



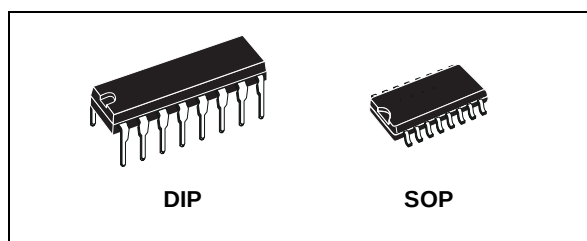
# HCF4053B

## TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

- LOW "ON" RESISTANCE : 125Ω (Typ.) OVER 15V p.p SIGNAL-INPUT RANGE FOR  $V_{DD} - V_{EE} = 15V$
- HIGH "OFF" RESISTANCE : CHANNEL LEAKAGE  $\pm 100pA$  (Typ.) at  $V_{DD} - V_{EE} = 18V$
- BINARY ADDRESS DECODING ON CHIP
- HIGH DEGREE OF LINEARITY :  $< 0.5\%$  DISTORTION TYP. at  $f_{IS} = 1KHz$ ,  $V_{IS} = 5 V_{pp}$ ,  $V_{DD} - V_{SS} \geq 10V$ ,  $R_L = 10K\Omega$
- VERY LOW QUIESCENT POWER DISSIPATION UNDER ALL DIGITAL CONTROL INPUT AND SUPPLY CONDITIONS : 0.2  $\mu W$  (Typ.) at  $V_{DD} - V_{SS} = V_{DD} - V_{EE} = 10V$
- MATCHED SWITCH CHARACTERISTICS :  $R_{ON} = 5\Omega$  (Typ.) FOR  $V_{DD} - V_{EE} = 15V$
- WIDE RANGE OF DIGITAL AND ANALOG SIGNAL LEVELS : DIGITAL 3 to 20, ANALOG TO 20V p.p.
- QUIESCENT CURRENT SPECIF. UP TO 20V
- 5V, 10V AND 15V PARAMETRIC RATINGS
- INPUT LEAKAGE CURRENT  $I_l = 100nA$  (MAX) AT  $V_{DD} = 18V$   $T_A = 25^\circ C$
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B " STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"

### DESCRIPTION

The HCF4053B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor



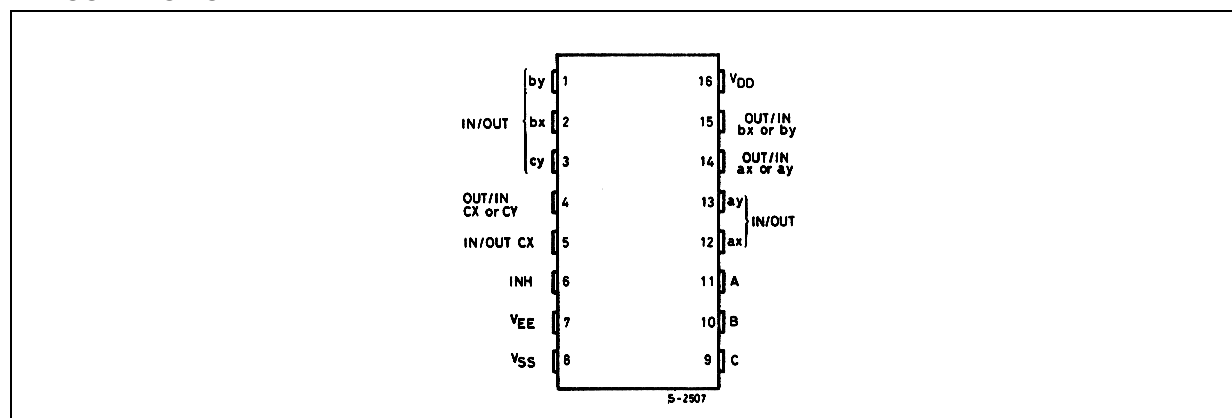
### ORDER CODES

| PACKAGE | TUBE       | T & R         |
|---------|------------|---------------|
| DIP     | HCF4053BEY |               |
| SOP     | HCF4053BM1 | HCF4053M013TR |

