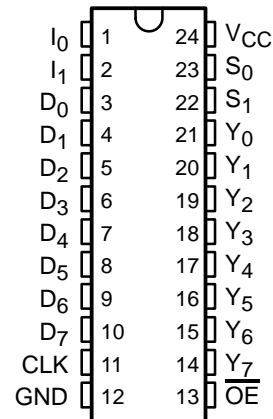


# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

SCCS011C – MAY 1994 – REVISED NOVEMBER 2001

- Function, Pinout, and Drive Compatible With FCT, F Logic, and AM29520
- Reduced  $V_{OH}$  (Typically = 3.3 V) Version of Equivalent FCT Functions
- Edge-Rate Control Circuitry for Significantly Improved Noise Characteristics
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Matched Rise and Fall Times
- Fully Compatible With TTL Input and Output Logic Levels
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)
- Single- and Dual-Pipeline Operation Modes
- Multiplexed Data Inputs and Outputs
- CY29FCT520T
  - 64-mA Output Sink Current
  - 32-mA Output Source Current
- CY29FCT520ATDMB, CY29FCT520BTDMB
  - 32-mA Output Sink Current
  - 12-mA Output Source Current
- 3-State Outputs

D, P, OR SO PACKAGE  
(TOP VIEW)



## description

The CY29FCT520T is a multilevel 8-bit-wide pipeline register. The device consists of four registers, A1, A2, B1, and B2, which are configured by the instruction inputs  $I_0$ ,  $I_1$  as a single four-level pipeline or as two two-level pipelines. The contents of any register can be read at the multiplexed output at any time by using the multiplex-selection controls ( $S_0$  and  $S_1$ ).

The pipeline registers are positive-edge triggered, and data is shifted by the rising edge of the clock input. Instruction  $I = 0$  selects the four-level pipeline mode. Instruction  $I = 1$  selects the two-level B pipeline, while  $I = 2$  selects the two-level A pipeline.  $I = 3$  is the hold instruction; no shifting is performed by the clock in this mode.

In the two-level operation mode, data is shifted from level 1 to level 2 and new data is loaded into level 1.

This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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**

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# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

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**PIPELINE INSTRUCTION TABLE**

| I = 0              |                    | I = 1              |                    | I = 2              |                    | I = 3              |                    |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| I <sub>1</sub> = 0 | I <sub>0</sub> = 0 | I <sub>1</sub> = 0 | I <sub>0</sub> = 1 | I <sub>1</sub> = 1 | I <sub>0</sub> = 0 | I <sub>1</sub> = 1 | I <sub>0</sub> = 1 |
|                    |                    |                    |                    |                    |                    |                    |                    |
| Single four-level  |                    | Dual two-level     |                    |                    |                    | Hold               |                    |

