

# TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE **IMPACT**™ **PAL**® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

- **High-Performance:**  $f_{\max}$  (w/o feedback)  
TIBPAL20R' -15C Series . . . 45 MHz  
TIBPAL20R' -20M Series . . . 41.6 MHz
- **High-Performance . . . 45 MHz Min**
- **Reduced  $I_{CC}$  of 180 mA Max**
- **Functionally Equivalent, but Faster Than**  
PAL20L8, PAL20R4, PAL20R6, PAL20R8
- **Power-Up Clear on Registered Devices (All**  
Register Outputs are Set Low, but Voltage  
Levels at the Output Pins Go High)
- **Preload Capability on Output Registers**  
Simplifies Testing
- **Package Options Include Both Plastic and**  
Ceramic Chip Carriers in Addition to Plastic  
and Ceramic DIPs

| DEVICE  | I<br>INPUTS | 3-STATE<br>O OUTPUTS | REGISTERED<br>Q OUTPUTS | I/O<br>PORT<br>S |
|---------|-------------|----------------------|-------------------------|------------------|
| PAL20L8 | 14          | 2                    | 0                       | 6                |
| PAL20R4 | 12          | 0                    | 4 (3-state buffers)     | 4                |
| PAL20R6 | 12          | 0                    | 6 (3-state buffers)     | 2                |
| PAL20R8 | 12          | 0                    | 8 (3-state buffers)     | 0                |

## description

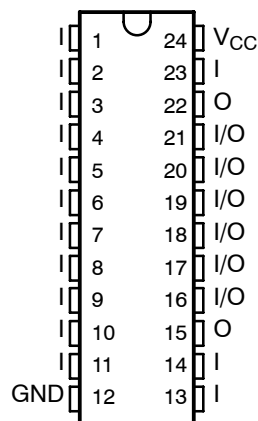
These programmable array logic devices feature high speed and functional equivalency when compared with currently available devices. These **IMPACT**™ circuits combine the latest Advanced Low-Power Schottky technology with proven titanium-tungsten fuses to provide reliable, high-performance substitutes 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.

Extra circuitry has been provided to allow loading of each register asynchronously to either a high or low state. This feature simplifies testing because the registers can be set to an initial state prior to executing the test sequence.

The TIBPAL20' C series is characterized from 0°C to 75°C. The TIBPAL20' M series is characterized for operation over the full military temperature range of –55°C to 125°C.

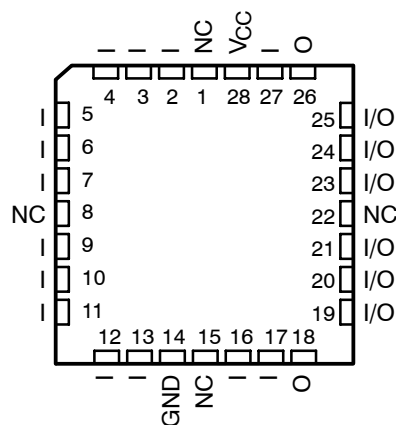
**TIBPAL20L8'**  
C SUFFIX . . . JT OR NT PACKAGE  
M SUFFIX . . . JT OR W PACKAGE

(TOP VIEW)



**TIBPAL20L8'**  
C SUFFIX . . . FN PACKAGE  
M SUFFIX . . . FK PACKAGE

(TOP VIEW)



NC – No internal connection  
Pin assignments in operating mode

IMPACT is a trademark of Texas Instruments Incorporated.  
PAL is a registered trademark of Advanced Micro Devices Inc.

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.

**TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

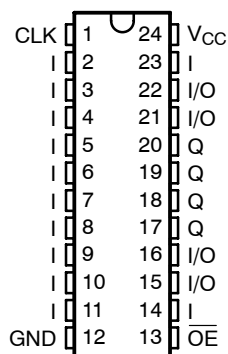
Copyright © 2010, Texas Instruments Incorporated

# TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

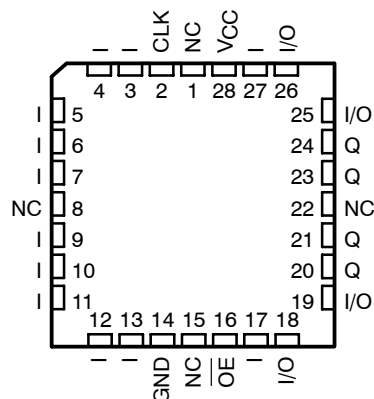
**TIBPAL20R4'**  
C SUFFIX ... JT OR NT PACKAGE  
M SUFFIX ... JT OR W PACKAGE

(TOP VIEW)



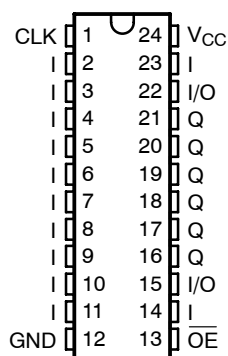
**TIBPAL20R4'**  
C SUFFIX ... FN PACKAGE  
M SUFFIX ... FK PACKAGE

(TOP VIEW)



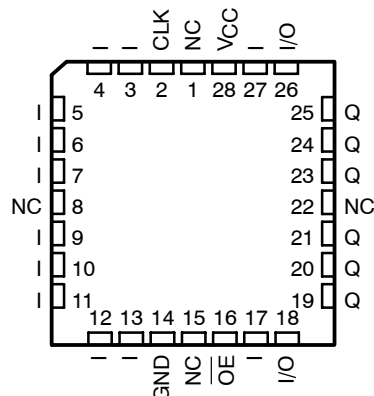
**TIBPAL20R6'**  
C SUFFIX ... JT OR NT PACKAGE  
M SUFFIX ... JT OR W PACKAGE

(TOP VIEW)



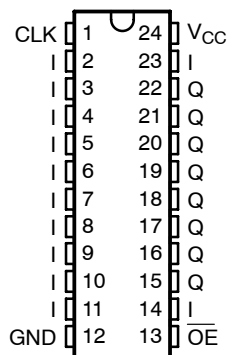
**TIBPAL20R6'**  
C SUFFIX ... FN PACKAGE  
M SUFFIX ... FK PACKAGE

(TOP VIEW)



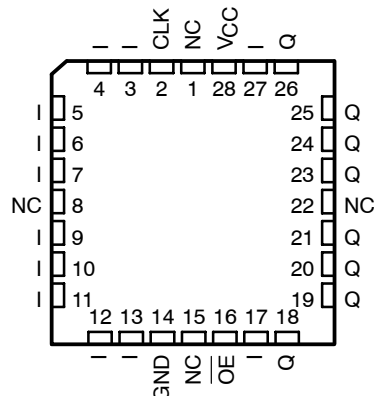
**TIBPAL20R8'**  
C SUFFIX ... JT OR NT PACKAGE  
M SUFFIX ... JT OR W PACKAGE

(TOP VIEW)



**TIBPAL20R8'**  
C SUFFIX ... FN PACKAGE  
M SUFFIX ... FK PACKAGE

(TOP VIEW)



