National Semiconductor

May 1995

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

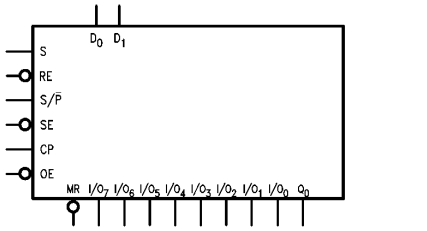
- Multiplexed parallel I/O ports
- Separate serial input and output
- Sign extend function
- TRI-STATE outputs for bus applications

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



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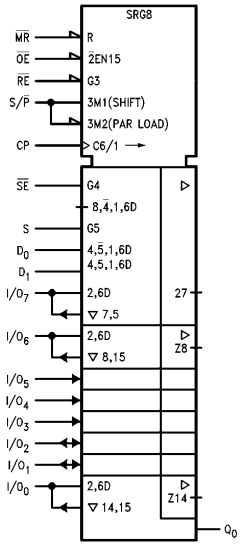
IEEE/IEC



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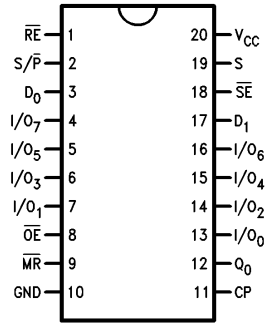
Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



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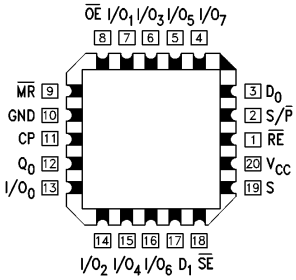
Pin Assignment for LCC



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Unit Loading/Fan Out

Pin Names	Description	54F/74F	
		U.L. HIGH/LOW	Input I_{IH}/I_{IL} Output I_{OH}/I_{OL}
$\overline{RE}$	Register Enable Input (Active LOW)	1.0/1.0	20 μA/−0.6 mA
$S/\overline{P}$	Serial (HIGH) or Parallel (LOW) Mode Control Input	1.0/1.0	20 μA/−0.6 mA
$\overline{SE}$	Sign Extend Input (Active LOW)	1.0/3.0	20 μA/−1.8 mA
S	Serial Data Select Input	1.0/2.0	20 μA/−1.2 mA
D_0, D_1	Serial Data Inputs	1.0/1.0	20 μA/−0.6 mA
CP	Clock Pulse Input (Active Rising Edge)	1.0/1.0	20 μA/−0.6 mA
$\overline{MR}$	Asynchronous Master Reset Input (Active LOW)	1.0/1.0	20 μA/−0.6 mA
$\overline{OE}$	TRI-STATE Output Enable Input (Active LOW)	1.0/1.0	20 μA/−0.6 mA
Q_0	Bi-State Serial Output	50/33.3	−1 mA/−20 mA
I/O_0–I/O_7	Multiplexed Parallel Data Inputs or	3.5/1.083	70 μA/−0.65 mA
	TRI-STATE Parallel Data Outputs	150/40 (33.3)	−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_0 or D_1, as determined by the S input. A LOW signal on $\overline{SE}$ enables shift right but Q_7 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_0
	$\overline{MR}$	$\overline{RE}$	$S/\overline{P}$	$\overline{SE}$	S	$\overline{OE}$*	CP	I/O_7	I/O_6	I/O_5	I/O_4	I/O_3	I/O_2	I/O_1	I/O_0	
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_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	I_0
Shift Right	H	L	H	H	L	L	⌐‾	D_0	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_1
	H	L	H	H	H	L	⌐‾	D_1	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_1
Sign Extend	H	L	H	L	X	L	⌐‾	O_7	O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_1
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_n terminals are at the high impedance state; sequential operation or clearing of the register is not affected.

