

## 54F/74F322 Octal Serial/Parallel Register with Sign Extend

### General Description

The 'F322 is an 8-bit shift register with provision for either serial or parallel loading and with TRI-STATE® parallel outputs plus a bi-state serial output. Parallel data inputs and parallel outputs are multiplexed to minimize pin count. State changes are initiated by the rising edge of the clock. Four synchronous modes of operation are possible: hold (store), shift right with serial entry, shift right with sign extend and parallel load. An asynchronous Master Reset ( $\overline{MR}$ ) input overrides clocked operation and clears the register.

### Features

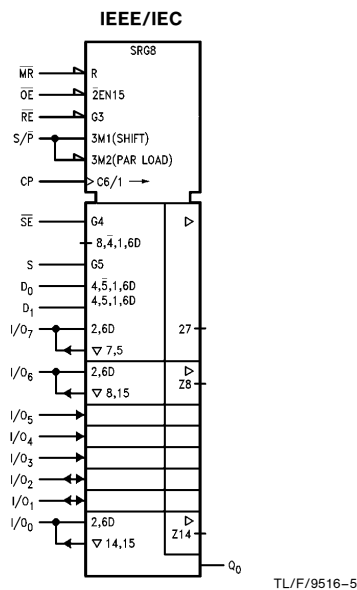
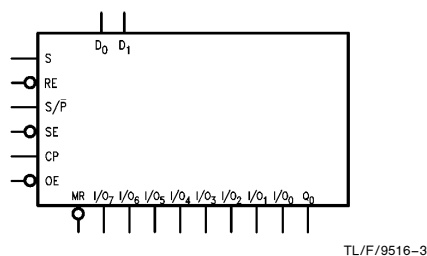
- Multiplexed parallel I/O ports
- Separate serial input and output
- Sign extend function
- TRI-STATE outputs for bus applications

| Commercial        | Military          | Package Number | Package Description                              |
|-------------------|-------------------|----------------|--------------------------------------------------|
| 74F322PC          |                   | N20A           | 20-Lead (0.300" Wide) Molded Dual-In-Line        |
|                   | 54F322DM (Note 2) | J20A           | 20-Lead Ceramic Dual-In-Line                     |
| 74F322SJ (Note 1) |                   | M20D           | 20-Lead (0.300" Wide) Molded Small Outline, EIAJ |
|                   | 54F322FM (Note 2) | W20A           | 20-Lead Cerpack                                  |
|                   | 54F322LM (Note 2) | E20A           | 20-Lead Ceramic Leadless Chip Carrier, Type C    |

**Note 1:** Devices also available in 13" reel. Use suffix = SJX.

**Note 2:** Military grade device with environmental and burn-in processing. Use suffix = DMQB, FMQB and LMQB.

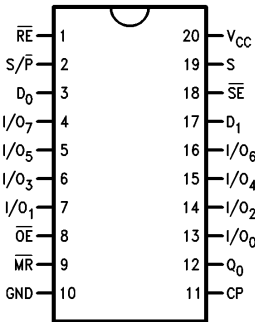
### Logic Symbols



TRI-STATE® is a registered trademark of National Semiconductor Corporation.

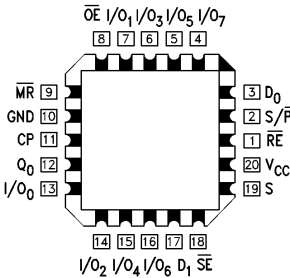
# Connection Diagrams

Pin Assignment  
for DIP, SOIC and Flatpak



TL/F/9516-1

Pin Assignment  
for LCC



TL/F/9516-2

## Unit Loading/Fan Out

| Pin Names                          | Description                                                            | 54F/74F                    |                                                 |
|------------------------------------|------------------------------------------------------------------------|----------------------------|-------------------------------------------------|
|                                    |                                                                        | U.L.<br>HIGH/LOW           | Input $I_{IH}/I_{IL}$<br>Output $I_{OH}/I_{OL}$ |
| $\overline{RE}$                    | Register Enable Input (Active LOW)                                     | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| S/ $\overline{P}$                  | Serial (HIGH) or Parallel (LOW) Mode Control Input                     | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| $\overline{SE}$                    | Sign Extend Input (Active LOW)                                         | 1.0/3.0                    | 20 $\mu$ A/ –1.8 mA                             |
| S                                  | Serial Data Select Input                                               | 1.0/2.0                    | 20 $\mu$ A/ –1.2 mA                             |
| D <sub>0</sub> , D <sub>1</sub>    | Serial Data Inputs                                                     | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| CP                                 | Clock Pulse Input (Active Rising Edge)                                 | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| $\overline{MR}$                    | Asynchronous Master Reset Input (Active LOW)                           | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| $\overline{OE}$                    | TRI-STATE Output Enable Input (Active LOW)                             | 1.0/1.0                    | 20 $\mu$ A/ –0.6 mA                             |
| Q <sub>0</sub>                     | Bi-State Serial Output                                                 | 50/33.3                    | –1 mA/ –20 mA                                   |
| I/O <sub>0</sub> –I/O <sub>7</sub> | Multiplexed Parallel Data Inputs or<br>TRI-STATE Parallel Data Outputs | 3.5/1.083<br>150/40 (33.3) | 70 $\mu$ A/ –0.65 mA<br>–3 mA/24 mA (20 mA)     |

