

# MC74LVX4066

## Quad Analog Switch/ Multiplexer/Demultiplexer High-Performance Silicon-Gate CMOS

The MC74LVX4066 utilizes silicon-gate CMOS technology to achieve fast propagation delays, low ON resistances, and low OFF-channel leakage current. This bilateral switch/multiplexer/demultiplexer controls analog and digital voltages that may vary across the full power-supply range (from  $V_{CC}$  to GND).

The LVX4066 is identical in pinout to the metal-gate CMOS MC14066 and the high-speed CMOS HC4066A. Each device has four independent switches. The device has been designed so that the ON resistances ( $R_{ON}$ ) are much more linear over input voltage than  $R_{ON}$  of metal-gate CMOS analog switches.

The ON/OFF control inputs are compatible with standard CMOS outputs; with pull-up resistors, they are compatible with LSTTL outputs.

### Features

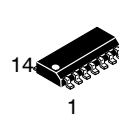
- Fast Switching and Propagation Speeds
- High ON/OFF Output Voltage Ratio
- Low Crosstalk Between Switches
- Diode Protection on All Inputs/Outputs
- Wide Power-Supply Voltage Range ( $V_{CC} - GND$ ) = 2.0 to 6.0 Volts
- Analog Input Voltage Range ( $V_{CC} - GND$ ) = 2.0 to 6.0 Volts
- Improved Linearity and Lower ON Resistance over Input Voltage than the MC14016 or MC14066
- Low Noise
- Chip Complexity: 44 FETs or 11 Equivalent Gates
- These Devices are Pb-Free and are RoHS Compliant



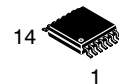
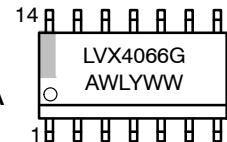
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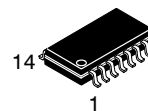
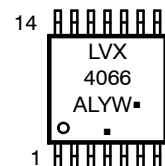
### MARKING DIAGRAMS



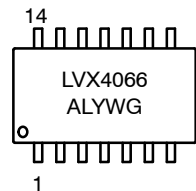
SOIC-14  
D SUFFIX  
CASE 751A



TSSOP-14  
DT SUFFIX  
CASE 948G



SOEIAJ-14  
M SUFFIX  
CASE 965



LVX4066 = Specific Device Code  
A = Assembly Location  
WL, L = Wafer Lot  
Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

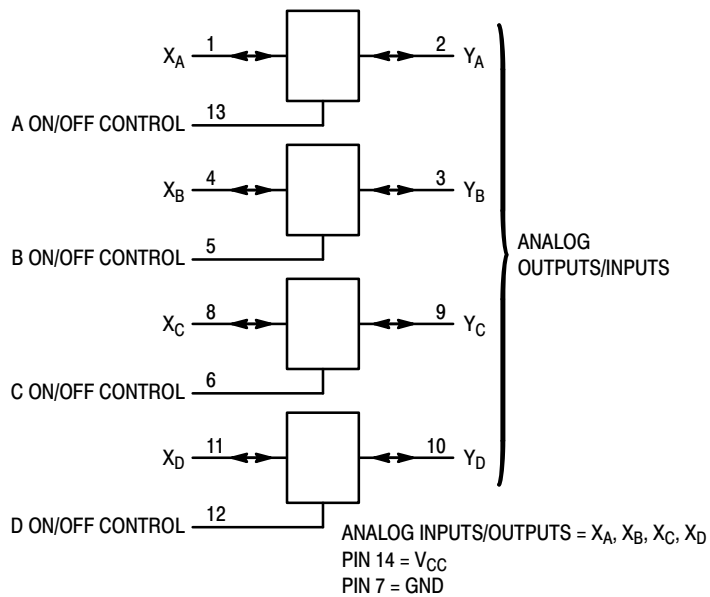
(Note: Microdot may be in either location)

### ORDERING INFORMATION

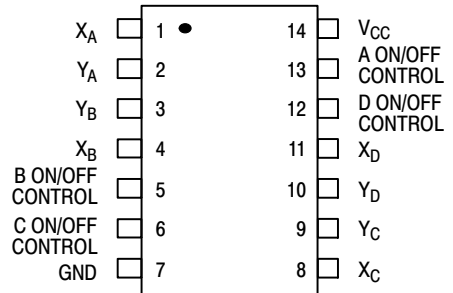
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# MC74LVX4066

## LOGIC DIAGRAM



## PIN CONNECTION (Top View)



## FUNCTION TABLE

On/Off Control Input	State of Analog Switch
L	Off
H	On

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
MC74LVX4066DR2G	SOIC-14 (Pb-Free)	2500 Tape & Reel
MC74LVX4066DTR2G	TSSOP-14* (Pb-Free)	2500 Tape & Reel
MC74LVX4066MG	SOEIAJ-14 (Pb-Free)	50 Units / Rail
MC74LVX4066MELG	SOEIAJ-14 (Pb-Free)	2000 Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.

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## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	Positive DC Supply Voltage (Referenced to GND)	- 0.5 to + 7.0	V
$V_{IS}$	Analog Input Voltage (Referenced to GND)	- 0.5 to $V_{CC} + 0.5$	V
$V_{in}$	Digital Input Voltage (Referenced to GND)	- 0.5 to $V_{CC} + 0.5$	V
$I_{in}$	DC Current Into or Out of ON/OFF Control Pins	$\pm 20$	mA
$I_s$	DC Current Into or Out of Switch Pins	$\pm 20$	mA
$P_D$	Power Dissipation in Still Air, SOIC Package† TSSOP Package†	500 450	mW
$T_{stg}$	Storage Temperature	- 65 to + 150	°C
$T_L$	Lead Temperature, 1 mm from Case for 10 Seconds	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

†Derating — SOIC Package: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open. I/O pins must be connected to a properly terminated line or bus.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	Positive DC Supply Voltage (Referenced to GND)	2.0	6.0	V
$V_{IS}$	Analog Input Voltage (Referenced to GND)	GND	$V_{CC}$	V
$V_{in}$	Digital Input Voltage (Referenced to GND)	GND	$V_{CC}$	V
$V_{IO}^*$	Static or Dynamic Voltage Across Switch	-	1.2	V
$T_A$	Operating Temperature, All Package Types	- 55	+ 85	°C
$t_r, t_f$	Input Rise and Fall Time, ON/OFF Control Inputs (Figure 10) $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ $V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$	0 0	100 20	ns/V

\*For voltage drops across the switch greater than 1.2 V (switch on), excessive  $V_{CC}$  current may be drawn; i.e., the current out of the switch may contain both  $V_{CC}$  and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded.

