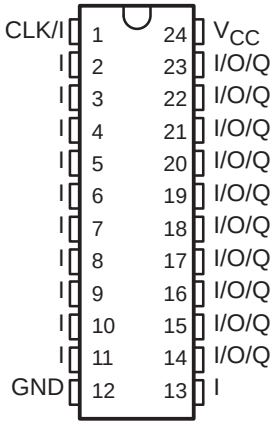
TIBPAL22V10-15BC
HIGH-PERFORMANCE *IMPACT-X* ™ PROGRAMMABLE ARRAY LOGIC CIRCUITS

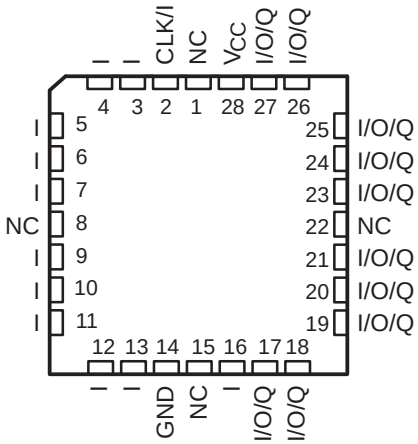
SRPS009A – D3356, OCTOBER 1989 – REVISED JUNE 1990

- **Second-Generation PLD Architecture**
- **High-Performance Operation:**
  f_{max} (External Feedback) . . . 40 MHz
  Propagation Delay . . . 15 ns Max
- **Increased Logic Power – Up to 22 Inputs and 10 Outputs**
- **Increased Product Terms – Average of 12 per Output**
- **Variable Product Term Distribution Allows More Complex Functions to Be Implemented**
- **Each Output Is User Programmable for Registered or Combinational Operation, Polarity, and Output Enable Control**
- **Power-Up Clear on Registered Outputs**
- **TTL-Level Preload for Improved Testability**
- **Extra Terms Provide Logical Synchronous Set and Asynchronous Reset Capability**
- **Fast Programming, High Programming Yield, and Unsurpassed Reliability Ensured Using Ti-W Fuses**
- **AC and DC Testing Done at the Factory Utilizing Special Designed-In Test Features**
- **Dependable Texas Instruments Quality and Reliability**
- **Package Options Include Plastic Dual-In-Line and Chip Carrier Packages**

NT PACKAGE
(TOP VIEW)



FN PACKAGE
(TOP VIEW)



NC – No internal connection
Pin assignments in operating mode

description

The TIBPAL22V10-15BC is a programmable array logic device featuring high speed and functional equivalency when compared to presently available devices. They are implemented with the familiar sum-of-products (AND-OR) logic structure featuring the new concept “Programmable Output Logic Macrocell”. These IMPACT-X™ circuits combine the latest Advanced Low-Power Schottky technology with proven titanium-tungsten fuses to provide reliable, high-performance substitutes for conventional TTL logic.

These devices contain up to 22 inputs and 10 outputs. They incorporate the unique capability of defining and programming the architecture of each output on an individual basis. Outputs may be registered or nonregistered and inverting or noninverting as shown in the output logic macrocell diagram. The ten potential outputs are enabled through the use of individual product terms.

Further advantages can be seen in the introduction of variable product term distribution. This technique allocates from 8 to 16 logical product terms to each output for an average of 12 product terms per output. This variable allocation of terms allows far more complex functions to be implemented than in previously available devices.

This device is covered by U.S. Patent 4,410,987.
IMPACT-X is a trademark of Texas Instruments Incorporated.

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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description (continued)

Circuit design is enhanced by the addition of a synchronous set and an asynchronous reset product term. These functions are common to all registers. When the synchronous set product term is a logic 1, the output registers are loaded with a logic 1 on the next low-to-high clock transition. When the asynchronous reset product term is a logic 1, the output registers are loaded with a logic 0. The output logic level after set or reset depends on the polarity selected during programming. Output registers can be preloaded to any desired state during testing. Preloading permits full logical verification during product testing.