## Functional Description

The 'F322 contains eight D-type edge triggered flip-flops and the interstage gating required to perform right shift and the intrastage gating necessary for hold and synchronous parallel load operations. A LOW signal on  $\overline{RE}$  enables shifting or parallel loading, while a HIGH signal enables the hold mode. A HIGH signal on S/ $\overline{P}$  enables shift right, while a LOW signal disables the TRI-STATE output buffers and enables parallel loading. In the shift right mode a HIGH signal

on  $\overline{SE}$  enables serial entry from either D<sub>0</sub> or D<sub>1</sub>, as determined by the S input. A LOW signal on  $\overline{SE}$  enables shift right but Q<sub>7</sub> reloads its contents, thus performing the sign extend function required for the 'F384 Twos Complement Multiplier. A HIGH signal on  $\overline{OE}$  disables the TRI-STATE output buffers, regardless of the other control inputs. In this condition the shifting and loading operations can still be performed.

Mode Select Table

| Mode          | Inputs          |                 |                   |                 |   |                   |                                                                                       | Outputs          |                  |                  |                  |                  |                  |                  |                  | Q <sub>0</sub> |
|---------------|-----------------|-----------------|-------------------|-----------------|---|-------------------|---------------------------------------------------------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------|
|               | $\overline{MR}$ | $\overline{RE}$ | S/ $\overline{P}$ | $\overline{SE}$ | S | $\overline{OE}^*$ | CP                                                                                    | I/O <sub>7</sub> | I/O <sub>6</sub> | I/O <sub>5</sub> | I/O <sub>4</sub> | I/O <sub>3</sub> | I/O <sub>2</sub> | I/O <sub>1</sub> | I/O <sub>0</sub> |                |
| Clear         | L               | X               | X                 | X               | X | L                 | X                                                                                     | L                | L                | L                | L                | L                | L                | L                | L                | L              |
|               | L               | X               | X                 | X               | X | H                 | X                                                                                     | Z                | Z                | Z                | Z                | Z                | Z                | Z                | Z                | L              |
| Parallel Load | H               | L               | L                 | X               | X | X                 |  | I <sub>7</sub>   | I <sub>6</sub>   | I <sub>5</sub>   | I <sub>4</sub>   | I <sub>3</sub>   | I <sub>2</sub>   | I <sub>1</sub>   | I <sub>0</sub>   | I <sub>0</sub> |
| Shift Right   | H               | L               | H                 | H               | L | L                 |  | D <sub>0</sub>   | O <sub>7</sub>   | O <sub>6</sub>   | O <sub>5</sub>   | O <sub>4</sub>   | O <sub>3</sub>   | O <sub>2</sub>   | O <sub>1</sub>   | O <sub>1</sub> |
|               | H               | L               | H                 | H               | H | L                 |  | D <sub>1</sub>   | O <sub>7</sub>   | O <sub>6</sub>   | O <sub>5</sub>   | O <sub>4</sub>   | O <sub>3</sub>   | O <sub>2</sub>   | O <sub>1</sub>   | O <sub>1</sub> |
| Sign Extend   | H               | L               | H                 | L               | X | L                 |  | O <sub>7</sub>   | O <sub>7</sub>   | O <sub>6</sub>   | O <sub>5</sub>   | O <sub>4</sub>   | O <sub>3</sub>   | O <sub>2</sub>   | O <sub>1</sub>   | O <sub>1</sub> |
| Hold          | H               | H               | X                 | X               | X | L                 |  | NC               | NC               | NC               | NC               | NC               | NC               | NC               | NC               | NC             |

\*When the  $\overline{OE}$  input is HIGH all I/O<sub>n</sub> terminals are at the high impedance state; sequential operation or clearing of the register is not affected.

**Note 1:** I<sub>7</sub>–I<sub>0</sub> = The level of the steady-state input at the respective I/O terminal is loaded into the flip-flop while the flip-flop outputs (except Q<sub>0</sub>) are isolated from the I/O terminal.

