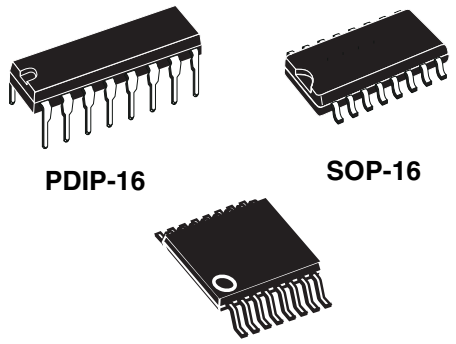
# M74HC4051

## Single 8-channel analog multiplexer/demultiplexer

## Features

- Low power dissipation:
  - $I_{CC}$ = 4 µA(max) at $T_A$= 25 °C
- Logic level translation to enable 5 V logic signal to communicate with ±5 V analog signal
- Low ON resistance:
  70 Ω typ ($V_{CC}$ - $V_{EE}$ = 4.5 V)
  50 Ω typ ($V_{CC}$ - $V_{EE}$ = 9 V)
- Wide analog input voltage range : ±6 V
- Fast switching:
  $t_{pd}$ = 15 ns (typ) at $T_A$ = 25 °C
- Low crosstalk between switches
- High ON/OFF output voltage ratio
- Wide operating supply voltage range
  ($V_{CC}$ - $V_{EE}$) = 2 to 12 V
- Low sine wave distortion:
  0.02% at $V_{CC}$ - $V_{EE}$ = 9 V
- High noise immunity:
  $V_{NIH}$ = $V_{NIL}$ = 28 % $V_{CC}$ (min)
- Pin and function compatible with
  74 series 4051




## Description

The M74HC4051 is a single 8-channel analog multiplexer/demultiplexer fabricated with silicon gate $C^2MOS$ technology, pin-to-pin compatible with the equivalent metal gate CMOS4000B series. It contains 8 bidirectional and digitally controlled analog switches.

A built-in level shifting is included to allow an input range up to ±6 V (peak) for an analog signal with digital control signal of 0 to 6 V.

The $V_{EE}$ supply pin is provided for analog input signals. It has an inhibit (INH) input terminal to disable all the switches when is at high level. For operation as a digital multiplexer/demultiplexer, $V_{EE}$ is connected to GND.

A, B and C control inputs select one channel out of eight. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

**Table 1. Device summary**

| Order code | Package | Packaging |
|---|---|---|
| M74HC4051RM13TR | SOP-16 | Tape and reel |
| M74HC4051TTR | TSSOP-16 | Tape and reel |

# 1 Pin connection and IEC logic symbols

**Figure 1. Pin connection**

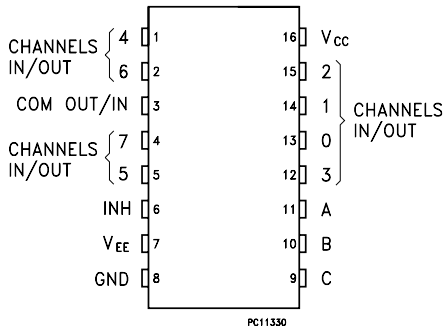
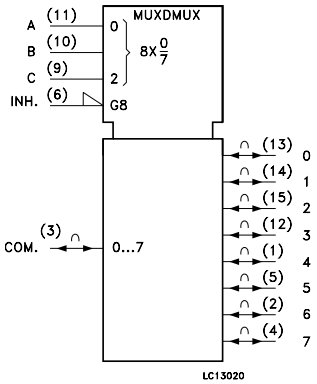



**Figure 2. IEC logic symbols**




## 1.1 Pin description

**Table 2. Pin description**

| Pin number | Symbol | Name and function |
|---|---|---|
| 3 | COM OUT/IN | Common output/input |
| 6 | INH | Inhibit input |
| 7 | $V_{EE}$ | Negative supply voltage |
| 11, 10, 9 | A, B, C | Select inputs |
| 13, 14, 15, 12, 1, 5, 2, 4 | 0 to 7 | Independent input/outputs |
| 8 | GND | Ground (0 V) |
| 16 | $V_{CC}$ | Positive supply voltage |