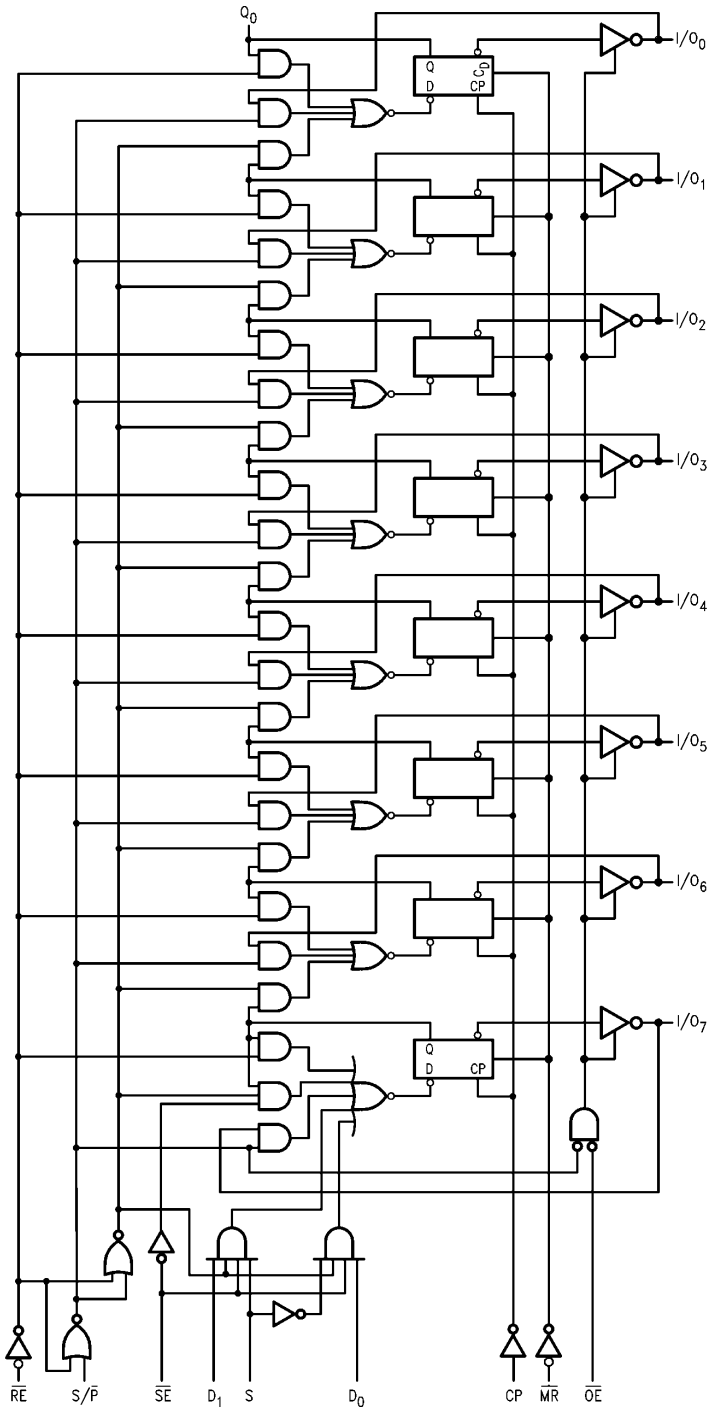
Note 1: I_7–I_0 = The level of the steady-state input at the respective I/O terminal is loaded into the flip-flop while the flip-flop outputs (except Q_0) are isolated from the I/O terminal.

Note 2: D_0, D_1 = The level of the steady-state inputs to the serial multiplexer input.

Note 3: O_7–O_0 = The level of the respective Q_n 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



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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_{CC} 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_{CC} = 0V)	
Standard Output	−0.5V to V_{CC}
TRI-STATE Output	−0.5V to +5.5V
Current Applied to Output in LOW State (Max)	twice the rated I_{OL} (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	
Military	−55°C to +125°C
Commercial	0°C to +70°C
Supply Voltage	
Military	+4.5V to +5.5V
Commercial	+4.5V to +5.5V