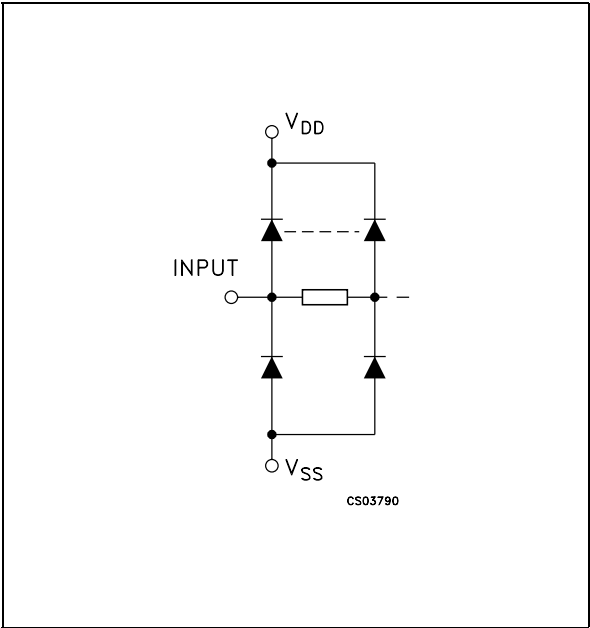
technology available in DIP and SOP packages. The HCF4053B analog multiplexer/demultiplexer is a digitally controlled analog switch having low ON impedance and very low OFF leakage current. This multiplexer circuit dissipate extremely low quiescent power over the full  $V_{DD} - V_{SS}$  and  $V_{DD} - V_{EE}$  supply voltage range, independent of the logic state of the control signals.

When a logic "1" is present at the inhibit input terminal all channel are off. This device is a triple 2-channel multiplexer having three separate digital control inputs, A, B, and C, and an inhibit input. Each control input selects one of a pair of channels which are connected in a single pole double-throw configuration.

### PIN CONNECTION



INPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

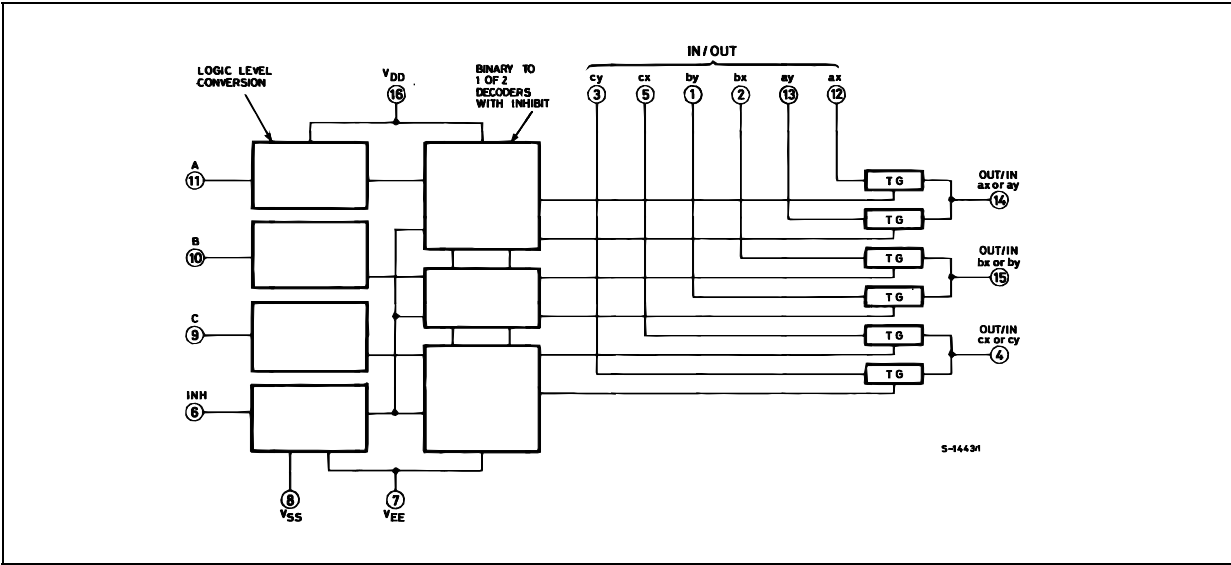
| PIN No             | SYMBOL          | NAME AND FUNCTION               |
|--------------------|-----------------|---------------------------------|
| 11, 10, 9          | A, B, C         | Binary Control Inputs           |
| 6                  | INH             | Inhibit Inputs                  |
| 12, 13, 2, 1, 5, 3 | IN/OUT          | ax,ay,bx,by,cx,cy Input/ Output |
| 14                 | OUT/IN          | ax or ay                        |
| 15                 | OUT/IN          | bx or by                        |
| 4                  | OUT/IN          | cx or cy                        |
| 7                  | V <sub>EE</sub> | Supply Voltage                  |
| 8                  | V <sub>SS</sub> | Negative Supply Voltage         |
| 16                 | V <sub>DD</sub> | Positive Supply Voltage         |

TRUTH TABLE

| INHIBIT | C or B or A |                |
|---------|-------------|----------------|
| 0       | 0           | ax or bx or cx |
| 0       | 1           | ay or by or cy |
| 1       | X           | NONE           |

X : Don't Care

FUNCTIONAL DIAGRAM



**ABSOLUTE MAXIMUM RATINGS**

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|-----------------------------------------|------------------------|------|
| $V_{DD}$  | Supply Voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC Input Voltage                        | -0.5 to $V_{DD} + 0.5$ | V    |
| $I_I$     | DC Input Current                        | $\pm 10$               | mA   |
| $P_D$     | Power Dissipation per Package           | 500 (*)                | mW   |
|           | Power Dissipation per Output Transistor | 100                    | mW   |
| $T_{op}$  | Operating Temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage Temperature                     | -65 to +150            | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

All voltage values are referred to  $V_{SS}$  pin voltage.

