National Semiconductor

October 1995

74VHC74 • 74VHCT74
Dual D-Type Flip Flop with Preset and Clear

General Description

The VHC/VHCT74 is an advanced high speed CMOS Dual D-Flip Flop fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. The signal level applied to the D INPUT is transferred to the Q OUTPUT during the positive going transition of the CK pulse. CLR and PR are independent of the CK and are accomplished by setting the appropriate input low.

An input protection circuit ensures that 0V to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

Features

- High noise immunity:
  VHC $V_{NIH} = V_{NIL} = 28\%\ V_{CC}$ (min)
  VHCT $V_{IH} = 2.0V$, $V_{IL} = 0.8V$
- Power down protection:
  VHC inputs only
  VHCT inputs and outputs
- Low power dissipation:
  $I_{CC} = 2\ \mu A$ (max) at $T_A = 25°C$
- Balanced propagation delays: $t_{PLH} \cong t_{PHL}$

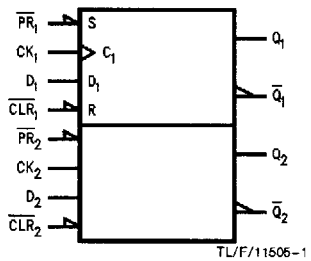
NOTE: ADD EXTERNAL PULL UP RESISTOR TO 'VHCT OUTPUTS TO DRIVE CMOS INPUTS

Commercial	Package Number	Package Description
74VHC74M	M14A	14-Lead Molded JEDEC SOIC
74VHC74SJ	M14D	14-Lead Molded EIAJ SOIC
74VHC74MSC	MSC14	14-Lead Molded EIAJ Type 1 SSOP
74VHC74MTC	MTC14	14-Lead Molded JEDEC Type 1 TSSOP
74VHC74N	N14A	14-Lead Molded DIP
74VHCT74M	M14A	14-Lead Molded JEDEC SOIC
74VHCT74SJ	M14D	14-Lead Molded EIAJ SOIC
74VHCT74MTC	MTC14	14-Lead Molded JEDEC Type 1 TSSOP
74VHCT74N	N14A	14-Lead Molded DIP

Note: Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.
EIAJ Type 1 SSOP available on Tape and Reel only, Order MSCX

Logic Symbol

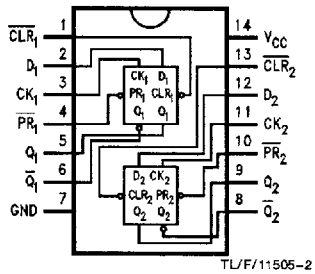
IEEE/IEC



TL/F/11505–1

Connection Diagram

Pin Assignment for DIP, SSOP, TSSOP and SOIC



TL/F/11505–2

Pin Names	Description
D_1, D_2	Data Inputs
CK_1, CK_2	Clock Pulse Inputs
$\overline{CLR}_1, \overline{CLR}_2$	Direct Clear Inputs
$\overline{PR}_1, \overline{PR}_2$	Direct Preset Inputs
$Q_1, \overline{Q}_1, Q_2, \overline{Q}_2$	Outputs

Inputs				Outputs		Function
$\overline{CLR}$	$\overline{PR}$	D	CK	Q	$\overline{Q}$	
L	H	X	X	L	H	Clear
H	L	X	X	H	L	Preset
L	L	X	X	H	H	
H	H	L	↑	L	H	
H	H	H	↑	H	L	
H	H	X	↓	Q_n	$\overline{Q}_n$	No Change

 TL/F/11505

RRD B30M125/Printed in U. S. A

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{CC})	−0.5V to +7.0V
DC Input Voltage (V_{IN})	−0.5V to +7.0V
DC Output Voltage (V_{OUT})	
VHC	−0.5V to V_{CC} + 0.5V
VHCT*	−0.5V to 7.0V
Input Diode Current (I_{IK})	−20 mA
Output Diode Current (I_{OK})	
VHC	±20 mA
VHCT	−20 mA
DC Output Current (I_{OUT})	±25 mA
DC V_{CC}/GND Current (I_{CC})	±50 mA
Storage Temperature (T_{STG})	−65°C to +150°C
Lead Temperature (T_L)	
Soldering (10 seconds)	260°C

*V_{OUT} > V_{CC} only if output is in H state.

