
VIH	Input HIGH Voltage	Contrained Input Logical Conditions of the second sec	2.0		V
VIL	Input LOW Voltage	Guaranteed Court aics O		0.8	v
Vi	Input Claring Voltage	IN TO MA ICC = Mile		-1.2	v
lн	Input HIGH Gurrent	VIN 4 V Vo Max. (Note 2)		25	μA
hL	Input LOW Current	VIN = 0, Vcc = Max. (Note 2)		-250	μA
lı	Maximum Input Conont	5.5 1, Vcc = Max.		100	μA
Іогн	Off-State Output Company of Contract HIGH	Vout = 2.4 V, Vcc = Max. Vin = ViH or ViL (Note 2)		100	μA
lozi	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA
lsc	Output Short-Circuit Current	Vout = 0.5 V, Vcc = Max. (Note 3)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		180	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

- 2. I/O pin leakage is the worst case of  $I_{\rm IL}$  and  $I_{\rm OZL}$  (or  $I_{\rm IH}$  and  $I_{\rm OZH}).$
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second.
   V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions	3	Тур.	Unit
Cin	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	8	
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	T <sub>A</sub> = 25°C f = 1 MHz	9	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Des	cription				Max.	Unit
t <sub>PD</sub>	Input or Feedbar Combinatorial O	ck to Putput		16L8, 16R6 165		15	ns
ts	Setup Time from	n Input or Feedback to	Clock				ns
tн	Hold Time				0		ns
tco	Clock to Output	or Feedback				12	ns
tw.	Clock Width	LOW		BR8, 16R6			ns
twн		HIGH		16R4			ns
thear	Maximum	Externation	<sup>(I</sup> s ∓lco)				MHz
10000	(Note 3)	No Fundback	1/(twn + twi		50		MHz
tezx	OE to Out	ble				15	ns
texz.	OF	ble				15	ns
tea .	The other	Enable Using Product	m Con	16L8, 16R6		15	ns
ter	put put	Disable Using Photoct	Ti. htrol	16R4		15	ns

#### Notes:

2. See Switching Test Circuit for t

3. These parameters are not 100% used, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	–1.5 V to + 5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## OPERATING RANGES

### Military (M) Devices (Note 1)

Ambient Temperature (TA	)
Operating in Free Air	-55°C Min.
Operating Case (Tc)	
Temperature	125°C Max.
Supply Voltage (Vcc)	
with Respect to Ground	+4.50 V to +5.50 V

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

#### Note:

1. Military products are tested at The +25°C, +125°C, and -55°C, per MIL-ST4 783.

# DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

		AND			
Parameter Symbol	Parameter Description	Test Operation	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	h A Vh Vi H or ViL V <sub>CC</sub> = Min.	2.4		V
Vol	Output LOW Voltage	$V_{IN} = V_{IN} V_{II}$ $V_{CH} = \hat{n}.$		0.5	V
ViH	Input HIGH bitage	Guaranteed Pour coice Hig Voltage id of Inputs for the	2.0		v
ViL	Intert W. Dittere	Guy anteed pot Logic I LOW Volume for all the s (Note 3)		0.8	V
V <sub>I</sub>	npa Clarp Voltage	IN = - VCC = Min.		-1.5	v
18H	Input HIGH Current	2.4 V, Vcc = Max. (Note 4)		25	μA
1 <sub>L</sub>	Input LOW Curent	Vin = 0.4 V, V <sub>CC</sub> = Max. (Note 4)		-250	μA
li li	Maximum Input Offent	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
Іогн	Off-State Output Lessage Current HIGH	$V_{OUT} = 2.4 \text{ V}, V_{CC} = \text{Max}.$ $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 4)}$		100	μA
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 4)		-100	μA
Isc	Output Short-Circuit Current	Vour = 0.5 V, Vcc = Max. (Note 5)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		180	mA

#### Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of  $I_{IL}$  and  $I_{OZL}$  (or  $I_{IH}$  and  $I_{OZH}).$
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions	3	Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	9	- 5
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1  MHz	10	p⊦

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Des	cription				Max.	Unit
t <sub>PD</sub>	Input or Feedback to 16L8, 1976 Combinatorial Output 1		16L8, 1076 1		20	ns	
ts	Setup Time from	n Input or Feedback	to Clock				ns
tн	Hold Time				0		ns
tco	Clock to Output	or Feedback				15	ns
twi.		LOW		16R8, 16R6			ΠS
twн	Clock Width	HIGH		16R.1			ns
fmax.	Maximum	Externanteed to	17 s + tco)				MHz
	(Note 3)	No Feilbar	1/(twn + +		41.6		MHz
tezx	OE to Out 11-	ble (Note -/				20	ns
tpxz	<b>7</b> . C . N . 1	Sele (Note 4)				20	ns
tea	Ur 2 dail A) lo Ame	Enable Using Polue lote 4)	ct	161.9.1006		25	ns
ter	put to Output erm Control (N			16R4		20	ns

- 2. See Switching Test Circuit for test and titons. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 3. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 4. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

-65°C to +150°C
-55°C to +125°C
-0.5 V to +7.0 V
-1.5 V to Vcc + 0.5 V
-0.5 V to V <sub>CC</sub> + 0.5 V

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. Programming conditions may differ.

