

TIBPAL 16L8-15C, TIBPAL 16R4-15C, TIBPAL 16R6-15C, TIBPAL 16R8-15C  
TIBPAL 16L8-20M, TIBPAL 16R4-20M, TIBPAL 16R6-20M, TIBPAL 16R8-20M  
HIGH-PERFORMANCE **IMPACT™** PAL® CIRCUITS

SRPS019A – FEBRUARY 1984 – REVISED APRIL 2000

- **High-Performance Operation:**  
**Propagation Delay**  
C Suffix . . . 15 ns Max  
M Suffix . . . 20 ns Max
- **Functionally Equivalent, but Faster Than**  
**PAL16L8A, PAL16R4A, PAL16R6A, and**  
**PAL16R8A**
- **Power-Up Clear on Registered Devices (All**  
**Register Outputs Are Set High, but Voltage**  
**Levels at the Output Pins Go Low)**
- **Package Options Include Both Plastic and**  
**Ceramic Chip Carriers in Addition to**  
**Plastic and Ceramic DIPs**
- **Dependable Texas Instruments Quality and**  
**Reliability**

DEVICE	I INPUTS	3-STATE O OUTPUTS	REGISTERED Q OUTPUTS	I/O PORTS
PAL16L8	10	2	0	6
PAL16R4	8	0	4 (3-state buffers)	4
PAL16R6	8	0	6 (3-state buffers)	2
PAL16R8	8	0	8 (3-state buffers)	0

## description

These programmable array logic devices feature high speed and functional equivalency when compared with currently available devices. These IMPACT™ circuits combine the latest Advanced Low-Power Schottky technology with proven titanium-tungsten fuses to provide reliable, high-performance substitutes for conventional TTL logic. Their easy programmability allows for quick design of custom functions and typically results in a more compact circuit board. In addition, chip carriers are available for further reduction in board space.

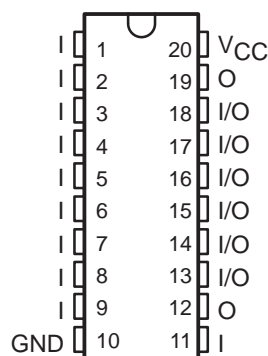
The TIBPAL16' C series is characterized from 0°C to 75°C. The TIBPAL16' M series is characterized for operation over the full military temperature range of -55°C to 125°C.



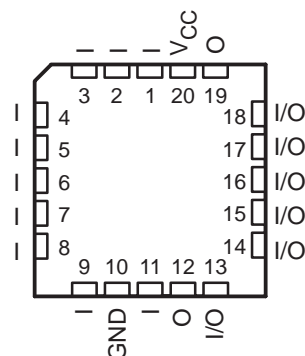
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These devices are covered by U.S. Patent 4,410,987.  
IMPACT is a trademark of Texas Instruments.  
PAL is a registered trademark of Advanced Micro Devices Inc.

TIBPAL16L8'  
C SUFFIX . . . J OR N PACKAGE  
M SUFFIX . . . J OR W PACKAGE  
(TOP VIEW)



TIBPAL16L8'  
C SUFFIX . . . FN PACKAGE  
M SUFFIX . . . FK PACKAGE  
(TOP VIEW)



PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



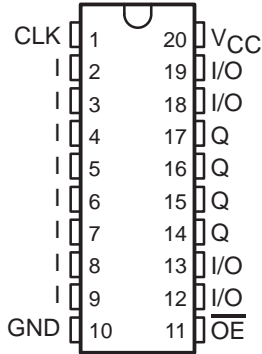
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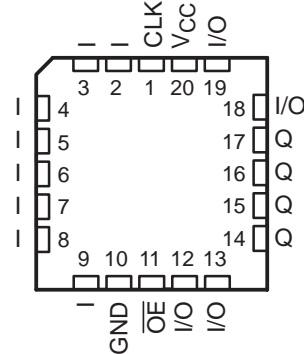
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 TIBPAL 16R4-20M, TIBPAL 16R6-20M, TIBPAL 16R8-20M  
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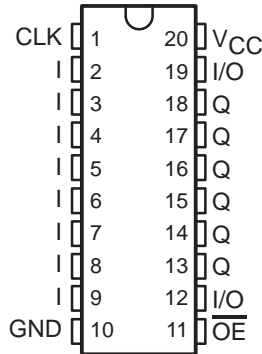
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 M SUFFIX ... J OR W PACKAGE  
 (TOP VIEW)



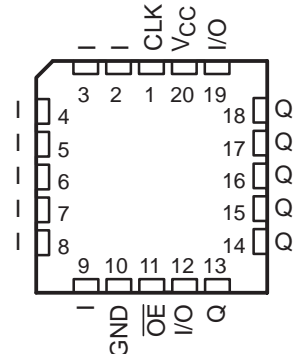
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 M SUFFIX ... FK PACKAGE  
 (TOP VIEW)



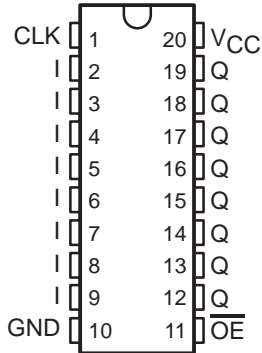
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 M SUFFIX ... J OR W PACKAGE  
 (TOP VIEW)



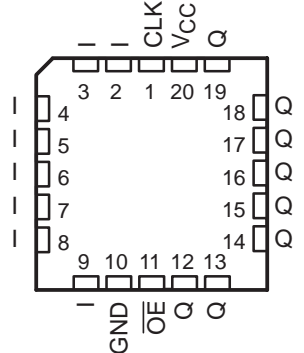
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 M SUFFIX ... FK PACKAGE  
 (TOP VIEW)