Note 1: *Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation outside databook specifications.*

Recommended Operating Conditions

Supply Voltage (V_{CC})	
VHC	2.0V to 5.5V
VHCT	4.5V to 5.5V
Input Voltage (V_{IN})	0V to +5.5V
Output Voltage (V_{OUT})	0V to V_{CC}
Operating Temperature (T_{OPR})	
74VHC/VHCT	−40°C to +85°C
Input Rise and Fall Time (t_r, t_f)	
V_{CC} = 3.3V ±0.3V (VHC only)	0 ~ 100 ns/V
V_{CC} = 5.0V ±0.5V	0 ~ 20 ns/V

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC T_A = 25°C			74VHC T_A = −40°C to +85°C		Units	Conditions	
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	2.0	1.50			1.50		V		
		3.0–5.5	0.7 V_{CC}			0.7 V_{CC}				
V_{IL}	Low Level Input Voltage	2.0			0.50		0.50	V		
		3.0–5.5			0.3 V_{CC}		0.3 V_{CC}			
V_{OH}	High Level Output Voltage	2.0	1.9	2.0		1.9		V	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −50 μA
		3.0	2.9	3.0		2.9				
		4.5	4.4	4.5		4.4				
		3.0	2.58			2.48		V		I_{OH} = −4 mA
		4.5	3.94			3.80				I_{OH} = −8 mA
V_{OL}	Low Level Output Voltage	2.0		0.0	0.1		0.1	V	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA
		3.0		0.0	0.1		0.1			
		4.5		0.0	0.1		0.1			
		3.0			0.36		0.44	V		I_{OL} = 4 mA
		4.5			0.36		0.44			I_{OL} = 8 mA
I_{IN}	Input Leakage Current	0–5.5			±0.1		±1.0	μA	V_{IN} = 5.5V or GND	
I_{CC}	Quiescent Supply Current	5.5			2.0		20.0	μA	V_{IN} = V_{CC} or GND	

DC Characteristics for 'VHCT Family Devices

Symbol	Parameter	V_{CC} (V)	74VHCT $T_A = 25°C$			74VHCT $T_A = -40°C$ to $+85°C$		Units	Conditions	
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	4.5	2.0			2.0		V		
		5.5	2.0			2.0				
V_{IL}	Low Level Input Voltage	4.5			0.8		0.8	V		
		5.5			0.8		0.8			
V_{OH}	High Level Output Voltage	4.5	3.15	3.65		3.15		V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -50\ \mu A$
		4.5	2.5			2.4				$I_{OH} = -8$ mA
V_{OL}	Low Level Output Voltage	4.5		0.0	0.1		0.1	V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 50\ \mu A$
		4.5			0.36		0.44			$I_{OL} = 8$ mA
I_{IN}	Input Leakage Current	0–5.5			±0.1		±1.0	μA	$V_{IN} = 5.5V$ or GND	
I_{CC}	Quiescent Supply Current	5.5			2.0		20.0	μA	$V_{IN} = V_{CC}$ or GND	
I_{CCT}	Maximum I_{CC}/Input	5.5			1.35		1.50	mA	$V_{IN} = 3.4V$ Other Inputs = V_{CC} or GND	
I_{OPD}	Output Leakage Current (Power Down State)	0.0			+0.5		+5.0	μA	$V_{OUT} = 5.5V$	

