54F109,74F109

Dual JK (Note: Overbar Over the K) Positive Edge-Triggered Flip-Flop

Literature Number: SNOS149A

November 1994

National Semiconductor

54F/74F109
Dual J$\overline{K}$ Positive Edge-Triggered Flip-Flop

DSXXX

General Description

The 'F109 consists of two high-speed, completely independent transition clocked J$\overline{K}$ flip-flops. The clocking operation is independent of rise and fall times of the clock waveform. The J$\overline{K}$ design allows operation as a D flip-flop (refer to 'F74 data sheet) by connecting the J and $\overline{K}$ inputs.

Asynchronous Inputs:

LOW input to $\overline{S}_D$ sets Q to HIGH level

LOW input to $\overline{C}_D$ sets Q to LOW level

Clear and Set are independent of clock

Simultaneous LOW on $\overline{C}_D$ and $\overline{S}_D$ makes both Q and $\overline{Q}$ HIGH

Features

- Guaranteed 4000V minimum ESD protection.

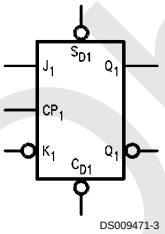
Ordering Code: See Section 0

Commercial	Military	Package Number	Package Description
74F109PC		N16E	16-Lead (0.300" Wide) Molded Dual-in-Line
	54F109DM (Note 2)	J16A	16-Lead Ceramic Dual-in-Line
74F109SC (Note 1)		M16A	16-Lead (0.150" Wide) Molded Small Outline, JEDEC
74F109SJ (Note 1)		M16D	16-Lead (0.300" Wide) Molded Small Outline, EIAJ
	54F109FM (Note 2)	W16A	16-Lead Cerpack
	54F109LM (Note 2)	E20A	16-Lead Ceramic Leadless Chip Carrier, Type C

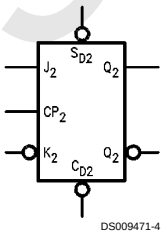
Note 1: Devices also available in 13" reel. Use suffix = SCX and SJX.

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

Logic Symbols

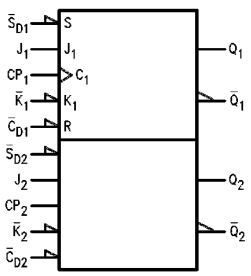


DS009471-3



DS009471-4

IEEE/IEC



DS009471-6

FAST® and TRI-STATE® are registered trademarks of National Semiconductor Corporation.

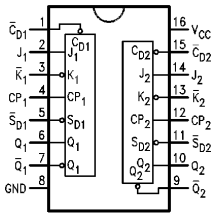
© 1997 National Semiconductor Corporation

Obsolete

PrintDate=1997/08/28 PrintTime=11:45:22 10182 ds009471 Rev. No. 1 cmserv **Proof** 1

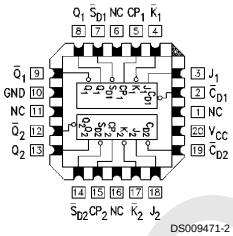
Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



DS009471-1

Pin Assignment for LCC



DS009471-2

Unit Loading/Fan Out

See Section 0 for U.L. definitions

DSXXX

Pin Names	Description	54F/74F	
		U.L. HIGH/LOW	Input I_{IH}/I_{IL} Output I_{OH}/I_{OL}
J_1, J_2, $\overline{K}_1$, $\overline{K}_2$	Data Inputs	1.0/1.0	20 µA/−0.6 mA
CP_1, CP_2	Clock Pulse Inputs (Active Rising Edge)	1.0/1.0	20 µA/−0.6 mA
$\overline{C}_{D1}$, $\overline{C}_{D2}$	Direct Clear Inputs (Active LOW)	1.0/3.0	20 µA/−1.8 mA
$\overline{S}_{D1}$, $\overline{S}_{D2}$	Direct Set Inputs (Active LOW)	1.0/3.0	20 µA/−1.8 mA
Q_1, Q_2, $\overline{Q}_1$, $\overline{Q}_2$	Outputs	50/33.3	−1 mA/20 mA