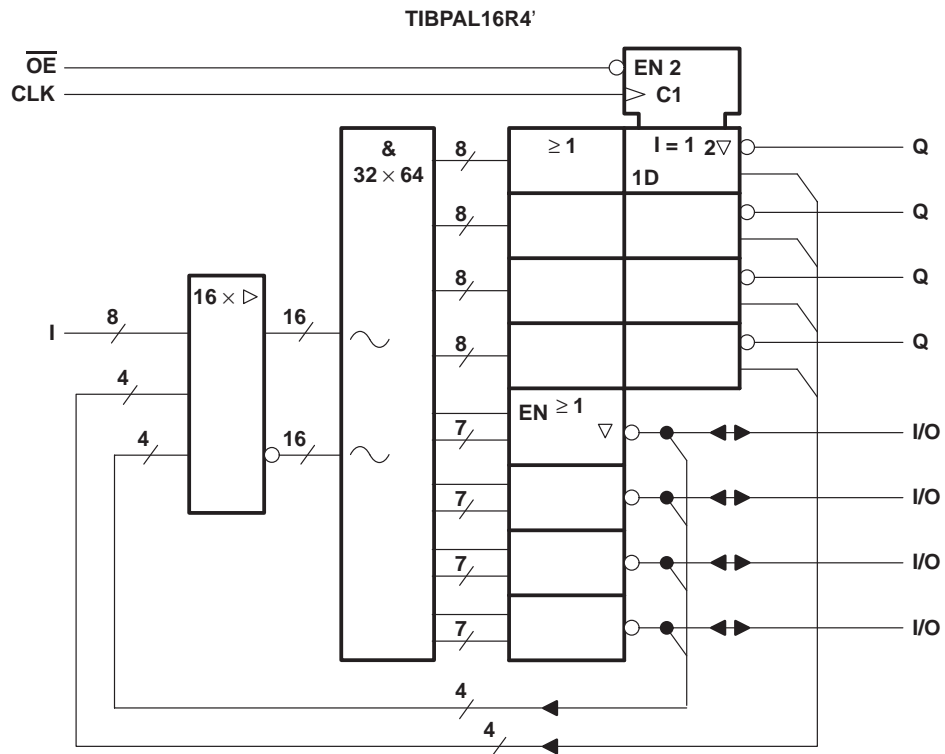
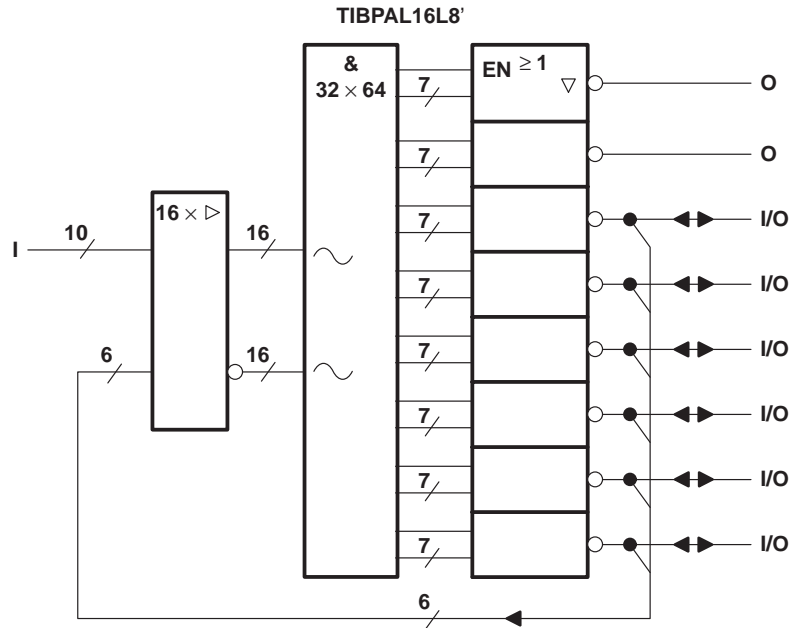
**TIBPAL16R8'**  
 C SUFFIX ... J OR N PACKAGE  
 M SUFFIX ... J OR W PACKAGE  
 (TOP VIEW)



**TIBPAL16R8'**  
 C SUFFIX ... FN PACKAGE  
 M SUFFIX ... FK PACKAGE  
 (TOP VIEW)



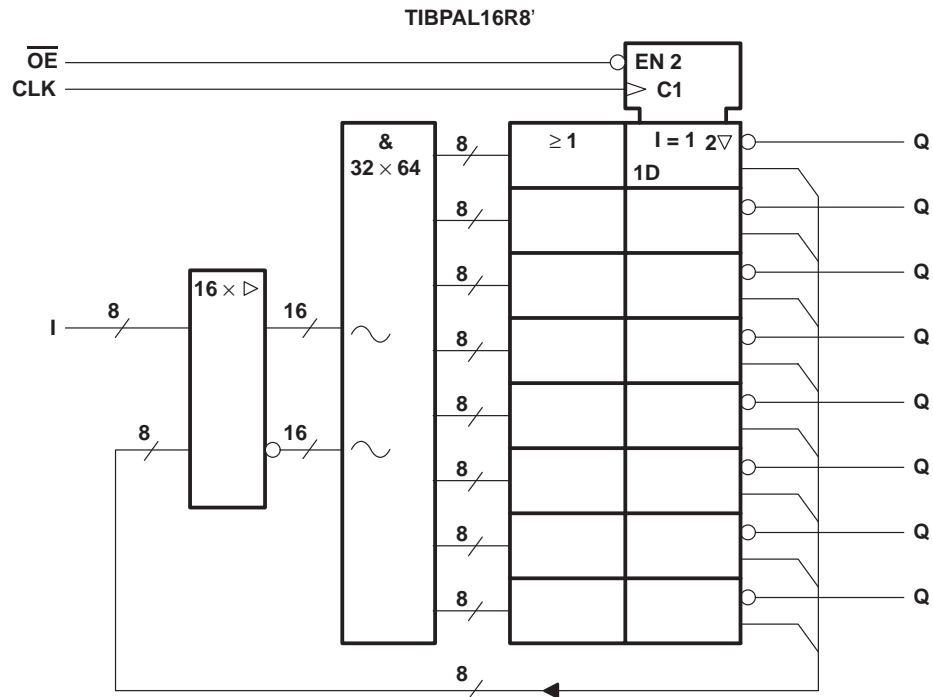
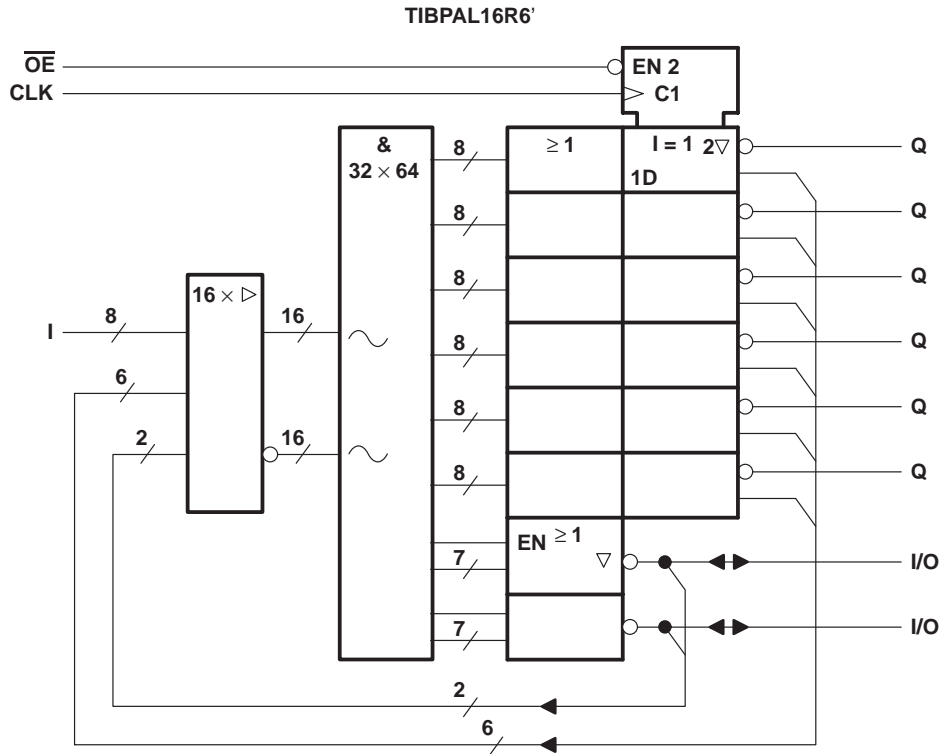
functional block diagrams (positive logic)



