

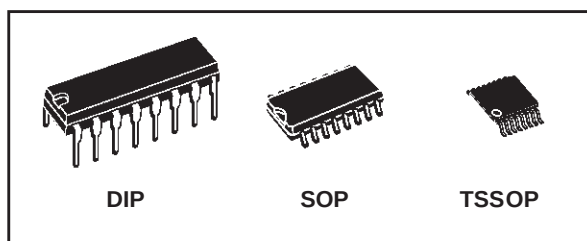
## QUAD BILATERAL SWITCH

- HIGH SPEED:  
 $t_{PD} = 13ns$  (TYP.) at  $V_{CC} = 6V$
- LOW POWER DISSIPATION:  
 $I_{CC} = 1\mu A$  (MAX.) at  $V_{CC} = 5V$
- LOW "ON" RESISTANCE:  
 $120\Omega$  TYP. ( $V_{CC} - V_{EE} = 2V$ )  
 $50\Omega$  TYP. ( $V_{CC} - V_{EE} = 4.5V$ )  
 $35\Omega$  TYP. ( $V_{CC} - V_{EE} = 9V$ )
- WIDE ANALOG INPUT VOLTAGE RANGE  $\pm 6V$
- LOW CROSSTALK BETWEEN SWITCHES
- FAST SWITCHING
- SINE WAVE DISTORTION:  
 $0.020$  at  $V_{CC} - V_{EE} = 9V$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (MIN.)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 4316

### DESCRIPTION

The M74HC4316 is an high speed CMOS QUAD BILATERAL SWITCH fabricated with silicon gate C<sup>2</sup>MOS technology.

This device has four independent analogue switches. Each switch has two input/output terminals (nI/O, nO/I) and an active high select input (nC).



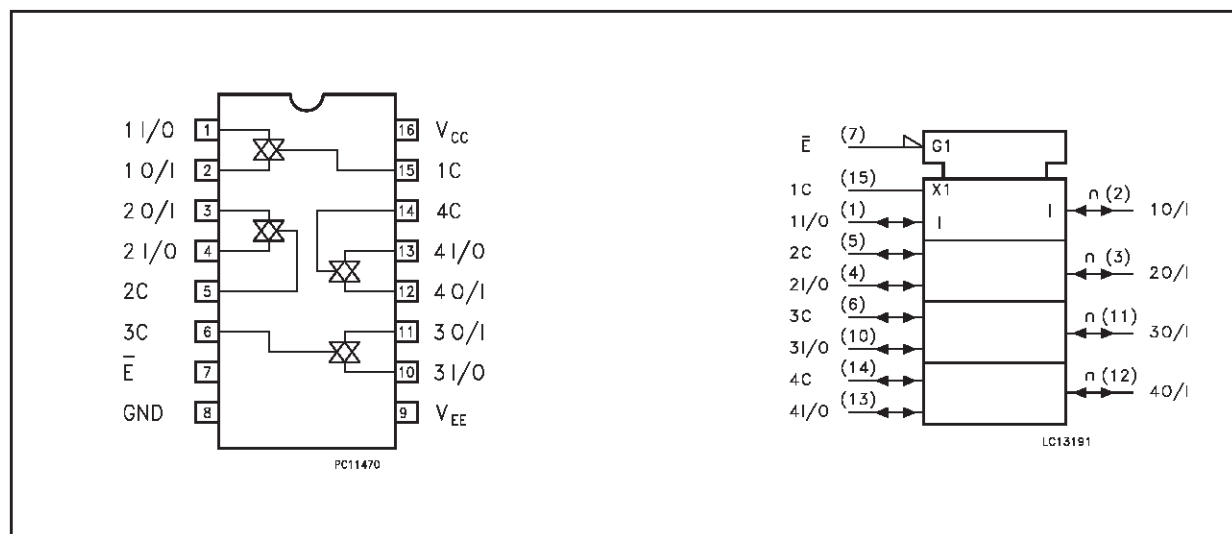
### ORDER CODES

| PACKAGE | TUBE         | T & R           |
|---------|--------------|-----------------|
| DIP     | M74HC4316B1R |                 |
| SOP     | M74HC4316M1R | M74HC4316RM13TR |
| TSSOP   |              | M74HC4316TTR    |

