



# PAL<sup>®</sup> 20 Series

## 16L8/16R8

## 16R6/16R4

### 4.5-ns, Industry-Standard PLDs

#### Features

- Ultra high speed supports today's and tomorrow's fastest microprocessors
  - $t_{pd} = 4.5 \text{ ns}$
  - $t_s = 2.5 \text{ ns}$
  - $f_{MAX} = 142.9 \text{ MHz}$  (external)
- Popular industry standard architectures
- Power-up RESET
- High reliability
  - Proven Ti-W fuses
  - AC and DC tested at the factory
- Security fuse

#### Functional Description

Cypress PAL20 Series devices consist of the PAL16L8, PAL16R8, PAL16R6, and PAL16R4. Using BiCMOS process and Ti-W fuses, these devices implement the familiar sum-of-products (AND-OR) logic structure.

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.

The product selector guide details all the different options available. All the regis-

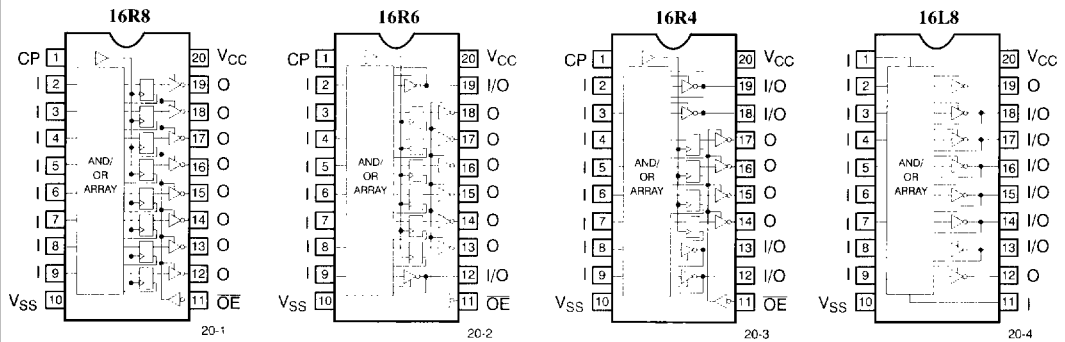
tered devices feature power-up RESET. The register Q output is set to a logic LOW when power is applied to the devices.

A security fuse is provided on all the devices to prevent copying of the device fuse pattern.

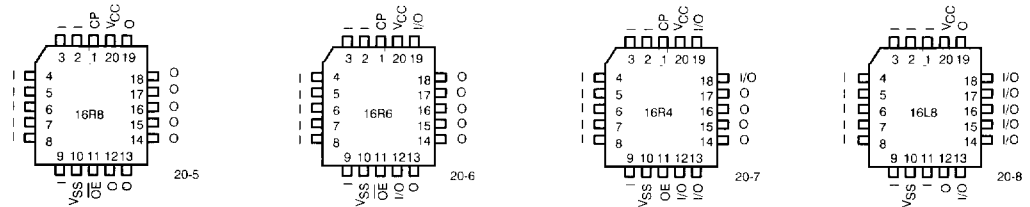
#### Programming

The PAL20 Series devices can be programmed using the *Impulse* programmer available from Cypress Semiconductor. See third party information in third party tool section for further programmer information.

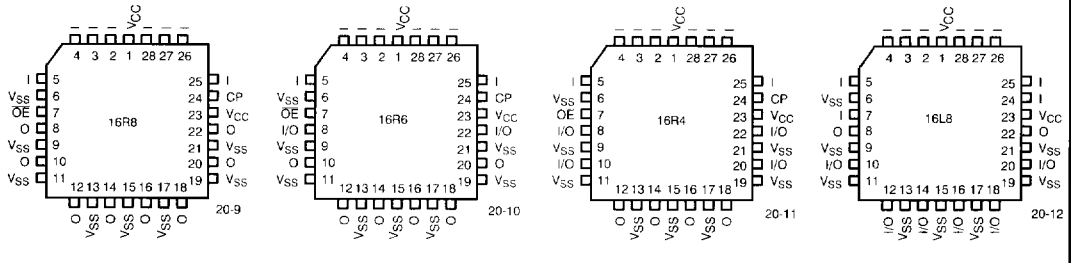
#### Logic Symbols and DIP Pinouts



#### 20-Pin PLCC/LCC Pinouts



#### 28-Pin PLCC (-4 Speed Bin Only) Pinouts



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**Function Selection Guide**

Device	Dedicated Inputs	Outputs	Product Terms/Outputs	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.