~ denotes fused inputs

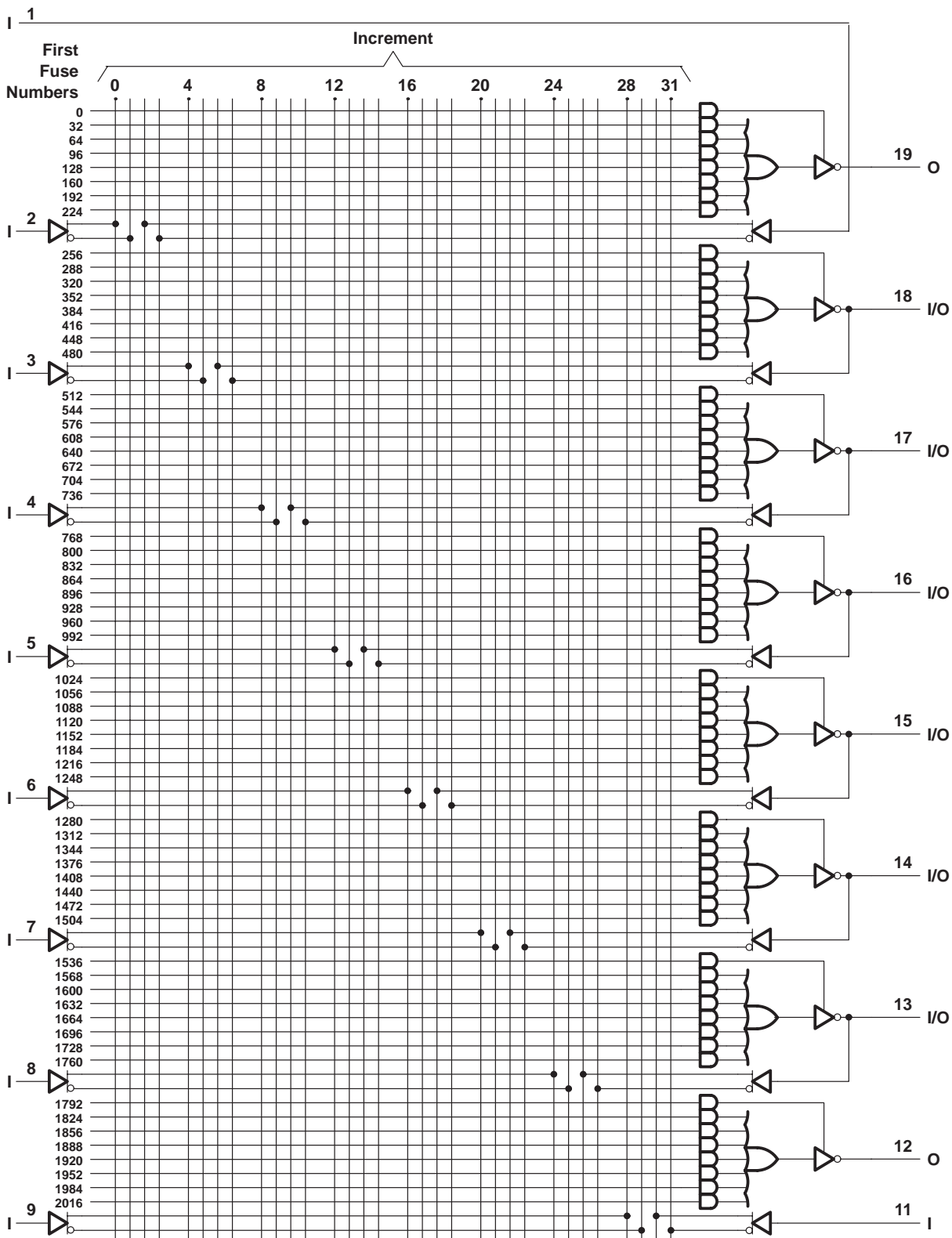
TIBPAL 16R6-15C, TIBPAL 16R8-15C  
 TIBPAL 16R6-20M, TIBPAL 16R8-20M  
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functional block diagrams (positive logic)



