29F01

4-Bit Bipolar Microprocessor Slice

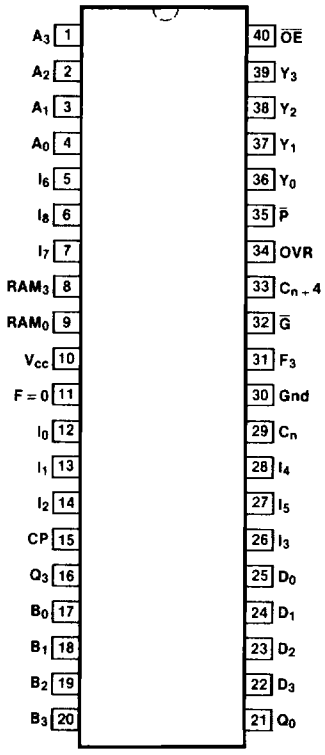
Description

The 29F01 is a 4-bit high-speed bipolar microprocessor slice. It features a 16-word by 4-bit dual-port Random Access Memory (RAM), a high-speed 8-function Arithmetic Logic Unit (ALU) and associated shifting, decoding and multiplexing circuitry. The microinstruction word consists of three groups of three bits that respectively control ALU operand source, ALU function and ALU result destination. Width of the data path may be increased by cascading with either ripple or full lookahead carry. Data outputs are 3-state for maximum versatility. Four status flag signals, carry, overflow, zero and sign, are provided by the ALU. The microprocessor slice is compatible with Fairchild Advanced Schottky TTL (FAST) devices and can be used along with FAST parts in microprogrammed systems to minimize cycle times.

- **Isoplanar FAST Technology**
- **Plug-In Replacement for Standard 2901 C Version**
- **20% to 30% Faster than Standard 2901 in Most System Configurations**

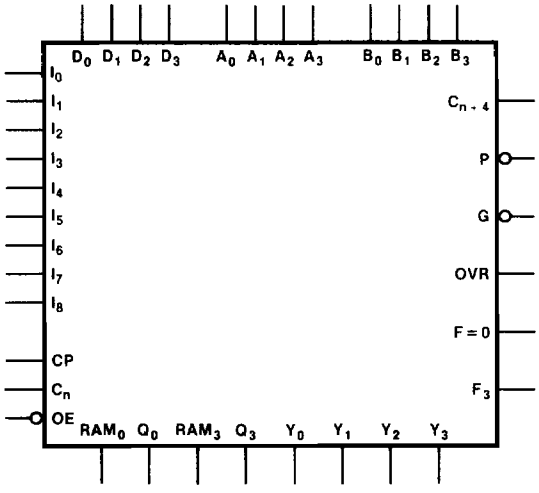
Ordering Code: See Section 5

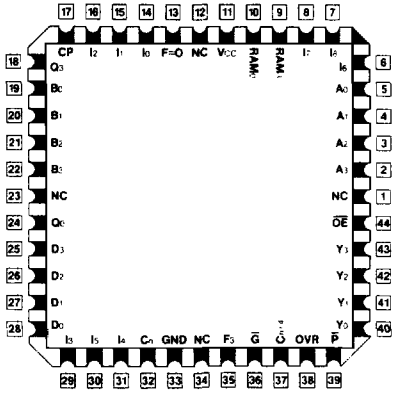
Connection Diagrams



Pin Assignment for DIP

Logic Symbol





Pin Assignment for LCC and PCC

Input Loading/Fan-Out: See Section 3 for U.L. definitions

Pin Names	Description	29F(U.L.) HIGH/LOW
A_0-A_3	A Address Inputs	0.5/0.375
B_0-B_3	B Address Inputs	0.5/0.375
I_0-I_8	Instruction Control Lines	0.5/0.375
Q_0, Q_3	Shift Lines	0.5/0.375
RAM_0, RAM_3	Shift Lines	0.5/0.375
D_0-D_3	Direct Data Field	0.5/0.375
Y_0-Y_3	Data Outputs	25/12.5
$\overline{OE}$	Output Enable	0.5/0.375
$\overline{P}$	Carry Propagate Output	25/12.5
$\overline{G}$	Carry Generate Output	25/12.5
OVR	Overflow	0.5/0.375
F = 0	ALU Operation Output	25/12.5
F_3	Most Significant ALU Output Bit	25/12.5
C_n	Carry-In	0.5/0.375
C_{n+4}	Carry-Out	0.5/0.375
CP	Clock	0.5/0.375

