

54F/74F138 1-of-8 Decoder/Demultiplexer

General Description

The 'F138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three 'F138 devices or a 1-of-32 decoder using four 'F138 devices and one inverter.

Features

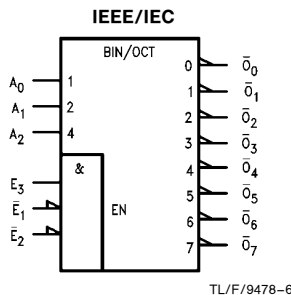
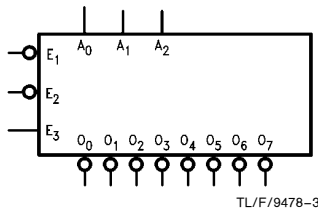
- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs
- Guaranteed 4000V minimum ESD protection

Commercial	Military	Package Number	Package Description
74F138PC		N16E	16-Lead (0.300" Wide) Molded Dual-In-Line
	54F138DM (Note 2)	J16A	16-Lead Ceramic Dual-In-Line
74F138SC (Note 1)		M16A	16-Lead (0.150" Wide) Molded Small Outline, JEDEC
74F138SJ (Note 1)		M16D	16-Lead (0.300" Wide) Molded Small Outline, EIAJ
	54F138FM (Note 2)	W16A	16-Lead Cerpack
	54F138LM (Note 2)	E20A	20-Lead Ceramic Leadless Chip Carrier, Type C

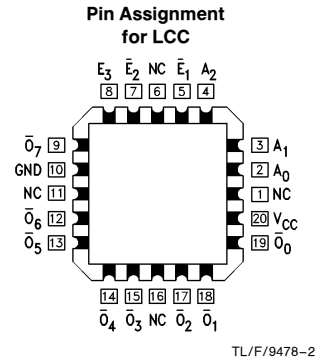
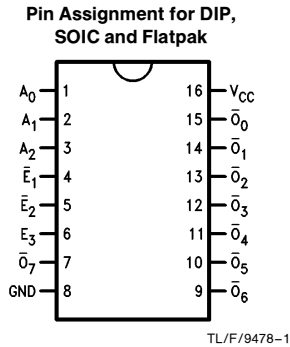
Note 1: Devices also available in 13" reel. Use suffix = SCX and SJX.

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

Logic Symbols



Connection Diagrams



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

Unit Loading/Fan Out

Pin Names	Description	54F/74F	
		U.L. HIGH/LOW	Input I _H /I _L Output I _{OH} /I _{OL}
A ₀ -A ₂	Address Inputs	1.0/1.0	20 μA/ -0.6 mA
\bar{E}_1, \bar{E}_2	Enable Inputs (Active LOW)	1.0/1.0	20 μA/ -0.6 mA
E ₃	Enable Input (Active HIGH)	1.0/1.0	20 μA/ -0.6 mA
$\bar{O}_0-\bar{O}_7$	Outputs (Active LOW)	50/33.3	-1 mA/20 mA

Functional Description

The 'F138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs (A₀, A₁, A₂) and, when enabled, provides eight mutually exclusive active LOW outputs ($\bar{O}_0-\bar{O}_7$). The 'F138 features three Enable inputs, two active LOW (\bar{E}_1, \bar{E}_2) and one active HIGH (E₃). All outputs will be HIGH unless \bar{E}_1 and \bar{E}_2 are LOW and E₃ is HIGH. This multiple enable function allows easy parallel expansion

of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four 'F138 devices and one inverter (See *Figure 1*). The 'F138 can be used as an 8-output demultiplexer by using one of the active LOW Enable inputs as the data input and the other Enable inputs as strobes. The Enable inputs which are not used must be permanently tied to their appropriate active HIGH or active LOW state.

