



PRELIMINARY



MM54HC4316/MM74HC4316 Quad Analog Switch with Level Translator

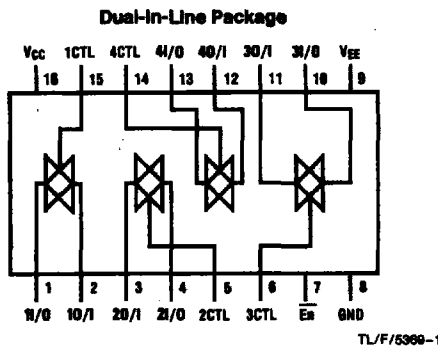
General Description

These devices are digitally controlled analog switches implemented in microCMOS Technology, 3.5 micron silicon gate P-well CMOS. These switches have low "on" resistance and low "off" leakages. They are bidirectional switches, thus any analog input may be used as an output and vice-versa. Three supply pins are provided on the '4316 to implement a level translator which enables this circuit to operate with 0–6V logic levels and up to $\pm 6V$ analog switch levels. The '4316 also has a common enable input in addition to each switch's control which when low will disable all switches to their off state. All analog inputs and outputs and digital inputs are protected from electrostatic damage by diodes to V_{CC} and ground.

Features

- Typical switch enable time: 20 ns
- Wide analog input voltage range: $\pm 6V$
- Low "on" resistance: 50 typ. ($V_{CC} - V_{EE} = 4.5V$)
30 typ. ($V_{CC} - V_{EE} = 9V$)
- Low quiescent current: 80 μA maximum (74HC)
- Matched switch characteristics
- Individual switch controls plus a common enable

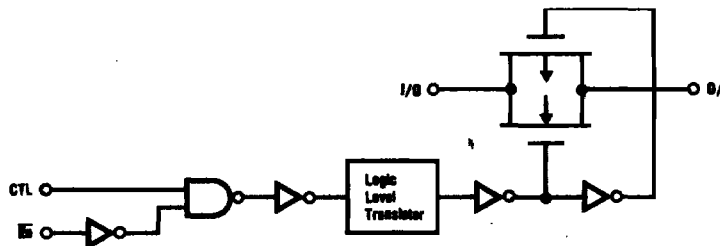
Connection and Logic Diagrams



Order Number MM54HC4316J or MM74HC4316J,N
See NS Package J16A or N16E

Truth Table

Inputs		Switch
En	CTL	I/O–O/I
H	X	"OFF"
L	L	"OFF"
L	H	"ON"



Absolute Maximum Ratings (Notes 1 & 2)

Supply Voltage (V_{CC})	-0.5 to +7.5V
Supply Voltage (V_{EE})	+0.5 to -7.5V
DC Control Input Voltage (V_{IN})	-1.5 to $V_{CC} + 1.5V$
DC Switch I/O Voltage (V_{IO})	$V_{EE} - 0.5$ to $V_{CC} + 0.5V$
Clamp Diode Current (I_{IK}, I_{OK})	± 20 mA
DC Output Current, per pin (I_{OUT})	± 25 mA
DC V_{CC} or GND Current, per pin (I_{CC})	± 50 mA
Storage Temperature Range (T_{STG})	-65°C to +150°C
Power Dissipation (P_D) (Note 3)	500 mW
Lead Temperature (T_L)	
(Soldering 10 seconds)	260°C

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	2	6	V
Supply Voltage (V_{EE})	0	-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_{EE}	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					
V_{IH}	Minimum High Level Input Voltage			2.0V	1.5	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	0.3	0.3	0.3	0.3	V		
					4.5V	0.9	0.9	0.9	V		
					6.0V	1.2	1.2	1.2	V		
R_{ON}	Minimum "ON" Resistance (See Note 5)	$V_{CTL} = V_{IH}, I_S = 1.0$ mA $V_{IS} = V_{CC}$ to V_{EE} (Figure 1)	GND	4.5V	100	170	200	220	Ω		
				-4.5V	40	85	105	110	Ω		
				-6.0V	30	70	85	90	Ω		
			GND	2.0V	100	180	215	240	Ω		
				4.5V	40	80	100	120	Ω		
				-4.5V	50	60	75	80	Ω		
-6.0V	20	40	60	70	Ω						
R_{ON}	Maximum "ON" Resistance Matching	$V_{CTL} = V_{IH}$ $V_{IS} = V_{CC}$ to GND	GND	4.5V	10	15	20	20	Ω		
				-4.5V	5	10	15	15	Ω		
				-6.0V	5	10	15	15	Ω		
I_{IN}	Maximum Control Input Current	$V_{IN} = V_{CC}$ or GND			6.0V	± 0.1	± 1.0	± 1.0	μA		
I_{IZ}	Maximum Switch "OFF" Leakage Current	$V_{OS} = V_{CC}$ or GND $V_{IS} = GND$ or V_{CC} $V_{CTL} = V_{IL}$ (Fig 2)	GND	5.5V		± 60	± 600	± 600	nA		
				-6.0V	6.0V	± 100	± 1000	± 1000	nA		
I_{IZ}	Maximum Switch "ON" Leakage Current	$V_{OS} = V_{CC}$ or GND $V_{CTL} = V_{IH}$ (Figure 3)	GND	5.5V		± 40	± 150	± 150	nA		
				-6.0V	6.0V	± 60	± 300	± 300	nA		
I_{CC}	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0$ μA	GND	6.0V		2.0	20	40	μA		
				-6.0V	6.0V	8.0	80	160	μA		