**ORDERING INFORMATION**

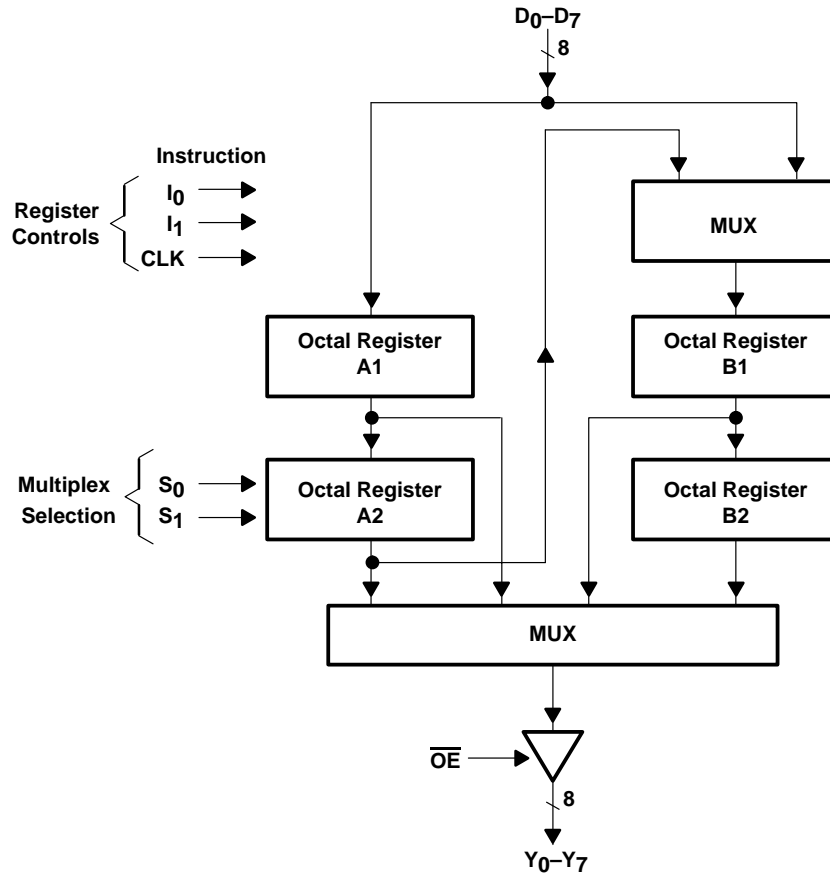
| T <sub>A</sub> | PACKAGE†  |               | SPEED (ns)       | ORDERABLE PART NUMBER                | TOP-SIDE MARKING |
|----------------|-----------|---------------|------------------|--------------------------------------|------------------|
| -40°C to 85°C  | SOIC – SO | Tube          | 6.0              | CY29FCT520CTSOC                      | 29FCT520C        |
|                |           | Tape and reel | 6.0              | CY29FCT520CTSOCT                     |                  |
|                | SOIC – SO | Tube          | 7.5              | CY29FCT520BTSOC                      | 29FCT520B        |
|                |           | Tape and reel | 7.5              | CY29FCT520BTSOCT                     |                  |
|                | DIP – P   | Tube          | 14.0             | CY29FCT520ATPC                       | CY29FCT520ATPC   |
|                | SOIC – SO | Tube          | 14.0             | CY29FCT520ATSOC                      | 29FCT520A        |
| Tape and reel  |           | 14.0          | CY29FCT520ATSOCT |                                      |                  |
| -55°C to 125°C | CDIP – D  | Tube          | 8.0              | 5962-9220504MLA<br>(CY29FCT520BTDMB) |                  |
|                |           | Tube          | 16.0             | 5962-9220502MLA<br>(CY29FCT520ATDMB) |                  |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

**FUNCTION TABLE**

| INPUTS         |                | OUTPUT |
|----------------|----------------|--------|
| S <sub>1</sub> | S <sub>0</sub> |        |
| 1              | 1              | A1     |
| 1              | 0              | A2     |
| 0              | 1              | B1     |
| 0              | 0              | B2     |

**logic diagram**



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

|  |                |
|--|----------------|
| Supply voltage range to ground potential .....                         | -0.5 V to 7 V  |
| DC input voltage range .....   | -0.5 V to 7 V  |
| DC output voltage range .....  | -0.5 V to 7 V  |
| DC output current (maximum sink current/pin) .....                     | 120 mA         |
| Package thermal impedance, $\theta_{JA}$ (see Note 1): P package ..... | 67°C/W         |
| (see Note 2): SO package .....   | 46°C/W         |
| Ambient temperature range with power applied, $T_A$ .....              | -65°C to 135°C |
| Storage temperature range, $T_{stg}$ .....                             | -65°C to 150°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The package thermal impedance is calculated in accordance with JESD 51-3.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

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## recommended operating conditions (see Note 3)

|                 |                                | CY29FCT520ATDMB<br>CY29FCT520BTDMB |     |     | CY29FCT520T |     |      | UNIT |
|-----------------|--------------------------------|------------------------------------|-----|-----|-------------|-----|------|------|
|                 |                                | MIN                                | NOM | MAX | MIN         | NOM | MAX  |      |
| V <sub>CC</sub> | Supply voltage                 | 4.5                                | 5   | 5.5 | 4.75        | 5   | 5.25 | V    |
| V <sub>IH</sub> | High-level input voltage       | 2                                  |     |     | 2           |     |      | V    |
| V <sub>IL</sub> | Low-level input voltage        |                                    |     | 0.8 |             |     | 0.8  | V    |
| I <sub>OH</sub> | High-level output current      |                                    |     | -12 |             |     | -32  | mA   |
| I <sub>OL</sub> | Low-level output current       |                                    |     | 32  |             |     | 64   | mA   |
| T <sub>A</sub>  | Operating free-air temperature | -55                                |     | 125 | -40         |     | 85   | °C   |