Truth Table

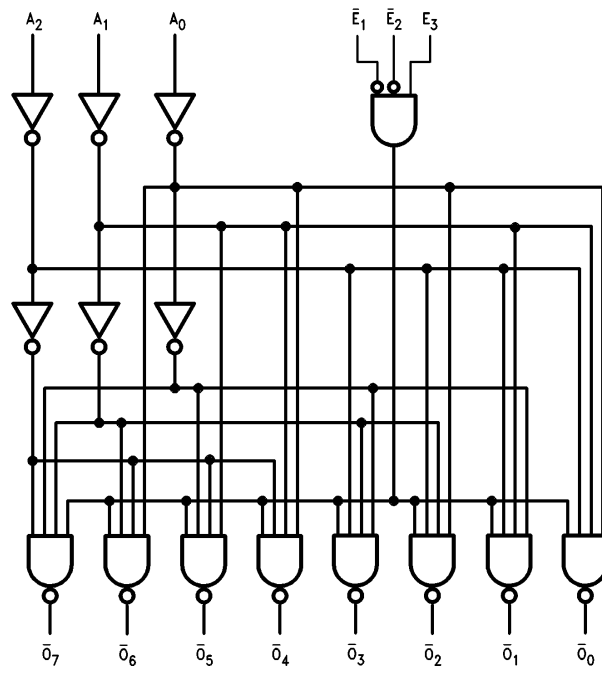
Inputs						Outputs							
\bar{E}_1	\bar{E}_2	E ₃	A ₀	A ₁	A ₂	\bar{O}_0	\bar{O}_1	\bar{O}_2	\bar{O}_3	\bar{O}_4	\bar{O}_5	\bar{O}_6	\bar{O}_7
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	L	X	X	X	H	H	H	H	H	H	H	H
L	L	H	L	L	L	L	H	H	H	H	H	H	H
L	L	H	H	L	L	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	L	H	H	H	H	H
L	L	H	H	H	L	H	H	H	L	H	H	H	H
L	L	H	H	L	H	H	H	H	H	L	H	H	H
L	L	H	L	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	L

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

Logic Diagram



TL/F/9478-4

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_{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)

ESD Last Passing Voltage (Min) 4000V

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			Units	V _{CC}	Conditions
		Min	Typ	Max			
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
		74F 10% V _{CC}	2.5				I _{OH} = –1 mA
		74F 5% V _{CC}	2.7				I _{OH} = –1 mA
V _{OL}	Output LOW Voltage	54F 10% V _{CC}		0.5	V	Min	I _{OL} = 20 mA
		74F 10% V _{CC}		0.5			I _{OL} = 20 mA
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
		74F		7.0			
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
I _{OS}	Output Short-Circuit Current	–60	–150		mA	Max	V _{OUT} = 0V
I _{CCH}	Power Supply Current	13 20			mA	Max	V _O = HIGH
I _{CCL}	Power Supply Current	13 20			mA	Max	V _O = LOW

AC Electrical Characteristics

Symbol	Parameter	74F			54F		74F		Units	Fig. No.
		$T_A = +25^\circ\text{C}$ $V_{CC} = +5.0\text{V}$ $C_L = 50\text{ pF}$			$T_A, V_{CC} = \text{Mil}$ $C_L = 50\text{ pF}$		$T_A, V_{CC} = \text{Com}$ $C_L = 50\text{ pF}$			
		Min	Typ	Max	Min	Max	Min	Max		
t_{PLH} t_{PHL}	Propagation Delay A_n to \overline{O}_n	3.5 4.0	5.6 6.1	7.5 8.0	3.0 4.0	12.0 9.5	3.5 4.0	8.5 9.0	ns	◆-3
t_{PLH} t_{PHL}	Propagation Delay \overline{E}_1 or \overline{E}_2 to \overline{O}_n	3.5 3.0	5.4 5.3	7.0 7.0	3.0 3.0	11.0 8.0	3.5 3.0	8.0 7.5	ns	◆-4
t_{PLH} t_{PHL}	Propagation Delay E_3 to \overline{O}_n	4.0 3.5	6.2 5.6	8.0 7.5	3.5 3.5	12.5 8.5	4.0 3.5	9.0 8.5	ns	◆-4