**Speed Selection Guide** (Commercial -4/-5/-7, Military -7/-10)

Speed Bin	t <sub>PD</sub> (ns)	t <sub>S</sub> (ns)	t <sub>CO</sub> (ns)	f <sub>MAX</sub> (MHz)	I <sub>CC</sub> (mA)
-4	4.5	2.5	4.5	142.9	180
-5	5	2.5	5	133.3	180
-7	7	3.5	6	105.3	180
-10	10	4.5	7	87.0	180

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**Maximum Ratings**

(Above which the useful life may be impaired. For user guidelines, not tested.)

- Storage Temperature ..... -65°C to +150°C
- Ambient Temperature with Power Applied ..... -55°C to +125°C
- Supply Voltage to Ground Potential ..... -0.5V to +7.0V
- DC Voltage Applied to Outputs in High Z State ..... -0.5V to V<sub>CC</sub> + 0.5V
- DC Input Voltage ..... -1.2V to V<sub>CC</sub> + 0.5V

DC Input Current (except during programming) ..... -30 mA to +5 mA

**Operating Range**

Range	Ambient Temperature	V <sub>CC</sub>
Commercial	0°C to +70°C	5V ±5%
Military <sup>[1]</sup>	-55°C to +125°C	5V ±10%

**DC Electrical Characteristics Over the Operating Range**

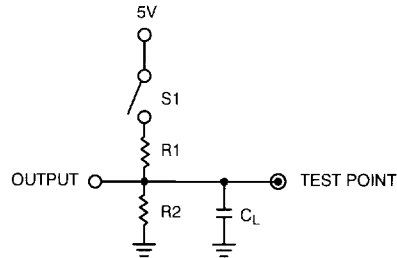
Parameter	Description	Test Conditions		Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = Min., V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -3.2 mA	Commercial	2.4	V
			I <sub>OH</sub> = -2 mA	Military		
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = Min., V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 24 mA	Commercial	0.5	V
			I <sub>OL</sub> = 12 mA	Military		
V <sub>IH</sub>	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for All Inputs <sup>[2]</sup>		2.0		V
V <sub>IL</sub>	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for All Inputs <sup>[2]</sup>			0.8	V
I <sub>IX</sub>	Input Leakage Current	0.4V ≤ V <sub>IN</sub> ≤ 2.7V, V <sub>CC</sub> = Max. <sup>[3]</sup>		-250	50	μA
I <sub>I</sub>	Maximum Input Current	V <sub>IN</sub> = 5.5V, V <sub>CC</sub> = Max.			1	mA
I <sub>OZ</sub>	Output Leakage Current	V <sub>CC</sub> = Max., V <sub>SS</sub> ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> <sup>[3]</sup>		-100	+100	μA
I <sub>SC</sub>	Output Short Circuit Current	V <sub>CC</sub> = Max., V <sub>OUT</sub> = 0.5V <sup>[4]</sup>		-30	-130	mA
I <sub>CC</sub>	Power Supply Current	V <sub>CC</sub> = Max., V <sub>IN</sub> = GND. Outputs Open			180	mA

**Notes:**

1. T<sub>A</sub> is the "instant on" case temperature.
2. These are absolute values with respect to device ground. All overshoots due to system or tester noise are included.
3. I/O pin leakage is the worse case of I<sub>IL</sub> and I<sub>OZL</sub> (or I<sub>IH</sub> and I<sub>OZH</sub>).
4. Not more than one output should be tested at a time. Duration of the short circuit should not be more than one second. V<sub>OUT</sub> = 0.5V has been chosen to avoid test problems caused by tester ground degradation.

**Capacitance<sup>[5]</sup>**

Parameter	Description		Test Conditions	Typical	Unit
C <sub>IN</sub>	Input Capacitance	CP, OE	T <sub>A</sub> = 25°C, f = 1 MHz, V <sub>IN</sub> = 0, V <sub>CC</sub> = 5.0V	8	pF
		I <sub>1</sub> - I <sub>8</sub>		5	pF
C <sub>OUT</sub>	Output Capacitance			8	pF