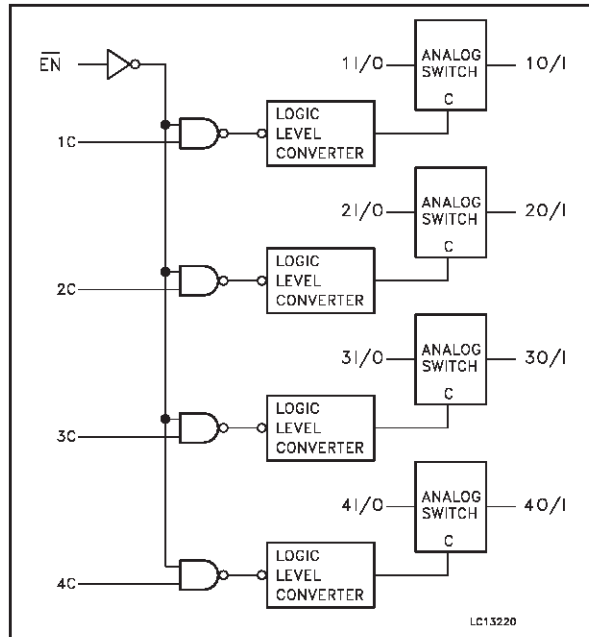
When the enable input is high, all four analog switches are off. The supply voltage for the digital signals applied to  $V_{CC}$  and GND must be within the range 0 to 6 V. The voltage swing on the analogue Inputs/Outputs can be between  $V_{CC}$  (positive limit) and  $V_{EE}$  (negative limit). The voltage between  $V_{CC}$  and  $V_{EE}$  must not exceed 12V.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



## LOGIC DIAGRAM



## PIN DESCRIPTION

| PIN No       | SYMBOL         | NAME AND FUNCTION           |
|--------------|----------------|-----------------------------|
| 1, 4, 10, 13 | 1 to 4 I/O     | Independent Inputs/Outputs  |
| 2, 3, 11, 12 | 1 to 4 O/I     | Independent Outputs/Inputs  |
| 7            | $\overline{E}$ | Enable Inputs (Active LOW)  |
| 15, 5, 6, 14 | 1C to 4C       | Enable Inputs (Active High) |
| 9            | $V_{EE}$       | Negative Supply Voltage     |
| 8            | GND            | Ground (0V)                 |
| 16           | $V_{CC}$       | Positive Supply Voltage     |

## TRUTH TABLE

| $\overline{E}$ | C | SWITCH FUNCTION |
|----------------|---|-----------------|
| L              | H | ON              |
| L              | L | OFF             |
| H              | X | OFF             |

## 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 Input/Output Voltage                  | $V_{EE} - 0.5$ to $V_{CC} + 0.5$ | V    |
| $I_{IK}$              | DC Input Diode Current                       | $\pm 20$                         | mA   |
| $I_{OK}$              | DC Output Diode Current                      | $\pm 20$                         | mA   |
| $I_O$                 | DC Output Source Sink Current Per Output Pin | $\pm 25$                         | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current                | $\pm 50$                         | mA   |
| $P_D$                 | Power Dissipation                            | 500(*)                           | mW   |
| $T_{stg}$             | Storage Temperature                          | -65 to +150                      | °C   |
| $T_L$                 | Lead Temperature (10 sec)                    | 300                              | °C   |

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

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

## RECOMMENDED OPERATING CONDITIONS

| Symbol                            | Parameter                |                        | Value                | Unit |
|-----------------------------------|--------------------------|------------------------|----------------------|------|
| V <sub>CC</sub>                   | Supply Voltage           |                        | 2 to 12              | V    |
| V <sub>EE</sub>                   | Supply Voltage           |                        | -6 to 0              | V    |
| V <sub>CC</sub> - V <sub>EE</sub> | Supply Voltage           |                        | 2 to 12              | V    |
| V <sub>I</sub>                    | Input Voltage            |                        | 0 to V <sub>CC</sub> | V    |
| V <sub>I/O</sub>                  | Switch I/O Voltage       |                        | 0 to V <sub>CC</sub> | V    |
| T <sub>op</sub>                   | Operating Temperature    |                        | -55 to 125           | °C   |
| t <sub>r</sub> , t <sub>f</sub>   | Input Rise and Fall Time | V <sub>CC</sub> = 2.0V | 0 to 1000            | ns   |
|                                   |                          | V <sub>CC</sub> = 4.5V | 0 to 500             |      |
|                                   |                          | V <sub>CC</sub> = 6.0V | 0 to 400             |      |

