

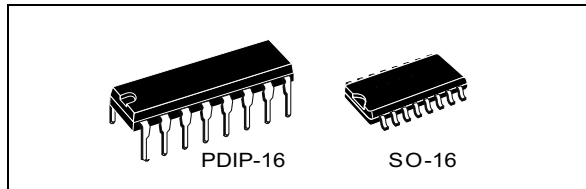


# THE DATASHEET OF HCF4051BE



## Single 8-channel analog multiplexer/demultiplexer

Datasheet - production data



### Features

- Low “ON” resistance: 125  $\Omega$  (typ.)
- Over 15 V p.p signal-input range for  $V_{DD} - V_{EE} = 15$  V
- High “OFF” resistance, channel leakage:  $\pm 100$  pA (typ.) at  $V_{DD} - V_{EE} = 18$  V
- Binary address decoding on chip
- High degree of linearity: < 0.5 % distortion typ. at  $f_{IS} = 1$  KHz,  $V_{IS} = 5$  V<sub>pp</sub>,  $V_{DD} - V_{SS} \geq 10$  V,  $R_L = 10$  k $\Omega$
- Very low quiescent power dissipation under all digital control input and supply conditions: 0.2  $\mu$ W (typ.)  $V_{DD} - V_{SS} = V_{DD} - V_{EE} = 10$  V
- Matched switch characteristics:  $R_{ON} = 5$   $\Omega$  (typ.) for  $V_{DD} - V_{EE} = 15$  V
- Wide range of digital and analog signal levels: digital 3 to 20, analog to 20 V p.p.
- Quiescent current specified up to 20 V
- 5 V, 10 V and 15 V parametric ratings
- ESD performance
  - HBM: 2 kV
  - MM: 200 V
  - CDM: 750 V

- Input leakage current  $I_I = 100$  nA (max.) at  $V_{DD} = 18$  V,  $T_A = 25$  °C
- 100 % tested for quiescent current

### Applications

- Automotive
- Industrial
- Computer
- Consumer

### Description

The HCF4051 device is a monolithic integrated circuit fabricated in MOS (metal oxide semiconductor) technology available in SO-16 and PDIP-16 packages.

The HCF4051 analog multiplexer/demultiplexer is a digitally controlled analog switch having low ON impedance and very low OFF leakage current. This multiplexer circuit dissipates 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.

This device is a single 8-channel multiplexer having three binary control inputs, A, B, and C, and an inhibit input. The three binary signals select 1 of 8 channels to be turned on, and connect one of the 8 inputs to the output. When a logic “1” is present at the inhibit input terminal all channels are off.

Table 1. Device summary

| Order code                    | Temperature range | Package                   | Packaging     | Marking   |
|-------------------------------|-------------------|---------------------------|---------------|-----------|
| HCF4051M013TR                 | -55/+125 °C       | SO-16                     | Tape and reel | HCF4051   |
| HCF4051YM013TR <sup>(1)</sup> | -40/+125 °C       | SO16 (automotive version) |               | HCF4051Y  |
| HCF4051BEY                    | -55/+125 °C       | PDIP-16                   | Tube          | HCF4051BE |

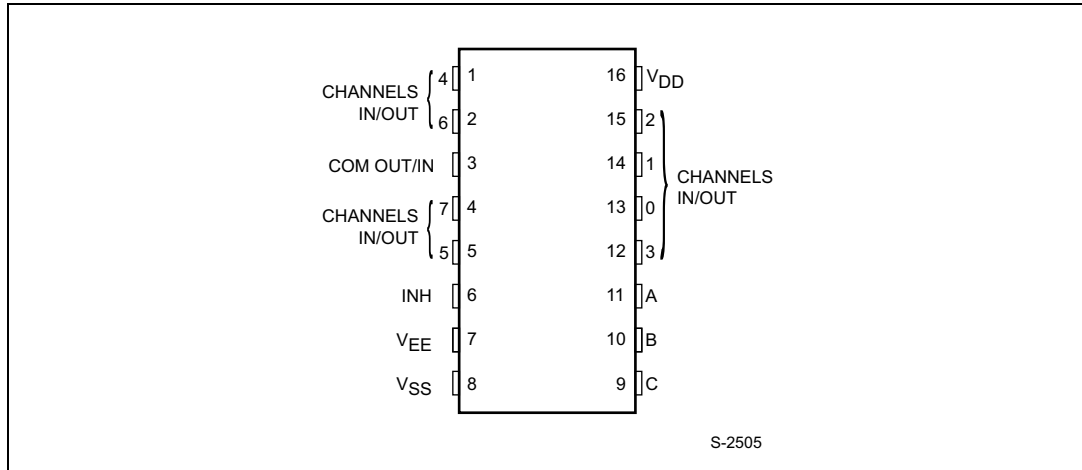
1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

