National Semiconductor

August 1989

MM54HC4066/MM74HC4066 Quad Analog Switch

General Description

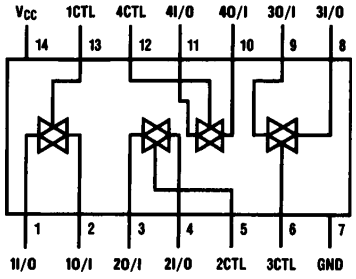
These devices are digitally controlled analog switches utilizing advanced silicon-gate CMOS technology. These switches have low "on" resistance and low "off" leakages. They are bidirectional switches, thus any analog input may be used as an output and visa-versa. Also the '4066 switches contain linearization circuitry which lowers the "on" resistance and increases switch linearity. The '4066 devices allow control of up to 12V (peak) analog signals with digital control signals of the same range. Each switch has its own control input which disables each switch when low. 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: 15 ns
- Wide analog input voltage range: 0–12V
- Low "on" resistance: 30 typ. ('4066)
- Low quiescent current: 80 μA maximum (74HC)
- Matched switch characteristics
- Individual switch controls

Connection Diagram

Dual-In-Line Package



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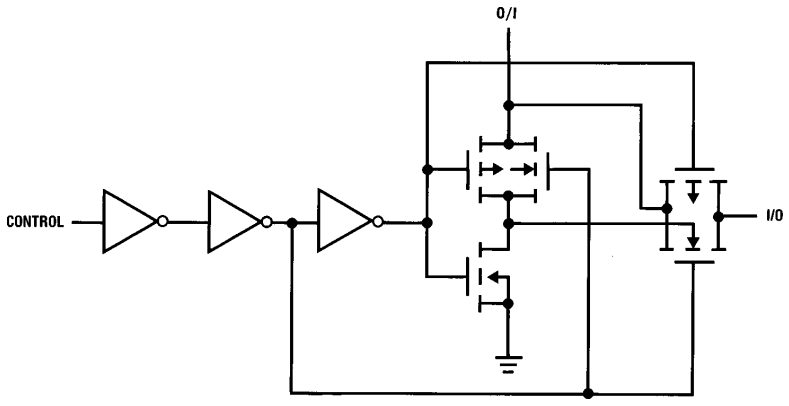
Top View

Order Number MM54HC4066 or MM74HC4066

Truth Table

Input	Switch
CTL	I/O–O/I
L	"OFF"
H	"ON"

Schematic Diagram



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RRD-B30M105/Printed in U. S. A.

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 +15V
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)	600 mW
S.O. Package only	500 mW
Lead Temperature (T_L)	
(Soldering 10 seconds)	260°C

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	2	12	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} = 9.0V		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
			9.0V		6.3	5.3	6.3	V
			12.0V		8.4	8.4	8.4	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
			9.0V		2.7	2.7	2.7	V
			12.0V		3.6	3.6	3.6	V
R_{ON}	Maximum "ON" Resistance (See Note 5)	V_{CTL} = V_{IH}, I_S = 2.0 mA V_{IS} = V_{CC} to GND (Figure 1)	4.5V	100	170	200	220	Ω
			9.0V	50	85	105	110	Ω
			12.0	30	70	85	90	Ω
		V_{CTL} = V_{IH}, I_S = 2.0 mA V_{IS} = V_{CC} or GND (Figure 1)	2.0V	120	180	215	240	Ω
			4.5V	50	80	100	120	Ω
			9.0V	35	60	75	80	Ω
			12.0V	20	40	60	70	Ω
R_{ON}	Maximum "ON" Resistance Matching	V_{CTL} = V_{IH} V_{IS} = V_{CC} to GND	4.5V	10	15	20	20	Ω
			9.0V	5	10	15	15	Ω
			12.0V	5	10	15	15	Ω
I_{IN}	Maximum Control Input Current	V_{IN} = V_{CC} or GND V_{CC} = 2–6V			±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} (Figure 2)	6.0V	10	±60	±600	±600	nA
			9.0V	15	±80	±800	±800	nA
			12.0V	20	±100	±1000	±1000	nA
I_{IZ}	Maximum Switch "ON" Leakage Current	V_{IS} = V_{CC} to GND V_{CTL} = V_{IH} (Figure 3) V_{OS} = OPEN	6.0V	10	±40	±150	±150	nA
			9.0V	15	±50	±200	±200	nA
			12.0V	20	±60	±300	±300	nA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA	6.0V		2.0	20	40	μA
			9.0V		4.0	40	80	μA
			12.0V		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 ±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}–GND) 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.

