National *Semiconductor*

54F/74F153
Dual 4-Input Multiplexer

General Description

The 'F153 is a high-speed dual 4-input multiplexer with common select inputs and individual enable inputs for each section. It can select two lines of data from four sources. The two buffered outputs present data in the true (non-inverted) form. In addition to multiplexer operation, the 'F153 can generate any two functions of three variables.

Features

■ Guaranteed 4000V minimum ESD protection

| Commercial	Military	Package Number	Package Description
74F153PC		N16E	16-Lead (0.300″ Wide) Molded Dual-In-Line
	54F153DM (Note 2)	J16A	16-Lead Ceramic Dual-In-Line
74F153SC (Note 1)		M16A	16-Lead (0.150″ Wide) Molded Small Outline, JEDEC
74F153SJ (Note 1)		M16D	16-Lead (0.300″ Wide) Molded Small Outline, EIAJ
	54F153FM (Note 2)	W16A	16-Lead Cerpack
	54F153LM (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 = DMQB, FMQB and LMQB.

Logic Symbols

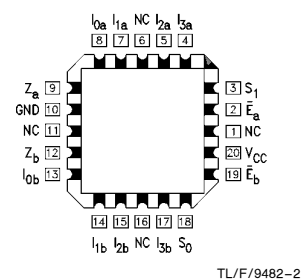

TL/F/9482–3

IEEE/IEC

TL/F/9482–5

Connection Diagrams
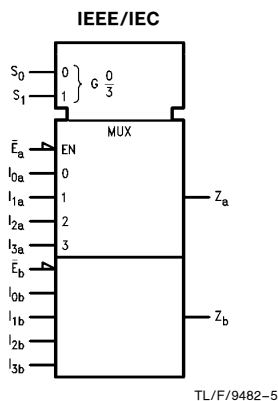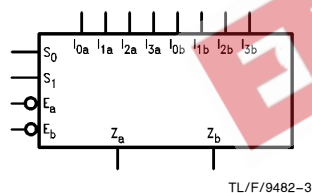
**Pin Assignment
for DIP, SOIC and Flatpak**

TL/F/9482–1
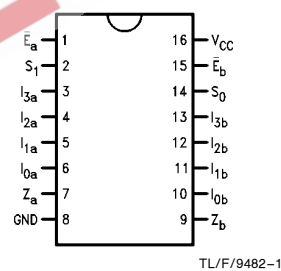
**Pin Assignment
for LCC**

TL/F/9482–2

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_{IH}/I_{IL} Output I_{OH}/I_{OL}
$I_{0a}-I_{3a}$	Side A Data Inputs	1.0/1.0	20 μA/$-$0.6 mA
$I_{0b}-I_{3b}$	Side B Data Inputs	1.0/1.0	20 μA/$-$0.6 mA
S_0, S_1	Common Select Inputs	1.0/1.0	20 μA/$-$0.6 mA
$\overline{E}_a$	Side A Enable Input (Active LOW)	1.0/1.0	20 μA/$-$0.6 mA
$\overline{E}_b$	Side B Enable Input (Active LOW)	1.0/1.0	20 μA/$-$0.6 mA
Z_a	Side A Output	50/33.3	$-$1 mA/20 mA
Z_b	Side B Output	50/33.3	$-$1 mA/20 mA

Functional Description

The 'F153 is a dual 4-input multiplexer. It can select two bits of data from up to four sources under the control of the common Select inputs (S_0, S_1). The two 4-input multiplexer circuits have individual active LOW Enables ($\overline{E}_a$, $\overline{E}_b$) which can be used to strobe the outputs independently. When the Enables ($\overline{E}_a$, $\overline{E}_b$) are HIGH, the corresponding outputs (Z_a, Z_b) are forced LOW. The 'F153 is the logic implementation of a 2-pole, 4-position switch, where the position of the switch is determined by the logic levels supplied to the two Select inputs. The logic equations for the outputs are as follows:

$$Z_a = \overline{E}_a \bullet (I_{0a} \bullet \overline{S}_1 \bullet \overline{S}_0 + I_{1a} \bullet \overline{S}_1 \bullet S_0 + I_{2a} \bullet S_1 \bullet \overline{S}_0 + I_{3a} \bullet S_1 \bullet S_0)$$

$$Z_b = \overline{E}_b \bullet (I_{0b} \bullet \overline{S}_1 \bullet \overline{S}_0 + I_{1b} \bullet \overline{S}_1 \bullet S_0 + I_{2b} \bullet S_1 \bullet \overline{S}_0 + I_{3b} \bullet S_1 \bullet S_0)$$

The 'F153 can be used to move data from a group of registers to a common output bus. The particular register from which the data came would be determined by the state of the Select inputs. A less obvious application is as a function generator. The 'F153 can generate two functions of three variables. This is useful for implementing highly irregular random logic.

