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.

Rochester Electronics 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.

PAL16R8 Family

20-pin TTL Programmable Array Logic

**Advanced
Micro
Devices**

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

- Easy design with PALASM® software

- Programmable on standard PAL® device programmers

- 20-pin DIP and PLCC packages save space

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.

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_{CC} 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.

PRODUCT SELECTOR GUIDE

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

PERFORMANCE OPTIONS

(Commercial)

	55	80–100	155–180
35	B–4	A-2	
25		B-2	A
15		H-15	B
10			D
7.5			-7

Speed (t$_{PD}$, ns) — Power (I$_{CC}$, mA)

Note:

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

OPERATING RANGES

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)

BLOCK DIAGRAMS

PAL16L8

INPUTS

PROGRAMMABLE
AND ARRAY
(32 X 64)

O_1 I/O_2 I/O_3 I/O_4 I/O_5 I/O_6 I/O_7 O_8

12468-004A

PAL16R8

CLK   INPUTS $\overline{OE}$

PROGRAMMABLE
AND ARRAY
(32 X 64)

D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q   D $\overline{Q}$ Q

O_1 O_2 O_3 O_4 O_5 O_6 O_7 O_8

12468-001A

PAL16R8 Family

BLOCK DIAGRAMS

PAL16R6

CLK   INPUTS   OE

PROGRAMMABLE
AND ARRAY
(32 X 64)

I/O$_1$ O$_2$ O$_3$ O$_4$ O$_5$ O$_6$ O$_7$ I/O$_8$

12468-002A

2

PAL16R4

CLK   INPUTS   OE

PROGRAMMABLE
AND ARRAY
(32 X 64)

I/O$_1$ I/O$_2$ O$_3$ O$_4$ O$_5$ O$_6$ I/O$_7$ I/O$_8$

12468-003A

CONNECTION DIAGRAMS
Top View

DIP/FLATPACK

(NOTE 1)	1 ●	20	V_CC
I_1	2	19	(NOTE 10)
I_2	3	18	(NOTE 9)
I_3	4	17	(NOTE 8)
I_4	5	16	(NOTE 7)
I_5	6	15	(NOTE 6)
I_6	7	14	(NOTE 5)
I_7	8	13	(NOTE 4)
I_8	9	12	(NOTE 3)
GND	10	11	(NOTE 2)
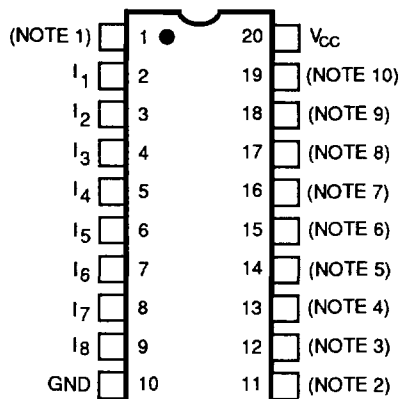
12468-005A

PLCC/LCC
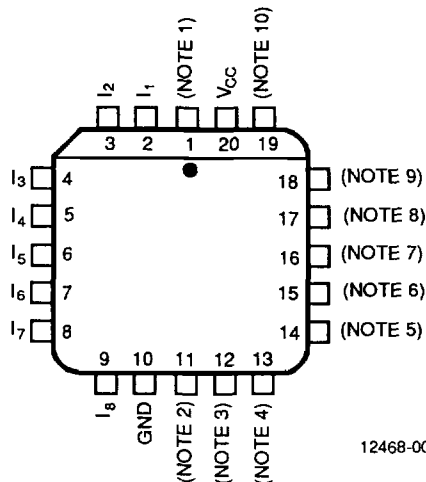
12468-006A

Note	16L8	16R8	16R6	16R4
1	I_0	CLK	CLK	CLK
2	I_9	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$
3	O_1	O_1	I/O_1	I/O_1
4	I/O_2	O_2	O_2	I/O_2
5	I/O_3	O_3	O_3	O_3
6	I/O_4	O_4	O_4	O_4
7	I/O_5	O_5	O_5	O_5
8	I/O_6	O_6	O_6	O_6
9	I/O_7	O_7	O_7	I/O_7
10	O_8	O_8	I/O_8	I/O_8

PIN DESIGNATIONS

CLK	Clock
GND	Ground
I	Input
I/O	Input/Output
O	Output
$\overline{OE}$	Output Enable
V_CC	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

PAL 16 R 8 H -15 P C

a. **FAMILY TYPE**
PAL = Programmable Array Logic

b. **NUMBER OF ARRAY INPUTS**

c. **OUTPUT TYPE**
R = Registered
L = Active-Low Combinatorial

d. **NUMBER OF OUTPUTS**

e. **POWER**
H = Half Power (100 mA I_{CC})
Blank = Full Power (180 mA I_{CC})

f. **SPEED**
-7 = 7.5 ns t_{PD}
-15 = 15 ns t_{PD}

i. **OPTIONAL PROCESSING**
Blank = Standard Processing

h. **OPERATING CONDITIONS**
C = Commercial (0°C to +75°C)

g. **PACKAGE TYPE**
P = 20-Pin Plastic DIP (PD 020)
J = 20-Pin Plastic Leaded Chip Carrier (PL 020)
D = 20-Pin Ceramic DIP (CD 020)

Valid Combinations		
PAL16L8		
PAL16R8	-7, H-15	PC, JC, DC
PAL16R6		
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.
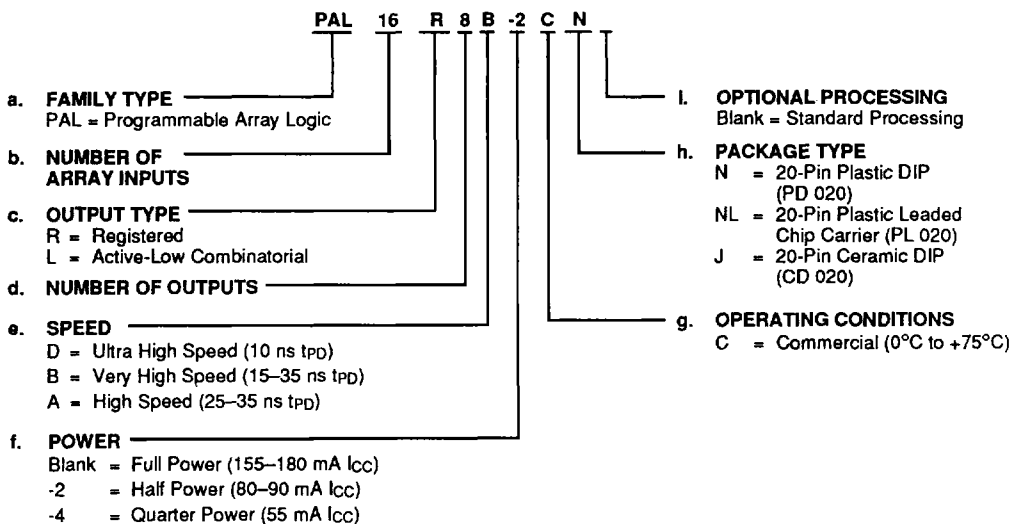
Note: Marked with AMD logo.

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

PAL 16 R 8 B -2 C N

a. FAMILY TYPE
PAL = Programmable Array Logic

b. NUMBER OF ARRAY INPUTS

c. OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial

d. NUMBER OF OUTPUTS

e. SPEED
D = Ultra High Speed (10 ns t_{PD})
B = Very High Speed (15–35 ns t_{PD})
A = High Speed (25–35 ns t_{PD})

f. POWER
Blank = Full Power (155–180 mA I_{CC})
-2 = Half Power (80–90 mA I_{CC})
-4 = Quarter Power (55 mA I_{CC})

i. OPTIONAL PROCESSING
Blank = Standard Processing

h. PACKAGE TYPE
N = 20-Pin Plastic DIP (PD 020)
NL = 20-Pin Plastic Leaded Chip Carrier (PL 020)
J = 20-Pin Ceramic DIP (CD 020)

g. OPERATING CONDITIONS
C = Commercial (0°C to +75°C)

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.
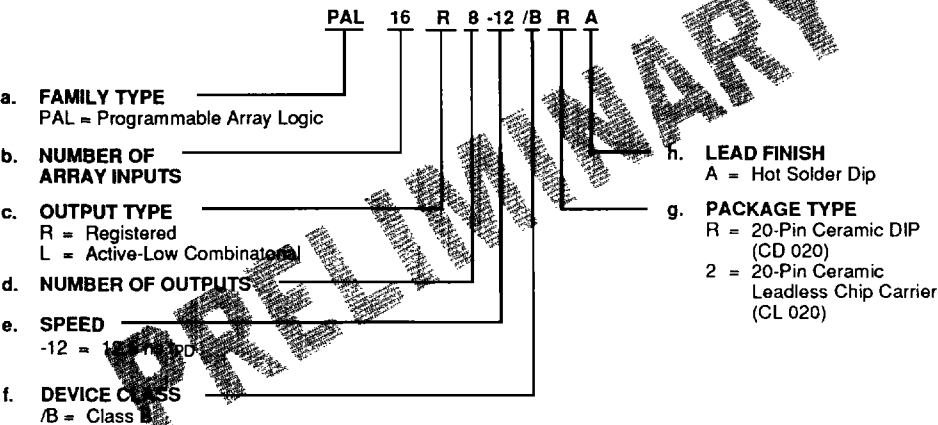
Note: Marked with MMI logo.