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# 1 Pin information

**Figure 1. Pin connections (top view)**



**Table 2. Pin description**

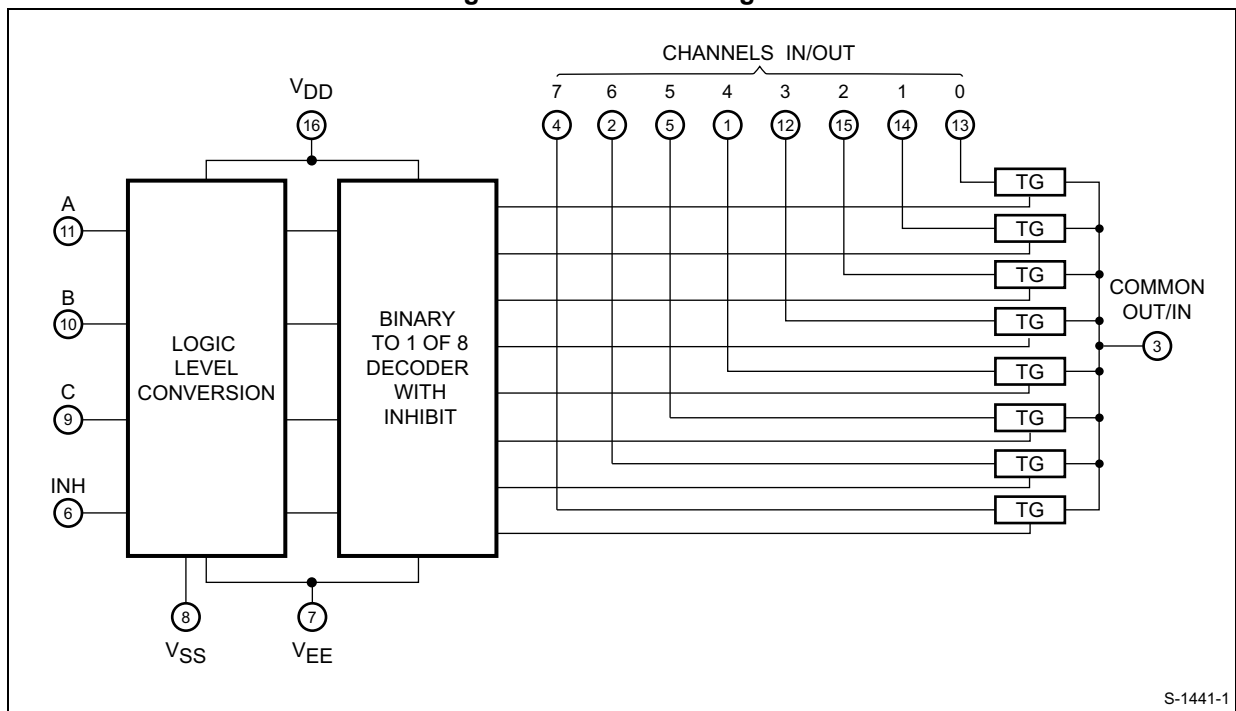
| Pin no.                    | Symbol                | Name and function          |
|----------------------------|-----------------------|----------------------------|
| 11, 10, 9                  | A, B, C               | Binary control inputs      |
| 6                          | INH                   | Inhibit inputs             |
| 13, 14, 15, 12, 1, 5, 2, 4 | 0 to 7 channel IN/OUT | Independent inputs/outputs |
| 3                          | COM OUT/IN            | Common output/input        |
| 7                          | V <sub>EE</sub>       | Supply voltage             |
| 8                          | V <sub>SS</sub>       | Negative supply voltage    |
| 16                         | V <sub>DD</sub>       | Positive supply voltage    |