AC Electrical Characteristics for 'VHC

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$			74VHC $T_A = -40°C$ to $+85°C$		Units	Conditions
			Min	Typ	Max	Min	Max		
f_{MAX}	Maximum Clock Frequency	3.3 ± 0.3	80	125		70		MHz	C_L = 15 pF
			50	75		45			C_L = 50 pF
		5.0 ± 0.5	130	170		110		MHz	C_L = 15 pF
			90	115		75			C_L = 50 pF
t_{PLH}, t_{PHL}	Propagation Delay Time (CK-Q, $\overline{Q}$)	3.3 ± 0.3		6.7	11.9	1.0	14.0	ns	C_L = 15 pF
				9.2	15.4	1.0	17.5		C_L = 50 pF
		5.0 ± 0.5		4.6	7.3	1.0	8.5	ns	C_L = 15 pF
				6.1	9.3	1.0	10.5		C_L = 50 pF
t_{PLH}, t_{PHL}	Propagation Delay Time ($\overline{CLR}$, $\overline{PR}$-Q, $\overline{Q}$)	3.3 ± 0.3		7.6	12.3	1.0	14.5	ns	C_L = 15 pF
				10.1	15.8	1.0	18.0		C_L = 50 pF
		5.0 ± 0.5		4.8	7.7	1.0	9.0	ns	C_L = 15 pF
				6.3	9.7	1.0	11.0		C_L = 50 pF
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open
C_{PD}	Power Dissipation Capacitance			25				pF	(Note 1)

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained from the equation: I_{CC} (opr.) = C_{PD} * V_{CC} * f_{IN} + I_{CC}/2 (per F/F).

AC Operating Requirements for 'VHC

Symbol	Parameter	*V_{CC} (V)	74VHC $T_A = 25°C$	74VHC $T_A = -40°C$ to $+85°C$	Units	Conditions
			Typ	Guaranteed Minimum		
$t_{W(L)}$ $t_{W(H)}$	Minimum Pulse Width (CK)	3.3		6.0	7.0	ns	
		5.0		5.0	5.0		
$t_{W(L)}$	Minimum Pulse Width ($\overline{CLR}$, $\overline{PR}$)	3.3		6.0	7.0	ns	
		5.0		5.0	5.0		
t_S	Minimum Setup Time	3.3		6.0	7.0	ns	
		5.0		5.0	5.0		
t_H	Minimum Hold Time	3.3		0.5	0.5	ns	
		5.0		0.5	0.5		
t_{rem}	Minimum Removal Time ($\overline{CLR}$, $\overline{PR}$)	3.3		5.0	5.0	ns	
		5.0		3.0	3.0		

*V_{CC} is 3.3 ±0.3V or 5.0 ±0.5V

AC Electrical Characteristics for 'VHCT

Symbol	Parameter	*V_{CC} (V)	74VHCT T_A = 25°C			74VHCT T_A = −40°C to +85°C		Units	Conditions
			Min	Typ	Max	Min	Max		
f_{MAX}	Maximum Clock Frequency	5.0	100	160		80		MHz	C_L = 15 pF
		5.0	80	140		65			C_L = 50 pF
t_{PLH}, t_{PHL}	Propagation Delay Time (CK-Q, $\overline{Q}$)	5.0		5.8	7.8	1.0	9.0	ns	C_L = 15 pF
		5.0		6.3	8.8	1.0	10.0		C_L = 50 pF
t_{PLH}, t_{PHL}	Propagation Delay Time ($\overline{CLR}$, $\overline{PR}$-Q, $\overline{Q}$)	5.0		7.6	10.4	1.0	12.0	ns	C_L = 15 pF
		5.0		8.1	11.4	1.0	13.0		C_L = 50 pF
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open
C_{PD}	Power Dissipation Capacitance			24				pF	(Note 1)