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 A

a. FAMILY TYPE
PAL = Programmable Array Logic

b. NUMBER OF ARRAY INPUTS

c. OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial

d. NUMBER OF OUTPUTS

e. SPEED
-12 = 12 ns tPD

f. DEVICE CLASS
/B = Class B

h. LEAD FINISH
A = Hot Solder Dip

g. PACKAGE TYPE
R = 20-Pin Ceramic DIP
     (CD 020)
2 = 20-Pin Ceramic
     Leadless Chip Carrier
     (CL 020)

Valid Combinations		
PAL16L8		
PAL16R8	-12	/BRA, /B2A
PAL16R6		
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, 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

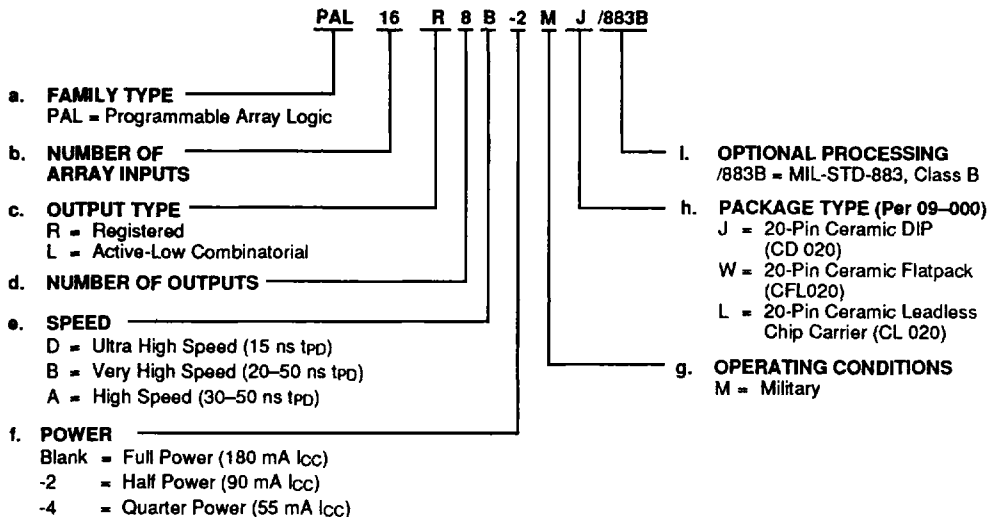Group A Tests consist of Subgroups: 1, 2, 3, 7, 8, 9, 10, 11.

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
f. Power
g. Operating Conditions
h. Package Type
i. Optional Processing

<div align="center">

PAL 16 R 8 B -2 M J /883B

</div>

a. FAMILY TYPE
PAL = Programmable Array Logic

b. NUMBER OF ARRAY INPUTS

c. OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial

d. NUMBER OF OUTPUTS

e. SPEED
D = Ultra High Speed (15 ns tPD)
B = Very High Speed (20–50 ns tPD)
A = High Speed (30–50 ns tPD)

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

i. OPTIONAL PROCESSING
/883B = MIL-STD-883, Class B

h. PACKAGE TYPE (Per 09–000)
J = 20-Pin Ceramic DIP (CD 020)
W = 20-Pin Ceramic Flatpack (CFL020)
L = 20-Pin Ceramic Leadless Chip Carrier (CL 020)

g. OPERATING CONDITIONS
M = Military

Valid Combinations		
PAL16L8	D, B,	MJ/883B,
PAL16R8	B-2, A,	MW/883B,
PAL16R6	B-4, A-2	ML/883B
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, to check on newly released combinations, and to obtain additional information on AMD's Standard Military grade products.

Note: Marked with MMI 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.

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 three-state 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.
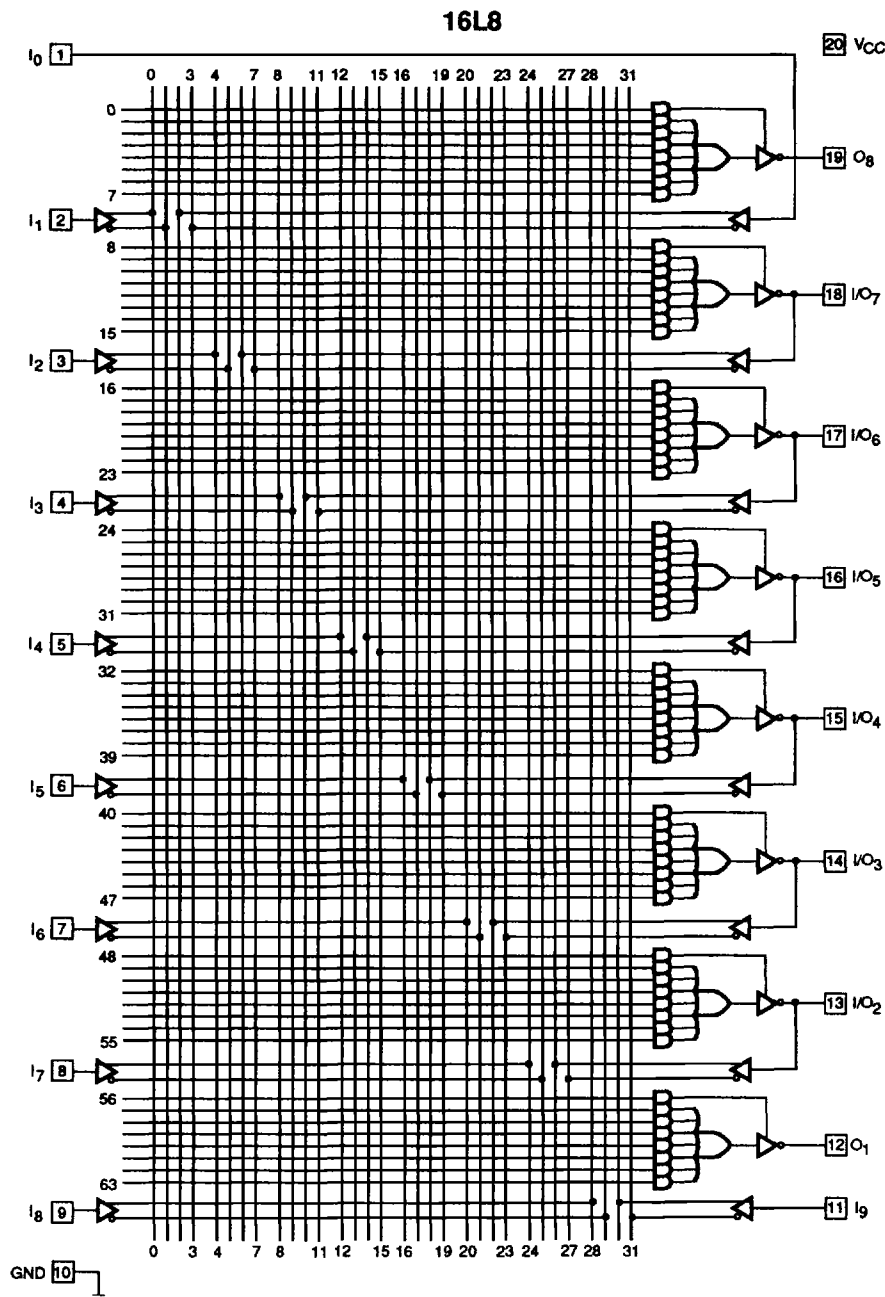
Quality and Testability