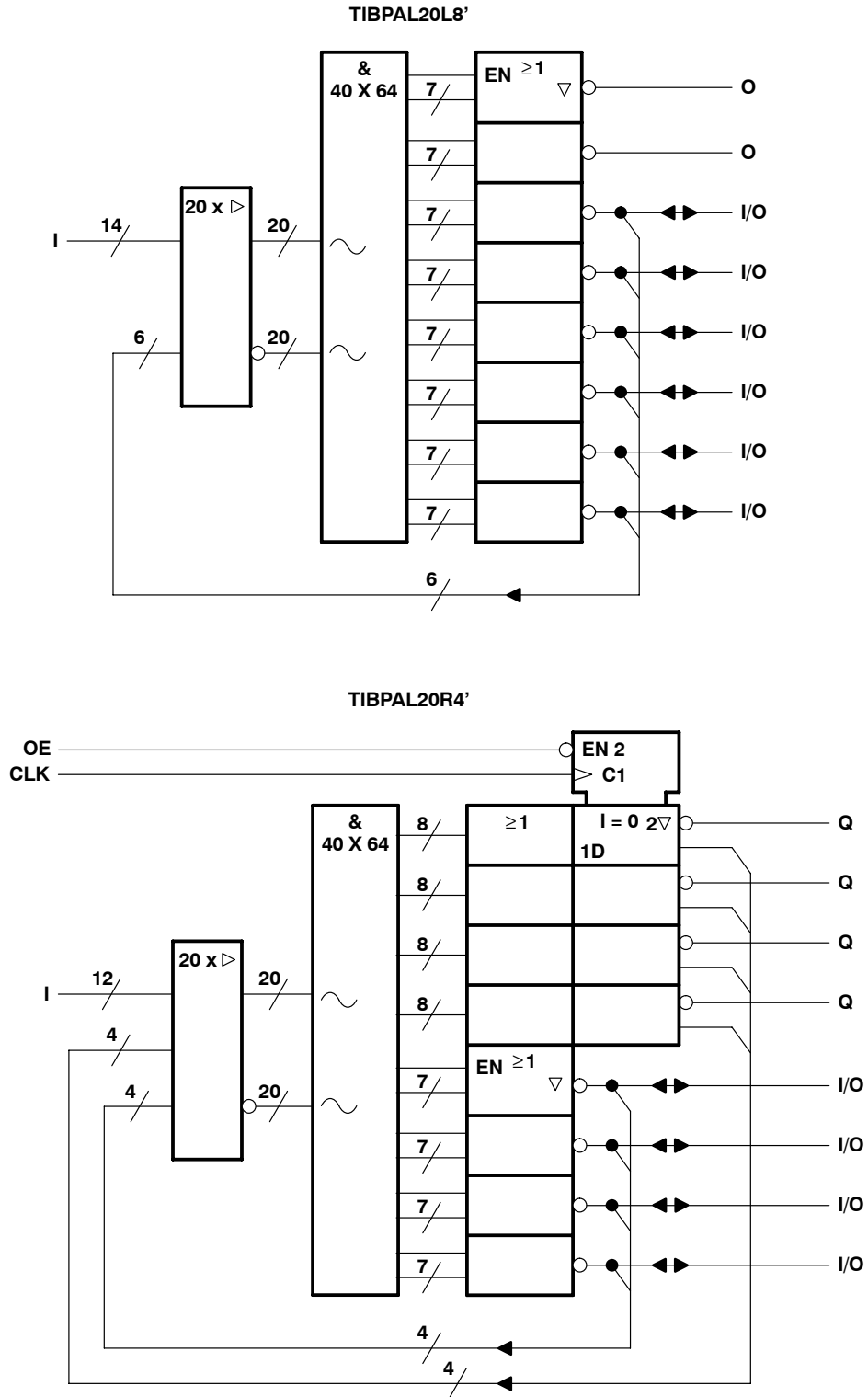
Pin assignments in operating mode

NC – No internal connection



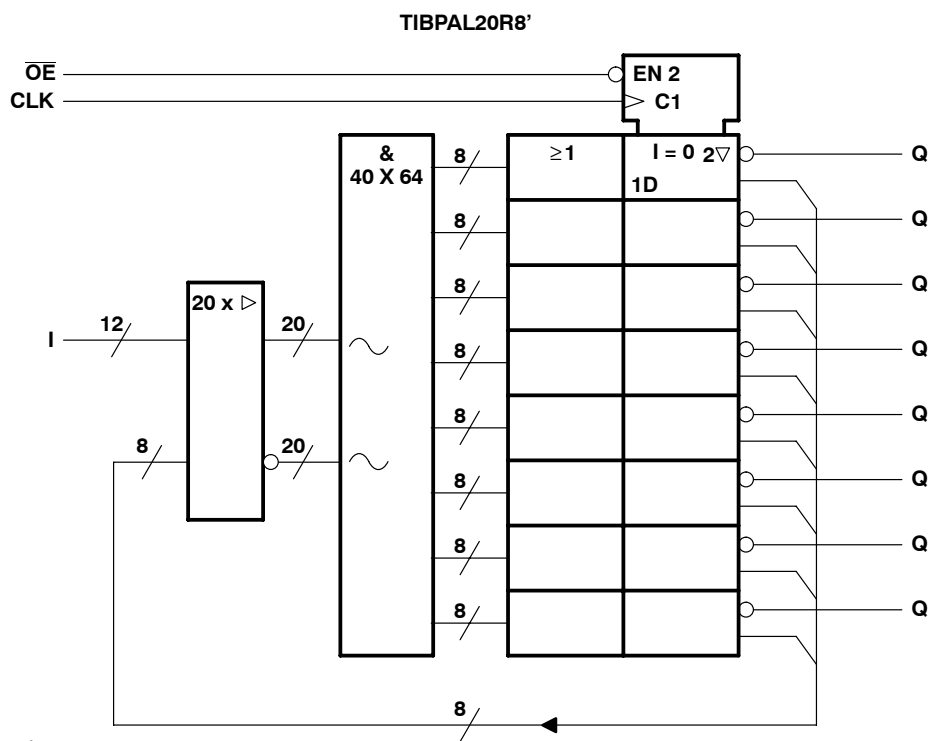
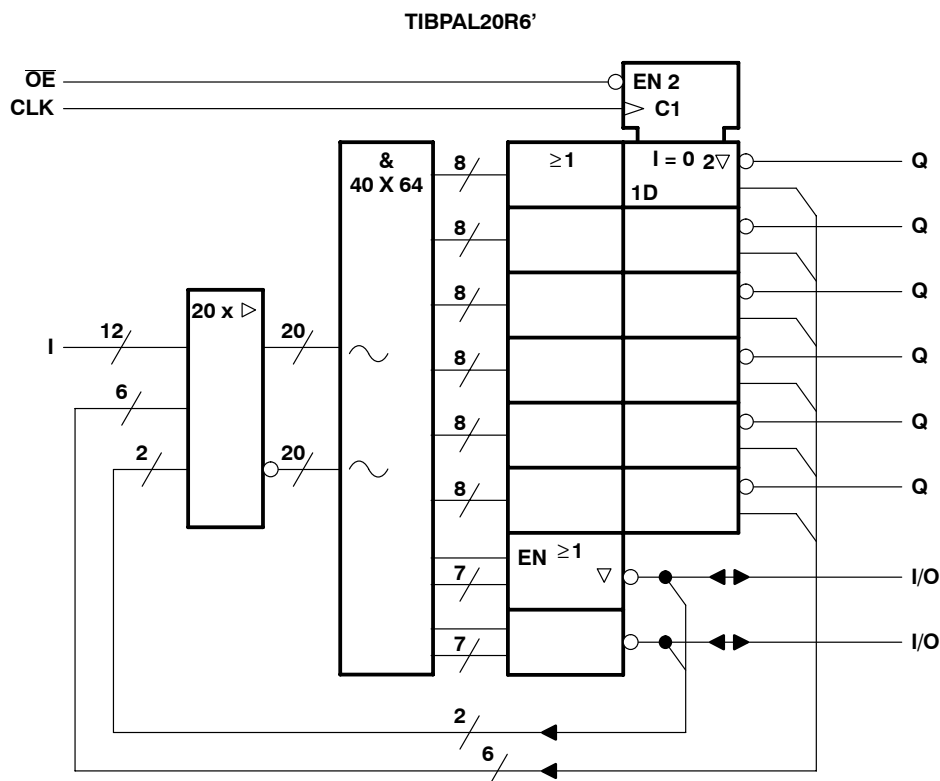
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**functional block diagrams (positive logic)**



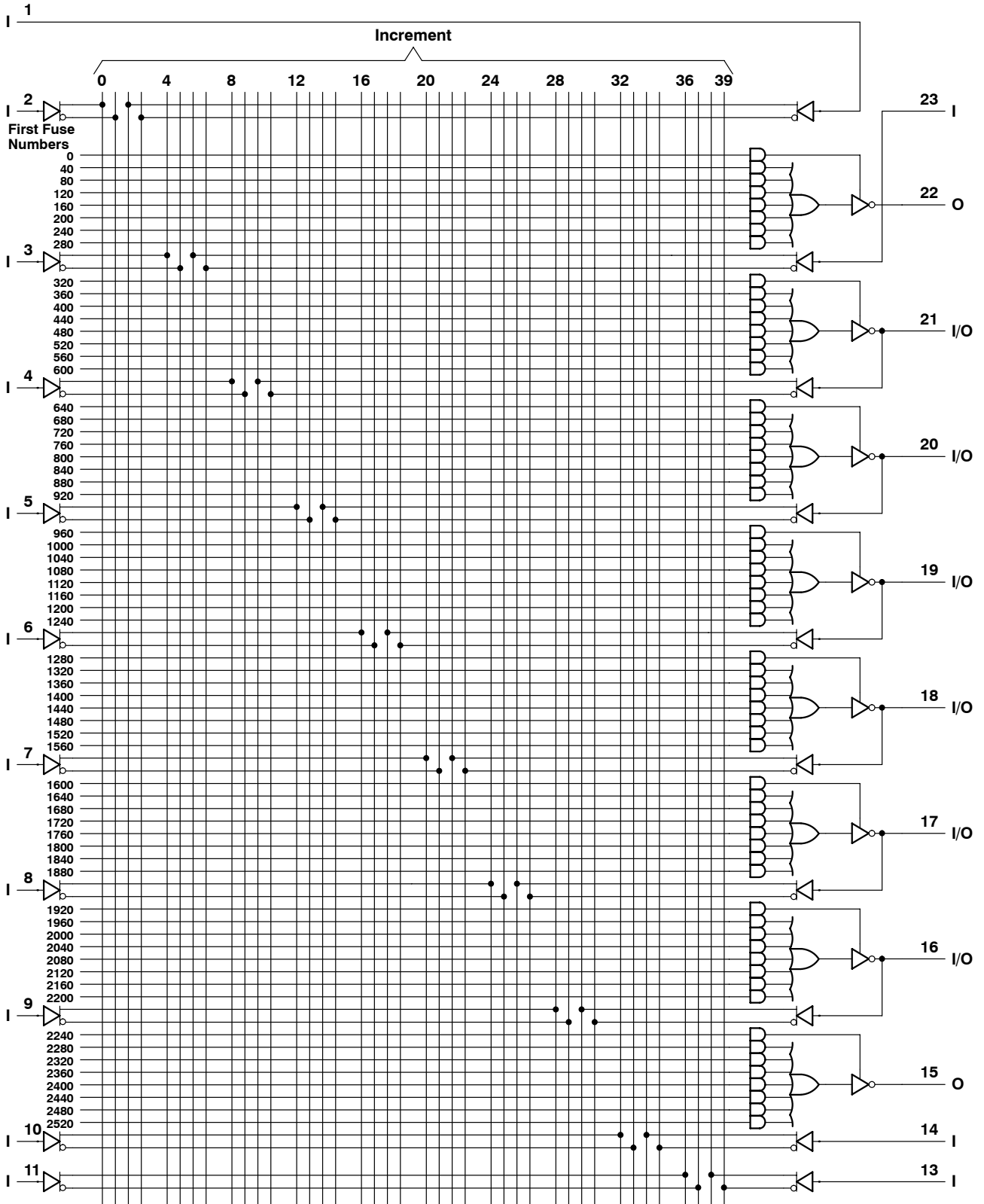
**TIBPAL20R6-15C, TIBPAL20R8-15C**  
**TIBPAL20R6-20M, TIBPAL20R8-20M**  
**HIGH-PERFORMANCE *IMPACT*™ PAL® CIRCUITS**  
 SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