DC Electrical Characteristics

Symbol	Parameter		54F/74F Min	54F/74F Typ	54F/74F Max	Units	V_{CC}	Conditions
V_{IH}	Input HIGH Voltage		2.0			V		Recognized as a HIGH Signal
V_{IL}	Input LOW Voltage				0.8	V		Recognized as a LOW Signal
V_{CD}	Input Clamp Diode Voltage				−1.2	V	Min	I_{IN} = −18 mA
V_{OH}	Output HIGH Voltage	54F 10% V_{CC}	2.5			V	Min	I_{OH} = −1 mA (Q_0, I/O_n)
		54F 10% V_{CC}	2.4					I_{OH} = −3 mA (I/O_n)
		74F 10% V_{CC}	2.5					I_{OH} = −1 mA (Q_0, I/O_n)
		74F 10% V_{CC}	2.4					I_{OH} = −3 mA (I/O_n)
		74F 5% V_{CC}	2.7					I_{OH} = −1 mA (Q_0, I/O_n)
		74F 5% V_{CC}	2.7					I_{OH} = −3 mA (I/O_n)
V_{OL}	Output LOW Voltage	54F 10% V_{CC}			0.5	V	Min	I_{OL} = 20 mA (Q_0, I/O_n)
		74F 10% V_{CC}			0.5			I_{OL} = 20 mA (Q_0)
		74F 10% V_{CC}			0.5			I_{OL} = 24 mA (I/O_n)
I_{IH}	Input HIGH Current	54F			20.0	μA	Max	V_{IN} = 2.7V
		74F			5.0			
I_{BVI}	Input HIGH Current Breakdown Test	54F			100	μA	Max	V_{IN} = 7.0V (Non-I/O Inputs)
		74F			7.0			
I_{BVIT}	Input HIGH Current Breakdown Test (I/O)	54F			1.0	mA	Max	V_{IN} = 5.5V (I/O_n)
		74F			0.5			
I_{CEX}	Output HIGH Leakage Current	54F			250	μA	Max	V_{OUT} = V_{CC}
		74F			50			
V_{ID}	Input Leakage Test	74F	4.75			V	0.0	I_{ID} = 1.9 μA All Other Pins Grounded
I_{OD}	Output Leakage Circuit Current	74F			3.75	μA	0.0	V_{IOD} = 150 mV All Other Pins Grounded
I_{IL}	Input LOW Current				−0.6	mA	Max	V_{IN} = 0.5V ($\overline{RE}$, S/$\overline{P}$, D_n, CP, $\overline{MR}$, $\overline{OE}$)
					−1.2	mA	Max	V_{IN} = 0.5V (S)
					−1.8	mA	Max	V_{IN} = 0.5V ($\overline{SE}$)
I_{IH} + I_{OZH}	Output Leakage Current				70	μA	Max	$V_{I/O}$ = 2.7V (I/O_n)
I_{IL} + I_{OZL}	Output Leakage Current				−650	μA	Max	$V_{I/O}$ = 0.5V (I/O_n)
I_{OS}	Output Short-Circuit Current		−60		−150	mA	Max	V_{OUT} = 0V
I_{ZZ}	Bus Drainage Test				500	μA	0.0V	V_{OUT} = 5.25V
I_{CC}	Power Supply Current			60	90	mA	Max	