**AC Test Loads and Waveforms**


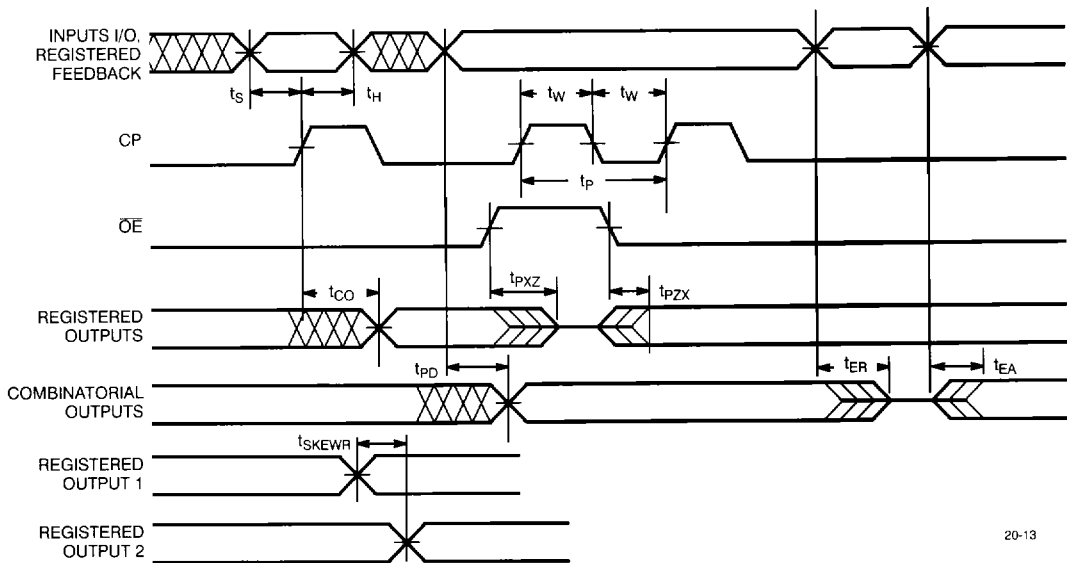
Specification	S <sub>1</sub>	C <sub>L</sub>	Commercial		Military		Measured Output Value
			R <sub>1</sub>	R <sub>2</sub>	R <sub>1</sub>	R <sub>2</sub>	
t <sub>PD</sub> , t <sub>CO</sub>	Closed	50 pF	200Ω	390Ω	390Ω	750Ω	1.5V
t <sub>PZX</sub> , t <sub>EA</sub>	Z ♦ H: Open Z ♦ L: Closed	5 pF	200Ω	390Ω	390Ω	750Ω	1.5V
t <sub>PXZ</sub> , t <sub>ER</sub>	H ♦ Z: Open L ♦ Z: Closed						H ♦ Z: V <sub>OH</sub> - 0.5V L ♦ Z: V <sub>OL</sub> + 0.5V

**Switching Characteristics Over the Operating Range<sup>[6]</sup>**

Parameter	Description	-4		-5		-7		-10		Unit	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
t <sub>PD</sub>	Input or Feedback to Non-Registered Output 16L8, 16R6, 16R4	1	4.5	1	5	2	7	2	10	ns	
t <sub>EA</sub>	Input to Output Enable 16L8, 16R6, 16R4	2	6.5	2	6.5	2	7	2	10	ns	
t <sub>ER</sub>	Input to Output Disable Delay 16L8, 16R6, 16R4	2	5.5	2	5.5	2	7	2	10	ns	
t <sub>PZX</sub>	Pin 11 to Output Enable 16R8, 16R6, 16R4	1	6	1	6	2	7	2	10	ns	
t <sub>PXZ</sub>	Pin 11 to Output Disable 16R8, 16R6, 16R4	1	5	1	5	2	7	2	10	ns	
t <sub>CO</sub>	Clock to Output 16R8, 16R6, 16R4	1	4.5	1	5	2	6	2	7	ns	
t <sub>SKEWR</sub>	Skew Between Registered Outputs 16R8, 16R6, 16R4 <sup>[5]</sup>		0.75		1		1		1	ns	
t <sub>S</sub>	Input or Feedback Set-Up Time 16R8, 16R6, 16R4	2.5		2.5		3.5		4.5		ns	
t <sub>H</sub>	Hold Time 16R8, 16R6, 16R4	0		0		0		0		ns	
t <sub>P</sub>	Clock Period (t <sub>CO</sub> + t <sub>S</sub> )	7		7.5		9.5		11.5		ns	
t <sub>W</sub>	Clock Width	3		3		3.5		5		ns	
f <sub>MAX</sub>	Maximum Frequency	External Feedback (1/t <sub>P</sub> ) <sup>[7]</sup>		142.9		133.3		105.3		87	MHz
		Internal Feedback <sup>[5, 8]</sup>		175		175		150		133	

**Notes:**

- Tested initially and after any design or process changes that may affect these parameters.
- See the last page of this specification for Group A subgroup testing information.
- This specification indicates the guaranteed maximum frequency at which a state machine configuration with external feedback can operate.
- This specification indicates the guaranteed maximum frequency at which a state machine configuration with internal-only feedback can operate.