**Figure 3. Control input equivalent circuit**

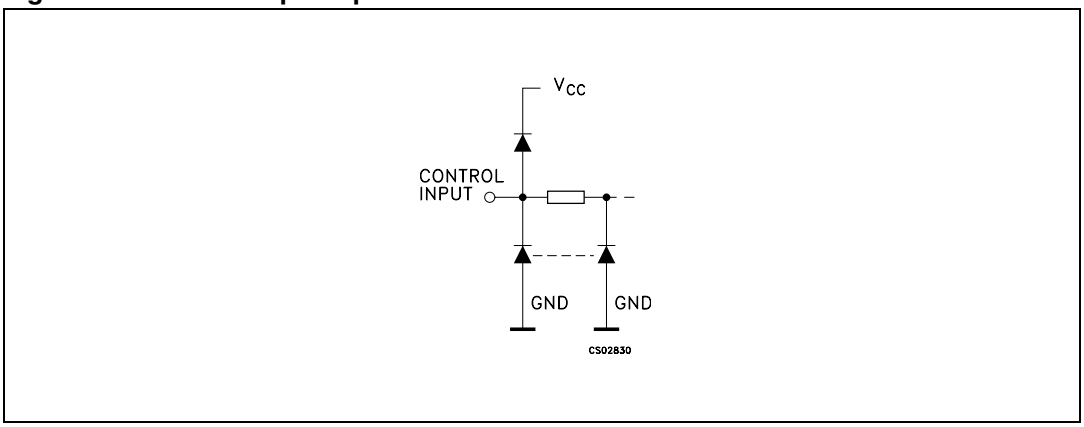



**Figure 4. I/O equivalent circuit**

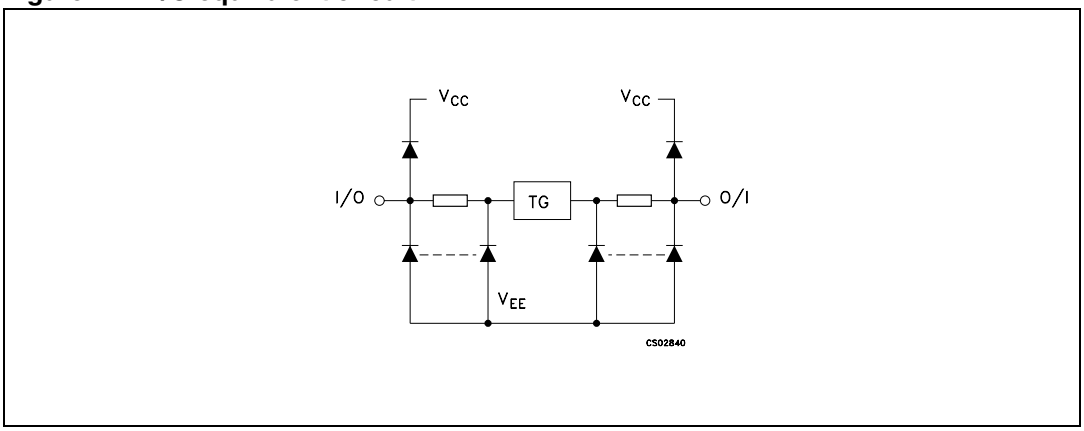
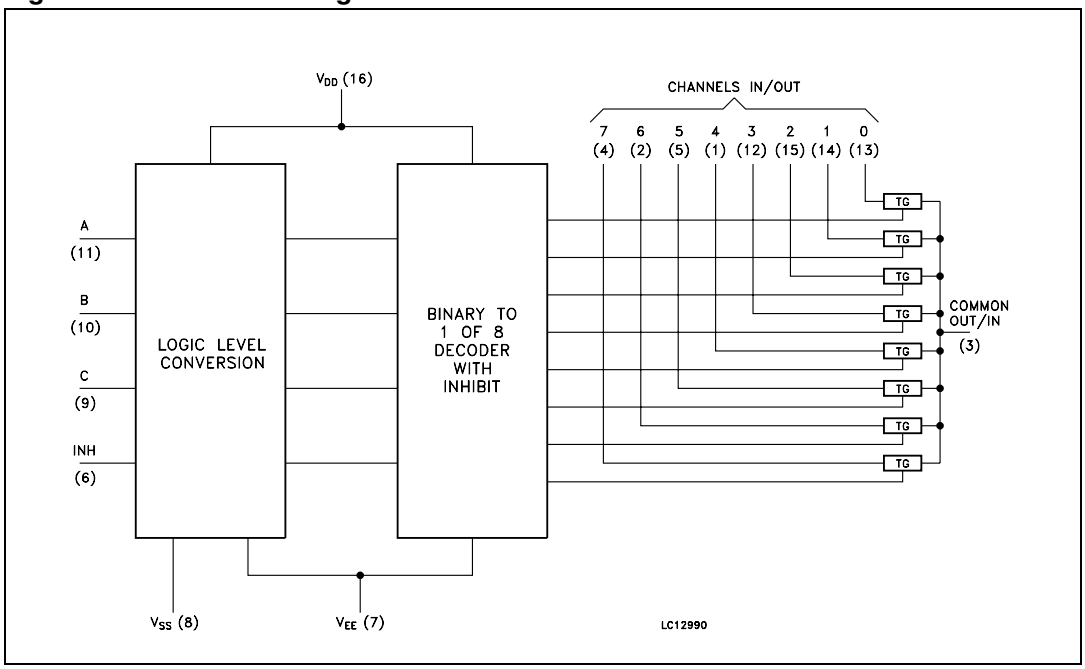