## **OPERATING RANGES**

## **Commercial (C) Devices**

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (Vcc)	
with Respect to Ground	+4.75 V to +5.25 V

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

DC CHARA specified	C CHARACTERISTICS over COMMERCIAL operating ranges unress on prwise pecified						
Parameter Symbol	Parameter Description	Test Condition	Min.	Max.	Unit		
Voн	Output HIGH Voltage	I <sub>OH</sub> = -3.2 m/A V <sub>IM</sub> V <sub>IH</sub> or V <sub>IL</sub> Vec = Min.	2.4		V		
VoL	Output LOW Voltage	1		0.5	V		
ViH	Input HIGH Voltage	Guaranteed Input Logical AGR	ø		V		
VIL	Input LOW Voltage	Guaranteed mount of a Control of the Control of Control		0.8	V		
Vi	Labor Clarino Voltage	IIN TO MALA CC = MIR		-1.2	V		
Ін 🌪	Ingut High Current	VIN 2.7 V. Ve Max. (Note 2)		25	μA		
հն է	Input CW Current	VIN = V, Vcc = Max. (Note 2)		-100	μA		
1	Maximum Input Cument	5.5 V, Vcc ≈ Max.		100	μA		
ЮZH	Off-State Output Leaders	$V_{OUT} = 2.7 \text{ V}, \text{ V}_{CC} = \text{Max}.$ $V_{IN} = V_{IH} \text{ or } V_{IL} (\text{Note } 2)$		100	μA		
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA		
Isc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 3)	-30	-130	mA		
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		90	mA		

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

2. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).

3. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. VOUT = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions	3	Тур.	Unit
CiN	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	7	
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	$f_A = 25 \text{ C}$ f = 1  MHz	7	p⊦

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				R.	Max.	Unit
tep	Input or Feedback Combinatorial Ou	Input or Feedback to Combinatorial Output		16L8, 16R6 16 <b>P</b>		25	ns
ts	Setup Time from	Input or Feedback to	Clock	and a			ns
tн	Hold Time				0		ns
tco	Clock to Output					15	ns
tc⊧	Clock to Feedbac	k (Note 3)		<b>6</b> R8, 16R6		10	ns
tw∟	Clock Width	LOW		16R4 🐔	16		ns
twn		HIGH 🕋 🔨			<b>6</b>		ns
	Maximum	External Feedback	1/(ts + tco)		25		MHz
fmax	Frequency	Interna Tee back	1/(ts + +=)		28.5		MHz
	(Note 4)	No Feedback	1/(tv + tw.)		33		MHz
tezx	DE LO CA DU STIS	õh.	C VL	1994 - C		20	ns
tpxz 🐐	OE IQ QUIDUI DIS	able	NAPP.			20	ns
tea	oput to Output E	nable User Procest	Termoontrol	16L8, 16R6		25	ns
ter	put to Output B	Us q adus	Ferm Control	16R4		25	ns

#### Notes:

- 2. See Switching Test Circuit for test additions.
- 3. Calculated from measured fMAX internal.
- 4. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.

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Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	–0.5 V to +7.0 V
DC input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## OPERATING RANGES

## Military (M) Devices (Note 1)

Ambient Temperature $(T_A)$	
Operating in Free Air -	-55°C Min.
Operating Case (T <sub>C</sub> )	
Temperature 1	25°C Max.
Supply Voltage (Vcc)	
with Respect to Ground +	4.50 V to +5.50 V