**functional block diagrams (positive logic)**



~ denotes fused inputs

**logic diagram (positive logic)**

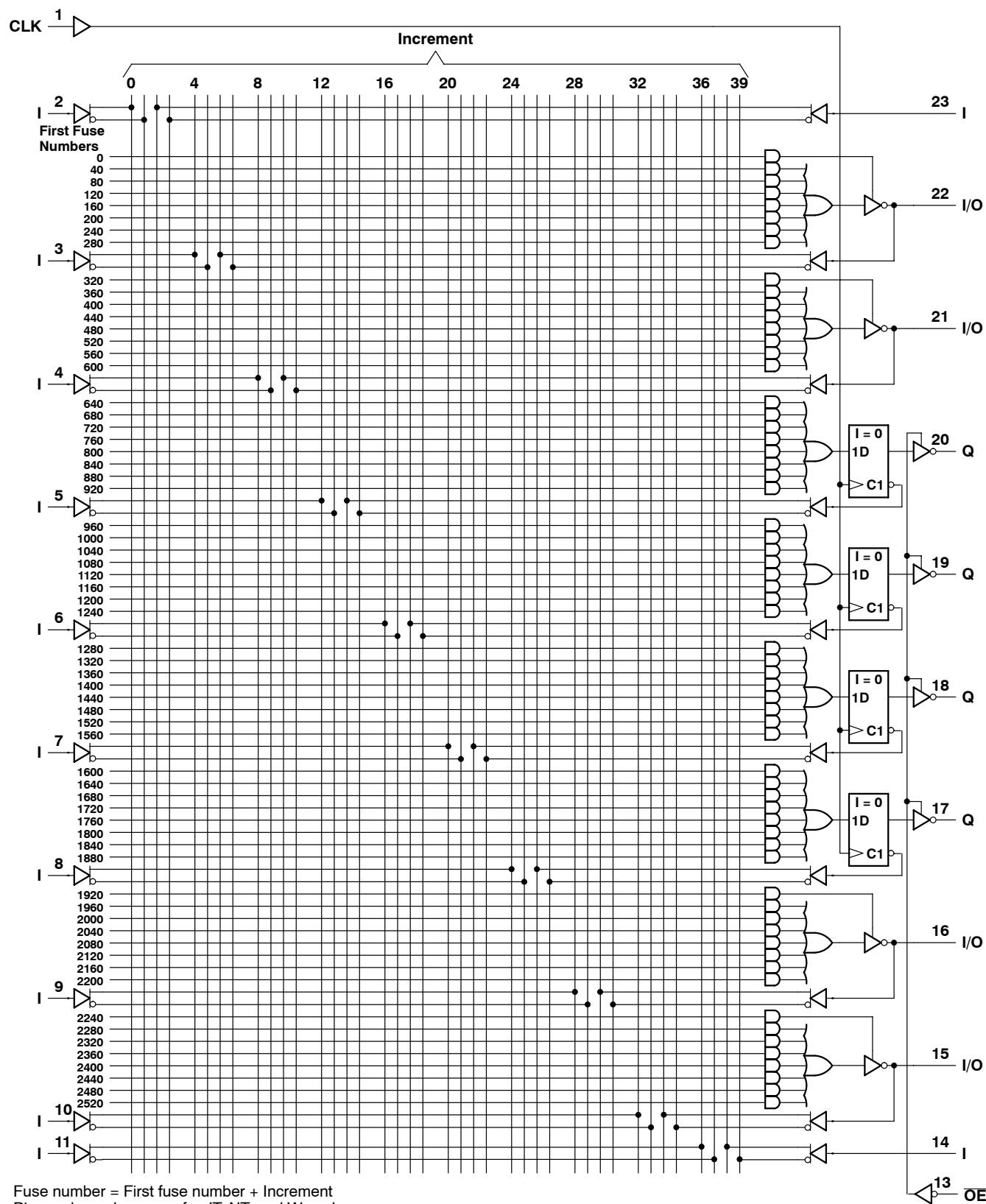


Fuse number = First fuse number + Increment  
 Pin numbers shown are for JT, NT, and W packages.

# TIBPAL20R4-15C TIBPAL20R4-20M HIGH-PERFORMANCE *IMPACT*™ PAL® CIRCUITS

SRPS021A - D2920, JUNE 1986 - REVISED DECEMBER 2010

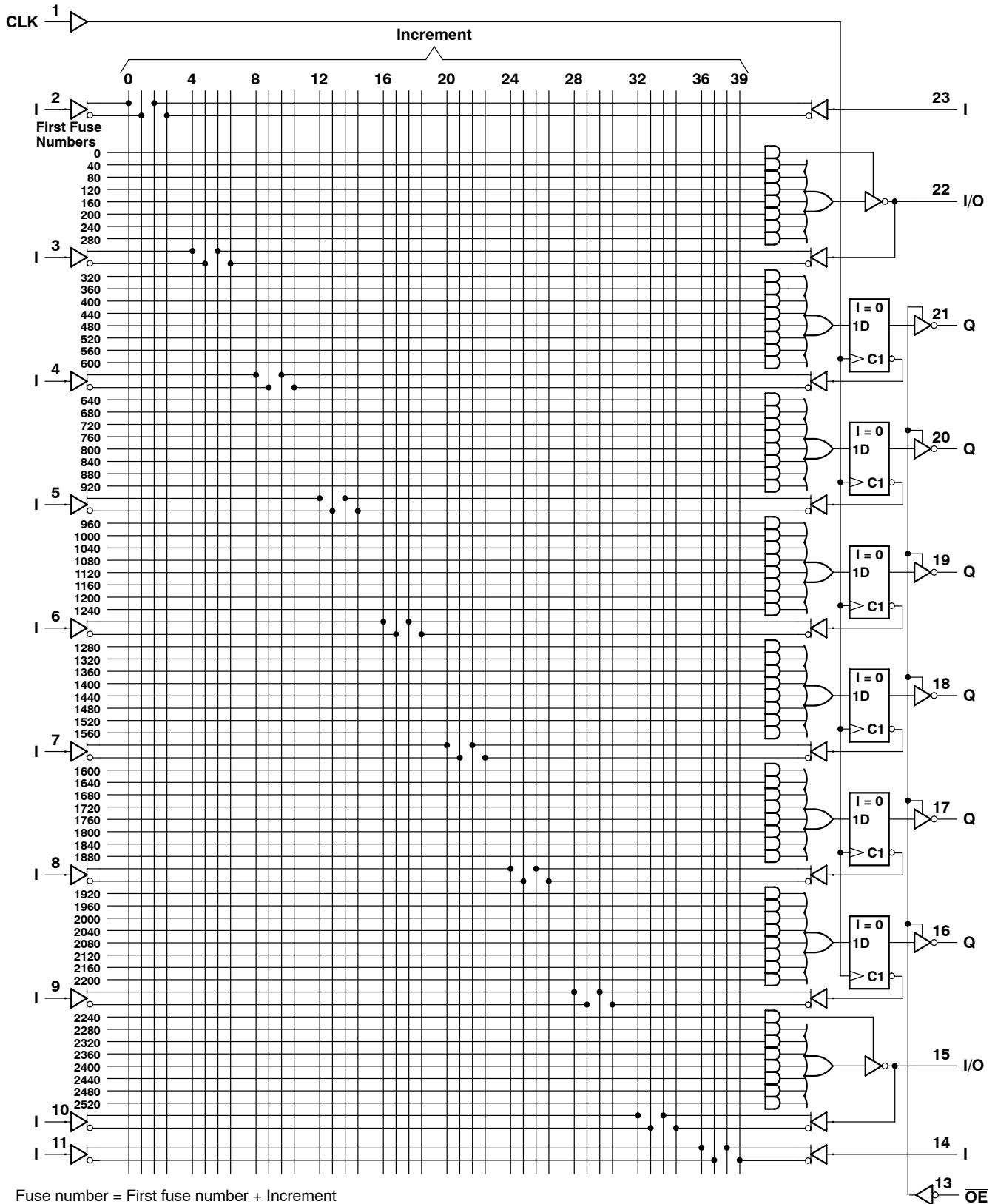
## logic diagram (positive logic)