**Table 3. Truth table**

| Input state | | | | ON channel |
|---|---|---|---|---|
| INH | C | B | A | |
| L | L | L | L | 0 |
| L | L | L | H | 1 |
| L | L | H | L | 2 |
| L | L | H | H | 3 |
| L | H | L | L | 4 |
| L | H | L | H | 5 |
| L | H | H | L | 6 |
| L | H | H | H | 7 |
| H | X | X | X | NONE |

x: Don’t care

**Figure 5. Functional diagram**



# 2 Maximum ratings

Stressing the device above the rating listed in the “absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 4. Absolute maximum ratings**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | -0.5 to +7 | V |
| $V_{CC}$ - $V_{EE}$ | Supply voltage | | -0.5 to +13 | V |
| $V_I$ | Control input voltage | | -0.5 to $V_{CC}$ + 0.5 | V |
| $V_{I/O}$ | Switch I/O voltage | | $V_{EE}$ -0.5 to $V_{CC}$ + 0.5 | V |
| $I_{CK}$ | Control input diode current | | ±20 | mA |
| $I_{IOK}$ | I/O diode current | | ±20 | mA |
| $I_T$ | Switch through current | | ±25 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or ground current | | ±50 | mA |
| $P_D$ | Power dissipation | DIP-16 | 500(1) | mW |
| | | SOP-16 and TSSOP-16 | 180 | mW |
| $T_{stg}$ | Storage temperature | | -65 to +150 | °C |
| $T_L$ | Lead temperature (10 sec) | | 300 | °C |

1. 500 mW at 65 °C; derate to 300 mW by 10 mW/xC from 65 °C to 85 °C

**Table 5. Recommended operating conditions**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 2 to 6 | V |
| $V_{EE}$ | Supply voltage | | -6 to 0 | V |
| $V_{CC}$ - $V_{EE}$ | Supply voltage | | 2 to 12 | V |
| $V_I$ | Input voltage | | 0 to $V_{CC}$ | V |
| $V_{I/O}$ | I/O voltage | | $V_{EE}$ to $V_{CC}$ | V |
| $T_{op}$ | Operating temperature | | -55 to 125 | °C |
| $t_r$, $t_f$ | Input rise and fall time | $V_{CC}$ = 2.0 V | 0 to 1000 | ns |
| | | $V_{CC}$ = 4.5 V | 0 to 500 | |
| | | $V_{CC}$ = 6.0 V | 0 to 400 | |

**Table 6. DC electrical specifications**

| Symbol | Parameter | Test condition | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | $V_{EE}$ (V) | | $T_A$ = 25 °C | | | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $V_{IHC}$ | High level input voltage | 2.0 | | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 4.5 | | | 3.15 | | | 3.15 | | 3.15 | | |
| | | 6.0 | | | 4.2 | | | 4.2 | | 4.2 | | |
| $V_{ILC}$ | Low level input voltage | 2.0 | | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | | | 1.35 | | 1.35 | | 1.35 | |
| | | 6.0 | | | | | 1.8 | | 1.8 | | 1.8 | |
| $R_{ON}$ | ON resistance | 4.5 | GND | $V_I = V_{IHC}$ or $V_{ILC}$<br>$V_{I/O} = V_{CC}$ to $V_{EE}$<br>$I_{I/O} \leq 2mA$ | | 85 | 180 | | 225 | | 270 | W |
| | | 4.5 | -4.5 | | | 55 | 120 | | 150 | | 180 | |
| | | 6.0 | -6.0 | | | 50 | 100 | | 125 | | 150 | |
| | | 2.0 | GND | $V_I = V_{IHC}$ or $V_{ILC}$<br>$V_{I/O} = V_{CC}$ or $V_{EE}$<br>$I_{I/O} \leq 2$ mA | | 150 | | | | | | |
| | | 4.5 | GND | | | 70 | 150 | | 190 | | 230 | |
| | | 4.5 | -4.5 | | | 50 | 100 | | 125 | | 150 | |
| | | 6.0 | -6.0 | | | 45 | 80 | | 100 | | 120 | |
| $\Delta R_{ON}$ | Difference of ON resistance between switches | 4.5 | GND | $V_I = V_{IHC}$ or $V_{ILC}$<br>$V_{I/O} = V_{CC}$ or $V_{EE}$<br>$I_{I/O} \leq 2$ mA | | 10 | 30 | | 35 | | 45 | W |
| | | 4.5 | -4.5 | | | 5 | 12 | | 15 | | 18 | |
| | | 6.0 | -6.0 | | | 5 | 10 | | 12 | | 15 | |
| $I_{OFF}$ | Input/output leakage current (switch off) | 6.0 | GND | $V_{OS} = V_{CC}$ or GND<br>$V_{IS}$ = GND or $V_{CC}$<br>$V_I = V_{ILC}$ or $V_{IHC}$ | | | ±0.06 | | ±0.6 | | ±1.2 | µA |
| | | 6.0 | -6.0 | | | | ±0.1 | | ±1 | | ±2 | |
| $I_{IZ}$ | Switch input leakage current (switch on, output open) | 6.0 | GND | $V_{OS} = V_{CC}$ or GND<br>$V_I = V_{IHC}$ or $V_{ILC}$ | | | ±0.06 | | ±0.6 | | ±1.2 | µA |
| | | 6.0 | -6.0 | | | | ±0.1 | | ±1 | | ±2 | |
| $I_I$ | Input leakage current | 6.0 | GND | $V_I = V_{CC}$ or GND | | | ±0.1 | | ±0.1 | | ±1 | µA |
| $I_{CC}$ | Quiescent supply current | 6.0 | GND | $V_I = V_{CC}$ or GND | | | 4 | | 40 | | 80 | µA |
| | | 6.0 | -6.0 | | | | 8 | | 80 | | 160 | |