## 2 Functional description

Table 3. Truth table

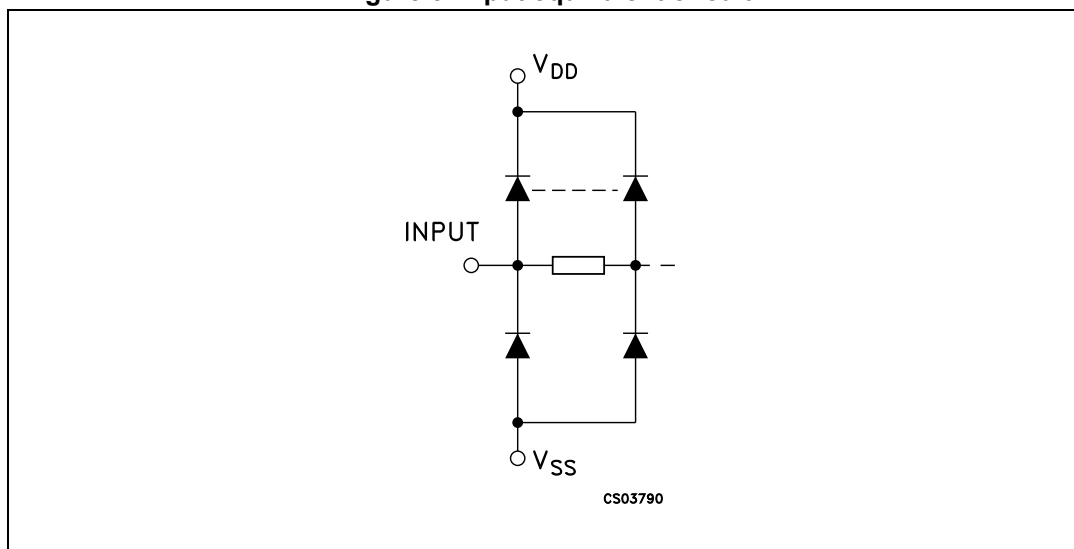
| Input states |   |   |   | "ON" channel (S) |
|--------------|---|---|---|------------------|
| Inhibit      | C | B | A |                  |
| 0            | 0 | 0 | 0 | 0                |
| 0            | 0 | 0 | 1 | 1                |
| 0            | 0 | 1 | 0 | 2                |
| 0            | 0 | 1 | 1 | 3                |
| 0            | 1 | 0 | 0 | 4                |
| 0            | 1 | 0 | 1 | 5                |
| 0            | 1 | 1 | 0 | 6                |
| 0            | 1 | 1 | 1 | 7                |
| 1            | X | X | X | None             |

Figure 2. Functional diagram



S-1441-1

Figure 3. Input equivalent circuit



### 3 Electrical characteristics

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.

**Table 4. Absolute maximum ratings**

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|---|------------------------|------|
| $V_{DD}$  | Supply voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC input voltage                        | -0.5 to $V_{DD} + 0.5$ |      |
| $I_I$     | DC input current                        | $\pm 10$               | mA   |
| $P_D$     | Power dissipation per package           | 500 <sup>(1)</sup>     | mW   |
|           | Power dissipation per output transistor | 100                    |      |
| $T_{op}$  | Operating temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage temperature                     | -65 to +150            |      |