TEXAS  
INSTRUMENTS

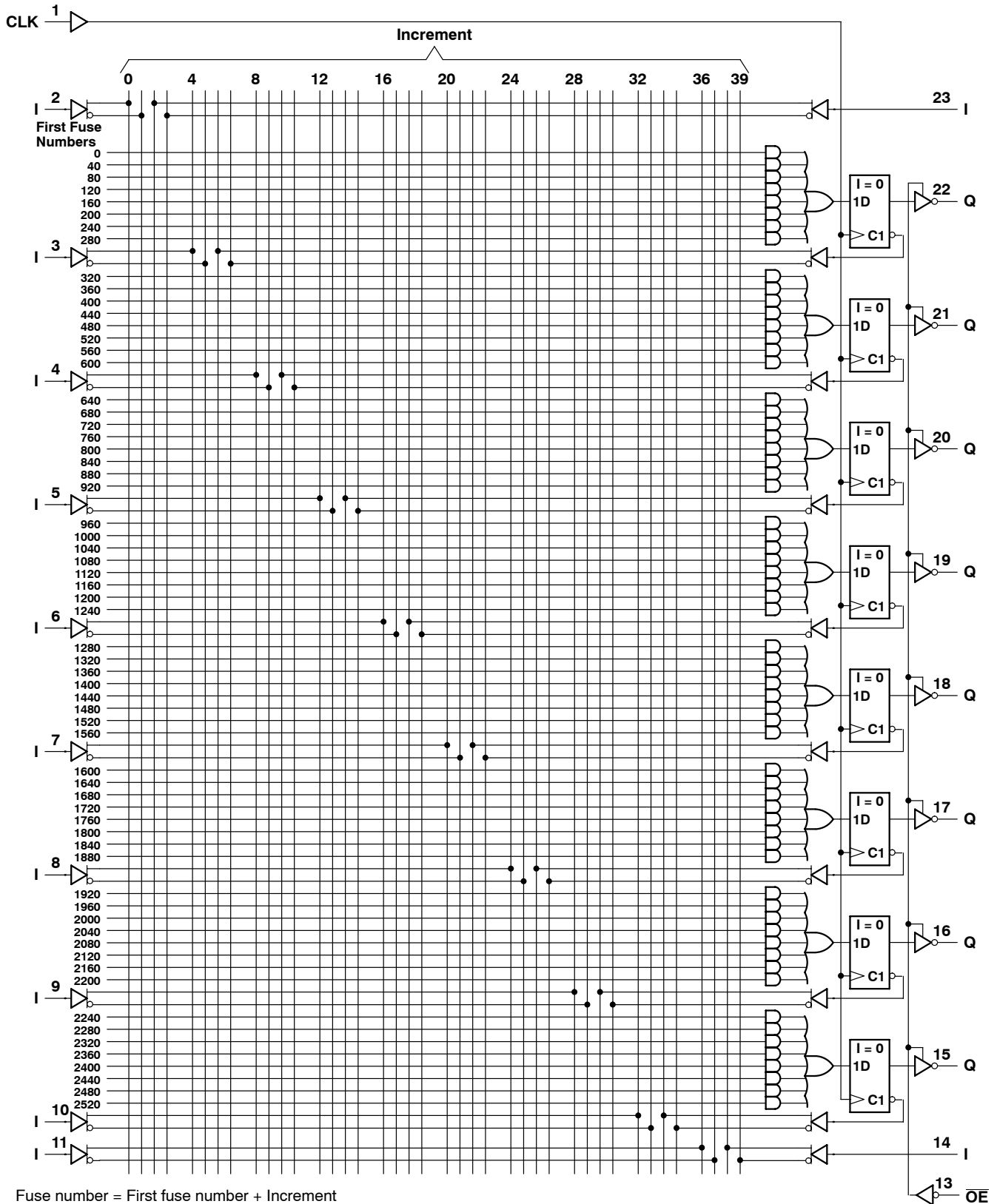
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**logic diagram (positive logic)**



**TIBPAL20R8-15C**  
**TIBPAL20R8-20M**  
**HIGH-PERFORMANCE *IMPACT*™ PAL® CIRCUITS**  
 SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

**logic diagram (positive logic)**





# TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

## 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.

## 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   |
| $f_{clock}^{\dagger}$ | Clock frequency                                       | 0    |     | 45   | MHz  |
| $t_w^{\dagger}$       | Pulse duration, clock                                 | High |     | 10   | ns   |
|                       |                                                       | Low  |     | 12   |      |
| $t_{su}^{\dagger}$    | Setup time, input or feedback before clock $\uparrow$ | 15   |     |      | ns   |
| $t_h^{\dagger}$       | Hold time, input or feedback after clock $\uparrow$   | 0    |     |      | ns   |
| $T_A$                 | Operating free-air temperature                        | 0    | 25  | 75   | °C   |

$^{\dagger} f_{clock}$ ,  $t_w$ ,  $t_{su}$ , and  $t_h$  do not apply for TIBPAL20L8'.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

# TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

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

| PARAMETER         |              | TEST CONDITIONS                             |                                            | MIN | TYP† | MAX   | UNIT          |
|-------------------|--------------|---------------------------------------------|--------------------------------------------|-----|------|-------|---------------|
| $V_{IK}$          |              | $V_{CC} = 4.75\text{ V}$ ,                  | $I_I = -18\text{ mA}$                      |     | -0.8 | -1.5  | V             |
| $V_{OH}$          |              | $V_{CC} = 4.75\text{ V}$ ,                  | $I_{OH} = -3.2\text{ mA}$                  | 2.4 |      |       | V             |
| $V_{OL}$          |              | $V_{CC} = 4.75\text{ V}$ ,                  | $I_{OL} = 24\text{ mA}$                    |     | 0.3  | 0.5   | V             |
| $I_{OZH}$         | O, Q outputs | $V_{CC} = 5.25\text{ V}$ ,                  | $V_O = 2.7\text{ V}$                       |     |      | 20    | $\mu\text{A}$ |
|                   | I/O ports    |                                             |                                            |     |      | 100   |               |
| $I_{OZL}$         | O, Q outputs | $V_{CC} = 5.25\text{ V}$ ,                  | $V_O = 0.4\text{ V}$                       |     |      | -20   | $\mu\text{A}$ |
|                   | I/O ports    |                                             |                                            |     |      | -250  |               |
| $I_I$             |              | $V_{CC} = 5.25\text{ V}$ ,                  | $V_I = 5.5\text{ V}$                       |     |      | 0.1   | mA            |
| $I_{IH}^\ddagger$ |              | $V_{CC} = 5.25\text{ V}$ ,                  | $V_I = 2.7\text{ V}$                       |     |      | 25    | $\mu\text{A}$ |
| $I_{IL}^\ddagger$ |              | $V_{CC} = 5.25\text{ V}$ ,                  | $V_I = 0.4\text{ V}$                       |     |      | -0.25 | mA            |
| $I_{OS}^\S$       |              | $V_{CC} = 5.25\text{ V}$ ,                  | $V_O = 0.5\text{ V}$                       | -30 | -70  | -130  | mA            |
| $I_{CC}$          |              | $V_{CC} = 5.25\text{ V}$ ,<br>Outputs open, | $V_I = 0$ ,<br>$\overline{OE}$ at $V_{IH}$ |     | 120  | 180   | mA            |

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

| PARAMETER                     | FROM<br>(INPUT)  | TO<br>(OUTPUT) | TEST CONDITION                             | MIN | TYP† | MAX | UNIT |
|-------------------------------|------------------|----------------|--------------------------------------------|-----|------|-----|------|
| f <sub>max</sub> <sup>¶</sup> | With feedback    |                | R1 = 200 Ω,<br>R2 = 390 Ω,<br>See Figure 3 | 37  | 40   |     | MHz  |
|                               | Without feedback |                |                                            | 45  | 50   |     |      |
| t <sub>pd</sub>               | I, I/O           | O, I/O         |                                            |     | 12   | 15  | ns   |
| t <sub>pd</sub>               | CLK↑             | Q              |                                            |     | 8    | 12  | ns   |
| t <sub>en</sub>               | OE               | Q              |                                            |     | 10   | 15  | ns   |
| t <sub>dis</sub>              | OE↑              | Q              |                                            |     | 8    | 12  | ns   |
| t <sub>en</sub>               | I, I/O           | O, I/O         |                                            |     | 12   | 18  | ns   |
| t <sub>dis</sub>              | I, I/O           | O, I/O         |                                            |     | 12   | 15  | ns   |

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second.

$$^\P f_{\max}(\text{with feedback}) = \frac{1}{t_{su} + t_{pd}(\text{CLK to Q})}, \quad f_{\max}(\text{without feedback}) = \frac{1}{t_{w\text{ high}} + t_{w\text{ low}}},$$

$f_{\max}$  does not apply for TIBPAL20L8.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

# TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

## 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                       | –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   |
| $f_{clock}^{\dagger}$ | Clock frequency                                       | 0    |     | 41.6 | MHz  |
| $t_w^{\dagger}$       | Pulse duration, clock                                 | High |     | 12   | ns   |
|                       |                                                       | Low  |     | 12   |      |
| $t_{su}^{\dagger}$    | Setup time, input or feedback before clock $\uparrow$ | 20   |     |      | ns   |
| $t_h^{\dagger}$       | Hold time, input or feedback after clock $\uparrow$   | 0    |     |      | ns   |
| $T_A$                 | Operating free-air temperature                        | –55  | 25  | 125  | °C   |

$^{\dagger} f_{clock}$ ,  $t_w$ ,  $t_{su}$ , and  $t_h$  do not apply for TIBPAL20L8'.



# TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

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

| PARAMETER          |              | TEST CONDITIONS                            |                              | MIN | TYP† | MAX   | UNIT          |
|--------------------|--------------|--------------------------------------------|------------------------------|-----|------|-------|---------------|
| $V_{IK}$           |              | $V_{CC} = 4.5\text{ V}$ ,                  | $I_I = -18\text{ mA}$        |     | -0.8 | -1.5  | V             |
| $V_{OH}$           |              | $V_{CC} = 4.5\text{ V}$ ,                  | $I_{OH} = -2\text{ mA}$      | 2.4 | 3.2  |       | V             |
| $V_{OL}$           |              | $V_{CC} = 4.5\text{ V}$ ,                  | $I_{OL} = 12\text{ mA}$      |     | 0.3  | 0.5   | V             |
| $I_{OZH}$          |              | $V_{CC} = 5.5\text{ V}$ ,                  | $V_O = 2.7\text{ V}$         |     |      | 100   | $\mu\text{A}$ |
| $I_{OZL}^\ddagger$ | O, Q outputs | $V_{CC} = 5.5\text{ V}$ ,                  | $V_O = 0.4\text{ V}$         |     |      | -20   | $\mu\text{A}$ |
|                    | I/O ports    |                                            |                              |     |      | -250  |               |
| $I_I$              |              | $V_{CC} = 5.5\text{ V}$ ,                  | $V_I = 5.5\text{ V}$         |     |      | 1     | mA            |
| $I_{IH}^\ddagger$  | I/O ports    | $V_{CC} = 5.5\text{ V}$ ,                  | $V_I = 2.7\text{ V}$         |     |      | 100   | $\mu\text{A}$ |
|                    | All others   |                                            |                              |     |      | 25    |               |
| $I_{IL}^\ddagger$  |              | $V_{CC} = 5.5\text{ V}$ ,                  | $V_I = 0.4\text{ V}$         |     |      | -0.25 | mA            |
| $I_{OS}^\S$        |              | $V_{CC} = 5.5\text{ V}$ ,                  | $V_O = 0.5\text{ V}$         | -30 | -70  | -250  | mA            |
| $I_{CC}$           |              | $V_{CC} = 5.5\text{ V}$ ,<br>Outputs open, | $V_I = 0$ ,<br>$OE = V_{IH}$ |     | 120  | 180   | mA            |

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

| PARAMETER                     | FROM<br>(INPUT)         | TO<br>(OUTPUT) | TEST CONDITION                             | MIN  | TYP† | MAX | UNIT |
|-------------------------------|-------------------------|----------------|--------------------------------------------|------|------|-----|------|
| f <sub>max</sub> <sup>¶</sup> | With feedback           |                | R1 = 390 Ω,<br>R2 = 750 Ω,<br>See Figure 3 | 28.5 | 40   |     | MHz  |
|                               | Without feedback        |                |                                            | 41.6 | 50   |     |      |
| t <sub>pd</sub>               | I, I/O                  | O, I/O         |                                            |      | 12   | 20  | ns   |
| t <sub>pd</sub>               | CLK↑                    | Q              |                                            |      | 8    | 15  | ns   |
| t <sub>en</sub>               | $\overline{OE}$         | Q              |                                            |      | 10   | 20  | ns   |
| t <sub>dis</sub>              | $\overline{OE}\uparrow$ | Q              |                                            |      | 8    | 20  | ns   |
| t <sub>en</sub>               | I, I/O                  | O, I/O         |                                            |      | 12   | 25  | ns   |
| t <sub>dis</sub>              | I, I/O                  | O, I/O         |                                            |      | 12   | 20  | ns   |

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second. Set  $V_O$  at 0.5 V to avoid test equipment ground degradation.

$$^\P f_{\max}(\text{with feedback}) = \frac{1}{t_{su} + t_{pd}(\text{CLK to Q})}, \quad f_{\max}(\text{without feedback}) = \frac{1}{t_{w\text{ high}} + t_{w\text{ low}}},$$

$f_{\max}$  does not apply for TIBPAL20L8.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

## programming information

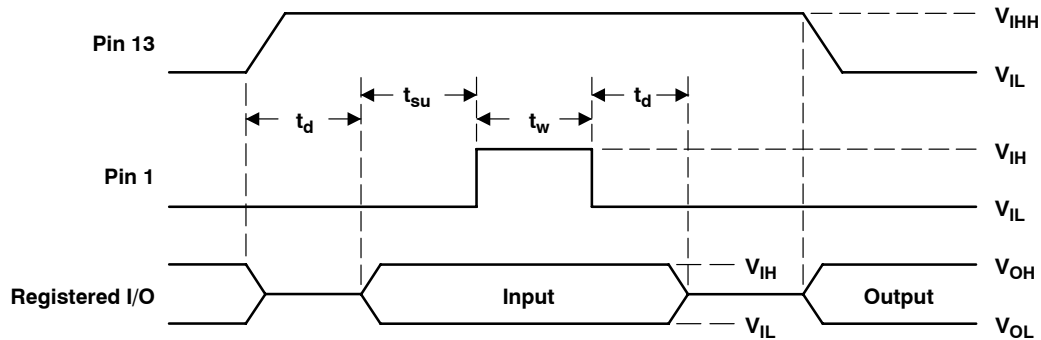
Texas Instruments programmable logic devices can be programmed using widely available software and inexpensive device programmers.

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.

## preload procedure for registered outputs (see Figure 1 and 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 volts 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 1. Preload Waveforms**

NOTES: 2. Pin numbers shown are for JT, NT, and W packages only. If chip carrier socket adapter is not used, pin numbers must be changed accordingly.

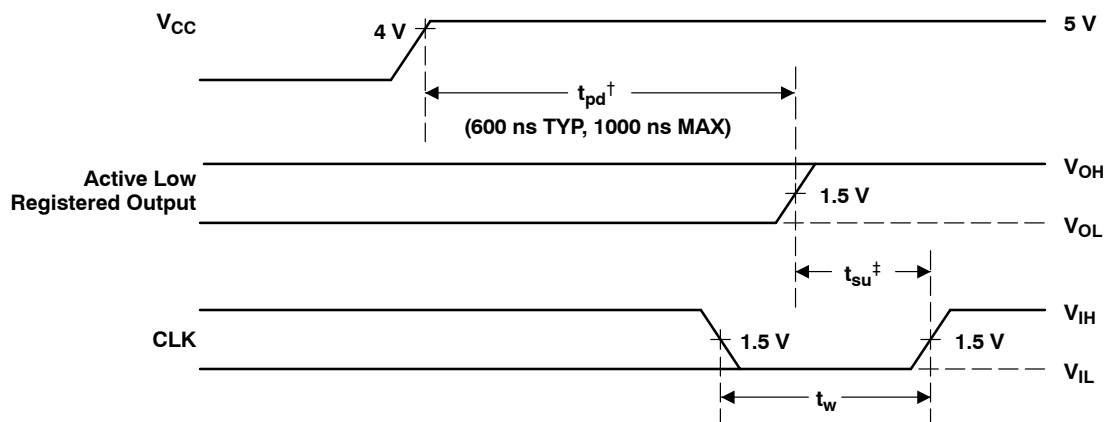
3.  $t_d = t_{su} = t_h = 100$  ns to 1000 ns  $V_{IHH} = 10.25$  V to 10.75 v

**TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C**  
**TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M**  
**HIGH-PERFORMANCE *IMPACT*™ PAL® CIRCUITS**

SRPS021 D– D2920, JUNE 1986 – REVISED DECEMBER 2010

**power-up reset (see Figure 2)**

Following power up, all registers are reset to zero. 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.

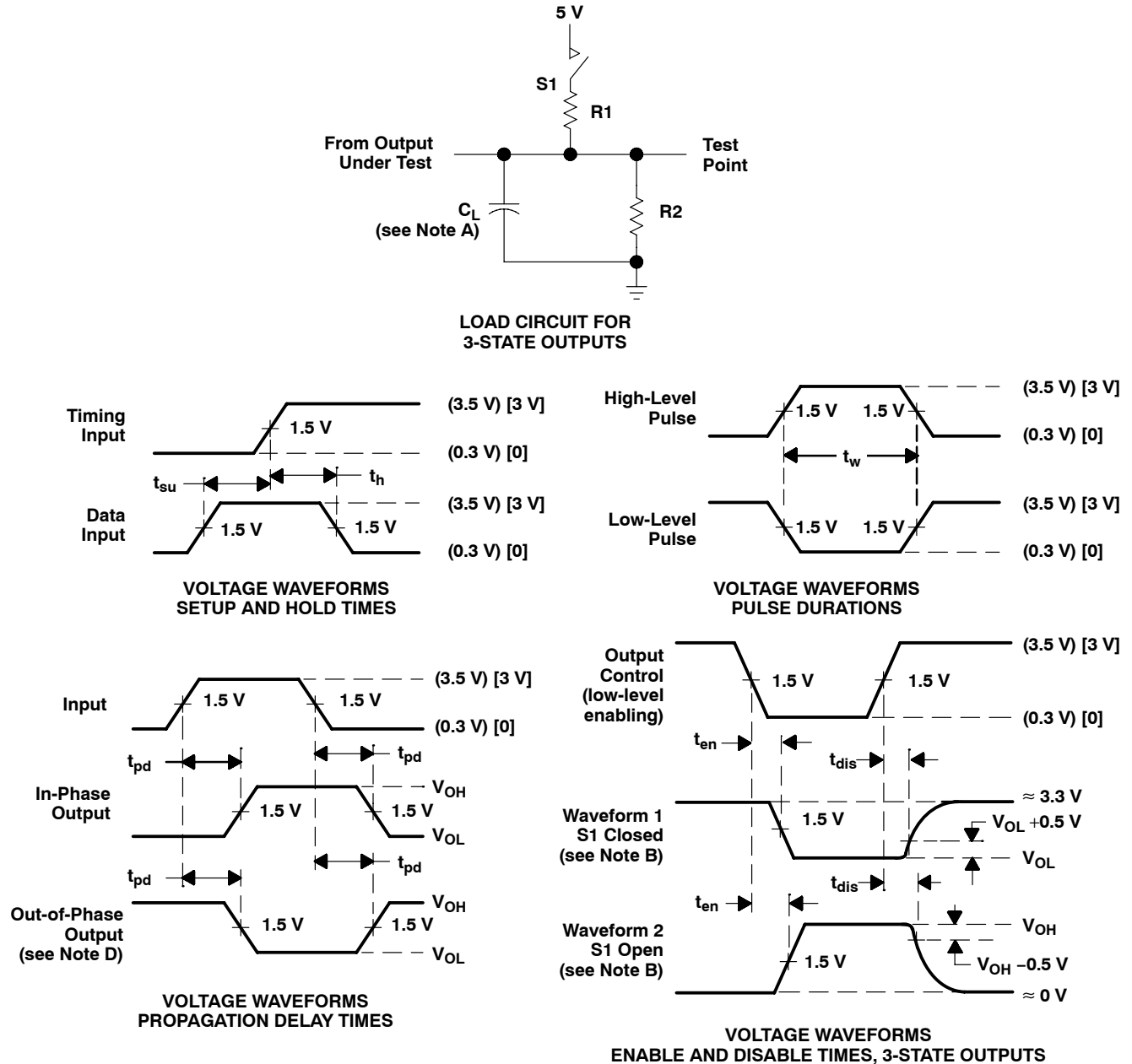


<sup>†</sup> This is the power-up reset time and applies to registered outputs only. The values shown are from characterization data.