NOTE 3: All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER         | TEST CONDITIONS  | CY29FCT520ATDMB<br>CY29FCT520BTDMB |      |      | CY29FCT520T |      |      | UNIT |
|-------------------|--|------------------------------------|------|------|-------------|------|------|------|
|                   |  | MIN                                | TYP† | MAX  | MIN         | TYP† | MAX  |      |
| V <sub>IK</sub>   | V <sub>CC</sub> = 4.5 V, I <sub>IN</sub> = -18 mA  |                                    | -0.7 | -1.2 |             |      |      | V    |
|                   | V <sub>CC</sub> = 4.75 V, I <sub>IN</sub> = -18 mA   |                                    |      |      | -0.7        | -1.2 |      |      |
| V <sub>OH</sub>   | V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -12 mA  | 2.4                                | 3.3  |      |             |      |      | V    |
|                   | V <sub>CC</sub> = 4.75 V   | I <sub>OH</sub> = -15 mA           |      |      | 2.4         | 3.3  |      |      |
|                   |  | I <sub>OH</sub> = -32 mA           |      |      |             | 2    |      |      |
| V <sub>OL</sub>   | V <sub>CC</sub> = 4.5 V, I <sub>OL</sub> = 32 mA   |                                    | 0.3  | 0.55 |             |      |      | V    |
|                   | V <sub>CC</sub> = 4.75 V, I <sub>OL</sub> = 64 mA  |                                    |      |      | 0.3         | 0.55 |      |      |
| V <sub>hys</sub>  | All inputs   |                                    | 0.2  |      | 0.2         |      |      | V    |
| I <sub>I</sub>    | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = V <sub>CC</sub>                                   |                                    |      | 5    |             |      |      | μA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = V <sub>CC</sub>                                  |                                    |      |      |             | 5    |      |      |
| I <sub>IH</sub>   | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 2.7 V   |                                    |      | ±1   |             |      |      | μA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 2.7 V  |                                    |      |      |             | ±1   |      |      |
| I <sub>IL</sub>   | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 0.5 V   |                                    |      | ±1   |             |      |      | μA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 0.5 V  |                                    |      |      |             | ±1   |      |      |
| I <sub>off</sub>  | V <sub>CC</sub> = 0 V, V <sub>OUT</sub> = 4.5 V  |                                    |      | ±1   |             |      | ±1   | μA   |
| I <sub>OS</sub> ‡ | V <sub>CC</sub> = 5.5 V, V <sub>OUT</sub> = 0 V  | -60                                | -120 | -225 |             |      |      | mA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>OUT</sub> = 0 V   |                                    |      |      | -60         | -120 | -225 |      |
| I <sub>OZH</sub>  | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 2.7 V   |                                    |      | 10   |             |      |      | μA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 2.7 V  |                                    |      |      |             | 10   |      |      |
| I <sub>OZL</sub>  | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 0.5 V   |                                    |      | -10  |             |      |      | μA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 0.5 V  |                                    |      |      |             | -10  |      |      |
| I <sub>CC</sub>   | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> ≤ 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V  |                                    | 0.1  | 0.2  |             |      |      | mA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> ≤ 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V |                                    |      |      | 0.1         | 0.2  |      |      |
| ΔI <sub>CC</sub>  | V <sub>CC</sub> = 5.5 V, V <sub>IN</sub> = 3.4 V§, f <sub>1</sub> = 0, Outputs open          |                                    | 0.5  | 2    |             |      |      | mA   |
|                   | V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 3.4 V§, f <sub>1</sub> = 0, Outputs open         |                                    |      |      | 0.5         | 2    |      |      |

† 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. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample-and-hold techniques are preferable to minimize internal chip heating and more accurately reflect operational values. Otherwise, prolonged shorting of a high output can raise the chip temperature well above normal and cause invalid readings in other parametric tests. In any sequence of parameter tests, I<sub>OS</sub> tests should be performed last.

