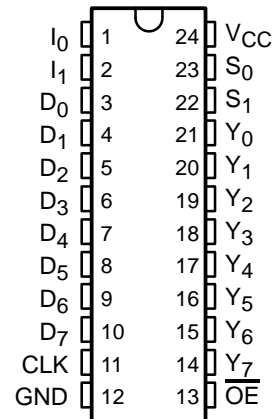


CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

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- 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 ₁ = 0 | I ₀ = 0 | I ₁ = 0 | I ₀ = 1 | I ₁ = 1 | I ₀ = 0 | I ₁ = 1 | I ₀ = 1 |
| | | | | | | | |
| Single four-level | | Dual two-level | | | | Hold | |

ORDERING INFORMATION

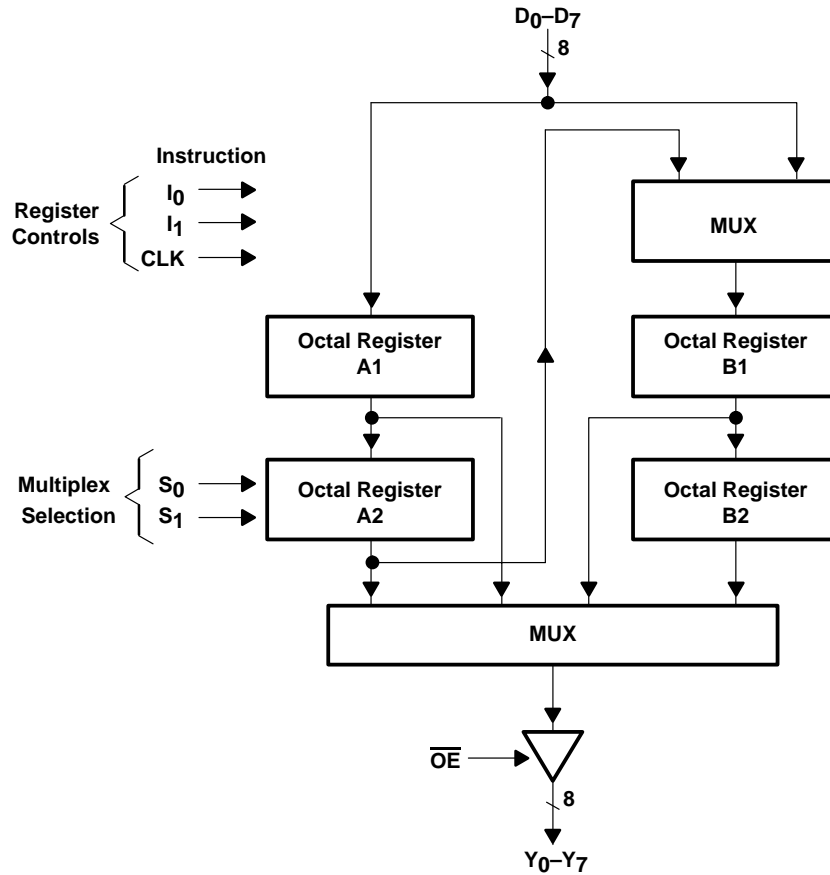
| T _A | PACKAGE† | | SPEED (ns) | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|-----------|---------------|------------------|--------------------------------------|------------------|
| -40°C to 85°C | SOIC – SO | Tube | 6.0 | CY29FCT520CTSOC | 29FCT520C |
| | | Tape and reel | 6.0 | 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 (CY29FCT520BTDMB) | |
| | | Tube | 16.0 | 5962-9220502MLA (CY29FCT520ATDMB) | |

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

FUNCTION TABLE

| INPUTS | | OUTPUT |
|----------------|----------------|--------|
| S ₁ | S ₀ | |
| 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, θ_{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 CY29FCT520BTDMB | | | CY29FCT520T | | | UNIT |
|-----------------|--------------------------------|------------------------------------|-----|-----|-------------|-----|------|------|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| V _{CC} | Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| V _{IH} | High-level input voltage | 2 | | | 2 | | | V |
| V _{IL} | Low-level input voltage | | | 0.8 | | | 0.8 | V |
| I _{OH} | High-level output current | | | -12 | | | -32 | mA |
| I _{OL} | Low-level output current | | | 32 | | | 64 | mA |
| T _A | Operating free-air temperature | -55 | | 125 | -40 | | 85 | °C |

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation.

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

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

† Typical values are at V_{CC} = 5 V, T_A = 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_{OS} tests should be performed last.

§ Per TTL-driven input (V_{IN} = 3.4 V); all other inputs at V_{CC} 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 CY29FCT520BTDMB | | | CY29FCT520T | | | UNIT |
|----------------------|---|--|--|------|------|-------------|------|-----|------------|
| | | | MIN | TYP† | MAX | MIN | TYP† | MAX | |
| I_{CCD}^{\ddagger} | $V_{CC} = 5.5$ V, Outputs open, One bit switching at 50% duty cycle, $\overline{OE} = GND$, $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V | | | 0.06 | 0.12 | | | | mA/ MHz |
| | $V_{CC} = 5.25$ V, Outputs open, One bit switching at 50% duty cycle, $\overline{OE} = GND$, $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V | | | | | 0.06 | 0.12 | | |
| $I_C^{\#}$ | $V_{CC} = 5.5$ V, Outputs open, $f_0 = 10$ MHz, $\overline{OE} = GND$ | One bit switching at $f_1 = 5$ MHz at 50% duty cycle | $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V | 0.7 | 1.4 | | | | mA |
| | | | $V_{IN} = 3.4$ V or GND | 1.2 | 3.4 | | | | |
| | | Eight bits switching at $f_1 = 5$ MHz at 50% duty cycle | $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V | 2.8 | 5.6 | | | | |
| | | | $V_{IN} = 3.4$ V or GND | 5.1 | 14.3 | | | | |
| | $V_{CC} = 5.25$ V, Outputs open, $f_0 = 10$ MHz, $\overline{OE} = GND$ | One bit switching at $f_1 = 5$ MHz at 50% duty cycle | $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ V | | | 0.7 | 1.4 | | |
| | | | $V_{IN} = 3.4$ V or GND | | | 1.2 | 3.4 | | |
| | | Eight bits switching at $f_1 = 5$ MHz at 50% duty cycle | $V_{IN} \leq 0.2$ V or $V_{IN} \geq V_{CC} - 0.2$ 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