** 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

V_{CC} = 2.0V–6.0V V_{EE} = 0V–12V, C_L = 50 pF (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 Switch In to Out		2.0V	25	50	30	75	ns
			4.5V	5	10	13	15	ns
			9.0V	4	8	10	12	ns
			12.0V	3	7	11	13	ns
t_{PZL}, t_{PZH}	Maximum Switch Turn "ON" Delay	R_L = 1 kΩ	2.0V	30	100	125	150	ns
			4.5V	12	20	25	30	ns
			9.0V	6	12	15	18	ns
			12.0V	5	10	13	15	ns
t_{PHZ}, t_{PLZ}	Maximum Switch Turn "OFF" Delay	R_L = 1 kΩ	2.0V	60	168	210	252	ns
			4.5V	25	36	45	54	ns
			9.0V	20	32	40	48	ns
			12.0V	15	30	38	45	
	Minimum Frequency Response (Figure 7)	R_L = 600Ω	4.5V	40				MHz
		V_{IS} = 2 V_{PP} at (V_{CC}/2)	9.0V	100				MHz
	20 log(V_O/V_I) = −3 dB	(Notes 6 & 7)						
	Crosstalk Between any Two Switches (Figure 8)	R_L = 600Ω, F = 1 MHz (Notes 7 & 8)	4.5V	−52				dB
			9.0V	−50				dB
	Peak Control to Switch Feedthrough Noise (Figure 9)	R_L = 600Ω, F = 1 MHz	4.5V	100				mV
		C_L = 50 pF	9.0V	250				mV
	Switch OFF Signal Feedthrough Isolation (Figure 10)	R_L = 600Ω, F = 1 MHz $V_{(CT)}$ V_{IL} (Notes 7 & 8)	4.5V	−42				dB
			9.0V	−44				dB
THD	Total Harmonic Distortion (Figure 11)	R_L = 10 kΩ, C_L = 50 pF, F = 1 kHz						
		V_{IS} = 4 V_{PP}	4.5V	.013				%
		V_{IS} = 8 V_{PP}	9.0V	.008				%
C_{IN}	Maximum Control Input Capacitance			5	10	10	10	pF
C_{IN}	Maximum Switch Input Capacitance			20				pF
C_{IN}	Maximum Feedthrough Capacitance	V_{CTL} = GND		0.5				pF
C_{PD}	Power Dissipation Capacitance			15				pF

Note 6: Adjust 0 dBm for F = 1 kHz (Null R_L/R_{ON} Attenuation).

Note 7: V_{IS} is centered at V_{CC}/2.

Note 8: Adjust input for 0 dBm.

AC Test Circuits and Switching Time Waveforms

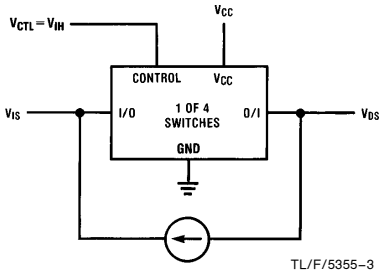

FIGURE 1. "ON" Resistance

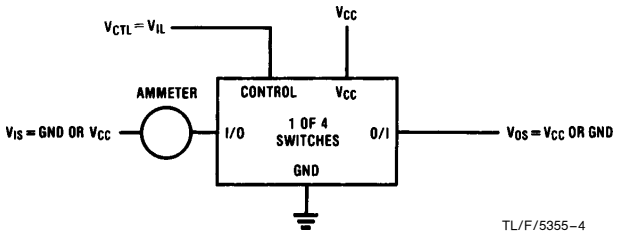

FIGURE 2. "OFF" Channel Leakage Current

AC Test Circuits and Switching Time Waveforms (Continued)

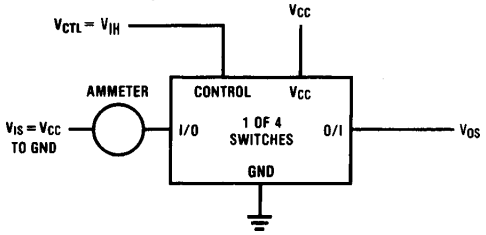

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FIGURE 3. "ON" Channel Leakage Current