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

**Table 5. Recommended operating conditions**


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

Table 6. DC specifications

| Symbol                              | Parameter  | Test condition                     |                       |   |                 | Value                            |               |           |   |         | Unit          |
|-------------------------------------|--|------------------------------------|-----------------------|---|-----------------|----------------------------------|---------------|-----------|---|---------|---------------|
|                                     |  | $V_{IS}$<br>(V)                    | $V_{EE}$<br>(V)       | $V_{SS}$<br>(V)   | $V_{DD}$<br>(V) | $T_A = 25\text{ }^\circ\text{C}$ |               |           | $-55\text{ to }125\text{ }^\circ\text{C}$ |         |               |
|                                     |  |                                    |                       |   |                 | Min.                             | Typ.          | Max.      | Min.                                      | Max.    |               |
| $I_L$                               | Quiescent device current (all switches ON or all switches OFF) |                                    |                       |   | 5               |                                  | 0.04          | 5         |   | 150     | $\mu\text{A}$ |
|                                     |  |                                    |                       |   | 10              |                                  | 0.04          | 10        |   | 300     |               |
|                                     |  |                                    |                       |   | 15              |                                  | 0.04          | 20        |   | 600     |               |
|                                     |  |                                    |                       |   | 20              |                                  | 0.08          | 100       |   | 3000    |               |
| <b>Switch</b>                       |  |                                    |                       |   |                 |                                  |               |           |   |         |               |
| $R_{ON}$                            | Resistance   | $0 \leq V_I \leq V_{DD}$           | 0                     | 0   | 5               |                                  | 470           | 1050      |   | 1200    | $\Omega$      |
|                                     |  |                                    |                       |   | 10              |                                  | 180           | 400       |   | 520     |               |
|                                     |  |                                    |                       |   | 15              |                                  | 125           | 280       |   | 360     |               |
| $D_{ON}$                            | Resistance $\Delta R_{ON}$<br>(between any 2 of 4 switches)    | $0 \leq V_I \leq V_{DD}$           | 0                     | 0   | 5               |                                  | 10            |           |   |         | $\Omega$      |
|                                     |  |                                    |                       |   | 10              |                                  | 10            |           |   |         |               |
|                                     |  |                                    |                       |   | 15              |                                  | 5             |           |   |         |               |
| OFF <sup>(1)</sup>                  | Channel leakage current (all channels OFF)<br>(COMMON O/I)     |                                    | 0                     | 0   | 18              |                                  | $\pm 0.1$     | 100       |   | 1000    | $\text{nA}$   |
| OFF <sup>(1)</sup>                  | Channel leakage current (any channel OFF)                      |                                    | 0                     | 0   | 18              |                                  | $\pm 0.1$     | 100       |   | 1000    |               |
| $C_I$                               | Input capacitance  |                                    |                       |   |                 |                                  | 5             |           |   |         | $\text{pF}$   |
| $C_O$                               | Output capacitance   |                                    | -5                    | -5  | 5               |                                  | 30            |           |   |         |               |
| $C_{IO}$                            | Feedthrough  |                                    |                       |   |                 |                                  | 0.2           |           |   |         |               |
| <b>Control (address or inhibit)</b> |  |                                    |                       |   |                 |                                  |               |           |   |         |               |
| $V_{IL}$                            | Input low voltage  | $= V_{DD}$ through<br>1 K $\Omega$ |                       | $V_{EE} = V_{SS}$<br>$R_L = 1\text{K}\Omega$<br>to $V_{SS}$<br>$I_{IS} < 2\mu\text{A}$<br>(on all OFF channels) | 5               |                                  |               | 1.5       |   | 1.5     | $\text{V}$    |
|                                     |  |                                    |                       |   | 10              |                                  |               | 3         |   | 3       |               |
|                                     |  |                                    |                       |   | 15              |                                  |               | 4         |   | 4       |               |
| $V_{IH}$                            | Input high voltage   |                                    |                       |   | 5               | 3.5                              |               |           | 3.5                                       |         | $\text{V}$    |
|                                     |  |                                    |                       |   | 10              | 7                                |               |           | 7   |         |               |
|                                     |  |                                    |                       |   | 15              | 11                               |               |           | 11  |         |               |
| $I_{IH}, I_{IL}$                    | Input leakage current  |                                    | $V_I = 0/18\text{ V}$ |   | 18              |                                  | $\pm 10^{-3}$ | $\pm 0.1$ |   | $\pm 1$ | $\mu\text{A}$ |
| $C_I$                               | Input capacitance  |                                    |                       |   |                 |                                  | 5             | 7.5       |   |         | $\text{pF}$   |

