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74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer 74VHC4053, Triple 2-Channel Analog Multiplexer

Features

- Wide analog input voltage range: $\pm 6V$
- Low "ON" resistance: 50 Typ. ($V_{CC}-V_{EE} = 4.5V$)
- 30 Typ. ($V_{CC}-V_{EE} = 9V$)
- Logic level translation to enable 5V logic with $\pm 5V$ analog signals
- Low quiescent current: 80 μA maximum
- Matched switch characteristic
- Pin and function compatible with the 74HC4051/ 4052/4053

General Description

These multiplexers are digitally controlled analog switches implemented in 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 vice-versa. Also these switches contain linearization circuitry which lowers the "ON" resistance and increases switch linearity. These devices allow control of up to $\pm 6V$ (peak) analog signals with digital control signals of 0 to 6V. Three supply pins are provided for V_{CC} , ground, and V_{EE} . This enables the connection of 0–5V logic signals when $V_{CC} = 5V$ and an analog input range of $\pm 5V$ when $V_{EE} = 5V$. All three devices also have an inhibit control which when high 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.

VHC4051: This device connects together the outputs of 8 switches, thus achieving an 8 channel Multiplexer. The binary code placed on the A, B, and C select lines determines which one of the eight switches is "ON", and connects one of the eight inputs to the common output.

VHC4052: This device connects together the outputs of 4 switches in two sets, thus achieving a pair of 4-channel multiplexers. The binary code placed on the A, and B select lines determine which switch in each 4 channel section is "ON", connecting one of the four inputs in each section to its common output. This enables the implementation of a 4-channel differential multiplexer.

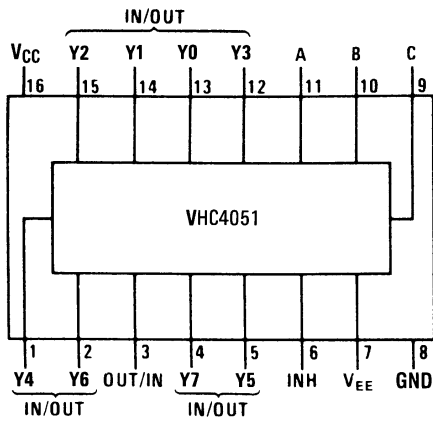
VHC4053: This device contains 6 switches whose outputs are connected together in pairs, thus implementing a triple 2 channel multiplexer, or the equivalent of 3 single-pole-double throw configurations. Each of the A, B, or C select lines independently controls one pair of switches, selecting one of the two switches to be "ON".

Ordering Information

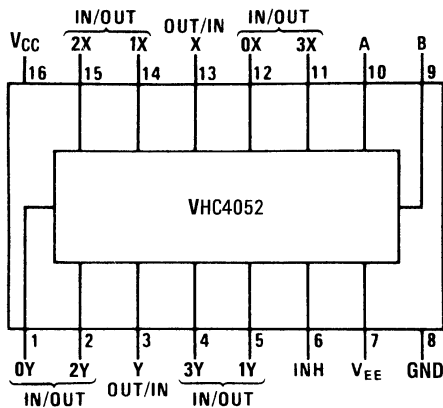
| Order Number | Package Number | Package Description |
|--------------|----------------|--|
| 74VHC4051M | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74VHC4051WM | M16B | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74VHC4051MTC | MTC16 | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |
| 74VHC4051N | N16E | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |
| 74VHC4052M | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74VHC4052WM | M16B | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74VHC4052MTC | MTC16 | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |
| 74VHC4053M | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74VHC4053WM | M16B | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74VHC4053MTC | MTC16 | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |

Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering number.

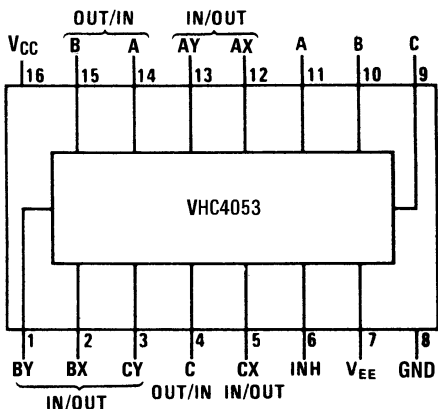
Connection Diagrams



Top View



Top View



Top View

Truth Tables

74VHC4051

| Input | | | | "ON" Channel |
|-------|---|---|---|--------------|
| INH | C | B | A | |
| H | X | X | X | None |
| L | L | L | L | Y0 |
| L | L | L | H | Y1 |
| L | L | H | L | Y2 |
| L | L | H | H | Y3 |
| L | H | L | L | Y4 |
| L | H | L | H | Y5 |
| L | H | H | L | Y6 |
| L | H | H | H | Y7 |

