

## 54F407 Data Access Register

### General Description

The 'F407 Data Access Register (DAR) performs memory address arithmetic for RAM resident stack applications. It contains three 4-bit registers intended for Program Counter (R<sub>0</sub>), Stack Pointer (R<sub>1</sub>), and Operand Address (R<sub>2</sub>). The 'F407 implements 16 instructions which allow either pre- or post-decrement/increment and register-to-register transfer in a single clock cycle. It is expandable in 4-bit increments and can operate at a 30 MHz microinstruction rate on a 16-bit word. The TRI-STATE® outputs are provided for bus-oriented applications. The 'F407 is fully compatible with all TTL families.

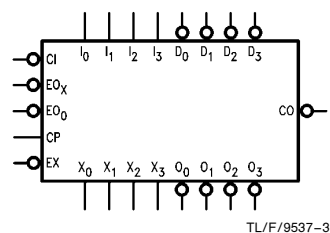
### Features

- High-speed—greater than a 30 MHz microinstruction rate
- Three 4-bit registers
- 16 instructions for register manipulation
- Two separate output ports, one transparent
- Relative addressing capability
- TRI-STATE Outputs
- Optional pre- or post- arithmetic
- Expandable in multiples of four bits
- 24-pin slim package
- 9407 replacement

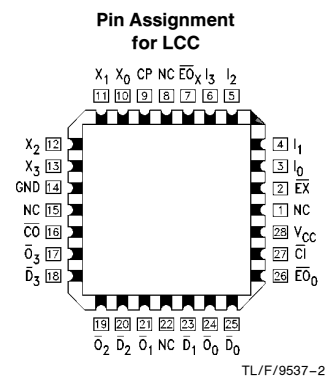
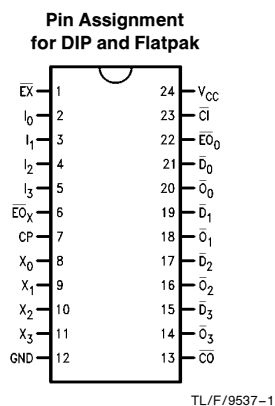
Military	Package Number	Package Description
54F407DM (Note 1)	J24A	24-Lead Ceramic Dual-In-Line
54F407SDM (Note 1)	J24F	24-Lead (0.300" Wide) Ceramic Dual-In-Line
54F407FM (Note 1)	W24C	24-Lead Cerpack
54F407FM (Note 1)	E28A	28-Lead Ceramic Leadless Chip Carrier, Type C

**Note 1:** Military grade device with environmental and burn-in processing. Use suffix = DMQB, FMQB and LMQB.

### Logic Symbol



### Connection Diagrams



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## Unit Loading/Fan Out

Pin Names	Description	54F	
		U.L. HIGH/LOW	Input $I_{IH}/I_{IL}$ Output $I_{OH}/I_{OL}$
$\overline{D}_0\text{--}\overline{D}_3$	Data Inputs (Active LOW)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$I_0\text{--}I_3$	Instruction Word Inputs	1.0/0.67	20 $\mu$ A/ –0.4 mA
$\overline{CI}$	Carry Input (Active LOW)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$\overline{CO}$	Carry Output (Active LOW)	20/13.3 (0.67)	0.4 mA/8 mA (4 mA)
CP	Clock Input (L-H Edge-Triggered)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$\overline{EX}$	Execute Input (Active LOW)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$\overline{EO}_X$	Address Output Enable Input (Active LOW)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$\overline{EO}_0$	Data Output Enable Input (Active LOW)	1.0/0.67	20 $\mu$ A/ –0.4 mA
$X_0\text{--}X_3$	Address Outputs	284 (100)/26.7 (13.3)	–5.7 mA (2 mA)/16 mA (8 mA)
$\overline{O}_0\text{--}\overline{O}_3$	Data Outputs (Active LOW)	284 (100)/26.7 (13.3)	–5.7 mA (2 mA)/16 mA (8 mA)

## Functional Description

The 'F407 contains a 4-bit slice of three Registers ( $R_0\text{--}R_2$ ), a 4-bit Adder, a TRI-STATE Address Output Buffer ( $X_0\text{--}X_3$ ) and a separate Output Register with TRI-STATE buffers ( $\overline{O}_0\text{--}\overline{O}_3$ ), allowing output of the register contents on the data bus (refer to the Block Diagram). The DAR performs sixteen instructions, selected by  $I_0\text{--}I_3$ , as listed in the Function Table.