1. Determined by minimum feasible leakage measurement for automating testing.

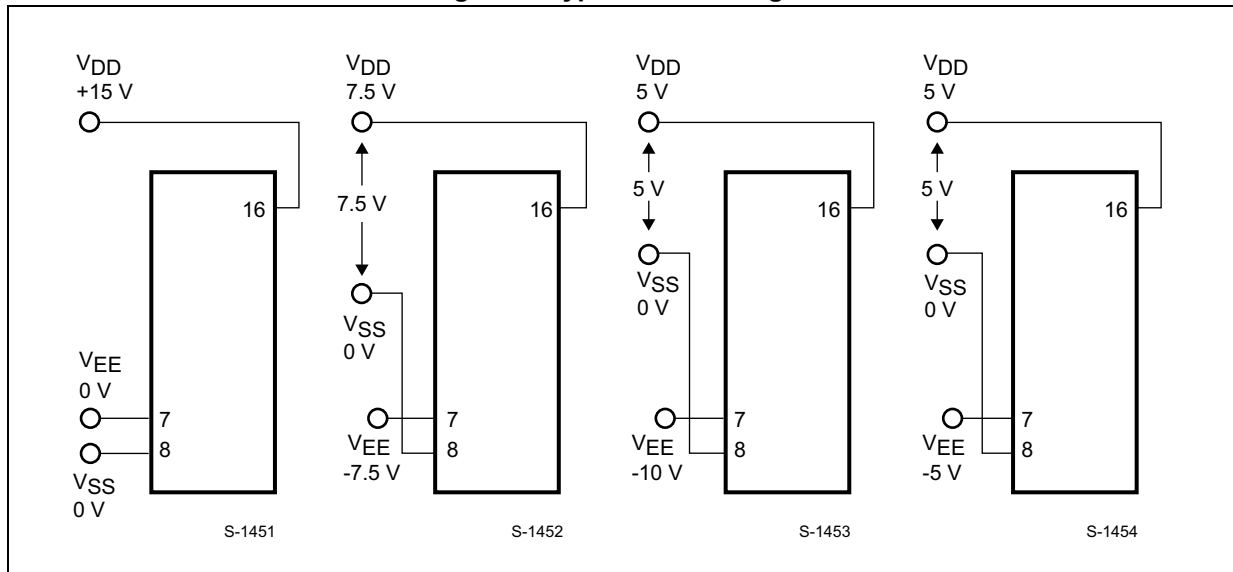
**Table 7. Dynamic electrical characteristics**  
 (T<sub>amb</sub> = 25 °C, C<sub>L</sub> = 50 pF, all input square wave rise and fall time = 20 ns)<sup>(1)</sup>

| Parameter  | Test condition      |                     |                      |  |                     |                     |  | Value |      |      | Unit    |    |
|--|---------------------|---------------------|----------------------|--|---------------------|---------------------|--|-------|------|------|---------|----|
|  | V <sub>EE</sub> (V) | R <sub>L</sub> (KΩ) | f <sub>i</sub> (KHz) | V <sub>I</sub> (V)   | V <sub>SS</sub> (V) | V <sub>DD</sub> (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> = -3 dB | =V <sub>SS</sub>    | 1                   |                      | 5 <sup>(2)</sup>   |                     | 10                  | V <sub>O</sub> at common OUT/IN                                  |       | 20   |      | MHz     |    |
|  |                     |                     |                      |  |                     |                     | V <sub>O</sub> at any channel                                    |       | 60   |      |         |    |
| Feedthrough (all channels OFF) at 20 log V <sub>O</sub> /V <sub>I</sub> = -40 dB                   | =V <sub>SS</sub>    | 1                   |                      | 5 <sup>(2)</sup>   |                     | 10                  | V <sub>O</sub> at common OUT/IN                                  |       | 12   |      | MHz     |    |
|  |                     |                     |                      |  |                     |                     | V <sub>O</sub> at any channel                                    |       | 8    |      |         |    |
| Frequency signal crosstalk at 20 log V <sub>O</sub> /V <sub>I</sub> = -40 dB                       | =V <sub>SS</sub>    | 1                   |                      | 5 <sup>(2)</sup>   |                     | 10                  | Between any 2 channels   |       | 3    |      |         |    |
| Sine wave distortion f <sub>IS</sub> = 1 KHz sine wave   | =V <sub>SS</sub>    | 10                  | 1                    | 2 <sup>(2)</sup>   |                     | 5                   |  |       | 0.3  |      | %       |    |
|  |                     |                     |                      | 3 <sup>(2)</sup>   |                     | 10                  |  |       | 0.2  |      |         |    |
|  |                     |                     |                      | 5 <sup>(2)</sup>   |                     | 15                  |  |       | 0.12 |      |         |    |
| <b>Control (address or inhibit)</b>  |                     |                     |                      |  |                     |                     |  |       |      |      |         |    |
| 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.  
 2. Peak-to-peak voltage symmetrical about (V<sub>DD</sub> - V<sub>EE</sub>) /2.