**Note 2:** D<sub>0</sub>, D<sub>1</sub> = The level of the steady-state inputs to the serial multiplexer input.

**Note 3:** O<sub>7</sub>–O<sub>0</sub> = The level of the respective Q<sub>n</sub> flip-flop prior to the last Clock LOW-to-HIGH transition.

H = HIGH Voltage Level

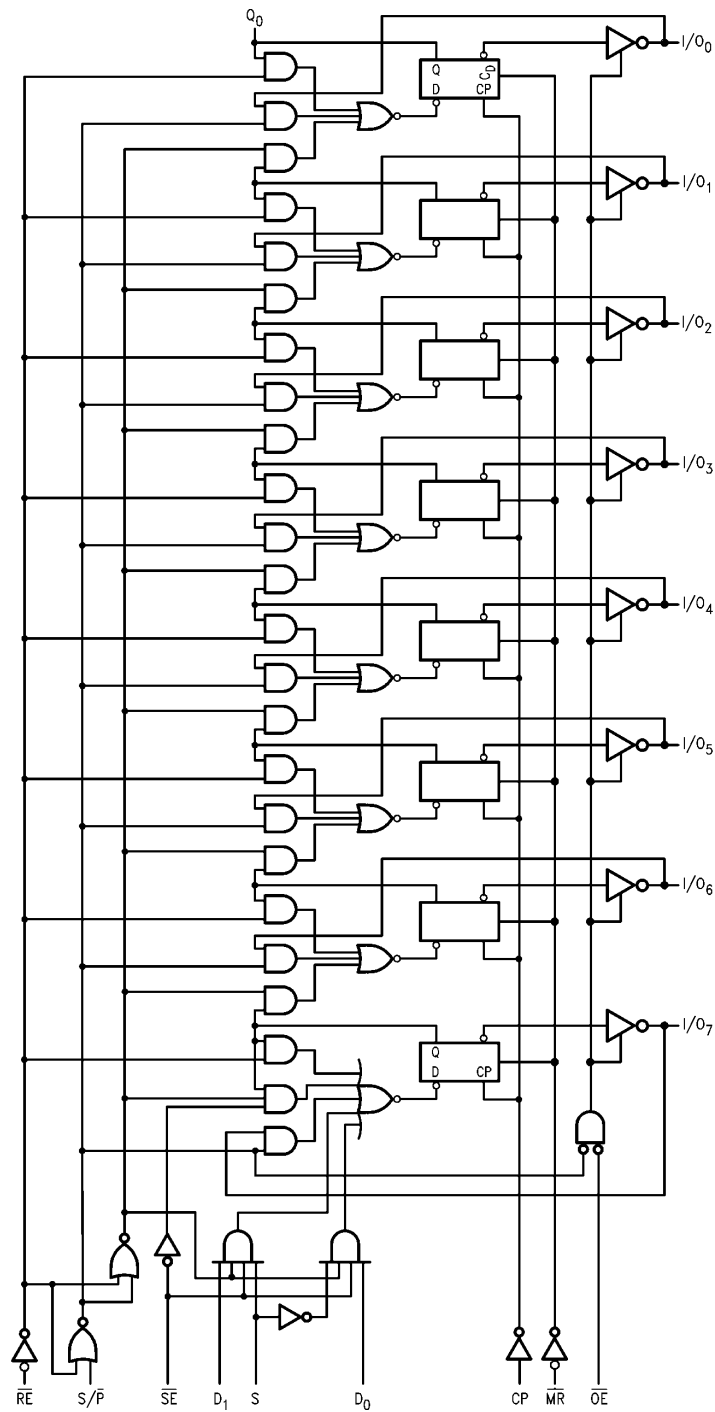
L = LOW Voltage Level

Z = High Impedance Output State

 = LOW-to-HIGH Transition

NC = No Change

## Logic Diagram



TL/F/9516-4

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

## 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   |
| Plastic                                     | −55°C to +150°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 |

**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.

Voltage Applied to Output  
in HIGH State (with V<sub>CC</sub> = 0V)  
Standard Output  
TRI-STATE Output