**Table 7. AC electrical characteristics** ($C_L$ = 50 pF, Input $t_r = t_f$ = 6ns)

| Symbol | Parameter | Test condition | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | $V_{EE}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | | Min. | Typ | Max | Min | Max | Min | Max | |
| $\Phi_{I/O}$ | Phase difference between input and output | 2.0 | GND | | | 25 | 60 | | 75 | | 90 | ns |
| | | 4.5 | GND | | | 6 | 12 | | 15 | | 18 | |
| | | 6.0 | GND | | | 5 | 10 | | 13 | | 15 | |
| | | 4.5 | -4.5 | | | 4 | | | | | | |
| $t_{PZL}$ $t_{PZH}$ | Output enable time | 2.0 | GND | $R_L$ = 1 KΩ | | 64 | 225 | | 280 | | 340 | ns |
| | | 4.5 | GND | | | 18 | 45 | | 56 | | 68 | |
| | | 6.0 | GND | | | 15 | 38 | | 48 | | 58 | |
| | | 4.5 | -4.5 | | | 18 | | | | | | |
| $t_{PLZ}$ $t_{PHZ}$ | Output disable time | 2.0 | GND | $R_L$ = 1 KΩ | | 100 | 250 | | 315 | | 375 | ns |
| | | 4.5 | GND | | | 33 | 50 | | 63 | | 70 | |
| | | 6.0 | GND | | | 28 | 43 | | 54 | | 64 | |
| | | 4.5 | -4.5 | | | 29 | | | | | | |

**Table 8. Capacitive characteristics**

| Symbol | Parameter | Test condition | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | $V_{EE}$ (V) | | $T_A$ = 25 °C | | | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $C_{IN}$ | Input capacitance | 5.0 | | | | 5 | 10 | | 10 | | 10 | pF |
| $C_{I/O}$ | Common terminal capacitance | 5.0 | -5.0 | | | 36 | 70 | | 70 | | 70 | pF |
| $C_{I/O}$ | Switch terminal capacitance | 5.0 | -5.0 | | | 7 | 15 | | 15 | | 15 | pF |
| $C_{IOS}$ | Feed through capacitance | 5.0 | -5.0 | | | 0.95 | 2 | | 2 | | 2 | pF |
| $C_{PD}$ | Power dissipation capacitance (1) | 5.0 | GND | | | 70 | | | | | | pF |

1. $C_{PD}$ is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$ .