(\*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

**RECOMMENDED OPERATING CONDITIONS**

| Symbol   | Parameter             | Value         | Unit |
|----------|-----------------------|---------------|------|
| $V_{DD}$ | Supply Voltage        | 3 to 20       | V    |
| $V_I$    | Input Voltage         | 0 to $V_{DD}$ | V    |
| $T_{op}$ | Operating Temperature | -55 to 125    | °C   |

## DC SPECIFICATIONS

| Symbol                            | Parameter                                                      | Test Condition                       |                                                                                                                             |                        |                        | Value                 |                   |      |             |      |              |      |    | Unit |
|-----------------------------------|----------------------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|-----------------------|-------------------|------|-------------|------|--------------|------|----|------|
|                                   |                                                                | V <sub>IS</sub><br>(V)               | V <sub>EE</sub><br>(V)                                                                                                      | V <sub>SS</sub><br>(V) | V <sub>DD</sub><br>(V) | T <sub>A</sub> = 25°C |                   |      | -40 to 85°C |      | -55 to 125°C |      |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        |                        | Min.                  | Typ.              | Max. | Min.        | Max. | Min.         | Max. |    |      |
| I <sub>L</sub>                    | Quiescent Device Current (all switches ON or all switches OFF) |                                      |                                                                                                                             |                        | 5                      |                       | 0.04              | 5    |             | 150  |              | 150  | μA |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 10                     |                       | 0.04              | 10   |             | 300  |              | 300  |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 15                     |                       | 0.04              | 20   |             | 600  |              | 600  |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 20                     |                       | 0.08              | 100  |             | 3000 |              | 3000 |    |      |
| SWITCH                            |                                                                |                                      |                                                                                                                             |                        |                        |                       |                   |      |             |      |              |      |    |      |
| R <sub>ON</sub>                   | Resistance                                                     | 0 ≤ V <sub>I</sub> ≤ V <sub>DD</sub> | 0                                                                                                                           | 0                      | 5                      |                       | 470               | 1050 |             | 1200 |              | 1200 | Ω  |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 10                     |                       | 180               | 400  |             | 520  |              | 520  |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 15                     |                       | 125               | 280  |             | 360  |              | 360  |    |      |
| Δ <sub>ON</sub>                   | Resistance Δ <sub>RON</sub> (between any 2 of 4 switches)      | 0 ≤ V <sub>I</sub> ≤ V <sub>DD</sub> | 0                                                                                                                           | 0                      | 5                      |                       | 10                |      |             |      |              |      | Ω  |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 10                     |                       | 10                |      |             |      |              |      |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 15                     |                       | 5                 |      |             |      |              |      |    |      |
| OFF*                              | Channel Leakage Current (All Channel OFF) (COMMON O/I)         |                                      | 0                                                                                                                           | 0                      | 18                     |                       | ±0.1              | 100  |             | 1000 |              | 1000 | nA |      |
| OFF*                              | Channel Leakage Current (Any Channel OFF)                      |                                      | 0                                                                                                                           | 0                      | 18                     |                       | ±0.1              | 100  |             | 1000 |              | 1000 | nA |      |
| C <sub>I</sub>                    | Input Capacitance                                              |                                      | -5                                                                                                                          | -5                     | 5                      |                       | 5                 |      |             |      |              |      | pF |      |
| C <sub>O</sub>                    | Output Capacitance                                             |                                      |                                                                                                                             |                        |                        |                       | 9                 |      |             |      |              |      |    |      |
| C <sub>IO</sub>                   | Feed through                                                   |                                      |                                                                                                                             |                        |                        |                       | 0.2               |      |             |      |              |      |    |      |
| CONTROL (Address or Inhibit)      |                                                                |                                      |                                                                                                                             |                        |                        |                       |                   |      |             |      |              |      |    |      |
| V <sub>IL</sub>                   | Input Low Voltage                                              | = VDD thru 1KΩ                       | V <sub>EE</sub> = V <sub>SS</sub><br>R <sub>L</sub> = 1KΩ to V <sub>SS</sub><br>I <sub>IS</sub> < 2μA (on all OFF channels) |                        | 5                      |                       |                   | 1.5  |             | 1.5  |              | 1.5  | V  |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 10                     |                       |                   | 3    |             | 3    |              | 3    |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 15                     |                       |                   | 4    |             | 4    |              | 4    |    |      |
| V <sub>IH</sub>                   | Input High Voltage                                             |                                      |                                                                                                                             |                        | 5                      | 3.5                   |                   |      | 3.5         |      | 3.5          |      |    | V    |
|                                   |                                                                |                                      |                                                                                                                             |                        | 10                     | 7                     |                   |      | 7           |      | 7            |      |    |      |
|                                   |                                                                |                                      |                                                                                                                             |                        | 15                     | 11                    |                   |      | 11          |      | 11           |      |    |      |
| I <sub>IH</sub> , I <sub>IL</sub> | Input Leakage Current                                          | V <sub>I</sub> = 0/18V               |                                                                                                                             |                        | 18                     |                       | ±10 <sup>-3</sup> | ±0.1 |             | ±1   |              | ±1   | μA |      |
| C <sub>I</sub>                    | Input Capacitance                                              |                                      |                                                                                                                             |                        |                        |                       | 5                 | 7.5  |             |      |              |      | pF |      |