Note 1: Absolute 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 on resistance (R_{ON}) occurs 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 occurs for CMOS at the higher voltage and so the 5.5V values should be used.

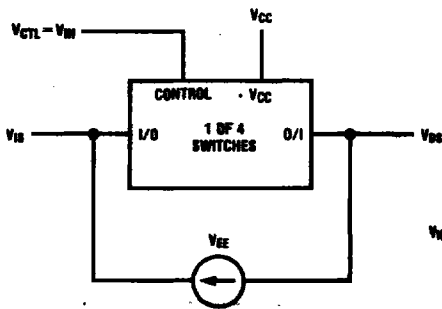
Note 5: At supply voltages ($V_{CC} - V_{EE}$) approaching 2V the analog switch on resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital only when using these supply voltages.

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AC Electrical Characteristics $V_{CC} = 2.0V - 6.0V$, $V_{EE} = 0V - 8V$, $C_L = 50 pF$ (unless otherwise specified)

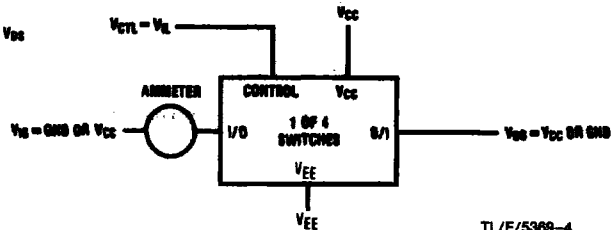
Symbol	Parameter	Conditions	V_{EE}	V_{CC}	$T_A = 25^\circ C$		74HC	54HC	Units
							$T_A = -40$ to $85^\circ C$	$T_A = -55$ to $125^\circ C$	
					Typ		Guaranteed Limits		
t_{PHL} , t_{PLH}	Maximum Propagation Delay Switch In to Out		GND	2.0V	25	50	63	75	ns
			GND	4.5V	5	10	13	15	ns
			-4.5V	4.5V	4	8	12	14	ns
			-6.0V	6.0V	3	7	11	13	ns
t_{PZL} , t_{PZH}	Maximum Switch Turn "ON" Delay (Control)	$R_L = 1 k\Omega$	GND	2.0V		65	206	250	ns
			GND	4.5V		35	43	53	ns
			-4.5V	4.5V		32	39	48	ns
			-6.0V	6.0V		30	37	45	ns
t_{PHZ} , t_{PLZ}	Maximum Switch Turn "OFF" Delay (Control)	$R_L = 1 k\Omega$	GND	2.0V	45	250	312	375	ns
			GND	4.5V	15	50	63	75	ns
			-4.5V	4.5V	10	44	55	66	ns
			-6.0V	6.0V	8	44	55	66	ns
t_{PZL} , t_{PZH}	Maximum Switch Turn "ON" Delay (Enable)		GND	2.0V	35	205	256	308	ns
			GND	4.5V	20	41	52	62	ns
			-4.5V	4.5V	19	38	48	57	ns
			-6.0V	6.0V	18	36	45	54	ns
t_{PLZ} , t_{PHZ}	Maximum Switch Turn "OFF" Delay (Enable)		GND	2.0V	48	265	330	400	ns
			GND	4.5V	18	53	67	79	ns
			-4.5V	4.5V	13	47	59	70	ns
			-6.0V	6.0V	11	47	59	70	ns
f_{MAX}	Minimum Switch Frequency Response* $20 \log(V_I/V_O) = 3 \text{ dB}$		GND	4.5V	30				MHz
			-4.5V	4.5V	35				MHz
	Cross Talk Control to Switch	(Figure 7)	-4.5V	4.5V	100				mVp.p
	Cross Talk Between any Two Switches (Frequency at -50 dB)	(Figure 8)	-4.5V	4.5V					MHz
	Feedthrough, Switch Input to Switch Output		GND	4.5V					dB
			GND	4.5V					dB
C_{IN}	Maximum Control Input Capacitance				5	10	10	10	pF
C_{IN}	Maximum Switch Input Capacitance	Input			15				pF
C_{IN}	Maximum Feedthrough Capacitance	$V_{CTL} = GND$			5				pF
C_{PD}	Power Dissipation Capacitance				15				pF