## DC SPECIFICATIONS

| Symbol           | Parameter                                             | Test Condition         |                                         |                                                                                                                        | Value                 |                  |       |             |       |              | Unit |      |  |
|------------------|-------------------------------------------------------|------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------|-------|-------------|-------|--------------|------|------|--|
|                  |                                                       | V <sub>CC</sub><br>(V) | V <sub>EE</sub><br>(V)                  |                                                                                                                        | T <sub>A</sub> = 25°C |                  |       | -40 to 85°C |       | -55 to 125°C |      |      |  |
|                  |                                                       |                        |                                         |                                                                                                                        | Min.                  | Typ.             | Max.  | Min.        | Max.  | Min.         |      | Max. |  |
| V <sub>IHC</sub> | High Level Control 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 <sub>ILC</sub> | Low Level Control 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 <sub>ON</sub>  | ON Resistance                                         | 4.5                    | GND                                     | V <sub>I</sub> = V <sub>IHC</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub><br>I <sub>I/O</sub> = 0.1mA |                       | 70               | 170   |             | 200   |              |      | Ω    |  |
|                  |                                                       | 4.5                    | -4.5                                    |                                                                                                                        |                       | 50               | 85    |             | 105   |              |      |      |  |
|                  |                                                       | 6.0                    | -6.0                                    |                                                                                                                        |                       | 30               | 70    |             | 85    |              |      |      |  |
|                  |                                                       | 2.0                    | GND                                     | V <sub>I</sub> = V <sub>IHC</sub><br>V <sub>I/O</sub> = V <sub>CC</sub> or V <sub>EE</sub><br>I <sub>I/O</sub> = 0.1mA |                       | 120              | 180   |             | 215   |              |      |      |  |
|                  |                                                       | 4.5                    | GND                                     |                                                                                                                        |                       | 50               | 80    |             | 100   |              |      |      |  |
|                  |                                                       | 4.5                    | -4.5                                    |                                                                                                                        |                       | 35               | 60    |             | 75    |              |      |      |  |
|                  |                                                       | 6.0                    | -6.0                                    |                                                                                                                        |                       | 20               | 40    |             | 60    |              |      |      |  |
| ΔR <sub>ON</sub> | Difference of ON Resistance between switches          | 4.5                    | GND                                     | V <sub>IN</sub> = V <sub>IHC</sub> or V <sub>ILC</sub>                                                                 |                       | 10               | 15    |             | 20    |              |      | Ω    |  |
|                  |                                                       | 4.5                    | -4.5                                    | V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub>                                                                  |                       | 5                | 10    |             | 15    |              |      |      |  |
|                  |                                                       | 6.0                    | -6.0                                    | I <sub>I/O</sub> = 0.1mA                                                                                               |                       | 5                | 10    |             | 15    |              |      |      |  |
| I <sub>OFF</sub> | Input/Output Leakage Current (SWITCH OFF)             | 6.0                    | GND                                     | V <sub>OS</sub> = V <sub>CC</sub> or GND                                                                               |                       |                  | ±0.06 |             | ± 0.6 |              | ± 2  | μA   |  |
|                  |                                                       | 6.0                    | -6.0                                    | V <sub>IS</sub> = V <sub>CC</sub> or GND<br>V <sub>IN</sub> = V <sub>IHC</sub> or V <sub>ILC</sub>                     |                       |                  | ± 0.1 |             | ± 1   |              | ± 2  |      |  |
| I <sub>IZ</sub>  | Switch Input Leakage Current (SWITCH ON, OUTPUT OPEN) | 6.0                    | GND                                     | V <sub>OS</sub> = V <sub>CC</sub> or GND                                                                               |                       |                  | ±0.06 |             | ± 0.6 |              | ± 2  | μA   |  |
|                  |                                                       | 6.0                    | -6.0                                    | V <sub>IN</sub> = V <sub>IHC</sub> or V <sub>ILC</sub>                                                                 |                       |                  | ± 0.1 |             | ± 1   |              | ± 2  |      |  |
| I <sub>IN</sub>  | Control Input Current                                 | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                                                                                                                        |                       | 10 <sup>-5</sup> | ± 0.1 |             | ± 1   |              | ± 1  | μA   |  |