74VHC4052

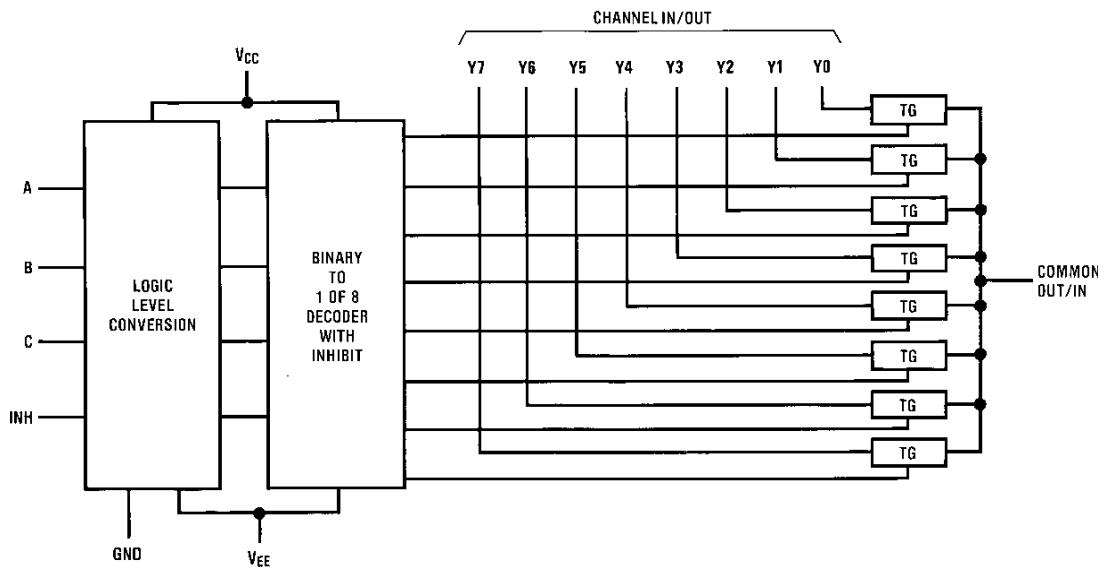
| Inputs | | | "ON" Channels | |
|--------|---|---|---------------|------|
| INH | B | A | X | Y |
| H | X | X | None | None |
| L | L | L | 0X | 0Y |
| L | L | H | 1X | 1Y |
| L | H | L | 2X | 2Y |
| L | H | H | 3X | 3Y |

74VHC4053

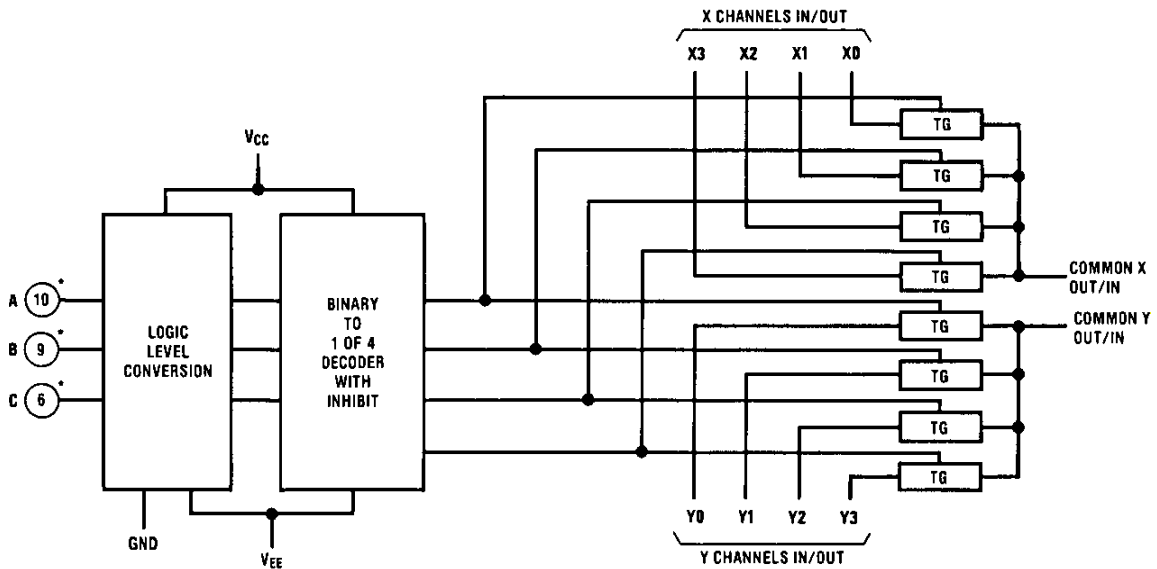
| Input | | | | "ON" Channels | | |
|-------|---|---|---|---------------|------|------|
| INH | C | B | A | C | B | A |
| H | X | X | X | None | None | None |
| L | L | L | L | CX | BX | AX |
| L | L | L | H | CX | BX | AY |
| L | L | H | L | CX | BY | AX |
| L | L | H | H | CX | BY | AY |
| L | H | L | L | CY | BX | AX |
| L | H | L | H | CY | BX | AY |
| L | H | H | L | CY | BY | AX |
| L | H | H | H | CY | BY | AY |

Logic Diagrams

74VHC4051

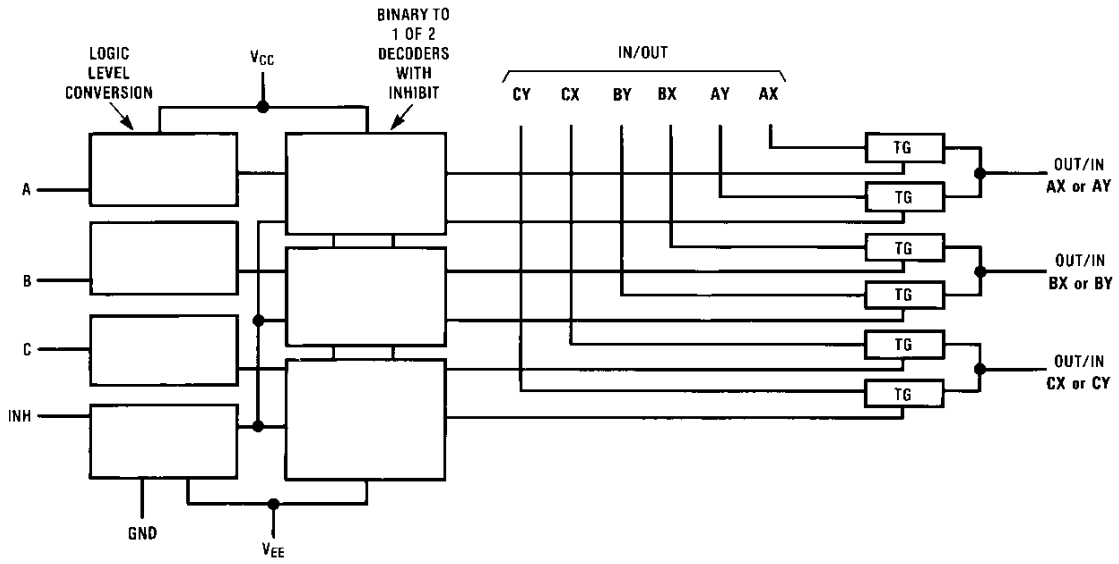


74VHC4052



74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer
 74VHC4053, Triple 2-Channel Analog Multiplexer