**Table 9. Analog switch characteristics** (GND = 0 V; $T_A$ = 25°C)

| Symbol | Parameter | Test condition | | | | Value | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | $V_{EE}$ (V) | $V_{IN}$ ($V_{p-p}$) | | Typ | |
| | Sine wave distortion | 2.25 | -2.25 | 4 | $f_{IN}$ = 1 KHz $R_L$ = 10 KΩ $C_L$ = 50 pF | 0.025 | % |
| | | 4.5 | -4.5 | 8 | | 0.020 | |
| | | 6.0 | -6.0 | 11 | | 0.018 | |
| $f_{MAX}$ | Frequency response (Switch on)(1) | 2.25 | -2.25 | Adjust $f_{IN}$ voltage to obtain 0 dBm at $V_{OS}$. Increase $f_{IN}$ Frequency until dB meter reads -3dB $R_L$ = 50 Ω, $C_L$ = 10 pF, $f_{IN}$ = 1 KHz sine wave | | 120 | MHz |
| | | 4.5 | -4.5 | | | 190 | |
| | | 6.0 | -6.0 | | | 200 | |
| $f_{MAX}$ | Frequency response (switch on)(2) | 2.25 | -2.25 | Adjust $f_{IN}$ voltage to obtain 0 dBm at $V_{OS}$. Increase $f_{IN}$ Frequency until dB meter reads -3dB $R_L$ = 50Ω, $C_L$ = 10 pF, $f_{IN}$ = 1KHz sine wave | | 45 | MHz |
| | | 4.5 | -4.5 | | | 70 | |
| | | 6.0 | -6.0 | | | 85 | |
| | Feed through attenuation (switch off) | 2.25 | -2.25 | $V_{IN}$ is centered at ($V_{CC}$ - $V_{EE}$)/2 Adjust input for 0 dBm $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 KHz sine wave | | -50 | dB |
| | | 4.5 | -4.5 | | | -50 | |
| | | 6.0 | -6.0 | | | -50 | |
| | Crosstalk (control input to signal output) | 2.25 | -2.25 | Adjust $R_L$ at set up so that $I_S$ = 0A. $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 KHz square wave | | 60 | mV |
| | | 4.5 | -4.5 | | | 140 | |
| | | 6.0 | -6.0 | | | 200 | |
| | Crosstalk (between any two switches) | 2.25 | -2.25 | Adjust $V_{IN}$ to obtain 0d Bm at input $R_L$ = 600 Ω, $C_L$ = 50 pF, $f_{IN}$ = 1 KHz sine wave | | -50 | dB |
| | | 4.5 | -4.5 | | | -50 | |
| | | 6.0 | -6.0 | | | -50 | |

1. Input common terminal, and measured at switch terminal.
2. Input switch terminal, and measured at common terminal.

These characteristics are determined by the design of the device.