**Switching Waveforms<sup>(9)</sup>**


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**Note:**

9. Input rise and fall time is 2-ns typical.

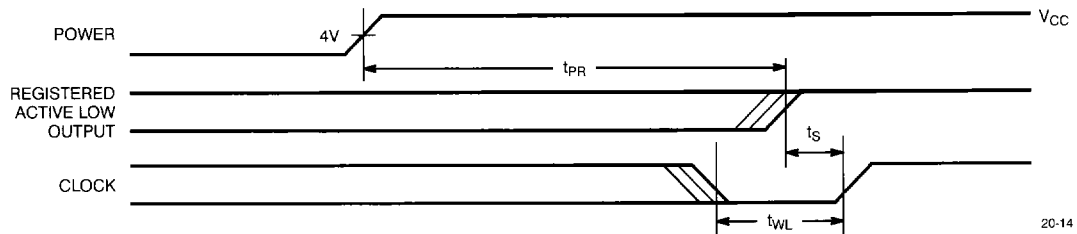
**Power-Up Reset**

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  $V_{CC}$  must be monotonic.
2. Following reset, the clock input must not be driven from LOW to HIGH until all applicable input and feedback set-up times are met.

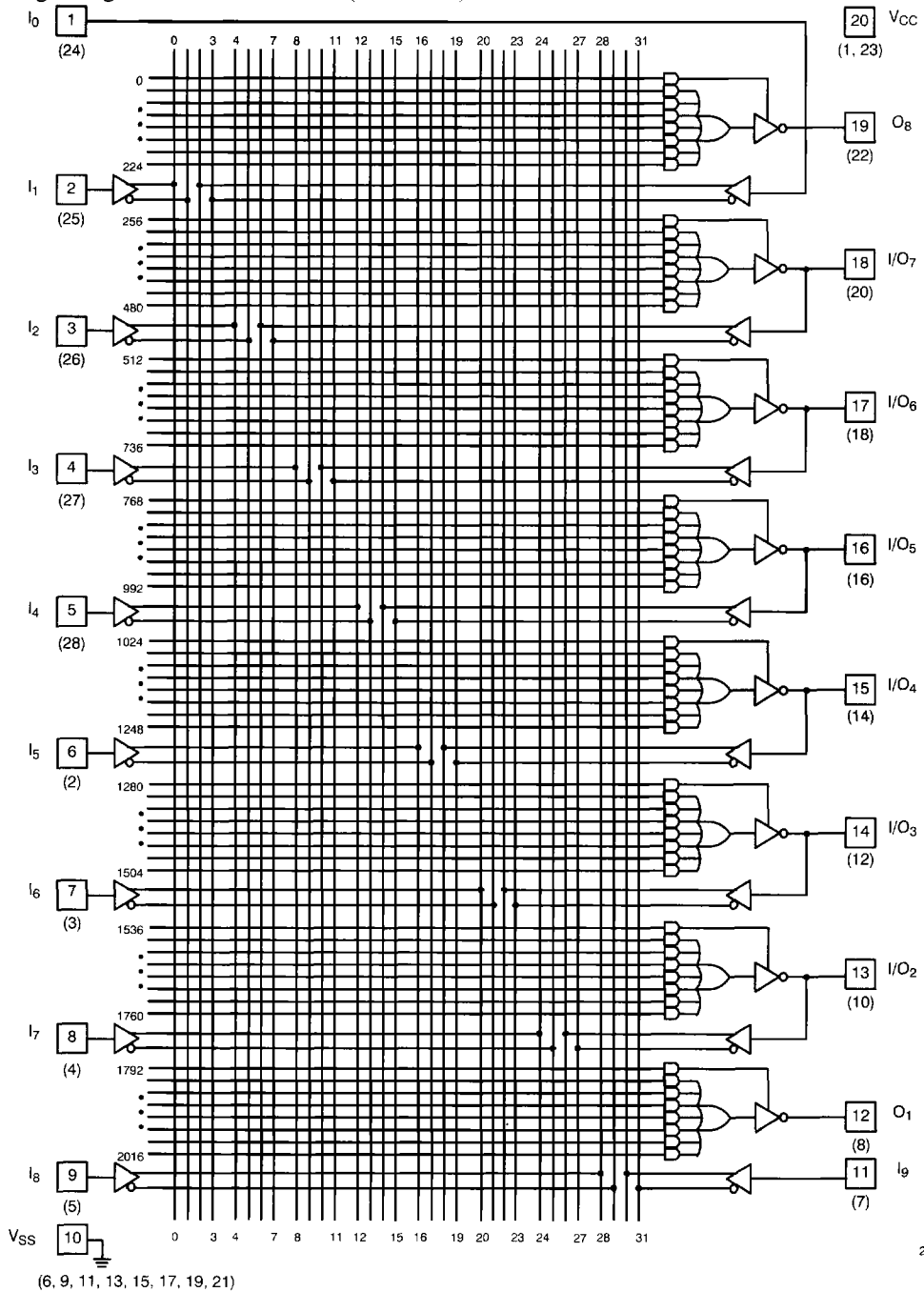
Parameter Symbol	Parameter Description	Max.	Unit
$t_{PR}$	Power-Up Reset Time	1000	ns
$t_s$	Input or Feedback Set-Up Time	See Switching Characteristics	
$t_{WL}$	Clock Width LOW		