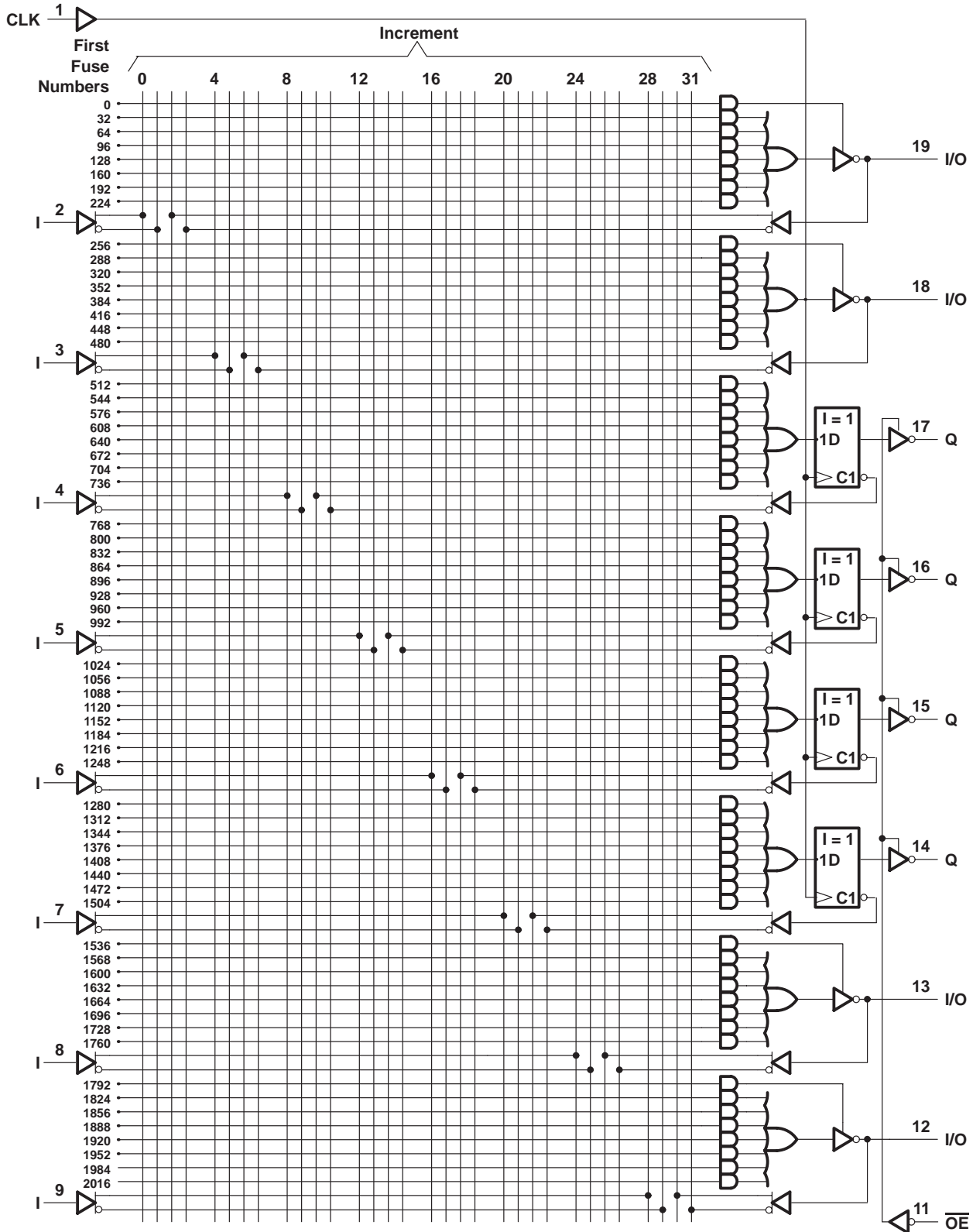
~ denotes fused inputs

logic diagram (positive logic)



Fuse number = First fuse number + Increment

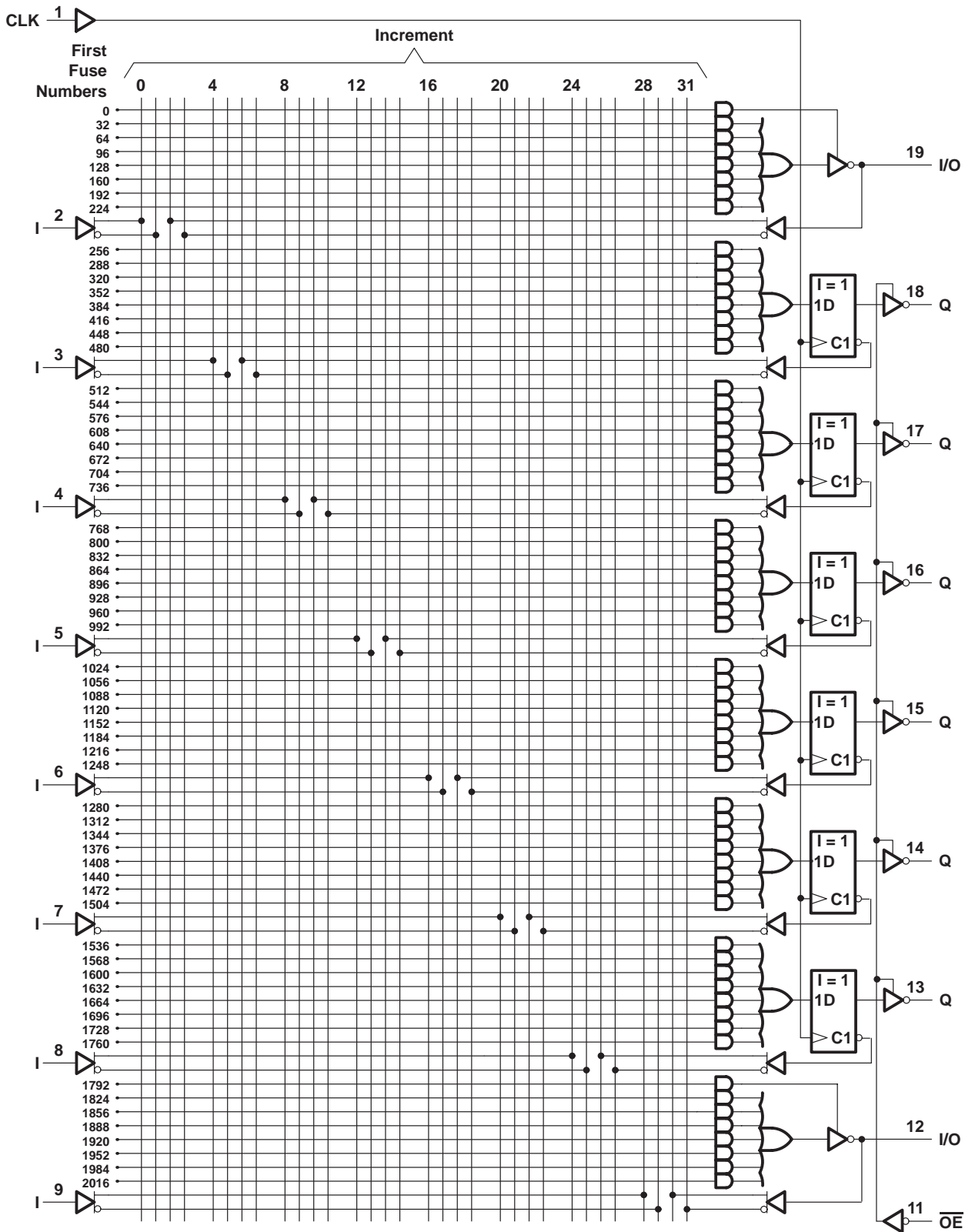
logic diagram (positive logic)