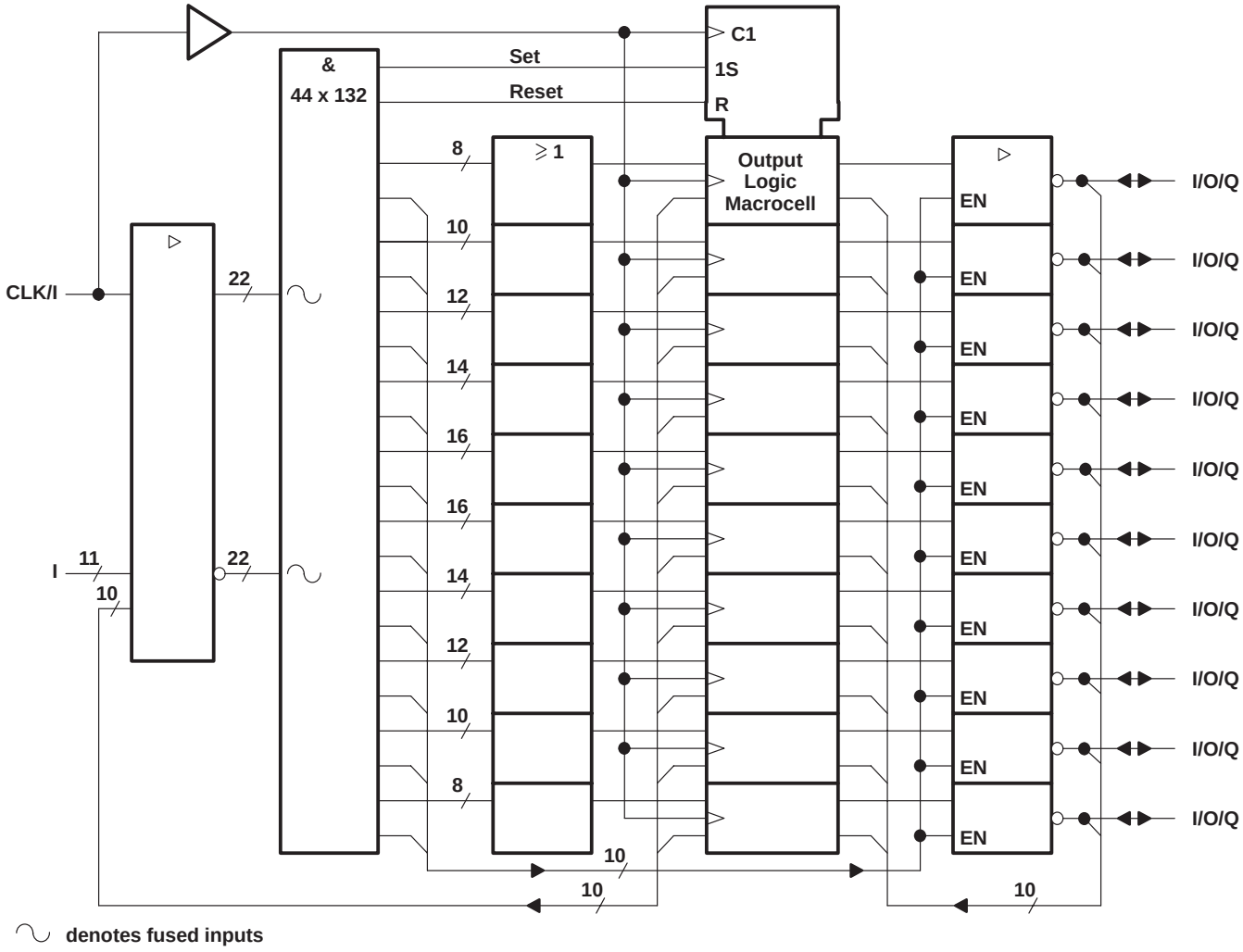
With features such as programmable output logic macrocells and variable product term distribution, the TIBPAL22V10-15BC offers quick design and development of custom LSI functions with complexities of 500 to 800 equivalent gates. Since each of the ten output pins may be individually configured as inputs on either a temporary or permanent basis, functions requiring up to 21 inputs and a single output or down to 12 inputs and 10 outputs are possible.

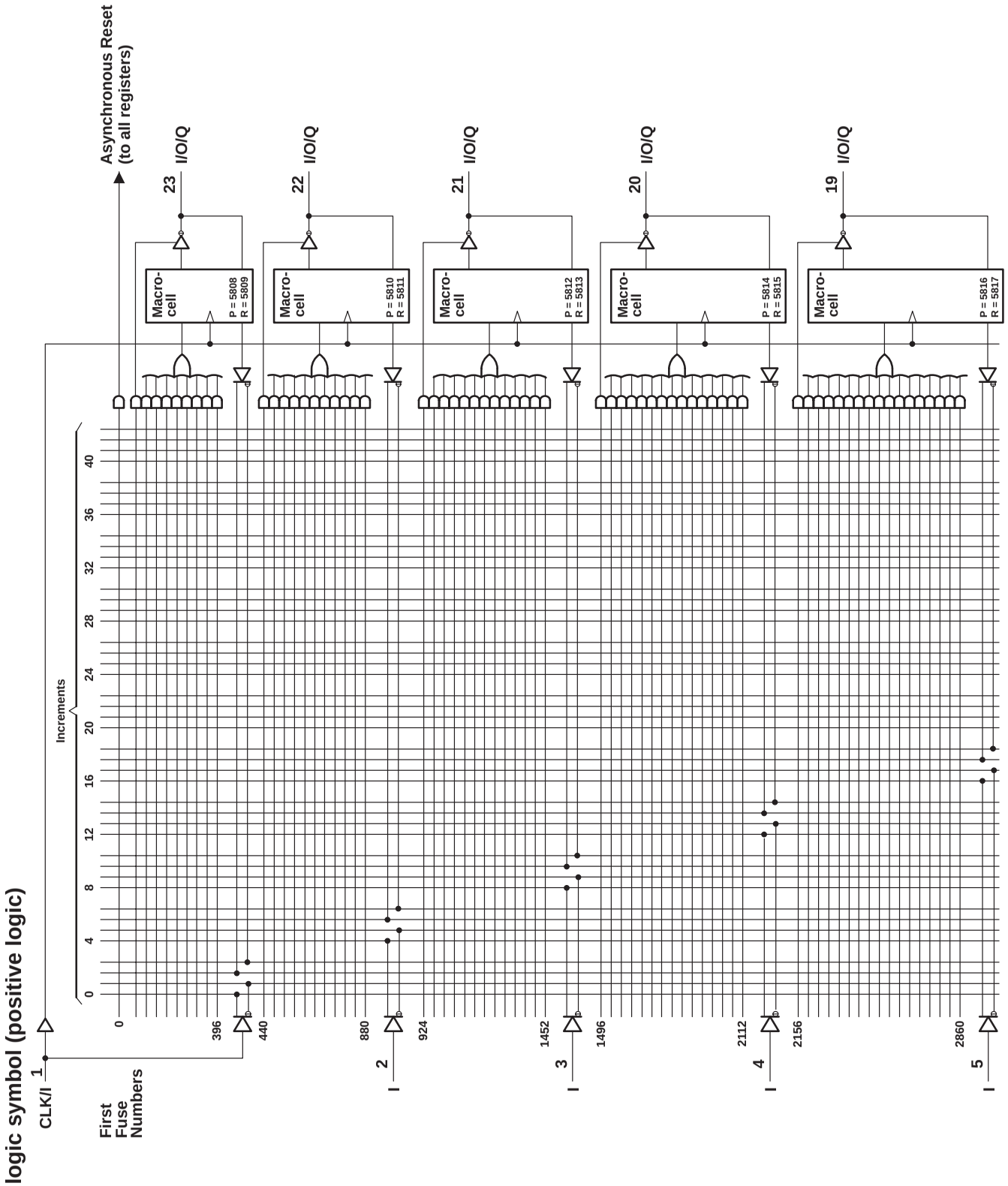
A power-up clear function is supplied that forces all registered outputs to a predetermined state after power is applied to the device. Registered outputs selected as active-low power up with their outputs high. Registered outputs selected as active-high power up with their outputs low.