§ Per TTL-driven input (V<sub>IN</sub> = 3.4 V); all other inputs at V<sub>CC</sub> or GND



**CY29FCT520T**  
**MULTILEVEL PIPELINE REGISTER**  
**WITH 3-STATE OUTPUTS**

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**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted) (continued)**

| PARAMETER            | TEST CONDITIONS   |  | CY29FCT520ATDMB<br>CY29FCT520BTDMB                     |      |      | CY29FCT520T |      |     | UNIT       |
|----------------------|---|--|--|------|------|-------------|------|-----|------------|
|                      |   |  | MIN  | TYP† | MAX  | MIN         | TYP† | MAX |            |
| $I_{CCD}^{\ddagger}$ | $V_{CC} = 5.5$ V, Outputs open,<br>One bit switching at 50% duty cycle, $\overline{OE} = GND$ ,<br>$V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V  |  |  | 0.06 | 0.12 |             |      |     | mA/<br>MHz |
|                      | $V_{CC} = 5.25$ V, Outputs open,<br>One bit switching at 50% duty cycle, $\overline{OE} = GND$ ,<br>$V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V |  |  |      |      | 0.06        | 0.12 |     |            |
| $I_C^{\#}$           | $V_{CC} = 5.5$ V,<br>Outputs open,<br>$f_0 = 10$ MHz,<br>$\overline{OE} = GND$  | One bit switching<br>at $f_1 = 5$ MHz at<br>50% duty cycle       | $V_{IN} \leq 0.2$ V or<br>$V_{IN} \geq V_{CC} - 0.2$ V | 0.7  | 1.4  |             |      |     | mA         |
|                      |   |  | $V_{IN} = 3.4$ V or GND                                | 1.2  | 3.4  |             |      |     |            |
|                      |   | Eight bits<br>switching at<br>$f_1 = 5$ MHz at<br>50% duty cycle | $V_{IN} \leq 0.2$ V or<br>$V_{IN} \geq V_{CC} - 0.2$ V | 2.8  | 5.6  |             |      |     |            |
|                      |   |  | $V_{IN} = 3.4$ V or GND                                | 5.1  | 14.3 |             |      |     |            |
|                      | $V_{CC} = 5.25$ V,<br>Outputs open,<br>$f_0 = 10$ MHz,<br>$\overline{OE} = GND$   | One bit switching<br>at $f_1 = 5$ MHz at<br>50% duty cycle       | $V_{IN} \leq 0.2$ V or<br>$V_{IN} \geq V_{CC} - 0.2$ V |      |      | 0.7         | 1.4  |     |            |
|                      |   |  | $V_{IN} = 3.4$ V or GND                                |      |      | 1.2         | 3.4  |     |            |
|                      |   | Eight bits<br>switching at<br>$f_1 = 5$ MHz at<br>50% duty cycle | $V_{IN} \leq 0.2$ V or<br>$V_{IN} \geq V_{CC} - 0.2$ V |      |      | 2.8         | 5.6  |     |            |
|                      |   |  | $V_{IN} = 3.4$ V or GND                                |      |      | 5.1         | 14.3 |     |            |
| $C_i$                |   |  |  | 5    | 10   |             | 5    | 10  | pF         |
| $C_o$                |   |  |  | 9    | 12   |             | 9    | 12  | pF         |

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

‡ This parameter is derived for use in total power-supply calculations.

#  $I_C = I_{CC} + \Delta I_{CC} \times D_H \times N_T + I_{CCD} (f_0/2 + f_1 \times N_1)$

Where:

$I_C$  = Total supply current

$I_{CC}$  = Power-supply current with CMOS input levels

$\Delta I_{CC}$  = Power-supply current for a TTL high input ( $V_{IN} = 3.4$  V)

$D_H$  = Duty cycle for TTL inputs high

$N_T$  = Number of TTL inputs at  $D_H$

$I_{CCD}$  = Dynamic current caused by an input transition pair (HLH or LHL)

$f_0$  = Clock frequency for registered devices, otherwise zero

$f_1$  = Input signal frequency

$N_1$  = Number of inputs changing at  $f_1$

All currents are in milliamperes and all frequencies are in megahertz.

|| Values for these conditions are examples of the  $I_{CC}$  formula.



# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

|          |                                   | CY29FCT520ATDMB |     | CY29FCT520BTDMB |     | UNIT |
|----------|-----------------------------------|-----------------|-----|-----------------|-----|------|
|          |                                   | MIN             | MAX | MIN             | MAX |      |
| $t_w$    | Pulse duration, CLK high or low   | 8               |     | 6               |     | ns   |
| $t_{su}$ | Setup time, before CLK $\uparrow$ | Data            | 6   | 2.8             |     | ns   |
|          |                                   | I               | 6   | 4.5             |     |      |
| $t_h$    | Hold time, after CLK $\uparrow$   | Data            | 2   | 2               |     | ns   |
|          |                                   | I               | 2   | 2               |     |      |