AC Electrical Characteristics

Symbol	Parameter	74F $T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50$ pF			54F T_A, V_{CC} = Mil, $C_L = 50$ pF		74F T_A, V_{CC} = Com, $C_L = 50$ pF		Units
		Min	Typ	Max	Min	Max	Min	Max	
f_{max}	Maximum Clock Frequency	70	90		50		70		MHz
t_{PLH} t_{PHL}	Propagation Delay CP to I/O_n	3.5 5.0	7.0 8.5	7.5 11.0	3.5 3.5	9.5 10.0	3.5 5.0	8.5 12.0	ns
t_{PLH} t_{PHL}	Propagation Delay CP to Q_0	3.5 3.5	7.0 7.0	9.0 8.0	3.5 3.5	11.0 10.0	3.5 3.5	10.0 9.0	ns
t_{PHL}	Propagation Delay $\overline{MR}$ to I/O_n	6.0	10.0	13.0	6.0	15.0	6.0	14.0	ns
t_{PHL}	Propagation Delay $\overline{MR}$ to Q_0	5.5	7.5	12.0	5.5	14.0	5.5	13.0	ns
t_{PZH} t_{PZL}	Output Enable Time $\overline{OE}$ to I/O_n	3.0 4.0	6.5 8.5	9.0 11.0	3.0 4.0	12.5 14.5	3.0 4.0	10.0 12.0	ns
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{OE}$ to I/O_n	2.0 2.0	4.5 5.0	6.0 7.0	2.0 2.0	8.0 10.0	2.0 2.0	7.0 8.0	
t_{PZH} t_{PZL}	Output Enable Time $S/\overline{P}$ to I/O_n	4.5 5.5	8.0 10.0	10.5 14.0	4.5 5.5	13.5 17.0	4.5 5.5	11.5 15.0	ns
t_{PHZ} t_{PLZ}	Output Disable Time $S/\overline{P}$ to I/O_n	5.0 6.0	9.0 12.0	11.5 15.5	5.0 6.0	16.5 19.5	5.0 6.0	12.5 16.5	

AC Operating Requirements

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

74F 322 S C X

Temperature Range Family
- 74F = Commercial
- 54F = Military

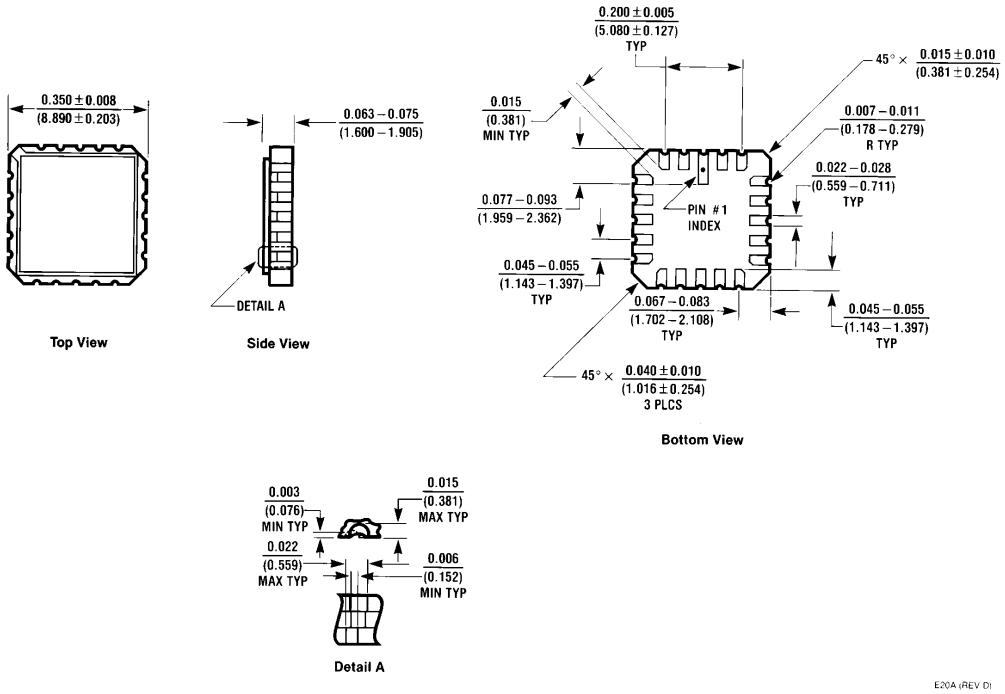
Device Type

Package Code
- P = Plastic DIP
- D = Ceramic DIP
- F = Flatpak
- SJ = Small Outline SOIC EIAJ
- L = Leadless Chip Carrier (LCC)

Temperature Range
- C = Commercial (0°C to +70°C)
- M = Military (−55°C to +125°C)