Truth Table

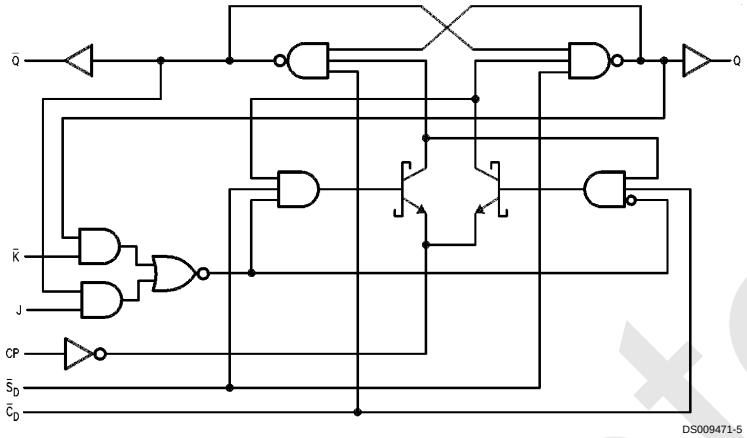
Inputs					Outputs	
$\overline{S}_D$	$\overline{C}_D$	CP	J	$\overline{K}$	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H	H
H	H	⌐	l	l	L	H
H	H	⌐	h	l	Toggle	
H	H	⌐	l	h	Q_0	$\overline{Q}_0$
H	H	⌐	h	h	H	L
H	H	L	X	X	Q_0	$\overline{Q}_0$

H (h) = HIGH Voltage Level
L (l) = LOW Voltage Level
⌐ = LOW-to-HIGH Transition
X = Immaterial
Q_0 ($\overline{Q}_0$) = Before LOW-to-HIGH Transition of Clock
Lower case letters indicate the state of the referenced output one setup time prior to the LOW-to-HIGH clock transition.

Obsolete

PrintDate=1997/08/28 PrintTime=11:45:23 10182 ds009471 Rev. No. 1 cmserv **Proof** 2

Logic Diagram (One Half Shown)



DS009471-5

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

Obsolete

PrintDate=1997/08/28 PrintTime=11:45:24 10182 ds009471 Rev. No. 1 cmserv **Proof**

Absolute Maximum Ratings (Note 3)

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 4)	−0.5V to +7.0V
Input Current (Note 4)	−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

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

Note 3: 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 4: Either voltage limit or current limit is sufficient to protect inputs.

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					I_{OH} = −1 mA
		74F 10% V_{CC}	2.5			V	Min	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 (J_n, $\overline{K}_n$)
					−1.8	mA	Max	V_{IN} = 0.5V ($\overline{C}_{Dn}$, $\overline{S}_{Dn}$)
I_{OS}	Output Short-Circuit Current		−60		−150	mA	Max	V_{OUT} = 0V
I_{CC}	Power Supply Current			11.7	17.0	mA	Max	CP = 0V

AC Electrical Characteristics

See Section 0 for Waveforms and Load Configurations

DSXXX

Symbol	Parameter	74F T_A = +25˚C, V_{CC} = +5.0V, C_L = 50 pF Min	Typ	Max	54F T_A, V_{CC} = Mil, C_L = 50 pF Min	Max	74F T_A, V_{CC} = Com, C_L = 50 pF Min	Max	Units	Fig. No.
f_{max}	Maximum Clock Frequency	100	125		70		90		MHz	♦♦-♦♦

DSXXX

Obsolete

PrintDate=1997/08/28 PrintTime=11:45:27 10182 ds009471 Rev. No. 1 cmserv **Proof** 4

AC Electrical Characteristics (Continued)