**Power-Up Reset Waveform**


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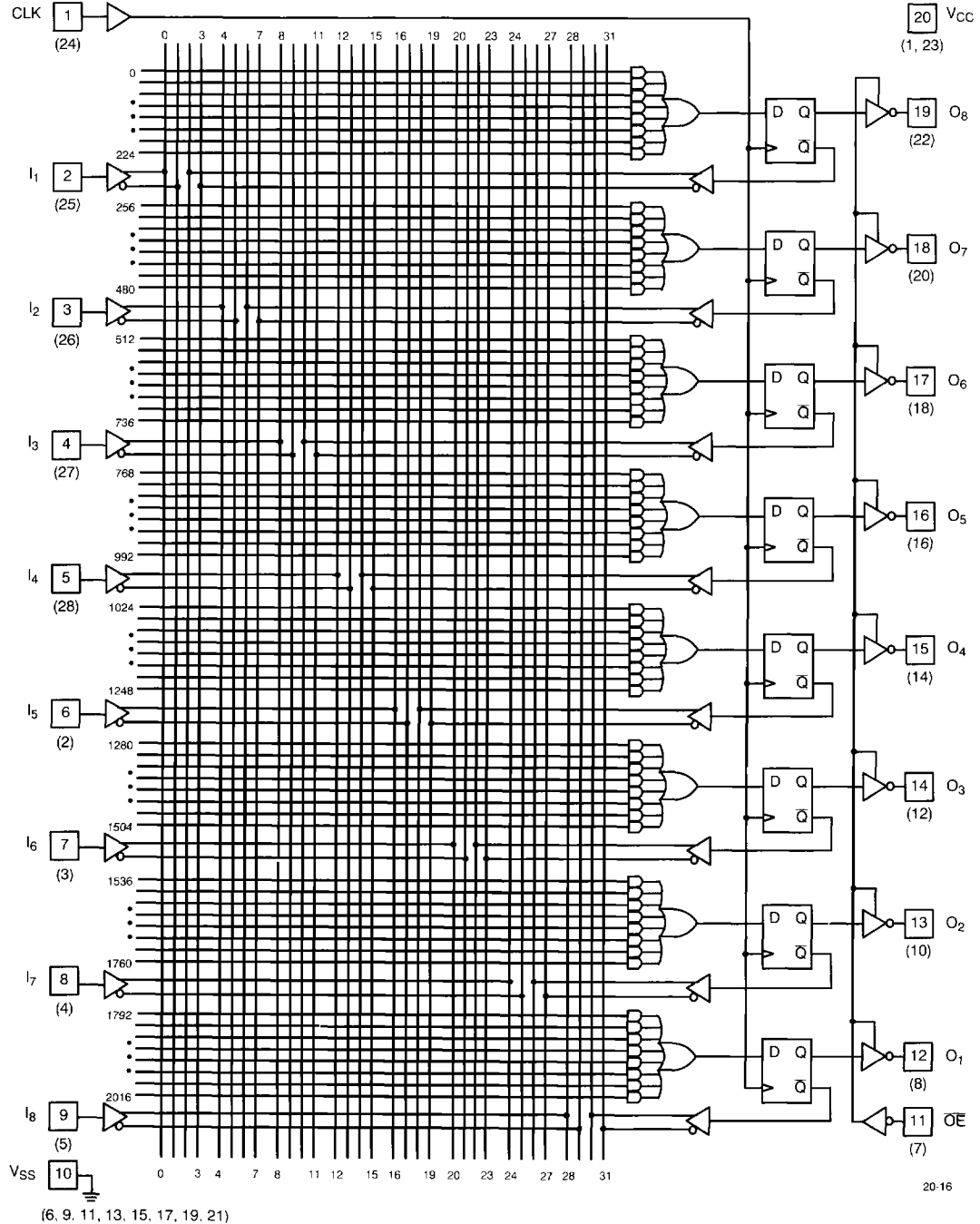
**16L8 Logic Diagram 20-Pin DIP/PLCC/LCC (28-Pin PLCC) Pinouts**



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**16R8 Logic Diagram** 20-Pin DIP/PLCC/LCC (28-Pin PLCC) Pinouts