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

#### Note:

1. Military products are tested at 12.25°C, +125°C, and -55°C, per MIL-S12033,

## DC CHARACTERISTICS over MILITARY operating ranges up and on unlise specified (Note 2)

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Parameter Symbol	Parameter Description	Test Completion	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	Vice = Min.	.4		V
Vol	Output LOW Voltage	$\begin{array}{ll} MA & V_{IN} = V_{IN} V_{IN} \\ V_{CM} = -1 \end{array}$		0.5	v
ViH	Input HIGH	Guaranteed four and to all Voltage to all inputs of	2.0		V
Va		Gun ancean out Loghan LOW Volume for all works (Note 3)		0.8	V
Vi	nph Dip Voltage	Nin = - Vcc = Min.		-1.5	v
lн	Input HIGH Current	2.4 V, V <sub>CC</sub> = Max. (Note 4)		25	μA
IIL.	Input LOW Culture	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 4)		250	μA
h	Maximum Input Gent	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
Іогн	Off-State Output Lemage Current HIGH	$V_{OUT} = 2.4 \text{ V}, V_{CC} = \text{Max.}$ $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 4)}$		100	μΑ
łozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 4)		-100	μA
Isc	Output Short-Circuit Current	Vout = 0.5 V, Vcc = Max. (Note 5)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		90	mA

#### Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V<sub>OUT</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	7	
Соит	Output Capacitance	V <sub>OUT</sub> = 2.0 V	T <sub>A</sub> = 25°C f = 1 MHz	7	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Desc	ription			MN	Max.	Unit
t <sub>PD</sub>	Input or Feedback to Combinatorial Output			16L8, 16B6		30	ns
ts	Setup Time from	Input or Feedback to	Clock		30		ns
tн	Hold Time	Hold Time			0		ns
tco	Clock to Output of	Clock to Output or Feedback			- States	20	ns
twL	Clock Width	LOW		6R8, 16R6	20		ns
twн		HIGH		16R4	20	2	ns
	Maximum	External Feedback	17 + tco)		20		MHz
TMAX	(Note 3)	No Feedback	1/(twn + twi		25		MHz
tezx	OE to Output En	ble (Note 4)				25	ns
texz	OE to Output Dis	able (Note 4)				25	ns
tea	Input to Output E Term Control (No	nable Using Product ote 4)		16L8, 16R6		30	ns
ter	Term Control (No	isable Using Product the 4)		16R4		30	ns

Notes:

 See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

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- 3. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 4. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-1.5 V to Vcc + 0.5 V
DC Output or I/O Pin Voltage	-0.5 V to Vcc + 0.5 V

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. Programming conditions may differ.

## OPERATING RANGES

Comm	erc	ial (C	) Device	S	

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (Vcc)	
with Respect to Ground	+4.75 V to +5.25 V

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

DC CHARA specified	CTERISTICS ove	er COMME	RCIAL operating ranges unlos	d iv	vise	
Parameter Symbol	Parameter Descrip	otion	Test Condition	Min.	Max.	Unit
Vон	Output HIGH Volta	ge	$l_{OH} = -3.2 \text{ mAs } V_{IIV} = V_{IH} \text{ or } V_{IE}$	2.4		v
Vol	Output LOW Voltag	je	$\begin{array}{c} 2^2  A  V_{\rm ICC} = V_{\rm IH} \text{ or } V_{\rm IL} \\ V_{\rm CC} = \text{Min.} \end{array}$		0.5	v
Viн	Input HIGH Voltage	C	Course for all inputs on test			V
ViL	Input LOWING tage	V	Guaranteed Course ic		0.8	v
V <sub>I</sub>	I an a word	е	In actin cc = ML		-1.2	V
ін	In H. H. vrem	t 📢	VIN VIN Max. (Note 2)		25	μA
l <u>i</u> L.	input V Current		Viv = Vcc = Max. (Note 2)		-250	μA
1	Maximum Input	Int	5.5 V, V <sub>CC</sub> = Max.		100	μA
Іогн	Off-State Output Current HIGH	ag.	$V_{OUT} = 2.7 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		100	μA
lozl	Off-State Output Le Current LOW	age	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA
Isc	Output Short-Circu	it Current	Vout = 0.5 V, Vcc = Max. (Note 3)	-30	-130	mA
lcc	Supply Current	16L8 16R8/6/4	$V_{IN} = 0 V$ , Outputs Open (I <sub>OUT</sub> = 0 mA) $V_{CC} = Max$ .		155 180	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