−0.5V to V<sub>CC</sub>  
−0.5V to +5.5V

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

## Recommended Operating Conditions

Free Air Ambient Temperature

−55°C to +125°C  
0°C to +70°C

Military  
Commercial

Supply Voltage

+4.5V to +5.5V  
+4.5V to +5.5V

Military  
Commercial

## DC Electrical Characteristics

| Symbol                             | Parameter                               | 54F/74F                                                                                                                                                      |                                        |                      | 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               |                                                                                                                                                              |                                        | −1.2                 | V              | Min               | I <sub>IN</sub> = −18 mA                                                                                                                                                                                                                                                                                                                  |
| V <sub>OH</sub>                    | Output HIGH Voltage                     | 54F 10% V <sub>CC</sub><br>54F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub><br>74F 5% V <sub>CC</sub><br>74F 5% V <sub>CC</sub> | 2.5<br>2.4<br>2.5<br>2.4<br>2.7<br>2.7 |                      | V              | Min               | I <sub>OH</sub> = −1 mA (Q <sub>0</sub> , I/O <sub>n</sub> )<br>I <sub>OH</sub> = −3 mA (I/O <sub>n</sub> )<br>I <sub>OH</sub> = −1 mA (Q <sub>0</sub> , I/O <sub>n</sub> )<br>I <sub>OH</sub> = −3 mA (I/O <sub>n</sub> )<br>I <sub>OH</sub> = −1 mA (Q <sub>0</sub> , I/O <sub>n</sub> )<br>I <sub>OH</sub> = −3 mA (I/O <sub>n</sub> ) |
| V <sub>OL</sub>                    | Output LOW Voltage                      | 54F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub>                                                                                |                                        | 0.5<br>0.5<br>0.5    | V              | Min               | I <sub>OL</sub> = 20 mA (Q <sub>0</sub> , I/O <sub>n</sub> )<br>I <sub>OL</sub> = 20 mA (Q <sub>0</sub> )<br>I <sub>OL</sub> = 24 mA (I/O <sub>n</sub> )                                                                                                                                                                                  |
| I <sub>IH</sub>                    | Input HIGH Current                      | 54F<br>74F                                                                                                                                                   |                                        | 20.0<br>5.0          | μA             | Max               | V <sub>IN</sub> = 2.7V                                                                                                                                                                                                                                                                                                                    |
| I <sub>BVI</sub>                   | Input HIGH Current Breakdown Test       | 54F<br>74F                                                                                                                                                   |                                        | 100<br>7.0           | μA             | Max               | V <sub>IN</sub> = 7.0V (Non-I/O Inputs)                                                                                                                                                                                                                                                                                                   |
| I <sub>BVIT</sub>                  | Input HIGH Current Breakdown Test (I/O) | 54F<br>74F                                                                                                                                                   |                                        | 1.0<br>0.5           | mA             | Max               | V <sub>IN</sub> = 5.5V (I/O <sub>n</sub> )                                                                                                                                                                                                                                                                                                |
| I <sub>CEX</sub>                   | Output HIGH Leakage Current             | 54F<br>74F                                                                                                                                                   |                                        | 250<br>50            | μA             | Max               | V <sub>OUT</sub> = V <sub>CC</sub>                                                                                                                                                                                                                                                                                                        |
| V <sub>ID</sub>                    | Input Leakage Test                      | 74F                                                                                                                                                          | 4.75                                   |                      | V              | 0.0               | I <sub>ID</sub> = 1.9 μA<br>All Other Pins Grounded                                                                                                                                                                                                                                                                                       |
| I <sub>OD</sub>                    | Output Leakage Circuit Current          | 74F                                                                                                                                                          |                                        | 3.75                 | μA             | 0.0               | V <sub>IOD</sub> = 150 mV<br>All Other Pins Grounded                                                                                                                                                                                                                                                                                      |
| I <sub>IL</sub>                    | Input LOW Current                       |                                                                                                                                                              |                                        | −0.6<br>−1.2<br>−1.8 | mA<br>mA<br>mA | Max<br>Max<br>Max | V <sub>IN</sub> = 0.5V (RE, S/P, D <sub>n</sub> , CP, MR, OE)<br>V <sub>IN</sub> = 0.5V (S)<br>V <sub>IN</sub> = 0.5V (SE)                                                                                                                                                                                                                |
| I <sub>IH</sub> + I <sub>OZH</sub> | Output Leakage Current                  |                                                                                                                                                              |                                        | 70                   | μA             | Max               | V <sub>I/O</sub> = 2.7V (I/O <sub>n</sub> )                                                                                                                                                                                                                                                                                               |
| I <sub>IL</sub> + I <sub>OZL</sub> | Output Leakage Current                  |                                                                                                                                                              |                                        | −650                 | μA             | Max               | V <sub>I/O</sub> = 0.5V (I/O <sub>n</sub> )                                                                                                                                                                                                                                                                                               |
| I <sub>OS</sub>                    | Output Short-Circuit Current            |                                                                                                                                                              | −60                                    | −150                 | mA             | Max               | V <sub>OUT</sub> = 0V                                                                                                                                                                                                                                                                                                                     |
| I <sub>ZZ</sub>                    | Bus Drainage Test                       |                                                                                                                                                              |                                        | 500                  | μA             | 0.0V              | V <sub>OUT</sub> = 5.25V                                                                                                                                                                                                                                                                                                                  |
| I <sub>CC</sub>                    | Power Supply Current                    |                                                                                                                                                              | 60                                     | 90                   | mA             | Max               |                                                                                                                                                                                                                                                                                                                                           |