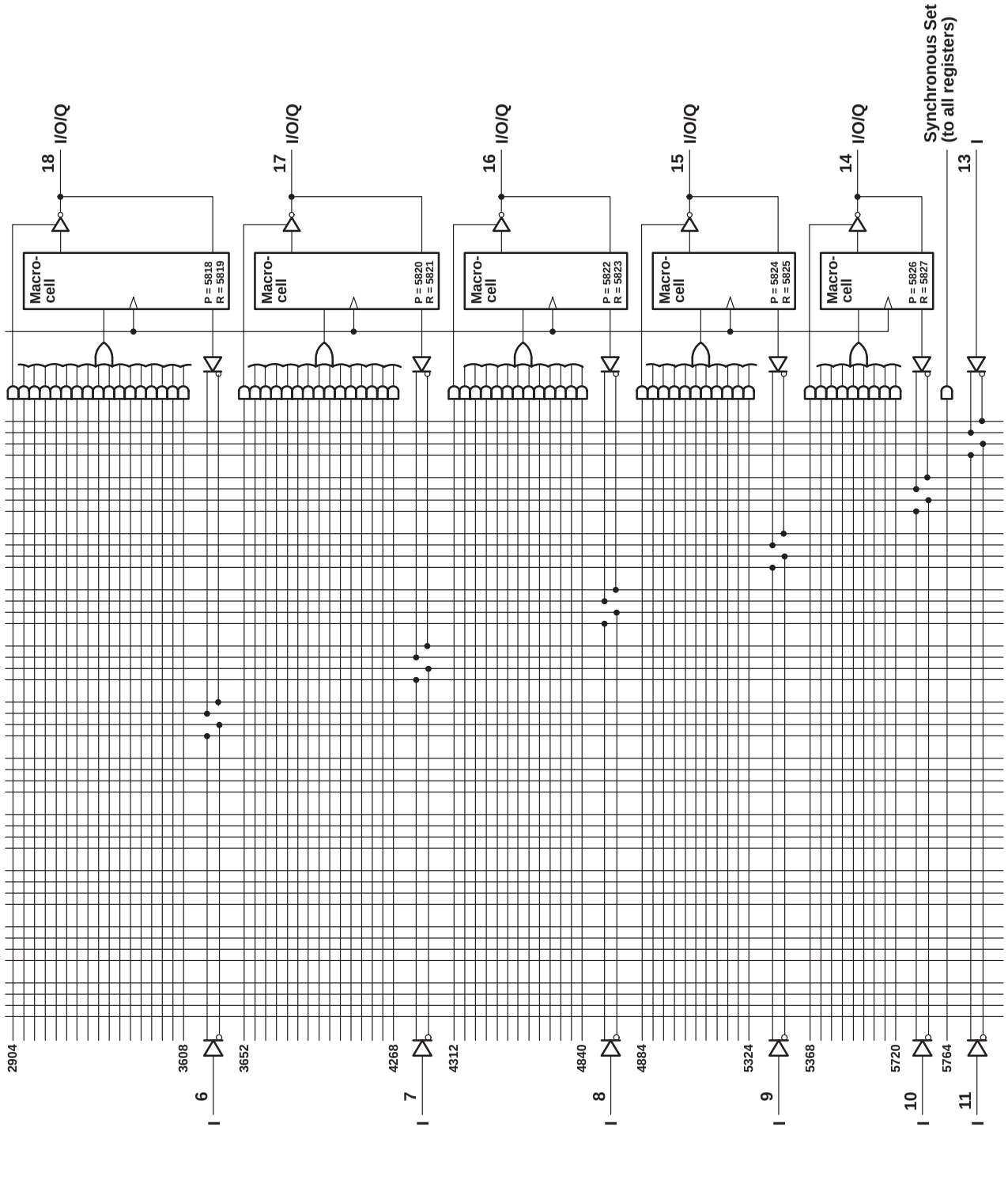
A single security fuse is provided on each device to discourage unauthorized copying of fuse patterns. Once blown, the verification circuitry is disabled and all other fuses will appear to be open.

The TIBPAL22V10-15BC is characterized for operation from 0°C to 75°C.