## 2.1 Switching characteristics test circuit

**Figure 6. Output enable/disable time**

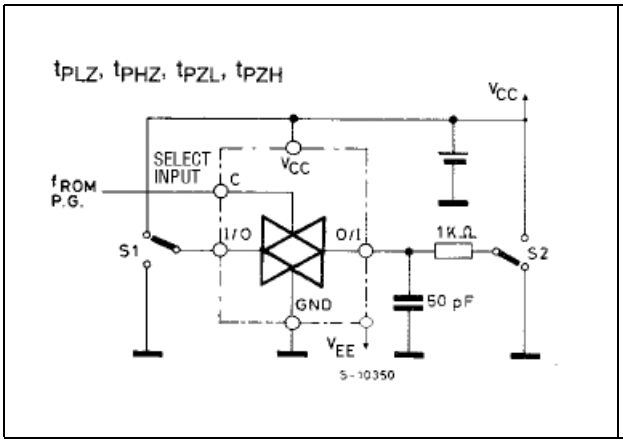



**Figure 7. Crosstalk (control to output)**

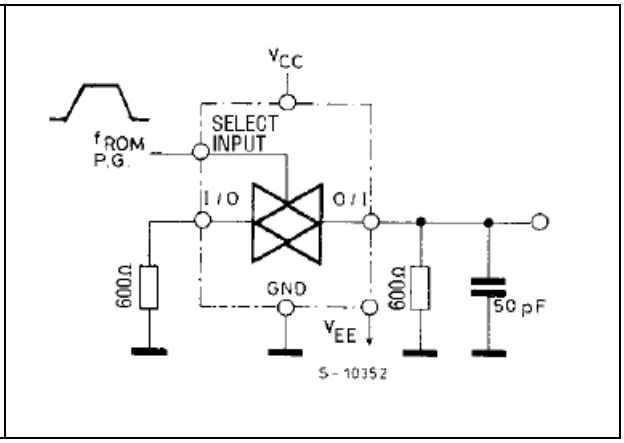



**Figure 8. Bandwidth and feedthrough attenuation**

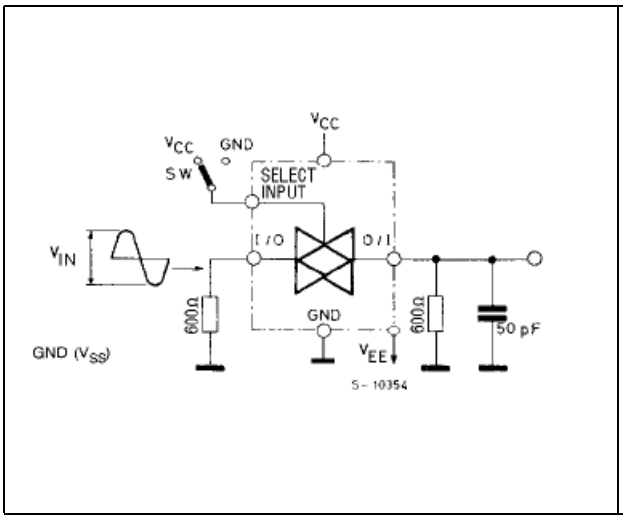



**Figure 9. Crosstalk between any two switches**

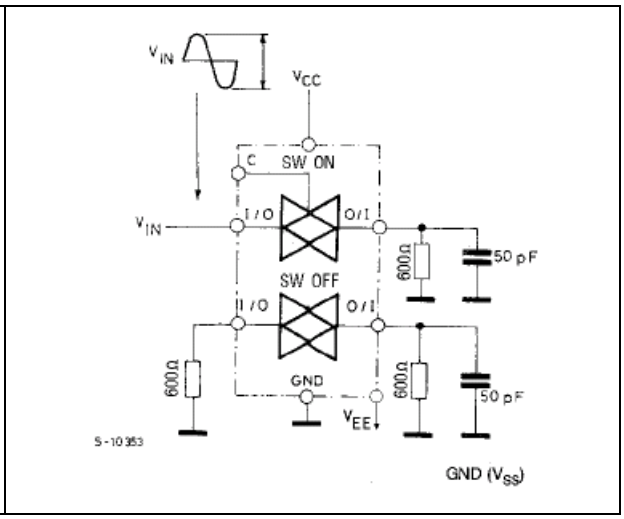