## DC ELECTRICAL CHARACTERISTIC Digital Section (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	$V_{CC}$ V	Guaranteed Limit			Unit
				- 55 to 25°C	$\leq 85^\circ\text{C}$	$\leq 125^\circ\text{C}$	
$V_{IH}$	Minimum High-Level Voltage ON/OFF Control Inputs (Note 1)	$R_{on} = \text{Per Spec}$	2.0	1.5	1.5	1.5	V
			3.0	2.1	2.1	2.1	
			4.5	3.15	3.15	3.15	
			5.5	3.85	3.85	3.85	
$V_{IL}$	Maximum Low-Level Voltage ON/OFF Control Inputs (Note 1)	$R_{on} = \text{Per Spec}$	2.0	0.5	0.5	0.5	V
			3.0	0.9	0.9	0.9	
			4.5	1.35	1.35	1.35	
			5.5	1.65	1.65	1.65	
$I_{in}$	Maximum Input Leakage Current ON/OFF Control Inputs	$V_{in} = V_{CC} \text{ or } GND$	5.5V	$\pm 0.1$	$\pm 1.0$	$\pm 1.0$	$\mu\text{A}$
$I_{CC}$	Maximum Quiescent Supply Current (per Package)	$V_{in} = V_{CC} \text{ or } GND$ $V_{IO} = 0 \text{ V}$	5.5	4.0	40	160	$\mu\text{A}$

1. Specifications are for design target only. Not final specification limits.

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## DC ELECTRICAL CHARACTERISTICS Analog Section (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				- 55 to 25 °C	≤ 85 °C	≤ 125 °C	
R <sub>on</sub>	Maximum "ON" Resistance	V <sub>in</sub> = V <sub>IH</sub> V <sub>IS</sub> = V <sub>CC</sub> to GND  I <sub>S</sub>   ≤ 10 mA (Figures 1, 2)	2.0†	-	-	-	Ω
			3.0	40	45	50	
			4.5	25	30	35	
			5.5	20	25	30	
		V <sub>in</sub> = V <sub>IH</sub> V <sub>IS</sub> = V <sub>CC</sub> or GND (Endpoints)  I <sub>S</sub>   ≤ 10 mA (Figures 1, 2)	2.0	-	-	-	
			3.0	30	35	40	
			4.5	25	30	35	
			5.5	20	25	30	
ΔR <sub>on</sub>	Maximum Difference in "ON" Resistance Between Any Two Channels in the Same Package	V <sub>in</sub> = V <sub>IH</sub> V <sub>IS</sub> = 1/2 (V <sub>CC</sub> - GND) I <sub>S</sub> ≤ 2.0 mA	3.0	15	20	25	Ω
			4.5	10	12	15	
			5.5	10	12	15	
I <sub>off</sub>	Maximum Off-Channel Leakage Current, Any One Channel	V <sub>in</sub> = V <sub>IL</sub> V <sub>IO</sub> = V <sub>CC</sub> or GND Switch Off (Figure 3)	5.5	0.1	0.5	1.0	μA
I <sub>on</sub>	Maximum On-Channel Leakage Current, Any One Channel	V <sub>in</sub> = V <sub>IH</sub> V <sub>IS</sub> = V <sub>CC</sub> or GND (Figure 4)	5.5	0.1	0.5	1.0	μA

† At supply voltage (V<sub>CC</sub>) approaching 2 V the analog switch-on resistance becomes extremely non-linear. Therefore, for low-voltage operation, it is recommended that these devices only be used to control digital signals (See Figure 1a).

## AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50 pF, ON/OFF Control Inputs: t<sub>r</sub> = t<sub>f</sub> = 6 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit	
			- 55 to 25 °C	≤ 85 °C	≤ 125 °C		
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Analog Input to Analog Output (Figures 8 and 9)	2.0	4.0	6.0	8.0	ns	
		3.0	3.0	5.0	6.0		
		4.5	1.0	2.0	2.0		
		5.5	1.0	2.0	2.0		
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Maximum Propagation Delay, ON/OFF Control to Analog Output (Figures 10 and 11)	2.0	30	35	40	ns	
		3.0	20	25	30		
		4.5	15	18	22		
		5.5	15	18	20		
t <sub>PZL</sub> , t <sub>PZH</sub>	Maximum Propagation Delay, ON/OFF Control to Analog Output (Figures 10 and 1 1)	2.0	20	25	30	ns	
		3.0	12	14	15		
		4.5	8.0	10	12		
		5.5	8.0	10	12		
C	Maximum Capacitance	ON/OFF Control Input	-	10	10	10	pF
		Control Input = GND	-	35	35	35	
		Analog I/O Feedthrough	-	1.0	1.0	1.0	
C <sub>PD</sub>	Power Dissipation Capacitance (Per Switch) (Figure 13)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V			pF		
		15					

\* Used to determine 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>.