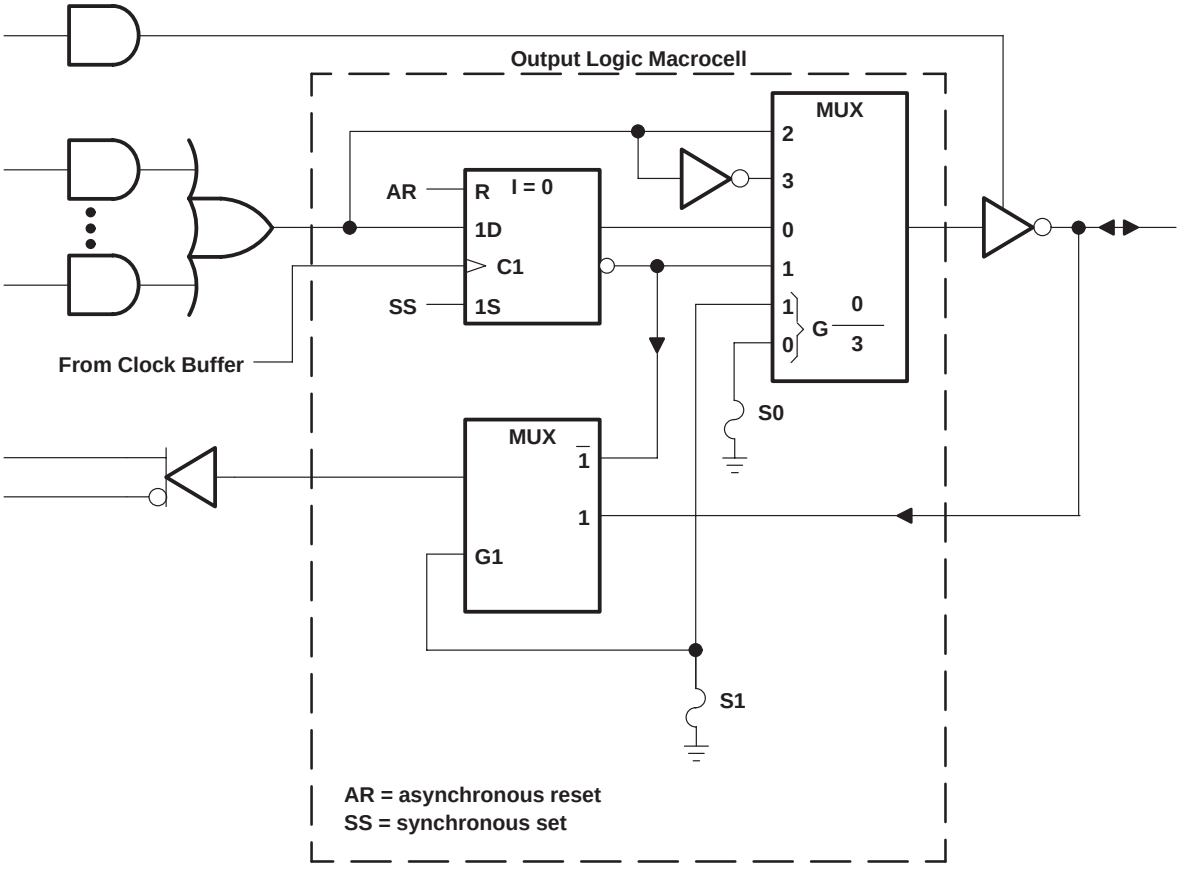
functional block diagram (positive logic)

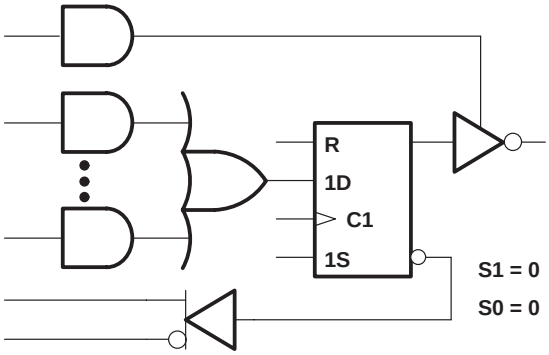



logic symbol (positive logic)
CLK/I 1
Asynchronous Reset (to all registers)
23 I/O/Q
22 I/O/Q
21 I/O/Q
20 I/O/Q
19 I/O/Q
Macro-cell
P = 5808
R = 5809
P = 5810
R = 5811
P = 5812
R = 5813
P = 5814
R = 5815
P = 5816
R = 5817
Increments
0
4
8
12
16
20
24
28
32
36
40
First Fuse Numbers
0
396
440
880
924
1452
1496
2112
2156
2860
2
3
4
5
I

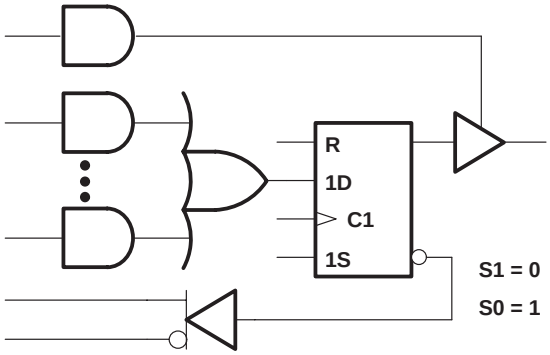

18 I/O/Q
17 I/O/Q
16 I/O/Q
15 I/O/Q
14 I/O/Q
Synchronous Set (to all registers)
13 I
Macro-cell
P = 5818 R = 5819
P = 5820 R = 5821
P = 5822 R = 5823
P = 5824 R = 5825
P = 5826 R = 5827
2904
3608
3652
4268
4312
4840
4884
5324
5368
5720
5764
6 I
7 I
8 I
9 I
10 I
11 I
Fuse number = First fuse number + Increment
Inside each MACROCELL the "P" fuse is the polarity fuse and the "R" fuse is the register fuse.