74VHC4053



74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer
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Absolute Maximum Ratings⁽¹⁾

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | Rating |
|------------------|---|-------------------------------|
| V_{CC} | Supply Voltage | -0.5 to +7.5V |
| V_{EE} | Supply Voltage | +0.5 to -7.5V |
| V_{IN} | Control Input Voltage | -1.5 to $V_{CC}+1.5V$ |
| V_{IO} | Switch I/O Voltage | $V_{EE}-0.5$ to $V_{CC}+0.5V$ |
| I_{IK}, I_{OK} | Clamp Diode Current | $\pm 20mA$ |
| I_{OUT} | Output Current, per pin | $\pm 25mA$ |
| I_{CC} | V_{CC} or GND Current, per pin | $\pm 50mA$ |
| T_{STG} | Storage Temperature Range | -65°C to +150°C |
| P_D | Power Dissipation ⁽²⁾ | 600mW |
| | S.O. Package only | 500mW |
| T_L | Lead Temperature (Soldering 10 seconds) | 260°C |

Note:

1. Unless otherwise specified all voltages are referenced to ground.
2. Power Dissipation temperature derating; plastic "N" package: -12mW/°C from 65°C to 85°C.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol | Parameter | Min. | Max. | Units |
|-------------------|-----------------------------|------|----------|-------|
| V_{CC} | Supply Voltage | 2 | 6 | V |
| V_{EE} | Supply Voltage | 0 | -6 | V |
| V_{IN}, V_{OUT} | DC Input or Output Voltage | 0 | V_{CC} | V |
| T_A | Operating Temperature Range | -40 | +85 | °C |
| t_r, t_f | Input Rise or Fall Times | | | |
| | $V_{CC} = 2.0V$ | | 1000 | ns |
| | $V_{CC} = 4.5V$ | | 500 | |
| | $V_{CC} = 6.0V$ | | 400 | |

DC Electrical Characteristics⁽³⁾

| Symbol | Parameter | Conditions | V _{EE} | V _{CC} | Typ. | T _A = 25°C | T _A = -40 to 85°C | Units | |
|-----------------|---|---|--|-----------------|------|-----------------------|------------------------------|-------|----|
| | | | | | | Guaranteed Limits | | | |
| V _{IH} | Minimum HIGH Level Input Voltage | | | 2.0V | | 1.5 | 1.5 | V | |
| | | | | 4.5V | | 3.15 | 3.15 | | |
| | | | | 6.0V | | 4.2 | 4.2 | | |
| V _{IL} | Maximum LOW Level Input Voltage | | | 2.0V | | 0.5 | 0.5 | V | |
| | | | | 4.5V | | 1.35 | 1.35 | | |
| | | | | 6.0V | | 1.8 | 1.8 | | |
| R _{ON} | Maximum "ON" Resistance ⁽⁴⁾ | V _{INH} = V _{IL} , I _S = 2.0mA, V _{IS} = V _{CC} to V _{EE} (Fig. 1) | GND | 4.5V | 40 | 160 | 200 | Ω | |
| | | | -4.5V | 4.5V | 30 | 120 | 150 | | |
| | | | -6.0V | 6.0V | 20 | 100 | 125 | | |
| | | V _{INH} = V _{IL} , I _S = 2.0mA, V _{IS} = V _{CC} or V _{EE} (Fig. 1) | GND | 2.0V | 100 | 230 | 280 | Ω | |
| | | | GND | 4.5V | 40 | 110 | 140 | | |
| | | | -4.5V | 4.5V | 20 | 90 | 120 | | |
| R _{ON} | Maximum "ON" Resistance Matching | V _{INH} = V _{IL} , V _{IS} = V _{CC} to GND | GND | 4.5V | 10 | 20 | 25 | Ω | |
| | | | -4.5V | 4.5V | 5 | 10 | 15 | | |
| | | | -6.0V | 6.0V | 5 | 10 | 12 | | |
| I _N | Maximum Control Input Current | V _{IN} = V _{CC} or GND, V _{CC} = 2 - 6V | | | | ±0.05 | ±0.5 | μA | |
| I _{CC} | Maximum Quiescent Supply Current | V _{IN} = V _{CC} or GND, I _{OUT} = 0μA | GND | 6.0V | | 4 | 40 | μA | |
| | | | -6.0V | 6.0V | | 8 | 80 | | |
| I _{IZ} | Maximum Switch "OFF" Leakage Current (Switch Input) | V _{OS} = V _{CC} or V _{EE} , V _{IS} = V _{EE} or V _{CC} , V _{INH} = V _{IH} (Fig. 2) | GND | 6.0V | | ±60 | ±300 | nA | |
| | | | -6.0V | 6.0V | | ±100 | ±500 | | |
| I _{IZ} | Maximum Switch "ON" Leakage Current | VHC4051 | V _{IS} = V _{CC} to V _{EE} , V _{INH} = V _{IL} (Fig. 3) | GND | 6.0V | | ±0.1 | ±1.0 | μA |
| | | | | -6.0V | 6.0V | | ±0.2 | ±2.0 | |
| | | VHC4052 | V _{IS} = V _{CC} to V _{EE} , V _{INH} = V _{IL} (Fig. 3) | GND | 6.0V | | ±0.050 | ±0.5 | μA |
| | | | | -6.0V | 6.0V | | ±0.1 | ±1.0 | |
| | | VHC4053 | V _{IS} = V _{CC} to V _{EE} , V _{INH} = V _{IL} (Fig. 3) | GND | 6.0V | | ±0.05 | ±0.5 | μA |
| | | | | -6.0V | 6.0V | | ±0.5 | ±0.5 | |
| I _{IZ} | Maximum Switch "OFF" Leakage Current (Common Pin) | VHC4051 | V _{OS} = V _{CC} or V _{EE} , V _{IS} = V _{EE} or V _{CC} , V _{INH} = V _{IH} | GND | 6.0V | | ±0.1 | ±1.0 | μA |
| | | | | -6.0V | 6.0V | | ±0.2 | ±2.0 | |
| | | VHC4052 | V _{OS} = V _{CC} or V _{EE} , V _{IS} = V _{EE} or V _{CC} , V _{INH} = V _{IH} | GND | 6.0V | | ±0.05 | ±0.5 | μA |
| | | | | -6.0V | 6.0V | | ±0.1 | ±1.0 | |
| | | VHC4053 | V _{OS} = V _{CC} or V _{EE} , V _{IS} = V _{EE} or V _{CC} , V _{INH} = V _{IH} | GND | 6.0V | | ±0.05 | ±0.5 | μA |
| | | | | -6.0V | 6.0V | | ±0.05 | ±0.5 | |

