

**MM54HC365/MM74HC365 Hex TRI-STATE<sup>®</sup> Buffer**  
**MM54HC366/MM74HC366 Inverting Hex TRI-STATE Buffer**  
**MM54HC367/MM74HC367 Hex TRI-STATE Buffer**  
**MM54HC368/MM74HC368 Inverting Hex TRI-STATE Buffer**

**General Description**

These TRI-STATE buffers are general purpose high speed inverting and non-inverting buffers that utilize advanced silicon-gate CMOS technology. They have high drive current outputs which enable high speed operation even when driving large bus capacitances. These circuits possess the low power dissipation of CMOS circuitry, yet have speeds comparable to low power Schottky TTL circuits. All 4 circuits are capable of driving up to 15 low power Schottky inputs.

The MM54/74HC366 and the MM54/74HC368 are inverting buffers, whereas the MM54/74HC365 and the MM54/74HC367 are non-inverting buffers. The MM54/74HC365 and the MM54/74HC366 have two TRI-STATE control inputs ( $\overline{G1}$  and  $\overline{G2}$ ) which are NORed together to control all

six gates. The MM54/74HC367 and the MM54/74HC368 also have two output enables, but one enable ( $\overline{G1}$ ) controls 4 gates and the other ( $\overline{G2}$ ) controls the remaining 2 gates.

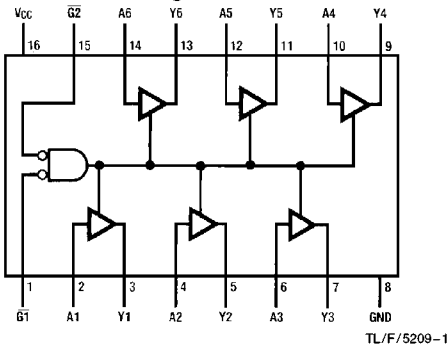
All inputs are protected from damage due to static discharge by diodes to  $V_{CC}$  and ground.

**Features**

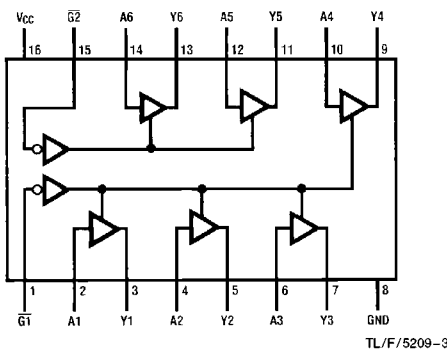
- Typical propagation delay: 15 ns
- Wide operating voltage range: 2V–6V
- Low input current: 1  $\mu$ A maximum
- Low quiescent current: 80  $\mu$ A maximum (74 Series)
- Output drive capability: 15 LS-TTL loads

**Connection Diagrams**

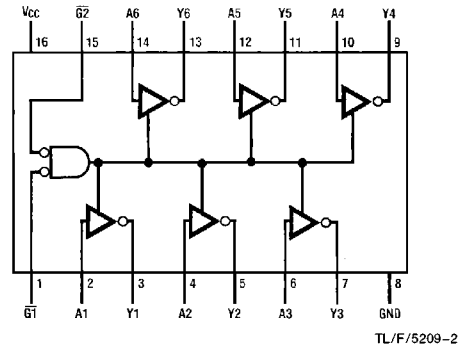
**Dual-In-Line Packages/Top Views**



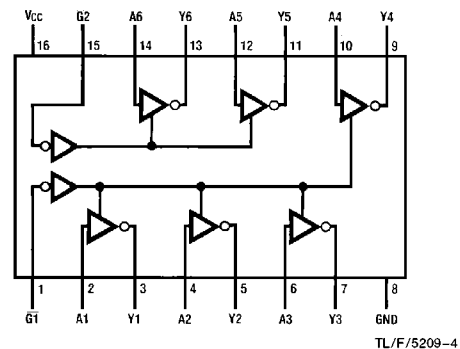
Order Number MM54HC365 or MM74HC365



Order Number MM54HC367 or MM74HC367



Order Number MM54HC366 or MM74HC366



Order Number MM54HC368 or MM74HC368

TRI-STATE<sup>®</sup> is a registered trademark of National Semiconductor Corporation.

MM54HC365/MM54HC366/MM54HC367/MM54HC368/  
MM74HC365/MM74HC366/MM74HC367/MM74HC368

## Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_{CC}$ )	-0.5 to +7.0V
DC Input Voltage ( $V_{IN}$ )	-1.5 to $V_{CC} + 1.5V$
DC Output Voltage ( $V_{OUT}$ )	-0.5 to $V_{CC} + 0.5V$
Clamp Diode Current ( $I_{IK}, I_{OK}$ )	$\pm 20$ mA
DC Output Current, per pin ( $I_{OUT}$ )	$\pm 35$ mA
DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ )	$\pm 70$ mA
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C
Power Dissipation ( $P_D$ )	
(Note 3)	600 mW
S.O. Package only	500 mW
Lead Temp. ( $T_L$ ) (Soldering 10 seconds)	260°C

## Operating Conditions

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	2	6	V
DC Input or Output Voltage ( $V_{IN}, V_{OUT}$ )	0	$V_{CC}$	V
Operating Temp. Range ( $T_A$ )			
MM74HC	-40	+85	°C
MM54HC	-55	+125	°C
Input Rise or Fall Times ( $t_r, t_f$ )			
$V_{CC} = 2.0V$		1000	ns
$V_{CC} = 4.5V$		500	ns
$V_{CC} = 6.0V$		400	ns

## DC Electrical Characteristics (Note 4)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$			74HC	54HC	Units
						$T_A = -40$ to $85^\circ C$	$T_A = -55$ to $125^\circ C$		
				Typ	Guaranteed Limits				
$V_{IH}$	Minimum High Level Input Voltage		2.0V		1.5	1.5	1.5	V	
			4.5V		3.15	3.15	3.15	V	
			6.0V		4.2	4.2	4.2	V	
$V_{IL}$	Maximum Low Level Input Voltage**		2.0V		0.5	0.5	0.5	V	
			4.5V		1.35	1.35	1.35	V	
			6.0V		1.8	1.8	1.8	V	
$V_{OH}$	Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	2.0	1.9	1.9	1.9	V	
			4.5V	4.5	4.4	4.4	4.4	V	
			6.0V	6.0	5.9	5.9	5.9	V	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 6.0$ mA $ I_{OUT}  \leq 7.8$ mA	4.5V	4.2	3.98	3.84	3.7	V	
			6.0V	5.7	5.48	5.34	5.2	V	
$V_{OL}$	Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	0	0.1	0.1	0.1	V	
			4.5V	0	0.1	0.1	0.1	V	
			6.0V	0	0.1	0.1	0.1	V	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 6.0$ mA $ I_{OUT}  \leq 7.8$ mA	4.5V	0.2	0.26	0.33	0.4	V	
			6.0V	0.2	0.26	0.33	0.4	V	
$I_{IN}$	Maximum Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		$\pm 0.1$	$\pm 1.0$	$\pm 1.0$	$\mu A$	
$I_{OZ}$	Maximum TRI-STATE Output Leakage Current	$V_{OUT} = V_{CC}$ or GND $\bar{G} = V_{IH}$	6.0V		$\pm 0.5$	$\pm 5.0$	$\pm 10$	$\mu A$	
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0 \mu A$	6.0V		8.0	80	160	$\mu A$	

**Note 1:** Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: -12 mW/°C from 65°C to 85°C; ceramic "J" package: -12 mW/°C from 100°C to 125°C.

**Note 4:** For a power supply of  $5V \pm 10\%$  the worst case output voltages ( $V_{OH}$  and  $V_{OL}$ ) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case  $V_{IH}$  and  $V_{IL}$  occur at  $V_{CC} = 5.5V$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current ( $I_{IN}$ ,  $I_{CC}$ , and  $I_{OZ}$ ) occur for CMOS at the higher voltage and so the 6.0V values should be used.

\*\* $V_{IL}$  limits are currently tested at 20% of  $V_{CC}$ . The above  $V_{IL}$  specification (30% of  $V_{CC}$ ) will be implemented no later than Q1, CY'89.

### AC Electrical Characteristics MM54HC365/MM74HC365

$V_{CC} = 5V$ ,  $T_A = 25^\circ C$ ,  $t_r = t_f = 6$  ns

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 45$ pF	15	22	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 45$ pF	29	40	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 5$ pF	25	36	ns

### AC Electrical Characteristics MM54HC365/MM74HC365

$V_{CC} = 2.0-6.0V$ ,  $C_L = 50$  pF,  $t_r = t_f = 6$  ns (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		74HC	54HC	Units
				Typ	Guaranteed Limits		$T_A = -40$ to $85^\circ C$	
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50$ pF	2.0V	35	105	130	150	ns
			2.0V	45	135	168	205	ns
			4.5V	14	24	30	36	ns
			4.5V	17	29	36	45	ns
			6.0V	11	19	24	28	ns
			6.0V	15	24	30	36	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	90	230	287	345	ns
			2.0V	98	245	306	367	ns
			4.5V	31	44	55	66	ns
			4.5V	38	53	66	80	ns
			6.0V	25	35	43	52	ns
			6.0V	29	41	51	62	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	58	175	218	260	ns
			4.5V	26	44	55	66	ns
			6.0V	22	37	46	55	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time	$C_L = 50$ pF	2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	ns
			6.0V	6	10	13	15	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	Any Enabled A Input Any Disabled A Input		45				pF
				8				pF
$C_{IN}$	Maximum Input Capacitance			5	10	10	10	pF
$C_{OUT}$	Maximum Output Capacitance			10	20	20	20	pF

Note 5:  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

### Truth Table

'HC365			
Inputs			Output
$\overline{G1}$	$\overline{G2}$	A	Y
H	X	X	Z
X	H	X	Z
L	L	H	H
L	L	L	L

## AC Electrical Characteristics (Continued) MM54HC366/MM74HC366

$V_{CC}=5V$ ,  $T_A=25^\circ C$ ,  $t_r=t_f=6$  ns

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 45$ pF	12	18	ns
$t_{PZL}$ , $t_{PZH}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 45$ pF	29	40	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 5$ pF	25	36	ns

## AC Electrical Characteristics MM54HC366/MM74HC366

$V_{CC}=2.0-6.0V$ ,  $C_L=50$  pF,  $t_r=t_f=6$  ns (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		74HC	54HC	Units
						$T_A = -40$ to $85^\circ C$	$T_A = -55$ to $125^\circ C$	
				Typ	Guaranteed Limits			
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50$ pF	2.0V	33	82	102	125	ns
			2.0V	43	107	134	160	ns
			4.5V	12	19	24	30	ns
			4.5V	16	26	32	39	ns
			6.0V	10	16	20	24	ns
			6.0V	14	22	27	33	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	90	230	287	345	ns
			2.0V	98	245	306	367	ns
			4.5V	31	44	55	66	ns
			4.5V	38	53	66	80	ns
			6.0V	25	35	43	52	ns
			6.0V	29	41	51	62	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	58	175	218	260	ns
			4.5V	26	44	55	66	ns
			6.0V	22	37	46	55	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time	$C_L = 50$ pF	2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	ns
			6.0V	6	10	13	15	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	Any Enabled A Input Any Disabled A Input		45				pF
				6				pF
$C_{IN}$	Maximum Input Capacitance			5	10	10	10	pF
$C_{OUT}$	Maximum Output Capacitance			10	20	20	20	pF

Note 5:  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

## Truth Table

'HC366

Inputs			Output
$\overline{G1}$	$\overline{G2}$	A	Y
H	X	X	Z
X	H	X	Z
L	L	H	L
L	L	L	H

### AC Electrical Characteristics (Continued) MM54HC367/MM74HC367

$V_{CC} = 5V$ ,  $T_A = 25^\circ C$ ,  $t_r = t_f = 6$  ns

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 45$ pF	13	22	ns
$t_{PZL}$ , $t_{PZH}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 45$ pF	23	37	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 5$ pF	25	33	ns

### AC Electrical Characteristics MM54HC367/MM74HC367

$V_{CC} = 2.0-6.0V$ ,  $C_L = 50$  pF,  $t_r = t_f = 6$  ns (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		74HC	54HC	Units
				Typ		$T_A = -40$ to $85^\circ C$	$T_A = -55$ to $125^\circ C$	
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50$ pF	2.0V	35	105	130	150	ns
			2.0V	45	135	168	205	ns
			4.5V	14	24	30	36	ns
			4.5V	17	29	36	45	ns
			6.0V	11	19	24	28	ns
			6.0V	15	24	30	36	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	69	172	216	250	ns
			2.0V	75	187	233	280	ns
			4.5V	24	38	47	57	ns
			4.5V	29	46	57	69	ns
			6.0V	22	35	43	52	ns
			6.0V	26	42	52	63	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1$ k $\Omega$ $C_L = 50$ pF	2.0V	47	117	146	220	ns
			4.5V	22	35	44	52	ns
			6.0V	19	31	39	46	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time	$C_L = 50$ pF	2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	ns
			6.0V	6	10	13	15	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	Any Enabled A Input Any Disabled A Input		45				pF
				8				pF
$C_{IN}$	Maximum Input Capacitance			5	10	10	10	pF
$C_{OUT}$	Maximum Output Capacitance			10	20	20	20	pF

Note 5:  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

### Truth Table

'HC367		
Inputs		Output
$\bar{G}$	A	Y
H	X	Z
L	H	H
L	L	L

## AC Electrical Characteristics (Continued) MM54HC368/MM74HC368

$V_{CC}=5V$ ,  $T_A=25^\circ C$ ,  $t_r=t_f=6\text{ ns}$

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 45\text{ pF}$	11	18	ns
$t_{PZL}$ , $t_{PZH}$	Maximum Output Enable Time	$R_L = 1\text{ k}\Omega$ $C_L = 45\text{ pF}$	23	37	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1\text{ k}\Omega$ $C_L = 5\text{ pF}$	19	33	ns

## AC Electrical Characteristics MM54HC368/MM74HC368

$V_{CC}=2.0\text{--}6.0V$ ,  $C_L=50\text{ pF}$ ,  $t_r=t_f=6\text{ ns}$  (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		74HC	54HC	Units
						$T_A = -40\text{ to }85^\circ C$	$T_A = -55\text{ to }125^\circ C$	
				Typ	Guaranteed Limits			
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50\text{ pF}$	2.0V	33	82	102	125	ns
			2.0V	43	107	134	160	ns
			4.5V	12	19	24	30	ns
			4.5V	16	26	32	39	ns
			6.0V	10	16	20	24	ns
			6.0V	14	22	27	33	ns
$t_{PZH}$ , $t_{PZL}$	Maximum Output Enable Time	$R_L = 1\text{ k}\Omega$ $C_L = 50\text{ pF}$	2.0V	69	172	216	250	ns
			2.0V	75	187	233	280	ns
			4.5V	24	38	47	57	ns
			4.5V	29	46	57	69	ns
			6.0V	22	35	43	52	ns
			6.0V	26	42	52	63	ns
$t_{PHZ}$ , $t_{PLZ}$	Maximum Output Disable Time	$R_L = 1\text{ k}\Omega$ $C_L = 50\text{ pF}$	2.0V	47	117	146	220	ns
			4.5V	22	35	44	52	ns
			6.0V	19	31	39	46	ns
$t_{THL}$ , $t_{TLH}$	Maximum Output Rise and Fall Time	$C_L = 50\text{ pF}$	2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	ns
			6.0V	6	10	13	15	ns
$C_{PD}$	Power Dissipation Capacitance (Note 5)	Any Enabled A Input		45				pF
			Any Disabled A Input	6				pF
$C_{IN}$	Maximum Input Capacitance			5	10	10	10	pF
$C_{OUT}$	Maximum Input Capacitance			10	20	20	20	pF

**Note 5:**  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

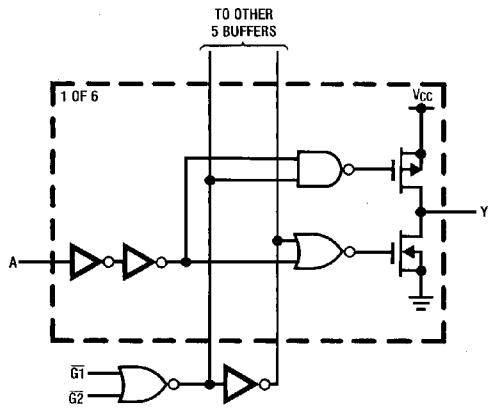
## Truth Table

'HC368

Inputs		Output
$\bar{G}$	A	Y
H	X	Z
L	H	L
L	L	H

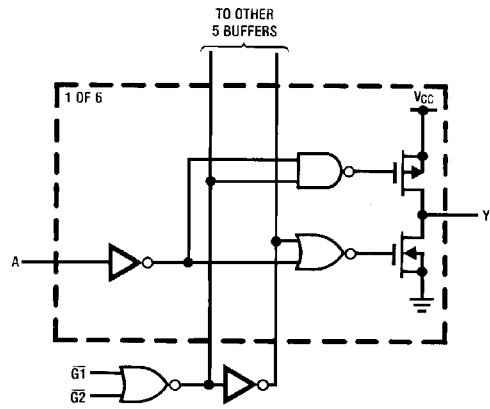
# Logic Diagrams

MM54HC365/MM74HC365



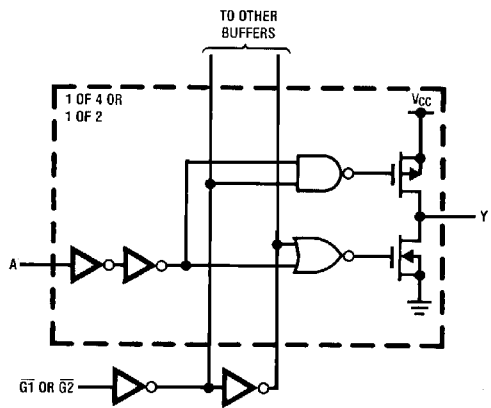
TL/F/5209-5

MM54HC366/MM74HC366



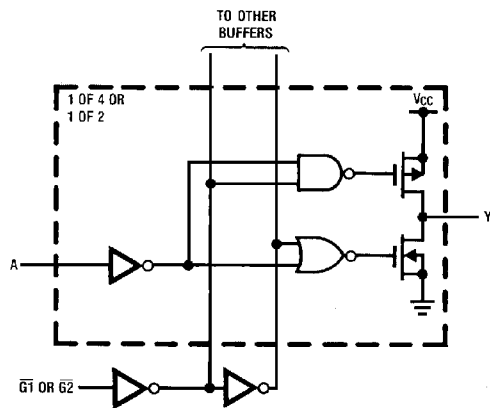
TL/F/5209-6

MM54HC367/MM74HC367



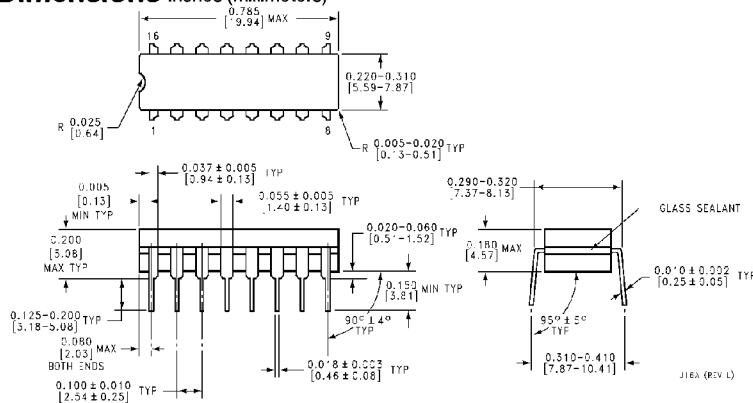
TL/F/5209-7

MM54HC368/MM74HC368

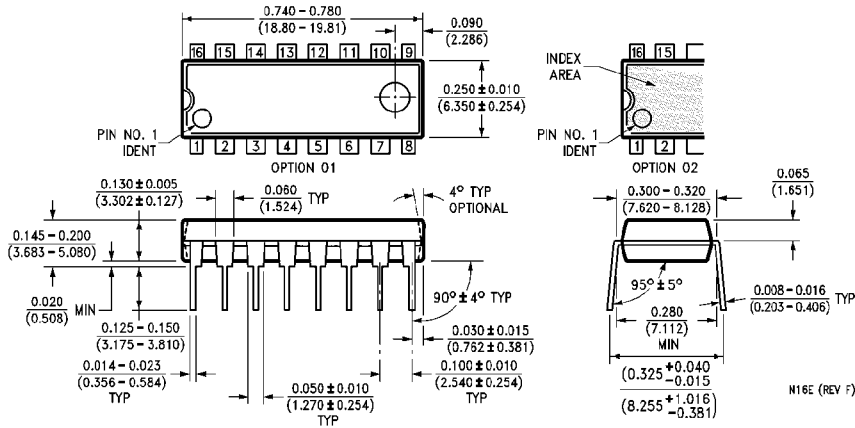


TL/F/5209-8

**Physical Dimensions** inches (millimeters)



**Order Number MM54HC365J, MM54HC366J, MM54HC367J, MM54HC368J,  
MM74HC365J, MM74HC366J, MM74HC367J, or MM74HC368J,  
NS Package J16A**



**Order Number MM74HC365N, MM74HC366N, MM74HC367N, or MM74HC368N  
NS Package N16E**

**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: onjwge@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

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.