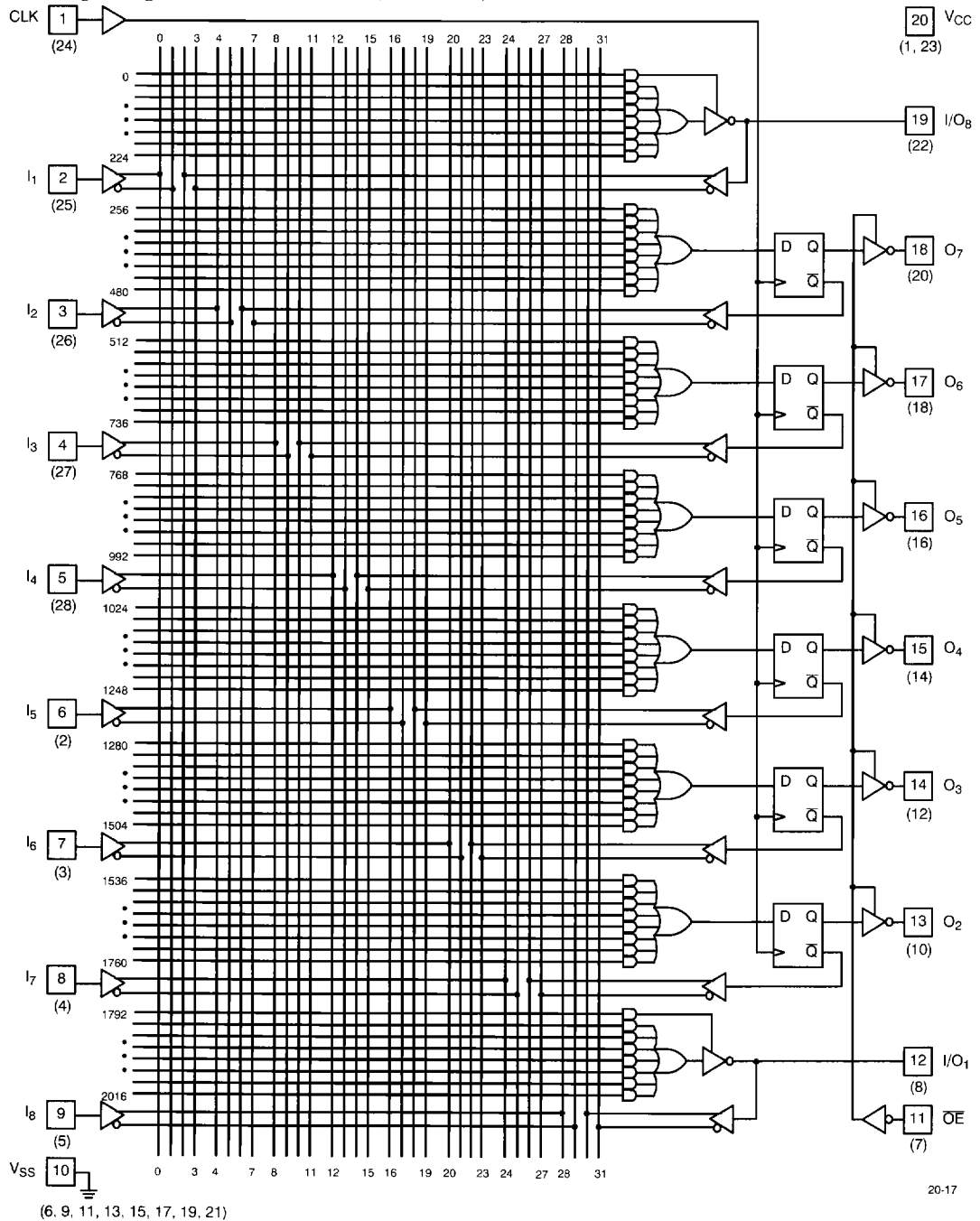


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**PAL20 Series**  
**16L8/16R8**  
**16R6/16R4**