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## ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Limit* 25°C	Unit
BW	Maximum On-Channel Bandwidth or Minimum Frequency Response (Figure 5)	f <sub>in</sub> = 1 MHz Sine Wave Adjust f <sub>in</sub> Voltage to Obtain 0 dBm at V <sub>OS</sub> Increase f <sub>in</sub> Frequency Until dB Meter Reads - 3 dB R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF	4.5 5.5	150 160	MHz
-	Off-Channel Feedthrough Isolation (Figure 6)	f <sub>in</sub> ≡ Sine Wave Adjust f <sub>in</sub> Voltage to Obtain 0 dBm at V <sub>IS</sub> f <sub>in</sub> = 10 kHz, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>in</sub> = 1.0 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF	4.5 5.5	- 50 - 50	dB
			4.5 5.5	- 37 - 37	
-	Feedthrough Noise, Control to Switch (Figure 7)	V <sub>in</sub> ≤ 1 MHz Square Wave (t <sub>r</sub> = t <sub>f</sub> = 6 ns) Adjust R <sub>L</sub> at Setup so that I <sub>S</sub> = 0 A R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 10 pF	4.5 5.5	100 200	mV <sub>PP</sub>
			4.5 5.5	50 100	
-	Crosstalk Between Any Two Switches (Figure 12)	f <sub>in</sub> ≡ Sine Wave Adjust f <sub>in</sub> Voltage to Obtain 0 dBm at V <sub>IS</sub> f <sub>in</sub> = 10 kHz, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>in</sub> = 1.0 MHz, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF	4.5 5.5	- 70 - 70	dB
			4.5 5.5	- 80 - 80	
THD	Total Harmonic Distortion (Figure 14)	f <sub>in</sub> = 1 kHz, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF THD = THD <sub>Measured</sub> - THD <sub>Source</sub> V <sub>IS</sub> = 4.0 V <sub>PP</sub> sine wave V <sub>IS</sub> = 5.0 V <sub>PP</sub> sine wave	4.5 5.5	0.10 0.06	%

\*Guaranteed limits not tested. Determined by design and verified by qualification.

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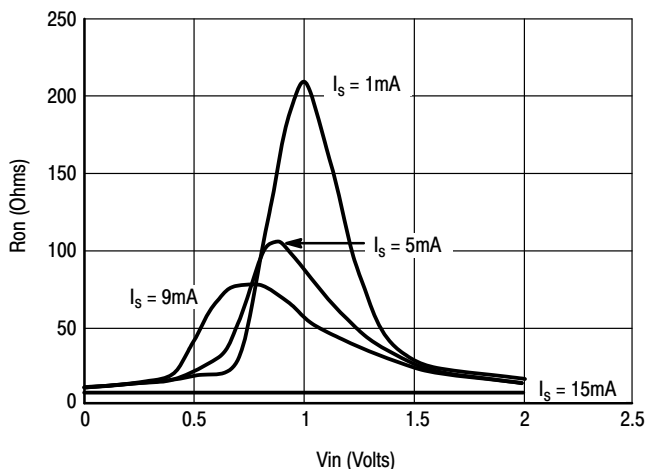


Figure 1a. Typical On Resistance,  $V_{CC} = 2.0\text{ V}$ ,  $T = 25^\circ\text{C}$