The 'F407 operates on a single clock. CP and  $\overline{EX}$  are inputs to a 2-input, active LOW AND gate. For normal operation  $\overline{EX}$  is brought LOW while CP is HIGH. A microcycle starts as the clock goes HIGH. Data inputs  $\overline{D}_0\text{--}\overline{D}_3$  are applied to the Adder as one of the operands. Three of the four instruction lines ( $I_1\text{--}I_2\text{--}I_3$ ) select which of the three registers, if any, is to be used as the other operand. The LOW-to-HIGH CP transition writes the result from the Adder into a register ( $R_0\text{--}R_2$ ) and into the output register provided  $\overline{EX}$  is LOW. If

the  $I_0$  instruction input is HIGH, the multiplexer routes the result from the Adder to the TRI-STATE Buffer controlling the address bus ( $X_0\text{--}X_3$ ), independent of  $\overline{EX}$  and CP. The 'F407 is organized as a 4-bit register slice. The active LOW  $\overline{CI}$  and  $\overline{CO}$  lines allow ripple-carry expansion over longer word lengths.

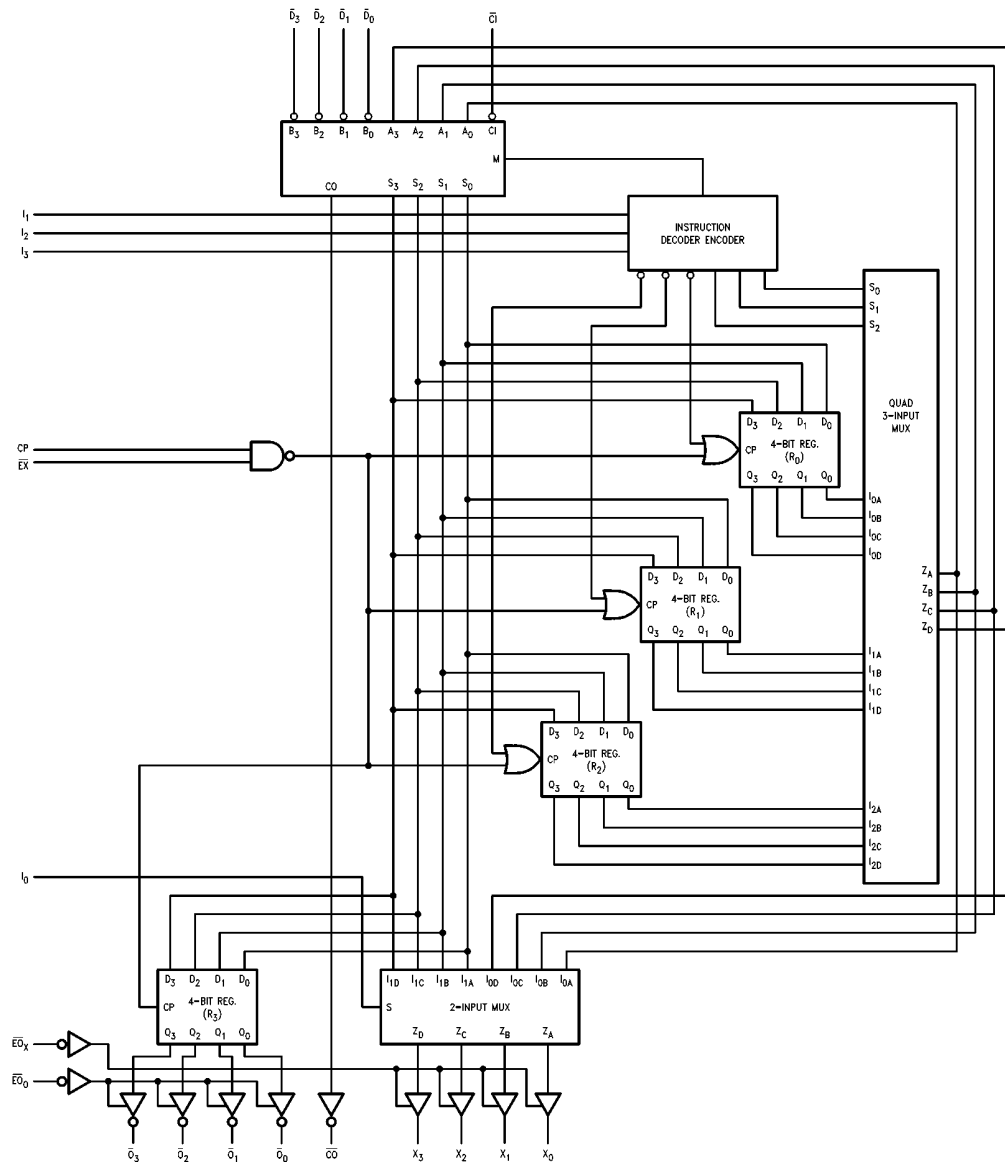
In a typical application, the register utilization in the DAR may be as follows:  $R_0$  is the Program Counter (PC),  $R_1$  is the Stack Pointer (SP) for memory resident stacks and  $R_2$  contains the operand address. For an instruction Fetch, PC can be gated on the X-Bus while it is being incremented (i.e., D-Bus = 1). If the fetched instruction calls for an effective address for execution, which is displaced from the PC, the displacement can be added to the PC and loaded into  $R_2$  during the next microcycle.