AC ELECTRICAL CHARACTERISTICS ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

| Symbol                               | Parameter                                       | Test Condition         |                        |                                                                                          | Value                 |      |      |             |      |              | Unit |      |
|--------------------------------------|-------------------------------------------------|------------------------|------------------------|------------------------------------------------------------------------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                                      |                                                 | V <sub>CC</sub><br>(V) | V <sub>EE</sub><br>(V) |                                                                                          | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                      |                                                 |                        |                        |                                                                                          | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| Φ <sub>I/O</sub>                     | Phase Difference<br>Between Input<br>and Output | 2.0                    | GND                    |                                                                                          |                       | 12   | 30   |             | 40   |              |      | ns   |
|                                      |                                                 | 4.5                    | GND                    |                                                                                          |                       | 3    | 6    |             | 8    |              |      |      |
|                                      |                                                 | 6.0                    | GND                    |                                                                                          |                       | 3    | 5    |             | 7    |              |      |      |
|                                      |                                                 | 4.5                    | -4.5                   |                                                                                          |                       | 2    | 4    |             | 5    |              |      |      |
|                                      |                                                 | 6.0                    | -6.0                   |                                                                                          |                       | 2    | 4    |             | 5    |              |      |      |
| t <sub>PZL</sub><br>t <sub>PZH</sub> | Output Enable<br>Time<br>(E, C - OUT)           | 2.0                    | GND                    | R <sub>L</sub> = 1KΩ                                                                     |                       | 56   | 115  |             | 145  |              |      | ns   |
|                                      |                                                 | 4.5                    | GND                    |                                                                                          |                       | 14   | 23   |             | 29   |              |      |      |
|                                      |                                                 | 6.0                    | GND                    |                                                                                          |                       | 12   | 20   |             | 25   |              |      |      |
|                                      |                                                 | 4.5                    | -4.5                   |                                                                                          |                       | 13   | 21   |             | 26   |              |      |      |
|                                      |                                                 | 6.0                    | -6.0                   |                                                                                          |                       | 11   | 18   |             | 23   |              |      |      |
| t <sub>PLZ</sub><br>t <sub>PHZ</sub> | Output Disable<br>Time<br>(E, C - OUT)          | 2.0                    | GND                    | R <sub>L</sub> = 1KΩ                                                                     |                       | 112  | 205  |             | 255  |              |      | ns   |
|                                      |                                                 | 4.5                    | GND                    |                                                                                          |                       | 28   | 41   |             | 51   |              |      |      |
|                                      |                                                 | 6.0                    | GND                    |                                                                                          |                       | 24   | 35   |             | 43   |              |      |      |
|                                      |                                                 | 4.5                    | -4.5                   |                                                                                          |                       | 24   | 34   |             | 43   |              |      |      |
|                                      |                                                 | 6.0                    | -6.0                   |                                                                                          |                       | 21   | 29   |             | 36   |              |      |      |
| f <sub>MAX</sub>                     | Maximum Control<br>Input Frequency              | 2.0                    | GND                    | R <sub>L</sub> = 1KΩ<br>C <sub>L</sub> = 15 pF<br>V <sub>OUT</sub> = 1/2 V <sub>CC</sub> |                       | 2    |      |             |      |              |      | MHz  |
|                                      |                                                 | 4.5                    | GND                    |                                                                                          |                       | 9    |      |             |      |              |      |      |
|                                      |                                                 | 6.0                    | GND                    |                                                                                          |                       | 11   |      |             |      |              |      |      |

## CAPACITIVE CHARACTERISTICS

| Symbol           | Parameter                              | Test Condition         |      | Value                 |      |      |             |      |              | Unit |      |
|------------------|----------------------------------------|------------------------|------|-----------------------|------|------|-------------|------|--------------|------|------|
|                  |                                        | V <sub>CC</sub><br>(V) |      | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                  |                                        |                        |      | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| C <sub>IN</sub>  | Input Capacitance                      |                        |      |                       | 5    | 10   |             | 10   |              | 10   | pF   |
| C <sub>I/O</sub> | Switch Terminal Capacitance            | 4.5                    | -4.5 |                       | 5    |      |             |      |              |      | pF   |
| C <sub>IOS</sub> | Feed Through Capacitance               | 4.5                    | -4.5 |                       | 1    |      |             |      |              |      | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance (note 1) | 5.0                    | GND  |                       | 16   |      |             |      |              |      | pF   |

