National Semiconductor

January 1988

MM54HC365/MM74HC365 Hex TRI-STATE® 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, where as 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.

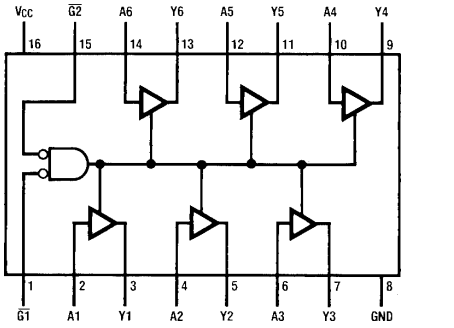
All inputs are protected from damage due to static discharge by diodes to V_{CC} and ground.

Features

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

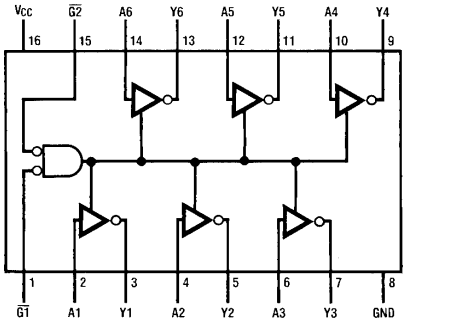
Connection Diagrams

Dual-In-Line Packages/Top Views



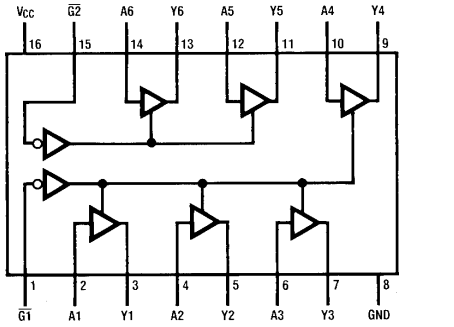
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Order Number MM54HC365 or MM74HC365



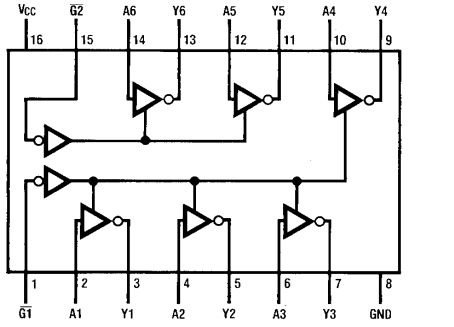
TL/F/5209–2

Order Number MM54HC366 or MM74HC366



TL/F/5209–3

Order Number MM54HC367 or MM74HC367



TL/F/5209–4

Order Number MM54HC368 or MM74HC368

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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})	±20 mA
DC Output Current, per pin (I_{OUT})	±35 mA
DC V_{CC} or GND Current, per pin (I_{CC})	±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°C	74HC T_A = −40 to 85°C	54HC T_A = −55 to 125°C	Units
				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	4.5V	4.2	3.98	3.84	3.7	V
		$\|I_{OUT}\| \leq 7.8$ mA	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	4.5V	0.2	0.26	0.33	0.4	V
		$\|I_{OUT}\| \leq 7.8$ mA	6.0V	0.2	0.26	0.33	0.4	V
I_{IN}	Maximum Input Current	V_{IN} = V_{CC} or GND	6.0V		±0.1	±1.0	±1.0	μA
I_{OZ}	Maximum TRI-STATE Output Leakage Current	V_{OUT} = V_{CC} or GND $\overline{G}$ = V_{IH}	6.0V		±0.5	±5.0	±10	μA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA	6.0V		8.0	80	160	μA

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 ±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

$V_{CC}=5V$, $T_A=25°C$, $t_r=t_f=6$ 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	$R_L=1$ kΩ $C_L=45$ pF	29	40	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	$R_L=1$ kΩ $C_L=5$ 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}	$T_A=25°C$	74HC $T_A=-40$ to $85°C$		54HC $T_A=-55$ to $125°C$	Units
				Typ	Guaranteed Limits			
t_{PHL}, t_{PLH}	Maximum Propagation Delay	$C_L=50$ pF	2.0V	35	105	130	150	ns
		$C_L=150$ pF	2.0V	45	135	168	205	ns
		$C_L=50$ pF	4.5V	14	24	30	36	ns
		$C_L=150$ pF	4.5V	17	29	36	45	ns
		$C_L=50$ pF	6.0V	11	19	24	28	ns
		$C_L=150$ pF	6.0V	15	24	30	36	ns
t_{PZH}, t_{PZL}	Maximum Output Enable Time	$R_L=1$ kΩ						
		$C_L=50$ pF	2.0V	90	230	287	345	ns
		$C_L=150$ pF	2.0V	98	245	306	367	ns
		$C_L=50$ pF	4.5V	31	44	55	66	ns
		$C_L=150$ pF	4.5V	38	53	66	80	ns
		$C_L=50$ pF	6.0V	25	35	43	52	ns
		$C_L=150$ pF	6.0V	29	41	51	62	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	$R_L=1$ kΩ $C_L=50$ 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		45				pF
		Any Disabled A Input		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°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 kΩ C_L = 45 pF	29	40	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	R_L = 1 kΩ 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°C	74HC T_A = −40 to 85°C	54HC T_A = −55 to 125°C	Units
				Typ	Guaranteed Limits		
t_{PHL}, t_{PLH}	Maximum Propagation Delay	C_L = 50 pF	2.0V	33	82	102	125	ns
		C_L = 150 pF	2.0V	43	107	134	160	ns
		C_L = 50 pF	4.5V	12	19	24	30	ns
		C_L = 150 pF	4.5V	16	26	32	39	ns
		C_L = 50 pF	6.0V	10	16	20	24	ns
		C_L = 150 pF	6.0V	14	22	27	33	ns
t_{PZH}, t_{PZL}	Maximum Output Enable Time	R_L = 1 kΩ						ns
		C_L = 50 pF	2.0V	90	230	287	345	ns
		C_L = 150 pF	2.0V	98	245	306	367	ns
		C_L = 50 pF	4.5V	31	44	55	66	ns
		C_L = 150 pF	4.5V	38	53	66	80	ns
		C_L = 50 pF	6.0V	25	35	43	52	ns
		C_L = 150 pF	6.0V	29	41	51	62	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	R_L = 1 kΩ 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		45				pF
		Any Disabled A Input		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

$V_{CC}=5V$, $T_A=25°C$, $t_r=t_f=6$ 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	$R_L=1$ kΩ $C_L=45$ pF	23	37	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	$R_L=1$ kΩ $C_L=5$ 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}	$T_A=25°C$	74HC $T_A=-40$ to $85°C$	54HC $T_A=-55$ to $125°C$	Units
				Typ	Guaranteed Limits		
t_{PHL}, t_{PLH}	Maximum Propagation Delay	$C_L=50$ pF	2.0V	35	105	130	150	ns
		$C_L=150$ pF	2.0V	45	135	168	205	ns
		$C_L=50$ pF	4.5V	14	24	30	36	ns
		$C_L=150$ pF	4.5V	17	29	36	45	ns
		$C_L=50$ pF	6.0V	11	19	24	28	ns
		$C_L=150$ pF	6.0V	15	24	30	36	ns
t_{PZH}, t_{PZL}	Maximum Output Enable Time	$R_L=1$ kΩ						ns
		$C_L=50$ pF	2.0V	69	172	216	250	ns
		$C_L=150$ pF	2.0V	75	187	233	280	ns
		$C_L=50$ pF	4.5V	24	38	47	57	ns
		$C_L=150$ pF	4.5V	29	46	57	69	ns
		$C_L=50$ pF	6.0V	22	35	43	52	ns
		$C_L=150$ pF	6.0V	26	42	52	63	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	$R_L=1$ kΩ $C_L=50$ 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		45				pF
		Any Disabled A Input		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
$\overline{G}$	A	Y
H	X	Z
L	H	H
L	L	L

AC Electrical Characteristics (Continued) MM54HC368/MM74HC368

V_{CC} = 5V, T_A = 25°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	11	18	ns
t_{PZL}, t_{PZH}	Maximum Output Enable Time	R_L = 1 kΩ C_L = 45 pF	23	37	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	R_L = 1 kΩ C_L = 5 pF	19	33	ns

AC Electrical Characteristics MM54HC368/MM74HC368

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°C		74HC T_A = −40 to 85°C	54HC T_A = −55 to 125°C	Units
				Typ	Guaranteed Limits			
t_{PHL}, t_{PLH}	Maximum Propagation Delay	C_L = 50 pF	2.0V	33	82	102	125	ns
		C_L = 150 pF	2.0V	43	107	134	160	ns
		C_L = 50 pF	4.5V	12	19	24	30	ns
		C_L = 150 pF	4.5V	16	26	32	39	ns
		C_L = 50 pF	6.0V	10	16	20	24	ns
		C_L = 150 pF	6.0V	14	22	27	33	ns
t_{PZH}, t_{PZL}	Maximum Output Enable Time	R_L = 1 kΩ						ns
		C_L = 50 pF	2.0V	69	172	216	250	ns
		C_L = 150 pF	2.0V	75	187	233	280	ns
		C_L = 50 pF	4.5V	24	38	47	57	ns
		C_L = 150 pF	4.5V	29	46	57	69	ns
		C_L = 50 pF	6.0V	22	35	43	52	ns
		C_L = 150 pF	6.0V	26	42	52	63	ns
t_{PHZ}, t_{PLZ}	Maximum Output Disable Time	R_L = 1 kΩ 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		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, $I_S = C_{PD} V_{CC} f + I_{CC}$.

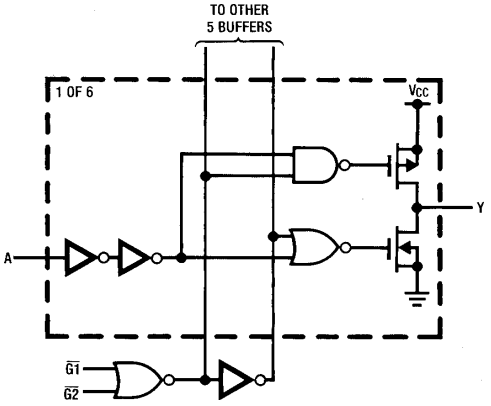
Truth Table

'HC368

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

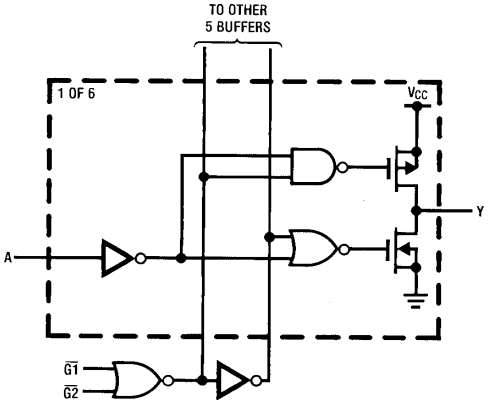
Logic Diagrams

MM54HC365/MM74HC365



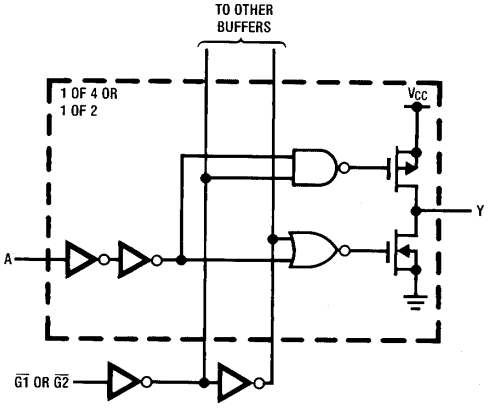
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MM54HC366/MM74HC366



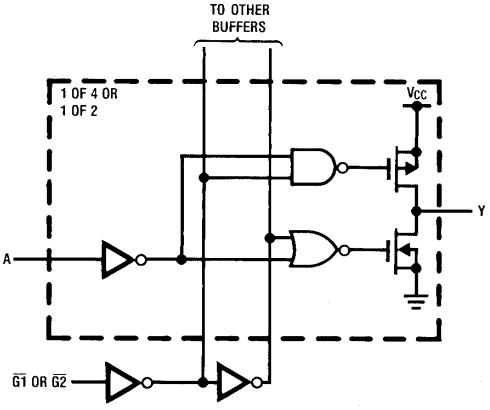
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MM54HC367/MM74HC367



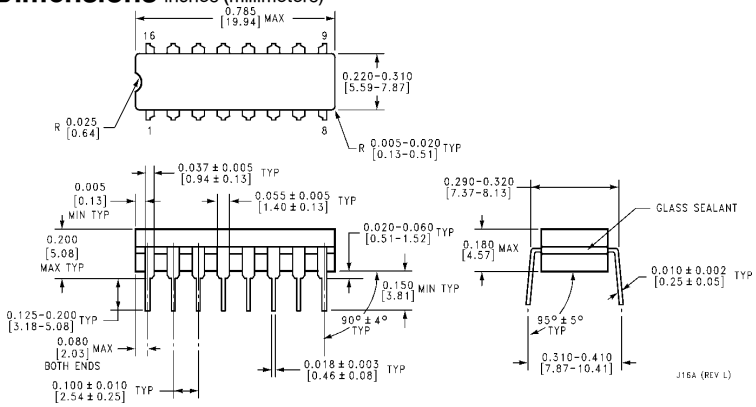
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MM54HC368/MM74HC368

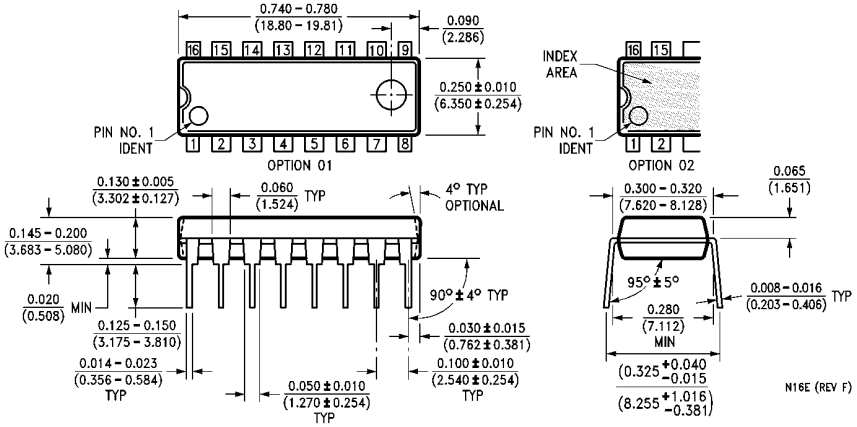


TL/F/5209–8

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

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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.

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