Function Table

Instruction				Combinatorial Function Available on the X-Bus	Sequential Function Occurring on the Next Rising CP Edge
$I_3$	$I_2$	$I_1$	$I_0$		
L	L	L	L	$R_0$	$R_0$ Plus D Plus CI $\rightarrow R_0$ and 0-Register
L	L	L	H	$R_0$ Plus D Plus CI	
L	L	H	L	$R_0$	$R_0$ Plus D Plus CI $\rightarrow R_1$ and 0-Register
L	L	H	H	$R_0$ Plus D Plus CI	
L	H	L	L	$R_0$	$R_0$ Plus D Plus CI $\rightarrow R_2$ and 0-Register
L	H	L	H	$R_0$ Plus D Plus CI	
L	H	H	L	$R_1$	$R_1$ Plus D Plus CI $\rightarrow R_1$ and 0-Register
L	H	H	H	$R_1$ Plus D Plus CI	
H	L	L	L	$R_2$	D Plus CI $\rightarrow R_2$ and 0-Register
H	L	L	H	D Plus CI	
H	L	H	L	$R_0$	D Plus CI $\rightarrow R_0$ and 0-Register
H	L	H	H	D Plus CI	
H	H	L	L	$R_2$	$R_2$ Plus D Plus CI $\rightarrow R_2$ and 0-Register
H	H	L	H	$R_2$ Plus D Plus CI	
H	H	H	L	$R_1$	D Plus CI $\rightarrow R_1$ and 0-Register
H	H	H	H	D Plus CI	