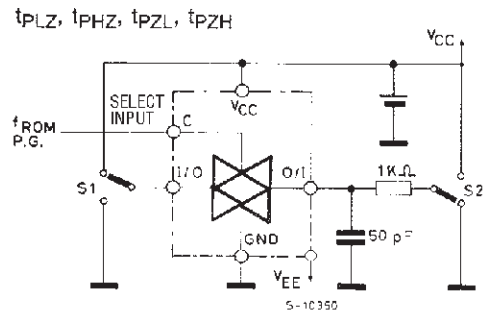
1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(oper)} = C_{PD} \times V_{CC} \times f_{IN}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

ANALOG SWITCH CHARACTERISTICS (GND = 0V;  $T_A = 25^\circ\text{C}$ )

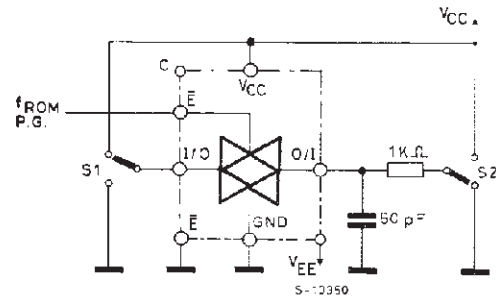
| Symbol    | Parameter                                  | Test Condition  |                 |                                                                                                                                                                                      | Value | Unit |
|-----------|--------------------------------------------|-----------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|
|           |                                            | $V_{CC}$<br>(V) | $V_{EE}$<br>(V) | $V_{IN}$<br>(V <sub>p-p</sub> )                                                                                                                                                      | Typ.  |      |
|           | Sine Wave Distortion (THD)                 | 2.25            | 2.25            | 4                                                                                                                                                                                    | 0.025 | %    |
|           |                                            | 4.5             | 4.5             | 8                                                                                                                                                                                    | 0.020 |      |
|           |                                            | 6.0             | 6.0             | 11                                                                                                                                                                                   | 0.018 |      |
| $f_{MAX}$ | Frequency Response (Switch ON)             | 2.25            | 2.25            | Adjust $f_{IN}$ voltage to obtain 0 dBm at $V_{OS}$ .<br>Increase $f_{IN}$ Frequency until dB meter reads -3dB<br>$R_L = 50\Omega$ , $C_L = 10$ pF, $f_{IN} = 1\text{MHz}$ sine wave | 28    | MHz  |
|           |                                            | 4.5             | 4.5             |                                                                                                                                                                                      | 42    |      |
|           |                                            | 6.0             | 6.0             |                                                                                                                                                                                      | 43    |      |
|           | Feed through Attenuation (Switch OFF)      | 2.25            | 2.25            | $V_{IN}$ is centered at $V_{CC}/2$ . Adjust input for 0 dBm<br>$R_L = 600\Omega$ , $C_L = 50$ pF, $f_{IN} = 1\text{MHz}$ sine wave                                                   | -50   | dB   |
|           |                                            | 4.5             | 4.5             |                                                                                                                                                                                      | -50   |      |
|           |                                            | 6.0             | 6.0             |                                                                                                                                                                                      | -50   |      |
|           | Crosstalk (Control Input to Signal Output) | 2.25            | 2.25            | $R_L = 600\Omega$ , $C_L = 50$ pF, $f_{IN} = 1\text{MHz}$ square wave ( $t_r = t_f = 6\text{ns}$ )                                                                                   |       | mV   |
|           |                                            | 4.5             | 4.5             |                                                                                                                                                                                      | 5     |      |
|           |                                            | 6.0             | 6.0             |                                                                                                                                                                                      |       |      |
|           | Crosstalk (Between Any Switches)           | 2.25            | 2.25            | Adjust $V_{IN}$ to Obtain 0 dBm at input<br>$R_L = 600\Omega$ , $C_L = 50$ pF, $f_{IN} = 1\text{MHz}$ sine wave                                                                      | -50   | dB   |
|           |                                            | 4.5             | 4.5             |                                                                                                                                                                                      | -50   |      |
|           |                                            | 6.0             | 6.0             |                                                                                                                                                                                      | -50   |      |