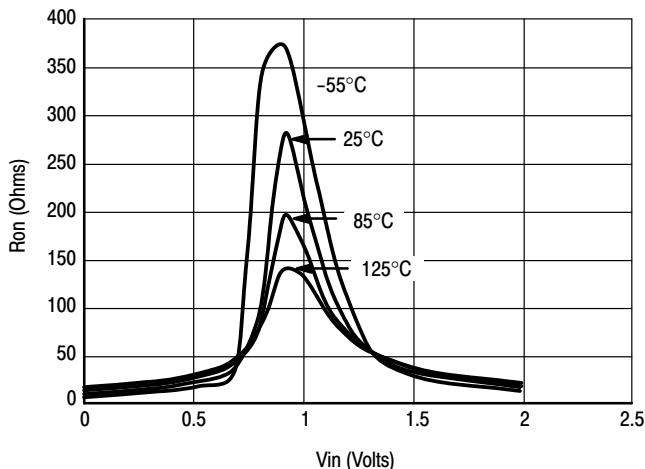


Figure 1b. Typical On Resistance,  $V_{CC} = 2.0\text{ V}$

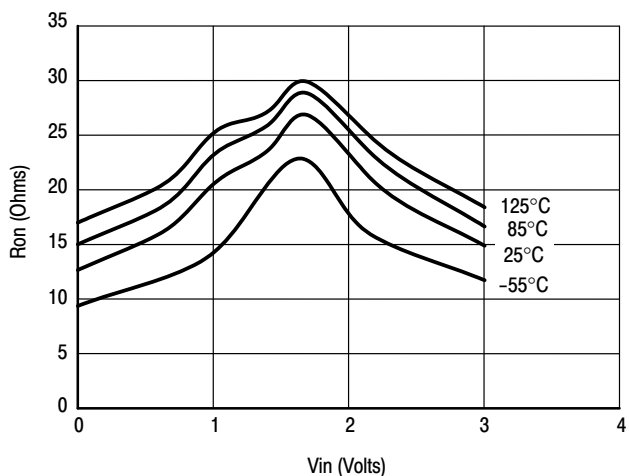


Figure 1c. Typical On Resistance,  $V_{CC} = 3.0\text{ V}$

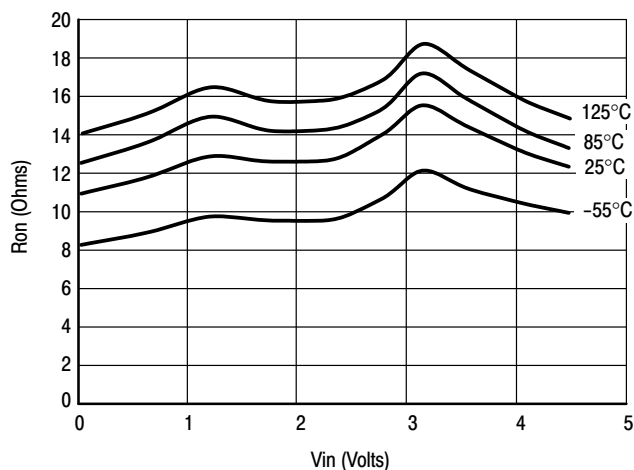


Figure 1d. Typical On Resistance,  $V_{CC} = 4.5\text{ V}$

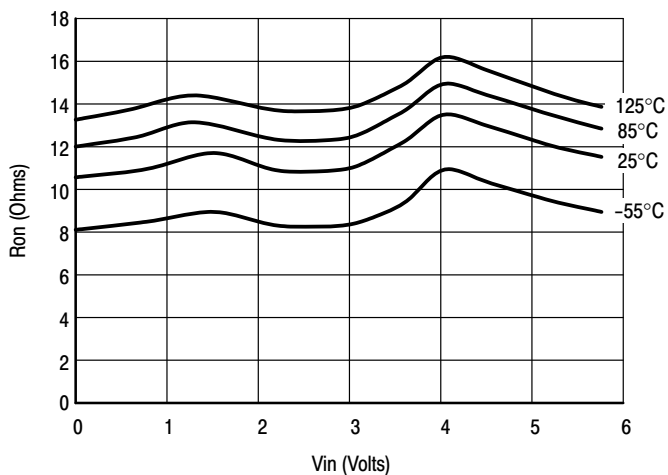


Figure 1e. Typical On Resistance,  $V_{CC} = 5.5\text{ V}$

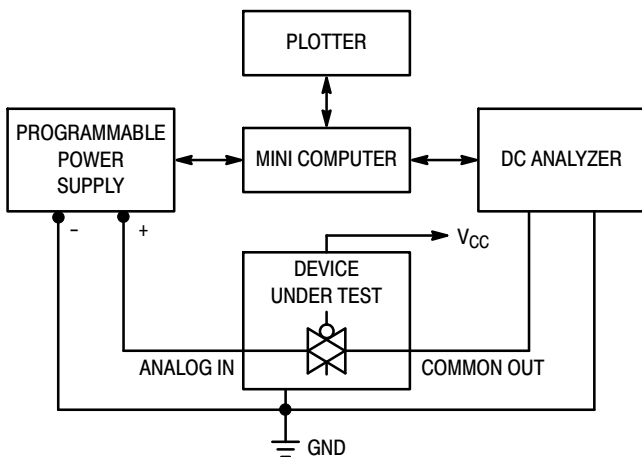
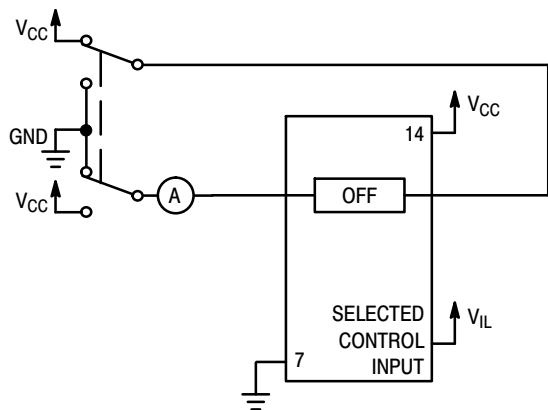
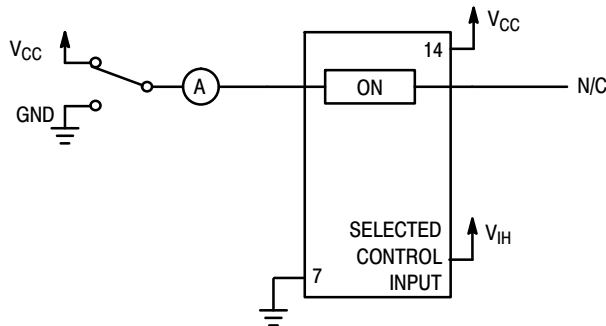


Figure 2. On Resistance Test Set-Up

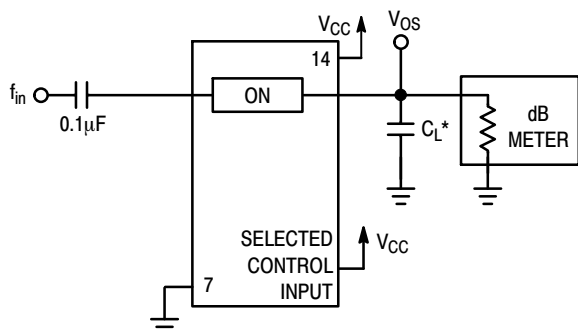
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**Figure 3. Maximum Off Channel Leakage Current, Any One Channel, Test Set-Up**

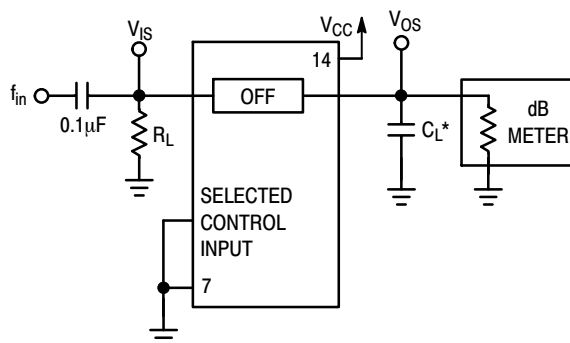


**Figure 4. Maximum On Channel Leakage Current, Test Set-Up**



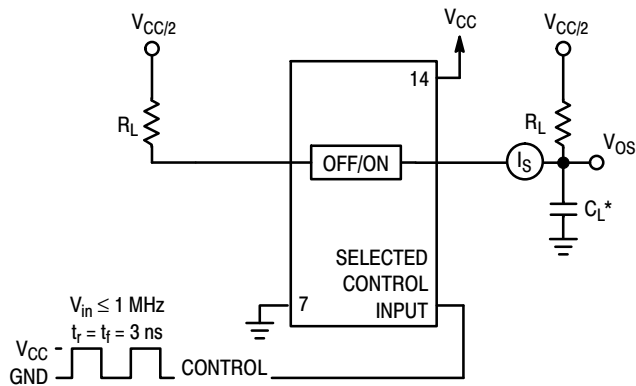
\*Includes all probe and jig capacitance.

