

# P29FCT520/A/B (P29PCT520/A/B) P29FCT521/A/B (P29PCT521/A/B) PIPELINE REGISTERS

## ★ FEATURES

- Function, Pinout, and Drive Compatible with the FCT and F Logic
- FCT-B speed at 7.5ns max. (Com'1)  
FCT-A speed at 14.0ns max. (Com'1)
- CMOS  $V_{OH}$  Levels for Low Power Consumption  
— Typically 1/3 of FAST Bipolar Logic
- Edge-rate Control Circuitry for Significantly Improved Noise Characteristics
- ESD protection exceeds 2000V
- Inputs and Outputs Interface Directly with TTL, NMOS, and CMOS Devices
- Outputs Meet Levels Required for CMOS Static RAM Low Power Standby Mode
- 64 mA Sink Current (Com'1), 48 mA (MII)  
15 mA Source Current (Com'1), 12 mA (MII)
- Single and Dual Pipeline Operation Modes
- Multiplexed Data Inputs and Outputs
- Functionally Equivalent to Bipolar 29520/29521 Type Products
- Manufactured in 0.8 micron PACE Technology™

## ★ DESCRIPTION

The 'FCT520 and 'FCT521 are multi-level 8-bit wide pipeline registers. Each device consists of 4 registers A1, A2, B1 and B2 which are configured by the instruction inputs  $I_0$ ,  $I_1$  as a single 4-level pipeline or as two 2-level pipelines. The contents of any register may be read at the multiplexed output at any time by using the mux-selection controls  $S_0$  and  $S_1$ .

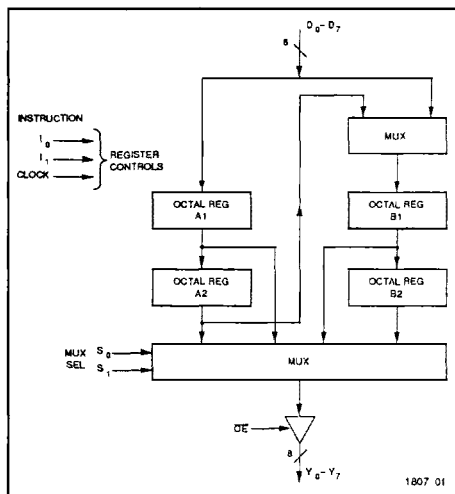
The pipeline registers are positive edge triggered and data is shifted by the rising edge of the clock input. Instruction  $I = 0$  selects the 4-level pipeline mode. Instruction  $I = 1$  selects the 2-level B pipeline while  $I = 2$  selects the 2-level

A pipeline.  $I = 3$  is the HOLD instruction; no shifting is performed by the clock in this mode.

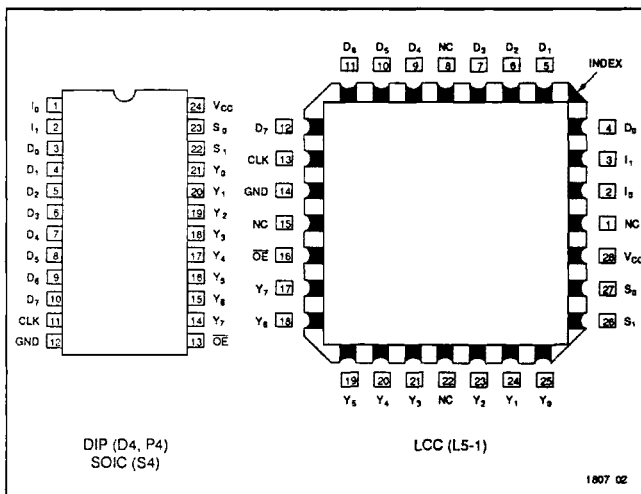
The 'FCT520 and 'FCT521 differ only in the 2-level operation mode. For the 'FCT520, data is shifted from level 1 to level 2 and new data is loaded into level 1. In the 'FCT521, new data is overwritten into level 1. To shift data from level 1 to level 2 in the 'FCT521, the 4-level pipeline mode must be used. Note that new data will also be clocked into both A1 and B1 during this 4-level shift operation.

The 'FCT520 and 'FCT521 are available in standard 24-pin 300 mil DIP, SOIC and 28-pad square LCC package.

