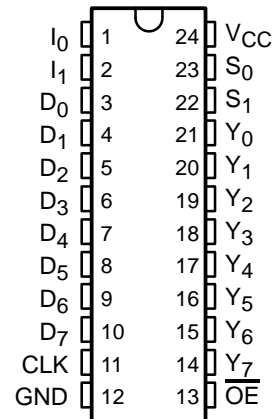


# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

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**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2001, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# CY29FCT520T MULTILEVEL PIPELINE REGISTER WITH 3-STATE OUTPUTS

SCCS011C – MAY 1994 – REVISED NOVEMBER 2001

**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**

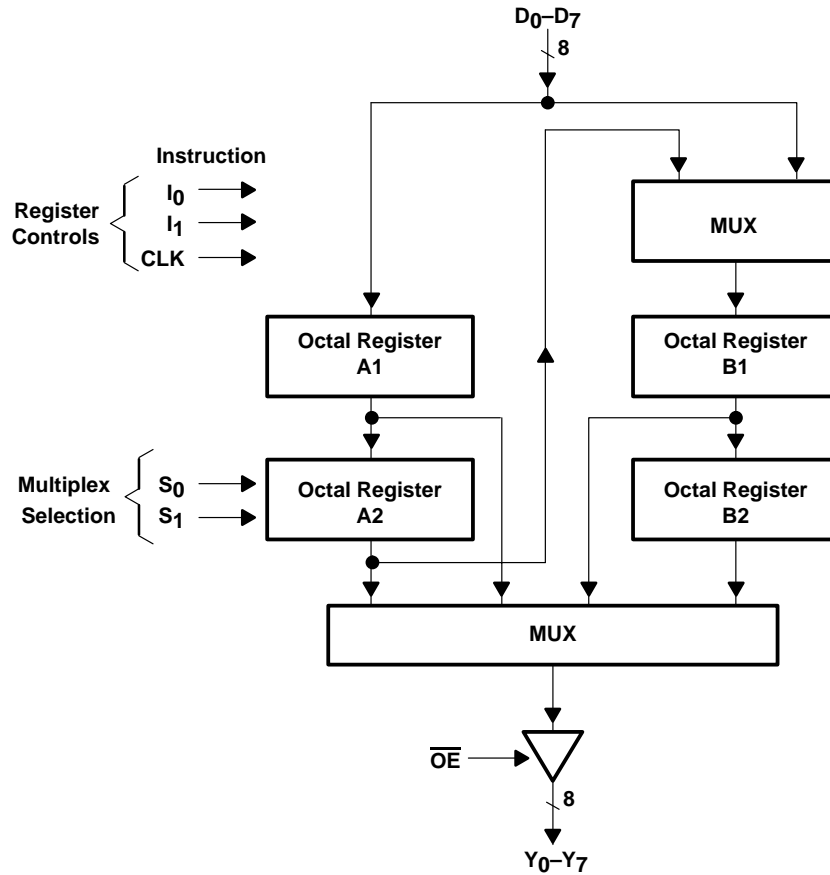
T <sub>A</sub>	PACKAGE†		SPEED (ns)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SOIC – SO	Tube	6.0	CY29FCT520CTSOC	29FCT520C
		Tape and reel	6.0	CY29FCT520CTSOCT	
	SOIC – SO	Tube	7.5	CY29FCT520BTSOC	29FCT520B
		Tape and reel	7.5	CY29FCT520BTSOCT	
	DIP – P	Tube	14.0	CY29FCT520ATPC	CY29FCT520ATPC
	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 (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](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

SCCS011C – MAY 1994 – REVISED NOVEMBER 2001

## recommended operating conditions (see Note 3)

		CY29FCT520ATDMB 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 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

SCCS011C – MAY 1994 – REVISED NOVEMBER 2001

**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

$\Delta I_{CC}$  = 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

SCCS011C – MAY 1994 – REVISED NOVEMBER 2001

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)