**Figure 5. Maximum On-Channel Bandwidth Test Set-Up**



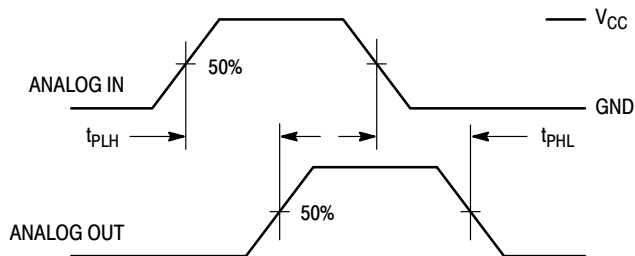
\*Includes all probe and jig capacitance.

**Figure 6. Off-Channel Feedthrough Isolation, Test Set-Up**

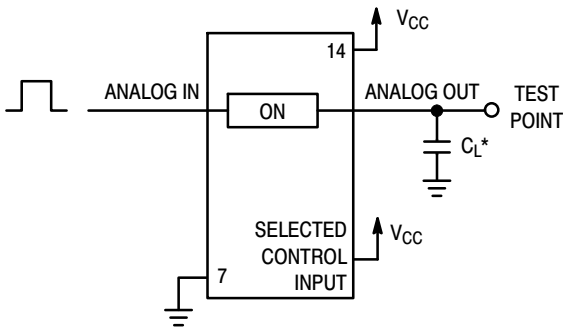


\*Includes all probe and jig capacitance.

**Figure 7. Feedthrough Noise, ON/OFF Control to Analog Out, Test Set-Up**



**Figure 8. Propagation Delays, Analog In to Analog Out**



\*Includes all probe and jig capacitance.

Figure 9. Propagation Delay Test Set-Up

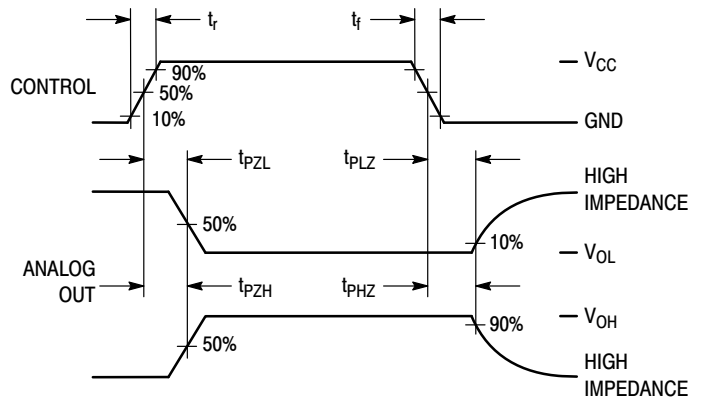
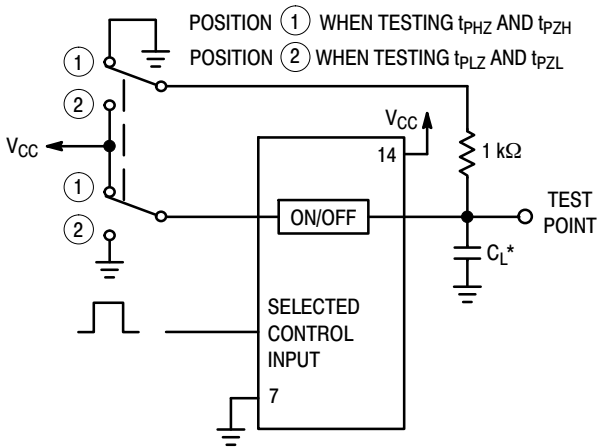
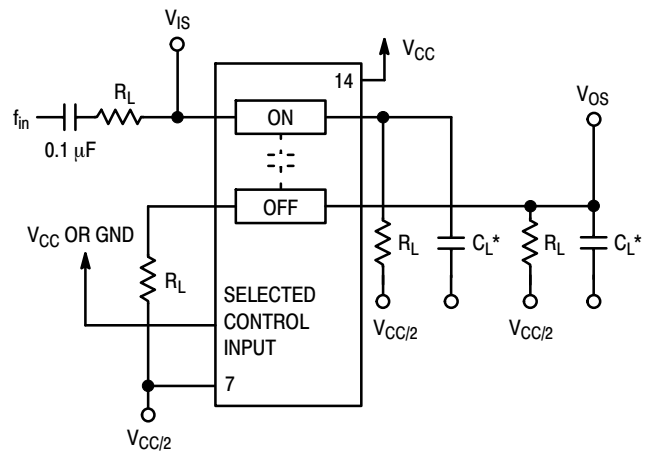


Figure 10. Propagation Delay, ON/OFF Control to Analog Out



\*Includes all probe and jig capacitance.

Figure 11. Propagation Delay Test Set-Up



\*Includes all probe and jig capacitance.