output logic macrocell diagram

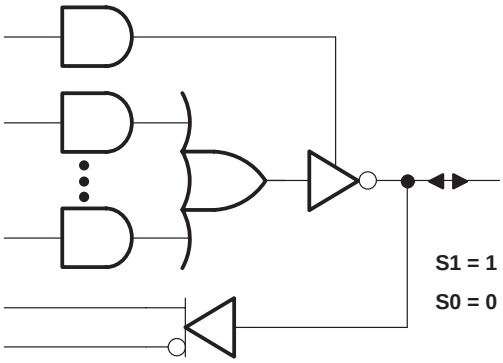




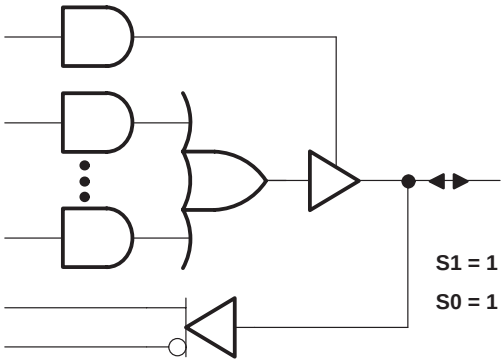
REGISTER FEEDBACK, REGISTERED, ACTIVE-LOW OUTPUT



REGISTER FEEDBACK, REGISTERED, ACTIVE-HIGH OUTPUT



I/O FEEDBACK, COMBINATIONAL, ACTIVE-LOW OUTPUT



I/O FEEDBACK, COMBINATIONAL, ACTIVE-HIGH OUTPUT

MACROCELL FEEDBACK AND OUTPUT FUNCTION TABLE

FUSE SELECT		FEEDBACK AND OUTPUT CONFIGURATION		
S1	S0			
0	0	Register feedback	Registered	Active low
0	1	Register feedback	Registered	Active high
1	0	I/O feedback	Combinational	Active low
1	1	I/O feedback	Combinational	Active high

0 = unblown fuse, 1 = blown fuse
S1 and S0 are select-function fuses as shown in the output logic macrocell diagram.

Figure 1. Resultant Macrocell Feedback and Output Logic After Programming

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 . . . . . –65°C to 150°C

NOTE 1: These ratings apply except for programming pins during a programming cycle or during a preload 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				16	mA
t_w	Pulse duration	Clock high or low	10			ns
		Asynchronous Reset high or low	15			
t_{su}	Setup time before clock↑	Input	13			ns
		Feedback	13			
		Synchronous Preset (active)	13			
		Asynchronous Reset (inactive)	15			
t_h	Hold time, input, set, or feedback after clock↑		0			ns
T_A	Operating free-air temperature		0		75	°C

electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 4.75 V,	I_I = –18 mA				–1.2	V
V_{OH}		V_{CC} = 4.75 V,	I_{OH} = –3.2 mA		2.4	3.5		V
V_{OL}		V_{CC} = 4.75 V,	I_{OL} = 16 mA			0.35	0.5	V
I_{OZH}		V_{CC} = 5.25 V,	V_O = 2.7 V				0.1	mA
I_{OZL}		V_{CC} = 5.25 V,	V_O = 0.4 V				–0.1	mA
I_I		V_{CC} = 5.25 V,	V_I = 5.5 V				1	mA
I_{IH}		V_{CC} = 5.25 V,	V_I = 2.7 V				25	µA
I_{IL}	CLK	V_{CC} = 5.25 V,	V_I = 0.4 V				–0.15	mA
	All others						–0.1	
I_{OS}‡		V_{CC} = 5.25 V,	V_O = 0.5 V		–30		–90	mA
I_{CC}		V_{CC} = 5.25 V,	V_I = GND,	Outputs open		155	180	mA
C_i		f = 1 MHz,	V_I = 2 V			5.5		pF
C_o		f = 1 MHz,	V_O = 2 V			8		pF
C_{clk}		f = 1 MHz,	V_{CLK} = 2 V			7		pF

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITION	MIN	TYP†	MAX	UNIT
f_{max}§	External feedback			40	60		MHz
t_{pd}	I, I/O	I/O			11	15	ns
t_{pd}	I, I/O (reset)	Q	R1 = 300 Ω,		13	20	ns
t_{pd}	CLK	Q	R2 = 390 Ω,		7	12	ns
t_{pd}	CLK	I/O	See Figure 4		15	22	ns
t_{en}	I, I/O	I/O, Q			11	15	ns
t_{dis}	I, I/O	I/O, Q			11	15	ns

† All typical values are at V_{CC} = 5 V, T_A = 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. V_O is set at 0.5 V to avoid test problems caused by test equipment ground degradation.

§ f_{max} (with feedback) = $\frac{1}{t_{su} + t_{pd}(\text{CLK to Q})}$.

preload procedure for registered outputs (see Notes 2 and 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 13 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 13 to V_{IL}. Preload can be verified by observing the voltage level at the output pin.