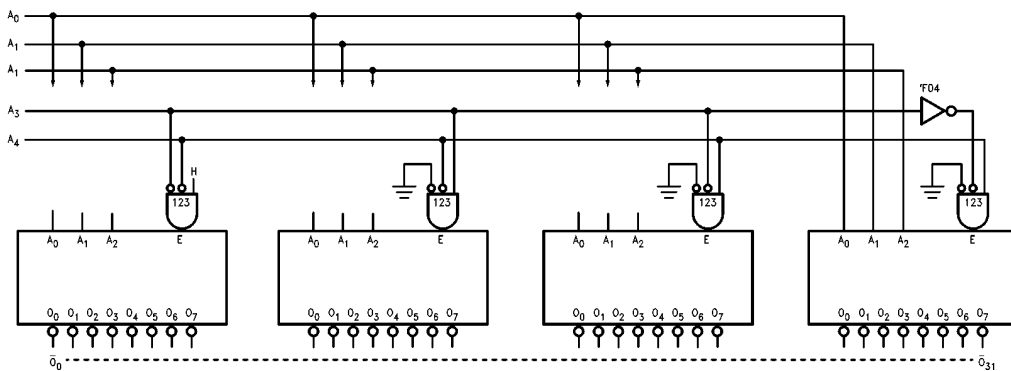
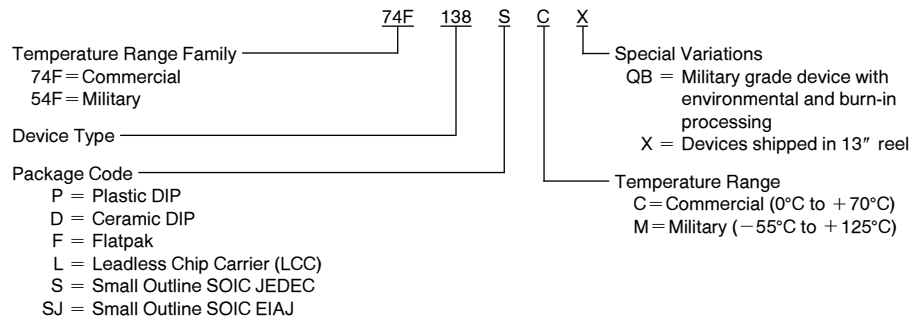