- 2. I/O pin leakage is the worst case of I<sub>IL</sub> and I<sub>OZL</sub> (or I<sub>IH</sub> and I<sub>OZH</sub>).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V<sub>CC</sub> = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	V <sub>CC</sub> = 5.0 V	7	_
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	7	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Desc	ription				Max.	Unit
teo	Input or Feedback Combinatorial Ou	< to tput		16L8, 16R6 16P		25	ns
ts	Setup Time from	Input or Feedback	to Clock				ns
tн	Hold Time				0		ns
tco	Clock to Output					15	ns
tcF	Clock to Feedbac	k (Note 3)		6R8, 16R6	A	10	ns
twL	Clock Width	LOW		16R4			ns
twн		HIGH					ns
	Maximum	External Feed	k 17(ts + tco)		25		MHz
fмах	Frequency	Interna Feinbac	k 1/(ts		28.5		MHz
	(Note 4)	No Feedback	(two 101)	A and	33		MHz
tezx		<b>\$</b>	K Ka			20	ns
tpxz 🔪	OE to Que it Dis	able	NAV-			20	ns
tea	nput to Output E	nable Ut no Proc	t Term Control	16L8, 16R6		25	ns
ter	Poput to Output	ab. Us o Ddu	Term Control	16R4		25	ns

#### Notes:

- 2. See Switching Test Circuit for test conditions.
- 3. Calculated from measured fMAX internal.
- 4. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.

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Storage Temperature	65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## **OPERATING RANGES**

#### Military (M) Devices (Note 1)

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	–55°C Min.
Operating Case (T <sub>C</sub> )	
Temperature	125°C Max.
Supply Voltage (Vcc)	
with Respect to Ground	+4.50 V to +5.50 V

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

#### Note:

1. Military products are tested at +25°C, +125°C, and -55°C, per MIL-S1, 283.

# DC CHARACTERISTICS over MILITARY operating ranges up export and is specified (Note 2)

·				_	
Parameter Symbol	Parameter Description	Test Optimient	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	- TA $V_{\rm HC}$ $V_{\rm H}$ or $V_{\rm H}$ $V_{\rm CC}$ = Min.	.4		V
Vol	Output LOW Voltage	$\begin{array}{ll} MA & V_{IN} = V & V_{IL} \\ V_{CO} = -D_{L}. \end{array}$		0.5	>
VIH	Input HIGH	Guaranteed Input and Alle	2.0		V
Vil	Linem DV Dinge	Gueranteed out Logical LOW Volume for all seconds (Note 3)		0.8	V
Vi Vi	npu Clarip Voltage	Jin = - VCC = Min.		-1.5	V
Ін	Input HIGH Current	2.4 V, Vcc = Max. (Note 4)		25	μΑ
liL	Input LOW Culturat	Vin = 0.4 V, Vcc = Max. (Note 4)		250	μA
lı lı	Maximum Input Corrent	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
Іогн	Off-State Output Laskage Current HIGH	$V_{OUT} = 2.4 \text{ V}, V_{CC} = \text{Max}.$ $V_{IN} = V_{IH} \text{ or } V_{IL} \text{ (Note 4)}$		100	μA
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH}$ or $V_{IL}$ (Note 4)		-100	μΑ
Isc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 5)	-30	-130	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		180	mA

- 2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. Vour = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	7	
Солт	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	7	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Desc	cription			M.	Max.	Unit
t <sub>PD</sub>	Input or Feedbac Combinatorial O	ck to utput		16L8, 16D6 10	EX.	<b>B</b> 0	ns
ts	Setup Time from	Input or Feedback	to Clock				ns
tн	Hold Time			L 🛷	0		ns
tco	Clock to Output	or Feedback				20	ns
twi	Clock Width	LOW		668, 16R6	31		ns
twn		HIGH		16R			ns
	Maximum	Externar reed	o 1), s + tco)	LCN			MHz
	(Note 3)	No Felloat	1/(twn. wyu		25		MHz
t <sub>PZX</sub>	OE to Out	ble (Note 4)				25	ns
tpxz	T 10 1 1	(Note 4)				25	ns
tea	Inpl. C. pl.a. orm. ol (N	Enable Using Picture ote 4)		16L8, 16R6		30	ns
ter	put to Output I verm Control (N			16R4		30	ns

- See Switching Test Circuit for test orditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 3. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 4. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	-0.5 V to +7.0 V
DC Input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ.

## **OPERATING RANGES**

### Commercial (C) Devices

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (Vcc)	
with Respect to Ground	+4.75 V to +5.25 V

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

DC CHARA specified	CTERISTICS over COMME	RCIAL operating ranges unter	ottern	vise	
Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	$i_{OH} = -1 \text{ mA}$ $V_{IH} \text{ or } V_{IL}$	2.4		v
Vol	Output LOW Voltage	$W_{CC} = Min.$		0.5	V
ViH	Input HIGH Voltage	Contractived Input Logics (IG) Voluge for all Inputs (Conte 1)			V
VIL	Input LOW Maltage	Guaranteed Hou and ice Out		0.8	V
VI	In a chaine Vonage			-1.5	V
Ін 🏑	Inter High Corrent	VIN 4 V. W. Max. (Note 2)		25	μA
	hput Gurrent	VIN = WCC = Max. (Note 2)		-250	μA
1,	Maximum Input Coment	5.5 V, V <sub>CC</sub> = Max.		100	μA
lozh	Off-State Output Learning Current HIGH	V <sub>OUT</sub> = 2.4 V, V <sub>CC</sub> = Max. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> (Note 2)		100	μA
lozl	Off-State Output Leghage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA
Isc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 3)	-30	-250	mA
lcc	Supply Current	$V_{IN} = 0$ V, Outputs Open ( $I_{OUT} = 0$ mA) V <sub>CC</sub> = Max.		55	mA