## SWITCHING CHARACTERISTICS TEST CIRCUIT

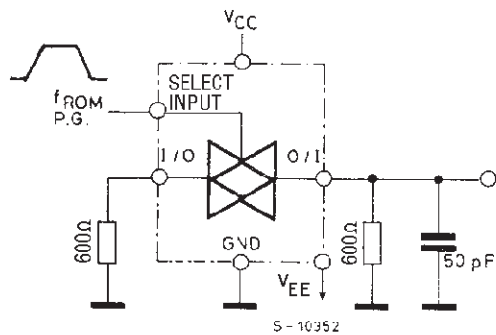
## CONTROL



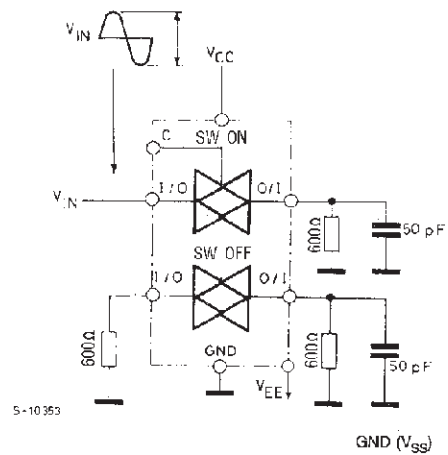
## ENABLE



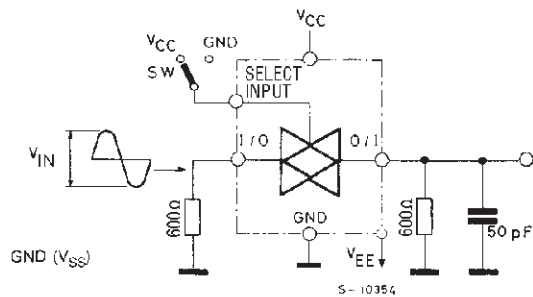
## CROSSTALK (control to output)



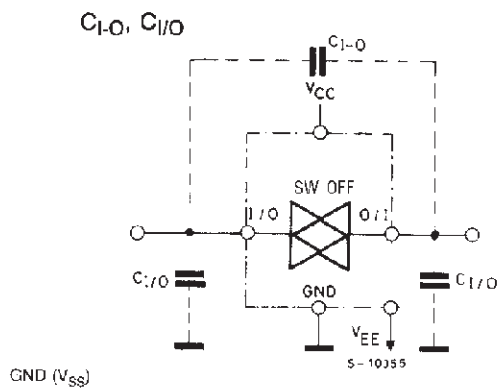
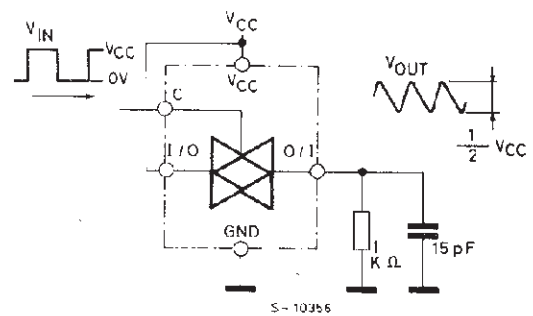
## CROSSTALK BETWEEN ANY TWO SWITCHES

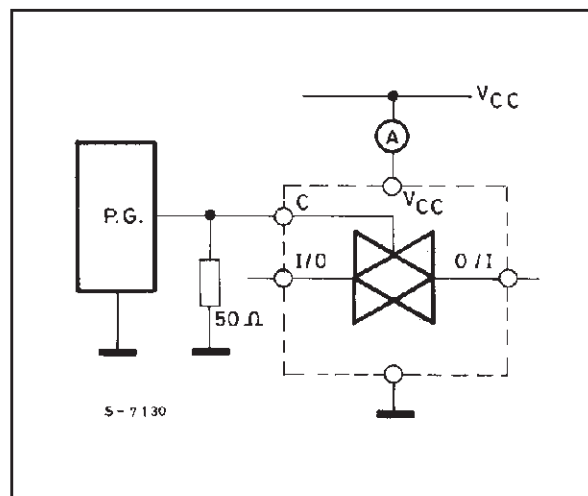
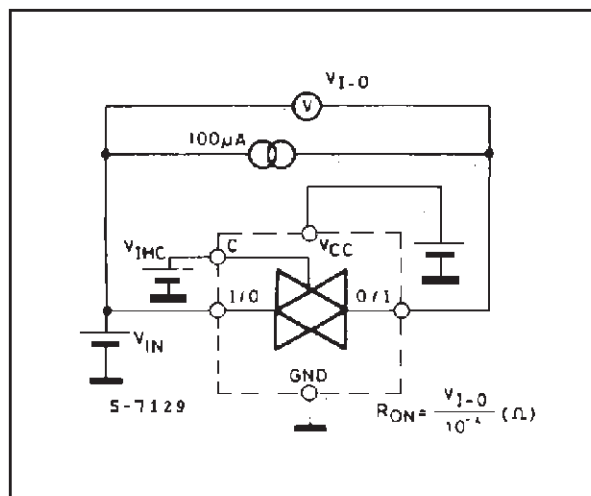