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.
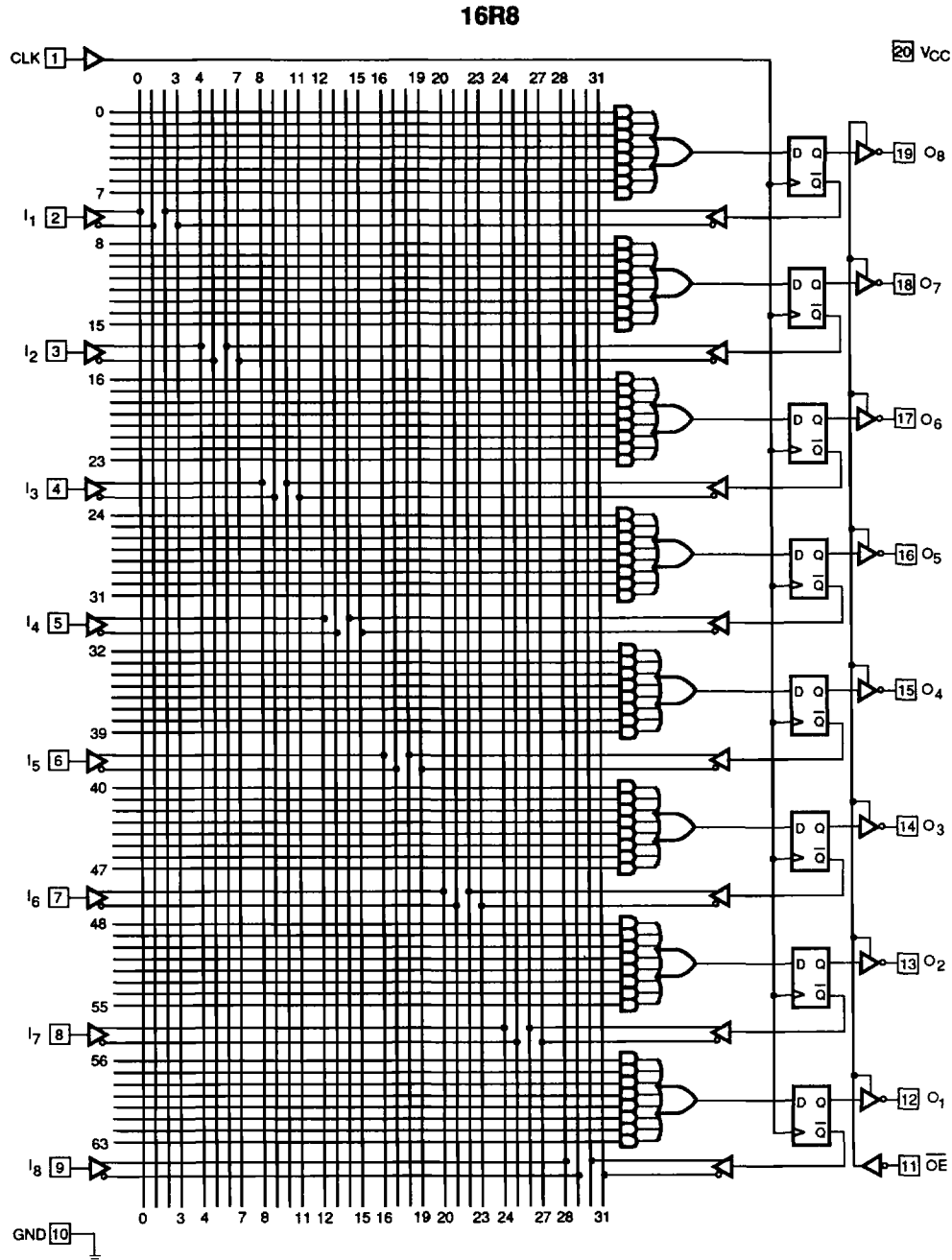
Technology

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.