Notes:

- For a power supply of 5V ±10% the worst case on resistances (R_{ON}) occurs for VHC 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 occur for CMOS at the higher voltage and so the 5.5V values should be used.
- 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.
- Adjust 0dB for f = 1kHz (Null R1/R_{ON} Attenuation).

AC Electrical Characteristics

$V_{CC} = 2.0V - 6.0V$, $V_{EE} = 0V - 6V$, $C_L = 50pF$ (unless otherwise specified)

| Symbol | Parameter | Conditions | V_{EE} | V_{CC} | $T_A = 25^\circ C$ | | $T_A = -40 \text{ to } 85^\circ C$ | | Units |
|-----------------------|--|--|---------------------|----------|--------------------|-------------------|------------------------------------|-----|-------|
| | | | | | Typ. | Guaranteed Limits | | | |
| t_{PHL} , t_{PLH} | Maximum Propagation Delay Switch In to Out | | GND | 3.3V | 25 | 35 | 40 | ns | |
| | | | GND | 4.5V | 5 | 12 | 15 | | |
| | | | -4.5V | 4.5V | 4 | 8 | 12 | | |
| | | | -6.0V | 6.0V | 3 | 7 | 11 | | |
| t_{PZL} , t_{PZH} | Maximum Switch Turn "ON" Delay | $R_L = 1k\Omega$ | GND | 3.3V | 92 | 200 | 250 | ns | |
| | | | GND | 4.5V | | 69 | 87 | | |
| | | | -4.5V | 4.5V | 16 | 46 | 58 | | |
| | | | -6.0V | 6.0V | 15 | 41 | 51 | | |
| t_{PHZ} , t_{PLZ} | Maximum Switch Turn "OFF" Delay | | GND | 3.3V | 65 | 170 | 210 | ns | |
| | | | GND | 4.5V | 28 | 58 | 73 | | |
| | | | -4.5V | 4.5V | 18 | 37 | 46 | | |
| | | | -6.0V | 6.0V | 16 | 32 | 41 | | |
| f_{MAX} | Minimum Switch Frequency Response $20 \log (V_I/V_O) = 3dB$ | | GND | 4.5V | 30 | | | MHz | |
| | | | -4.5V | 4.5V | 35 | | | | |
| | Control to Switch Feedthrough Noise | $R_L = 600\Omega$, $f = 1MHz$, $C_L = 50pF$ | $V_{IS} = 4 V_{PP}$ | 0V | 4.5V | 1080 | | mV | |
| | | | $V_{IS} = 8 V_{PP}$ | -4.5V | 4.5V | 250 | | | |
| | Crosstalk Between any Two Switches | $R_L = 600\Omega$, $f = 1 MHz$ | $V_{IS} = 4 V_{PP}$ | 0V | 4.5 | -52 | | dB | |
| | | | $V_{IS} = 8 V_{PP}$ | -4.5V | 4.5V | -50 | | | |
| | Switch OFF Signal Feedthrough Isolation | $R_L = 600\Omega$, $f = 1 MHz$, $V_{CTL} = V_{IL}$ | $V_{IS} = 4 V_{PP}$ | 0V | 4.5V | -42 | | dB | |
| | | | $V_{IS} = 8 V_{PP}$ | -4.5V | 4.5V | -44 | | | |
| THD | Sinewave Harmonic Distortion | $R_L = 10k\Omega$, $C_L = 50pF$, $f = 1kHz$ | $V_{IS} = 4 V_{PP}$ | 0V | 4.5V | 0.013 | | % | |
| | | | $V_{IS} = 8 V_{PP}$ | -4.5V | 4.5V | 0.008 | | | |
| C_{IN} | Maximum Control Input Capacitance | | | | 5 | 10 | 10 | pF | |
| C_{IN} | Maximum Switch Input Capacitance | Input | | | 15 | | | pF | |
| | | 4051 Common | | | 90 | | | | |
| | | 4052 Common | | | 45 | | | | |
| | | 4053 Common | | | 30 | | | | |
| C_{IN} | Maximum Feedthrough Capacitance | | | | 5 | | | pF | |