See Section 0 for Waveforms and Load Configurations

Symbol	Parameter	74F $T_A = +25^\circ C$ $V_{CC} = +5.0V$ $C_L = 50$ pF			54F $T_A, V_{CC} =$ Mil $C_L = 50$ pF		74F $T_A, V_{CC} =$ Com $C_L = 50$ pF		Units	Fig. No.
		Min	Typ	Max	Min	Max	Min	Max		
t_{PLH}	Propagation Delay	3.8	5.3	7.0	3.8	9.0	3.8	8.0	ns	♦♦-♦♦
t_{PHL}	CP_n to Q_n or $\overline{Q}_n$	4.4	6.2	8.0	4.4	10.5	4.4	9.2		
t_{PLH}	Propagation Delay	3.2	5.2	7.0	3.2	9.0	3.2	8.0		
t_{PHL}	$\overline{C}_{Dn}$ or $\overline{S}_{Dn}$ to Q_n or $\overline{Q}_n$	3.5	7.0	9.0	3.5	11.5	3.5	10.5	ns	♦♦-♦♦

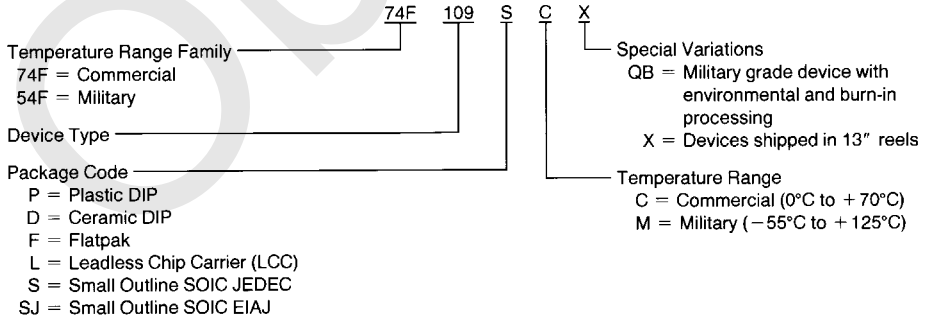
AC Operating Requirements

See Section 0 for Waveforms

Symbol	Parameter	74F $T_A = +25^\circ C$ $V_{CC} = +5.0V$		54F $T_A, V_{CC} =$ Mil		74F $T_A, V_{CC} =$ Com		Units	Fig. No.
		Min	Max	Min	Max	Min	Max		
$t_s(H)$	Setup Time, HIGH or LOW	3.0		3.0		3.0			
$t_s(L)$	J_n or $\overline{K}_n$ to CP_n	3.0		4.0		3.0		ns	♦♦-♦♦
$t_h(H)$	Hold Time, HIGH or LOW	1.0		1.0		1.0			
$t_h(L)$	J_n or $\overline{K}_n$ to CP_n	1.0		1.0		1.0			
$t_w(H)$	CP_n Pulse Width	4.0		4.0		4.0		ns	♦♦-♦♦
$t_w(L)$	HIGH or LOW	5.0		5.0		5.0			
$t_w(L)$	$\overline{C}_{Dn}$ or $\overline{S}_{Dn}$ Pulse Width, LOW	4.0		4.0		4.0		ns	♦♦-♦♦
t_{rec}	Recovery Time $\overline{C}_{Dn}$ or $\overline{S}_{Dn}$ to CP	2.0		2.0		2.0		ns	♦♦-♦♦