## BANDWIDTH AND FEEDTHROUGH ATTENUATION



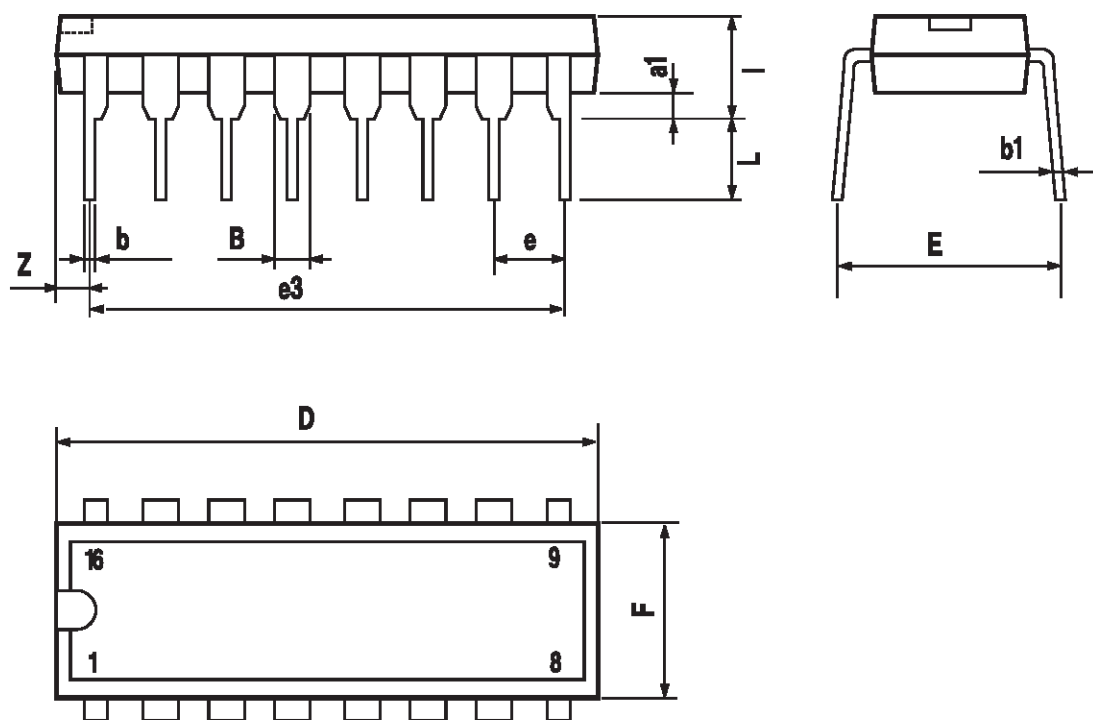
## MAXIMUM CONTROL FREQUENCY



$I_{CC} \text{ (Opr.)}$ 

## Plastic DIP-16 (0.25) MECHANICAL DATA

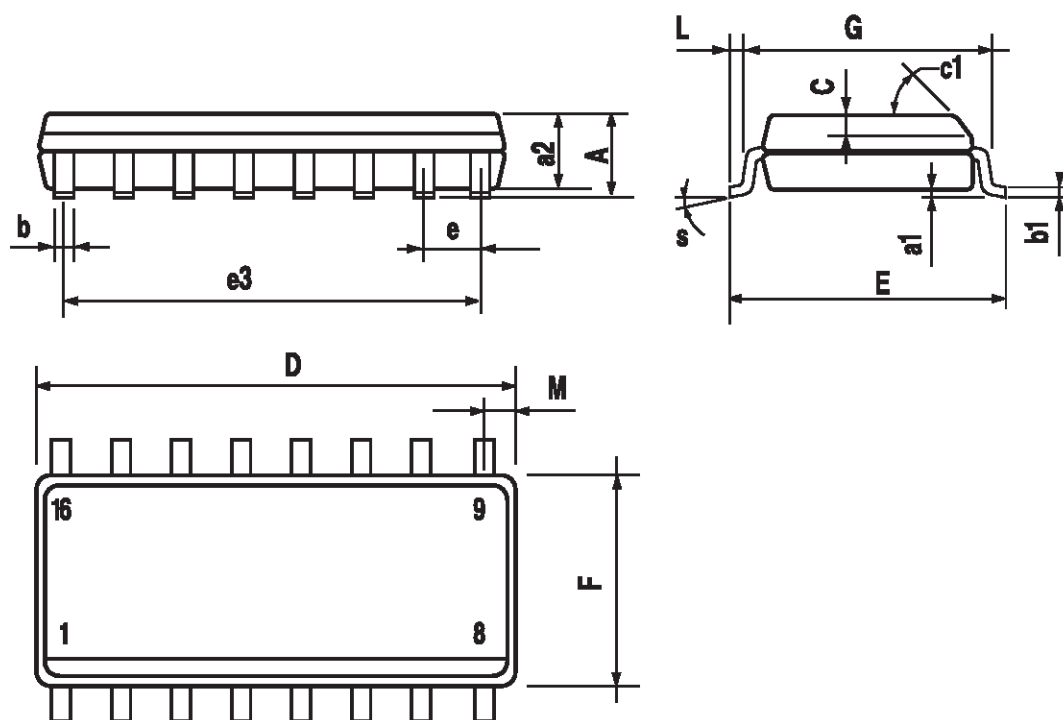
| DIM. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP   | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 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