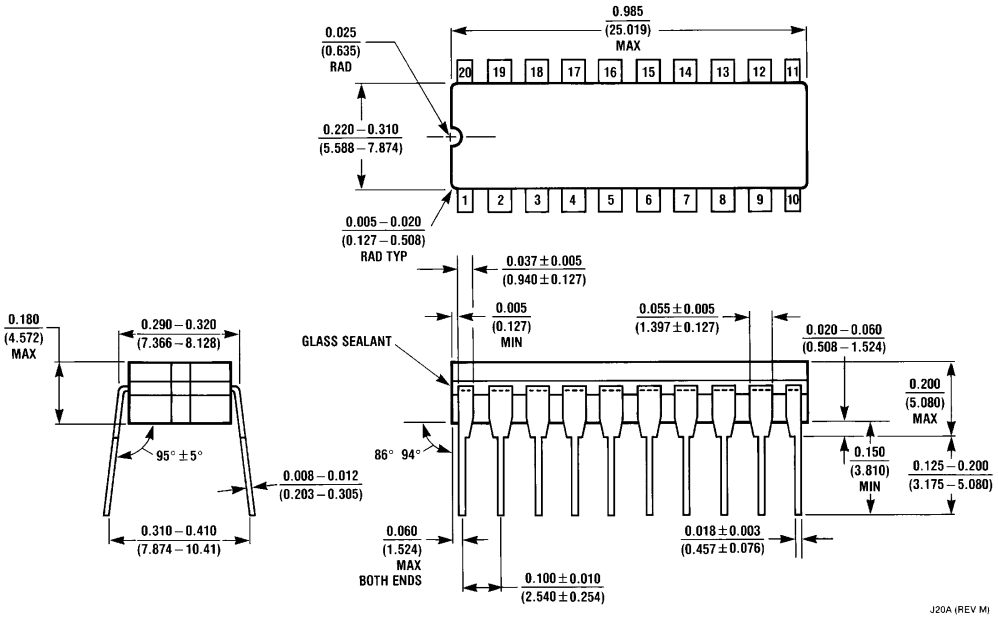
Special Variations
- QB = Military grade device with environmental and burn-in processing
- X = Devices shipped in 13″ reel

Physical Dimensions inches (millimeters)



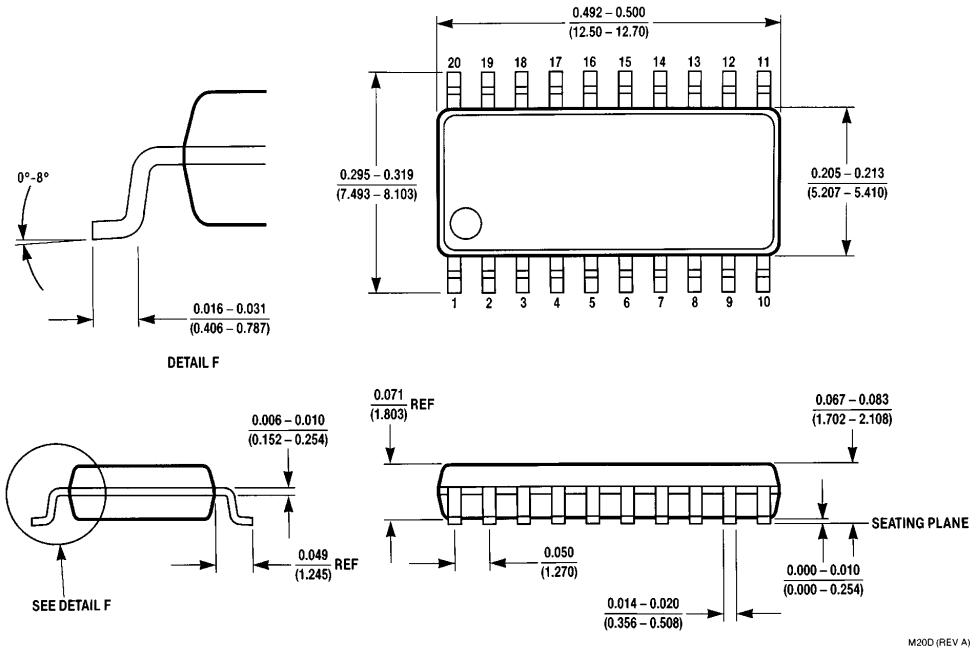
20-Lead Ceramic Leadless Chip Carrier (L)
NS Package Number E20A