Fuse number = First fuse number + Increment

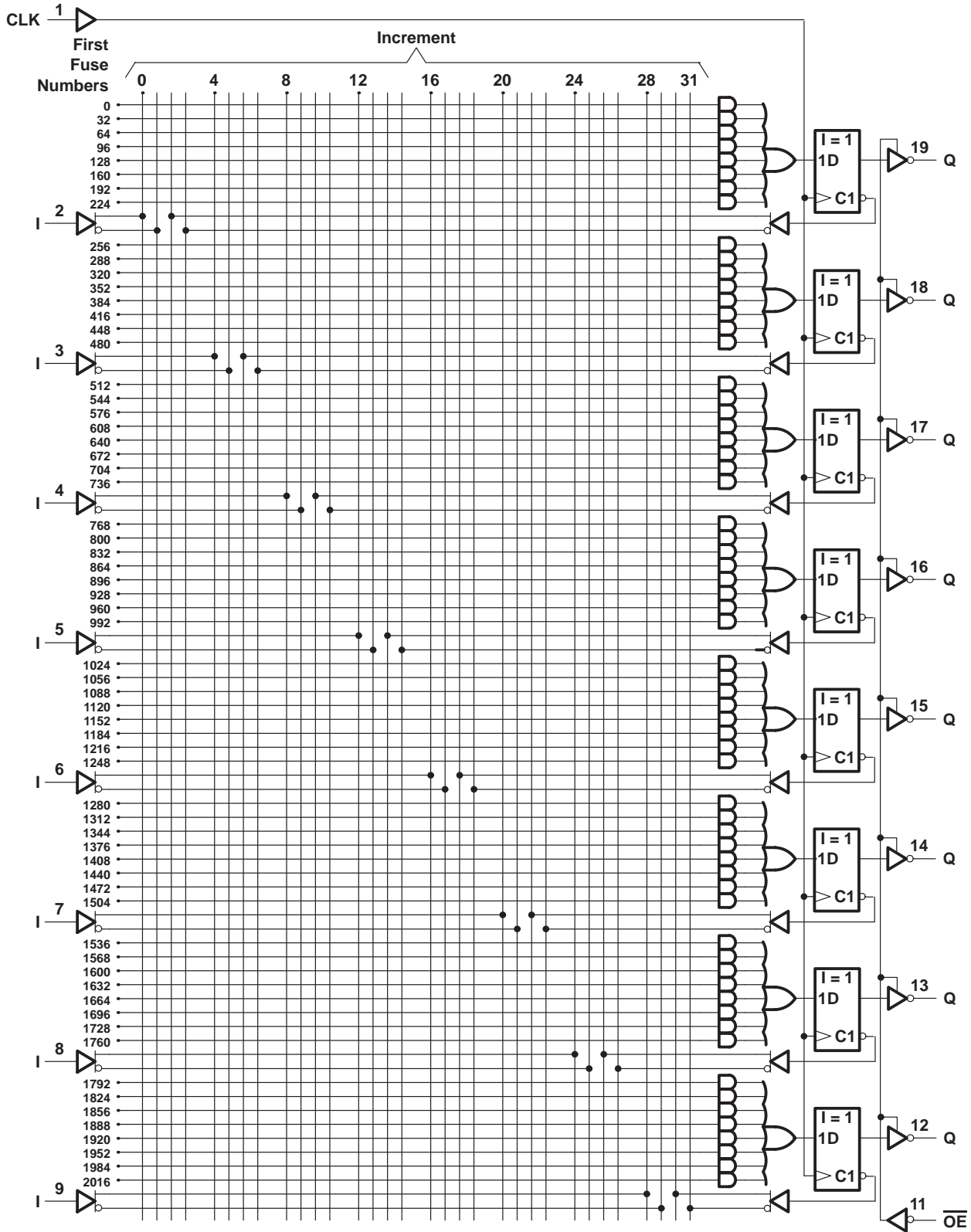


logic diagram (positive logic)



Fuse number = First fuse number + Increment

logic diagram (positive logic)



Fuse number = First fuse number + Increment





# TIBPAL 16L8-15C, TIBPAL 16R4-15C, TIBPAL 16R6-15C, TIBPAL 16R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1) .....	7 V
Input voltage (see Note 1) .....	5.5 V
Voltage applied to disabled output (see Note 1) .....	5.5 V
Operating free-air temperature range .....	0°C to 75°C
Storage temperature range, $T_{stg}$ .....	–65°C to 150°C

NOTE 1: These ratings apply, except for programming pins, during a programming cycle.