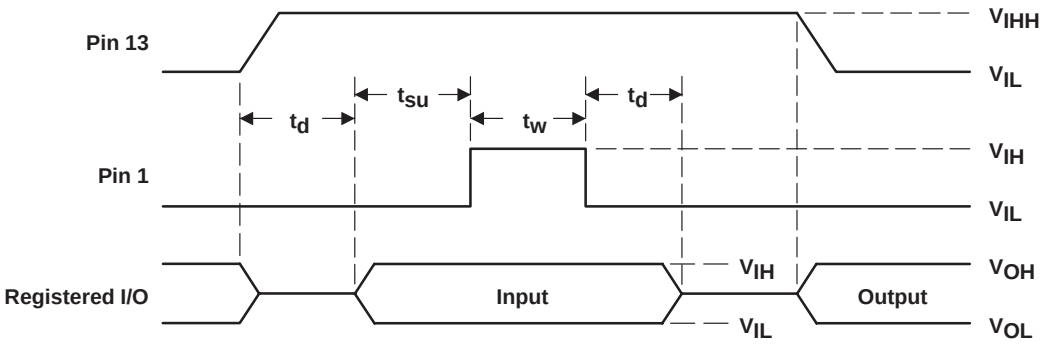
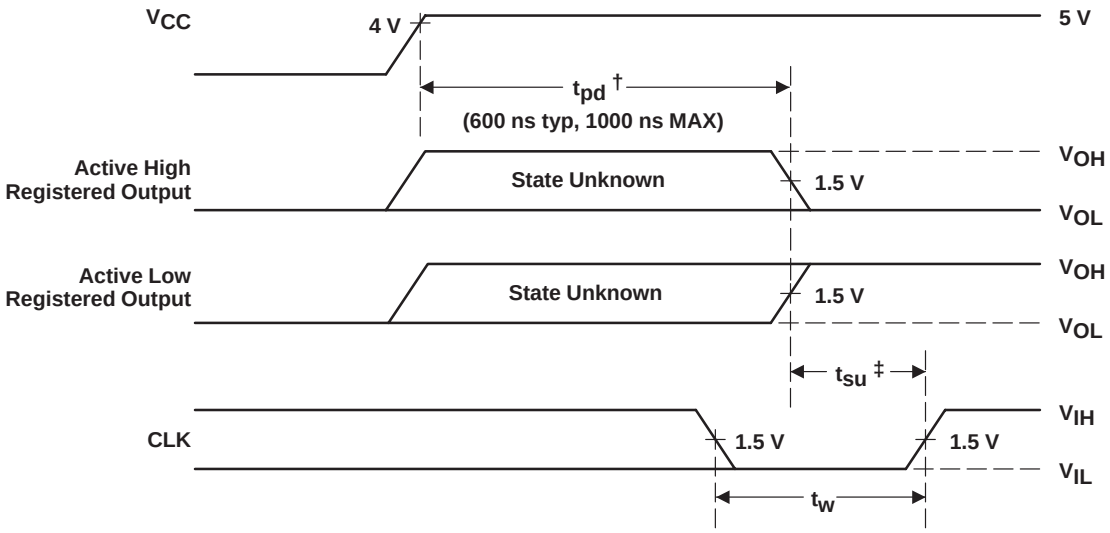


Figure 2. Preload Waveforms

NOTES: 2. Pin numbers shown are for the NT package only. If chip-carrier socket adapter is not used, pin numbers must be changed accordingly.
3. $t_d = t_{su} = t_w = 100$ ns to 1000 ns. $V_{IHH} = 10.25$ V to 10.75 V.

power-up reset

Following power up, all registers are reset to zero. The output level depends on the polarity selected during programming. 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.

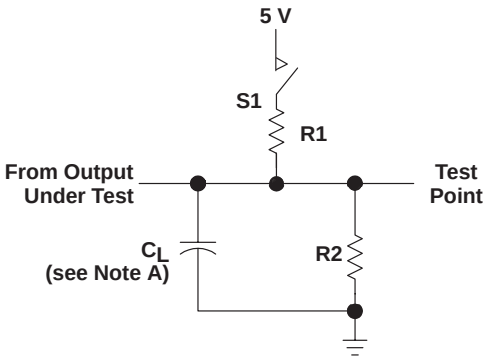
Figure 3. Power-Up Reset Waveforms

programming information

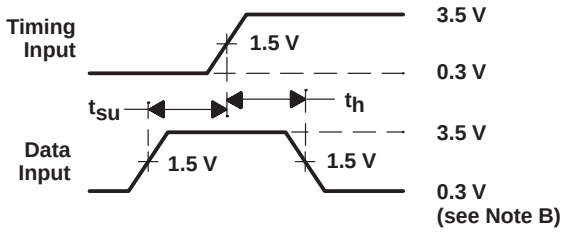
Texas Instruments programmable logic devices can be programmed using widely available software and inexpensive device programmers.

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 is also available, upon request, from the nearest TI field sales office, local authorized TI distributor, or by calling Texas Instruments at (214) 997-5666.

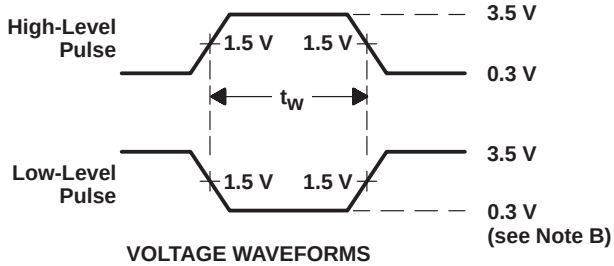
PARAMETER MEASUREMENT INFORMATION



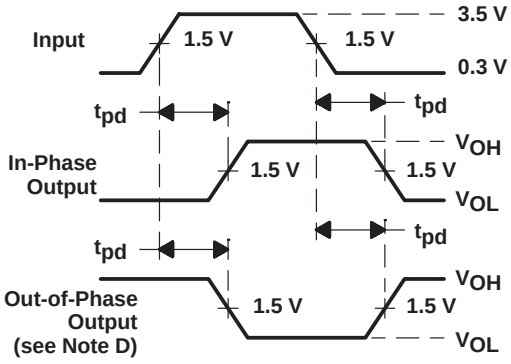
LOAD CIRCUIT FOR 3-STATE OUTPUTS



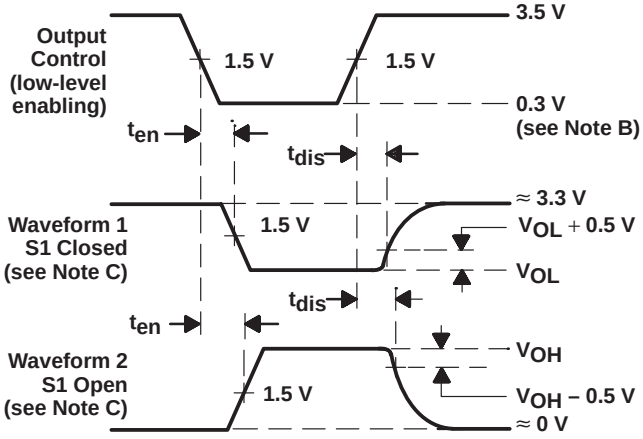
VOLTAGE WAVEFORMS SETUP AND HOLD TIMES



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. All input pulses have the following characteristics: PRR ≤ 1 MHz, $t_r = t_f$ = 2 ns, duty cycle = 50%.
C. 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.
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