AC Test Circuits and Switching Time Waveforms



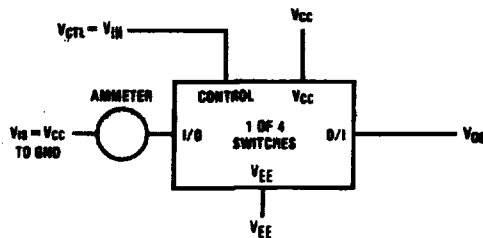
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FIGURE 1. "ON" Resistance



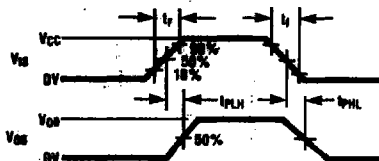
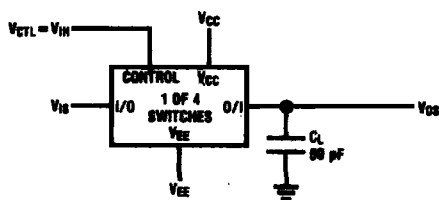
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FIGURE 2. "OFF" Channel Leakage Current



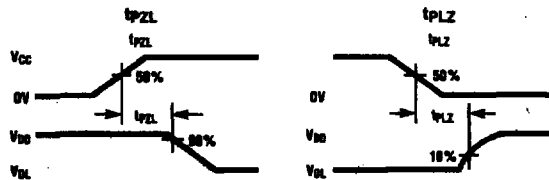
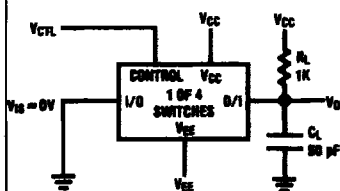
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FIGURE 3. "ON" Channel Leakage Current



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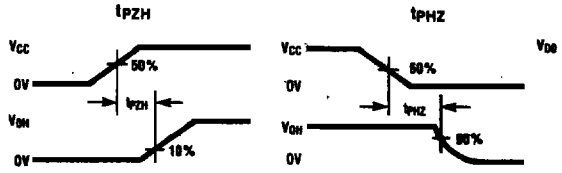
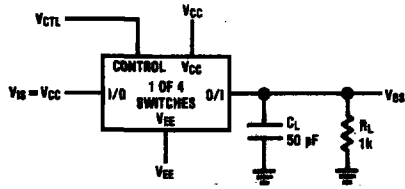
FIGURE 4. t_{PHL} , t_{PLH} Propagation Delay Time Signal Input to Signal Output



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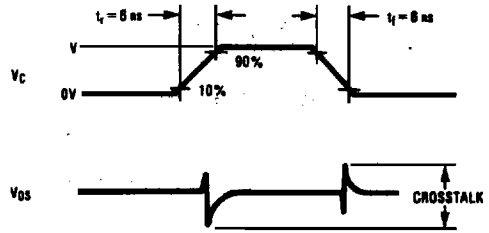
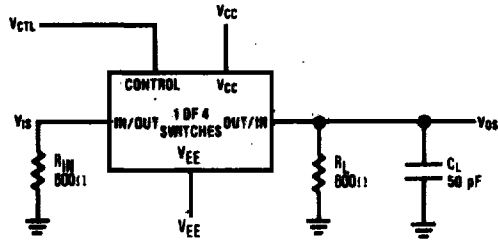
FIGURE 5. t_{PZL} , t_{PLZ} Propagation Delay Time Control to Signal Output

AC Test Circuits and Switching Time Waveforms (Continued)



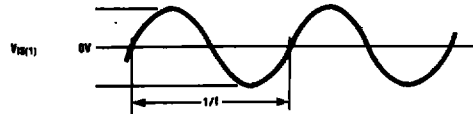
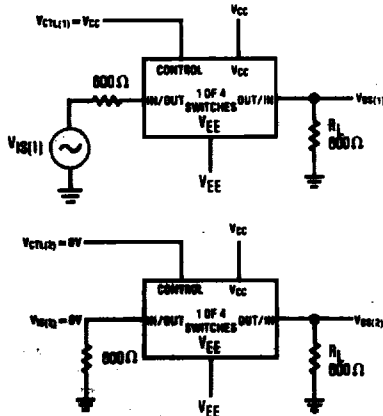
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FIGURE 6. t_{PHZ} , t_{PHZ} Propagation Delay Time Control to Signal Output



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FIGURE 7. Crosstalk: Control Input to Signal Output

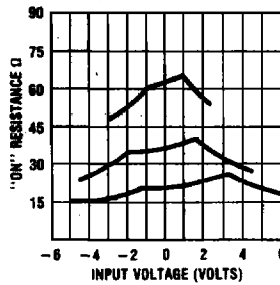


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FIGURE 8: Crosstalk Between Any Two Switches

Typical Performance Characteristics

Typical "ON" Resistance Vs. Input Voltage



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