FIGURE 1. Expansion to 1-of-32 Decoding

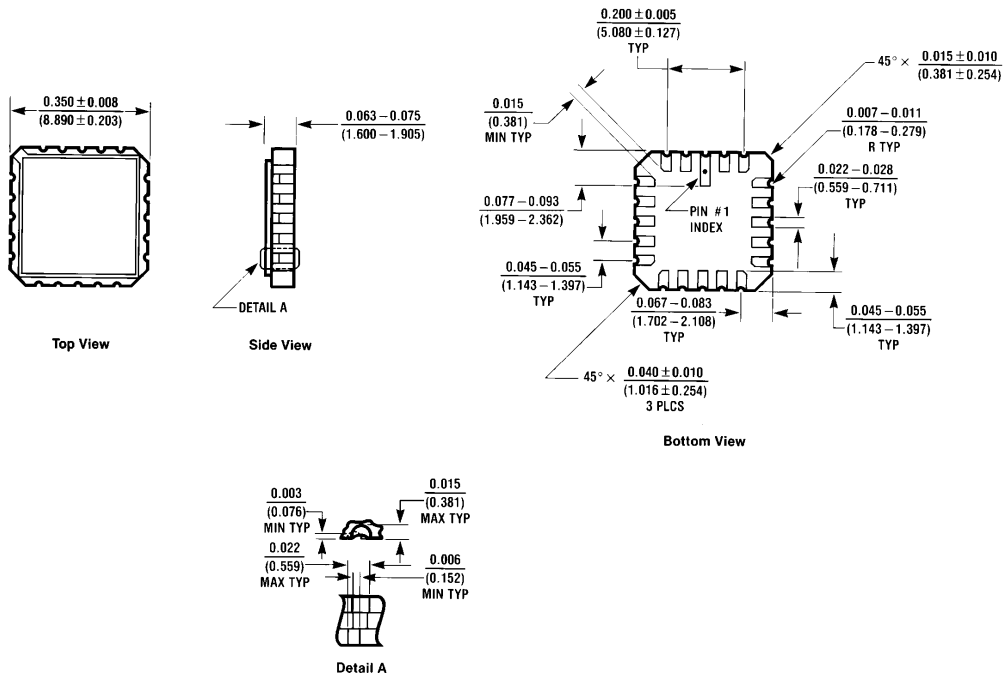
TL/F/9478-5

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:



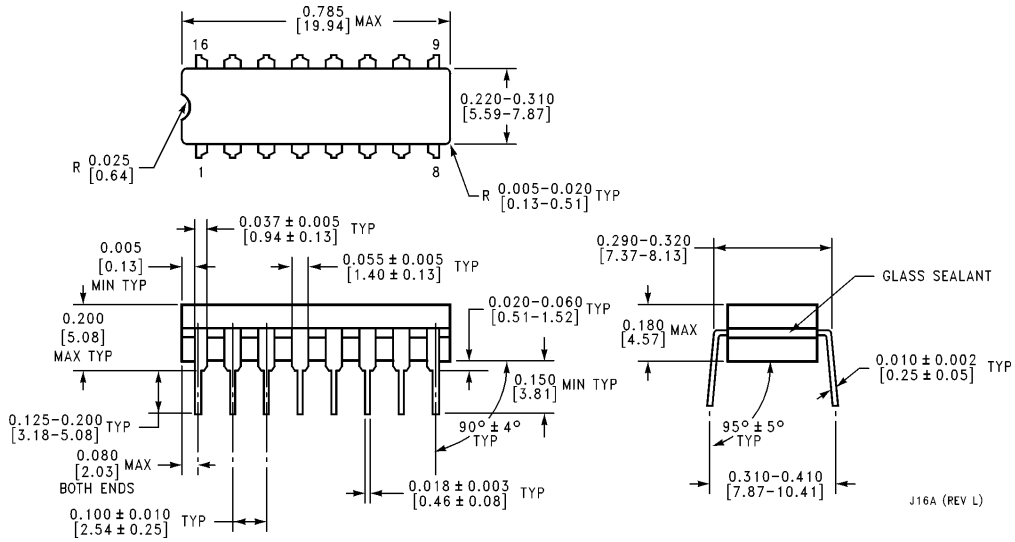
Physical Dimensions inches (millimeters)



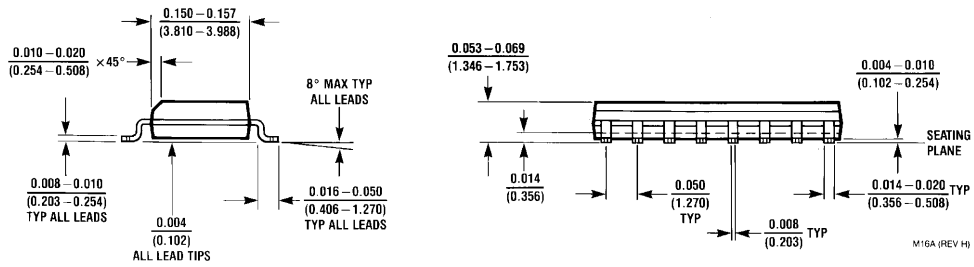
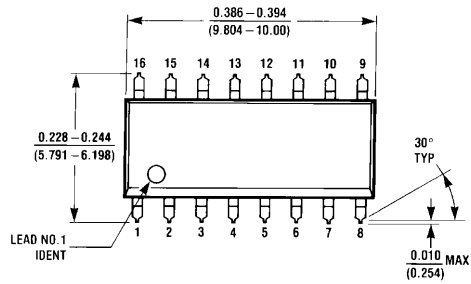
**20-Lead Ceramic Leadless Chip Carrier (L)
 NS Package Number E20A**