Truth Table

Select Inputs		Inputs (a or b)					Output
S_0	S_1	$\overline{E}$	I_0	I_1	I_2	I_3	Z
X	X	H	X	X	X	X	L
L	L	L	L	X	X	X	L
L	L	L	H	X	X	X	H
H	L	L	X	L	X	X	L
H	L	L	X	H	X	X	H
L	H	L	X	X	L	X	L
L	H	L	X	X	H	X	H
H	H	L	X	X	X	L	L
H	H	L	X	X	X	H	H

H = HIGH Voltage Level
L = LOW
X = Immaterial

Logic Diagram

$\bar{E}_a$ I_{0a} I_{1a} I_{2a} I_{3a} S_1 S_0 I_{0b} I_{1b} I_{2b} I_{3b} $\bar{E}_b$

Z_a Z_b
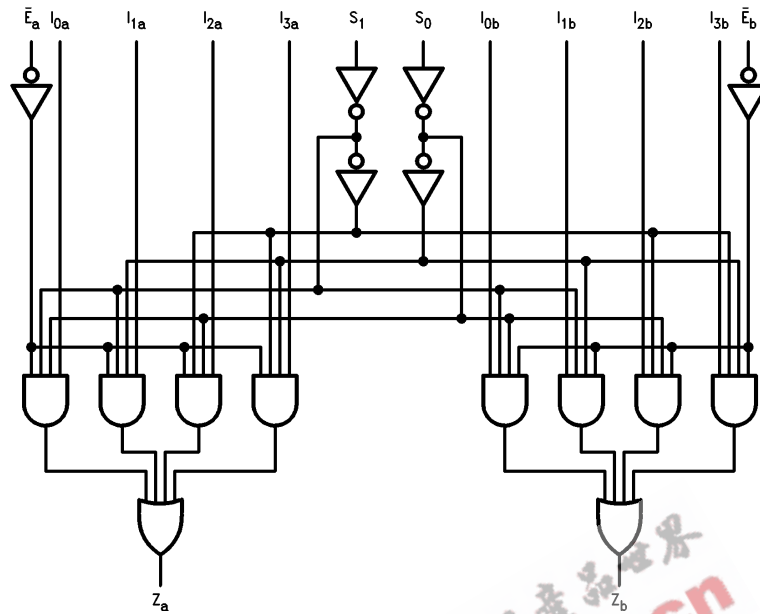
TL/F/9482–4

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)

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

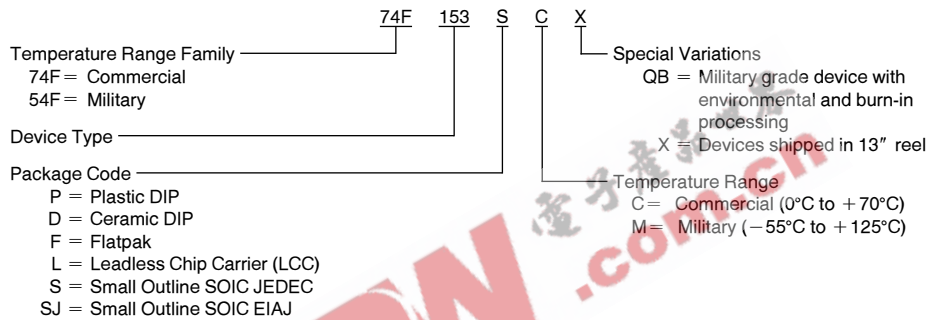|	
Free Air Ambient Temperature	
Military	$-55°C$ to $+125°C$
Commercial	$0°C$ to $+70°C$
Supply Voltage	
Military	$+4.5V$ to $+5.5V$
Commercial	$+4.5V$ to $+5.5V$