## recommended operating conditions

		MIN	NOM	MAX	UNIT
$V_{CC}$	Supply voltage	4.75	5	5.25	V
$V_{IH}$	High-level input voltage	2		5.5	V
$V_{IL}$	Low-level input voltage			0.8	V
$I_{OH}$	High-level output current			–3.2	mA
$I_{OL}$	Low-level output current			24	mA
$f_{clock}$	Clock frequency	0		50	MHz
$t_w$	Pulse duration, clock (see Note 2)	High	8		ns
		Low	9		
$t_{su}$	Setup time, input or feedback before clock↑	15			ns
$t_h$	Hold time, input or feedback after clock↑	0			ns
$T_A$	Operating free-air temperature	0	25	75	°C

NOTE 2: The total clock period of clock high and clock low must not exceed clock frequency,  $f_{clock}$ . The minimum pulse durations specified are for clock high or low only, but not for both simultaneously.



# TIBPAL 16L8-15C, TIBPAL 16R4-15C, TIBPAL 16R6-15C, TIBPAL 16R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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## electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>		V <sub>CC</sub> = 4.75 V,	I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>		V <sub>CC</sub> = 4.75 V,	I <sub>OH</sub> = -3.2 mA	2.4	3.3		V
V <sub>OL</sub>		V <sub>CC</sub> = 4.75 V,	I <sub>OL</sub> = 24 mA		0.35	0.5	V
I <sub>OZH</sub>	Outputs	V <sub>CC</sub> = 5.25 V,	V <sub>O</sub> = 2.7 V			20	μA
	I/O ports					100	
I <sub>OZL</sub>	Outputs	V <sub>CC</sub> = 5.25 V,	V <sub>O</sub> = 0.4 V			-20	μA
	I/O ports					-250	
I <sub>I</sub>		V <sub>CC</sub> = 5.25 V,	V <sub>I</sub> = 5.5 V			0.1	mA
I <sub>IH</sub>		V <sub>CC</sub> = 5.25 V,	V <sub>I</sub> = 2.7 V			20	μA
I <sub>IL</sub>		V <sub>CC</sub> = 5.25 V,	V <sub>I</sub> = 0.4 V			-0.2	mA
I <sub>O‡</sub>		V <sub>CC</sub> = 5.25 V,	V <sub>O</sub> = 2.25 V	-30		-125	mA
I <sub>CC</sub>		V <sub>CC</sub> = 5.25 V,	V <sub>I</sub> = 0,                      Outputs open		140	180	mA

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ The output conditions have been chosen to produce a current that closely approximates one-half of the short-circuit output current, I<sub>OS</sub>.

## switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
f <sub>max</sub>			R1 = 500 Ω, R2 = 500 Ω, See Figure 3	50			MHz
t <sub>pd</sub>	I, I/O	O, I/O		10	15		ns
t <sub>pd</sub>	CLK↑	Q		8	12		ns
t <sub>en</sub>	OE↓	Q		8	12		ns
t <sub>dis</sub>	OE↑	Q		7	10		ns
t <sub>en</sub>	I, I/O	O, I/O		10	15		ns
t <sub>dis</sub>	I, I/O	O, I/O		10	15		ns

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.



# TIBPAL 16L8-20M, TIBPAL 16R4-20M, TIBPAL 16R6-20M, TIBPAL 16R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1) .....	7 V
Input voltage (see Note 1) .....	5.5 V
Voltage applied to disabled output (see Note 1) .....	5.5 V
Operating free-air temperature range .....	–55°C to 125°C
Storage temperature range, $T_{stg}$ .....	–65°C to 150°C

NOTE 1: These ratings apply, except for programming pins, during a programming cycle.

## recommended operating conditions

		MIN	NOM	MAX	UNIT
$V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2		5.5	V
$V_{IL}$	Low-level input voltage			0.8	V
$I_{OH}$	High-level output current			–2	mA
$I_{OL}$	Low-level output current			12	mA
$f_{clock}$	Clock frequency	0		41.6	MHz
$t_w$	Pulse duration, clock (see Note 2)	High	10		ns
		Low	11		
$t_{su}$	Setup time, input or feedback before clock↑	20			ns
$t_h$	Hold time, input or feedback after clock↑	0			ns
$T_A$	Operating free-air temperature	–55	25	125	°C

NOTE 2: The total clock period of clock high and clock low must not exceed clock frequency,  $f_{clock}$ . The minimum pulse durations specified are for clock high or low only, but not for both simultaneously.



# TIBPAL 16L8-20M, TIBPAL 16R4-20M, TIBPAL 16R6-20M, TIBPAL 16R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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## electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>		V <sub>CC</sub> = 4.5 V,	I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>		V <sub>CC</sub> = 4.5 V,	I <sub>OH</sub> = -2 mA	2.4	3.2		V
V <sub>OL</sub>		V <sub>CC</sub> = 4.5 V,	I <sub>OL</sub> = 12 mA		0.25	0.4	V
I <sub>OZH</sub>	Outputs	V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 2.7 V			20	μA
	I/O ports					100	
I <sub>OZL</sub>	Outputs	V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0.4 V			-20	μA
	I/O ports					-250	
I <sub>I</sub>	Pin 1, 11	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 5.5 V			0.2	mA
	All others					0.1	
I <sub>IH</sub>	Pin 1, 11	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 2.7 V			50	μA
	I/O ports					100	
	All others					20	
I <sub>IL</sub>	I/O ports	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 0.4 V			-0.25	mA
	All others					-0.2	
I <sub>OS</sub> ‡		V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0.5 V	-30		-250	mA
I <sub>CC</sub>		V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 0,      Outputs open		140	190	mA

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ Not more than one output should be shorted at a time and the duration of the short circuit should not exceed one second. Set V<sub>O</sub> at 0.5 V to avoid test-equipment degradation.

## switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP†	MAX	UNIT	
f <sub>max</sub>			R1 = 390 Ω, R2 = 750 Ω, See Figure 4	41.6			MHz	
t <sub>pd</sub>	I, I/O	O, I/O				10	20	ns
t <sub>pd</sub>	CLK↑	Q				8	15	ns
t <sub>en</sub>	OE↓	Q				8	15	ns
t <sub>dis</sub>	OE↑	Q				7	15	ns
t <sub>en</sub>	I, I/O	O, I/O				10	20	ns
t <sub>dis</sub>	I, I/O	O, I/O				10	20	ns

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.