\* Determined by minimum feasible leakage measurement for automating testing.

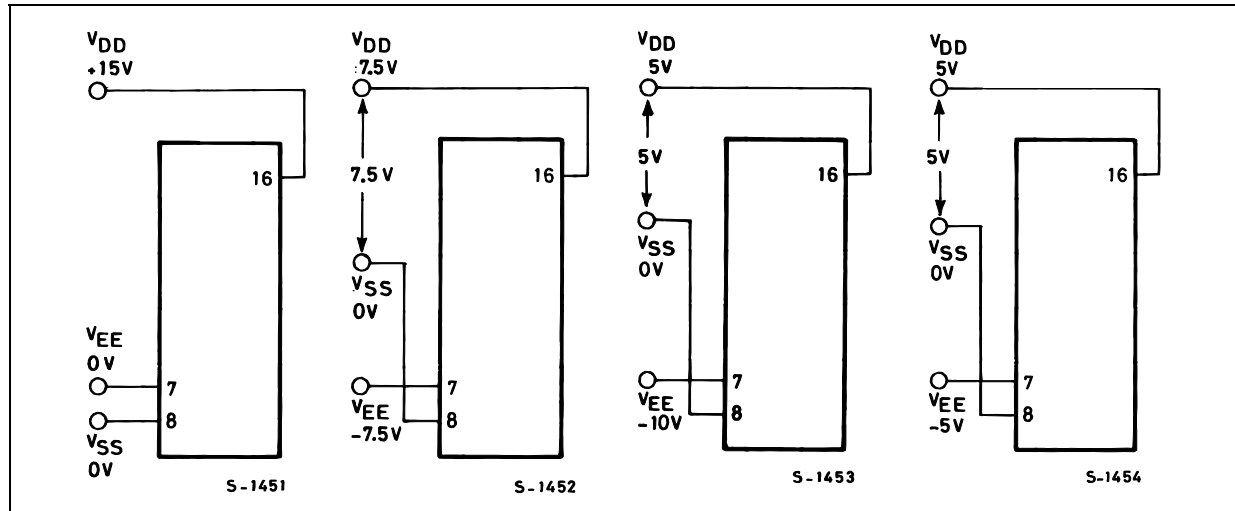
**DYNAMIC ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25^{\circ}\text{C}$ ,  $C_L = 50\text{pF}$ , all input square wave rise and fall time = 20 ns )