Figure 12. Crosstalk Between Any Two Switches, Test Set-Up

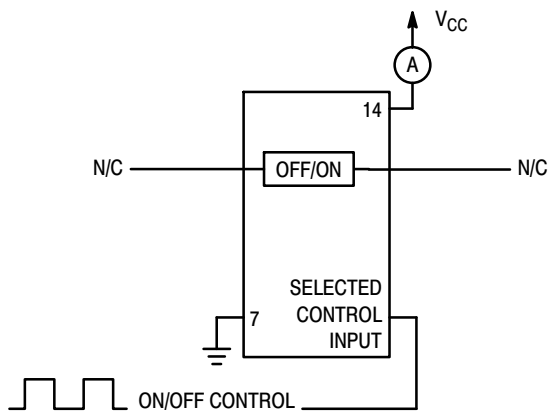
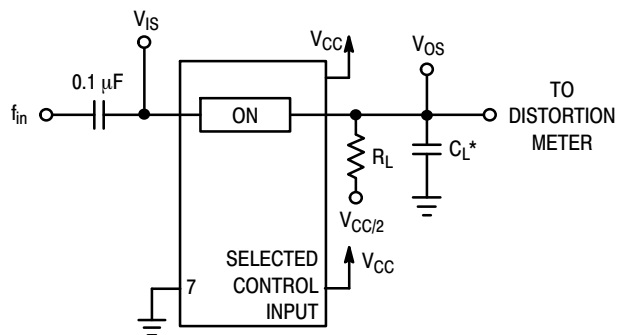


Figure 13. Power Dissipation Capacitance Test Set-Up



\*Includes all probe and jig capacitance.

Figure 14. Total Harmonic Distortion, Test Set-Up



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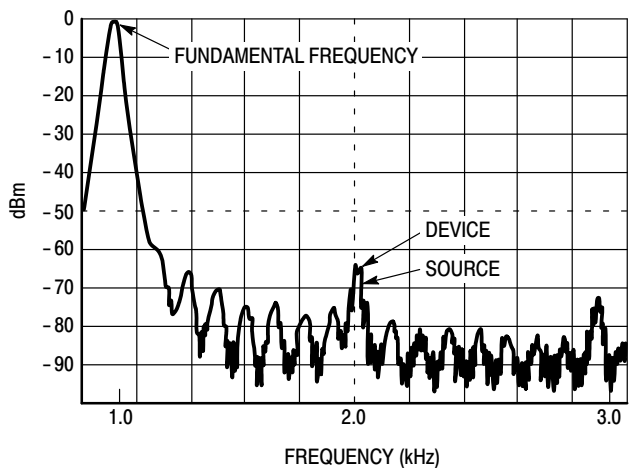


Figure 15. Plot, Harmonic Distortion

## APPLICATION INFORMATION

The ON/OFF Control pins should be at  $V_{CC}$  or GND logic levels,  $V_{CC}$  being recognized as logic high and GND being recognized as a logic low. Unused analog inputs/outputs may be left floating (not connected). However, it is advisable to tie unused analog inputs and outputs to  $V_{CC}$  or GND through a low value resistor. This minimizes crosstalk and feedthrough noise that may be picked-up by the unused I/O pins.

The maximum analog voltage swings are determined by the supply voltages  $V_{CC}$  and GND. The positive peak analog voltage should not exceed  $V_{CC}$ . Similarly, the negative peak analog voltage should not go below GND. In the example below, the difference between  $V_{CC}$  and GND is six volts.

Therefore, using the configuration in Figure 16, a maximum analog signal of six volts peak-to-peak can be controlled.

When voltage transients above  $V_{CC}$  and/or below GND are anticipated on the analog channels, external diodes ( $D_x$ ) are recommended as shown in Figure 17. These diodes should be small signal, fast turn-on types able to absorb the maximum anticipated current surges during clipping. An alternate method would be to replace the  $D_x$  diodes with Mosorbs (Mosorb™ is an acronym for high current surge protectors). Mosorbs are fast turn-on devices ideally suited for precise DC protection with no inherent wear out mechanism.