## AC Electrical Characteristics

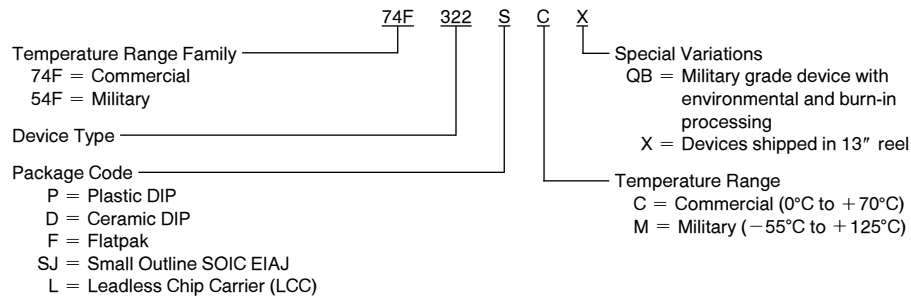
| Symbol                               | Parameter                                      | 74F                                                                            |             |              | 54F                                                |              | 74F                                                |              | Units |
|--------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------|-------------|--------------|----------------------------------------------------|--------------|----------------------------------------------------|--------------|-------|
|                                      |                                                | $T_A = +25^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V}$<br>$C_L = 50\text{ pF}$ |             |              | $T_A, V_{CC} = \text{Mil}$<br>$C_L = 50\text{ pF}$ |              | $T_A, V_{CC} = \text{Com}$<br>$C_L = 50\text{ pF}$ |              |       |
|                                      |                                                | Min                                                                            | Typ         | Max          | Min                                                | Max          | Min                                                | Max          |       |
| f <sub>max</sub>                     | Maximum Clock Frequency                        | 70                                                                             | 90          |              | 50                                                 |              | 70                                                 |              | MHz   |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP to I/O <sub>n</sub>    | 3.5<br>5.0                                                                     | 7.0<br>8.5  | 7.5<br>11.0  | 3.5<br>3.5                                         | 9.5<br>10.0  | 3.5<br>5.0                                         | 8.5<br>12.0  | ns    |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>CP to Q <sub>0</sub>      | 3.5<br>3.5                                                                     | 7.0<br>7.0  | 9.0<br>8.0   | 3.5<br>3.5                                         | 11.0<br>10.0 | 3.5<br>3.5                                         | 10.0<br>9.0  |       |
| t <sub>PHL</sub>                     | Propagation Delay<br>MR to I/O <sub>n</sub>    | 6.0                                                                            | 10.0        | 13.0         | 6.0                                                | 15.0         | 6.0                                                | 14.0         | ns    |
| t <sub>PHL</sub>                     | Propagation Delay<br>MR to Q <sub>0</sub>      | 5.5                                                                            | 7.5         | 12.0         | 5.5                                                | 14.0         | 5.5                                                | 13.0         | ns    |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>OE to I/O <sub>n</sub>   | 3.0<br>4.0                                                                     | 6.5<br>8.5  | 9.0<br>11.0  | 3.0<br>4.0                                         | 12.5<br>14.5 | 3.0<br>4.0                                         | 10.0<br>12.0 | ns    |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>OE to I/O <sub>n</sub>  | 2.0<br>2.0                                                                     | 4.5<br>5.0  | 6.0<br>7.0   | 2.0<br>2.0                                         | 8.0<br>10.0  | 2.0<br>2.0                                         | 7.0<br>8.0   |       |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>S/P to I/O <sub>n</sub>  | 4.5<br>5.5                                                                     | 8.0<br>10.0 | 10.5<br>14.0 | 4.5<br>5.5                                         | 13.5<br>17.0 | 4.5<br>5.5                                         | 11.5<br>15.0 | ns    |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>S/P to I/O <sub>n</sub> | 5.0<br>6.0                                                                     | 9.0<br>12.0 | 11.5<br>15.5 | 5.0<br>6.0                                         | 16.5<br>19.5 | 5.0<br>6.0                                         | 12.5<br>16.5 |       |