E20A (REV D)

Physical Dimensions inches (millimeters) (Continued)

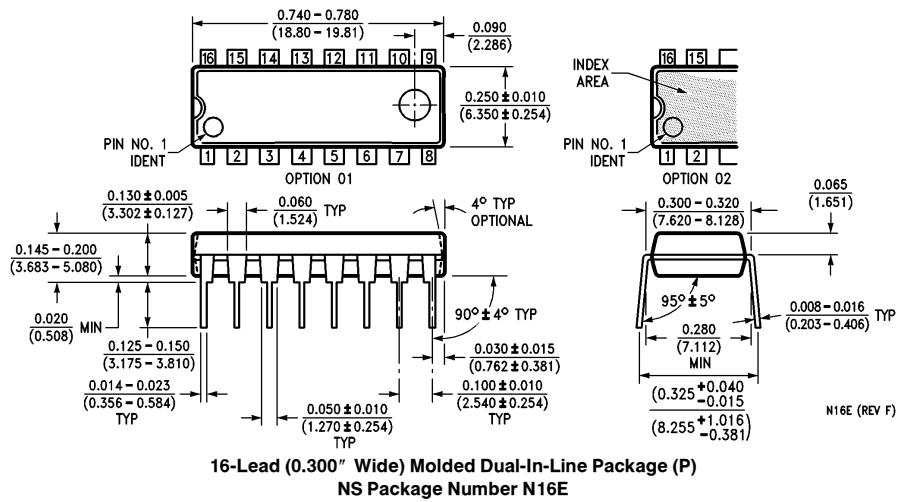
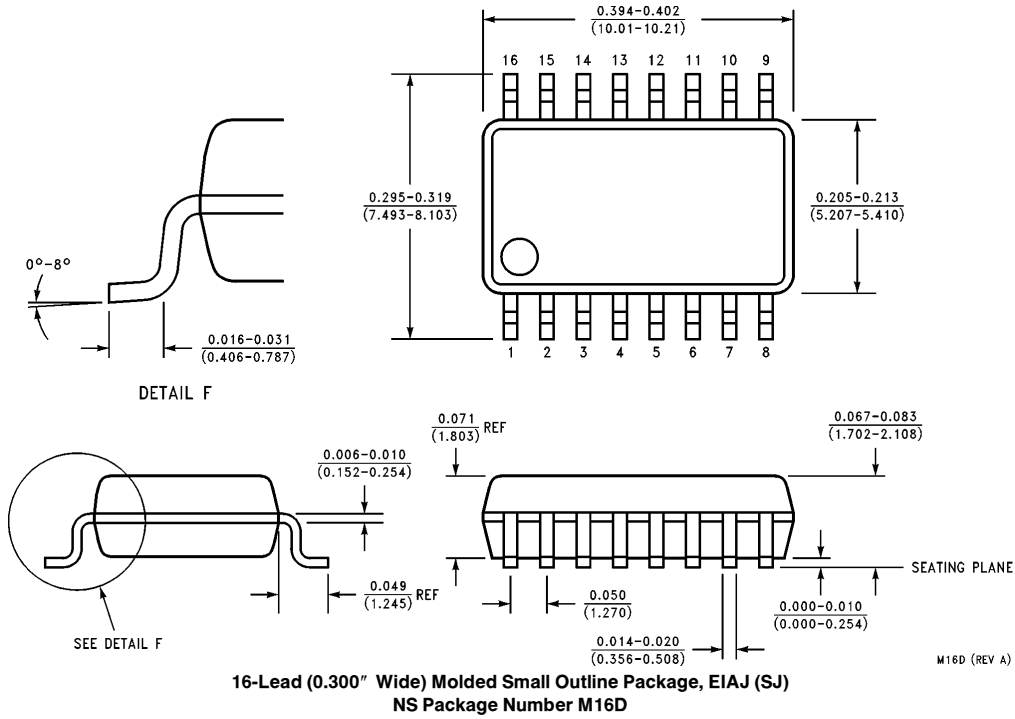