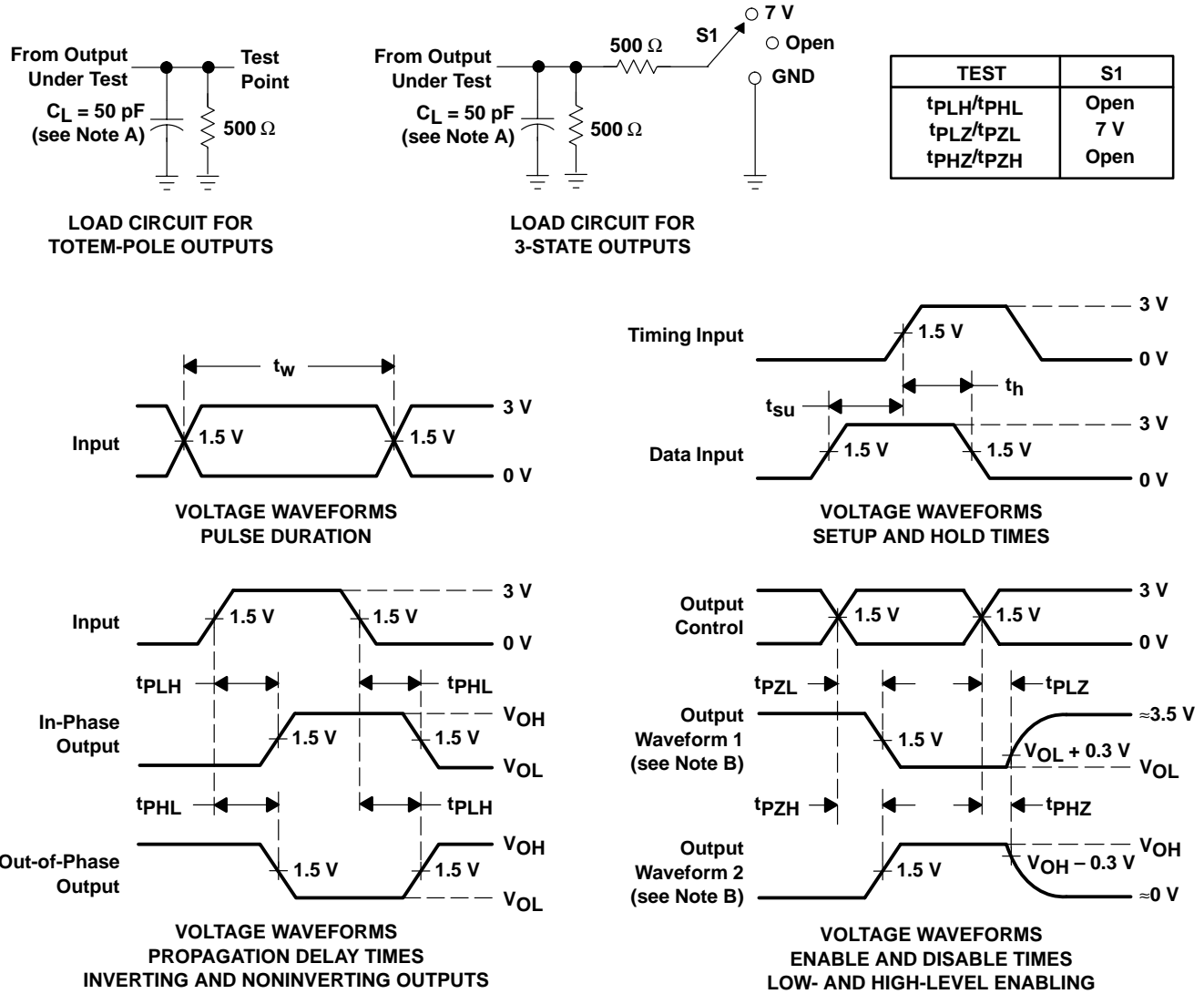
PARAMETER	FROM (INPUT)	TO (OUTPUT)	CY29FCT520ATDMB		CY29FCT520BTDMB		UNIT
			MIN	MAX	MIN	MAX	
$t_{PLH}$	CLK	Y	2	16	2	8	ns
$t_{PHL}$			2	16	2	8	
$t_{PLH}$	$S_0$ or $S_1$	Y	2	15	2	8	ns
$t_{PHL}$			2	15	2	8	
$t_{PHZ}$	$\overline{OE}$	Y	1.5	13	1.5	7.5	ns
$t_{PLZ}$			1.5	13	1.5	7.5	
$t_{PZH}$	$\overline{OE}$	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 finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-9220502MLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9220502ML A	<a href="#">Samples</a>
5962-9220504MLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9220504ML A	<a href="#">Samples</a>
CY29FCT520ATSOC	ACTIVE	SOIC	DW	24	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	29FCT520A	<a href="#">Samples</a>
CY29FCT520BTSOC	ACTIVE	SOIC	DW	24	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	29FCT520B	<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.

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

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

(5) 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.

(6) Lead finish/Ball material - Orderable Devices 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.

**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.

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CY29FCT520ATSOC	DW	SOIC	24	25	506.98	12.7	4826	6.6
CY29FCT520BTSOC	DW	SOIC	24	25	506.98	12.7	4826	6.6

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.

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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 will 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](#) or other applicable terms available either on [ti.com](https://www.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.

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2023, Texas Instruments Incorporated