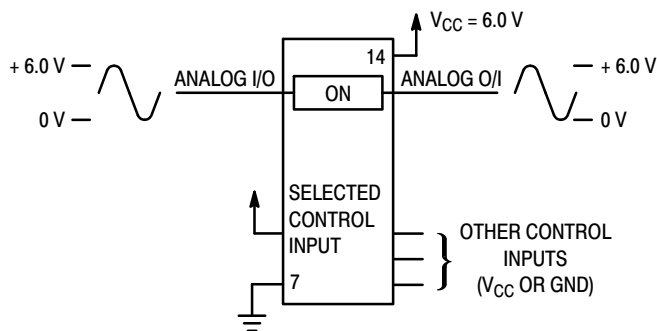


Figure 16. 6.0 V Application

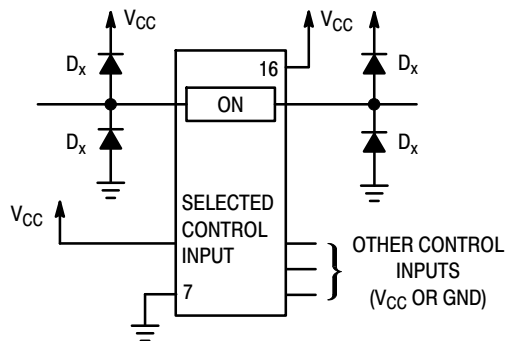


Figure 17. Transient Suppressor Application

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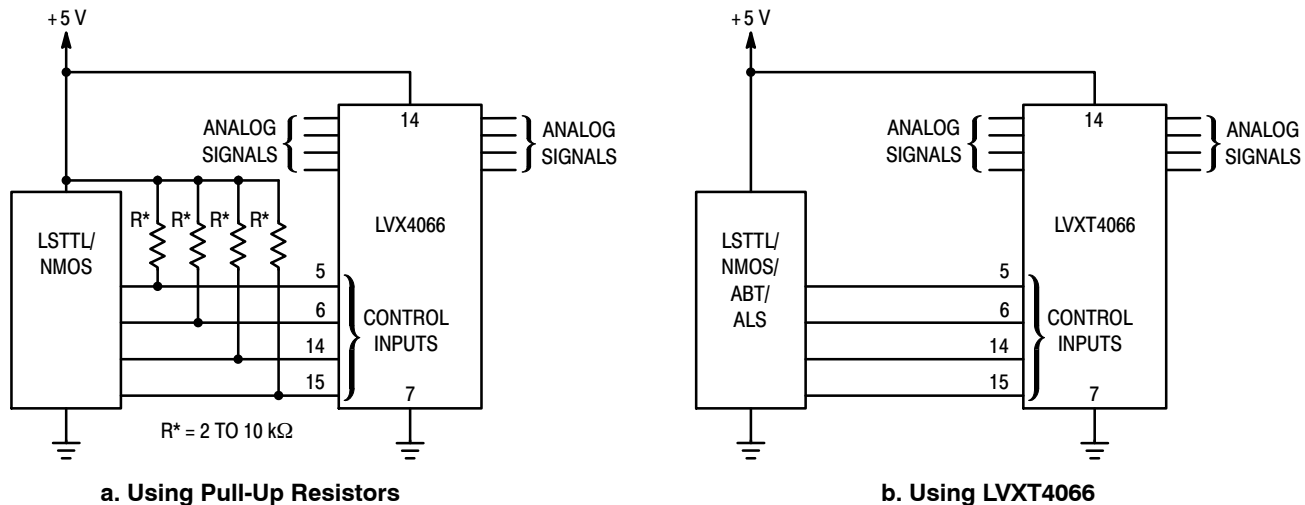


Figure 18. LSTTL/NMOS to CMOS Interface

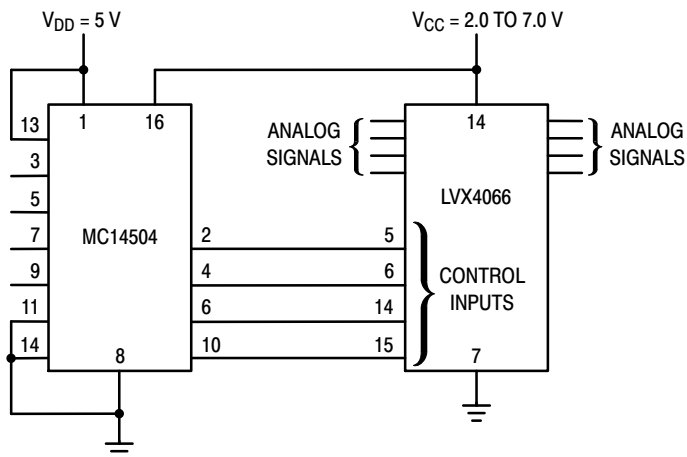


Figure 19. TTL/NMOS-to-CMOS Level Converter  
Analog Signal Peak-to-Peak Greater than 5 V

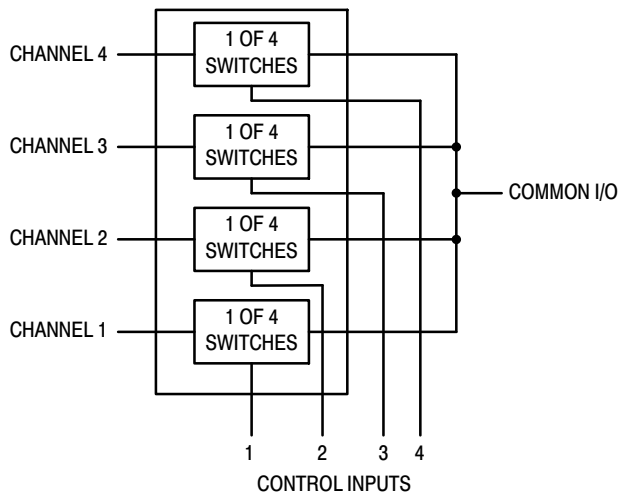


Figure 20. 4-Input Multiplexer

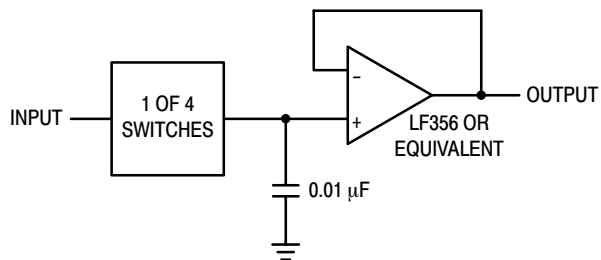
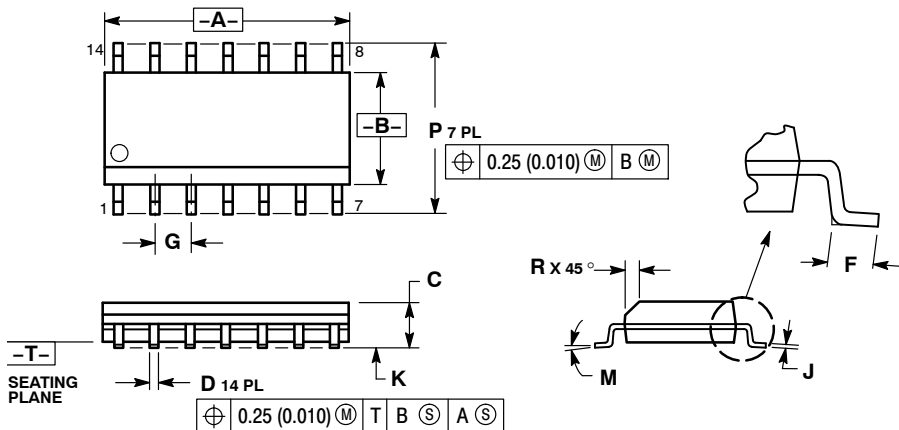