TYPICAL CHARACTERISTICS

SUPPLY CURRENT vs FREE–AIR TEMPERATURE

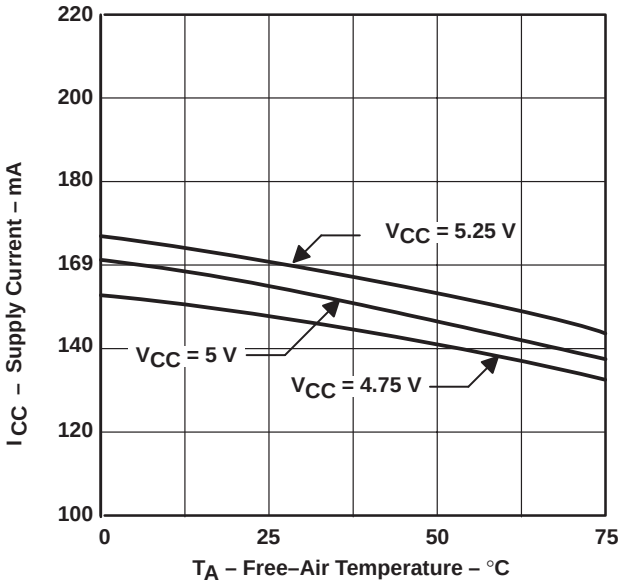


Figure 5

PROPAGATION DELAY TIME vs SUPPLY VOLTAGE

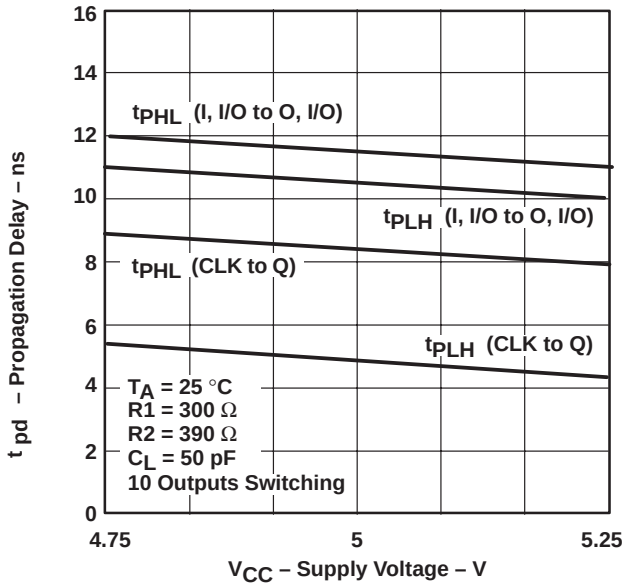


Figure 6

PROPAGATION DELAY TIME vs FREE–AIR TEMPERATURE

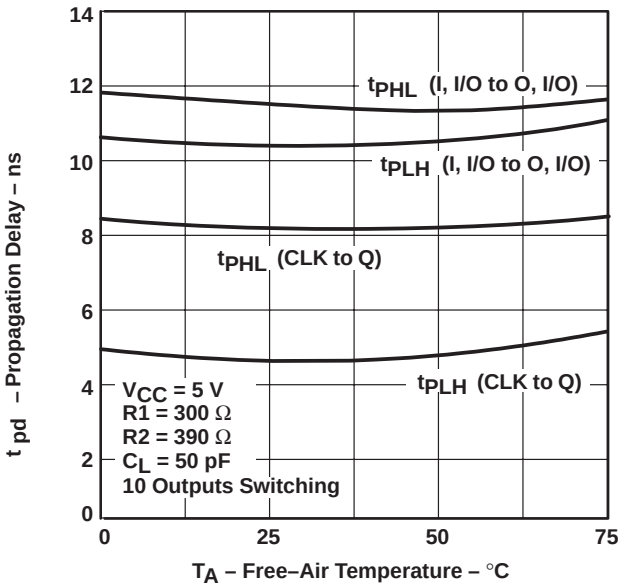


Figure 7

PROPAGATION DELAY TIME vs LOAD CAPACITANCE

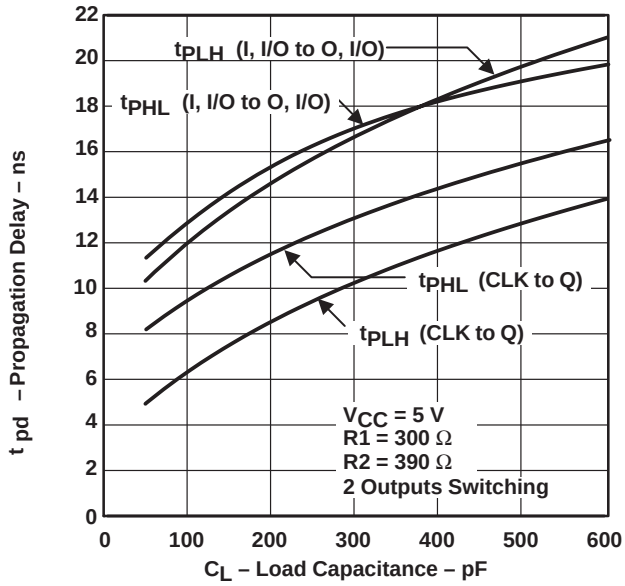


Figure 8

TYPICAL CHARACTERISTICS

POWER DISSIPATION vs FREQUENCY 10–BIT COUNTER MODE

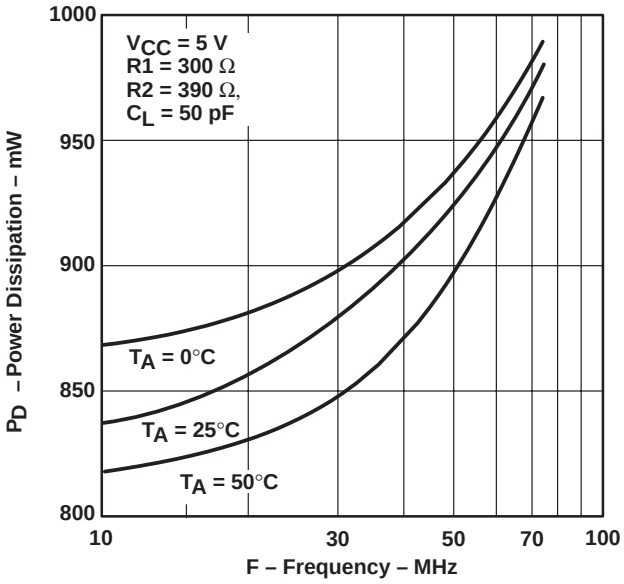


Figure 9

PROPAGATION DELAY TIME vs NUMBER OF OUTOUTS SWITCHING

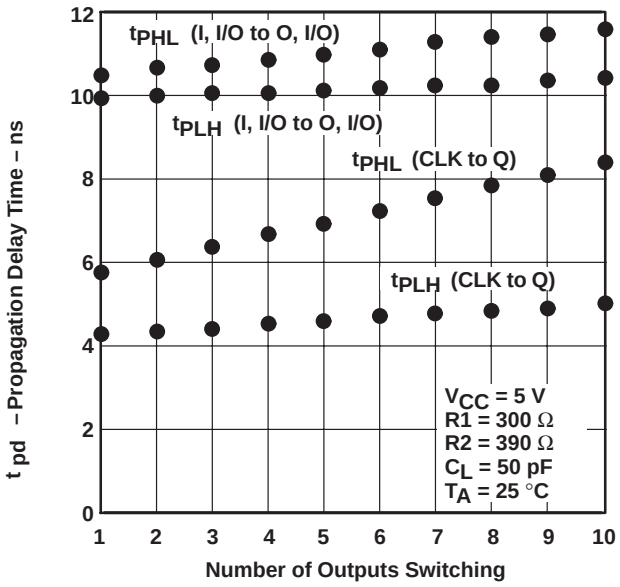


Figure 10

TI Worldwide Sales Offices

ALABAMA: Huntsville: 4960 Corporate Drive, Suite 150, Huntsville, AL 35805, (205) 837-7530.

ARIZONA: Phoenix: 8825 N. 23rd Avenue, Suite 100, Phoenix, AZ 85021, (602) 995-1007.

CALIFORNIA: Irvine: 1920 Main Street, Suite 900, Irvine, CA 92714, (714) 660-1200;
San Diego: 5625 Ruffin Road, Suite 100, San Diego, CA 92123, (619) 278-9600;
Santa Clara: 5353 Betsy Ross Drive, Santa Clara, CA 95054, (408) 980-9000;
Woodland Hills: 21550 Oxnard Street, Suite 700, Woodland Hills, CA 91367, (818) 704-8100.

COLORADO: Aurora: 1400 S. Potomac Street, Suite 101, Aurora, CO 80012, (303) 368-8000.