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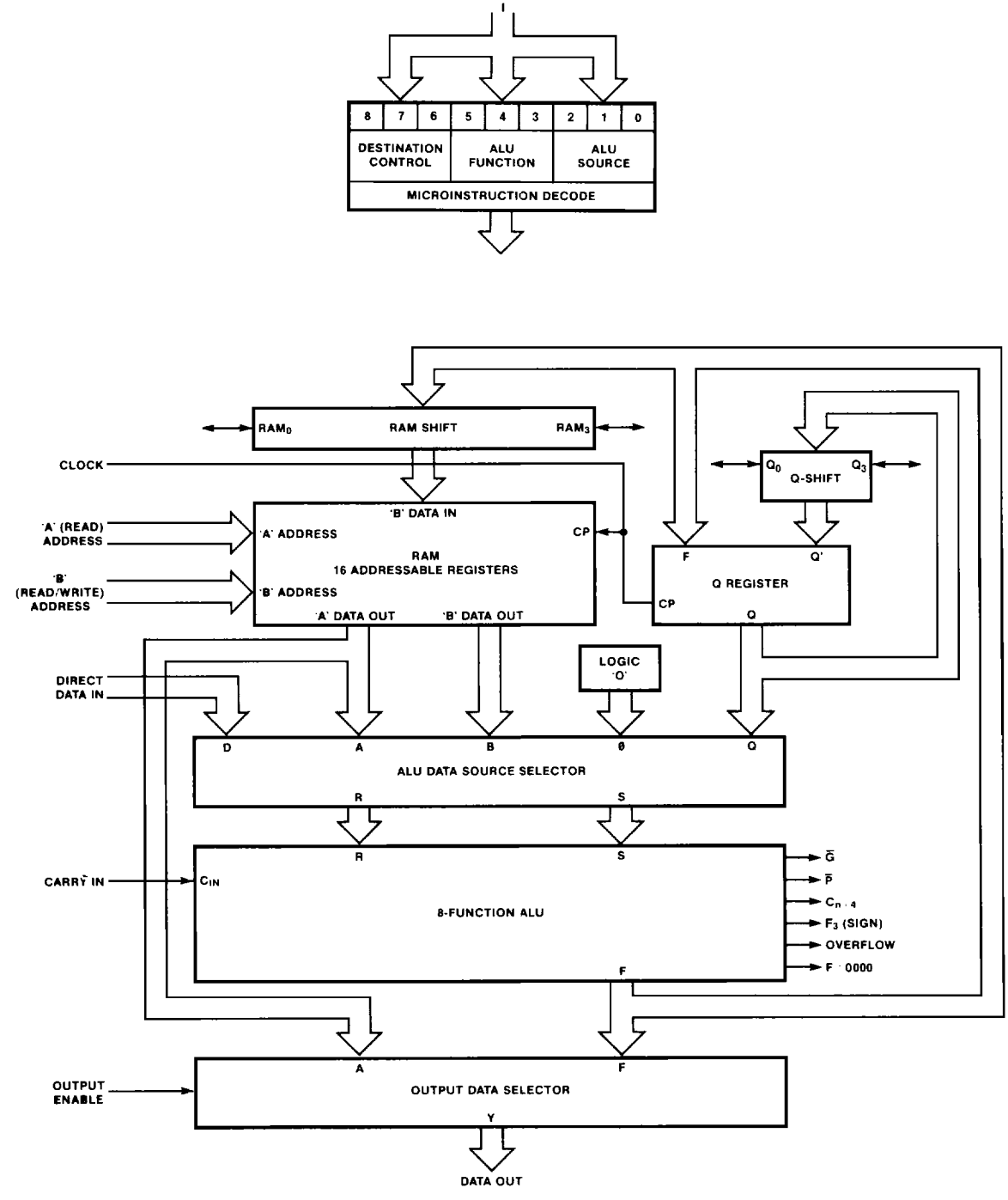
ALU Logic Functions