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

|          |                                   | CY29FCT520AT |     | CY29FCT520BT |     | CY29FCT520CT |     | UNIT |
|----------|-----------------------------------|--------------|-----|--------------|-----|--------------|-----|------|
|          |                                   | MIN          | MAX | MIN          | MAX | MIN          | MAX |      |
| $t_w$    | Pulse duration, CLK high or low   | 7            |     | 5.5          |     | 5.5          |     | ns   |
| $t_{su}$ | Setup time, before CLK $\uparrow$ | Data         | 5   | 2.5          |     | 2.5          |     | ns   |
|          |                                   | I            | 5   | 4            |     | 4            |     |      |
| $t_h$    | Hold time, after CLK $\uparrow$   | Data         | 2   | 2            |     | 2            |     | ns   |
|          |                                   | I            | 2   | 2            |     | 2            |     |      |

switching characteristics over operating free-air temperature range (see Figure 1)

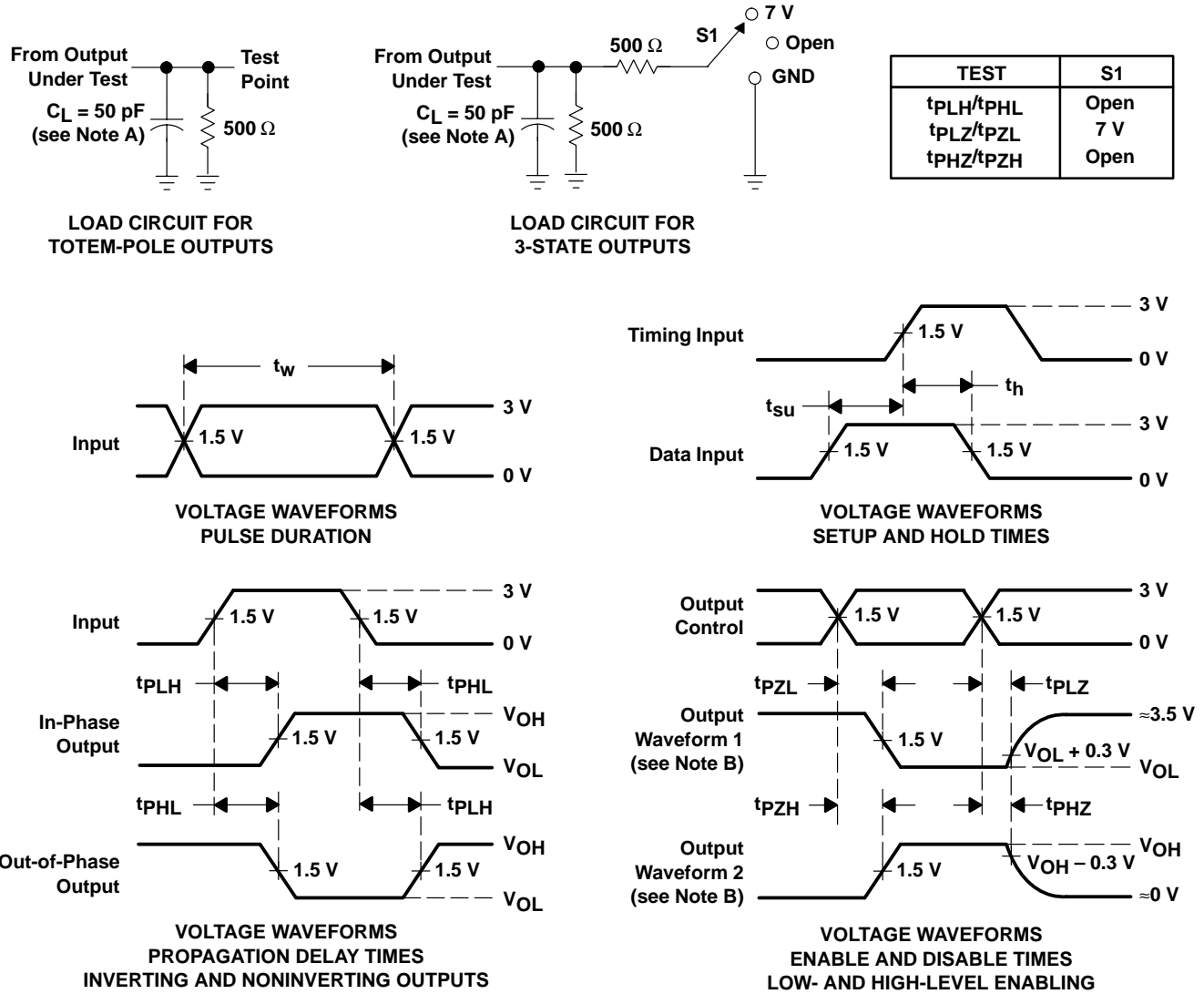
| PARAMETER | FROM (INPUT)    | TO (OUTPUT) | CY29FCT520ATDMB |     | CY29FCT520BTDMB |     | UNIT |
|-----------|-----------------|-------------|-----------------|-----|-----------------|-----|------|
|           |                 |             | MIN             | MAX | MIN             | MAX |      |
| $t_{PLH}$ | CLK             | Y           | 2               | 16  | 2               | 8   | ns   |
| $t_{PHL}$ |                 |             | 2               | 16  | 2               | 8   |      |
| $t_{PLH}$ | $S_0$ or $S_1$  | Y           | 2               | 15  | 2               | 8   | ns   |
| $t_{PHL}$ |                 |             | 2               | 15  | 2               | 8   |      |
| $t_{PHZ}$ | $\overline{OE}$ | Y           | 1.5             | 13  | 1.5             | 7.5 | ns   |
| $t_{PLZ}$ |                 |             | 1.5             | 13  | 1.5             | 7.5 |      |
| $t_{PZH}$ | $\overline{OE}$ | Y           | 1.5             | 16  | 1.5             | 8   | ns   |
| $t_{PZL}$ |                 |             | 1.5             | 16  | 1.5             | 8   |      |