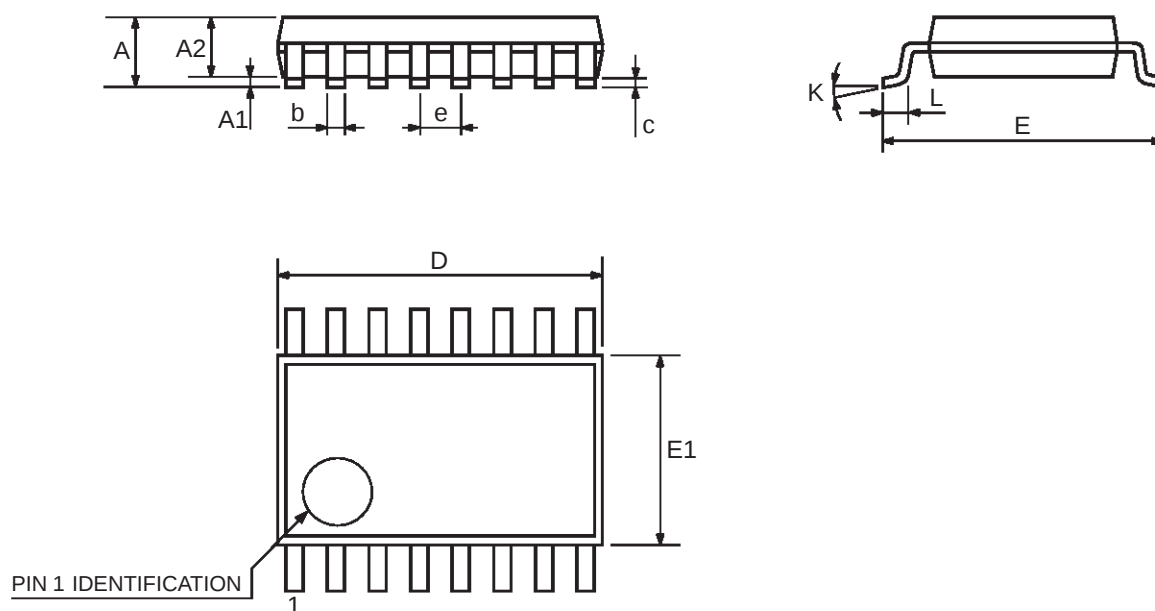
| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
|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

## 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 |            | 0.0089 |
| 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  |



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