Figure 4. Typical bias voltages



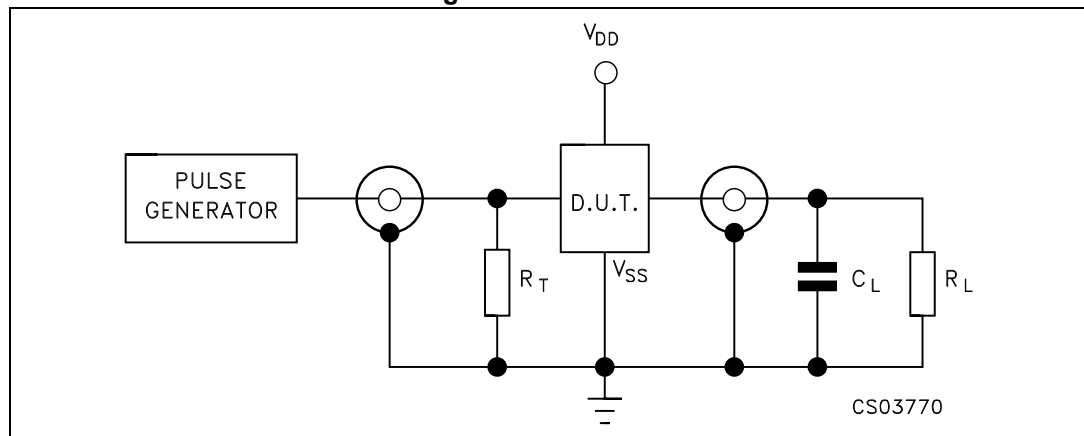
- The ADDRESS (digital-control inputs) and INHIBIT logic levels are : "0" =  $V_{SS}$  and "1" =  $V_{DD}$ . The analog signal (through the TG) may swing from  $V_{EE}$  to  $V_{DD}$ .

### Special considerations

Control of analog signals up to 20 V peak-to-peak can be achieved by digital signal amplitudes of 4.5 to 20 V (if  $V_{DD} - V_{SS} = 3$  V, a  $V_{DD} - V_{EE}$  of up to 13 V can be controlled; for  $V_{DD} - V_{EE}$  level differences above 13 V, a  $V_{DD} - V_{SS}$  of at least 4.5 V is required).

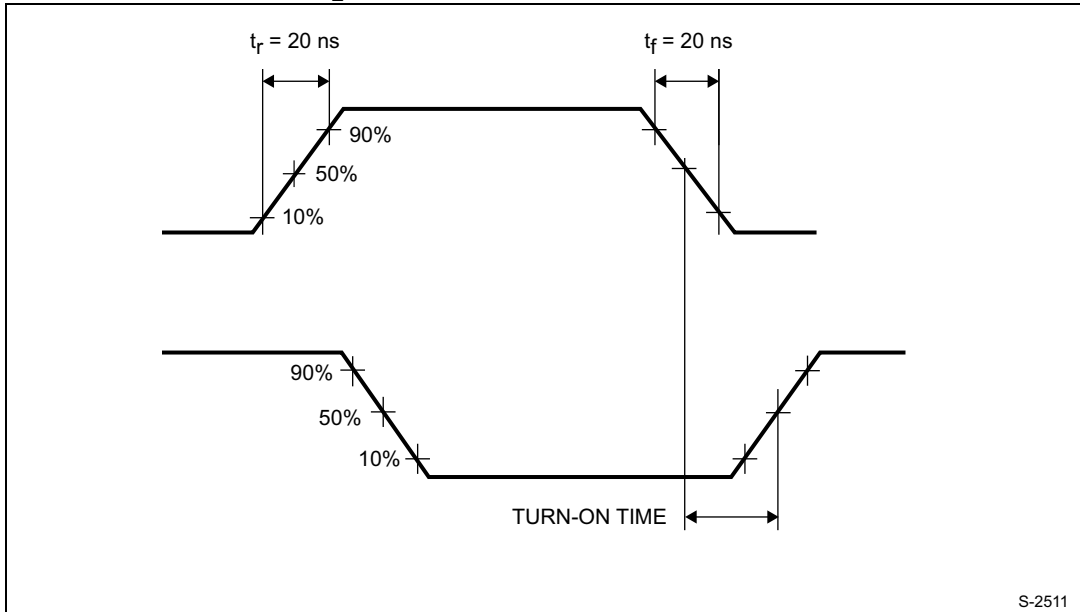
For example, if  $V_{DD} = +5$ ,  $V_{SS} = 0$ , and  $V_{EE} = -13.5$ , analog signals from -13.5 V to 4.5 V can be controlled by digital inputs of 0 to 4.5 V. In certain applications, the external load resistor current may include both  $V_{DD}$  and signal-line components. To avoid drawing  $V_{DD}$  current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.8 V (calculated from  $R_{ON}$  values shown in [Table 6: DC specifications](#)). No  $V_{DD}$  current flows through  $R_L$  if the switch current flows into lead 3.