Physical Dimensions inches (millimeters) (Continued)

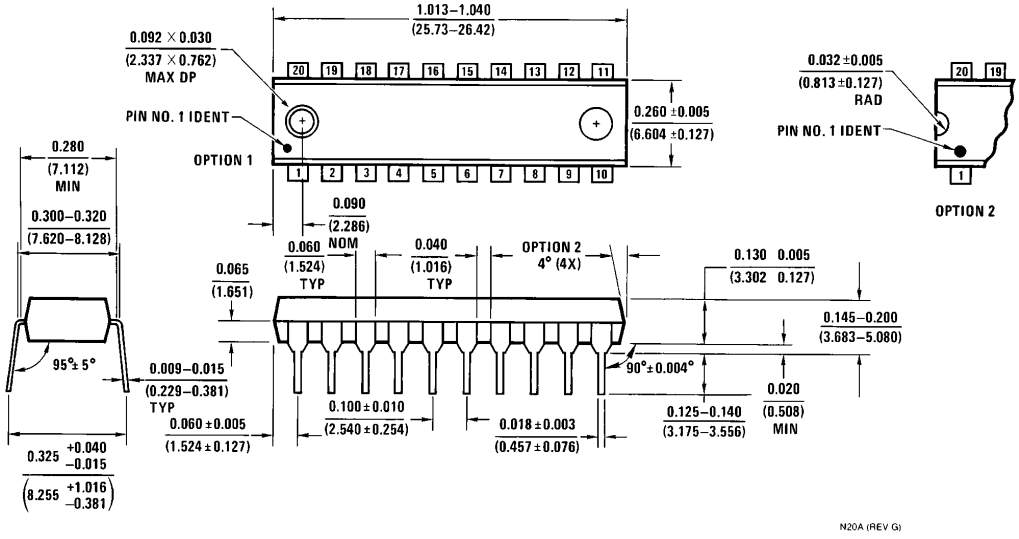


20-Lead Ceramic Dual-In-Line Package (D)
NS Package Number J20A

Physical Dimensions inches (millimeters) (Continued)

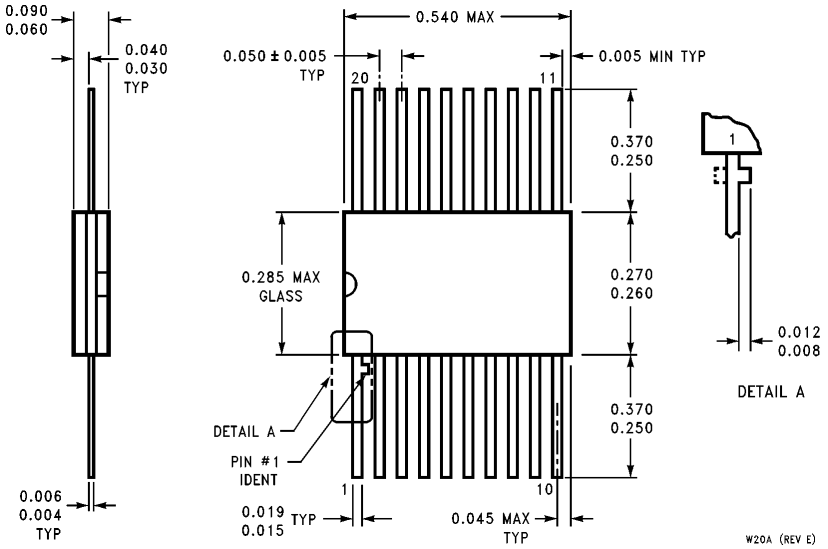


20-Lead (0.300″ Wide) Molded Small Outline Package, EIAJ (SJ)
NS Package Number M20D



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

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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.

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.
13th 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