## ★ LOGIC BLOCK DIAGRAM



## PIN CONFIGURATIONS



## ABSOLUTE MAXIMUM RATINGS<sup>1,2</sup>

Symbol	Parameter	Value	Unit
$T_{STG}$	Storage Temperature	-65 to +150	°C
$T_A$	Ambient Temperature Under Bias	-65 to +135	°C
$V_{CC}$	$V_{CC}$ Potential to Ground	-0.5 to +7.0	V
$I_{IN}$	Input Current	-30 to +5.0	mA

**Notes:** 1807 Tbl 01  
 1. Operation beyond the limits set forth in the above table may impair the useful life of the device. Unless otherwise noted, these limits are over the operating free-air temperature range.

## RECOMMENDED OPERATING CONDITIONS

Free Air Ambient Temperature	Min	Max
Military	-55°C	+125°C
Commercial	0°C	+70°C

1807 Tbl 03

Symbol	Parameter	Value	Unit
$I_{OUTPUT}$	Current Applied to Output	120	mA
$V_{IN}$	Input Voltage	-0.5 to $V_{CC} + 0.5$	V
$V_{OUT}$	Voltage Applied to Output	-0.5 to $V_{CC} + 0.5$	V

1807 Tbl 02

2. Unused inputs must always be connected to an appropriate logic voltage level, preferably either  $V_{CC}$  or ground.

Supply Voltage ( $V_{CC}$ )	Min	Max
Military	+4.5V	+5.5V
Commercial	+4.75V	+5.25V

1807 Tbl 04

## DC ELECTRICAL CHARACTERISTICS (Over recommended operating conditions)

Symbol	Parameter	Min	Typ <sup>1</sup>	Max	Units	$V_{CC}$	Conditions	
$V_{IH}$	Input HIGH Voltage	2.0			V			
$V_{IL}$	Input LOW Voltage			0.8	V			
$V_H$	Hysteresis		0.35		V		All inputs	
$V_{IK}$	Input Clamp Diode Voltage		-0.7	-1.2	V	MIN	$I_{IN} = -18mA$	
$V_{OH}$	Output HIGH Voltage	$V_{CC} = 3V, V_{IN} = 0.2V, \text{ or } V_{CC} - 0.2V$		$V_{CC} - 0.2$	$V_{CC}$	V	$I_{OH} = -32\mu A$	
		Military/Commercial (CMOS)	$V_{CC} - 0.2$		V	MIN	$I_{OH} = -300\mu A$	
		Military (TTL)	2.4	4.3	V	MIN	$I_{OH} = -12mA$	
		Commercial (TTL)	2.4	4.3	V	MIN	$I_{OH} = -15mA$	
$V_{OL}$	Output LOW Voltage	$V_{CC} = 3V, V_{IN} = 0.2V, \text{ or } V_{CC} - 0.2V$			GND	0.2	V	$I_{OL} = 300\mu A$
		Military/Commercial (CMOS)		GND	0.2	V	MIN	$I_{OL} = 300\mu A$
		Military (TTL)		0.3	0.5	V	MIN	$I_{OL} = 32mA$
		Commercial (TTL)		0.3	0.5	V	MIN	$I_{OL} = 48mA$
Commercial (TTL)		0.3	0.5	V	MIN	$I_{OL} = 64mA$		
$I_{IH}$	Input HIGH Current			5	$\mu A$	MAX	$V_{IN} = V_{CC}$	
$I_{IL}$	Input LOW Current			-5	$\mu A$	MAX	$V_{IN} = GND$	
$I_{IH}$	Input HIGH Current <sup>3</sup>			5	$\mu A$	MAX	$V_{IN} = 2.7V$	
$I_{IL}$	Input LOW Current <sup>3</sup>			-5	$\mu A$	MAX	$V_{IN} = 0.5V$	
$I_{OZH}$	Off State $I_{OUT}$ HIGH-Level Output Current			10	$\mu A$	MAX	$V_{OUT} = V_{CC}$	
$I_{OZL}$	Off State $I_{OUT}$ LOW-Level Output Current			-10	$\mu A$	MAX	$V_{OUT} = GND$	
$I_{OZH}$	Off State $I_{OUT}$ HIGH-Level Output Current <sup>3</sup>			10	$\mu A$	MAX	$V_{OUT} = 2.7V$	
$I_{OZL}$	Off State $I_{OUT}$ LOW-Level Output Current <sup>3</sup>			-10	$\mu A$	MAX	$V_{OUT} = 0.5V$	
$I_{OS}$	Output Short Circuit Current <sup>2</sup>	-60	-120	-225	mA	MAX	$V_{OUT} = 0.0V$	
$C_{IN}$	Input Capacitance <sup>3</sup>		5	10	pF	MAX	All inputs	
$C_{OUT}$	Output Capacitance <sup>3</sup>		9	12	pF	MAX	All outputs	

**Notes:** 1807 Tbl 05  
 1. Typical limits are at  $V_{CC} = 5.0V, T_A = +25^\circ C$  ambient.  
 2. 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 in order to minimize internal chip heating and more accurately reflect

operational values. Otherwise prolonged shorting of a high output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests,  $I_{OS}$  tests should be performed last.