**Figure 10. Common terminal capacitance ($C_{I-O}$, $C_{I/O}$)**

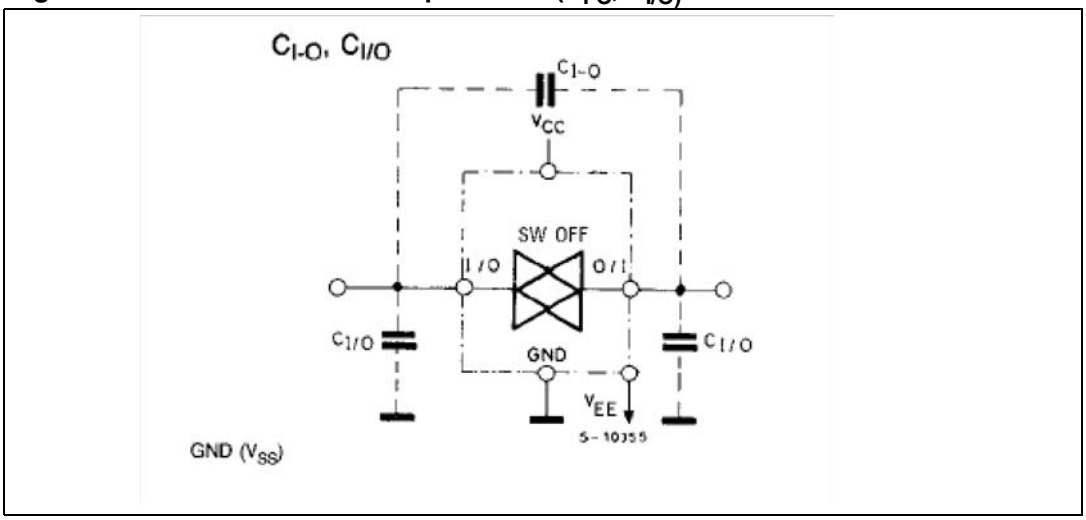



**Figure 11. Switching caracteristics waveform**

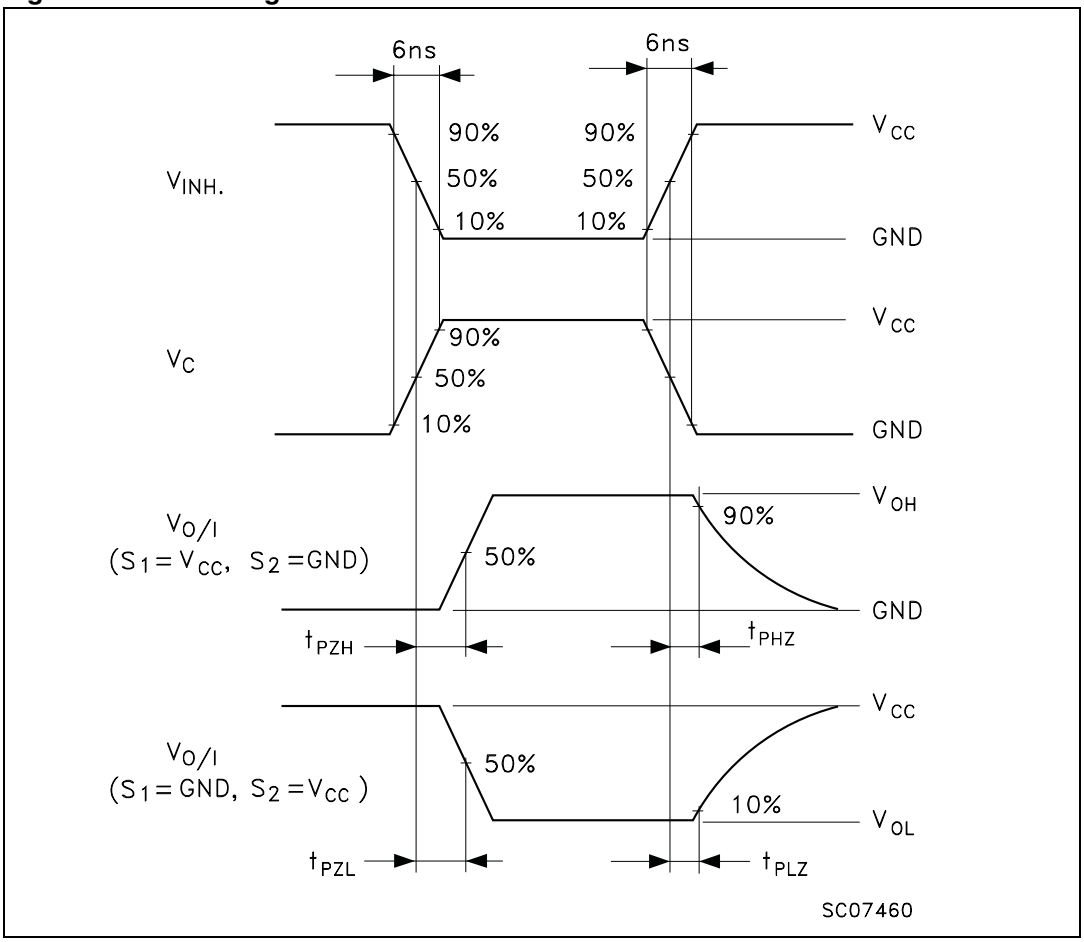


**Figure 12. Channel resistance ($R_{ON}$)**

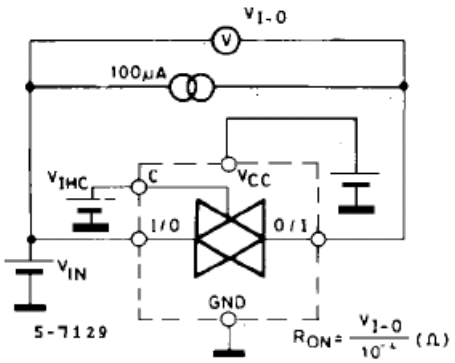
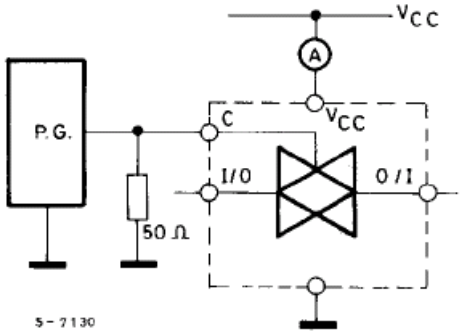



**Figure 13. Quiescent supply current - $I_{CC}$ (opr)**



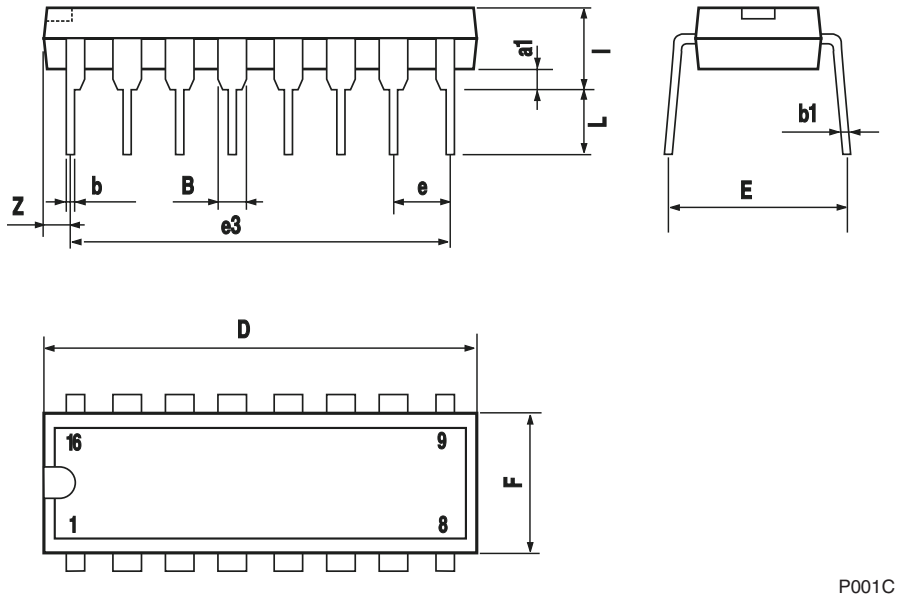
# 3 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