16L8

12468-012A

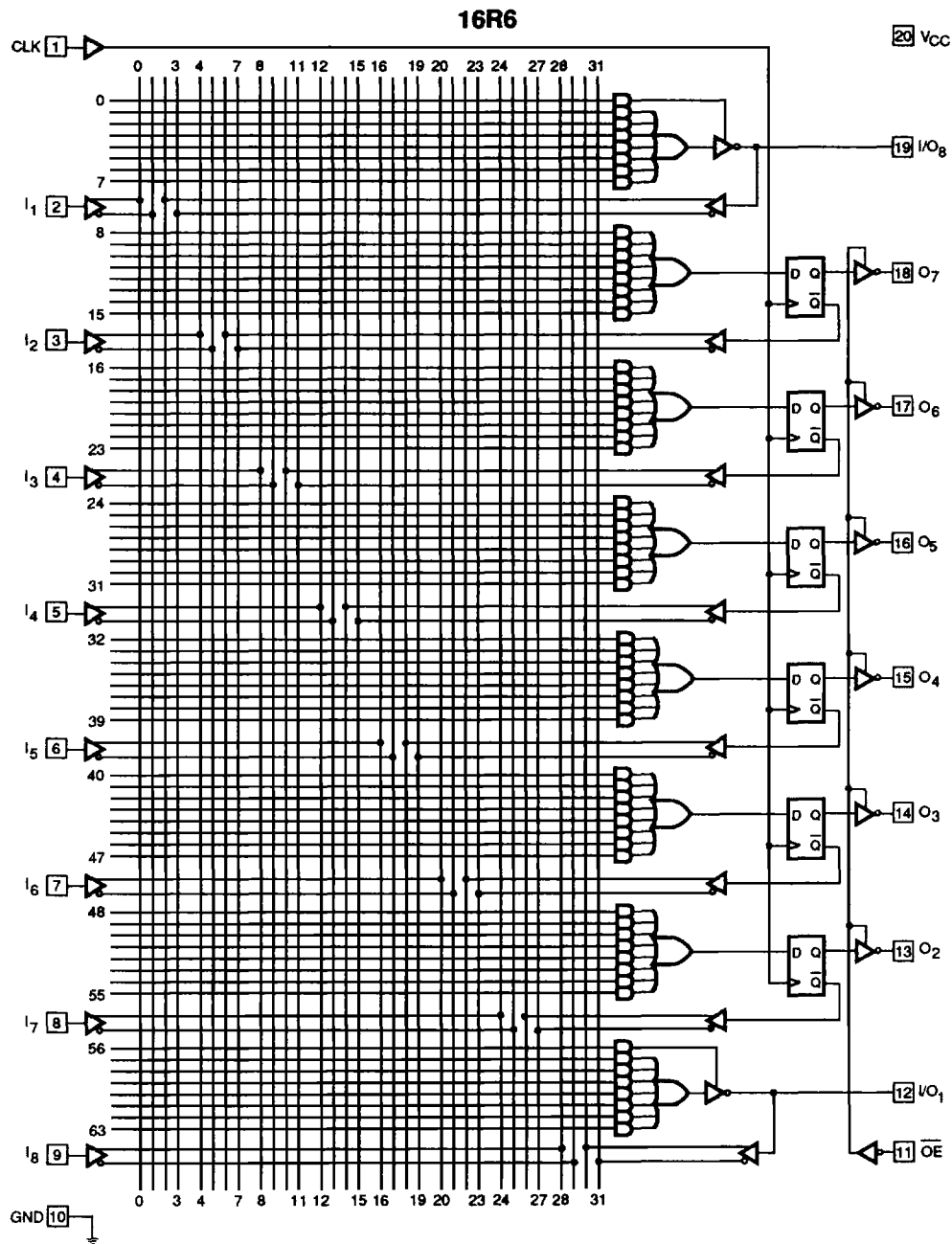**16R8**

CLK $\boxed{1}$

0 3 4 7 8 11 12 15 16 19 20 23 24 27 28 31

I_1 $\boxed{2}$

I_2 $\boxed{3}$

I_3 $\boxed{4}$

I_4 $\boxed{5}$

I_5 $\boxed{6}$

I_6 $\boxed{7}$

I_7 $\boxed{8}$

I_8 $\boxed{9}$

GND $\boxed{10}$

0 3 4 7 8 11 12 15 16 19 20 23 24 27 28 31

0
7
8
15
16
23
24
31
32
39
40
47
48
55
56
63

$\boxed{20}$ V_{CC}

D Q

$\boxed{19}$ O_8

D Q

$\boxed{18}$ O_7

D Q

$\boxed{17}$ O_6

D Q

$\boxed{16}$ O_5

D Q

$\boxed{15}$ O_4

D Q

$\boxed{14}$ O_3

D Q

$\boxed{13}$ O_2

D Q

$\boxed{12}$ O_1

$\boxed{11}$ $\overline{OE}$

2

12468-013A

LOGIC DIAGRAM

16R6

12468-014A

LOGIC DIAGRAM

16R4
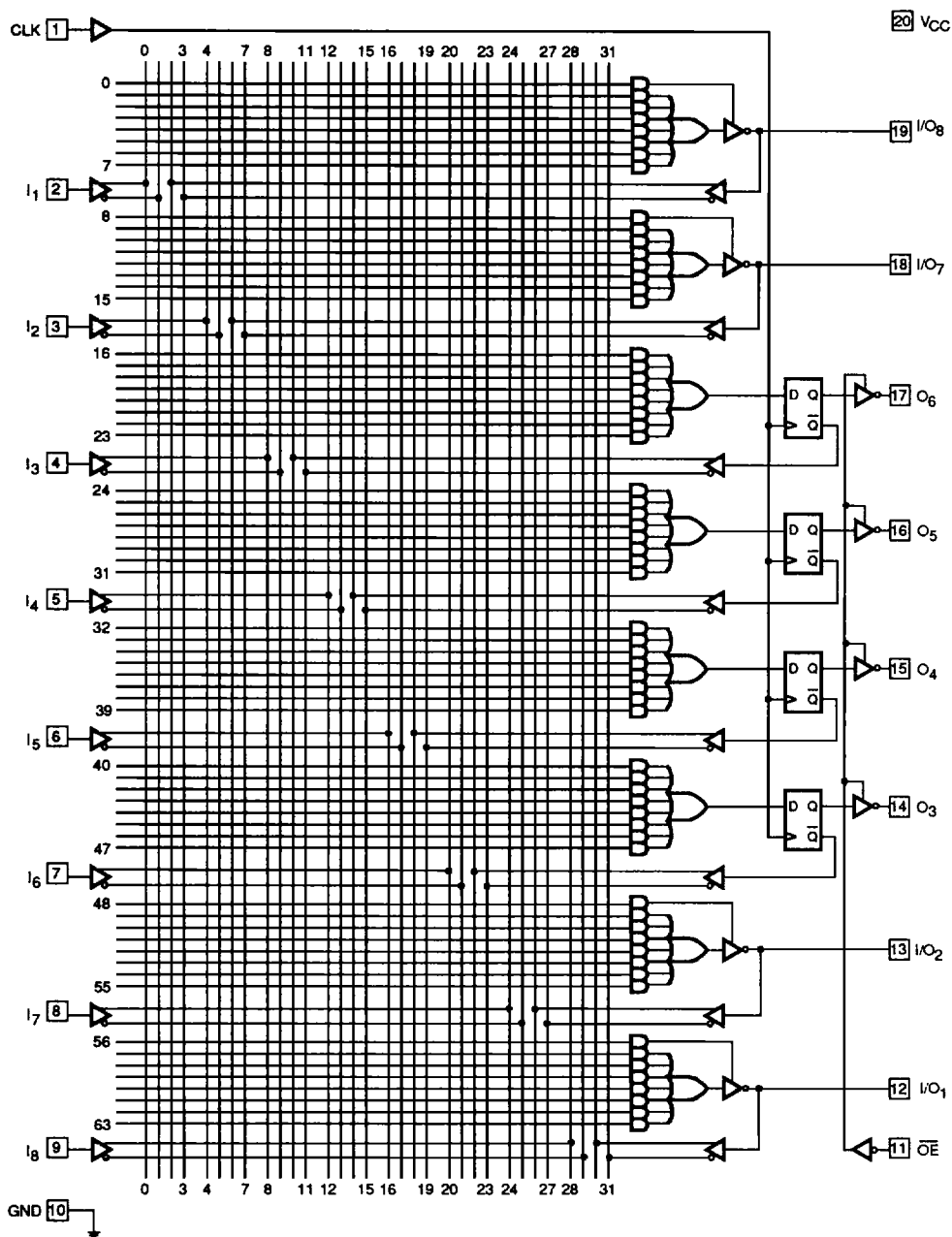
12468-015A

ABSOLUTE MAXIMUM RATINGS

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_{CC} + 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_A) Operating in Free Air	0°C to +75°C
Supply Voltage (V_{CC}) 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_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)	−30	−130	mA
I_{CC}	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_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V $T_A = 25°C$	5	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$f = 1$ MHz	8	

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
t_{PD}	Input or Feedback to Combinatorial Output	1 Output Switching	16L8, 16R6	3	7.5	ns
			16R4	3	7	
t_S	Setup Time from Input or Feedback to Clock			7		ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output			3	6.5	ns
t_{CF}	Clock to Feedback (Note 4)				3	ns
t_{SKEW}	Skew Between Registered Outputs (Note 5)		16R8, 16R6		1	ns
t_{WL}	Clock Width	LOW	16R4	5		ns
t_{WH}		HIGH		5		ns
f_{MAX}	Maximum Frequency (Note 6)	External Feedback	$1/(t_S + t_{CO})$	74		MHz
		Internal Feedback	$1/(t_S + t_{CF})$	100		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$	100		MHz
t_{PZX}	$\overline{OE}$ to Output Enable			3	8	ns
t_{PXZ}	$\overline{OE}$ to Output Disable			3	8	ns
t_{EA}	Input to Output Enable Using Product Term Control		16L8, 16R6	3	10	ns
t_{ER}	Input to Output Disable Using Product Term Control		16R4	3	10	ns

Notes:

2. See Switching Test Circuit for test conditions.
3. Output delay minimums are measured under best-case conditions.
4. Calculated from measured f_{MAX} 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.

ABSOLUTE MAXIMUM RATINGS

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 $V_{CC} + 0.5$ 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_A) Operating in Free Air	$-55°C$ Min.
Operating Case (T_C) Temperature	$125°C$ Max.
Supply Voltage (V_{CC}) 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_A = $+25°C$, $+125°C$, 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
V_{OH}	Output HIGH Voltage	$I_{OH} = -2$ mA, $V_{IN} = V_{IH}$ or V_{IL} $V_{CC} = $ Min.		2.4		V
V_{OL}	Output LOW Voltage	$I_{OL} = 12$ mA, $V_{IN} = V_{IH}$ or V_{IL} $V_{CC} = $ Min.			0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)		2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)			0.8	V
V_I	Input Clamp Voltage	$I_{IN} = -18$ mA, $V_{CC} = $ Min.			-1.2	V
I_{IH}	Input HIGH Current	$V_{IN} = 2.7$ V, $V_{CC} = $ Max. (Note 4)			25	μA
I_{IL}	Input LOW Current	$V_{IN} = 0.4$ V, $V_{CC} = $ Max. (Note 4)			-250	μA
I_I	Maximum Input Current	$V_{IN} = 5.5$ V, $V_{CC} = $ Max.			1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	$V_{OUT} = 2.7$ V, $V_{CC} = $ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 4)			100	μA
I_{OZL}	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4$ V, $V_{CC} = $ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 4)			-100	μA
I_{SC}	Output Short-Circuit Current	$V_{OUT} = 0.5$ V, $V_{CC} = $ Max. (Note 5)		-30	-130	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	5	
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$T_A = 25°C$ $f = 1$ 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 MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description			MIL (Note 3) Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R8	3	12.5	ns
		1 Output Switching	16R4	3	12	
t_S	Setup Time from Input or Feedback to Clock			12		ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output			3	11	ns
t_{CF}	Clock to Feedback (Note 4)				6.5	ns
t_{SKEW}	Skew Between Registered Outputs (Note 5)				1	ns
t_{WL}	Clock Width LOW		16R8, 16R6	10		ns
t_{WH}	HIGH		16R4	8		ns
f_{MAX}	Maximum Frequency (Note 6)	External Feedback	$1/(t_S + t_{CO})$		43.4		MHz
		Internal Feedback	$1/(t_S + t_{CF})$		54		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		55.5		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 7)			3	10	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 7)			3	10	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 7)		16L8, 16R6 16R4	3	15	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 7)			3	12	ns

Notes:

2. 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 t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} parameters should be used for simulation purposes only and are not tested.