H = HIGH Voltage Level  
L = LOW Voltage Level

## Block Diagram



TL/F/9537-4

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

## Timing Diagrams

$\overline{E\bar{O}_x} = \text{LOW}$

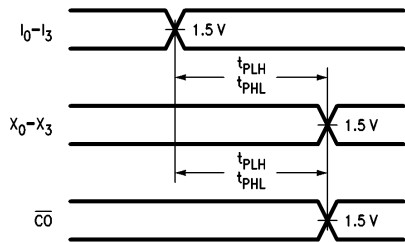


FIGURE 407-a

TL/F/9537-7

$\overline{E\bar{O}_x} = \text{LOW}$

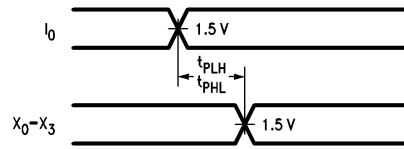


FIGURE 407-b

TL/F/9537-8

$\overline{E\bar{O}_0} = \text{LOW}$

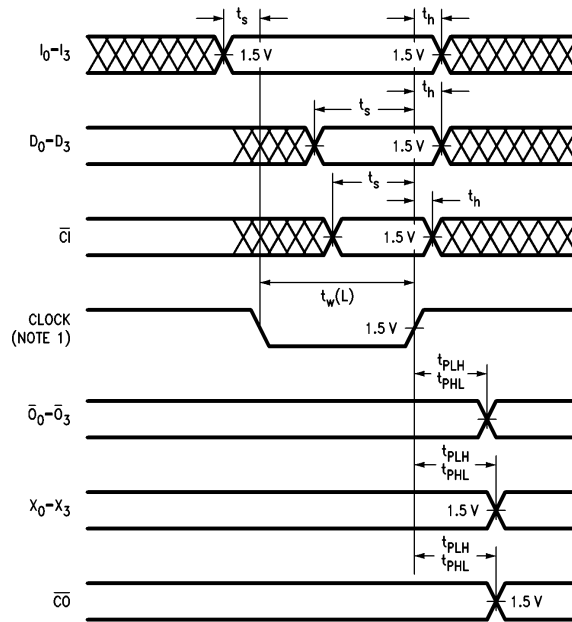


FIGURE 407-c

TL/F/9537-9

$\overline{E\bar{O}_x} = \text{LOW}, I_0 = \text{HIGH}$

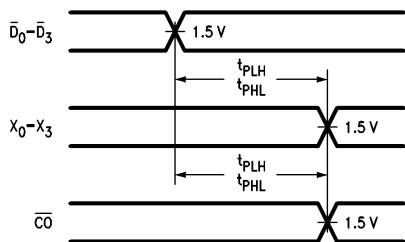


FIGURE 407-d

TL/F/9537-5

$\overline{E\bar{O}_x} = \text{LOW}, I_0 = \text{HIGH}$

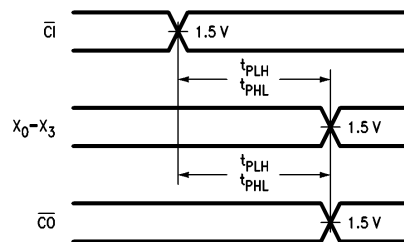


FIGURE 407-e

TL/F/9537-6

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature	−65°C to +150°C
Ambient Temperature under Bias	−55°C to +125°C
Junction Temperature under Bias	−55°C to +175°C
V <sub>CC</sub> Pin Potential to Ground Pin	−0.5V to +7.0V
Input Voltage (Note 2)	−0.5V to +7.0V
Input Current (Note 2)	−30 mA to +5.0 mA
Voltage Applied to Output in HIGH State (with V <sub>CC</sub> = 0V)	
Standard Output	−0.5V to V <sub>CC</sub>
TRI-STATE Output	−0.5V to +5.5V

Current Applied to Output in LOW State (Max) twice the rated I<sub>OL</sub> (mA)

**Note 1:** Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** Either voltage limit or current limit is sufficient to protect inputs.

## Recommended Operating Conditions

Free Air Ambient Temperature	−55°C to +125°C
Military	
Supply Voltage	+4.5V to +5.5V
Military	

## DC Electrical Characteristics

Symbol	Parameter	54F			Units	V <sub>CC</sub>	Conditions
		Min	Typ	Max			
V <sub>IH</sub>	Input HIGH Voltage	2.0			V		Recognized as a HIGH Signal
V <sub>IL</sub>	Input LOW Voltage			0.8	V		Recognized as a LOW Signal
V <sub>CD</sub>	Input Clamp Diode Voltage			−1.5	V	Min	I <sub>IN</sub> = −18 mA
V <sub>OH</sub>	Output HIGH Voltage	54F 10% V <sub>CC</sub> 54F 10% V <sub>CC</sub>	2.4 2.4		V	Min	I <sub>OH</sub> = −0.4 mA ( $\overline{CO}$ ) I <sub>OH</sub> = −2 mA (X <sub>0</sub> –X <sub>3</sub> , $\overline{O_0}$ – $\overline{O_3}$ )
V <sub>OL</sub>	Output LOW Voltage	54F 10% V <sub>CC</sub> 54F 10% V <sub>CC</sub>	0.5 0.5		V	Min	I <sub>OL</sub> = 4 mA ( $\overline{CO}$ ) I <sub>OL</sub> = 8 mA (X <sub>0</sub> –X <sub>3</sub> , $\overline{O_0}$ – $\overline{O_3}$ )
I <sub>IH</sub>	Input HIGH Current	54F		20.0	μA	Max	V <sub>IN</sub> = 2.7V
I <sub>BVI</sub>	Input HIGH Current Breakdown Test	54F		100	μA	Max	V <sub>IN</sub> = 7.0V
I <sub>CEX</sub>	Output HIGH Leakage Current	54F		250	μA	Max	V <sub>OUT</sub> = V <sub>CC</sub>
I <sub>IL</sub>	Input LOW Current			−0.4	mA	Max	V <sub>IN</sub> = 0.5V
I <sub>OZH</sub>	Output Leakage Current			50	μA	Max	V <sub>OUT</sub> = 2.7V (X <sub>0</sub> –X <sub>3</sub> , $\overline{O_0}$ – $\overline{O_3}$ )
I <sub>OZL</sub>	Output Leakage Current			−50	μA	Max	V <sub>OUT</sub> = 0.5V (X <sub>0</sub> –X <sub>3</sub> , $\overline{O_0}$ – $\overline{O_3}$ )
I <sub>OS</sub>	Output Short-Circuit Current		−30	−100	mA	Max	V <sub>OUT</sub> = 0V
I <sub>CC</sub>	Power Supply Current		90	145	mA	Max	