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	$I_{ID} = 1.9 \mu$A 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_{CCL}	Power Supply Current			12	20	mA	Max	$V_O = $ LOW

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	
t_{PLH} t_{PHL}	Propagation Delay S_n to Z_n	4.5 3.5	8.1 7.0	10.5 9.0	4.5 3.5	14.0 11.0	4.5 3.5	12.0 10.5	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{E}_n$ to Z_n	4.5 3.0	7.1 5.7	9.0 7.0	4.5 2.5	11.5 9.0	4.5 2.5	10.5 8.0	ns
t_{PLH} t_{PHL}	Propagation Delay I_n to Z_n	3.0 2.5	5.3 5.1	7.0 6.5	2.5 2.5	9.0 8.0	3.0 2.5	8.0 7.5	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   153   S   C   X

Temperature Range Family
74F = Commercial
54F = Military

Device Type

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

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

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

5

Physical Dimensions inches (millimeters)

0.350 ± 0.008
(8.890 ± 0.203)

Top View

$0.063 - 0.075$
$(1.600 - 1.905)$

DETAIL A

Side View

0.200 ± 0.005
(5.080 ± 0.127)
TYP

0.015
(0.381)
MIN TYP

$45° \times \quad \dfrac{0.015 \pm 0.010}{(0.381 \pm 0.254)}$

$0.007 - 0.011$
$(0.178 - 0.279)$
R TYP

$0.022 - 0.028$
$(0.559 - 0.711)$
TYP

$0.077 - 0.093$
$(1.959 - 2.362)$

PIN # 1
INDEX

$0.045 - 0.055$
$(1.143 - 1.397)$
TYP

$0.067 - 0.083$
$(1.702 - 2.108)$
TYP

$0.045 - 0.055$
$(1.143 - 1.397)$
TYP

$45° \times \quad \dfrac{0.040 \pm 0.010}{(1.016 \pm 0.254)}$
3 PLCS

Bottom View

0.003
(0.076)
MIN TYP

0.015
(0.381)
MAX TYP

0.022
(0.559)
MAX TYP

0.006
(0.152)
MIN TYP

Detail A

E20A (REV D)