## programming information

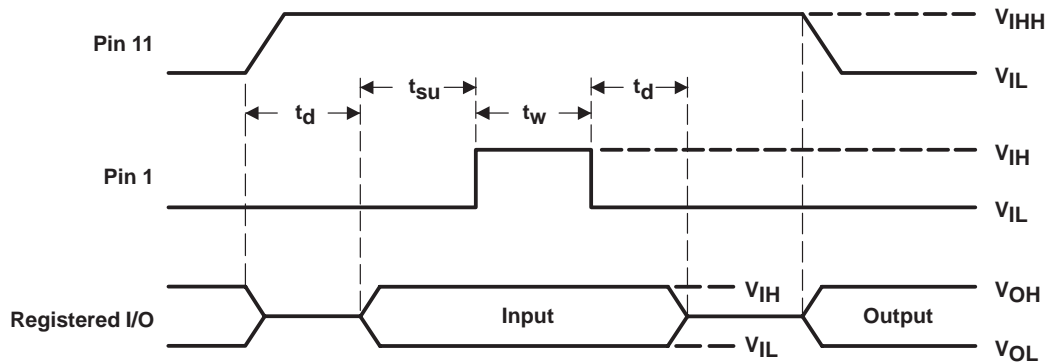
Texas Instruments programmable logic devices can be programmed using widely available software and inexpensive device programmers.

Complete programming specifications, algorithms, and the latest information on hardware, software, and firmware are available upon request. Information on programmers capable of programming Texas Instruments programmable logic also is available, upon request, from the nearest TI field sales office or local authorized TI distributor, by calling Texas Instruments at +1 (972) 644-5580, or by visiting the TI Semiconductor Home Page at [www.ti.com/sc](http://www.ti.com/sc).

## preload procedure for registered outputs (see Figure 1 and Note 3)

The output registers can be preloaded to any desired state during device testing. This permits any state to be tested without having to step through the entire state-machine sequence. Each register is preloaded individually by following the steps given below.

- Step 1. With  $V_{CC}$  at 5 V and Pin 1 at  $V_{IL}$ , raise Pin 11 to  $V_{IHH}$ .
- Step 2. Apply either  $V_{IL}$  or  $V_{IH}$  to the output corresponding to the register to be preloaded.
- Step 3. Pulse Pin 1, clocking in preload data.
- Step 4. Remove output voltage, then lower Pin 11 to  $V_{IL}$ . Preload can be verified by observing the voltage level at the output pin.



NOTE 3:  $t_d = t_{su} = t_h = 100$  ns to 1000 ns  $V_{IHH} = 10.25$  V to 10.75 V

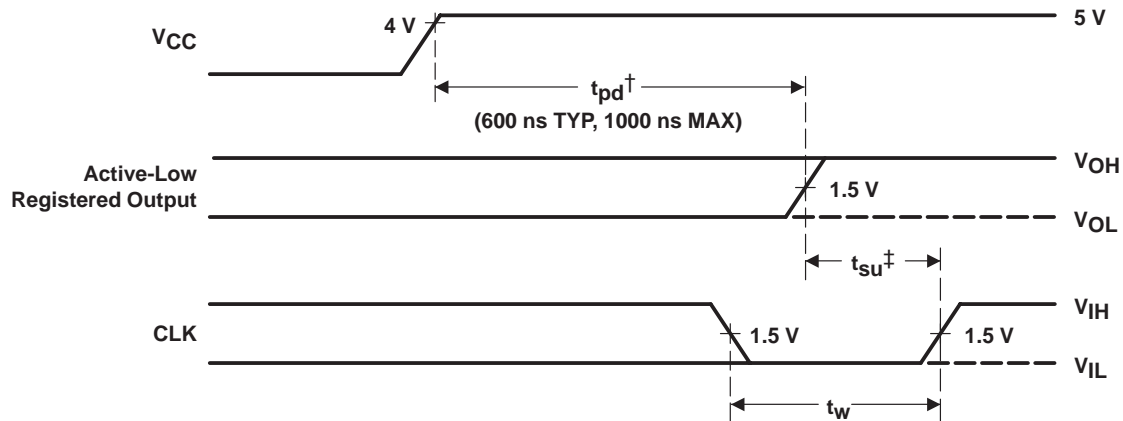
Figure 1. Preload Waveforms

TIBPAL 16L8-15C, TIBPAL 16R4-15C, TIBPAL 16R6-15C, TIBPAL 16R8-15C  
 TIBPAL 16L8-20M, TIBPAL 16R4-20M, TIBPAL 16R6-20M, TIBPAL 16R8-20M  
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**power-up reset (see Figure 2)**

Following power up, all registers are set high. This feature provides extra flexibility to the system designer and is especially valuable in simplifying state-machine initialization. To ensure a valid power-up reset, it is important that the rise of  $V_{CC}$  be monotonic. Following power-up reset, a low-to-high clock transition must not occur until all applicable input and feedback setup times are met.

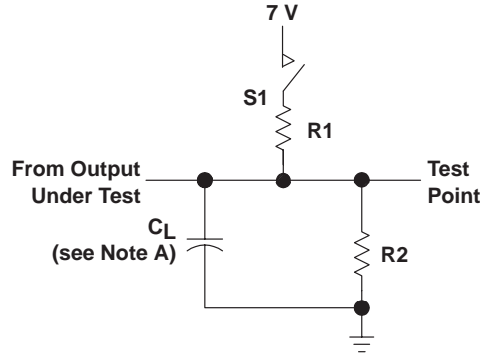


† This is the power-up reset time and applies to registered outputs only. The values shown are from characterization data.

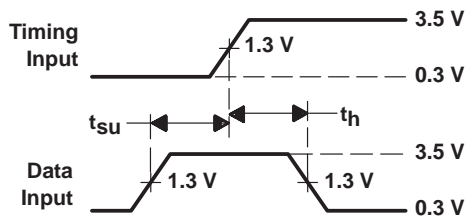
‡ This is the setup time for input or feedback.