AC Test Circuits and Switching Time Waveforms

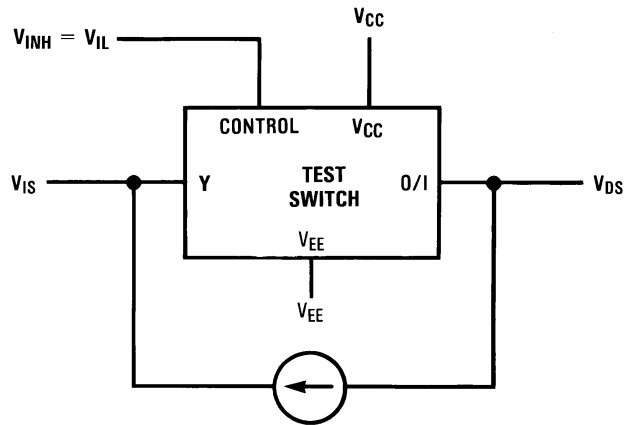


Figure 1. "ON" Resistance

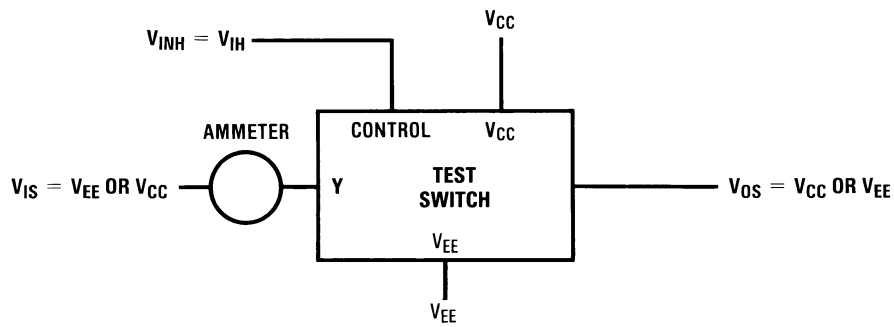


Figure 2. "OFF" Channel Leakage Current

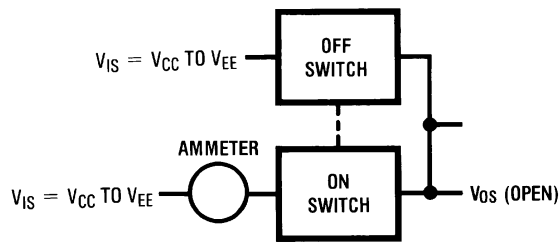


Figure 3. "ON" Channel Leakage Current

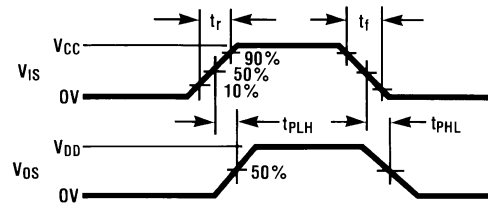
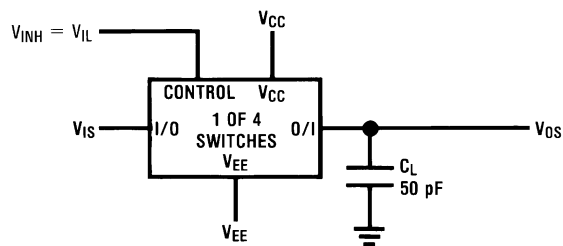