CONNECTICUT: Wallingford: 9 Barnes Industrial Park So., Wallingford, CT 06492, (203) 269-0074.

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Fort Lauderdale: 2950 N.W. 62nd Street, Suite 100, Fort Lauderdale, FL 33309, (305) 973-8502; **Tampa:** 4803 George Road, Suite 390, Tampa, FL 33634-6234, (813) 885-7588.

GEORGIA: Norcross: 5515 Spalding Drive, Norcross, GA 30092-2560, (404) 662-7967.

ILLINOIS: Arlington Heights: 515 West Algonquin, Arlington Heights, IL 60005, (708) 640-6925.

INDIANA: Carmel: 550 Congressional Drive, Suite 100, Carmel, IN 46032, (317) 573-6400;
Fort Wayne: 103 Airport North Office Park, Fort Wayne, IN 46825, (219) 489-4697.

KANSAS: Overland Park: 7300 College Boulevard, Lighton Plaza, Suite 150, Overland Park, KS 66210, (913) 451-4511.

MARYLAND: Columbia: 8815 Centre Park Drive, Suite 100, Columbia, MD 21045, (410) 964-2003.

MASSACHUSETTS: Waltham: Bay Colony Corporate Center 950 Winter Street, Suite 2800, Waltham, MA 02154, (617) 895-9100.

MICHIGAN: Farmington Hills: 33737 W. 12 Mile Road, Farmington Hills, MI 48018, (313) 553-1581.

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Pittsford: 2851 Clover Street, Pittsford, NY 14534, (716) 385-6770.

NORTH CAROLINA: Charlotte: 8 Woodlawn Green, Suite 100, Charlotte, NC 28217, (704) 527-0930;
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