**Figure 2. Power-Up Reset Waveforms**

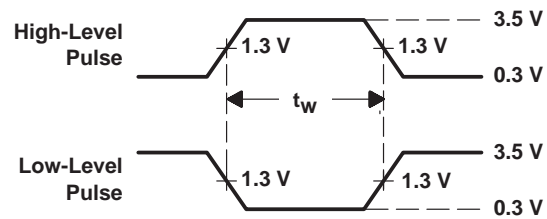
PARAMETER MEASUREMENT INFORMATION



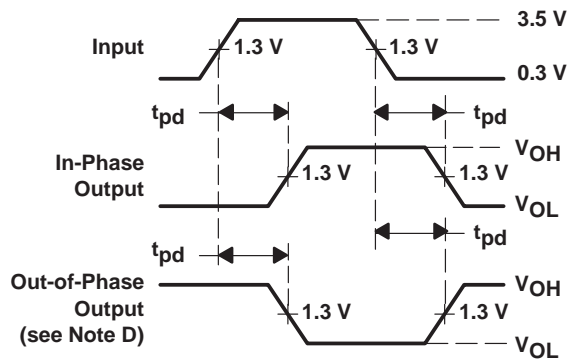
LOAD CIRCUIT FOR 3-STATE OUTPUTS



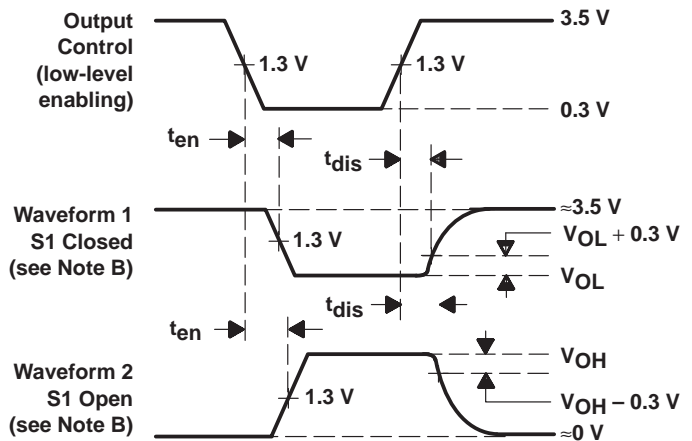
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PULSE DURATIONS



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES

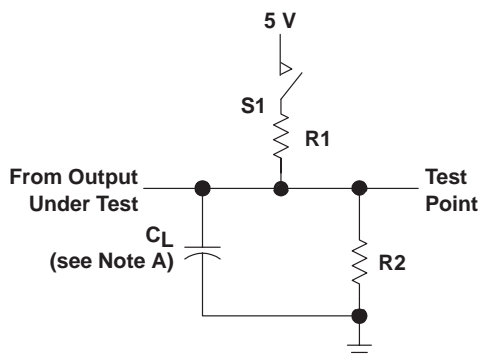


VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

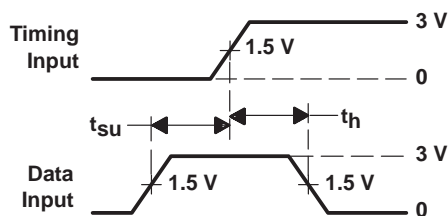
- NOTES: A.  $C_L$  includes probe and jig capacitance and is 50 pF for  $t_{pd}$  and  $t_{en}$ , 5 pF for  $t_{dis}$ .  
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.  
C. All input pulses have the following characteristics:  $PRR \leq 1$  MHz,  $t_r = t_f \leq 2$  ns, duty cycle = 50%.  
D. When measuring propagation delay times of 3-state outputs from low to high, switch S1 is closed. When measuring propagation delay times of 3-state outputs from high to low, switch S1 is open.  
E. Equivalent loads may be used for testing.

Figure 3. Load Circuit and Voltage Waveforms

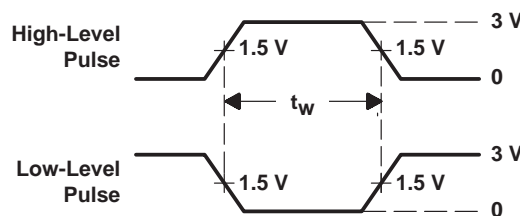
PARAMETER MEASUREMENT INFORMATION



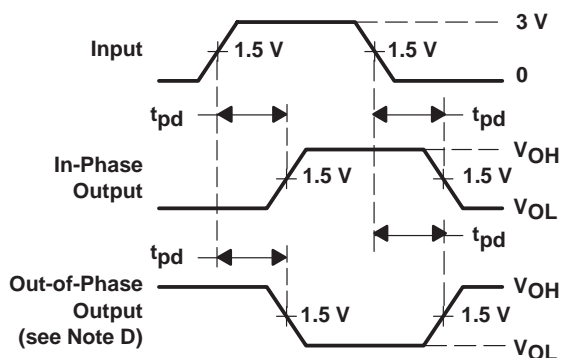
LOAD CIRCUIT FOR 3-STATE OUTPUTS



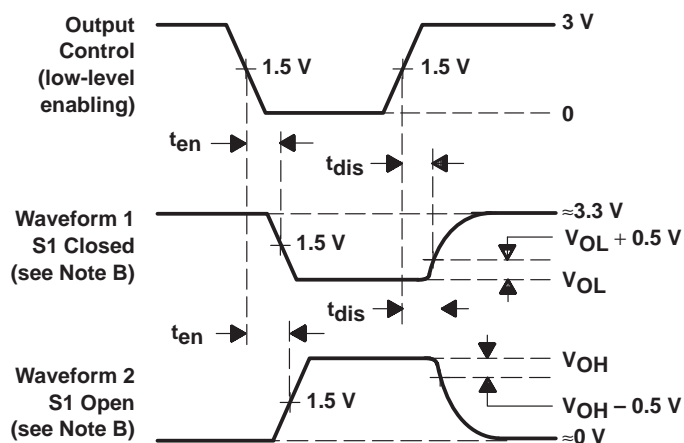
VOLTAGE WAVEFORMS  
 SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
 PULSE DURATIONS



VOLTAGE WAVEFORMS  
 PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
 ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

- NOTES: A.  $C_L$  includes probe and jig capacitance and is 50 pF for  $t_{pd}$  and  $t_{en}$ , 5 pF for  $t_{dis}$ .  
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.  
 C. All input pulses have the following characteristics:  $PRR \leq 10$  MHz,  $t_r = t_f \leq 2$  ns, duty cycle = 50%  
 D. When measuring propagation delay times of 3-state outputs, switch S1 is closed.  
 E. Equivalent loads may be used for testing.

Figure 4. Load Circuit and Voltage Waveforms



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