4. Calculated from measured f_{MAX} 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.
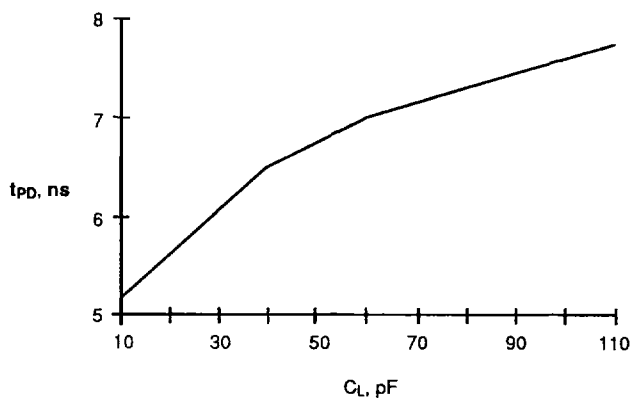
MEASURED SWITCHING CHARACTERISTICS

V_{CC} = 4.75 V, T_A = 75°C (Note 1)
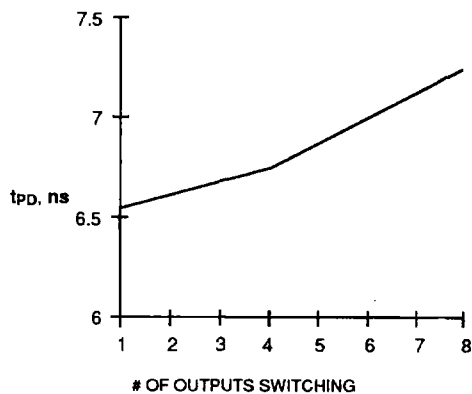
tpD vs. Number of Outputs Switching
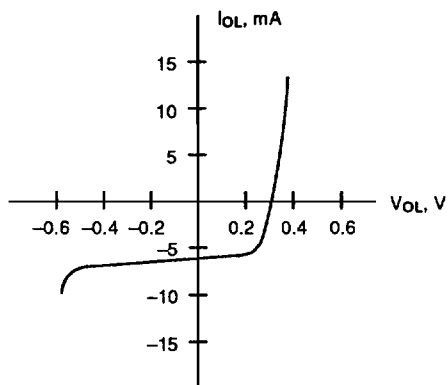
10240-001A

tpD 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.
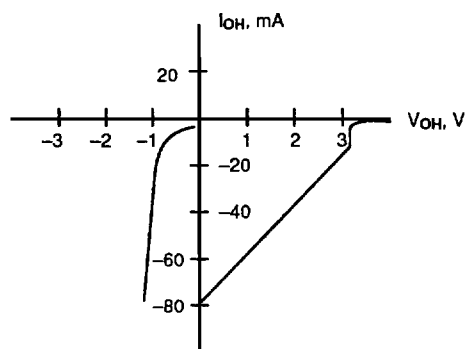
CURRENT VS. VOLTAGE (I-V) CHARACTERISTICS

$V_{CC} = 5.0$ V, $T_A = 25°C$

I_{OL}, mA

15

10

5

V_{OL}, V

−0.6 −0.4 −0.2   0.2   0.4   0.6

−5

−10

−15

Output, LOW

10240-003A

I_{OH}, mA

20

V_{OH}, V

−3   −2   −1   1   2   3

−20

−40

−60

−80

Output, HIGH

10240-004A

I_I, µA

20

1   2   3

V_I, V

−3   −2   −1

−20

−40

−60

−80
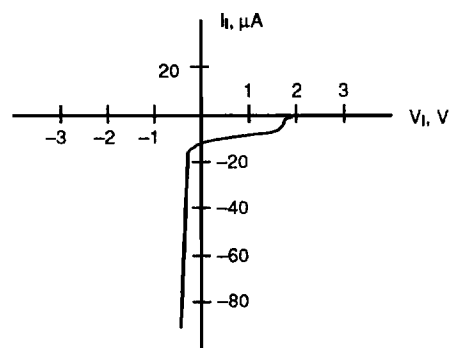
Input

10240-005A

ABSOLUTE MAXIMUM RATINGS

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

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air	0°C to +75°C
Supply Voltage (V_{CC}) 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_{OH}	Output HIGH Voltage	I_{OH} = –3.2 mA $V_{IN} = V_{IH}$ or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA $V_{IN} = V_{IH}$ or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min.		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)	–30	–130	mA
I_{CC}	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_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions			Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V $T_A = 25°C$	CLK, $\overline{OE}$	9	pF
				Other Inputs	2	
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ 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 Symbol	Parameter Description				Min. (Note 3)	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6 16R4	3	10	ns
t_S	Setup Time from Input or Feedback to Clock				10		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output				2	7	ns
t_{CF}	Clock to Feedback (Note 4)			16R8, 16R6 16R4	2	6.5	ns
t_{WL}	Clock Width	LOW			8		ns
t_{WH}		HIGH			8		ns
f_{MAX}	Maximum Frequency (Note 5)	External Feedback	$1/(t_S + t_{CO})$		58.8		MHz
		Internal Feedback	$1/(t_S + t_{CF})$		60		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		62.5		MHz
t_{PZX}	$\overline{OE}$ to Output Enable				3	10	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				3	10	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6	1	10	ns
t_{ER}	Input to Output Disable Using Product Term Control			16R4	1	10	ns

Notes:

2. See Switching Test Circuit for test conditions.

3. Output delay minimums are measured under best-case conditions.

4. Calculated from measured f_{MAX} 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.

2

ABSOLUTE MAXIMUM RATINGS

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_A) Operating in Free Air	–55°C Min.
Operating Case (T_C) Temperature	125°C Max.
Supply Voltage (V_{CC}) 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_C = +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
V_{OH}	Output HIGH Voltage	I_{OH} = –2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min.		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 4)		25	μA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 4)		–250	μA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	μA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 5)	–30	–130	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions			Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	CLK, $\overline{OE}$	9	
			$T_A = 25°C$	Other Inputs	2	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ 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_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6 16R4	3	15	ns
t_S	Setup Time from Input or Feedback to Clock				15		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback				2	12	ns
t_{WL}	Clock Width	LOW		16R8, 16R6	12		ns
t_{WH}		HIGH		16R4	8		ns
f_{MAX}	Max. Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$		37		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		50		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 5)				3	12	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 5)				3	10	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 5)			16L8, 16R6 16R4	1	17	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 5)				1	13	ns

Notes:

2. 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 t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} 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.

2

ABSOLUTE MAXIMUM RATINGS

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_{CC} + 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_A) Operating in Free Air	0°C to +75°C
Supply Voltage (V_{CC}) 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 unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –3.2 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min.		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)	–30	–130	mA
I_{CC}	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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions			Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	CLK, $\overline{OE}$	9	
			$T_A = 25°C$	Other Inputs	2	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ 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 Symbol	Parameter Description			Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output	16L8, 16R6			15	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output				12	ns
t_{CF}	Clock to Feedback (Note 3)		16R8, 16R6		11	ns
t_{WL}	Clock Width	LOW	16R4			ns
t_{WH}		HIGH				ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$		37	MHz
		Internal Feedback	$1/(t_S + t_{CF})$		38.4	MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		52.6	MHz
t_{PZX}	$\overline{OE}$ to Output Enable				12	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				10	ns
t_{EA}	Input to Output Enable Using Product Term Control	16L8, 16R6			15	ns
t_{ER}	Input to Output Disable Using Product Term Control	16R4			15	ns

Notes:

2. See Switching Test Circuit for test conditions.

3. Calculated from measured f_{MAX} 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.

ABSOLUTE MAXIMUM RATINGS

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_{CC} + 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_A) Operating in Free Air	0°C to +75°C
Supply Voltage (V_{CC}) 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_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)	−30	−130	mA
I_{CC}	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_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	8	
			$T_A = 25°C$		pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$f = 1$ MHz	9	

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.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R6 16R4		15	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback				12	ns
t_{WL}	Clock Width	LOW	16R8, 16R6			ns
t_{WH}		HIGH	16R4			ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback $1/(t_S + t_{CO})$				MHz
		No Feedback $1/(t_{WH} + t_{WL})$			50	MHz
t_{PZX}	$\overline{OE}$ to Output Enable				15	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				15	ns
t_{EA}	Input to Output Enable Using Product Term Control		16L8, 16R6		15	ns
t_{ER}	Input to Output Disable Using Product Term Control		16R4		15	ns

Notes:

2. See Switching Test Circuit for test conditions.
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.

2

ABSOLUTE MAXIMUM RATINGS

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_C) Temperature	125°C Max.
Supply Voltage (V_{CC}) 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_A = +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
V_{OH}	Output HIGH Voltage	I_{OH} = –2 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA V_{CC} = Min.		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 4)		25	μA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 4)		–250	μA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	μA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 5)	–30	–130	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V $T_A = 25°C$	9	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$f = 1$ MHz	10	

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.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R6 16		20	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback				15	ns
t_{WL}	Clock Width	LOW	16R8, 16R6			ns
t_{WH}		HIGH	16R			ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback $1/(t_S + t_{CO})$				MHz
		No Feedback $1/(t_{WH} + t_{WL})$			41.6	MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)				20	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)				20	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)		16L8, 16R6 16R4		25	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)				20	ns

Notes:

2. 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. 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.