Figure 21. Sample/Hold Amplifier

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## PACKAGE DIMENSIONS

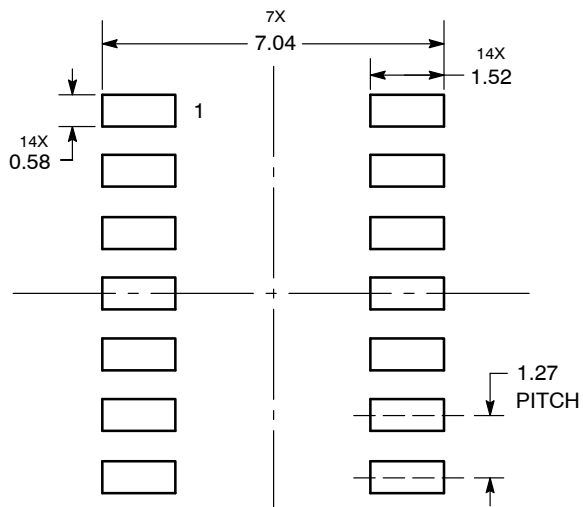
SOIC-14  
D SUFFIX  
CASE 751A-03  
ISSUE J



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

MILLIMETERS		INCHES		
DIM	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

## SOLDERING FOOTPRINT

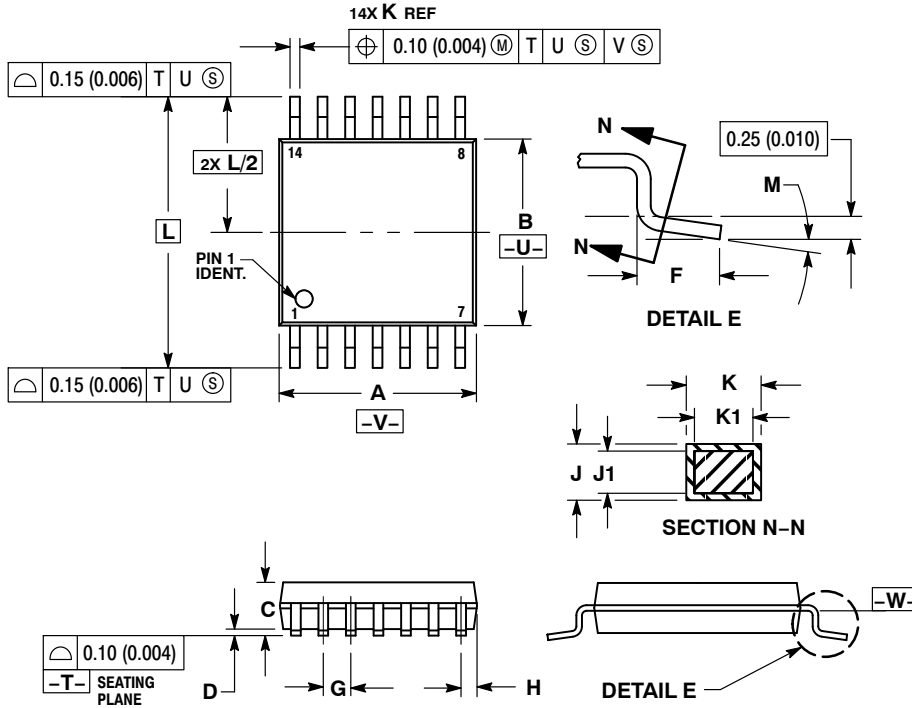


DIMENSIONS: MILLIMETERS

# MC74LVX4066

## PACKAGE DIMENSIONS

TSSOP-14  
DT SUFFIX  
CASE 948G-01  
ISSUE B

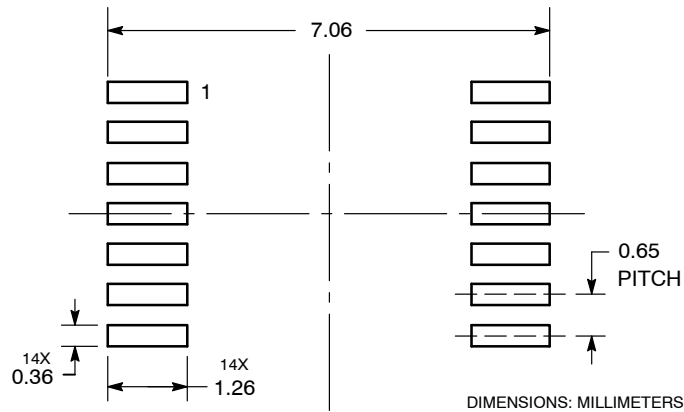


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.50	0.60	0.020	0.024
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

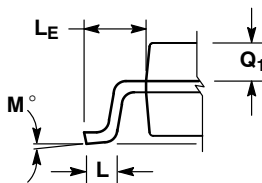
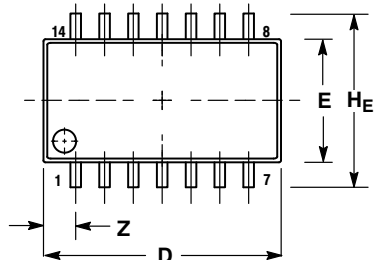
### SOLDERING FOOTPRINT



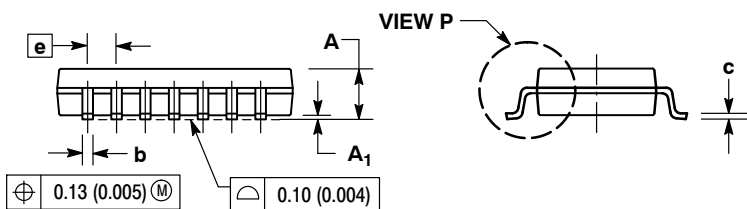
# MC74LVX4066

## PACKAGE DIMENSIONS

SOEIAJ-14  
M SUFFIX  
CASE 965-01  
ISSUE B



DETAIL P



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A <sub>1</sub>	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.10	0.20	0.004	0.008
D	9.90	10.50	0.390	0.413
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H <sub>E</sub>	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
L <sub>E</sub>	1.10	1.50	0.043	0.059
M	0°	10°	0°	10°
Q <sub>1</sub>	0.70	0.90	0.028	0.035
Z	---	1.42	---	0.056

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