<sup>‡</sup> This is the setup time for input or feedback.

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

## PARAMETER MEASUREMENT INFORMATION



- 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: For C suffix, use the voltage levels indicated in parentheses ( ). PRR  $\leq$  1 MHz,  $t_r = t_f \leq 2$  ns, duty cycle = 50%. For M suffix, use the voltage levels indicated in brackets [ ]. PRR  $\leq$  10 MHz,  $t_r$  and  $t_f \leq 2$  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 3. Load Circuit and Voltage Waveforms

# TI North American Sales Offices

**ALABAMA:** Huntsville: (205) 837-7530  
**ARIZONA:** Phoenix: (602) 995-1007  
**CALIFORNIA:** Irvine: (714) 660-1200  
San Diego: (619) 278-9600  
Santa Clara: (408) 980-9000  
Woodland Hills: (818) 704-8100  
**COLORADO:** Aurora: (303) 368-8000  
**CONNECTICUT:** Wallingford: (203) 269-0074  
**FLORIDA:** Altamonte Springs: (407) 260-2116  
Fort Lauderdale: (305) 973-8502  
Tampa: (813) 885-7588  
**GEORGIA:** Norcross: (404) 662-7967  
**ILLINOIS:** Arlington Heights: (708) 640-3000  
**INDIANA:** Carmel: (317) 573-6400  
Fort Wayne: (219) 489-4697  
**KANSAS:** Overland Park: (913) 451-4511  
**MARYLAND:** Columbia: (410) 964-2003  
**MASSACHUSETTS:** Waltham: (617) 895-9100  
**MICHIGAN:** Farmington Hills: (313) 553-1581  
**MINNESOTA:** Eden Prairie: (612) 828-9300  
**MISSOURI:** St. Louis: (314) 821-8400  
**NEW JERSEY:** Iselin: (908) 750-1050  
**NEW MEXICO:** Albuquerque: (505) 345-2555  
**NEW YORK:** East Syracuse: (315) 463-9291  
Fishkill: (914) 897-2900  
Melville: (516) 454-6600  
Pittsford: (716) 385-6770  
**NORTH CAROLINA:** Charlotte: (704) 527-0930  
Raleigh: (919) 876-2725  
**OHIO:** Beachwood: (216) 765-7258  
Beavercreek: (513) 427-6200  
**OREGON:** Beaverton: (503) 643-6758  
**PENNSYLVANIA:** Blue Bell: (215) 825-9500  
**PUERTO RICO:** Hato Rey: (809) 753-8700  
**TEXAS:** Austin: (512) 250-6769  
Dallas: (214) 917-1264  
Houston: (713) 778-6502  
Midland: (915) 561-7137  
**UTAH:** Salt Lake City: (801) 466-8972  
**WISCONSIN:** Waukesha: (414) 798-1001  
**CANADA:** Nepean: (613) 726-1970  
Richmond Hill: (416) 884-9181  
St. Laurent: (514) 335-8392

# TI Regional Technology Centers

**CALIFORNIA:** Irvine: (714) 660-8140  
Santa Clara: (408) 748-2222  
**GEORGIA:** Norcross: (404) 662-7945  
**ILLINOIS:** Arlington Heights: (708) 640-2909  
**INDIANA:** Indianapolis: (317) 573-6400  
**MASSACHUSETTS:** Waltham: (617) 895-9196  
**MEXICO:** Mexico City: 491-70834  
**MINNESOTA:** Minneapolis: (612) 828-9300  
**TEXAS:** Dallas: (214) 917-3881  
**CANADA:** Nepean: (613) 726-1970

## Customer Response Center

**TOLL FREE:** (800) 336-5236  
**OUTSIDE USA:** (214) 995-6611  
(8:00 a.m. – 5:00 p.m. CST)

# TI Authorized North American Distributors

Alliance Electronics, Inc. (military product only)  
Almac/Arrow  
Anthem Electronics  
Arrow/Schweber  
Future Electronics (Canada)  
GRS Electronics Co., Inc.  
Hall-Mark Electronics  
Marshall Industries  
Newark Electronics  
Rochester Electronics, Inc.  
(obsolete product only (508) 462-9332)  
Wyle Laboratories  
Zeus Components

# TI Distributors

**ALABAMA:** Arrow/Schweber (205) 837-6955; Hall-Mark (205) 837-8700; Marshall (205) 881-9235.  
**ARIZONA:** Anthem (602) 966-6600; Arrow/Schweber (602) 437-0750; Hall-Mark (602) 431-0030; Marshall (602) 496-0290; Wyle (602) 437-2088.  
**CALIFORNIA:** Los Angeles/Orange County: Anthem (818) 775-1333, (714) 768-4444; Arrow/Schweber (818) 380-9686, (714) 838-5422; Hall-Mark (818) 773-4500, (714) 727-6000; Marshall (818) 878-7000, (714) 458-5301; Wyle (818) 880-9000, (714) 863-9953; Zeus (714) 921-9000, (818) 889-3838;  
**Sacramento:** Anthem (916) 624-9744; Hall-Mark (916) 624-9781; Marshall (916) 635-9700; Wyle (916) 638-5282;  
**San Diego:** Anthem (619) 453-9005; Arrow/Schweber (619) 565-4800; Hall-Mark (619) 268-1201; Marshall (619) 578-9600; Wyle (619) 565-9171; Zeus (619) 277-9681.  
**San Francisco Bay Area:** Anthem (408) 453-1200; Arrow/Schweber (408) 441-9700, (510) 430-9477; Hall-Mark (408) 432-4000; Marshall (408) 942-4600; Wyle (408) 727-2500; Zeus (408) 629-4789.  
**COLORADO:** Anthem (303) 790-4500; Arrow/Schweber (303) 799-0258; Hall-Mark (303) 790-1662; Marshall (303) 451-8383; Wyle (303) 457-9953.  
**CONNECTICUT:** Anthem (203) 575-1575; Arrow/Schweber (203) 265-7741; Hall-Mark (203) 271-2844; Marshall (203) 265-3822.  
**FLORIDA:** Fort Lauderdale: Arrow/Schweber (305) 429-8200; Hall-Mark (305) 971-9280; Marshall (305) 977-4880.  
**Orlando:** Arrow/Schweber (407) 333-9300; Hall-Mark (407) 830-5855; Marshall (407) 767-8585; Zeus (407) 788-9100.  
**Tampa:** Hall-Mark (813) 541-7440; Marshall (813) 573-1399.  
**GEORGIA:** Arrow/Schweber (404) 497-1300; Hall-Mark (404) 623-4400; Marshall (404) 923-5750.  
**ILLINOIS:** Anthem (708) 884-0200; Arrow/Schweber (708) 250-0500; Hall-Mark (312) 860-3800; Marshall (708) 490-0155; Newark (312) 784-5100.  
**INDIANA:** Arrow/Schweber (317) 299-2071; Hall-Mark (317) 872-8875; Marshall (317) 297-0483.  
**IOWA:** Arrow/Schweber (319) 395-7230.  
**KANSAS:** Arrow/Schweber (913) 541-9542; Hall-Mark (913) 888-4747; Marshall (913) 492-3121.  
**MARYLAND:** Anthem (301) 995-6640; Arrow/Schweber (301) 596-7800; Hall-Mark (301) 988-9800; Marshall (301) 622-1118; Zeus (301) 997-1118.  
**MASSACHUSETTS:** Anthem (508) 657-5170; Arrow/Schweber (508) 658-0900; Hall-Mark (508) 667-0902; Marshall (508) 658-0810; Wyle (617) 272-7300; Zeus (617) 246-8200.