## AC Operating Requirements

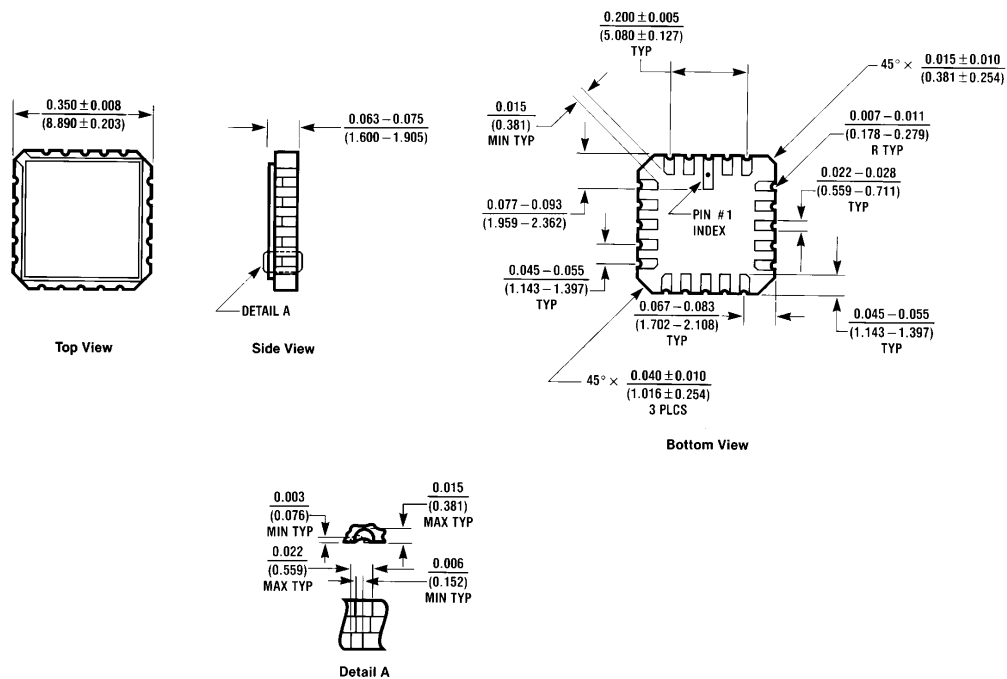
| Symbol                             | Parameter                                              | 74F                                                    |     | 54F                        |     | 74F                        |     | Units |
|------------------------------------|--------------------------------------------------------|--------------------------------------------------------|-----|----------------------------|-----|----------------------------|-----|-------|
|                                    |                                                        | $T_A = +25^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V}$ |     | $T_A, V_{CC} = \text{Mil}$ |     | $T_A, V_{CC} = \text{Com}$ |     |       |
|                                    |                                                        | Min                                                    | Max | Min                        | Max | Min                        | Max |       |
| $t_s(\text{H})$<br>$t_s(\text{L})$ | Setup Time, HIGH or LOW<br>$\overline{RE}$ to CP       | 6.0<br>14.0                                            |     | 14.0<br>18.0               |     | 7.0<br>16.0                |     | ns    |
| $t_h(\text{H})$<br>$t_h(\text{L})$ | Hold Time, HIGH or LOW<br>$\overline{RE}$ to CP        | 0<br>0                                                 |     | 0<br>0                     |     | 0<br>0                     |     | ns    |
| $t_s(\text{H})$<br>$t_s(\text{L})$ | Setup Time, HIGH or LOW<br>$D_0, D_1$ or $I/O_n$ to CP | 6.5<br>6.5                                             |     | 8.5<br>8.5                 |     | 7.5<br>7.5                 |     | ns    |
| $t_h(\text{H})$<br>$t_h(\text{L})$ | Hold Time, HIGH or LOW<br>$D_0, D_1$ or $I/O_n$ to CP  | 2.0<br>2.0                                             |     | 3.0<br>3.0                 |     | 3.0<br>3.0                 |     | ns    |
| $t_s(\text{H})$<br>$t_s(\text{L})$ | Setup Time, HIGH or LOW<br>$\overline{SE}$ to CP       | 7.0<br>2.5                                             |     | 9.0<br>11.0                |     | 8.0<br>3.5                 |     | ns    |
| $t_h(\text{H})$<br>$t_h(\text{L})$ | Hold Time, HIGH or LOW<br>$\overline{SE}$ to CP        | 2.0<br>0.0                                             |     | 2.0<br>1.0                 |     | 2.0<br>0.0                 |     | ns    |
| $t_s(\text{H})$<br>$t_s(\text{L})$ | Setup Time, HIGH or LOW<br>$S/\overline{P}$ to CP      | 11.0<br>13.5                                           |     | 13.0<br>21.0               |     | 12.0<br>15.5               |     | ns    |
| $t_s(\text{H})$<br>$t_s(\text{L})$ | Setup Time, HIGH or LOW<br>S to CP                     | 6.5<br>9.0                                             |     | 8.5<br>11.0                |     | 7.5<br>10.0                |     | ns    |
| $t_h(\text{H})$<br>$t_h(\text{L})$ | Hold Time, HIGH or LOW<br>S or $S/\overline{P}$ to CP  | 0<br>0                                                 |     | 1.0<br>0                   |     | 0<br>0                     |     | ns    |
| $t_w(\text{H})$<br>$t_w(\text{L})$ | CP Pulse Width, HIGH or LOW                            | 7.0                                                    |     | 8.0                        |     | 7.0                        |     | ns    |
| $t_w(\text{L})$                    | $\overline{MR}$ Pulse Width, LOW                       | 5.5                                                    |     | 7.5                        |     | 6.5                        |     |       |
| $t_{\text{rec}}$                   | Recovery Time<br>$\overline{MR}$ to CP                 | 8.0                                                    |     | 12.0                       |     | 8.0                        |     | ns    |