**16-Lead Ceramic Dual-In-Line Package (D)
 NS Package Number J16A**

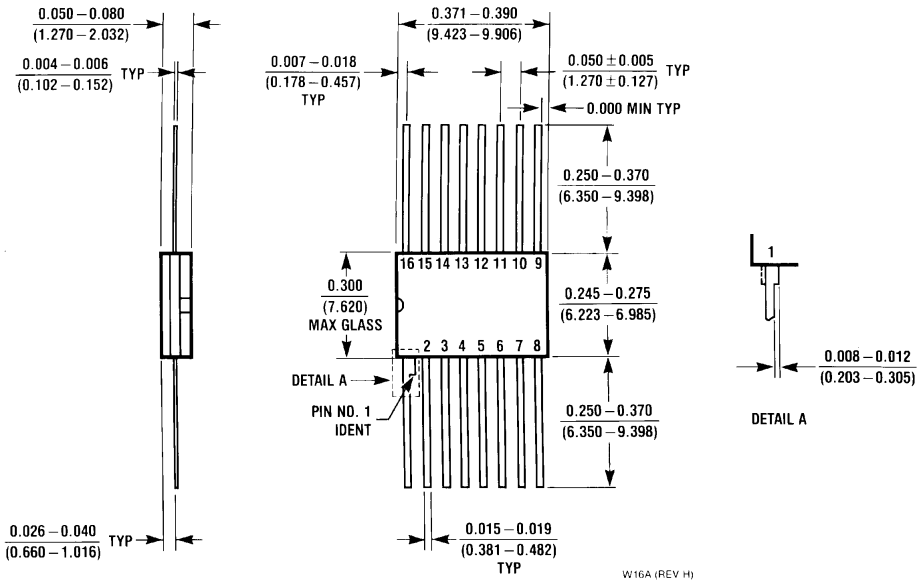


**16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)
 NS Package Number M16A**

Physical Dimensions inches (millimeters) (Continued)



Physical Dimensions inches (millimeters) (Continued)



**16-Lead Ceramic Flatpak (F)
NS Package Number W16A**

W16A (REV H)

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
2900 Semiconductor Drive
P.O. Box 58090
Santa Clara, CA 95052-8090
Tel: (1800) 272-9959
TWX: (910) 339-9240

National Semiconductor GmbH
Livry-Gargan-Str. 10
D-82256 Fürstenfeldbruck
Germany
Tel: (81-41) 35-0
Telex: 527849
Fax: (81-41) 35-1

National Semiconductor Japan Ltd.
Sumitomo Chemical
Engineering Center
Bldg. 7F
1-7-1, Nakase, Mihama-Ku
Chiba-City,
Ciba Prefecture 261
Tel: (043) 299-2300
Tel: (043) 299-2500
Fax: (043) 299-2500

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 Semicondutores Do Brazil Ltda.
Rue Deputado Lacorda Franco
120-3A
Sao Paulo-SP
Brazil 05418-000
Tel: (55-11) 212-5066
Telex: 391-1131931 NSBR BR
Fax: (55-11) 212-1181

National Semiconductor (Australia) Pty. Ltd.
Building 16
Business Park Drive
Monash Business Park
Nottingham, Melbourne
Victoria 3168 Australia
Tel: (3) 558-9999
Fax: (3) 558-9998

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.