*V_{CC} is 5.0 ±0.5V

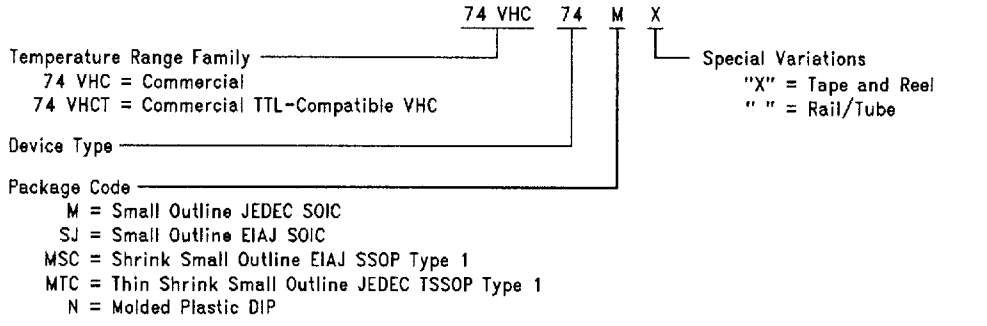
Note 1: C_{PD} is defined as the value of internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation. I_{CC} (opr) = C_{PD} × V_{CC} × f_{IN} + $I_{CC}/2$ (per flip-flop).

AC Operating Requirements for 'VHCT

Symbol	Parameter	V_{CC} (V)	74VHCT T_A = 25°C		74VHCT T_A = −40°C to +85°C	Units	Conditions
			Typ	Guaranteed Minimum			
$t_{W(L)}$ $t_{W(H)}$	Minimum Pulse Width (CK)	5.0 ± 0.5			5.0	ns	
$t_{W(L)}$	Minimum Pulse Width ($\overline{CLR}$, $\overline{PR}$)	5.0 ± 0.5		5.0	5.0	ns	
t_S	Minimum Setup Time	5.0 ± 0.5		5.0	5.0	ns	
t_H	Minimum Hold Time	5.0 ± 0.5		0	0	ns	
t_{rem}	Minimum Removal Time ($\overline{CLR}$, $\overline{PR}$)	5.0 ± 0.5		3.5	3.5	ns	

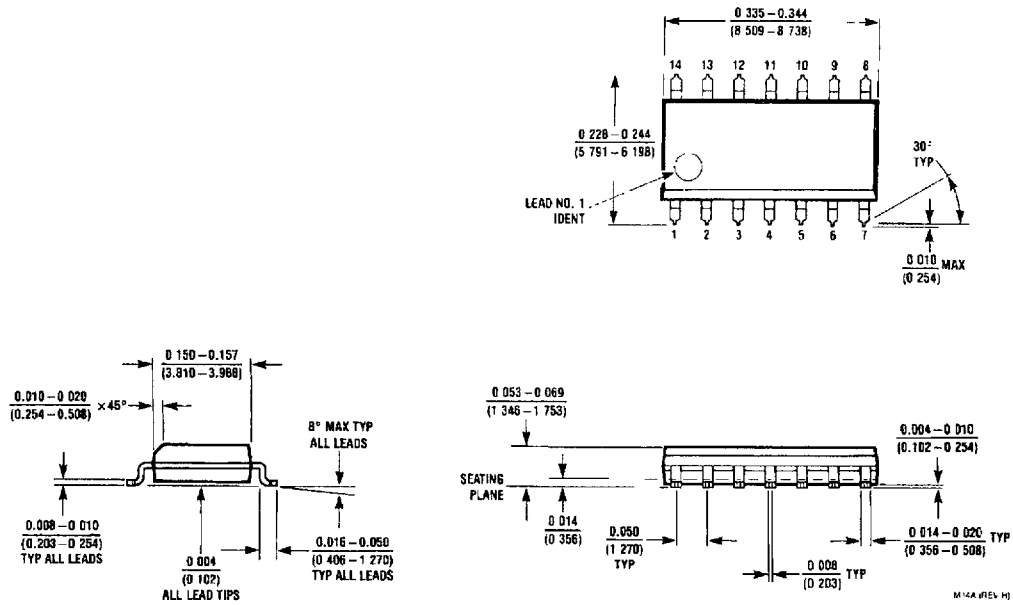
Ordering Information

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

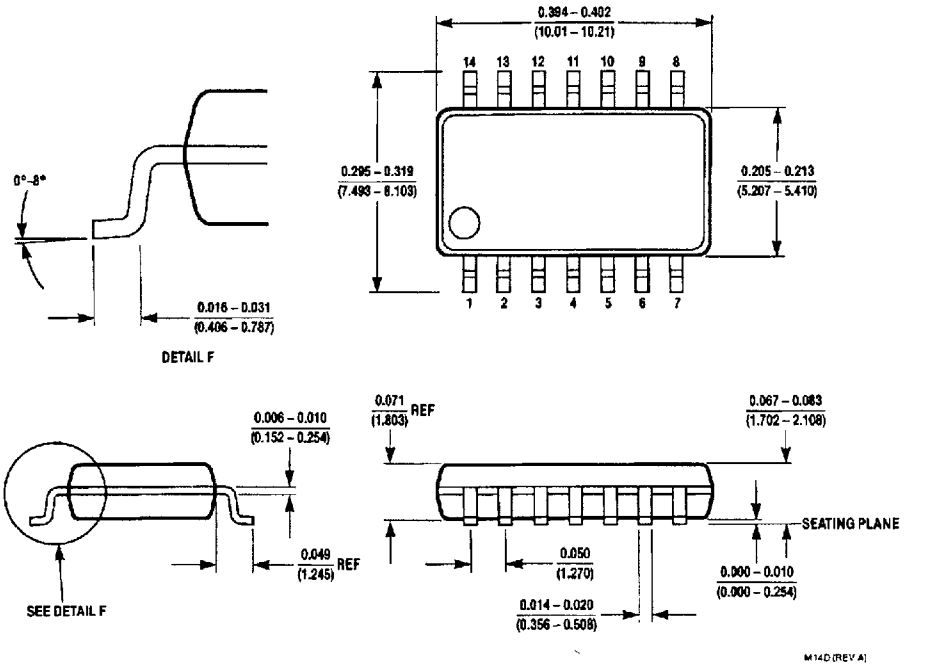


TL/F/11505–5

Physical Dimensions inches (millimeters)

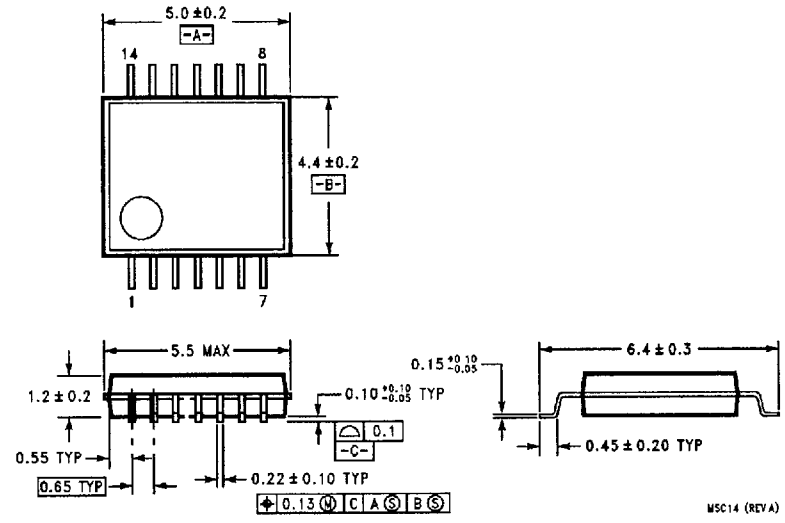


14-Lead Small Outline Integrated Circuit—JEDEC (M)
Order Number 74VHC74M, 74VHC74MX, 74VHCT74M or 74VHCT74MX
NS Package Number M14A

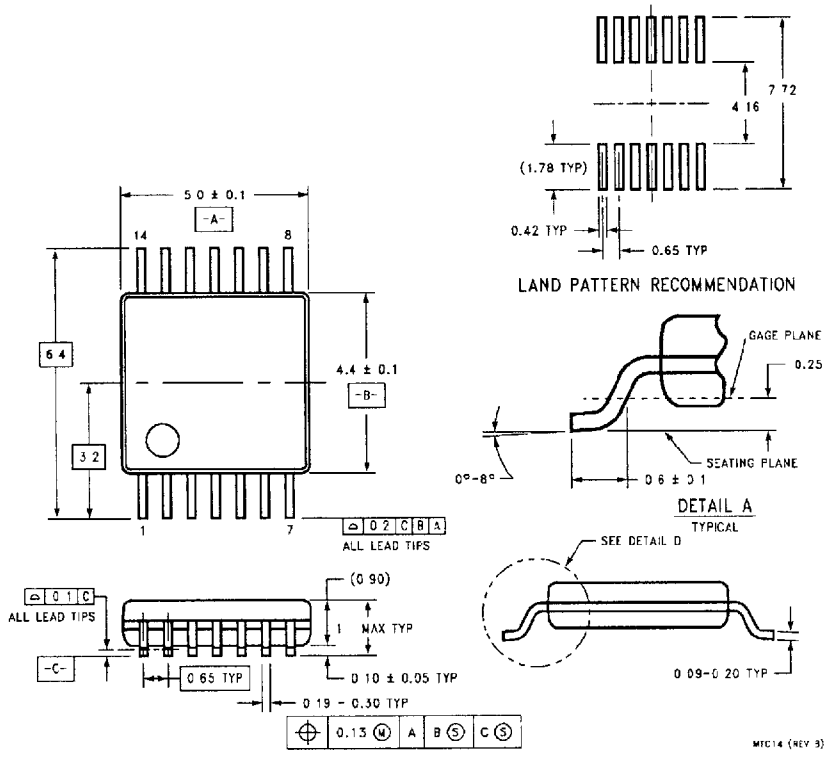


14-Lead Small Outline Package - EIAJ (SJ)
Order Number 74VHC74SJ, 74VHC74SJX, 74VHCT74SJ or 74VHCT74SJX
NS Package Number M14D

Physical Dimensions millimeters (Continued)

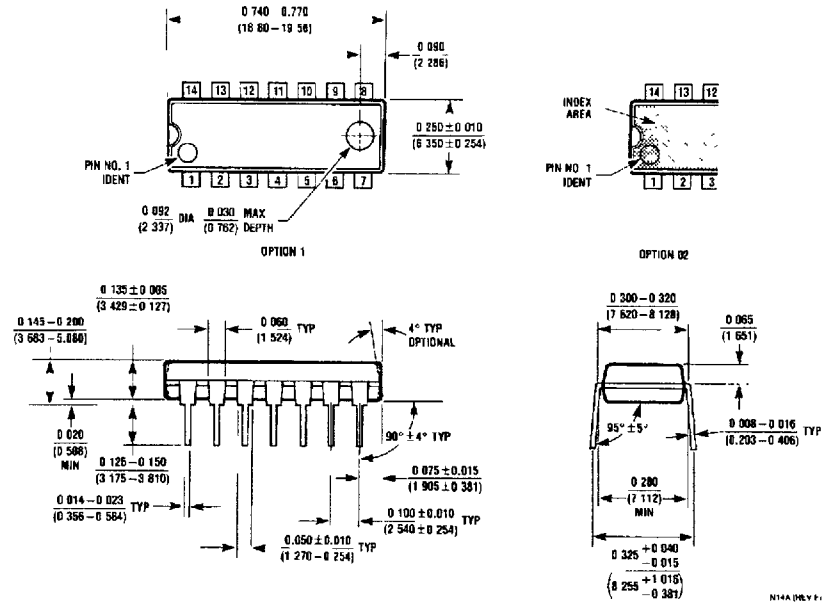


14-Lead Plastic EIAJ SSOP Type 1 (MSC)
Order Number 74VHC74MSCX
NS Package Number MSC14



14-Lead Plastic JEDEC TSSOP Type 1 (MTC)
Order Number 74VHC74MTC, 74VHC74MTCX, 74VHCT74MTC or 74VHCT74MTCX
NS Package Number MTC14

Physical Dimensions inches (millimeters) (Continued)



14-Lead Molded Dual In-Line Package
Order Number 74VHC74N or 74VHCT74N
NS Package Number N14A

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.
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