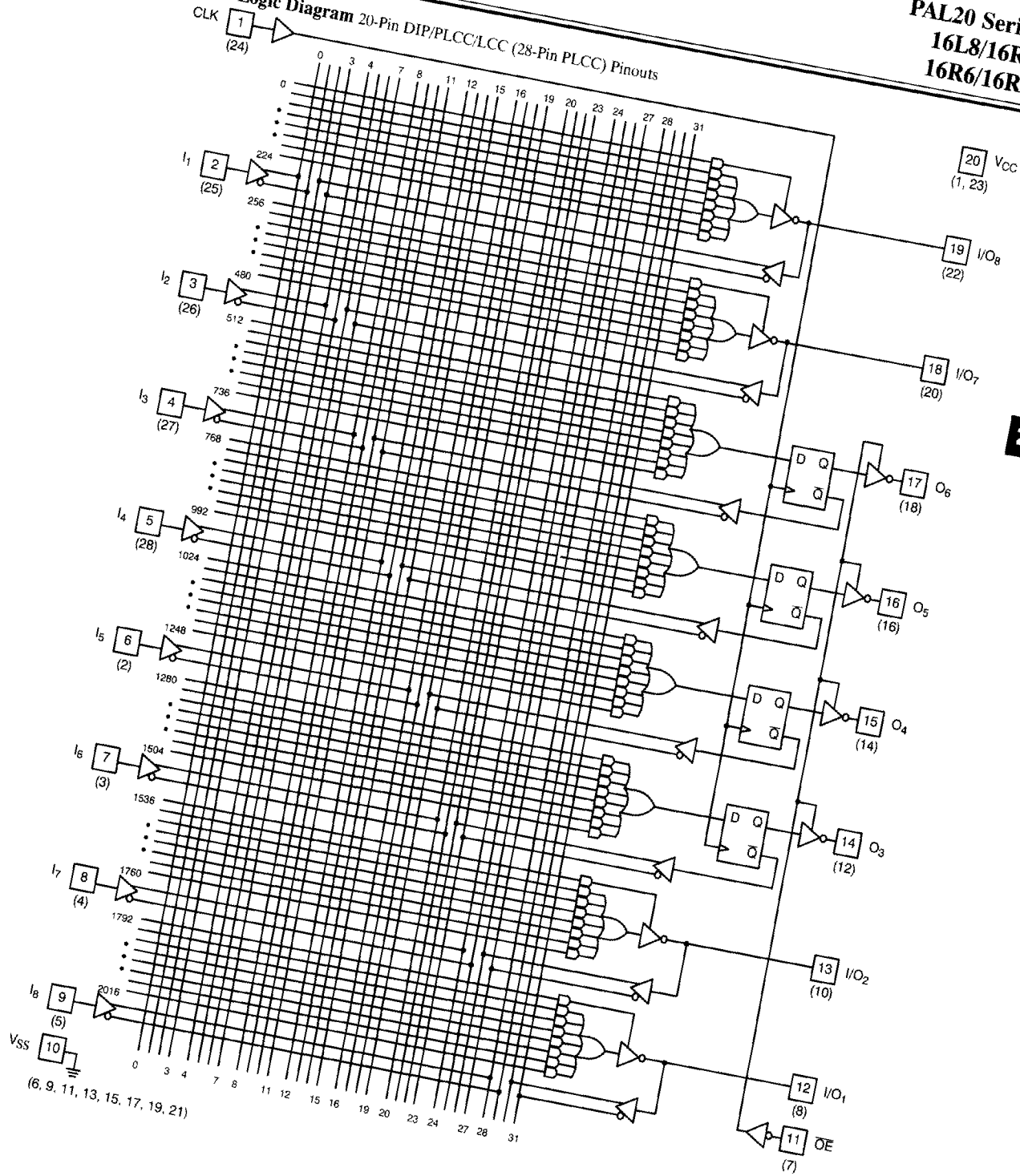
**16R6 Logic Diagram** 20-Pin DIP/PLCC/LCC (28-Pin PLCC) Pinouts





**16R4 Logic Diagram** 20-Pin DIP/PLCC/LCC (28-Pin PLCC) Pinouts

**PAL20 Series**  
**16L8/16R8**  
**16R6/16R4**







**Ordering Information**

I <sub>CC</sub> (mA)	t <sub>PD</sub> (ns)	Ordering Code	Package Name	Package Type	Operating Range	
180	4.5	PAL16L8-4JC	J64	28-Lead Plastic Leaded Chip Carrier	Commercial	
		5	PAL16L8-5DC	D6		20-Lead (300-Mil) CerDIP
			PAL16L8-5JC	J61		20-Lead Plastic Leaded Chip Carrier
			PAL16L8-5PC	P5		20-Lead (300-Mil) Molded DIP
	7	PAL16L8-7DC	D6	20-Lead (300-Mil) CerDIP		
		PAL16L8-7JC	J61	20-Lead Plastic Leaded Chip Carrier		
		PAL16L8-7PC	P5	20-Lead (300-Mil) Molded DIP		
		PAL16L8-7DMB	D6	20-Lead (300-Mil) CerDIP		Military
		PAL16L8-7LMB	L61	20-Pin Square Leadless Chip Carrier		
	10	PAL16L8-10DMB	D6	20-Lead (300-Mil) CerDIP		
		PAL16L8-10LMB	L61	20-Pin Square Leadless Chip Carrier		