## AC Electrical Characteristics

Symbol	Parameter	54F		Units	Fig. No.
		$T_A, V_{CC} = \text{Mil}$ $C_L = 50 \text{ pF}$			
		Min	Max		
$t_{PLH}$ $t_{PHL}$	Propagation Delay CP to $\overline{O}_n$ (Note 1)	7.0 4.0	24.0 15.0	ns	407-c
$t_{PLH}$ $t_{PHL}$	Propagation Delay, $I_0$ LOW $I_1-I_3$ to $X_0-X_3$	7.5 8.0	21.0 25.0	ns	407-a
$t_{PLH}$ $t_{PHL}$	Propagation Delay, $I_0$ HIGH $I_1-I_3$ to $X_0-X_3$	8.5 6.5	50.0 35.0	ns	407-a
$t_{PLH}$ $t_{PHL}$	Propagation Delay, $I_0$ LOW CP to $X_n$	7.0 8.5	24.0 28.0	ns	407-b
$t_{PLH}$ $t_{PHL}$	Propagation Delay, $I_0$ HIGH CP to $X_n$	16.0 11.5	43.0 36.5	ns	407-b
$t_{PLH}$ $t_{PHL}$	Propagation Delay $\overline{D}_n$ to $X_n$	6.5 3.0	29.0 20.5	ns	407-d
$t_{PLH}$ $t_{PHL}$	Propagation Delay CI to $X_n$	4.0 4.5	22.0 14.0	ns	407-e
$t_{PLH}$ $t_{PHL}$	Propagation Delay $I_0$ to $X_n$	4.0 3.0	14.5 19.5	ns	407-b
$t_{PLH}$ $t_{PHL}$	Propagation Delay CP to $\overline{CO}$	9.0 6.5	33.0 38.0	ns	407-a
$t_{PLH}$ $t_{PHL}$	Propagation Delay $\overline{CI}$ to $\overline{CO}$	3.0 3.0	11.0 10.0	ns	407-e
$t_{PLH}$ $t_{PHL}$	Propagation Delay $\overline{D}_n$ to $\overline{CO}$	3.0 3.5	10.0 10.0	ns	407-d
$t_{PLH}$ $t_{PHL}$	Propagation Delay $I_1-I_3$ to $\overline{CO}$	8.0 6.0	23.0 32.5	ns	407-a
$t_{PZH}$ $t_{PZL}$	Enable Time $\overline{EO}_0$ to $\overline{O}_n$ or $\overline{EO}_x$ to $X_n$	4.5 3.5	26.0 16.0	ns	
$t_{PHZ}$ $t_{PLZ}$	Disable Time $\overline{EO}_0$ to $\overline{O}_n$ or $\overline{EO}_x$ to $X_n$	2.0 5.0	9.0 18.0	ns	

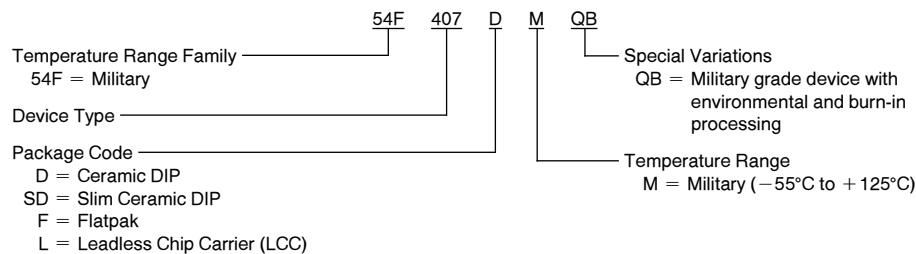
**Note 1:** The internal clock is generated from CP and  $\overline{EX}$ . The internal Clock is HIGH if  $\overline{EX}$  or CP is HIGH, LOW if  $\overline{EX}$  and CP are LOW.