**MICHIGAN:** Detroit: Arrow/Schweber (313) 462-2290; Hall-Mark (313) 416-5800; Marshall (313) 525-5850; Newark (313) 967-0600.  
**MINNESOTA:** Anthem (612) 944-5454; Arrow/Schweber (612) 941-5280; Hall-Mark (612) 881-2600; Marshall (612) 559-2211.  
**MISSOURI:** Arrow/Schweber (314) 567-6888; Hall-Mark (314) 291-5350; Marshall (314) 291-4650.  
**NEW JERSEY:** Anthem (201) 227-7960; Arrow/Schweber (201) 227-7880, (609) 596-8000; Hall-Mark (201) 515-3000, (609) 235-1900; Marshall (201) 882-0320, (609) 234-9100.  
**NEW MEXICO:** Alliance (505) 292-3360.  
**NEW YORK:** Long Island: Anthem (516) 864-6600; Arrow/Schweber (516) 231-1000; Hall-Mark (516) 737-0600; Marshall (516) 273-2424; Zeus (914) 937-7400.  
**Rochester:** Arrow/Schweber (716) 427-0300; Hall-Mark (716) 425-3300; Marshall (716) 235-7620.  
**Syracuse:** Marshall (607) 785-2345.  
**NORTH CAROLINA:** Arrow/Schweber (919) 876-3132; Hall-Mark (919) 872-0712; Marshall (919) 878-9882.  
**OHIO:** Cleveland: Arrow/Schweber (216) 248-3990; Hall-Mark (216) 349-4632; Marshall (216) 248-1788.  
**Columbus:** Hall-Mark (614) 888-3313.  
**Dayton:** Arrow/Schweber (513) 435-5563; Marshall (513) 898-4480; Zeus (513) 293-6162.  
**OKLAHOMA:** Arrow/Schweber (918) 252-7537; Hall-Mark (918) 254-6110.  
**OREGON:** Almac/Arrow (503) 629-8090; Anthem (503) 643-1114; Marshall (503) 644-5050; Wyle (503) 643-7900.  
**PENNSYLVANIA:** Anthem (215) 443-5150; Arrow/Schweber (215) 928-1800; GRS (215) 922-7037; (609) 964-8560; Marshall (412) 788-0441.  
**TEXAS:** Austin: Arrow/Schweber (512) 835-4180; Hall-Mark (512) 258-8848; Marshall (512) 837-1991; Wyle (512) 345-8853;  
**Dallas:** Anthem (214) 238-7100; Arrow/Schweber (214) 380-6464; Hall-Mark (214) 553-4300; Marshall (214) 233-5200; Wyle (214) 235-9953; Zeus (214) 783-7010;  
**Houston:** Arrow/Schweber (713) 530-4700; Hall-Mark (713) 781-6100; Marshall (713) 467-1666; Wyle (713) 879-9953.  
**UTAH:** Anthem (801) 973-8555; Arrow/Schweber (801) 973-6913; Marshall (801) 973-2288; Wyle (801) 974-9953.  
**WASHINGTON:** Almac/Arrow (206) 643-9992, Anthem (206) 483-1700; Marshall (206) 486-5747; Wyle (206) 881-1150.  
**WISCONSIN:** Arrow/Schweber (414) 792-0150; Hall-Mark (414) 797-7844; Marshall (414) 797-8400.  
**CANADA:** Calgary: Future (403) 235-5325;  
**Edmonton:** Future (403) 438-2858;  
**Montreal:** Arrow/Schweber (514) 421-7411; Future (514) 694-7710; Marshall (514) 694-8142  
**Ottawa:** Arrow/Schweber (613) 226-6903; Future (613) 820-8313.  
**Quebec:** Future (418) 897-6666.  
**Toronto:** Arrow/Schweber (416) 670-7769; Future (416) 612-9200; Marshall (416) 458-8046.  
**Vancouver:** Arrow/Schweber (604) 421-2333; Future (604) 294-1166.

## TI Die Processors

|                       |                |
|-----------------------|----------------|
| Chip Supply           | (407) 298-7100 |
| Elmo Semiconductor    | (818) 768-7400 |
| Minco Technology Labs | (512) 834-2022 |

D0892



**PACKAGING INFORMATION**

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                         |
|--------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------------------------------|
| <a href="#">5962-87671013A</a> | Active        | Production           | LCCC (FD)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>87671013A<br>TIBPAL20<br>L8-20MFDB |
| 5962-87671013A.A               | Active        | Production           | LCCC (FD)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>87671013A<br>TIBPAL20<br>L8-20MFDB |
| <a href="#">5962-87671043A</a> | Active        | Production           | LCCC (FD)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>87671043A<br>TIBPAL20<br>R4-20MFDB |
| 5962-87671043A.A               | Active        | Production           | LCCC (FD)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>87671043A<br>TIBPAL20<br>R4-20MFDB |
| <a href="#">5962-8767104LA</a> | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767104LA<br>TIBPAL20R4-20M<br>JTB     |
| 5962-8767104LA.A               | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767104LA<br>TIBPAL20R4-20M<br>JTB     |
| <a href="#">8412901XA</a>      | Active        | Production           | LCCC (FK)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412901XA<br>TIBPAL20<br>L8-20MFKB          |
| 8412901XA.A                    | Active        | Production           | LCCC (FK)   28 | 42   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412901XA<br>TIBPAL20<br>L8-20MFKB          |
| <a href="#">8412902LA</a>      | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412902LA<br>TIBPAL20R8-20M<br>JTB          |
| 8412902LA.A                    | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412902LA<br>TIBPAL20R8-20M<br>JTB          |

| Orderable part number             | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                     |
|-----------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|-----------------------------------------|
| <a href="#">8412904LA</a>         | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412904LA<br>TIBPAL20R4-20M<br>JTB      |
| 8412904LA.A                       | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 8412904LA<br>TIBPAL20R4-20M<br>JTB      |
| <a href="#">JM38510/50501BLA</a>  | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50501BLA                    |
| JM38510/50501BLA.A                | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50501BLA                    |
| <a href="#">JM38510/50502BLA</a>  | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50502BLA                    |
| JM38510/50502BLA.A                | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50502BLA                    |
| <a href="#">JM38510/50504BLA</a>  | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50504BLA                    |
| JM38510/50504BLA.A                | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50504BLA                    |
| <a href="#">M38510/50501BLA</a>   | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50501BLA                    |
| <a href="#">M38510/50502BLA</a>   | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50502BLA                    |
| <a href="#">M38510/50504BLA</a>   | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | JM38510/<br>50504BLA                    |
| <a href="#">TIBPAL20R4-20MJT</a>  | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | TIBPAL20R4-20M<br>JT                    |
| TIBPAL20R4-20MJT.A                | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | TIBPAL20R4-20M<br>JT                    |
| <a href="#">TIBPAL20R4-20MJTB</a> | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767104LA<br>TIBPAL20R4-20M<br>JTB |
| TIBPAL20R4-20MJTB.A               | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767104LA<br>TIBPAL20R4-20M<br>JTB |

| Orderable part number             | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                     |
|-----------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|-----------------------------------------|
| <a href="#">TIBPAL20R8-20MJTB</a> | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767102LA<br>TIBPAL20R8-20M<br>JTB |
| TIBPAL20R8-20MJTB.A               | Active        | Production           | CDIP (JT)   24 | 15   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8767102LA<br>TIBPAL20R8-20M<br>JTB |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

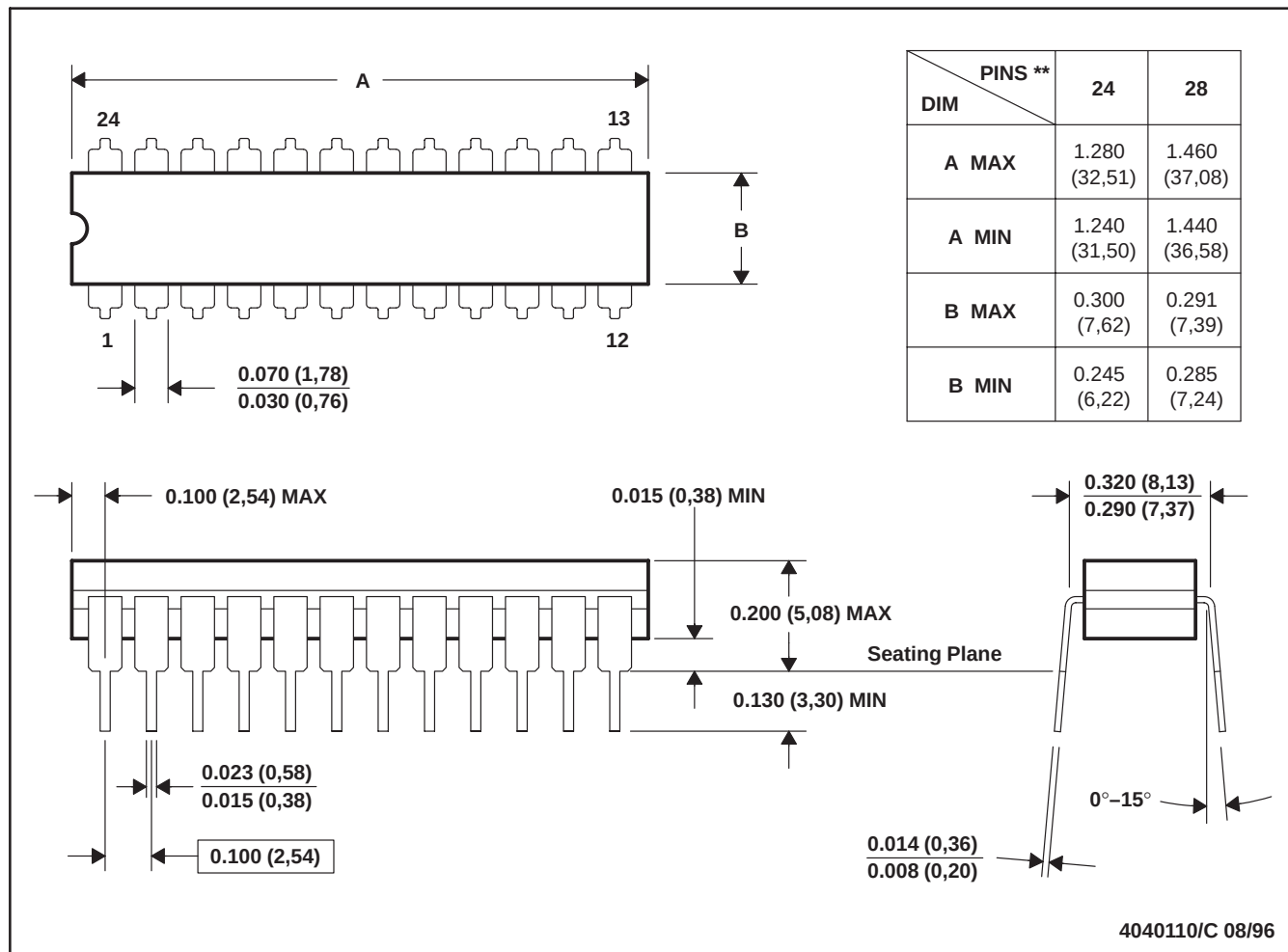
**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## JT (R-GDIP-T\*\*)