## 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:



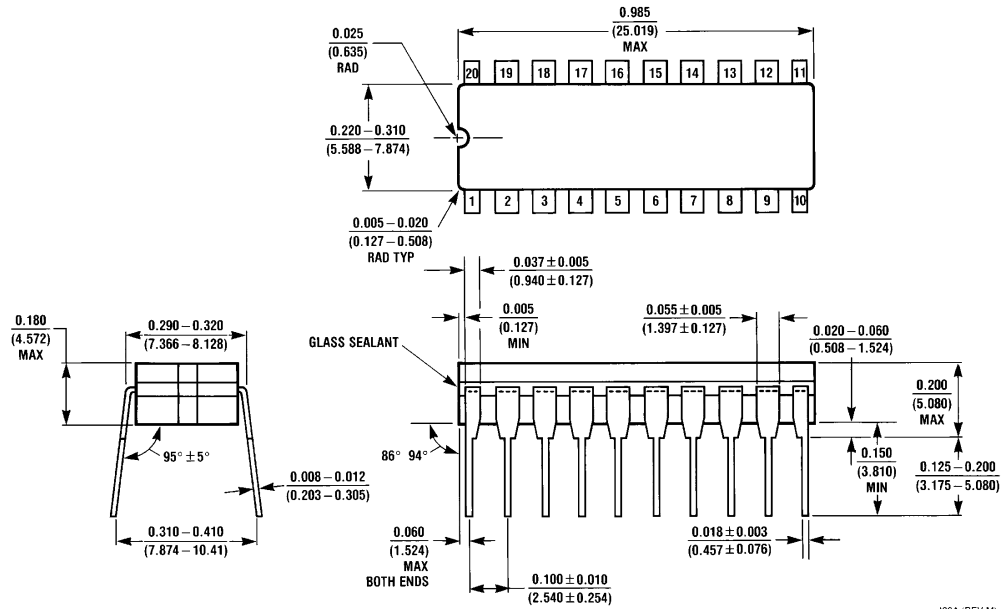
## Physical Dimensions inches (millimeters)



**20-Lead Ceramic Leadless Chip Carrier (L)  
NS Package Number E20A**

E20A (REV D)

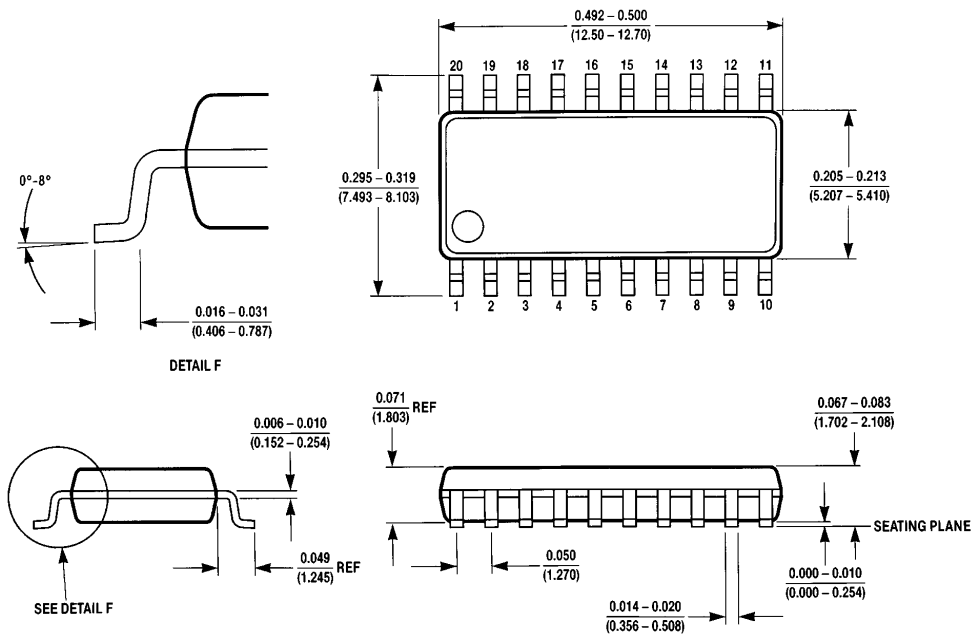
# Physical Dimensions inches (millimeters) (Continued)