I_{543}	Function	$\overline{P}$	$\overline{G}$	C_{n+4}	OVR
0	R + S	$\overline{P_3P_2P_1P_0}$	$\overline{G_3 + P_3G_2 + P_3P_2G_1 + P_3P_2P_1G_0}$	C_4	$C_3 \veebar C_4$
1	S - R	← Same as R + S equations, but substitute $\overline{R_i}$ for R_i in definitions →			
2	R - S	← Same as R + S equations, but substitute $\overline{S_i}$ for S_i in definitions →			
3	R ∨ S	LOW	$P_3P_2P_1P_0$	$\overline{P_3P_2P_1P_0} + C_n$	$\overline{P_3P_2P_1P_0} + C_n$
4	R ∧ S	LOW	$\overline{G_3 + G_2 + G_1 + G_0}$	$G_3 + G_2 + G_1 + G_0 + C_n$	$G_3 + G_2 + G_1 + G_0 + C_n$
5	$\overline{R}$ ∧ S	LOW	Same as R ∧ S equations, but substitute $\overline{R_i}$ for R in definitions		
6	R $\veebar$ S	← Same as $\overline{R \veebar S}$, but substitute $\overline{R_i}$ for R_i in definitions →			
7	$\overline{R \veebar S}$	$G_3 + G_2 + G_1 + G_0$	$G_3 + P_3G_2 + P_3P_2G_1 + P_3P_2P_1P_0$	$\overline{G_3 + P_3G_2 + P_3P_2G_1 + P_3P_2P_1P_0 \cdot G_0 + C_n}$	See note

Note: $\overline{P_2 + G_2P_1 + G_2G_1P_3 + G_2G_1G_0C_n} \veebar \overline{P_3 - G_3P_2 + G_3G_2P_1 + G_3G_2G_1P_0 - G_3G_2G_1G_0C_n}$ - = OR

Block Diagram



Source Operand and ALU Function Matrix

Octal $I_{5,4,3}$ / ALU Function \ $I_{2,1,0}$ Octal / ALU Source	0 A, Q	1 A, B	2 O, Q	3 O, B	4 O, A	5 D, A	6 D, Q	7 D, O
0	$C_n = L$ R Plus S $C_n = H$	A+Q A+Q+1	A+B A+B+1	Q Q+1	B B+1	A A+1	D+A D+A+1	D+Q D+Q+1	D D+1
1	$C_n = L$ S Minus R $C_n = H$	Q-A-1 Q-A	B-A-1 B-A	Q-1 Q	B-1 B	A-1 A	A-D-1 A-D	Q-D-1 Q-D	-D-1 -D
2	$C_n = L$ R Minus S $C_n = H$	A-Q-1 A-Q	A-B-1 A-B	-Q-1 -Q	-B-1 -B	-A-1 -A	D-A-1 D-A	D-Q-1 D-Q	D-1 D
3	R OR S	A ∨ Q	A ∨ B	Q	B	A	D ∨ A	D ∨ Q	D
4	R AND S	A ∧ Q	A ∧ B	0	0	0	D ∧ A	D ∧ Q	0
5	$\overline{R}$ AND S	$\overline{A}$ ∧ Q	$\overline{A}$ ∧ B	Q	B	A	$\overline{D}$ ∧ A	$\overline{D}$ ∧ Q	0
6	R EX-OR S	A ⊻ Q	A ⊻ B	Q	B	A	D ⊻ A	D ⊻ Q	D
7	R EX-NOR S	$\overline{A \veebar Q}$	$\overline{A \veebar B}$	$\overline{Q}$	$\overline{B}$	$\overline{A}$	$\overline{D \veebar A}$	$\overline{D \veebar Q}$	$\overline{D}$