| Parameter                                                                                          | Test Condition         |                        |                         |                                                                                                      |                        |                        |                                                                 | Value |      |      | Unit    |    |
|----------------------------------------------------------------------------------------------------|------------------------|------------------------|-------------------------|------------------------------------------------------------------------------------------------------|------------------------|------------------------|-----------------------------------------------------------------|-------|------|------|---------|----|
|                                                                                                    | V <sub>EE</sub><br>(V) | R <sub>L</sub><br>(KΩ) | f <sub>I</sub><br>(KHz) | V <sub>I</sub><br>(V)                                                                                | V <sub>SS</sub><br>(V) | V <sub>DD</sub><br>(V) |                                                                 | Min.  | Typ. | Max. |         |    |
| Propagation Delay Time (signal input to output)                                                    |                        | 200                    |                         | V <sub>DD</sub><br> |                        | 5                      |                                                                 |       | 30   | 60   | ns      |    |
|                                                                                                    |                        |                        |                         |                                                                                                      |                        | 10                     |                                                                 |       | 15   | 30   |         |    |
|                                                                                                    |                        |                        |                         |                                                                                                      |                        | 15                     |                                                                 |       | 11   | 20   |         |    |
| Frequency Response Channel "ON" (sine wave input) at 20 log V <sub>O</sub> /V <sub>I</sub> = - 3dB | = V <sub>SS</sub>      | 1                      |                         | 5(*)                                                                                                 |                        | 10                     | V <sub>O</sub> at Common OUT/IN                                 |       | 25   |      | MHz     |    |
|                                                                                                    |                        |                        |                         |                                                                                                      |                        |                        | V <sub>O</sub> at any channel                                   |       | 60   |      |         |    |
| Feed through (all channels OFF) at 20 log V <sub>O</sub> /V <sub>I</sub> = - 40dB                  | = V <sub>SS</sub>      | 1                      |                         | 5(*)                                                                                                 |                        | 10                     | V <sub>O</sub> at Common OUT/IN                                 |       | 10   |      | MHz     |    |
|                                                                                                    |                        |                        |                         |                                                                                                      |                        |                        | V <sub>O</sub> at any channel                                   |       | 8    |      |         |    |
| Frequency Signal Crosstalk at 20 log V <sub>O</sub> /V <sub>I</sub> = -40dB                        | = V <sub>SS</sub>      | 1                      |                         | 5(*)                                                                                                 |                        | 10                     | Between any 2 Sections (IN pin 2, OUT pin 14)                   |       | 2.5  |      | MHz     |    |
|                                                                                                    |                        |                        |                         |                                                                                                      |                        |                        | Between any 2 Sections (IN pin 15, OUT pin 14)                  |       | 6    |      |         |    |
| Sine Wave Distortion f <sub>IS</sub> = 1KHz Sine Wave                                              | = V <sub>SS</sub>      | 10                     | 1                       | 2(*)                                                                                                 |                        | 5                      |                                                                 |       | 0.3  |      | %       |    |
|                                                                                                    |                        |                        |                         | 3(*)                                                                                                 |                        | 10                     |                                                                 |       | 0.2  |      |         |    |
|                                                                                                    |                        |                        |                         | 5(*)                                                                                                 |                        | 15                     |                                                                 |       | 0.12 |      |         |    |
| CONTROL (Address or Inhibit)                                                                       |                        |                        |                         |                                                                                                      |                        |                        |                                                                 |       |      |      |         |    |
| Propagation Delay: Address to Signal OUT (Channels ON or OFF)                                      | 0                      |                        |                         |                                                                                                      |                        | 0                      | 5                                                               |       |      | 360  | 720     | ns |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        | 0                      | 10                                                              |       |      | 160  | 320     |    |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        | 0                      | 15                                                              |       |      | 120  | 240     |    |
|                                                                                                    | -5                     |                        |                         |                                                                                                      |                        | 0                      | 5                                                               |       |      | 225  | 450     |    |
| Propagation Delay: Inhibit to Signal OUT (Channel turning ON)                                      | 0                      | 1                      |                         |                                                                                                      |                        | 0                      | 5                                                               |       |      | 360  | 720     | ns |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        | 0                      | 10                                                              |       |      | 160  | 320     |    |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        | 0                      | 15                                                              |       |      | 120  | 240     |    |
|                                                                                                    | -10                    |                        |                         |                                                                                                      |                        | 0                      | 5                                                               |       |      | 200  | 400     |    |
| Propagation Delay: Inhibit to Signal OUT (Channel turning OFF)                                     | 0                      | 10                     |                         |                                                                                                      |                        |                        | 5                                                               |       |      | 200  | 450     | ns |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        |                        | 10                                                              |       |      | 90   | 210     |    |
|                                                                                                    | 0                      |                        |                         |                                                                                                      |                        |                        | 15                                                              |       |      | 70   | 160     |    |
|                                                                                                    | -10                    |                        |                         |                                                                                                      |                        |                        | 5                                                               |       |      | 130  | 300     |    |
| Address or Inhibit to Signal Crosstalk                                                             | 0                      | 10 <sup>(1)</sup>      |                         |                                                                                                      | 0                      | 10                     | V <sub>C</sub> = V <sub>DD</sub> -V <sub>SS</sub> (square wave) |       | 65   |      | mV peak |    |

(1) Both ends of channel.