**20-Lead Ceramic Dual-In-Line Package (D)  
NS Package Number J20A**

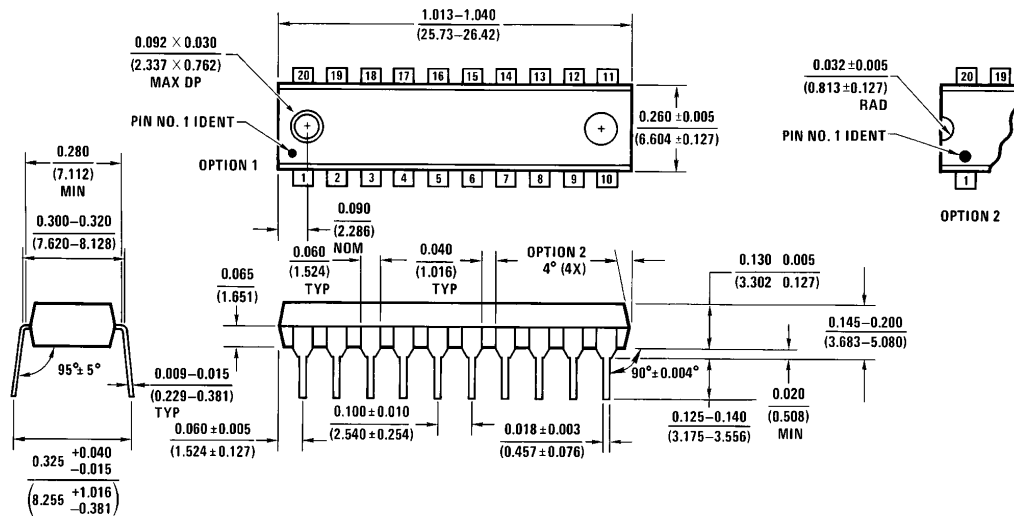


# Physical Dimensions inches (millimeters) (Continued)



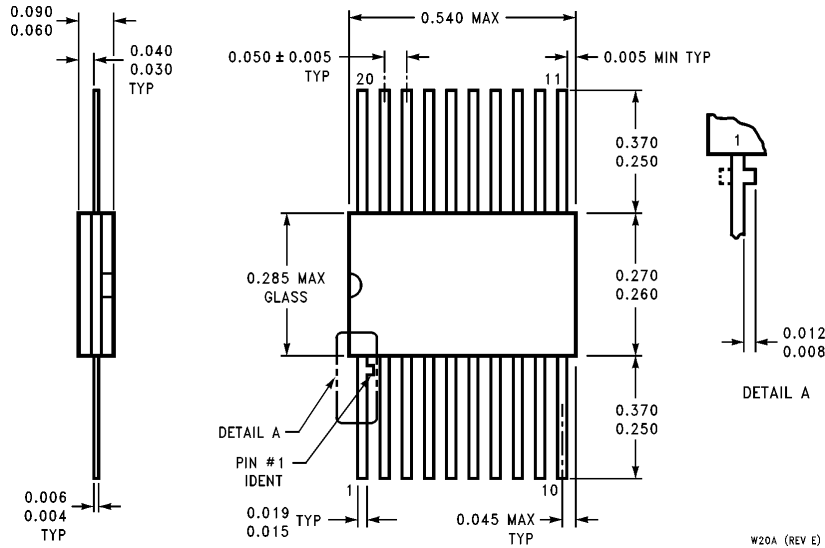
M20D (REV A)

**20-Lead (0.300" Wide) Molded Small Outline Package, EIAJ (SJ)  
NS Package Number M20D**



N20A (REV G)

**20-Lead (0.300" Wide) Molded Dual-In-Line Package (P)  
NS Package Number N20A**

**Physical Dimensions** inches (millimeters) (Continued)

**20-Lead Ceramic Flatpak (F)**  
**NS Package Number W20A**

**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
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.



**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: 1(800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 Fax: (+49) 0-180-530 85 86  
 Email: cnjwge@tevm2.nsc.com  
 Deutsch Tel: (+49) 0-180-530 85 85  
 English Tel: (+49) 0-180-532 78 32  
 Français Tel: (+49) 0-180-532 93 58  
 Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
 19th Floor, Straight Block,  
 Ocean Centre, 5 Canton Rd.  
 Tsimshatsui, Kowloon  
 Hong Kong  
 Tel: (852) 2737-1600  
 Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.