**Figure 14. Plastic DIP-16 (0.25) package information**

**Plastic DIP-16 (0.25) MECHANICAL DATA**

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |




P001C

**Figure 15. SO-16 package information**

**SO-16 MECHANICAL DATA**

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.64 | | | 0.063 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |

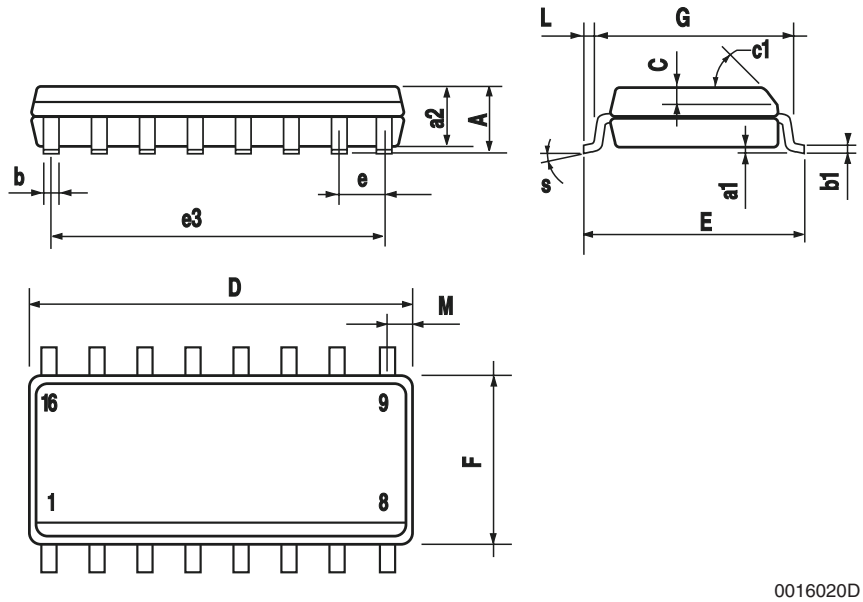
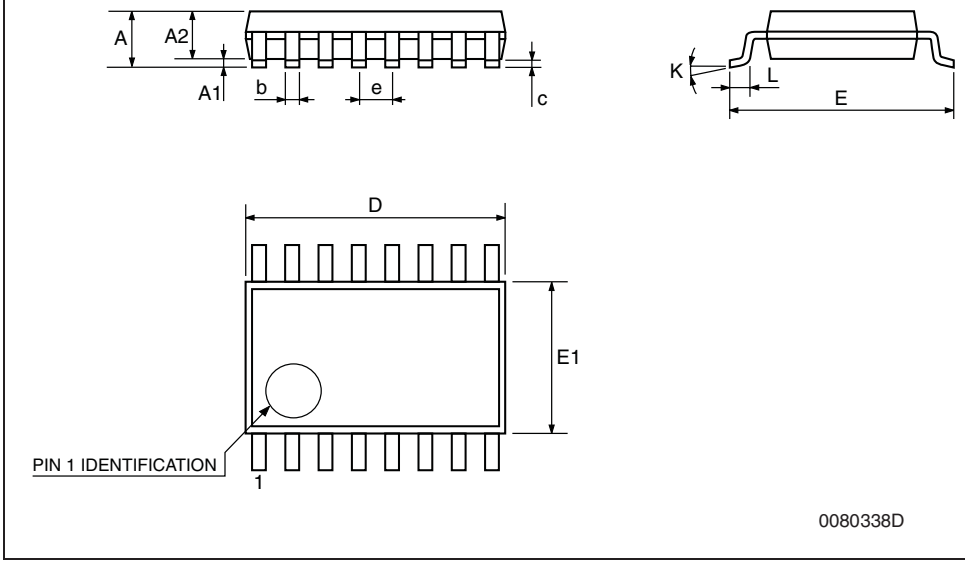


**Figure 16. TSSOP16 package information**

**TSSOP16 MECHANICAL DATA**

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0079 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



# 4 Revision history

**Table 10. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 01-Jul-2001 | 1 | Initial release. |
| 21-June-2004 | 2 | Document internal migration, no content change. |
| 10-Mar-2008 | 3 | Document restructured and converted to new ST template, updated *Table 4 on page 5* , removed tube packing info. |
| 21-Apr-2008 | 4 | Replaced M74HC4051M13TR with M74HC4051RM13TR in *Table 1 on page 1*. |

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