switching characteristics over operating free-air temperature range (see Figure 1)

| PARAMETER | FROM (INPUT)    | TO (OUTPUT) | CY29FCT520AT |     | CY29FCT520BT |     | CY29FCT520CT |     | UNIT |
|-----------|-----------------|-------------|--------------|-----|--------------|-----|--------------|-----|------|
|           |                 |             | MIN          | MAX | MIN          | MAX | MIN          | MAX |      |
| $t_{PLH}$ | CLK             | Y           | 2            | 14  | 2            | 7.5 | 2            | 6   | ns   |
| $t_{PHL}$ |                 |             | 2            | 14  | 2            | 7.5 | 2            | 6   |      |
| $t_{PLH}$ | $S_0$ or $S_1$  | Y           | 2            | 13  | 2            | 7.5 | 2            | 6   | ns   |
| $t_{PHL}$ |                 |             | 2            | 13  | 2            | 7.5 | 2            | 6   |      |
| $t_{PHZ}$ | $\overline{OE}$ | Y           | 1.5          | 12  | 1.5          | 7   | 1.5          | 6   | ns   |
| $t_{PLZ}$ |                 |             | 1.5          | 12  | 1.5          | 7   | 1.5          | 6   |      |
| $t_{PZH}$ | $\overline{OE}$ | Y           | 1.5          | 15  | 1.5          | 7.5 | 1.5          | 6   | ns   |
| $t_{PZL}$ |                 |             | 1.5          | 15  | 1.5          | 7.5 | 1.5          | 6   |      |



**PARAMETER MEASUREMENT INFORMATION**



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 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. The outputs are measured one at a time with one input transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**

**PACKAGING INFORMATION**

| Orderable Device   | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|--------------------|---------------|--------------|-----------------|------|-------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| 5962-9220502MLA    | ACTIVE        | CDIP         | JT              | 24   | 1           | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9220502ML<br>A     | <a href="#">Samples</a> |
| 5962-9220504MLA    | ACTIVE        | CDIP         | JT              | 24   | 1           | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9220504ML<br>A     | <a href="#">Samples</a> |
| CY29FCT520ATSOC    | ACTIVE        | SOIC         | DW              | 24   | 25          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 29FCT520A               | <a href="#">Samples</a> |
| CY29FCT520ATSOCT   | OBSOLETE      | SOIC         | DW              | 24   |             | TBD                        | Call TI                 | Call TI              | -40 to 85    |                         |                         |
| CY29FCT520ATSOCTE4 | OBSOLETE      | SOIC         | DW              | 24   |             | TBD                        | Call TI                 | Call TI              | -40 to 85    |                         |                         |
| CY29FCT520ATSOCTG4 | OBSOLETE      | SOIC         | DW              | 24   |             | TBD                        | Call TI                 | Call TI              | -40 to 85    |                         |                         |
| CY29FCT520BTSOC    | ACTIVE        | SOIC         | DW              | 24   | 25          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 29FCT520B               | <a href="#">Samples</a> |
| CY29FCT520CTSOCE4  | ACTIVE        | SOIC         | DW              | 24   |             | TBD                        | Call TI                 | Call TI              | -40 to 85    |                         | <a href="#">Samples</a> |
| CY29FCT520CTSOCG4  | ACTIVE        | SOIC         | DW              | 24   |             | TBD                        | Call TI                 | Call TI              | -40 to 85    |                         | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.