I <sub>CC</sub> (mA)	f <sub>MAX</sub> (MHz)	Ordering Code	Package Name	Package Type	Operating Range	
180	142.9	PAL16R8-4JC	J64	28-Lead Plastic Leaded Chip Carrier	Commercial	
		133.3	PAL16R8-5DC	D6		20-Lead (300-Mil) CerDIP
			PAL16R8-5JC	J61		20-Lead Plastic Leaded Chip Carrier
			PAL16R8-5PC	P5		20-Lead (300-Mil) Molded DIP
	105.3	PAL16R8-7DC	D6	20-Lead (300-Mil) CerDIP		
		PAL16R8-7JC	J61	20-Lead Plastic Leaded Chip Carrier		
		PAL16R8-7PC	P5	20-Lead (300-Mil) Molded DIP		
		PAL16R8-7DMB	D6	20-Lead (300-Mil) CerDIP		Military
		PAL16R8-7LMB	L61	20-Pin Square Leadless Chip Carrier		
	87	PAL16R8-10DMB	D6	20-Lead (300-Mil) CerDIP		
		PAL16R8-10LMB	L61	20-Pin Square Leadless Chip Carrier		

I <sub>CC</sub> (mA)	t <sub>PD</sub> (ns)	f <sub>MAX</sub> (MHz)	Ordering Code	Package Name	Package Type	Operating Range		
180	4.5	142.9	PAL16R6-4JC	J64	28-Lead Plastic Leaded Chip Carrier	Commercial		
			5	133.3	PAL16R6-5DC		D6	20-Lead (300-Mil) CerDIP
					PAL16R6-5JC		J61	20-Lead Plastic Leaded Chip Carrier
					PAL16R6-5PC		P5	20-Lead (300-Mil) Molded DIP
	7	105.3	PAL16R6-7DC	D6	20-Lead (300-Mil) CerDIP			
			PAL16R6-7JC	J61	20-Lead Plastic Leaded Chip Carrier			
			PAL16R6-7PC	P5	20-Lead (300-Mil) Molded DIP			
			PAL16R6-7DMB	D6	20-Lead (300-Mil) CerDIP		Military	
			PAL16R6-7LMB	L61	20-Pin Square Leadless Chip Carrier			
	10	87	PAL16R6-10DMB	D6	20-Lead (300-Mil) CerDIP			
			PAL16R6-10LMB	L61	20-Pin Square Leadless Chip Carrier			



**Ordering Information** (continued)

I <sub>CC</sub> (mA)	t <sub>PD</sub> (ns)	f <sub>MAX</sub> (MHz)	Ordering Code	Package Name	Package Type	Operating Range	
180	4.5	142.9	PAL16R4-4JC	J64	28-Lead Plastic Leaded Chip Carrier	Commercial	
			PAL16R4-5DC	D6	20-Lead (300-Mil) CerDIP		
				PAL16R4-5JC	J61		20-Lead Plastic Leaded Chip Carrier
	PAL16R4-5PC	P5		20-Lead (300-Mil) Molded DIP			
	7	105.5	PAL16R4-7DC	D6	20-Lead (300-Mil) CerDIP		Military
			PAL16R4-7JC	J61	20-Lead Plastic Leaded Chip Carrier		
			PAL16R4-7PC	P5	20-Lead (300-Mil) Molded DIP		
			PAL16R4-7DMB	D6	20-Lead (300-Mil) CerDIP		
	10	87	PAL16R4-7LMB	L61	20-Pin Square Leadless Chip Carrier	Military	
			PAL16R4-10DMB	D6	20-Lead (300-Mil) CerDIP		
PAL16R4-10LMB			L61	20-Pin Square Leadless Chip Carrier			

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**MILITARY SPECIFICATIONS**

**Group A Subgroup Testing**

**DC Characteristics**

Parameters	Subgroups
V <sub>OH</sub>	1, 2, 3
V <sub>OL</sub>	1, 2, 3
V <sub>IH</sub>	1, 2, 3
V <sub>IL</sub>	1, 2, 3
I <sub>IX</sub>	1, 2, 3
V <sub>PP</sub>	1, 2, 3
I <sub>CC</sub>	1, 2, 3
I <sub>OZ</sub>	1, 2, 3

**Switching Characteristics**

Parameters	Subgroups
t <sub>PD</sub>	9, 10, 11
t <sub>PZX</sub>	9, 10, 11
t <sub>CO</sub>	9, 10, 11
t <sub>S</sub>	9, 10, 11
t <sub>H</sub>	9, 10, 11

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