Figure 4. t_{PHL} , t_{PLH} Propagation Delay Time Signal Input to Signal Output

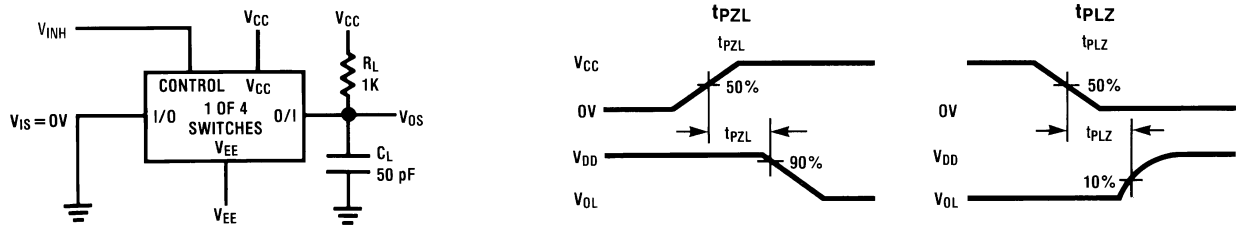


Figure 5. t_{PZL} , t_{PLZ} Propagation Delay Time Control to Signal Output

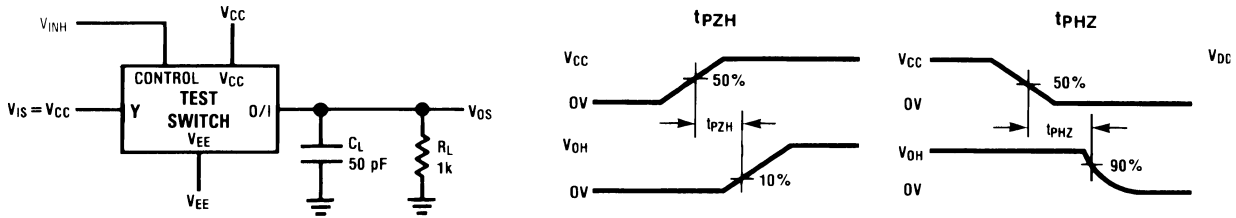


Figure 6. t_{PZH} , t_{PHZ} Propagation Delay Time Control to Signal Output

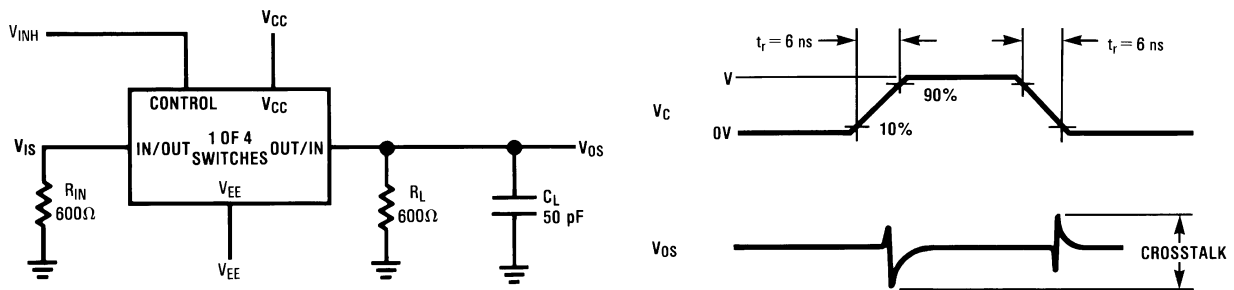


Figure 7. Crosstalk: Control Input to Signal Output

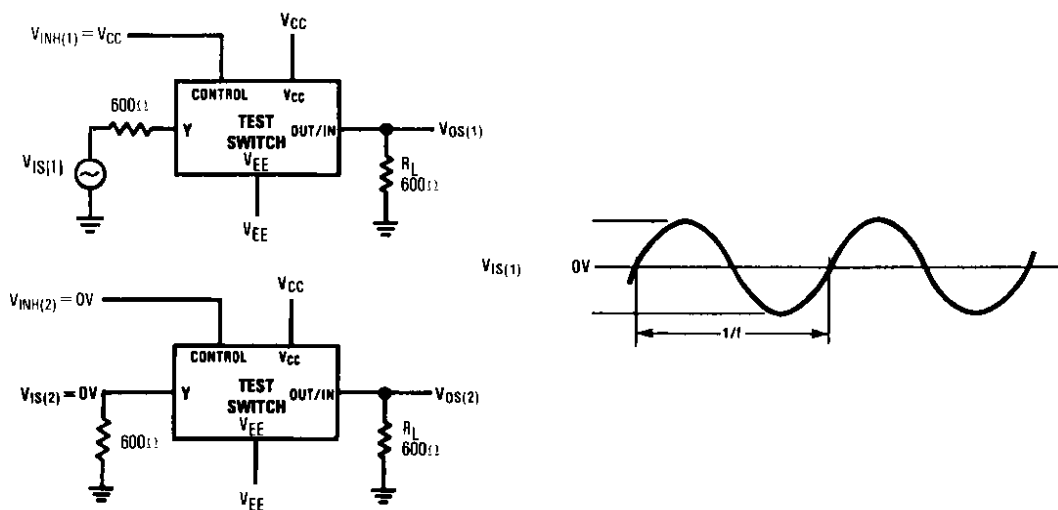
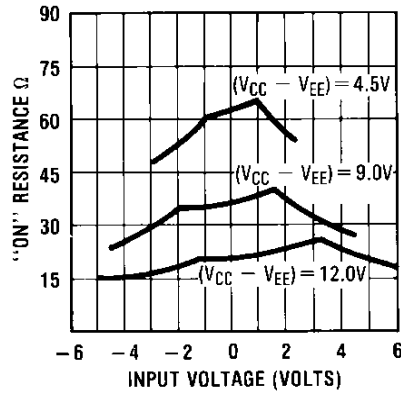


Figure 8. Crosstalk Between Any Two Switches

Typical Performance Characteristics

Typical "On" Resistance vs Input Voltage



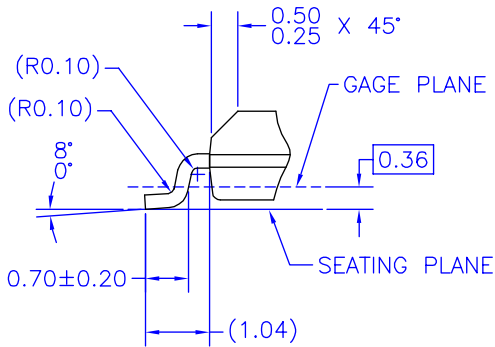
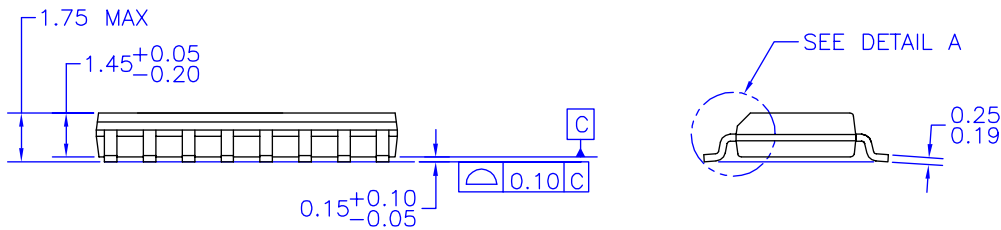
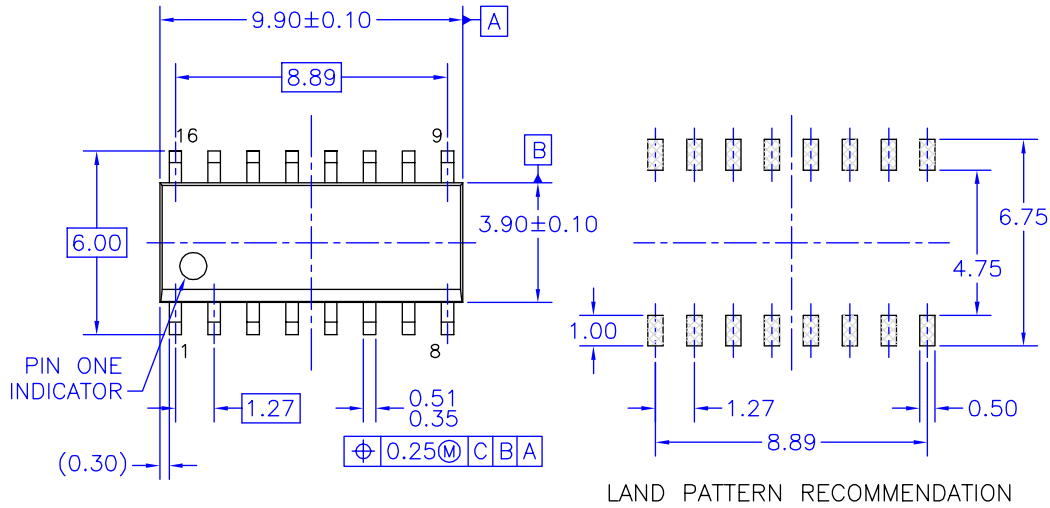
$$V_{CC} = -V_{EE}$$