ABSOLUTE MAXIMUM RATINGS

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_{CC} + 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_A)
Operating in Free Air   0°C to +75°C

Supply Voltage (V_{CC})
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_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 4)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 4)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)		−100	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)	−30	−130	mA
I_{CC}	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 I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	7	
			$T_A = 25°C$		pF
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	f = 1 MHz	7	

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.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R8 16R4		25	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output				15	ns
t_{CF}	Clock to Feedback (Note 3)		16R8, 16R6		10	ns
t_{WL}	Clock Width	LOW	16R4			ns
t_{WH}		HIGH				ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$	25		MHz
		Internal Feedback	$1/(t_S + t_{CF})$	28.5		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$	33		MHz
t_{PZX}	OE to Output Enable				20	ns
t_{PXZ}	OE to Output Disable				20	ns
t_{EA}	Input to Output Enable Using Product Term Control		16L8, 16R6		25	ns
t_{ER}	Input to Output Disable Using Product Term Control		16R4		25	ns

Notes:

2. See Switching Test Circuit for test conditions.

3. Calculated from measured f_{MAX} 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.

ABSOLUTE MAXIMUM RATINGS

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_C) Temperature	125°C Max.
Supply Voltage (V_{CC}) 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-STD-883.

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

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	$I_{OH} = $ μA $V_{IN} = V_{IH}$ or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	mA $V_{IN} = V_{IH}$ or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	$I_{IN} = -18$ mA V_{CC} = Min.		−1.5	V
I_{IH}	Input HIGH Current	$V_{IN} = 2.4$ V, V_{CC} = Max. (Note 4)		25	μA
I_{IL}	Input LOW Current	$V_{IN} = 0.4$ V, V_{CC} = Max. (Note 4)		−250	μA
I_I	Maximum Input Current	$V_{IN} = 5.5$ V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4$ V, V_{CC} = Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 4)		−100	μA
I_{SC}	Output Short-Circuit Current	$V_{OUT} = 0.5$ V, V_{CC} = Max. (Note 5)	−30	−130	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	7	
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$T_A = 25°C$ $f = 1$ 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 Description			Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R6 16R4		30	ns
t_S	Setup Time from Input or Feedback to Clock			30		ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback				20	ns
t_{WL}	Clock Width	LOW	16R8, 16R6 16R4	20		ns
t_{WH}		HIGH		20		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback 1/(t$_S$ + t$_{CO}$)		20		MHz
		No Feedback 1/(t$_{WH}$ + t$_{WL}$)		25		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)				25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)				25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)		16L8, 16R6 16R4		30	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)				30	ns

Notes:

2. 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. 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.

ABSOLUTE MAXIMUM RATINGS

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_{CC} + 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_A)
     Operating in Free Air   0°C to +75°C

     Supply Voltage (V_{CC})
     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_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.		2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.			0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)				V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)			0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.			−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max. (Note 2)			25	μA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 2)			−250	μA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.			100	μA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)			100	μA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 2)			−100	μA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 3)		−30	−130	mA
I_{CC}	Supply Current	16L8	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max.		155	mA
		16R8/6/4			180	

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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V T_A = 25°C	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V	f = 1 MHz	7	

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					Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6 16R		25	ns
t_S	Setup Time from Input or Feedback to Clock						ns
t_H	Hold Time					0	ns
t_{CO}	Clock to Output					15	ns
t_{CF}	Clock to Feedback (Note 3)			6R8, 16R6		10	ns
t_{WL}	Clock Width	LOW		16R4			ns
t_{WH}		HIGH					ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	1/(ts + tco)		25		MHz
		Internal Feedback	1/(ts + tcf)		28.5		MHz
		No Feedback	1/(twh + twl)		33		MHz
t_{PZX}	OE to Output Enable					20	ns
t_{PXZ}	OE to Output Disable					20	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6		25	ns
t_{ER}	Input to Output Disable Using Product Term Control			16R4		25	ns

Notes:

2. See Switching Test Circuit for test conditions.

3. Calculated from measured f_{MAX} 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.

ABSOLUTE MAXIMUM RATINGS

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_C)
Temperature   125°C Max.

Supply Voltage (V_{CC})
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-STD-883.

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

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –2 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min.		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 4)		25	μA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 4)		–250	μA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	μA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 5)	–30	–130	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	$V_{IN} = 2.0$ V	$V_{CC} = 5.0$ V	7	
C_{OUT}	Output Capacitance	$V_{OUT} = 2.0$ V	$T_A = 25°C$ $f = 1$ 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 Description			Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output	16L8, 16R6 16			30	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback				20	ns
t_{WL}	Clock Width	LOW	16R8, 16R6			ns
t_{WH}		HIGH	16R			ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	$1/(t_S + t_{CO})$			MHz
		No Feedback	$1/(t_{WH} + t_{WL})$	25		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)				25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)				25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)	16L8, 16R6 16R4			30	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)				30	ns

Notes:

2. 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. 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.

ABSOLUTE MAXIMUM RATINGS

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_A)
Operating in Free Air $0°C$ to $+75°C$

Supply Voltage (V_{CC})
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_{OH}	Output HIGH Voltage	$I_{OH} = -1$ mA, $V_{IN} = V_{IH}$ or V_{IL}, $V_{CC} =$ Min.	2.4		V
V_{OL}	Output LOW Voltage	$I_{OL} = 8$ mA, $V_{IN} = V_{IH}$ or V_{IL}, $V_{CC} =$ Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	$I_{IN} = -18$ mA, $V_{CC} =$ Min.		-1.5	V
I_{IH}	Input HIGH Current	$V_{IN} = 2.4$ V, $V_{CC} =$ Max. (Note 2)		25	µA
I_{IL}	Input LOW Current	$V_{IN} = 0.4$ V, $V_{CC} =$ Max. (Note 2)		-250	µA
I_I	Maximum Input Current	$V_{IN} = 5.5$ V, $V_{CC} =$ Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	$V_{OUT} = 2.4$ V, $V_{CC} =$ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	$V_{OUT} = 0.4$ V, $V_{CC} =$ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		-100	µA
I_{SC}	Output Short-Circuit Current	$V_{OUT} = 0.5$ V, $V_{CC} =$ Max. (Note 3)	-30	-250	mA
I_{CC}	Supply Current	$V_{IN} = 0$ V, Outputs Open ($I_{OUT} = 0$ mA) $V_{CC} =$ 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 I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

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

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 1)

Parameter Symbol	Parameter Description				Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6 16R4		35	ns
t_S	Setup Time from Input or Feedback to Clock				35		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback			16R8, 16R6		25	ns
t_{WL}	Clock Width	LOW		16R4	25		ns
t_{WH}		HIGH			25		ns
f_{MAX}	Maximum Frequency (Note 2)	External Feedback	$1/(t_S + t_{CO})$		16		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		20		MHz
t_{PZX}	$\overline{OE}$ to Output Enable					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable					25	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6		35	ns
t_{ER}	Input to Output Disable Using Product Term Control			16R4		35	ns

Notes:

1. See Switching Test Circuit for test conditions.
2. These parameters are not 100% tested, are evaluated at initial characterization and any time the design is modified where frequency may be affected.

2

ABSOLUTE MAXIMUM RATINGS

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_C)
Temperature   125°C Max.

Supply Voltage (V_{CC})
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_C = +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
V_{OH}	Output HIGH Voltage	I_{OH} = −1 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 4 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.		−1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 4)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 4)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 5)	−30	−250	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = 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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 1)

Parameter Symbol	Parameter Description				Min.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6 16R4		50	ns
t_S	Setup Time from Input or Feedback to Clock				50		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					25	ns
t_{WL}	Clock Width	LOW		16R8, 16R6	25		ns
t_{WH}		HIGH		16R4	25		ns
f_{MAX}	Maximum Frequency (Note 2)	External Feedback	$1/(t_S + t_{CO})$		13.3		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		20		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 3)					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 3)					25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 3)			16L8, 16R6 16R4		45	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 3)					45	ns

Notes:

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.