<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

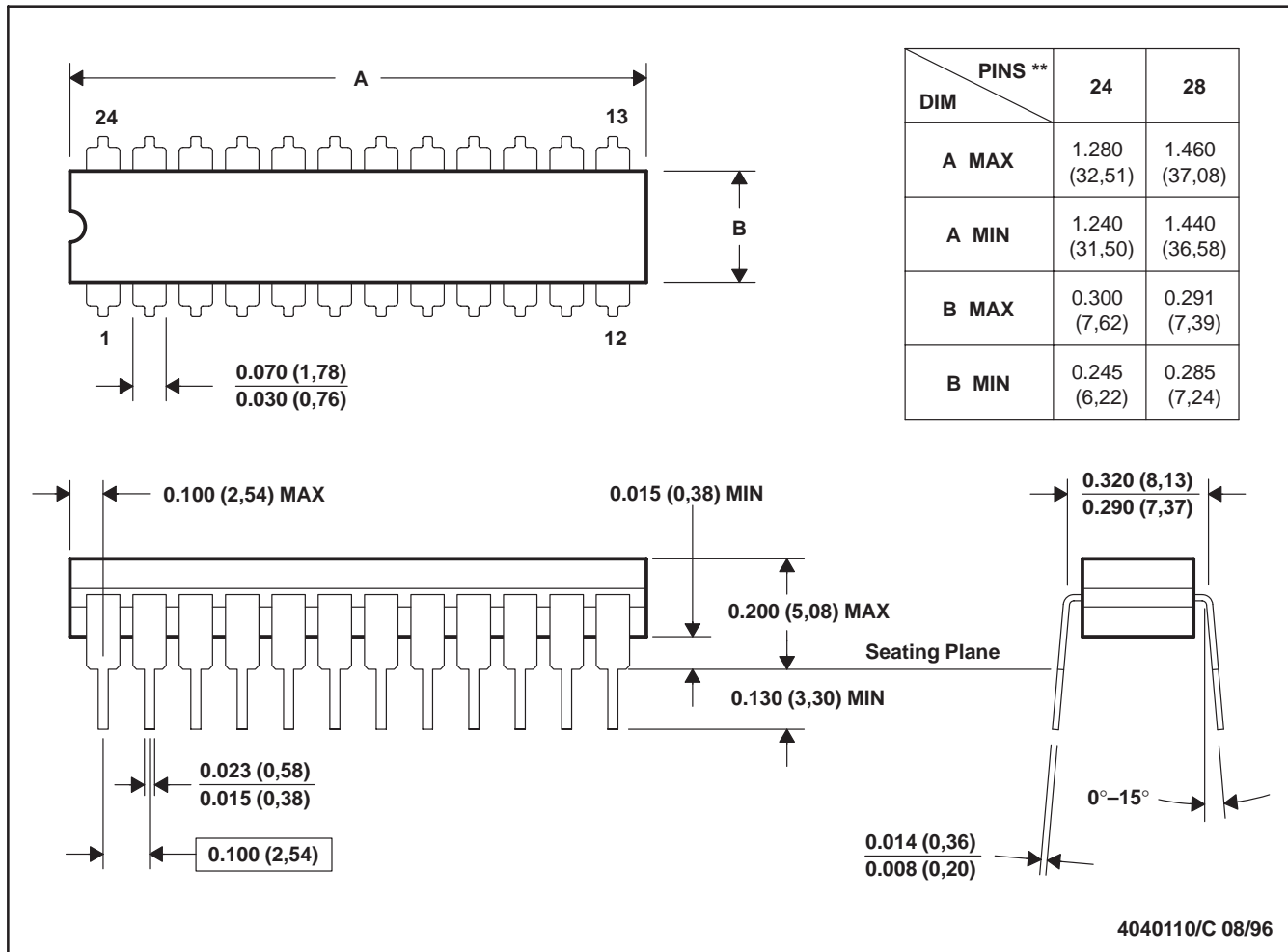
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JT (R-GDIP-T\*\*)