\* Peak to Peak voltage symmetrical about  $(V_{DD} - V_{EE}) / 2$

## TYPICAL BIAS VOLTAGES



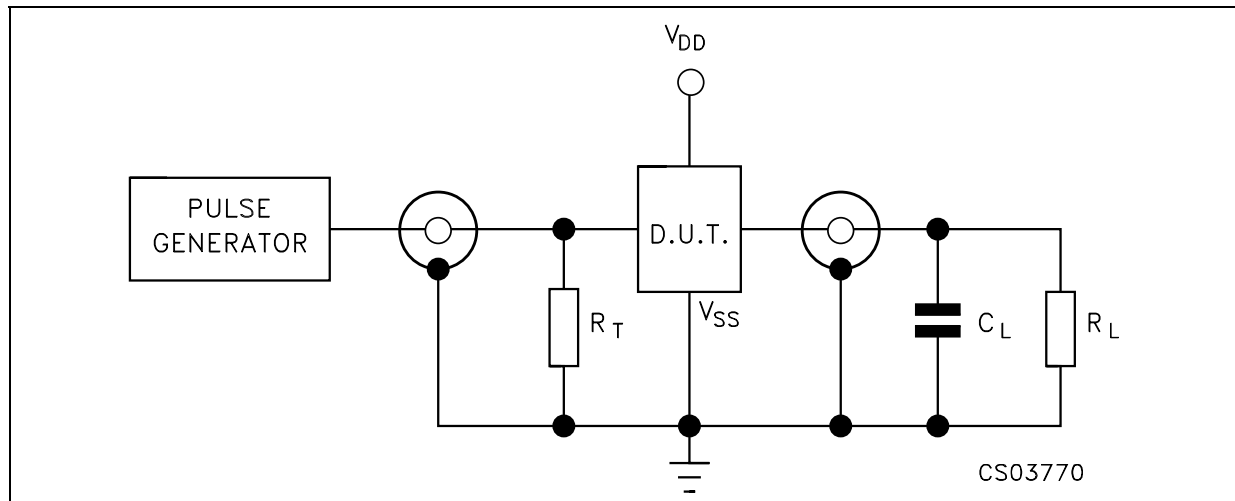
The ADDRESS (digital-control inputs) and INHIBIT logic levels are : "0"= $V_{SS}$  and "1"= $V_{DD}$ . The analog signal (through the TG) may swing from  $V_{EE}$  to  $V_{DD}$ .

## SPECIAL CONSIDERATIONS

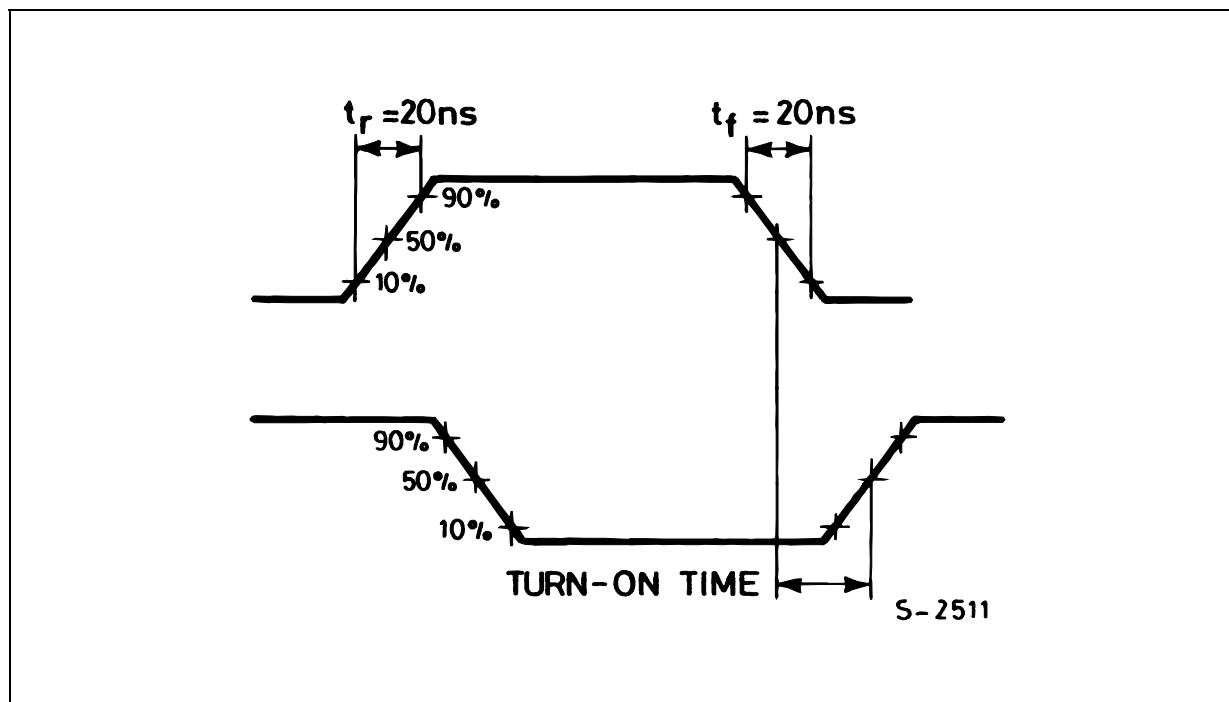
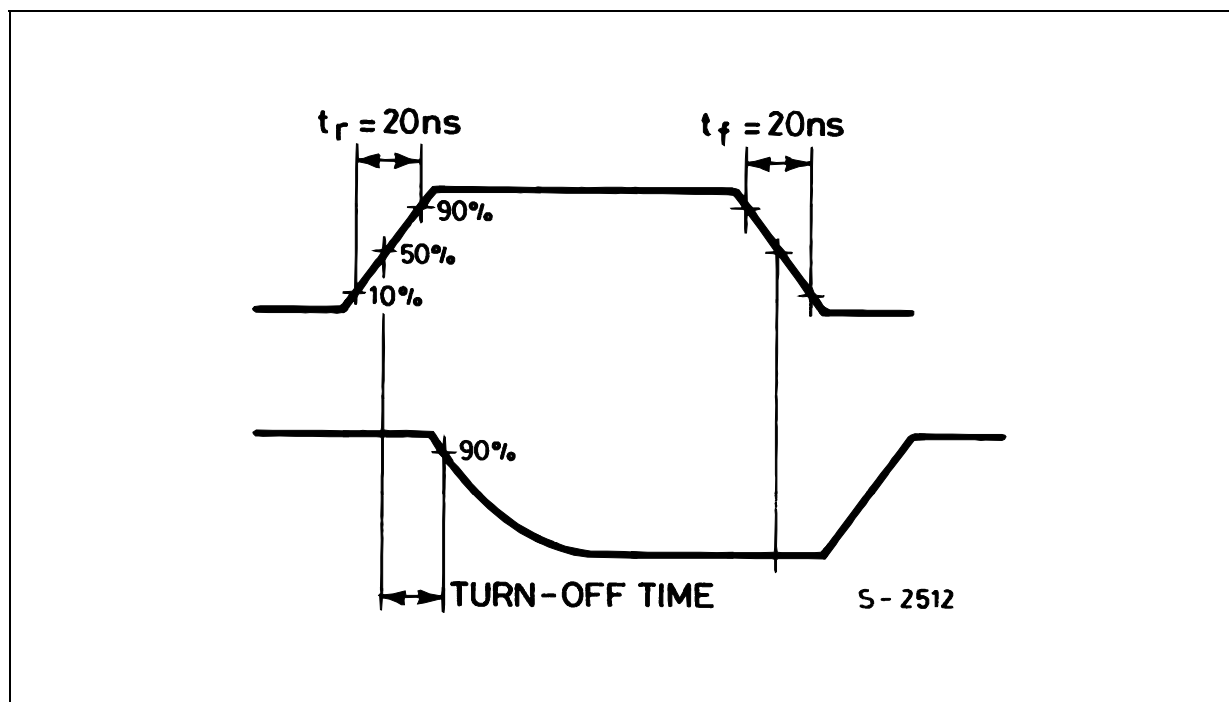
Control of analog signals up to 20V peak to peak can be achieved by digital signal amplitudes of 4.5 to 20V (if  $V_{DD} - V_{SS} = 3V$ , a  $V_{DD} - V_{EE}$  of up to 13V can be controlled; for  $V_{DD} - V_{EE}$  level differences above 13V, a  $V_{DD} - V_{SS}$  of at least 4.5V is required. For example, if  $V_{DD} = +5$ ,  $V_{SS} = 0$ , and  $V_{EE} = -13.5$ , analog signals from -13.5V to 4.5V can be controlled by digital inputs of 0 to 4.5V. In