## CERAMIC DUAL-IN-LINE

24 LEADS SHOWN



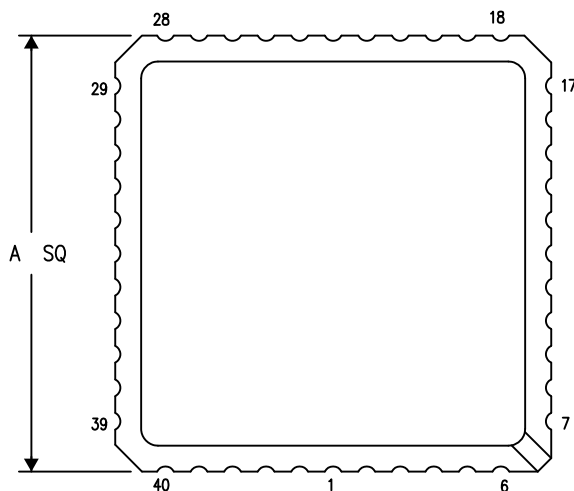
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification.  
 E. Falls within MIL STD 1835 GDIP3-T24, GDIP4-T28, and JEDEC MO-058 AA, MO-058 AB

# MECHANICAL DATA

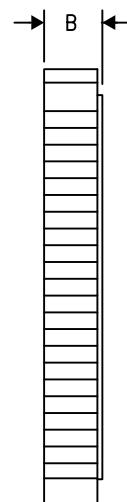
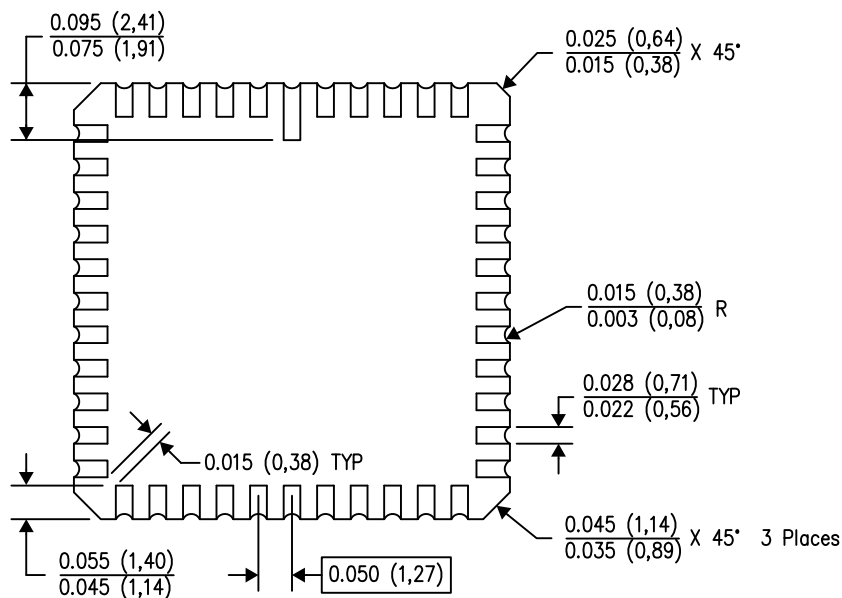
FD (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

44 TERMINAL SHOWN



| NO. OF<br>TERMINALS<br>** | A                |                  | B               |                 |
|---------------------------|------------------|------------------|-----------------|-----------------|
|                           | MIN              | MAX              | MIN             | MAX             |
| 20                        | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.064<br>(1,63) | 0.080<br>(2,03) |
| 28                        | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.064<br>(1,63) | 0.080<br>(2,03) |
| 44                        | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.069<br>(1,75) | 0.120<br>(3,05) |
| 52                        | 0.739<br>(18,78) | 0.761<br>(19,33) | 0.082<br>(2,08) | 0.120<br>(3,05) |
| 68                        | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.082<br>(2,08) | 0.120<br>(3,05) |
| 84                        | 1.135<br>(28,83) | 1.165<br>(29,59) | 0.082<br>(2,08) | 0.120<br>(3,05) |



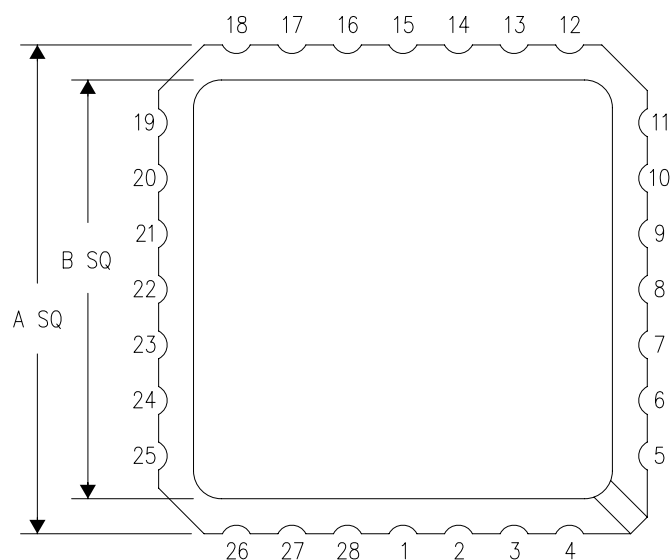
4040136/C 08/12

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - The terminals will be gold plated.
  - Falls within JEDEC MS-004.

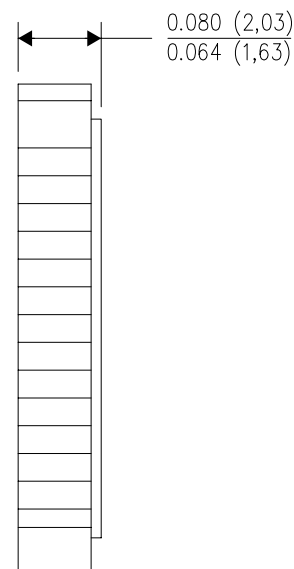
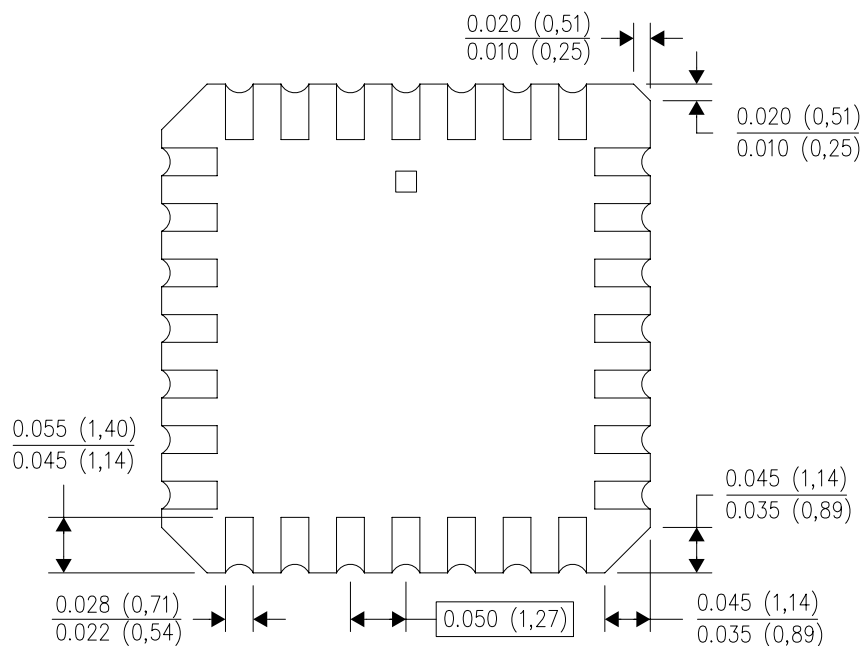
FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



| NO. OF<br>TERMINALS<br>** | A                |                  | B                |                  |
|---------------------------|------------------|------------------|------------------|------------------|
|                           | MIN              | MAX              | MIN              | MAX              |
| 20                        | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.307<br>(7,80)  | 0.358<br>(9,09)  |
| 28                        | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.406<br>(10,31) | 0.458<br>(11,63) |
| 44                        | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 52                        | 0.740<br>(18,78) | 0.761<br>(19,32) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 68                        | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.850<br>(21,6)  | 0.858<br>(21,8)  |
| 84                        | 1.141<br>(28,99) | 1.165<br>(29,59) | 1.047<br>(26,6)  | 1.063<br>(27,0)  |



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#), [TI's General Quality Guidelines](#), or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2025, Texas Instruments Incorporated

Last updated 10/2025