2

ABSOLUTE MAXIMUM RATINGS

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 $V_{CC} + 0.5$ 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_A) Operating in Free Air	$0°C$ to $+75°C$
Supply Voltage (V_{CC}) 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_{OH}	Output HIGH Voltage		$I_{OH} = -3.2$ mA, $V_{IN} = V_{IH}$ or V_{IL}, $V_{CC} = $ Min.	2.4		V
V_{OL}	Output LOW Voltage		$I_{OL} = 24$ mA, $V_{IN} = V_{IH}$ or V_{IL}, $V_{CC} = $ Min.		0.5	V
V_{IH}	Input HIGH Voltage		Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage		Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage		$I_{IN} = -18$ mA, $V_{CC} = $ Min.		-1.2	V
I_{IH}	Input HIGH Current		$V_{IN} = 2.4$ V, $V_{CC} = $ Max. (Note 2)		25	µA
I_{IL}	Input LOW Current		$V_{IN} = 0.4$ V, $V_{CC} = $ Max. (Note 2)		-250	µA
I_I	Maximum Input Current		$V_{IN} = 5.5$ V, $V_{CC} = $ Max.		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH		$V_{OUT} = 2.4$ V, $V_{CC} = $ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW		$V_{OUT} = 0.4$ V, $V_{CC} = $ Max. $V_{IN} = V_{IH}$ or V_{IL} (Note 2)		-100	µA
I_{SC}	Output Short-Circuit Current		$V_{OUT} = 0.5$ V, $V_{CC} = $ Max. (Note 3)	-30	-130	mA
I_{CC}	Supply Current	16L8	$V_{IN} = 0$ V, Outputs Open ($I_{OUT} = 0$ mA) $V_{CC} = $ Max.		80	mA
		16R8/6/4			90	

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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Descriptions	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V T_A = 25°C	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V	f = 1 MHz	7	

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.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output		16L8, 16R6 16R4		35	ns
t_S	Setup Time from Input or Feedback to Clock					ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback		16R8, 16R6		25	ns
t_{WL}	Clock Width	LOW	16R4	25		ns
t_{WH}		HIGH		25		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	1/(t_S + t_{CO})	16		MHz
		No Feedback	1/(t_{WH} + t_{WL})	20		MHz
t_{PZX}	OE to Output Enable				25	ns
t_{PXZ}	OE to Output Disable				25	ns
t_{EA}	Input to Output Enable Using Product Term Control		16L8, 16R6		35	ns
t_{ER}	Input to Output Disable Using Product Term Control		16R4		35	ns

Notes:

2. See Switching Test Circuit for test conditions.

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.
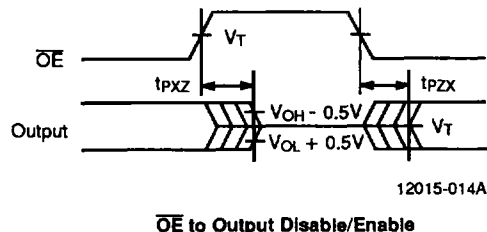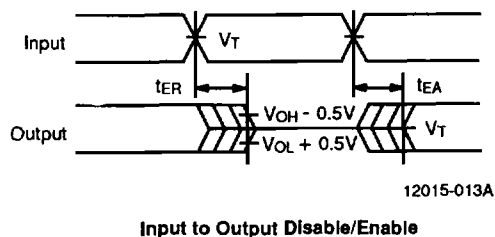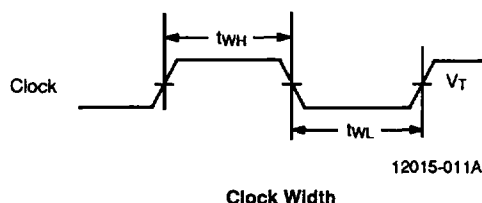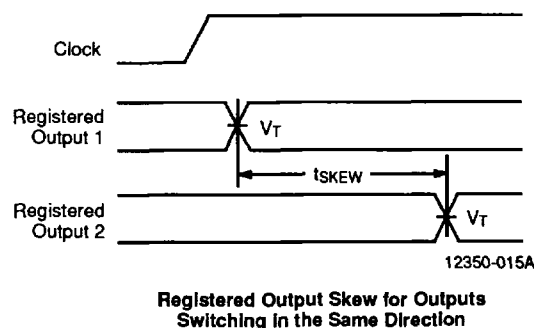
ABSOLUTE MAXIMUM RATINGS

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 to +125°C

Supply Voltage (V_{CC})
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_C = +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
V_{OH}	Output HIGH Voltage	I_{OH} = −2 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA, V_{IN} = V_{IH} or V_{IL} V_{CC} = Min.		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min.		−1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max. (Note 4)		25	μA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max. (Note 4)		−250	μA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max.		1	mA
I_{OZH}	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
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max. V_{IN} = V_{IH} or V_{IL} (Note 4)		−100	μA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max. (Note 5)	−30	−250	mA
I_{CC}	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.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} 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}).

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

CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ.	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V	7	
			T_A = 25°C		pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V	f = 1 MHz	7	

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.	Max.	Unit
t_{PD}	Input or Feedback to Combinatorial Output	16L8, 16R6 16R4			50	ns
t_S	Setup Time from Input or Feedback to Clock			50		ns
t_H	Hold Time			0		ns
t_{CO}	Clock to Output or Feedback				25	ns
t_{WL}	Clock Width	LOW	16R8, 16R6 16R4	25		ns
t_{WH}		HIGH		25		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	1/(t_S + t_CO)	16.6		MHz
		No Feedback	1/(t_WH + t_WL)	20		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)				25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)				25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)		16L8, 16R6 16R4		45	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)				45	ns

Notes:

2. 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. 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.
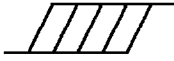
SWITCHING WAVEFORMS

Combinatorial Output

12015-010A

Registered Output

12015-012A

Clock to Feedback (f_{MAX} Internal)
See Path at Right

12149-025A

12015-021A

Registered Output Skew for Outputs
Switching in the Same Direction

12350-015A

Clock Width

12015-011A

Input to Output Disable/Enable
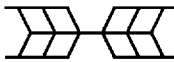
12015-013A

$\overline{OE}$ to Output Disable/Enable

12015-014A
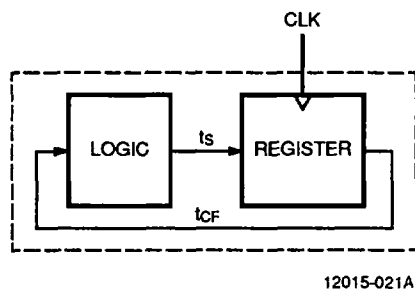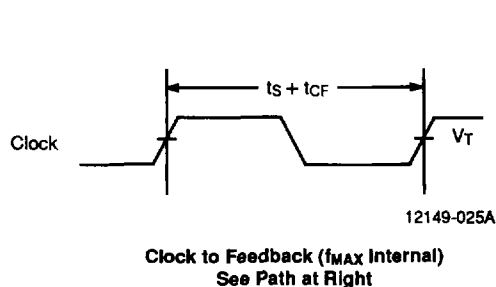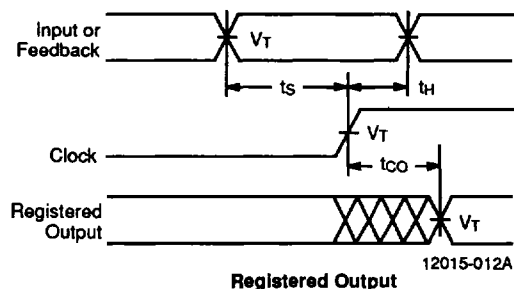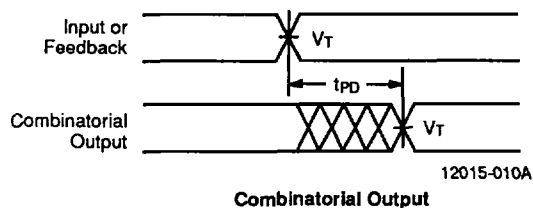
Notes:

1. $V_T = 1.5$ 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)