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

- 2. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second.
   V<sub>OUT</sub> = 0.5 V as been chosen to avoid test problems caused by tester ground degradation.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 1)

Parameter Symbol	Parameter Des	cription			Min.	Max.	Unit
tpp	Input or Feedba Combinatorial C	ck to Putput		16L8, 16R6 16R4		35	ns
ts	Setup Time fron	n Input or Feedback to	Clock		35		ns
tн	Hold Time				0		ns
tco	Clock to Output	or Feedback		16R8, 16R6		25	ns
tw.	Clock Width	LOW	LOW		25		ns
twн		HIGH			25		ns
<b>f</b>	Maximum	External Feedback	$1/(t_{\rm S} + t_{\rm CO})$		16		MHz
IMAX	(Note 2)	No Feedback	1/(twn + twL)		20		MHz
tpzx	OE to Output Enable				89 N	25	ns
t <sub>PXZ</sub>	OE to Output Disable			No the		25	ns
tea	Input to Output Enable Using Product Term Control			▶ 16L8, 16PC		35	ns
ter	Input to Output	Disable Using Product	Terr <b>Con</b> ti	16R4		35	ns

- 1. See Switching Test Circuit for test conditions
- 2. These parameters are not 100% tests of are strategies initial characterises are any of the design is modified where frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	–0.5 V to +7.0 V
DC Input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## **OPERATING RANGES**

#### Military (M) Devices (Note 1)

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	–55°C Min.
Operating Case (Tc)	
Temperature	125°C Max.
Supply Voltage (V <sub>CC</sub> )	
with Respect to Ground	+4.50 V to +5.50

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

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#### Note:

1. Military products are tested at T<sub>C</sub> = +25°C, +125°C, and -55°C, per MIL-STD-883.

# DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
Vон	Output HIGH Voltage	$\begin{split} I_{OH} = -1 \ mA \qquad V_{IN} = V_{IH} \ or \ V_{IL} \\ V_{CC} = Min. \end{split}$	2.4		v
Vol	Output LOW Voltage	$  I_{OL} = 4 \text{ mA} \qquad V_{IN} = V_{IH} \text{ or } V_{IL} \\ V_{CC} = \text{Min.} $		0.5	v
ViH	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
VIL	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
Vi	Input Clamp Voltage	$I_{IN} = -18 \text{ mA}, V_{CC} = \text{Min}.$		-1.5	v
ы	Input HIGH Current	V <sub>IN</sub> = 2.4 V, V <sub>CC</sub> = Max. (Note 4)		25	μA
l <sub>IL</sub>	Input LOW Current	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 4)		-250	μA
tı	Maximum Input Current	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
lozh	Off-State Output Leakage Current HIGH	$V_{OUT} = 2.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH}$ or $V_{IL}$ (Note 4)		100	μA
IOZL	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 4)		-100	μA
lsc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 5)	-30	-250	mA
lcc	Supply Current	V <sub>IN</sub> = 0 V, Outputs Open (lour = 0 mA) V <sub>CC</sub> = Max.		55	mA

#### Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- 5. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. Vout = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

SWITCHIN	IG CHARACT	ERISTICS over MI	LITARY ope	rating ranges	(Note 1	)	
Parameter Symbol	Parameter Des	rameter Description			Min.	Max.	Unit
tPD	Input or Feedback to Combinatorial Output			16L8, 16R6 16R4		50	ns
ts	Setup Time fro	m Input or Feedback to	Clock		50		ns
tн	Hold Time	d Time			0		ns
tco	Clock to Output	t or Feedback	or Feedback			25	ns
twL	Clock Width	LOW	LOW		25		ns
twn		HIGH		16R4	25		ns
6.4.2	Maximum	External Feedback	1/(ts + tco)		13.3		MHz
IMAX	(Note 2)	No Feedback	1/(twn + twr)		20		MHz
t <sub>PZX</sub>	OE to Output E	nable (Note 3)				25	ns
texz	OE to Output D	OE to Output Disable (Note 3)				25	ns
tea	Input to Output Enable Using Product Term Control (Note 3)		16L8, 16R6		45	ns	
ter	Input to Output Term Control (	Disable Using Product Note 3)		16R4		45	ns

## 9

- 1. See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 2. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 3. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	0.5 V to +7.0 V
DC Input Voltage	-1.5 V to Vcc + 0.5 V
DC Output or I/O Pin Voltage	-0.5 V to V <sub>CC</sub> + 0.5 V

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. Programming conditions may differ.