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

$\dfrac{0.785}{[19.94]}$ MAX

16   9

$0.220 - 0.310$
$[5.59 - 7.87]$

R 0.025
$[0.64]$

1   8

R $0.005 - 0.020$
$[0.13 - 0.51]$ TYP

0.037 ± 0.005
$[0.94 \pm 0.13]$ TYP

0.005
$[0.13]$
MIN TYP

0.055 ± 0.005
$[1.40 \pm 0.13]$ TYP

0.200
$[5.08]$
MAX TYP

$0.020 - 0.060$
$[0.51 - 1.52]$ TYP

0.150
$[3.81]$ MIN TYP

$0.290 - 0.320$
$[7.37 - 8.13]$

GLASS SEALANT

0.180
$[4.57]$ MAX

0.010 ± 0.002
$[0.25 \pm 0.05]$ TYP

$0.125 - 0.200$
$[3.18 - 5.08]$ TYP

$90° \pm 4°$
TYP

$95° \pm 5°$
TYP

0.080
$[2.03]$ MAX
BOTH ENDS

0.018 ± 0.003
$[0.46 \pm 0.08]$ TYP

$0.310 - 0.410$
$[7.87 - 10.41]$

0.100 ± 0.010
$[2.54 \pm 0.25]$ TYP
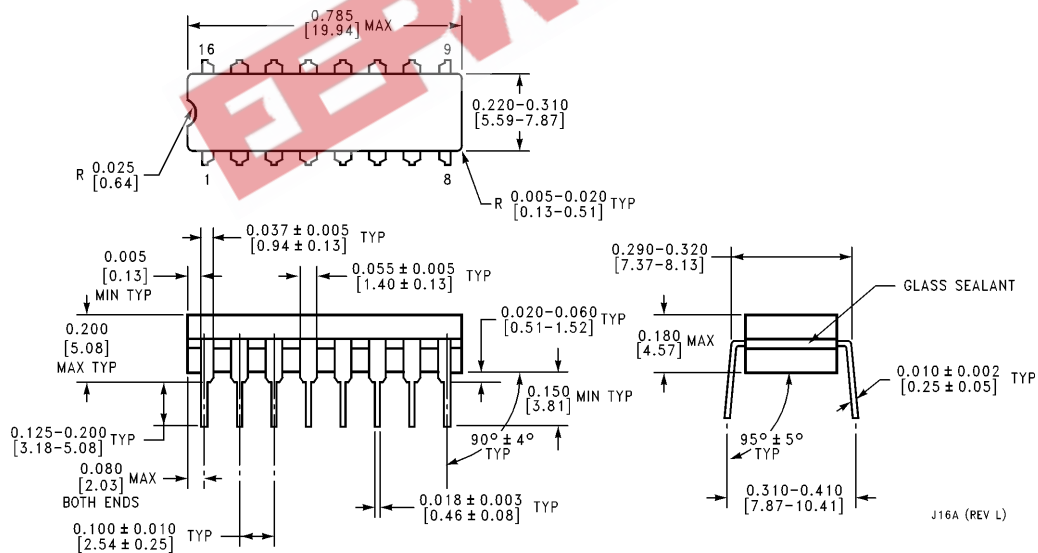
J16A (REV L)

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

Physical Dimensions inches (millimeters) (Continued)

0.386 − 0.394
(9.804 − 10.00)

0.228 − 0.244
(5.791 − 6.198)

30°
TYP

0.010 MAX
(0.254)

LEAD NO.1
IDENT

0.150 − 0.157
(3.810 − 3.988)

0.010 − 0.020
(0.254 − 0.508) × 45°

8° MAX TYP
ALL LEADS

0.008 − 0.010
(0.203 − 0.254)
TYP ALL LEADS

0.004
(0.102)
ALL LEAD TIPS

0.016 − 0.050
(0.406 − 1.270)
TYP ALL LEADS

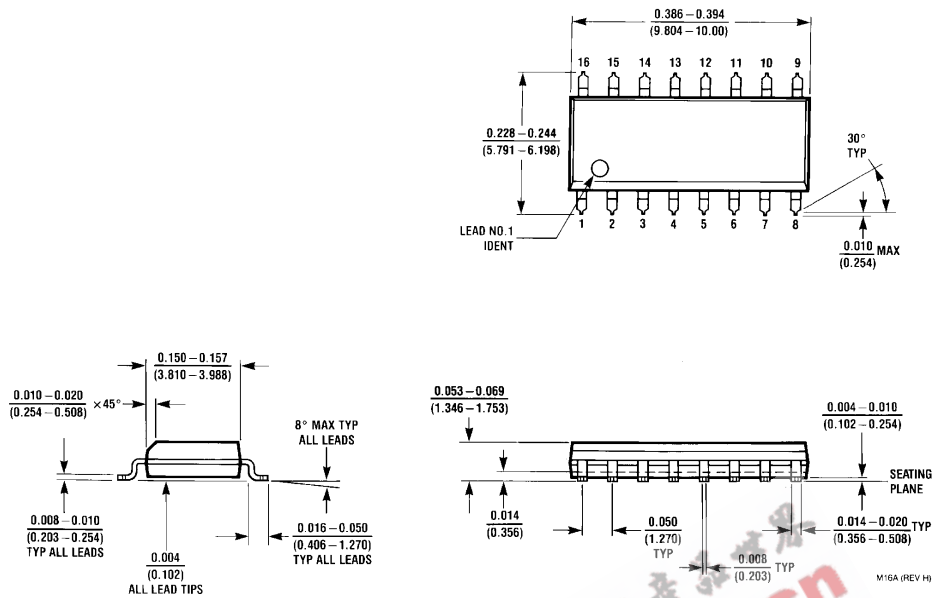0.053 − 0.069
(1.346 − 1.753)

0.004 − 0.010
(0.102 − 0.254)

SEATING
PLANE

0.014
(0.356)