3. This parameter is guaranteed but not tested.

**DC CHARACTERISTICS** (Over recommended operating conditions unless otherwise specified.)

Symbol	Parameter	Typ <sup>1</sup>	Max	Units	Conditions
$I_{CC}$	Quiescent Power Supply Current (CMOS inputs)	0.003	0.5	mA	$V_{CC} = \text{MAX}$ , $f_1 = 0$ , Outputs Open, $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC} - 0.2V$
$\Delta I_{CC}$	Quiescent Power Supply Current (TTL inputs)	0.5	2.0	mA	$V_{CC} = \text{MAX}$ , Outputs Open, $f_1 = 0$ , $V_{IN} = 3.4V$
$I_{CCD}$	Dynamic Power Supply Current <sup>3</sup>	0.15	0.25	mA/ mHz	$V_{CC} = \text{MAX}$ , One Input Toggling, 50% Duty Cycle, $\overline{OE} = \text{GND}$ , Outputs Open, $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC} - 0.2V$
$I_C$	Total Power Supply Current <sup>5</sup>	1.7	4.0	mA	$V_{CC} = \text{MAX}$ , $f_0 = 10\text{MHz}$ , 50% Duty Cycle, Outputs Open, One Bit Toggling at $f_1 = 5\text{MHz}$ , $\overline{OE} = \text{GND}$ , $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC} - 0.2V$
		2.2	6.0	mA	$V_{CC} = \text{MAX}$ , $f_0 = 10\text{MHz}$ , 50% Duty Cycle, Outputs Open, One Bit Toggling at $f_1 = 5\text{MHz}$ , $\overline{OE} = \text{GND}$ , $V_{IN} = 3.4V$ or $V_{IN} = \text{GND}$
		7.0	12.8 <sup>4</sup>	mA	$V_{CC} = \text{MAX}$ , $f_0 = 10\text{MHz}$ , 50% Duty Cycle, Outputs Open, Eight Bits Toggling $f_1 = 5\text{MHz}$ , $\overline{OE} = \text{GND}$ , $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC} - 0.2V$
		9.2	21.8 <sup>4</sup>	mA	$V_{CC} = \text{MAX}$ , $f_0 = 10\text{MHz}$ , 50% Duty Cycle, Outputs Open, Eight Bits and Four Controls Toggling, $\overline{OE} = \text{GND}$ , $f_1 = 5\text{MHz}$ , $V_{IN} = 3.4V$ or $V_{IN} = \text{GND}$

**Notes:**

- Typical values are at  $V_{CC} = 5.0V$ , +25°C ambient and maximum loading.
- Per TTL driven input ( $V_{IN} = 3.4V$ ); all other inputs at  $V_{CC}$  or GND.
- This parameter is not directly testable, but is derived for use in Total Power Supply calculations.
- Values for these conditions are examples of the  $I_{CC}$  formula. These limits are guaranteed but not tested.
- $$I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$$

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

$$I_{CC} = \text{Quiescent Current with CMOS input levels}$$

- 1807 Tbl 06
- $\Delta I_{CC}$  = Power Supply Current for a TTL High Input ( $V_{IN} = 3.4V$ )
  - $D_H$  = 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 Register Devices (Zero for Non-Register Devices)
  - $f_1$  = Input Frequency
  - $N_1$  = Number of Inputs at  $f_1$
- All currents are in milliamps and all frequencies are in megahertz.



**OUTPUT SELECTION MUX TABLE**

$S_1$	$S_0$	Output
1	1	A1
1	0	A2
0	1	B1
0	0	B2

1807 Tbl 07

**PIPELINE INSTRUCTION TABLE**

	I = 0	I = 1	I = 2	I = 3
P29FCT520				
P29FCT521				
	Single 4-level	Dual 2-level		Hold