## AC Electrical Characteristics (Continued)

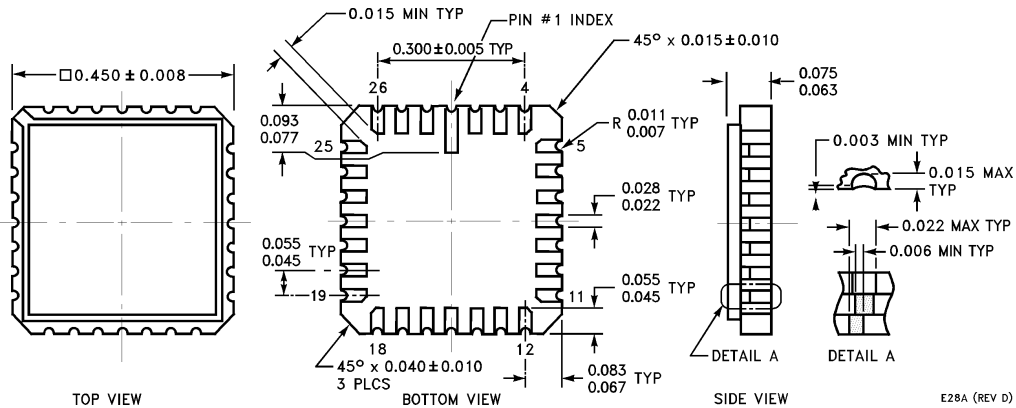
Symbol	Parameter	54F		Units	Fig. No.
		$T_A, V_{CC} = \text{Mil}$ $C_L = 50 \text{ pF}$			
		Min	Max		
$t_{cw}$	Clock Period	36.0		ns	
$t_s(H)$ $t_s(L)$	Setup Time, HIGH or LOW $I_1 - I_3$ to Negative-Going CP	4.5 4.5		ns	407-c
$t_h(H)$ $t_h(L)$	Hold Time, HIGH or LOW $I_1 - I_3$ to Positive-Going CP	0 0			
$t_s(H)$ $t_s(L)$	Setup Time, HIGH or LOW $\overline{D}_n$ or $\overline{C}_1$ to Negative-Going CP	18.5 18.5		ns	407-c
$t_h(H)$ $t_h(L)$	Hold Time, HIGH or LOW $\overline{D}_n$ or $\overline{C}_1$ to Negative-Going Clock	0 0			
$t_s(H)$ $t_s(L)$	Setup Time, HIGH or LOW $\overline{C}_1$ to Positive-Going CP	14.5 14.5		ns	407-c
$t_h(H)$ $t_h(L)$	Hold Time, HIGH or LOW $\overline{C}_1$ to Positive-Going CP	0 0			
$t_w(H)$ $t_w(L)$	Clock Pulse Width HIGH or LOW	8.5 8.5		ns	407-c

## Ordering Information

The device number is used to form part of a simplified purchasing code where the package type and temperature range are defined as follows:

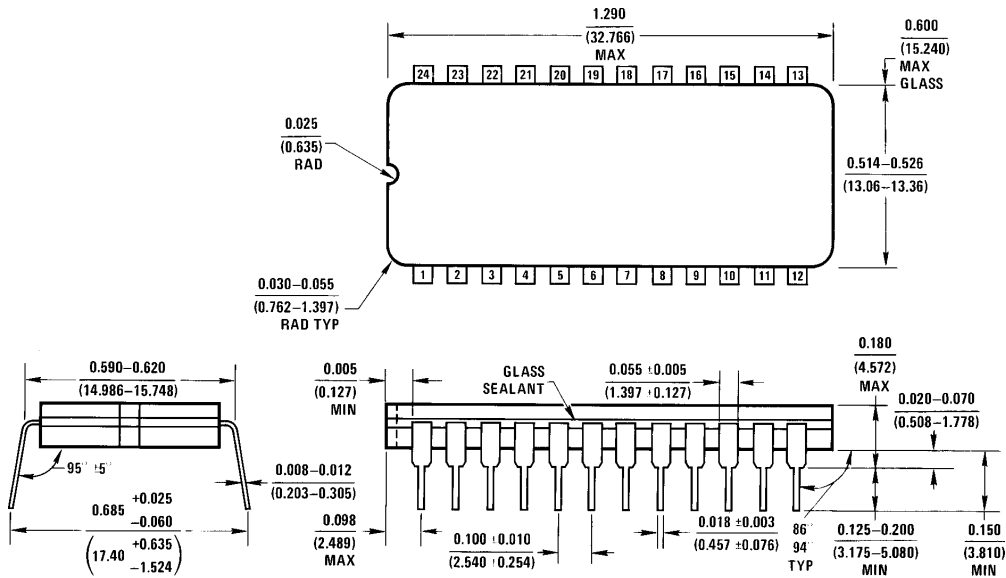


# Physical Dimensions inches (millimeters)



**28-Lead Ceramic Leadless Chip Carrier (L)**  
**NS Package Number E28A**

E28A (REV D)

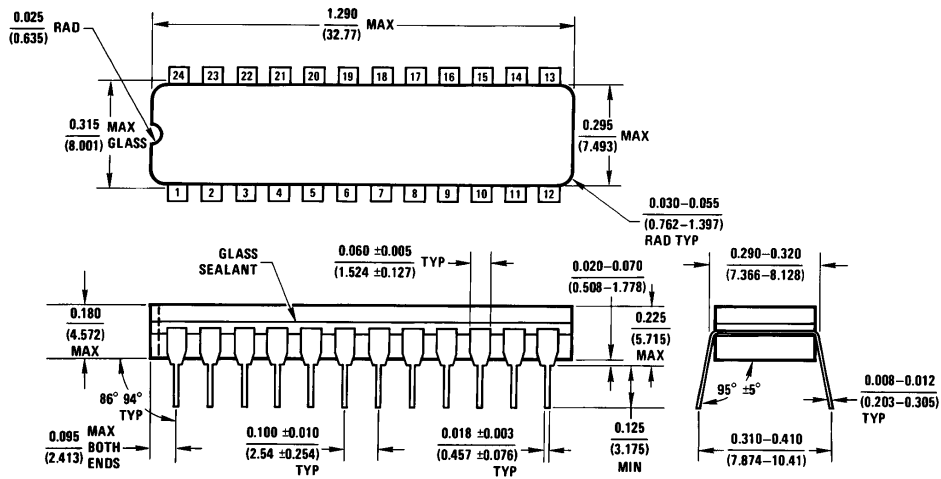


**24-Lead Ceramic Dual-In-Line Package (D)**  
**NS Package Number J24A**

J24A (REV H)

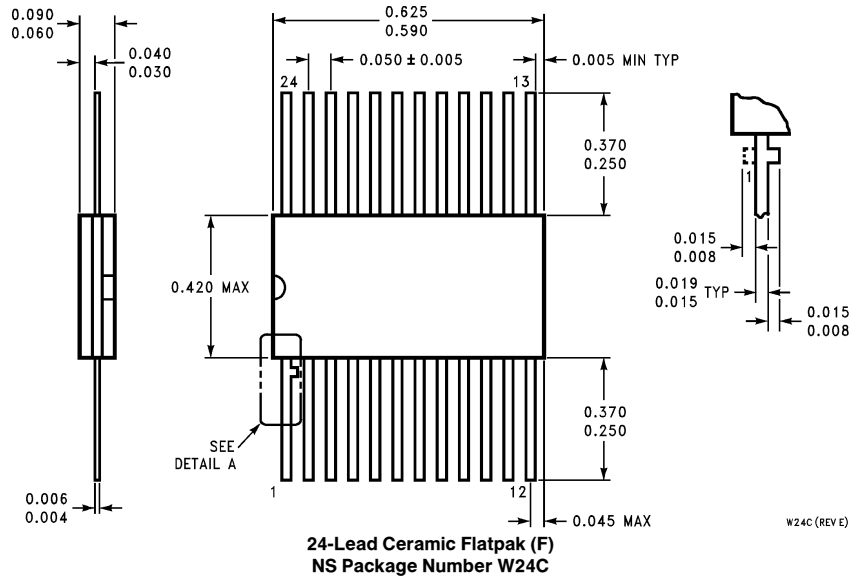


# Physical Dimensions inches (millimeters) (Continued)



24-Lead Slim (0.300" Wide) Ceramic Dual-In-Line Package (SD)  
NS Package Number J24F

J24F(REV G)

**Physical Dimensions** inches (millimeters) (Continued)**LIFE SUPPORT POLICY**

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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