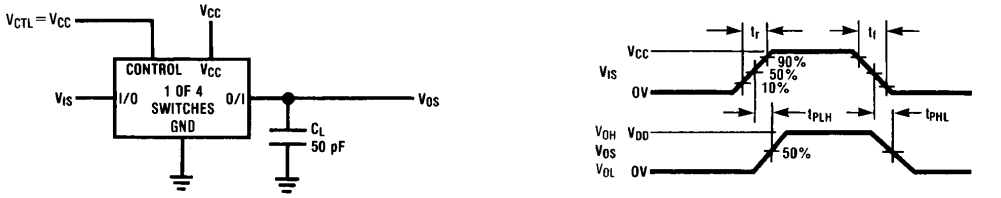

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FIGURE 4. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

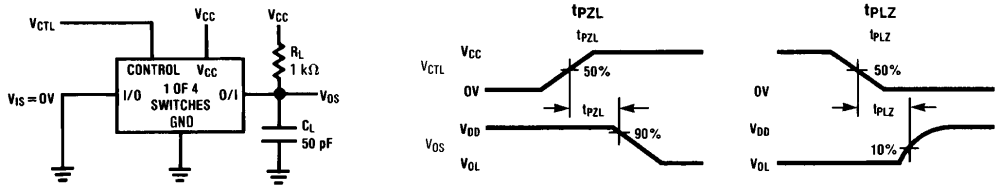

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FIGURE 5. t_{PZL}, t_{PLZ} Propagation Delay Time Control to Signal Output

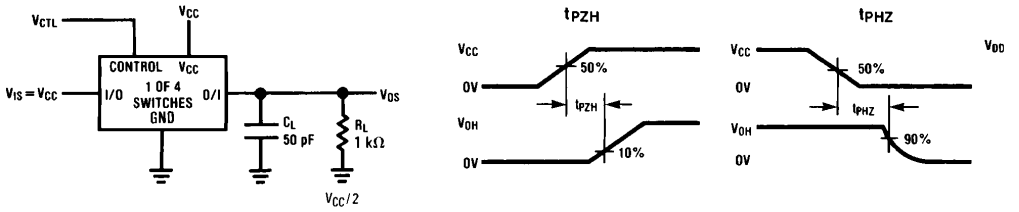

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FIGURE 6. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

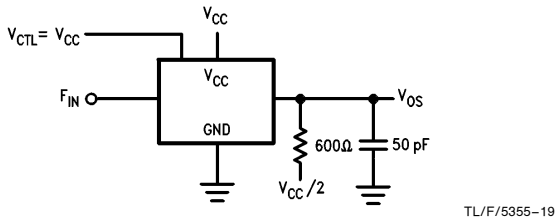

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FIGURE 7. Frequency Response

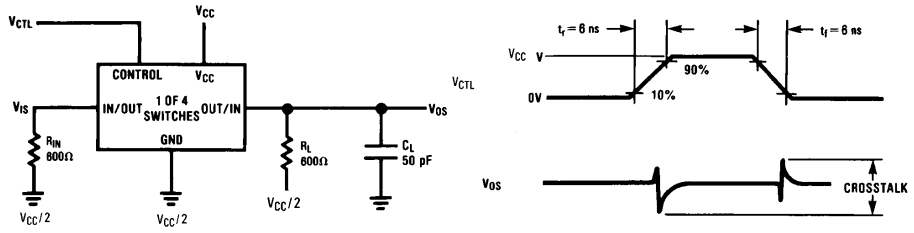

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FIGURE 8. Crosstalk: Control Input to Signal Output

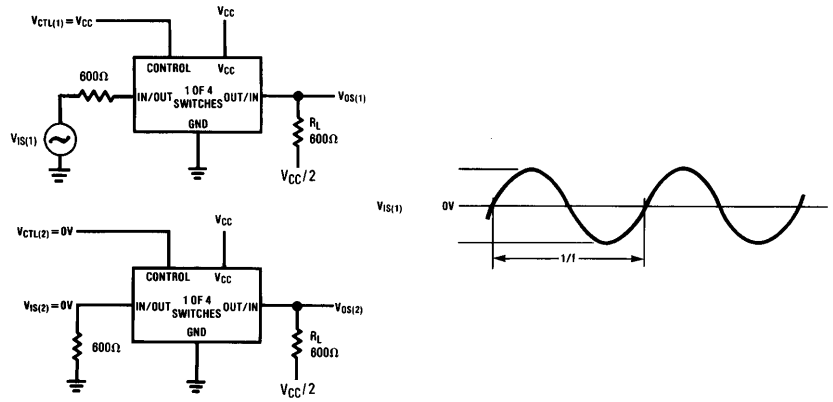

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FIGURE 9. Crosstalk Between Any Two Switches