1807 Tbl 08

**AC CHARACTERISTICS (P29FCT520/521)**

Symbol	Parameter	P29FCT520/521				Units	Fig. No.
		MIL		COM'L			
		Min. <sup>1</sup>	Max.	Min. <sup>1</sup>	Max.		
$t_{PLH}$ $t_{PHL}$	Propagation Delay Clock to Data Output	—	24.0	—	21.0	ns	5
$t_{PLH}$ $t_{PHL}$	Propagation Delay S0, S1 To Data Output	—	22.0	—	20.0	ns	5
$t_s$	Setup Time Input Data to Clock	10.0	—	10.0	—	ns	
$t_h$	Hold Time Input Data to Clock	10.0	—	10.0	—	ns	
$t_s$	Setup Time Instruction to Clock	10.0	—	10.0	—	ns	
$t_h$	Hold Time Instruction to Clock	10.0	—	10.0	—	ns	
$t_{PHZ}$ $t_{PLZ}$	Output Disable Time	—	14.0	—	13.0	ns	8, 7
$t_{PZH}$ $t_{PZL}$	Output Enable Time	—	22.0	—	20.0	ns	8, 7
$t_w(H)$ $t_w(L)$	Clock Pulse Width, High or Low	10.0	—	10.0	—	ns	5

1807 Tbl 09

**Notes:**

1. Minimum limits are guaranteed but not tested on Propagation Delays.  
AC Characteristics guaranteed with  $C_L = 50pF$  as shown in Figure 1.

**AC CHARACTERISTICS (P29FCT520A/521A—P29FCT520B/521B)**

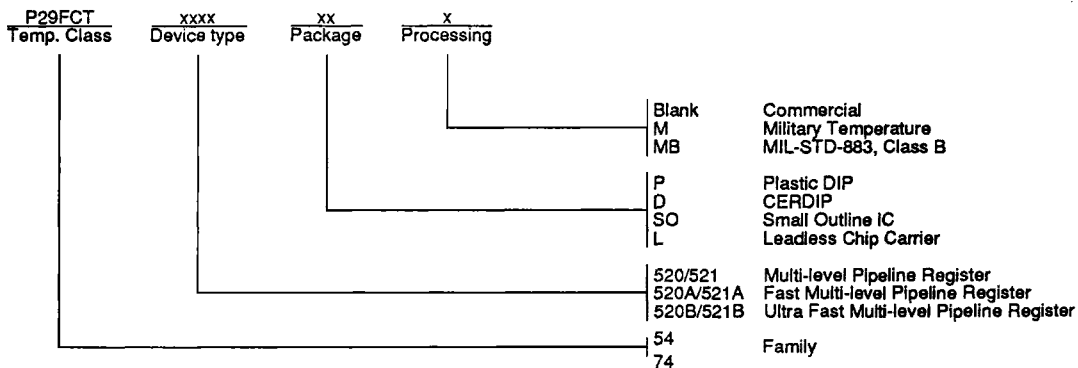
Symbol	Parameter	P29FCT520A/521A				P29FCT520B/521B				Units	Fig. No.
		MIL		COM'L		MIL		COM'L			
		Min. <sup>1</sup>	Max.	Min. <sup>1</sup>	Max.	Min. <sup>1</sup>	Max.	Min. <sup>1</sup>	Max.		
$t_{PLH}$ $t_{PHL}$	Clock to Data Output	2.0	16.0	2.0	14.0	2.0	8.0	2.0	7.5	ns	5
$t_{PLH}$ $t_{PHL}$	S0, S1 To Data Output	2.0	15.0	2.0	13.0	2.0	8.0	2.0	7.5	ns	5
$t_s$	Setup Time Input Data to Clock	6.0	—	5.0	—	2.8	—	2.5	—	ns	
$t_h$	Hold Time Input Data to Clock	2.0	—	2.0	—	2.0	—	2.0	—	ns	
$t_s$	Setup Time Instruction (Reg. Enable) to Clock	6.0	—	5.0	—	4.5	—	4.0	—	ns	
$t_h$	Hold Time Instruction (Reg. Enable) to Clock	2.0	—	2.0	—	2.0	—	2.0	—	ns	
$t_{PHZ}$ $t_{PLZ}$	Output Disable Time	6.0	—	5.0	—	4.5	—	4.0	—	ns	8, 7
$t_{PZH}$ $t_{PZL}$	Output Enable Time	2.0	—	2.0	—	2.0	—	2.0	—	ns	8, 7
$t_w(H)$ $t_w(L)$	Clock Pulse Width, High or Low	8.0	—	7.0	—	6.0	—	5.5	—	ns	5

1807 Tbl 10

**Notes:**

- 1. Minimum limits are guaranteed but not tested on Propagation Delays.
- AC Characteristics guaranteed with  $C_L = 50\text{pF}$  as shown in Figure 1.

**ORDERING INFORMATION**



1807 03