CERAMIC DUAL-IN-LINE

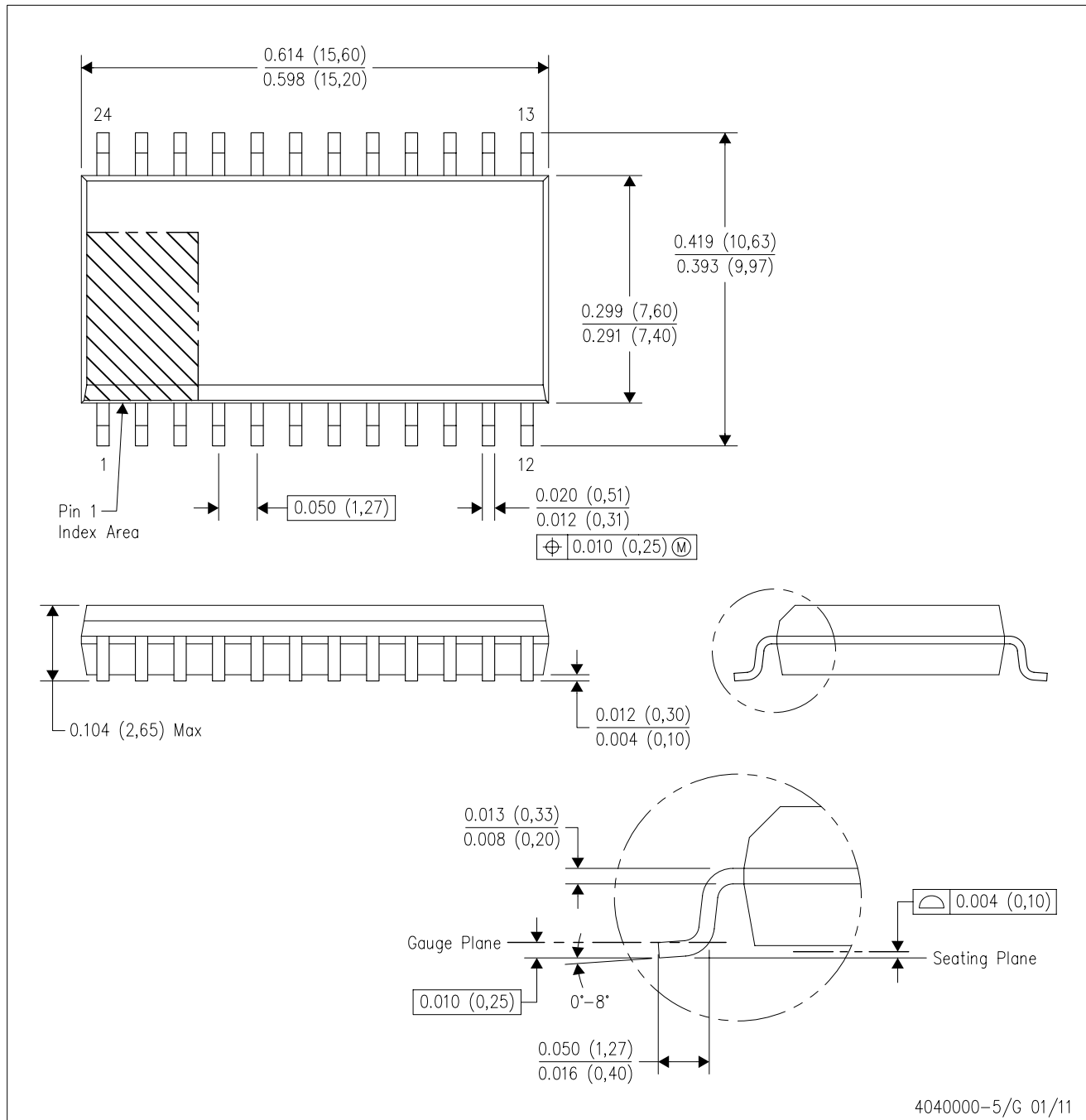
24 LEADS SHOWN



- 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

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-013 variation AD.

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|                               |  |
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