Ordering Information

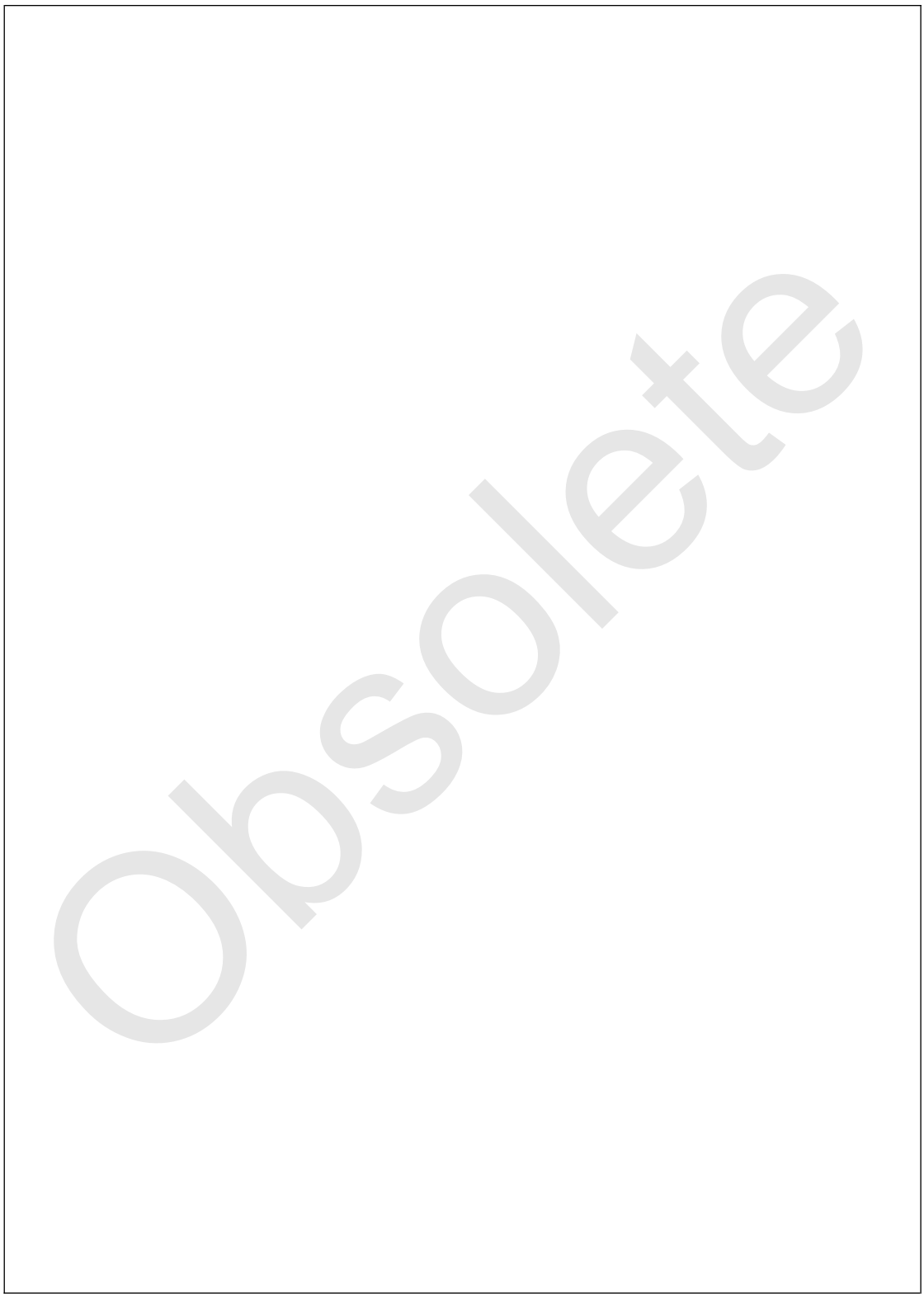
The device number is used to form part of a simplified purchasing code where the package type and temperature range are defined as follows:



DS009471-7

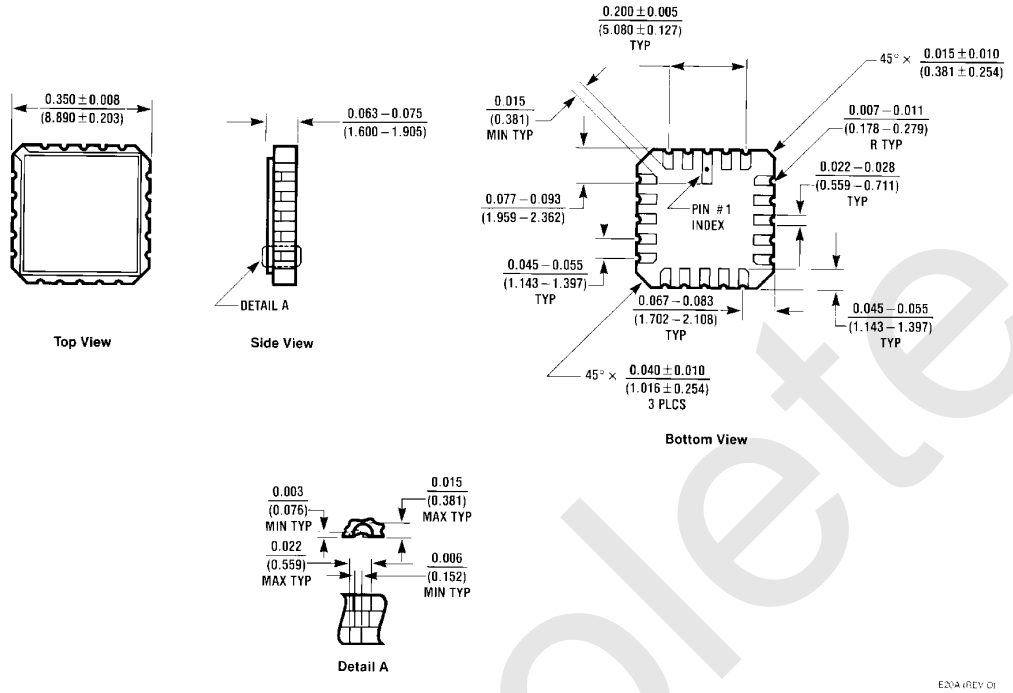
Obsolete

PrintDate=1997/08/28 PrintTime=11:45:30 10182 ds009471 Rev. No. 1 cmserv **Proof** 5

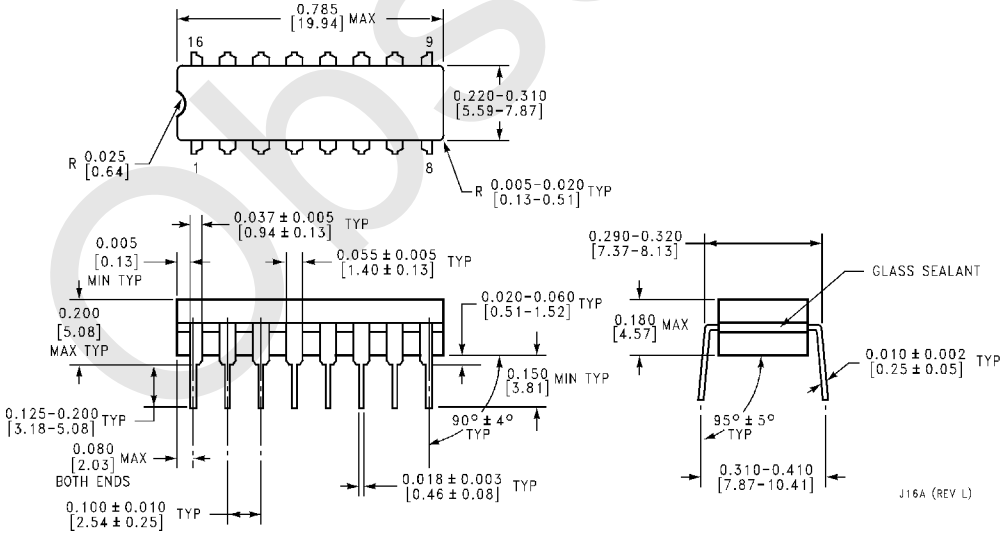


PrintDate=1997/08/28 PrintTime=11:45:31 10182 ds009471 Rev. No. 1 cmserv **Proof**