+ = Plus, - = Minus; ∨ = OR; ∧ = AND ⊻ = EX-OR

ALU Function Control

Mnemonic	Micro Code I_5	I_4	I_3	Octal Code	ALU Function	Symbol
ADD	L	L	L	0	R Plus S	R + S
SUBR	L	L	H	1	S Minus R	S - R
SUBS	L	H	L	2	R Minus S	R - S
OR	L	H	H	3	R OR S	R ∨ S
AND	H	L	L	4	R AND S	R ∧ S
NOTRS	H	L	H	5	$\overline{R}$ AND S	$\overline{R}$ ∧ S
EXOR	H	H	L	6	R EX-OR S	R ⊻ S
EXNOR	H	H	H	7	R EX-NOR S	$\overline{R \veebar S}$

ALU Source Operand Control

Mnemonic	Micro Code I_2	I_1	I_0	Octal Code	ALU Source Operands R	S
AQ	L	L	L	0	A	Q
AB	L	L	H	1	A	B
ZQ	L	H	L	2	O	Q
ZB	L	H	H	3	O	B
ZA	H	L	L	4	O	A
DA	H	L	H	5	D	A
DQ	H	H	L	6	D	Q
DZ	H	H	H	7	D	O

Definitions (+ = OR)

$P_0 = R_0 + S_0$ $\quad G_0 = R_0 S_0$
$P_1 = R_1 + S_1$ $\quad G_1 = R_1 S_1$
$P_2 = R_2 + S_2$ $\quad G_2 = R_2 S_2$
$P_3 = R_3 + S_3$ $\quad G_3 = R_3 S_3$
$C_4 = G_3 + P_3G_2 + P_3P_2G_1 + P_3P_2P_1G_0 + P_3P_2P_1P_0C_n$
$C_3 = G_2 + P_2G_1 + P_2P_1G_0 + P_2P_1P_0C_n$

Logic Functions for $\overline{G}$, $\overline{P}$, C_{n+4}, and OVR

The four signals $\overline{G}$, $\overline{P}$, C_{n+4}, and OVR are designed to indicate carry and overflow conditions when the 29F01 is in the add or subtract mode. The table below indicates the logic equations for these four signals for each of the eight ALU functions. The R and S inputs are the two inputs selected according to the ALU source operand code.

ALU Destination Control

Mnemonic	Micro Code				RAM Function		Q-Reg. Function		Y Output	RAM Shifter		Q Shifter	
	I_8	I_7	I_6	Octal Code	Shift	Load	Shift	Load		RAM_0	RAM_3	Q_0	Q_3
QREG	L	L	L	0	X	None	None	F → Q	F	X	X	X	X
NOP	L	L	H	1	X	None	X	None	F	X	X	X	X
RAMA	L	H	L	2	None	F → B	X	None	A	X	X	X	X
RAMF	L	H	H	3	None	F → B	X	None	F	X	X	X	X
RAMQD	H	L	L	4	Down	F/2 → B	Down	Q/2 → Q	F	F_0	IN_3	Q_0	IN_3
RAMD	H	L	H	5	Down	F/2 → B	X	None	F	F_0	IN_3	Q_0	X
RAMQU	H	H	L	6	Up	2F → B	Up	2Q → Q	F	IN_0	F_3	IN_0	Q_3
RAMU	H	H	H	7	Up	2F → B	X	None	F	IN_0	F_3	X	Q_3

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

B = Register addressed by B Inputs
Up is toward MSB
Down is toward LSB

DC Characteristics over Operating Temperature Range (unless otherwise specified)

Symbol	Parameter	29F			Units	Conditions
		Min	Typ	Max		
I_{CC}	Power Supply Current			250	mA	V_{CC} = Max