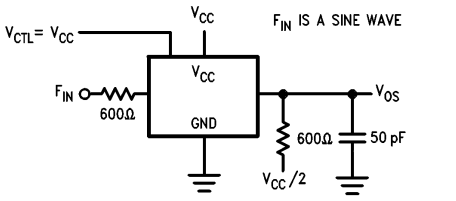

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FIGURE 10. Switch OFF Signal Feedthrough Isolation

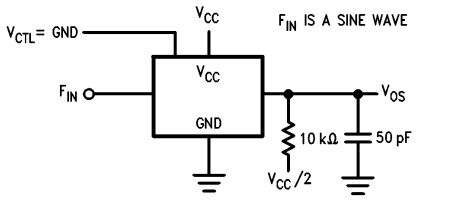

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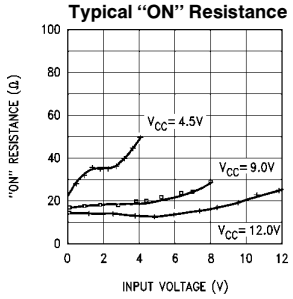
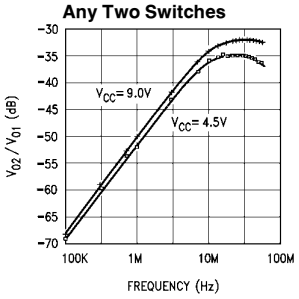
FIGURE 11. Sinewave Distortion

Typical Performance Characteristics

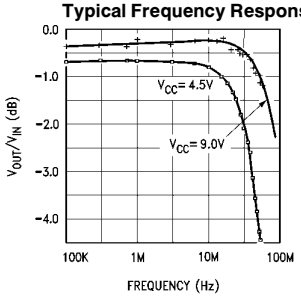
Typical "ON" Resistance



Typical Crosstalk Between Any Two Switches



Typical Frequency Response



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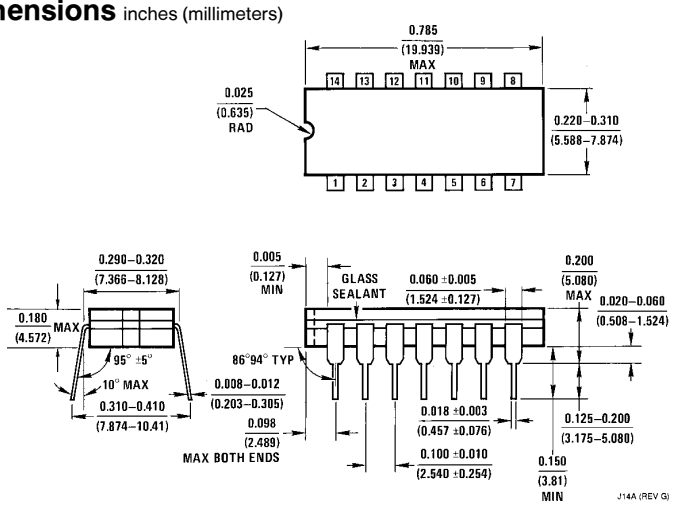
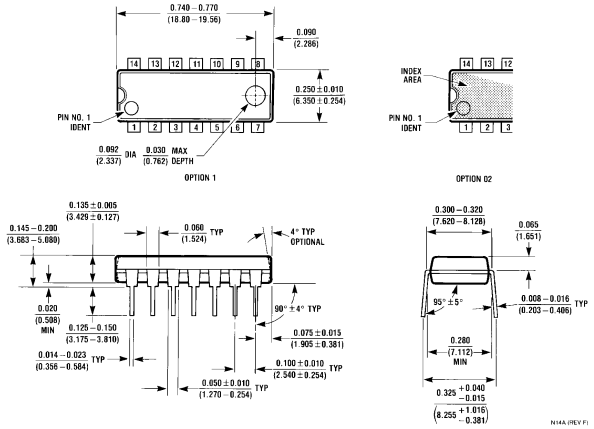
Special Considerations

In certain applications the external load-resistor current may include both V_{CC} and signal line components. To avoid drawing V_{CC} current when switch current flows into the analog switch input pins, the voltage drop across the switch must not exceed 0.6V (calculated from the ON resistance).

Physical Dimensions inches (millimeters)



Order Number MM54HC4066J or MM74HC4066J
NS Package J14A



Order Number MM74HC4066N
NS Package N14A

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