0.050
(1.270)
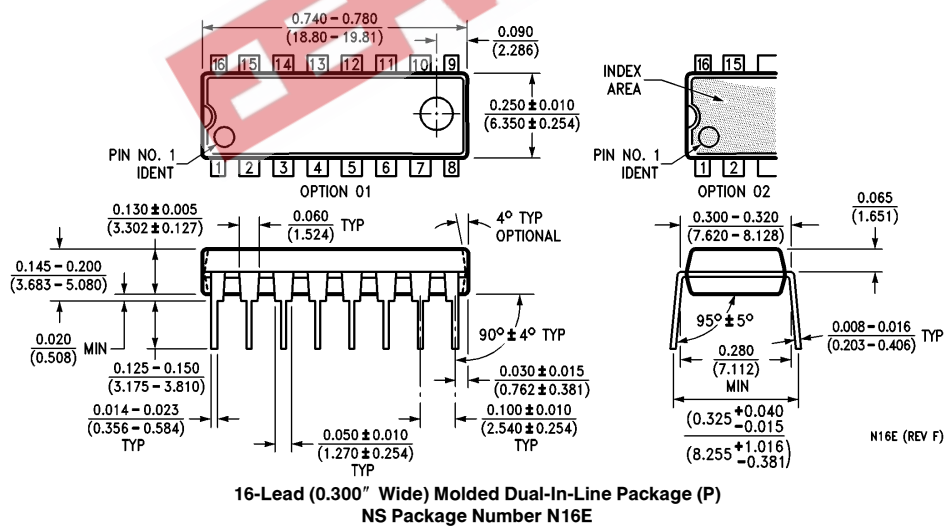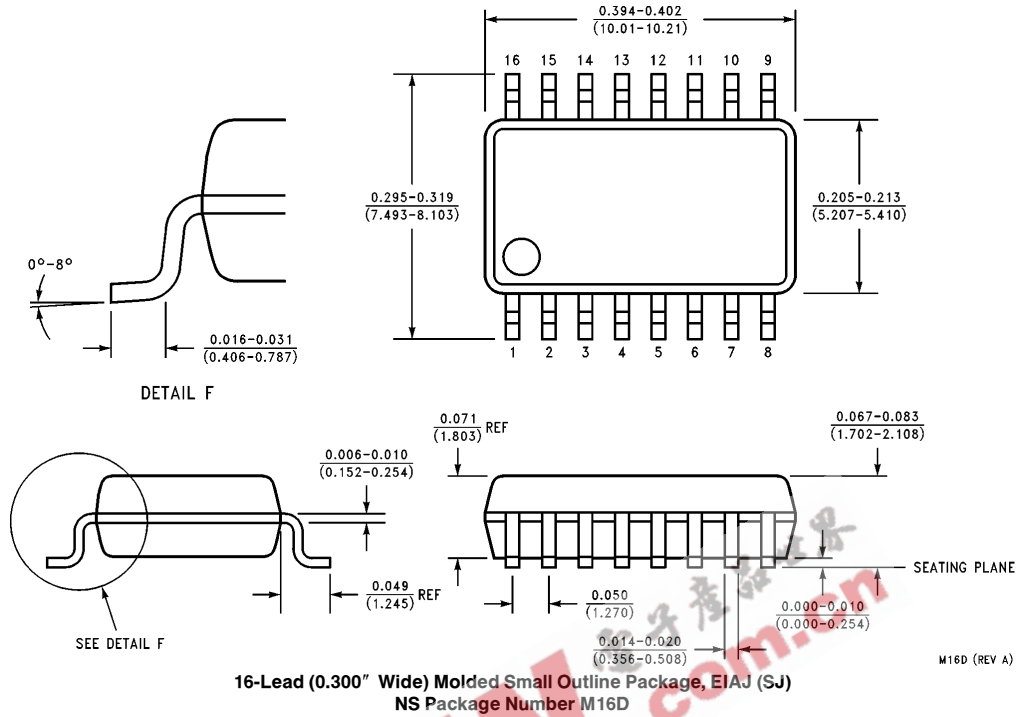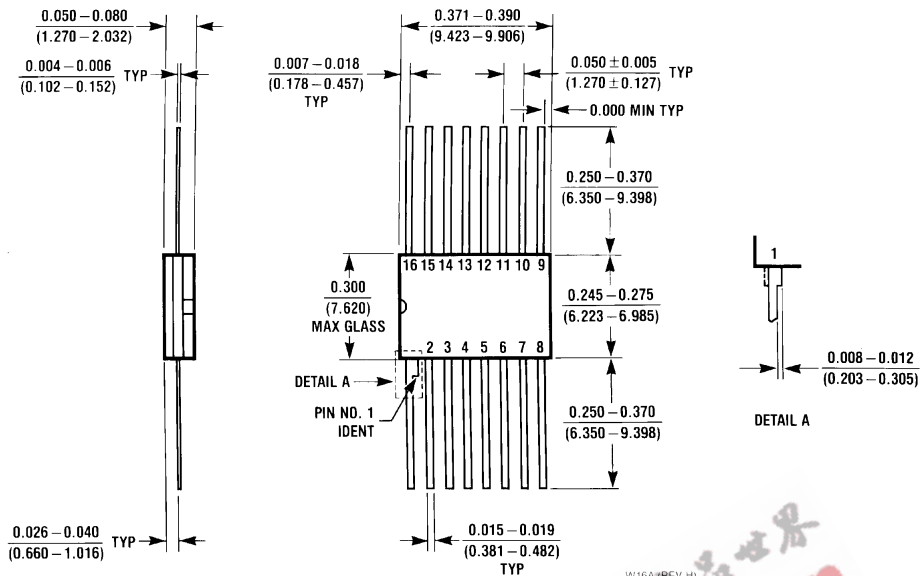TYP