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 pins, the voltage drop across the switch must not exceed 1.2V (calculated from the ON resistance).

Physical Dimensions

Dimensions are in millimeters unless otherwise noted.



DETAIL A
 SCALE: 2:1

NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AC, ISSUE C, DATED MAY 1990.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) STANDARD LEAD FINISH:
 200 MICRONS / 5.08 MICRONS MIN.
 LEAD/TIN (SOLDER) ON COPPER.

M16AREVK

Figure 9. 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Package Number M16A

Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

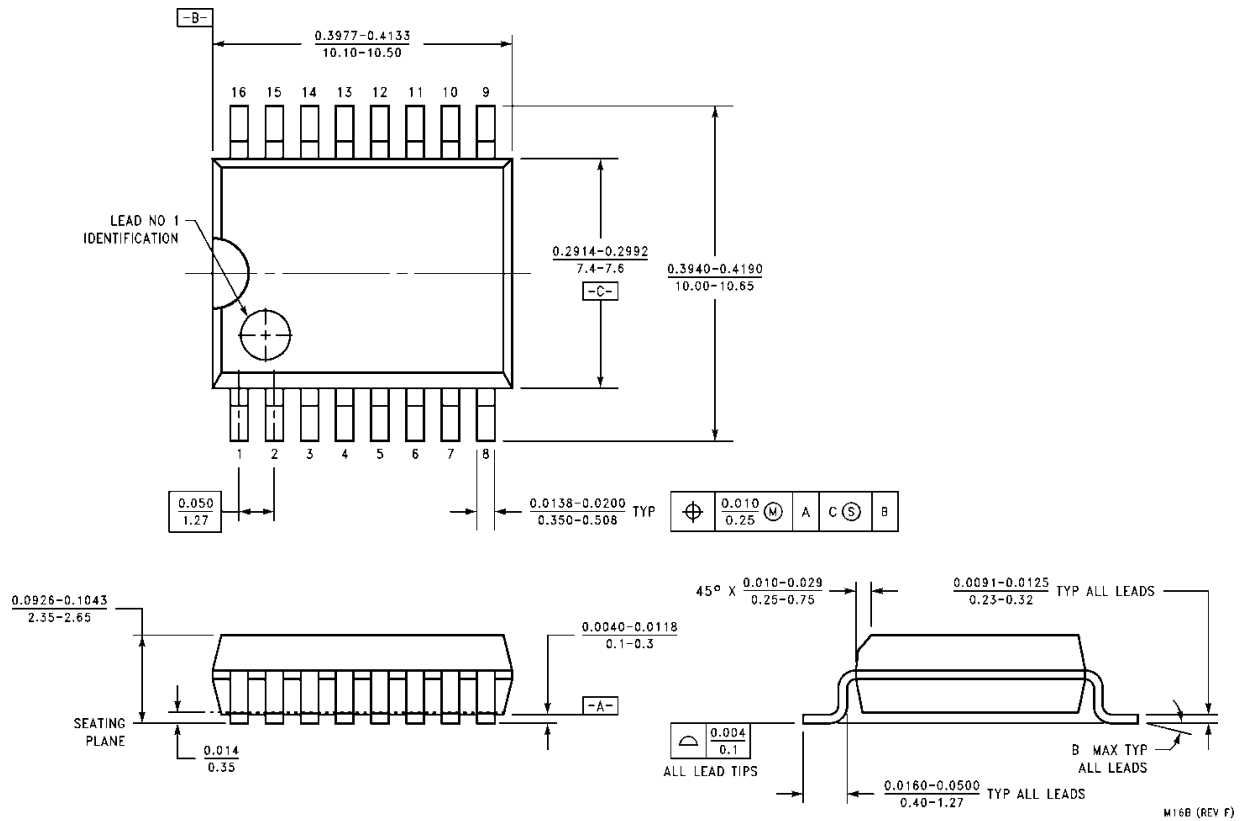
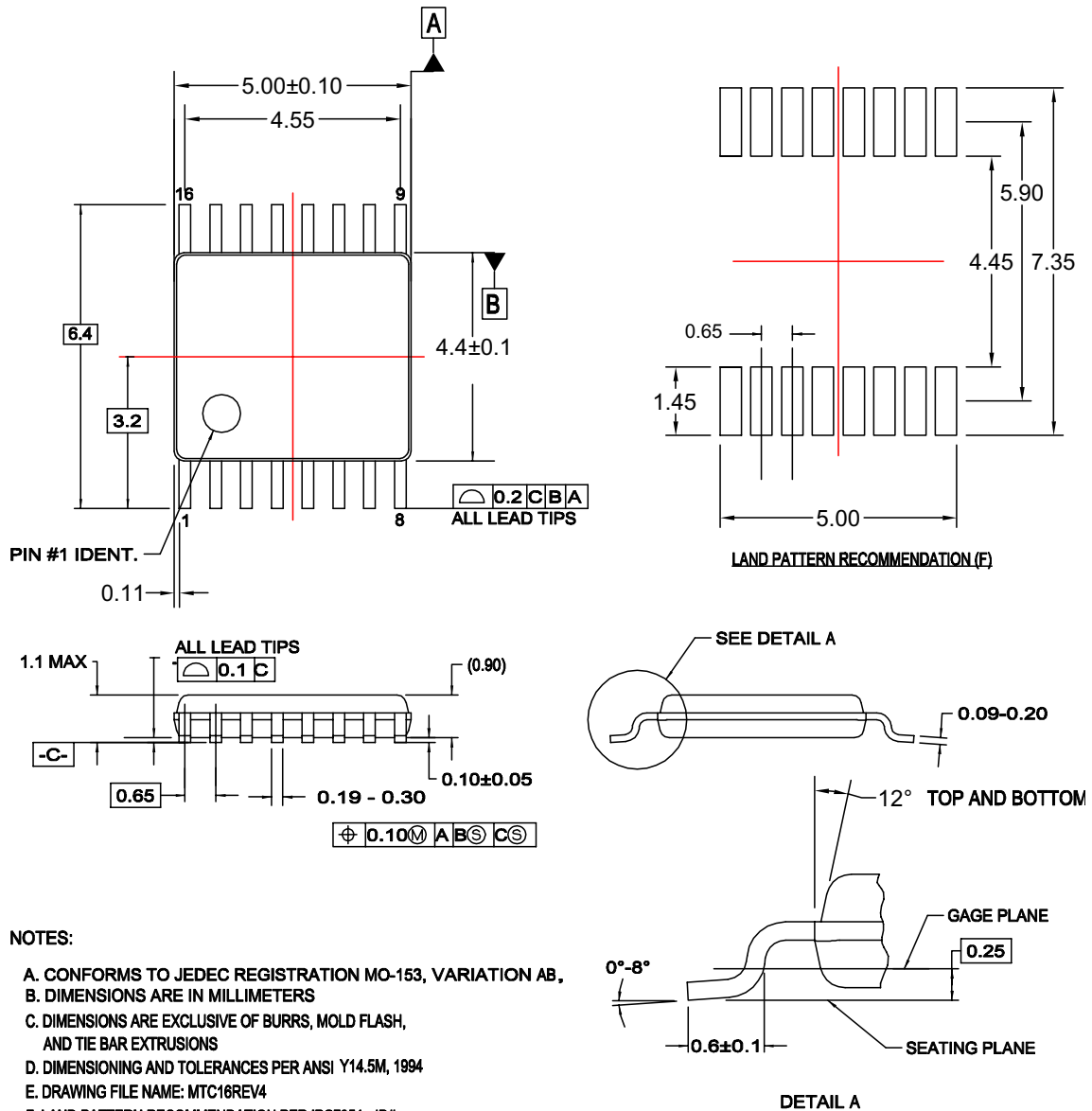