AC Characteristics: See Section 3 for waveforms and load configurations

Symbol	Parameter	29F			Military 29F		Commercial 29F		Units
		T_A = +25°C, V_{CC} = +5.0 V, C_L = 50 pF			T_A, V_{CC} = Mil, C_L = 50 pF		T_A, V_{CC} = Com, C_L = 50 pF		
		Min	Typ	Max	Min	Max	Min	Max	
f_{max}	Maximum Clock Frequency	25					25		MHz
t_{PLH} t_{PHL}	Propagation Delay A or B to Y		45.0 45.0					45.0 45.0	ns
t_{PLH} t_{PHL}	Propagation Delay A or B to F_3		46.0 46.0					46.0 46.0	ns
t_{PLH} t_{PHL}	Propagation Delay A or B to C_{n+4}		47.0 47.0					47.0 47.0	ns
t_{PLH} t_{PHL}	Propagation Delay A or B to $\overline{G}$ or $\overline{P}$		43.0 43.0					43.0 43.0	ns

AC Characteristics (Cont'd)

Symbol	Parameter	29F			Military 29F		Commercial 29F		Units
		$T_A = +25°C$ $V_{CC} = +5.0\ V$ $C_L = 50\ pF$			T_A, V_{CC} = Mil $C_L = 50\ pF$		T_A, V_{CC} = Com $C_L = 50\ pF$		
		Min	Typ	Max	Min	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation Delay A or B to F = 0		55.0 55.0					55.0 55.0	ns
t_{PLH} t_{PHL}	Propagation Delay A or B to OVR		50.0 50.0					50.0 50.0	ns
t_{PLH} t_{PHL}	Propagation Delay A or B to RAM		48.0 48.0					48.0 48.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to Y		34.0 34.0					34.0 34.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to F_3		40.0 40.0					40.0 40.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to C_{n+4}		34.0 34.0					34.0 34.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to $\overline{G}$ or $\overline{P}$		32.0 32.0					32.0 32.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to F = 0		42.0 42.0					42.0 42.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to OVR		35.0 35.0					35.0 35.0	ns
t_{PLH} t_{PHL}	Propagation Delay D to RAM		31.0 31.0					31.0 31.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to Y		24.0 24.0					24.0 24.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to F_3		34.0 34.0					34.0 34.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to C_{n+4}		24.0 24.0					24.0 24.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to F = 0		38.0 38.0					38.0 38.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to OVR		26.0 26.0					26.0 26.0	ns
t_{PLH} t_{PHL}	Propagation Delay C_n to RAM		29.0 29.0					29.0 29.0	ns

AC Characteristics (Cont'd)

Symbol	Parameter	29F $T_A = +25°C$ $V_{CC} = +5.0\ V$ $C_L = 50\ pF$			Military 29F $T_A, V_{CC} =$ Mil $C_L = 50\ pF$		Commercial 29F $T_A, V_{CC} =$ Com $C_L = 50\ pF$		Units
		Min	Typ	Max	Min	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to Y			39.0 39.0				39.0 39.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to F_3			43.0 43.0				43.0 43.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to C_{n+4}			39.0 39.0				39.0 39.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to $\overline{G}$ or $\overline{P}$			44.0 44.0				44.0 44.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to F = 0			49.0 49.0				49.0 49.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to OVR			44.0 44.0				44.0 44.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{0,1,2}$ to RAM			40.0 40.0				40.0 40.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to Y			41.0 41.0				41.0 41.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to F_3			39.0 39.0				39.0 39.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to C_{n+4}			45.0 45.0				45.0 45.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to $\overline{G}$ or $\overline{P}$			42.0 42.0				42.0 42.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to F = 0			48.0 48.0				48.0 48.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to OVR			50.0 50.0				50.0 50.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{3,4,5}$ to RAM			38.0 38.0				38.0 38.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{6,7,8}$ to Y			24.0 24.0				24.0 24.0	ns

AC Characteristics (Cont'd)