0.008
(0.203) TYP

0.014 − 0.020
(0.356 − 0.508) TYP

M16A (REV H)

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

Physical Dimensions inches (millimeters) (Continued)

0.394–0.402
(10.01–10.21)

16 15 14 13 12 11 10 9

0.295–0.319
(7.493–8.103)

0.205–0.213
(5.207–5.410)

1 2 3 4 5 6 7 8

0°–8°

0.016–0.031
(0.406–0.787)

DETAIL F

0.006–0.010
(0.152–0.254)

0.071
(1.803) REF

0.067–0.083
(1.702–2.108)

0.049
(1.245) REF

0.050
(1.270)

SEATING PLANE

0.014–0.020
(0.356–0.508)

0.000–0.010
(0.000–0.254)

SEE DETAIL F

M16D (REV A)

16-Lead (0.300″ Wide) Molded Small Outline Package, EIAJ (SJ)
NS Package Number M16D

0.740–0.780
(18.80–19.81)

0.090
(2.286)

16 15 14 13 12 11 10 9

0.250±0.010
(6.350±0.254)

PIN NO. 1
IDENT

1 2 3 4 5 6 7 8

OPTION 01

INDEX
AREA

16 15

PIN NO. 1
IDENT

1 2

OPTION 02

0.065
(1.651)

0.130±0.005
(3.302±0.127)

0.060
(1.524) TYP

4° TYP
OPTIONAL

0.145–0.200
(3.683–5.080)

0.300–0.320
(7.620–8.128)

0.020
(0.508) MIN

0.125–0.150
(3.175–3.810)

90°±4° TYP

95°±5°

0.008–0.016
(0.203–0.406) TYP

0.014–0.023
(0.356–0.584)
TYP

0.050±0.010
(1.270±0.254)
TYP

0.030±0.015
(0.762±0.381)

0.100±0.010
(2.540±0.254)
TYP

0.280
(7.112)
MIN

(0.325 +0.040 −0.015)

(8.255 +1.016 −0.381)

N16E (REV F)

16-Lead (0.300″ Wide) Molded Dual-In-Line Package (P)
NS Package Number N16E

Physical Dimensions inches (millimeters) (Continued)

0.050 − 0.080
(1.270 − 2.032)

0.004 − 0.006
(0.102 − 0.152) TYP

0.371 − 0.390
(9.423 − 9.906)

0.007 − 0.018
(0.178 − 0.457)
TYP

0.050 ± 0.005
(1.270 ± 0.127) TYP

0.000 MIN TYP

0.250 − 0.370
(6.350 − 9.398)

0.300
(7.620)
MAX GLASS

16 15 14 13 12 11 10 9

0.245 − 0.275
(6.223 − 6.985)

1

DETAIL A

PIN NO. 1
IDENT

2 3 4 5 6 7 8

0.250 − 0.370
(6.350 − 9.398)

0.008 − 0.012
(0.203 − 0.305)

DETAIL A

0.026 − 0.040
(0.660 − 1.016) TYP

0.015 − 0.019
(0.381 − 0.482)
TYP

W16A (REV H)

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

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.