PAL16R8 Family

KEY TO SWITCHING WAVEFORMS

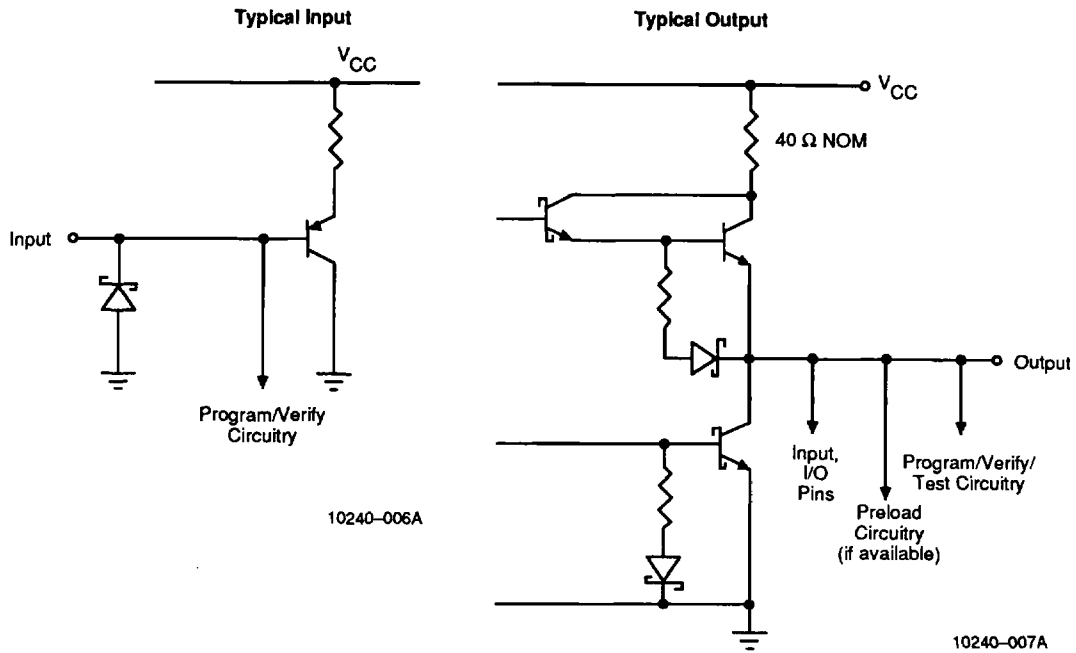| WAVEFORM	INPUTS	OUTPUTS
	Must be Steady	Will be Steady
	May Change from H to L	Will be Changing from H to L
	May Change from L to H	Will be Changing from L to H
	Don't Care; Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High-Impedance "Off" State

KS000010-PAL

SWITCHING TEST CIRCUIT
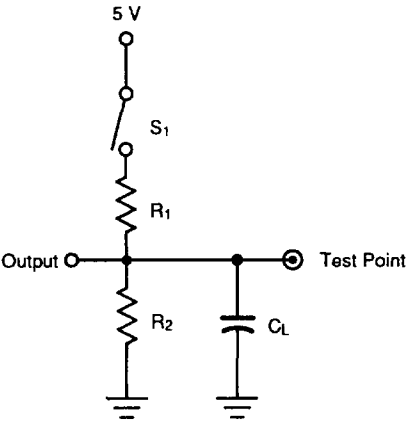
12350-019A

Specification	S₁	C_L	Commercial		Military		Measured Output Value
			R₁	R₂	R₁	R₂	
t_{PD}, t_{CO}, t_{CF}	Closed						1.5 V
t_{PZX}, t_{EA}	Z → H: Open	50 pF					1.5 V
	Z → L: Closed		200 Ω	390 Ω	390 Ω	750 Ω	
t_{PXZ}, t_{ER}	H → Z: Open	5 pF	B-4:	B-4:	B-4:	B-4:	H → Z: V_{OH} – 0.5 V
	L → Z: Closed		800 Ω	1.56 KΩ	800 Ω	1.56 KΩ	L → Z: V_{OL} + 0.5 V

INPUT/OUTPUT EQUIVALENT SCHEMATICS

Typical Input

V_{CC}

Input

Program/Verify
Circuitry

10240–006A

Typical Output

V_{CC}

40 Ω NOM

Output

Input,
I/O
Pins

Program/Verify/
Test Circuitry

Preload
Circuitry
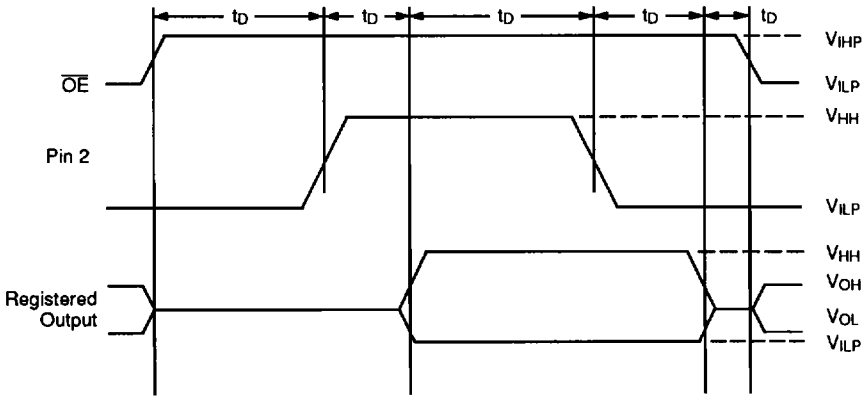(if available)

10240–007A

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 V_{CC} to V_{CCH}.

2. Set $\overline{OE}$ to V_{IHP} to disable output registers.

3. Raise pin 2 to V_{HH} to enter preload mode.

4. Apply either V_{HH} or V_{ILP} to all registered outputs. Use V_{HH} to preload a LOW in the flip-flop; use V_{ILP} to

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

5. Lower pin 2 to V_{ILP}.

6. Remove V_{ILP}/V_{HH} from all registered output pins.

7. Lower $\overline{OE}$ to V_{ILP} to enable the output registers.

8. Verify V_{OL}/V_{OH} 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
V_{HH}	Super-level input voltage	10	11	12	V
V_{ILP}	Low-level input voltage	0	0	0.5	V
V_{IHP}	High-level input voltage	2.4	5.0	5.5	V
V_{CCH}	Power supply during preload	5.4	5.7	6.0	V
t_D	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 V_{CC} to 4.5 V.

2. Set $\overline{OE}$ to V_{IHP} to disable output registers.

3. Apply either V_{IHP} or V_{ILP} to all registered outputs. Use V_{IHP} to preload a HIGH in the flip-flop; use V_{ILP} to preload a LOW in the flip-flop. Leave combinatorial outputs floating.

4. Pulse pin 8 to V_{HH}, then back to 0 V.

5. Remove V_{ILP}/V_{IHP} from all registered output pins.

6. Lower $\overline{OE}$ to V_{ILP} to enable the output registers.

7. Verify V_{OL}/V_{OH} 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
V_{HH}	Super-level input voltage	19	20	21	V
V_{ILP}	Low-level input voltage	0	0	0.5	V
V_{IHP}	High-level input voltage	2.4	5.0	5.5	V
t_D	Delay time	100	200	1000	ns

10240-008A
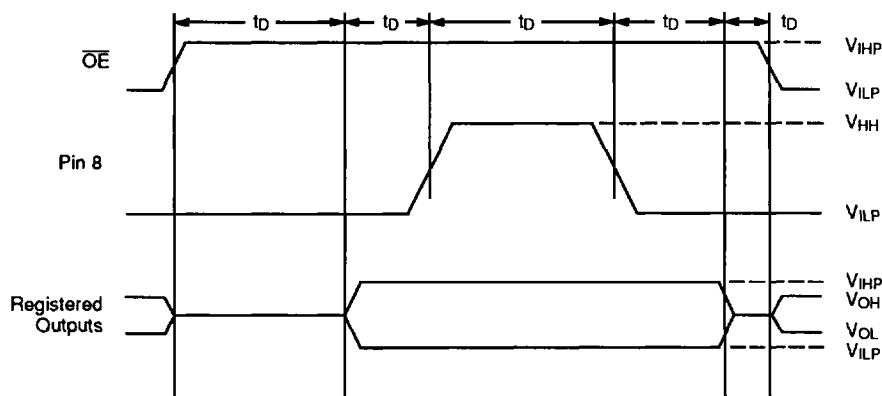
**Output Register Preload Waveform**

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_{CC} rise must be monotonic.

2. 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
t_{PR}	Power-up Reset Time	1000	ns
t_S	Input or Feedback Setup Time	See Switching	
t_{WL}	Clock Width LOW	Characteristics	
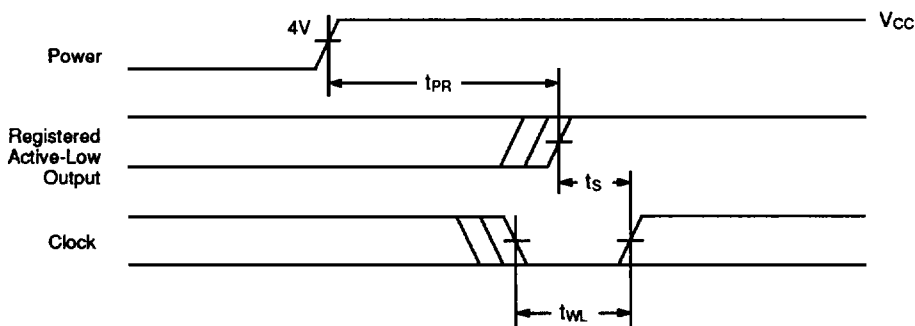
12350-024A

Power-Up Reset Waveform