## **OPERATING RANGES**

#### **Commercial (C) Devices**

Ambient Temperature (T <sub>A</sub> )	
Operating in Free Air	0°C to +75°C
Supply Voltage (V <sub>CC</sub> )	
with Respect to Ground	+4.75 V to +5.25 V

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

DC CHARACTERISTICS over COMMERCIAL operating ranges uppers operwise specified							
Parameter Symbol	Parameter Descri	ption	Test Condition	Min.	Max.	Unit	
Voн	Output HIGH Volta	ge	$l_{OH} = -3.2 \text{ mA}$ Var ViH or $V_{H}$	2.4		V	
Vol	Output LOW Voltag	ge	$\mathbf{f_{2}} = 24 \text{ mA} \cdot \mathbf{V_{IN}} = \mathbf{V_{IH}} \text{ or } \mathbf{V_{IL}}$ $\mathbf{V_{CC}} = \text{Min.}$		0.5	V	
ViH	Input HIGH Voltage		Verale in the second se	.0		v	
VIL	Input LOW Voltage		Guaranteed Input Longert, OW		0.8	V	
Vi	Inpol Claims Vehac	je	Vcc Min.		-1.2	٧	
ін 🚽	Input NGH Curren	t 🚲	= 2.4 = Max. (Note 2)		25	μA	
lı.	Input Cow Current	ALL AND	ViN • 0 • V, V <sub>CC</sub> = Max. (Note 2)		-250	μA	
la 📎	Maximum Input Cu	rrente Va			100	μA	
Іогн	Off-State Output Current HIGH	ako	$V_{OUT} = 2.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH}$ or $V_{IL}$ (Note 2)		100	μA	
lozi.	Off-State Output	eakage	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 2)		-100	μA	
Isc	Output Short-Circu	it Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 3)	-30	-130	mA	
lcc	Supply Current	16L8 16R8/6/4	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		80 90	mA	

#### Notes:

1. These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.

2. I/O pin leakage is the worst case of  $I_{IL}$  and  $I_{OZL}$  (or  $I_{IH}$  and  $I_{OZH}).$ 

Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second.
 V<sub>OUT</sub> = 0.5 V as been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Descriptions	Test Conditions		Тур.	Unit
Cin	Input Capacitance	V <sub>IN</sub> = 2.0 V	V <sub>CC</sub> = 5.0 V	7	
			$T_A = 25^{\circ}C$		рF
Сол	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1 MHz	7	μ.

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	r Parameter Description				M	Max.	Unit
t <sub>PD</sub>	Input or Feedback to Combinatorial Output			16L8, 16R6 16F4		35	ns
ts	Setup Time from	Input or Feedback to	Clock				ns
tн	Hold Time				0		ns
tco	Clock to Output o	r Feedback		46R8, 16R6		25	ns
tw.	Clock Width	LOW		🥻 16R4	25		ns
twн		HIGH			5		ns
fury	Maximum	External Feedback	((ts + tco)		1.		MHz
IMAX	(Note 3)	No Kandback	1/(twn + 🍂)		20		MHz
1 <sub>PZX</sub>	OE to Output Con	ible				25	ns
1 <sub>PXZ</sub>	OF OUTPUT	ble	12 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A TOBAL		25	ns
tea 🚽	Input to Cutput E	nable Using Produce	Term Control	16L8, 16R6		35	ns
t <sub>ER</sub>	Aput to Output D	isable Using Produc	Ter Control	16R4		35	ns
Notes:			the second s				

2. See Switching Test Circuit

3. These parameters are not 100 tested but are calculated at initial characterization and at any time the design is modified where frequency may be affected.