Physical Dimensions inches (millimeters) unless otherwise noted



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

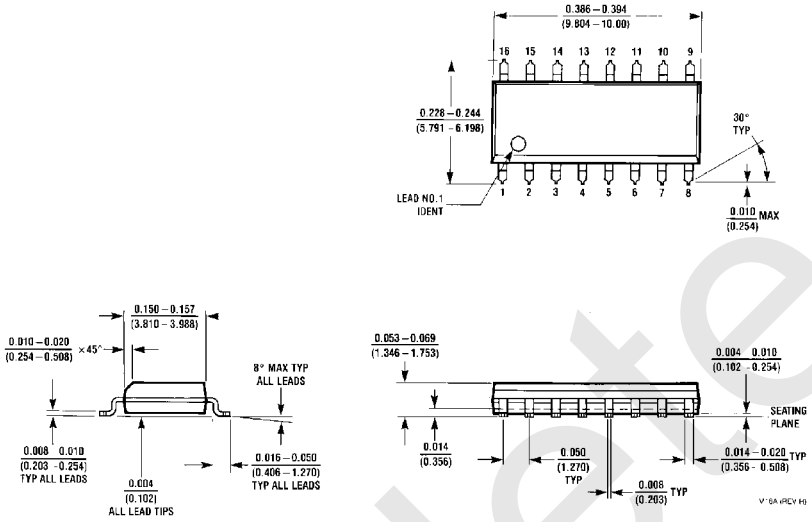


16-Lead Ceramic Dual-In-Line Package (D)
NS Package Number J16A

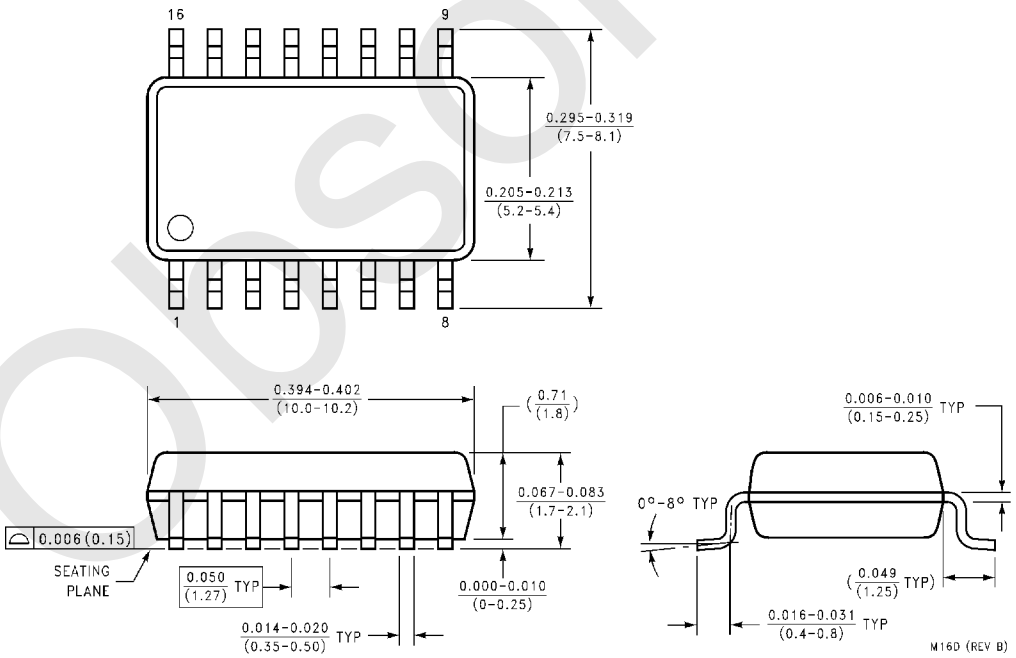
Obsolete

PrintDate=1997/08/28 PrintTime=11:45:32 10182 ds009471 Rev. No. 1 cmserv **Proof**