ΔI_{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)

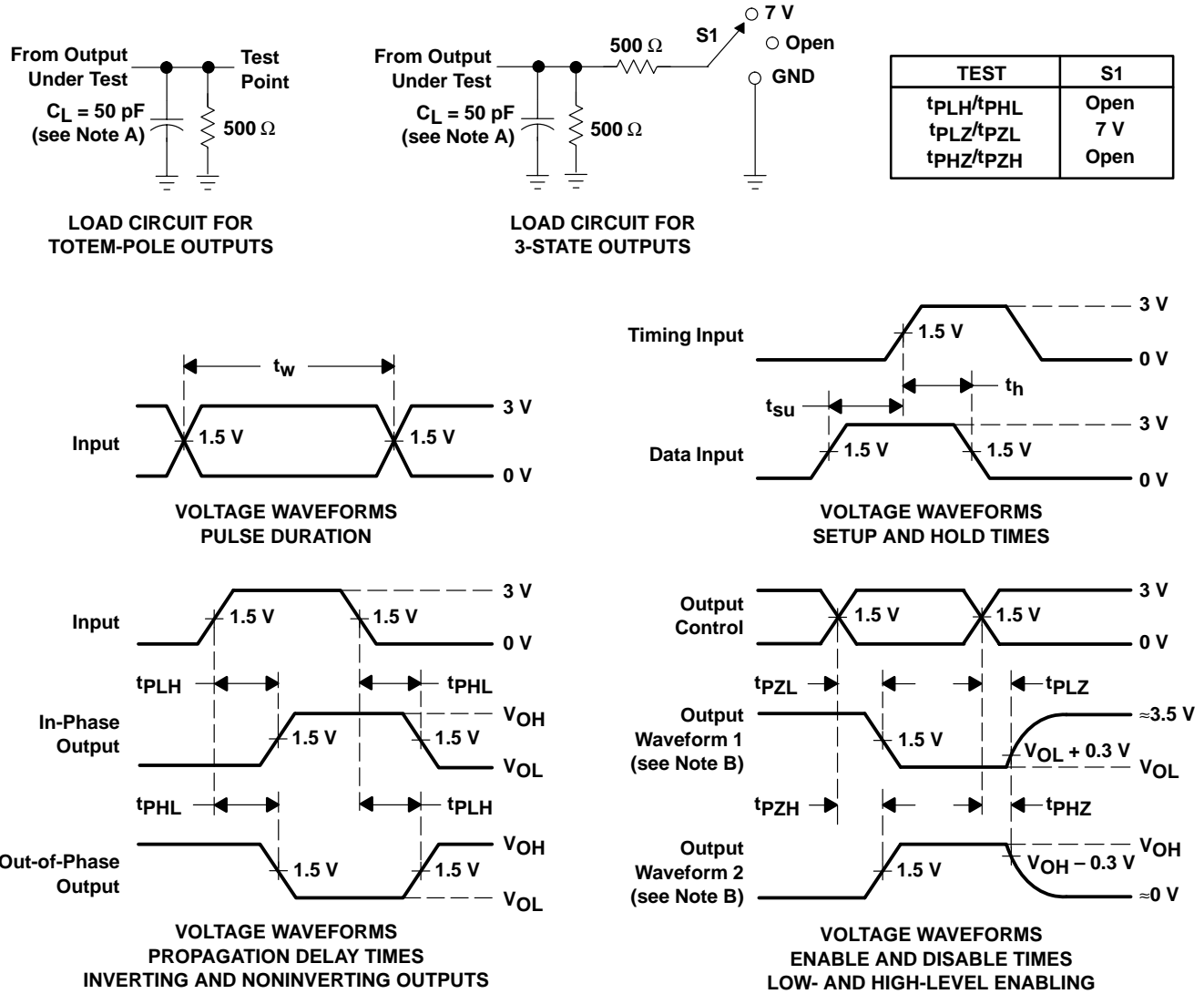
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | CY29FCT520ATDMB | | CY29FCT520BTDMB | | UNIT |
|-----------|-----------------|-------------|-----------------|-----|-----------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| t_{PLH} | CLK | Y | 2 | 16 | 2 | 8 | ns |
| t_{PHL} | | | 2 | 16 | 2 | 8 | |
| 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 ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-9220502MLA | ACTIVE | CDIP | JT | 24 | 1 | TBD | Call TI | Level-NC-NC-NC |
| 5962-9220504MLA | ACTIVE | CDIP | JT | 24 | 1 | TBD | Call TI | Level-NC-NC-NC |
| CY29FCT520ATPC | ACTIVE | PDIP | NT | 24 | 15 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| CY29FCT520ATPCE4 | ACTIVE | PDIP | NT | 24 | 15 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| CY29FCT520ATSOC | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520ATSOCE4 | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520ATSOCT | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520ATSOCTE4 | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520BTSOC | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520BTSOCE4 | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520BTSOCT | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520BTSOCTE4 | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520CTSOC | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520CTSOCE4 | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520CTSOCT | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CY29FCT520CTSOCTE4 | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽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) 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.

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.

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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

NT (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

24 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265