Figure 10. 16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide Package Number M16B

Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.



MTC16rev4

Figure 11. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC16

Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

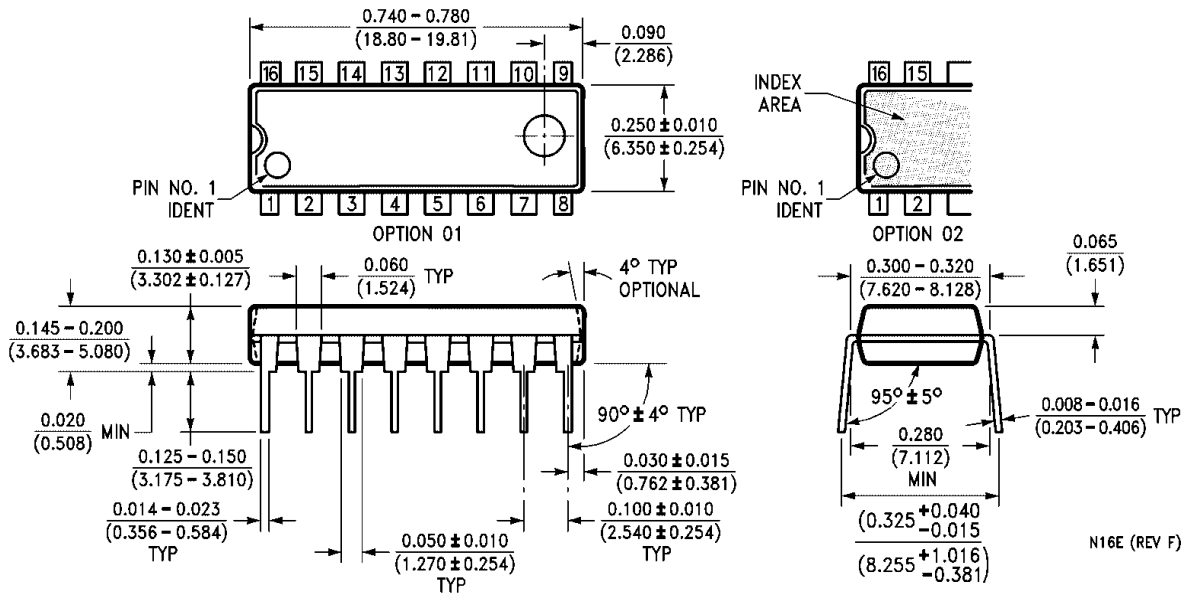



Figure 12. 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N16E



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