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-55°C to +125°C
Supply Voltage with Respect to Ground	0.5 V to +7.0 V
DC Input Voltage	-1.5 V to +5.5 V
DC Output or I/O Pin Voltage	5.5 V

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. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

## **OPERATING RANGES**

#### Military (M) Devices (Note 1)

Ambient Temperature (T <sub>A</sub> ) Operating in Free Air	–55°C to +125°C
Supply Voltage (V <sub>CC</sub> ) with Respect to Ground	+4.50 V to +5.50 V

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

#### Note:

1. Military products are tested at T<sub>C</sub> = +25°C, +125°C, and -55°C, per MIL-STD-883.

# DC CHARACTERISTICS over MILITARY operating ranges (100 of the specified (Note 2)

<u> </u>					
Parameter Symbol	Parameter Description	Test the one	Min.	Max.	Unit
V <sub>он</sub>	Output HIGH Voltage	$= -m^{2} + V_{IN} + V_{IH} \text{ or } V_{IL}$ $V_{CC} = Min.$	2.4		v
V <sub>OL</sub>	Output LOW Voltage	tin = v? mA Vin = Vin o. vin Vorumini.		0.5	V
ViH	Input HIG haltage	Guaranteed It in Landar (GH Voltageneral)	2.0		v
VIL		tage from the pical LOW		0.8	V
VI	Input of mp Voltage	line - to ma, V <sub>cc</sub> = Min.		-1.5	v
Ын	Input HIGH Current	Vo = 2.4 V, Vcc = Max. (Note 4)		25	μA
h.	Input LOW TR	V <sub>IN</sub> = 0.4 V, V <sub>CC</sub> = Max. (Note 4)		-250	μA
h	Maximum Inp. Surren	$V_{IN} = 5.5 V$ , $V_{CC} = Max$ .		1	mA
Іогн	Off-State Output eakage Current HIGH	$V_{OUT} = 2.4 \text{ V}, V_{CC} = \text{Max.}$ $V_{IN} = V_{H} \text{ or } V_{IL} \text{ (Note 4)}$		100	μA
lozl	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4 V$ , $V_{CC} = Max$ . $V_{IN} = V_{IH} \text{ or } V_{IL}$ (Note 4)		-100	μΑ
Isc	Output Short-Circuit Current	V <sub>OUT</sub> = 0.5 V, V <sub>CC</sub> = Max. (Note 5)	-30	-250	mA
lcc	Supply Current	$V_{IN} = 0 V$ , Outputs Open ( $I_{OUT} = 0 mA$ ) $V_{CC} = Max$ .		90	mA

- 2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- V<sub>IL</sub> and V<sub>IH</sub> are input conditions of output tests and are not themselves directly tested. V<sub>IL</sub> and V<sub>IH</sub> are absolute voltages with
  respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values
  without suitable equipment.
- 4. I/O pin leakage is the worst case of IIL and IOZL (or IIH and IOZH).
- Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. Vour = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

Parameter Symbol	Parameter Description	Test Conditions		Тур.	Unit
CIN	Input Capacitance	V <sub>IN</sub> = 2.0 V	$V_{CC} = 5.0 V$	7	_
Cout	Output Capacitance	V <sub>OUT</sub> = 2.0 V	f = 1  MHz	7	pF

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

## SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Desc	ription		Â	M	Max.	Unit
t <sub>PD</sub>	Input or Feedbac Combinatorial O	k to utput		16L8, 16R6		50	ns
ts	Setup Time from	Input or Feedback to	Clock		50		ns
tн	Hold Time			1989 - 1989 -	0		ns
tco	Clock to Output of	or Feedback			తోందాం.	25	ns
tw.	Clock Width	LOW		16R8, 16R6	25		ns
twn		HIGH		1684	AN A		ns
	Maximum	External Feedback	tts + tco)	10 V 400	VIII B		MHz
тмах	(Note 3)	No Feedback	1/(type +		20		MHz
t <sub>PZX</sub>	OE to Output En	able (Note 4)	a Ma			25	ns
texz	OE to Output Dis	ble (Note 4)	W WE	₿.		25	ns
tea 👘	Inpurto Output E	Enable Using Product	AN TOP	16L8, 16R6		45	ns
ten	Input to Output	isable Using Product		16R4		45	ns
	6	No. Martin					

- See Switching Test Circuit for the conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.
- 3. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.
- 4. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.