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



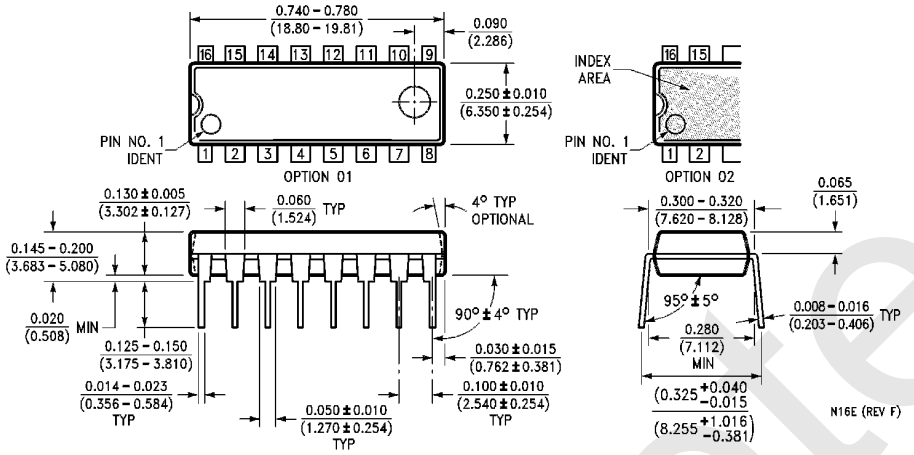
16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)
NS Package Number M16A



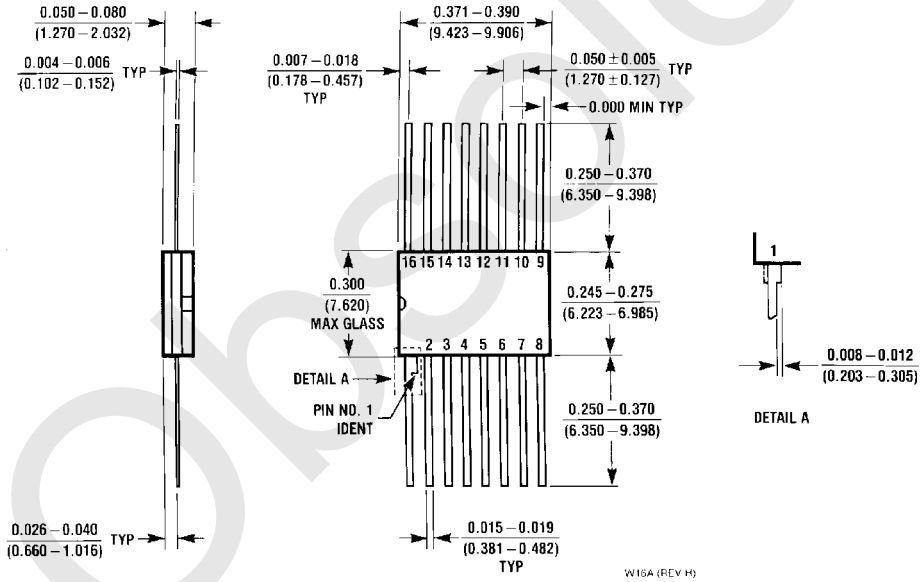
16-Lead (0.300" Wide) Molded Small Outline Package, EIAJ (SJ)
NS Package Number M16D

Obsolete

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



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



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

Obsolete

Obsolete

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 in 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
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
English Tel: +49 (0) 1 80-532 78 32
Français Tel: +49 (0) 1 80-532 93 58
Italiano Tel: +49 (0) 1 80-534 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: 81-3-5620-6175
Fax: 81-3-5620-6179

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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated