



**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, 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

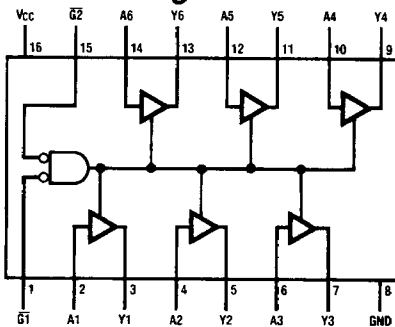
six gates. The MM54/74HC367 and the MM54/74HC368 also have two output enables, but one enable ( $\overline{G1}$ ) controls 4 gates and the other ( $\overline{G2}$ ) controls the remaining 2 gates. All inputs are protected from damage due to static discharge by diodes to  $V_{CC}$  and ground.

### 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

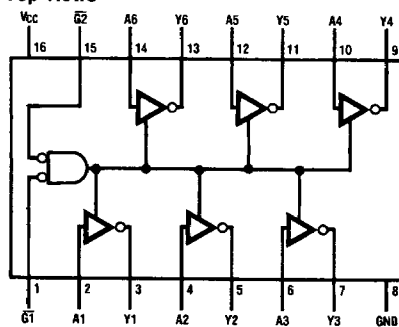
### Connection Diagrams

Dual-In-Line Packages/Top Views



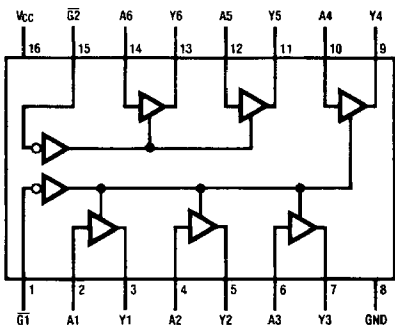
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Order Number MM54HC365\* or MM74HC365\*



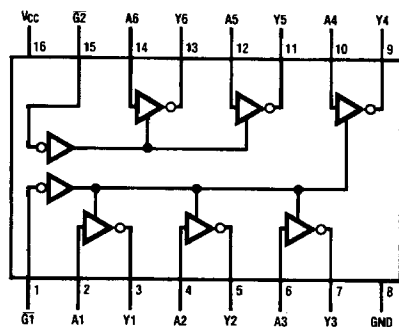
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Order Number MM54HC366\* or MM74HC366\*



TL/F/5209-3

Order Number MM54HC367\* or MM74HC367\*



TL/F/5209-4

Order Number MM54HC368\* or MM74HC368\*

\*Please look into Section 8, Appendix D for availability of various package types.

### Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, 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	$V_{CC}$	$T_A = 25^\circ C$			Units	
				Typ	74HC $T_A = -40$ to $85^\circ C$	54HC $T_A = -55$ to $125^\circ C$		
$V_{IH}$	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	V	
			4.5V	4.5	4.4	4.4	V	
			6.0V	6.0	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	V	
			4.5V	0	0.1	0.1	V	
			6.0V	0	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 $V_{CC} = 2.0\text{--}6.0V$ ,  $C_L = 50$  pF,  $t_r = t_f = 6$  ns (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		74HC $T_A = -40$ to $85^\circ C$		54HC $T_A = -55$ to $125^\circ C$		Units
				Typ	Guaranteed Limits					
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50$ pF $C_L = 150$ pF $C_L = 50$ pF $C_L = 150$ pF $C_L = 50$ pF $C_L = 150$ 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 $C_L = 150$ pF $C_L = 50$ pF $C_L = 150$ pF $C_L = 50$ pF $C_L = 150$ 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
G1	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 $T_A = -40$ to $85^\circ C$		54HC $T_A = -55$ to $125^\circ C$		Units
				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
$\bar{G}1$	$\bar{G}2$	A	
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 $T_A = -40$ to $85^\circ C$		54HC $T_A = -55$ to $125^\circ C$		Units
				Typ	Guaranteed Limits					
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay	$C_L = 50$ pF	2.0V	35	105	130	150	ns		
				45	135	168	205	ns		
				14	24	30	36	ns		
				17	29	36	45	ns		
				11	19	24	28	ns		
				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		
				75	187	233	280	ns		
				24	38	47	57	ns		
				29	46	57	69	ns		
				22	35	43	52	ns		
				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		
				22	35	44	52	ns		
				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		
				7	12	15	18	ns		
				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<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C, t<sub>r</sub> = t<sub>f</sub> = 6 ns

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
t <sub>PHL</sub> , t <sub>PLH</sub>	Maximum Propagation Delay	C <sub>L</sub> = 45 pF	11	18	ns
t <sub>PZL</sub> , t <sub>PZH</sub>	Maximum Output Enable Time	R <sub>L</sub> = 1 kΩ C <sub>L</sub> = 45 pF	23	37	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Maximum Output Disable Time	R <sub>L</sub> = 1 kΩ C <sub>L</sub> = 5 pF	19	33	ns

### AC Electrical Characteristics MM54HC368/MM74HC368

V<sub>CC</sub> = 2.0–6.0V, C<sub>L</sub> = 50 pF, t<sub>r</sub> = t<sub>f</sub> = 6 ns (unless otherwise specified)

Symbol	Parameter	Conditions	V <sub>CC</sub>	T <sub>A</sub> = 25°C		74HC	54HC	Units
				Typ	Guaranteed Limits	T <sub>A</sub> = -40 to 85°C	T <sub>A</sub> = -55 to 125°C	
t <sub>PHL</sub> , t <sub>PLH</sub>	Maximum Propagation Delay	C <sub>L</sub> = 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 <sub>PZH</sub> , t <sub>PZL</sub>	Maximum Output Enable Time	R <sub>L</sub> = 1 kΩ	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 <sub>PHZ</sub> , t <sub>PLZ</sub>	Maximum Output Disable Time	R <sub>L</sub> = 1 kΩ C <sub>L</sub> = 50 pF	2.0V	47	117	146	220	ns
			4.5V	22	35	44	52	ns
			6.0V	19	31	39	46	ns
t <sub>THL</sub> , t <sub>TLH</sub>	Maximum Output Rise and Fall Time	C <sub>L</sub> = 50 pF	2.0V	25	60	75	90	ns
			4.5V	7	12	15	18	ns
			6.0V	6	10	13	15	ns
C <sub>PD</sub>	Power Dissipation Capacitance (Note 5)	Any Enabled A Input Any Disabled A Input		45				pF
				6				pF
C <sub>IN</sub>	Maximum Input Capacitance			5	10	10	10	pF
C <sub>OUT</sub>	Maximum Input Capacitance			10	20	20	20	pF

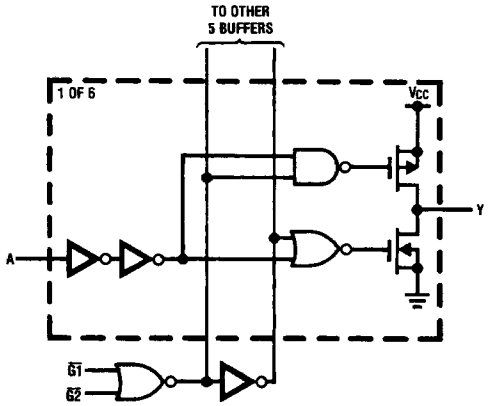
Note 5: C<sub>PD</sub> determines the no load dynamic power consumption, P<sub>D</sub> = C<sub>PD</sub> V<sub>CC</sub><sup>2</sup> f + I<sub>CC</sub> V<sub>CC</sub>, and the no load dynamic current consumption, I<sub>S</sub> = C<sub>PD</sub> V<sub>CC</sub> f + I<sub>CC</sub>.

### Truth Table

'HC368		
Inputs		Output
$\bar{G}$	A	Y
H	X	Z
L	H	L
L	L	H

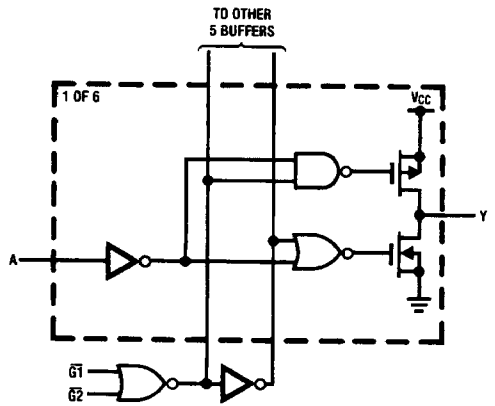
### Logic Diagrams

MM54HC365/MM74HC365



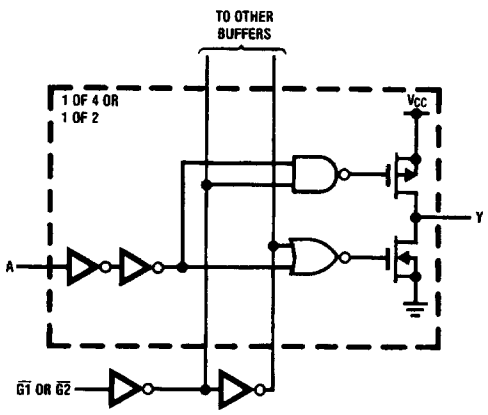
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MM54HC366/MM74HC366



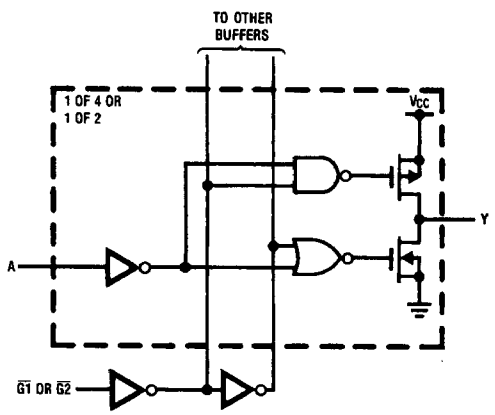
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MM54HC368/MM74HC368



TL/F/5209-8