certain applications, the external load resistor current may include both  $V_{DD}$  and signal-line components. To avoid drawing  $V_{DD}$  current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.8V (calculated from  $R_{ON}$  values shown in DC SPECIFICATIONS). No  $V_{DD}$  current will flow through  $R_L$  if the switch current flows into leads 4, 14 and 15.

## TEST CIRCUIT

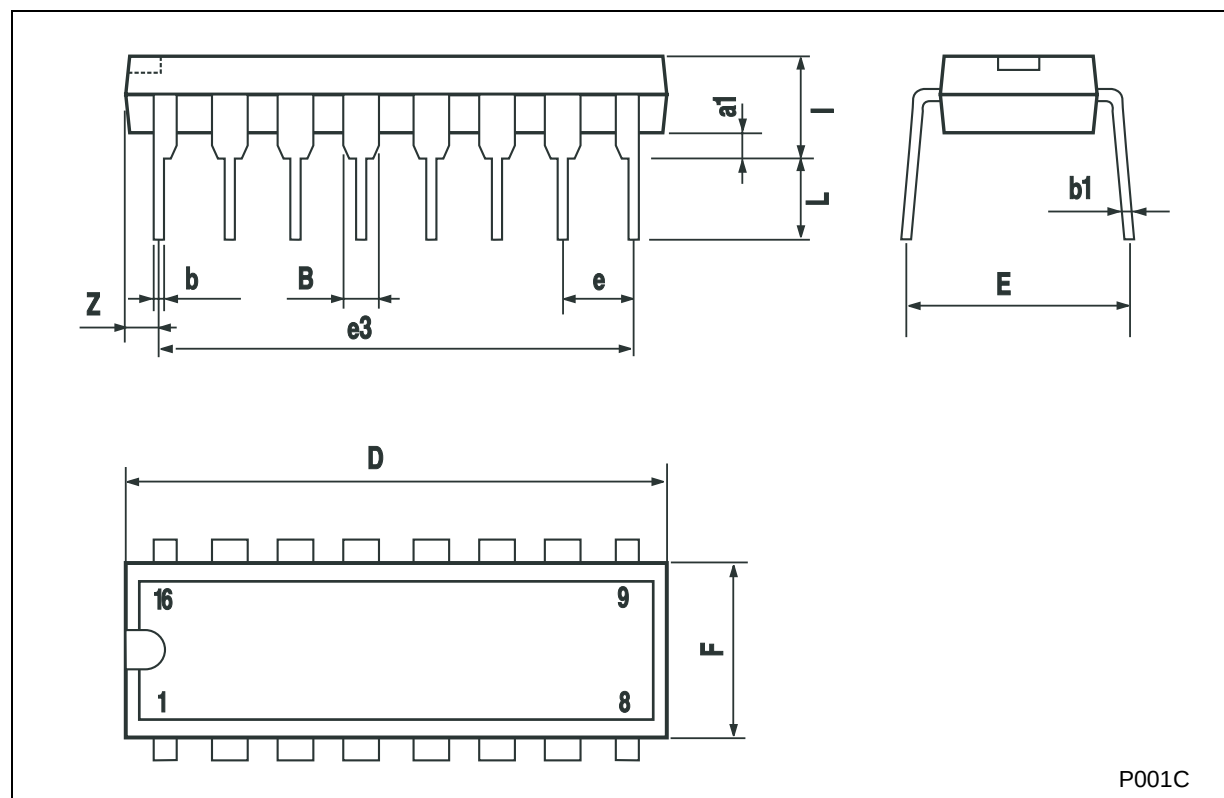


$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)  
 $R_L = 200\text{K}\Omega$   
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

**WAVEFORM 1 : CHANNEL BEING TURNED ON** ( $R_L = 1K\Omega$ ,  $f=1MHz$ ; 50% duty cycle)**WAVEFORM 2 : CHANNEL BEING TURNED OFF** ( $R_L = 1K\Omega$ ,  $f=1MHz$ ; 50% duty cycle)

## 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 |

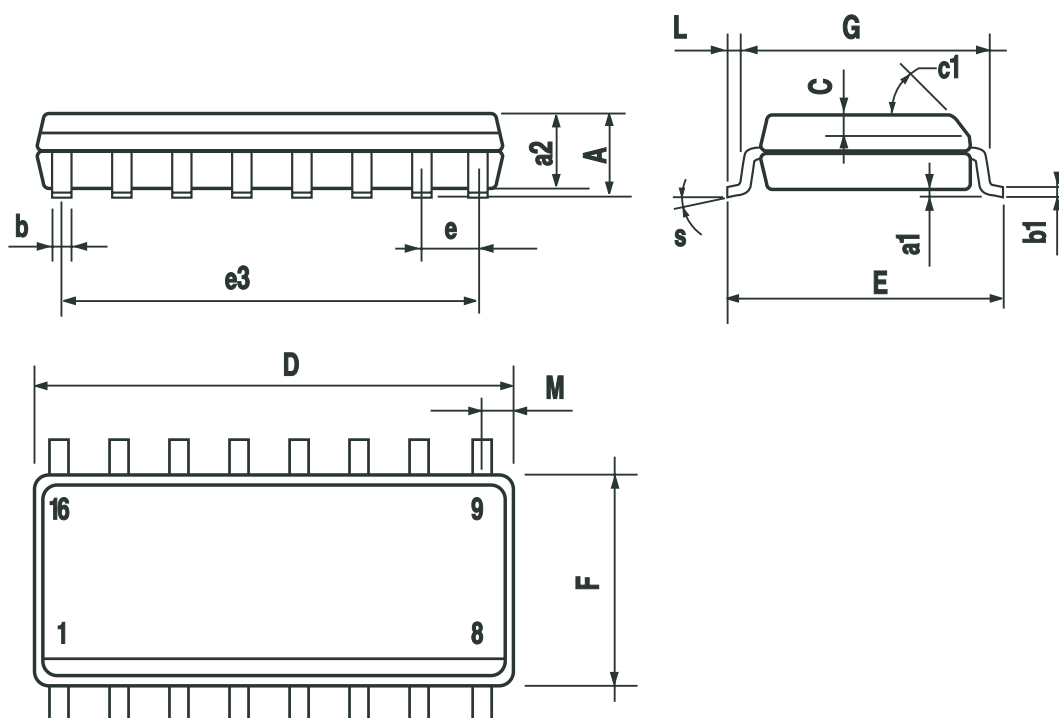


P001C



## SO-16 MECHANICAL DATA

| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| a2   |            |      | 1.65 |       |       | 0.064 |
| 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.)  |      |      |       |       |       |



PO13H

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