Figure 5. Test circuit

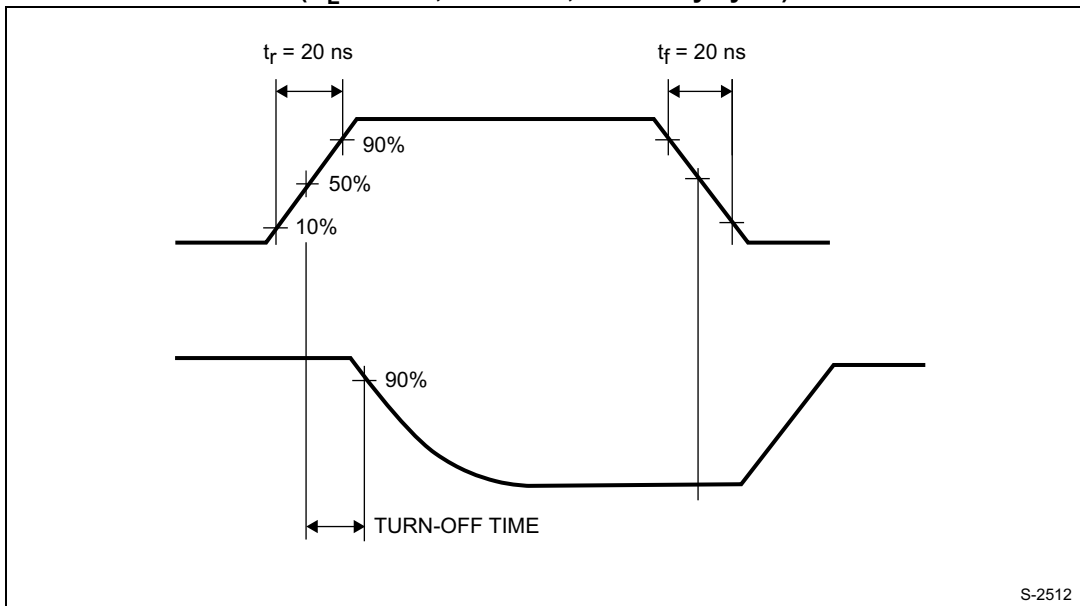


- $C_L = 50$  pF or equivalent (includes jig and probe capacitance)  
 $R_L = 200$  K $\Omega$   
 $R_T = Z_{OUT}$  of pulse generator (typically 50  $\Omega$ ).