#### SWITCHING WAVEFORMS



- 1. V<sub>T</sub> = 1.5 V
- 2. Input pulse amplitude 0 V to 3.0 V
- 3. Input rise and fall times 2–5 ns typical. (2–4 ns for -7 (-12 Mil) Series)

## **KEY TO SWITCHING WAVEFORMS**



KS000010-PAL

## SWITCHING TEST CIRCUIT



12350-019A

			Comn	Commercial Military		itary	Measured
Specification	S1	CL	R <sub>1</sub>	R <sub>2</sub>	R <sub>1</sub>	R <sub>2</sub>	Output Value
tpd, tco, tcf	Closed						1.5 V
tpzx, tea	Z → H: Open	50 pF	[				1.5 V
	$Z \rightarrow L$ : Closed		200 Ω	<b>390 Ω</b>	390 Ω	750 Ω	
t <sub>PXZ</sub> , t <sub>ER</sub>	H → Z: Open	5 pF	B-4:	B-4:	B-4:	B-4:	Н → Z: V <sub>OH</sub> – 0.5 V
	$L \rightarrow Z$ : Closed		800 Ω	1.56 KΩ	800 Ω	1.56 KΩ	L → Z: V <sub>OL</sub> + 0.5 V

## **INPUT/OUTPUT EQUIVALENT SCHEMATICS**



## OUTPUT REGISTER PRELOAD Applies to -7 (-12 Mil) Series Only

The preload function allows the register to be loaded from the output pins. This feature aids functional testing of sequential designs by allowing direct setting of output states. The procedure for preloading follows.

- 1. Raise Vcc to Vcch.
- 2. Set  $\overline{OE}$  to V<sub>IHP</sub> to disable output registers.
- 3. Raise pin 2 to V<sub>HH</sub> to enter preload mode.
- 4. Apply either V<sub>HH</sub> or V<sub>ILP</sub> to all registered outputs. Use V<sub>HH</sub> to preload a LOW in the flip-flop; use V<sub>ILP</sub> to

preload a HIGH in the flip-flop. Leave combinatorial outputs floating.

- 5. Lower pin 2 to VILP.
- 6. Remove VILP/VHH from all registered output pins.
- 7. Lower  $\overline{OE}$  to V<sub>ILP</sub> to enable the output registers.
- Verify V<sub>OL</sub>/V<sub>OH</sub> at all registered output pins. Note that because of the output inverter, a register that has been preloaded HIGH will provide a LOW at the output.

Parameter Symbol	Parameter Description	Min.	Rec.	Max.	Unit
VHH	Super-level input voltage	10	11	12	V
VILP	Low-level input voltage	0	0	0.5	۷
Vihp	High-level input voltage	2.4	5.0	5.5	V
Vссн	Power supply during preload	5.4	5.7	6.0	V
to	Delay time	100	200	1000	ns





10294-003A

**Output Register Preload Waveform** 

## OUTPUT REGISTER PRELOAD Applies to H-15 Series Only

The preload function allows the register to be loaded from the output pins. This feature aids functional testing of sequential designs by allowing direct setting of output states. The procedure for preloading follows.

- 1. Raise Vcc to 4.5 V.
- 2. Set  $\overline{OE}$  to V<sub>IHP</sub> to disable output registers.
- 3. Apply either V<sub>IHP</sub> or V<sub>ILP</sub> to all registered outputs. Use V<sub>IHP</sub> to preload a HIGH in the flip-flop; use V<sub>ILP</sub> to

preload a LOW in the flip-flop. Leave combinatorial outputs floating.

- 4. Pulse pin 8 to V<sub>HH</sub>, then back to 0 V.
- 5. Remove VILP/VIHP from all registered output pins.
- 6. Lower  $\overline{OE}$  to V<sub>ILP</sub> to enable the output registers.
- Verify V<sub>OL</sub>/V<sub>OH</sub> at all registered output pins. Note that because of the output inverter, a register that has been preloaded HIGH will provide a LOW at the output.

Parameter Symbol	Parameter Description	Min.	Rec.	Max.	Unit
Vнн	Super-level input voltage	19	20	21	v
VILP	Low-level input voltage	0	0	0.5	V
Vihp	High-level input voltage	2.4	5.0	5.5	V
to	Delay time	100	200	1000	ns



**Output Register Preload Waveform** 

### POWER-UP RESET Applies to -7 (-12 Mil), H-15, B, B-2, A, A-2 Series Only

The power-up reset feature ensures that all flip-flops will be reset to LOW after the device has been powered up. The output state will be HIGH due to the inverting output buffer. This feature is valuable in simplifying state machine initialization. A timing diagram and parameter table are shown below. Due to the synchronous operation of the power-up reset and the wide range of ways  $V_{CC}$  can rise to its steady state, two conditions are required to ensure a valid power-up reset. These conditions are:

- 1. The V<sub>CC</sub> rise must be monotonic.
- Following reset, the clock input must not be driven from LOW to HIGH until all applicable input and feedback setup times are met.

Parameter Symbol	Parameter Description	Max.	Unit	
tPR	Power-up Reset Time	1000	ns	
ts	Input or Feedback Setup Time	See Switching		
twL	Clock Width LOW	Characteristics		



12350-024A

**Power-Up Reset Waveform**