Symbol	Parameter	29F			Military 29F		Commercial 29F		Units
		$T_A = +25°C$ $V_{CC} = +5.0\ V$ $C_L = 50\ pF$			T_A, V_{CC} = Mil $C_L = 50\ pF$		T_A, V_{CC} = Com $C_L = 50\ pF$		
		Min	Typ	Max	Min	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation Delay $I_{6,7,8}$ to RAM		30.0 30.0					30.0 30.0	ns
t_{PLH} t_{PHL}	Propagation Delay $I_{6,7,8}$ to Q		32.0 32.0					32.0 32.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to Y		37.0 37.0					37.0 37.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to F_3		41.0 41.0					41.0 41.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to C_{n+4}		39.0 39.0					39.0 39.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to $\overline{G}$ or $\overline{P}$		42.0 42.0					42.0 42.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to F = 0		51.0 51.0					51.0 51.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to OVR		45.0 45.0					45.0 45.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to RAM		37.0 37.0					37.0 37.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to Q		23.0 23.0					23.0 23.0	ns
t_{PLH} t_{PHL}	Propagation Delay A to Y Bypassing ALU		28.0 28.0					28.0 28.0	ns
t_{PHZ} t_{PLZ}	Output Enable Time $\overline{OE}$ to Y		15.0 15.0					15.0 15.0	ns
t_{PZH} t_{PZL}	Output Enable Time $\overline{OE}$ to Y, $C_L = 5\ pF$		13.0 13.0					13.0 13.0	ns
t_{PZH} t_{PZL}	Output Disable Time $\overline{OE}$ to Y		38.0 38.0					38.0 38.0	ns
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{OE}$ to Y, $C_L = 5\ pF$		19.0 19.0					19.0 19.0	ns

AC Operating Requirements: See Section 3 for waveforms

Symbol	Parameter	29F	Military 29F	Commercial 29F	Units
		$T_A = +25°C$ $V_{CC} = +5.0\ V$	T_A, V_{CC} = Mil	T_A, V_{CC} = Com	
		Min Typ Max	Min Max	Min Max	
t_s Before HL	Setup Time A or B Source to CP	11.0		11.0	ns
t_h After LH	Hold Time A or B Source to CP	0		0	
t_s Before HL t_s Before LH	Setup Time B Destinations to CP	11.0 Do not change*		11.0 Do not change*	ns
t_h After HL t_h After LH	Hold Time B Destinations to CP	Do not change* 0		Do not change* 0	
t_s Before LH	Setup Time D to CP	23.0		23.0	ns
t_h After LH	Hold Time D to CP	0		0	
t_s Before LH	Setup Time C_n to CP	15.0		15.0	ns
t_h After LH	Hold Time C_n to CP	0		0	
t_s Before LH	Setup Time $I_{0,1,2}$ to CP	25.0		25.0	ns
t_h After LH	Hold Time $I_{0,1,2}$ to CP	0		0	
t_s Before LH	Setup Time $I_{3,4,5}$ to CP	37.0		37.0	ns
t_h After LH	Hold Time $I_{3,4,5}$ to CP	0		0	
t_s Before HL t_s Before LH	Setup Time $I_{6,7,8}$ to CP	4.0 Do not change*		4.0 Do not change*	ns
t_h After HL t_h After LH	Hold Time $I_{6,7,8}$ to CP	Do not change* 1.0		Do not change* 1.0	

*Once the HIGH-to-LOW CP transition occurs, no change is allowed until the CP is again HIGH.

AC Operating Requirements (Cont'd)

Symbol	Parameter	29F	Military 29F	Commercial 29F	Units
		$T_A = +25°C$ $V_{CC} = +5.0\ V$	T_A, V_{CC} = Mil	T_A, V_{CC} = Com	
		Min Typ Max	Min Max	Min Max	
t_s Before LH	Setup Time RAM or Q to CP	6.0		6.0	ns
t_h After LH	Hold Time RAM or Q to CP	2.0		2.0	
$t_w(H)$ $t_w(L)$	CP Pulse Width HIGH or LOW	11.0 9.0		11.0 9.0	ns

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Timing Waveforms

TYPICAL