**Figure 6. Waveform 1: channel turned ON**  
( $R_L = 1\text{ K}\Omega$ ,  $f = 1\text{ MHz}$ ; 50 % duty cycle)



**Figure 7. Waveform 2: channel turned OFF**  
( $R_L = 1\text{ KW}$ ,  $f = 1\text{ MHz}$ ; 50 % duty cycle)

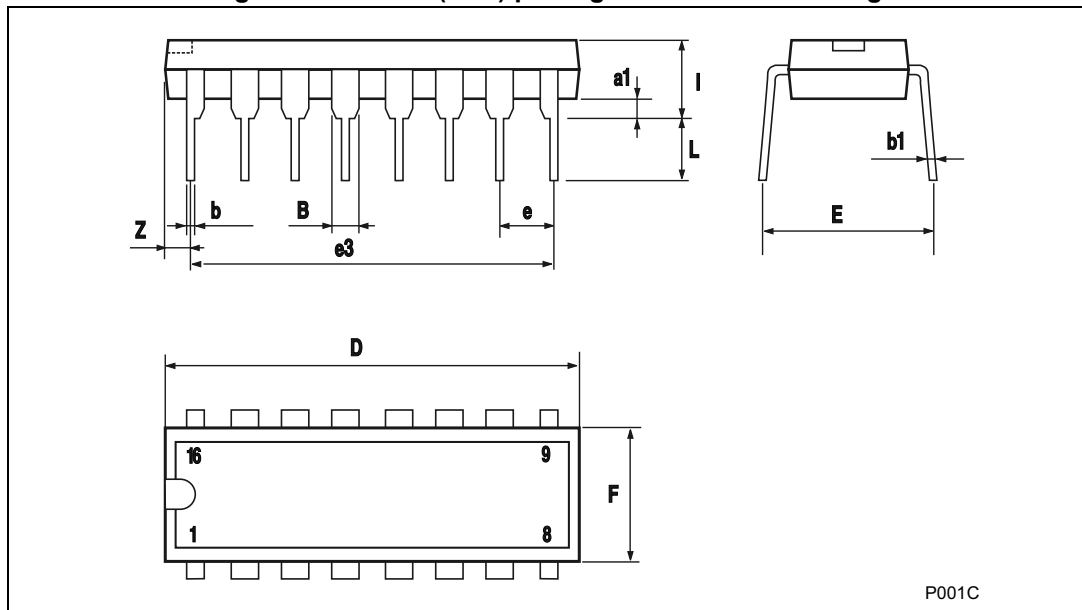


## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 PDIP-16 (0.25) package information

Figure 8. PDIP-16 (0.25) package mechanical drawing



P001C

Table 8. PDIP-16 (0.25) package mechanical data

| Symbol | Dimensions |       |      |       |       |       |
|--------|------------|-------|------|-------|-------|-------|
|        | 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 |

## 4.2 SO-16 package information

Figure 9. SO-16 package mechanical drawing

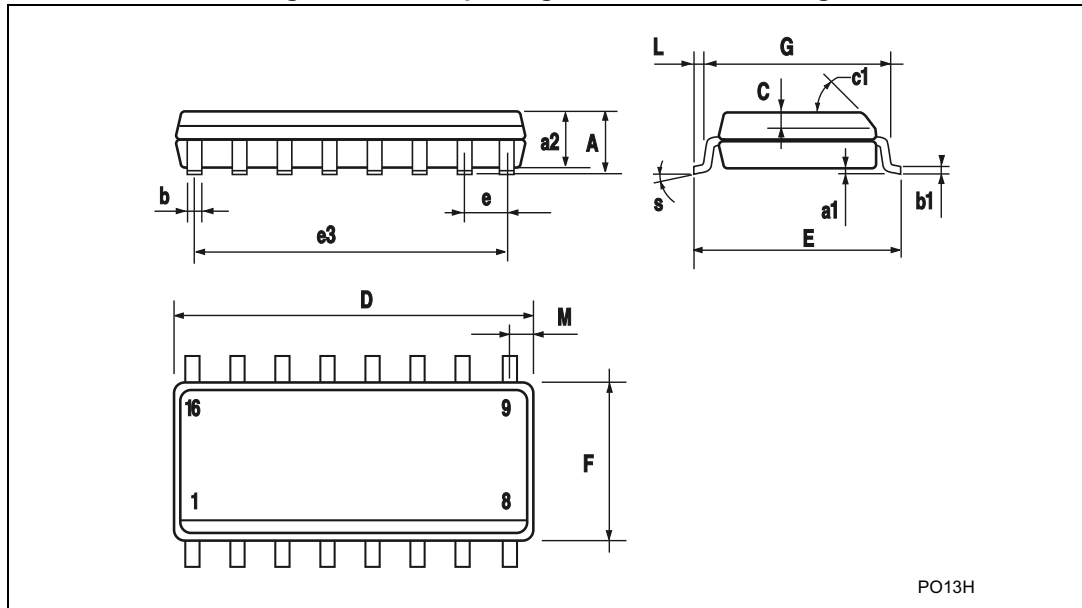


Table 9. SO-16 package mechanical data

| Symbol | Dimensions |      |      |       |       |       |
|--------|------------|------|------|-------|-------|-------|
|        | 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.)  |      |      |       |       |       |

## 5 Ordering information

**Table 10. Order codes**

| Order code                    | Temperature range | Package                      | Packaging     | Marking   |
|-------------------------------|-------------------|------------------------------|---------------|-----------|
| HCF4051M013TR                 | -55/+125 °C       | SO-16                        | Tape and reel | HCF4051   |
| HCF4051YM013TR <sup>(1)</sup> | -40/+125 °C       | SO16<br>(automotive version) |               | HCF4051Y  |
| HCF4051BEY                    | -55/+125 °C       | PDIP-16                      | Tube          | HCF4051BE |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

## 6 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 26-Oct-2012 | 2        | Updated <a href="#">Features</a> (added ESD values), added <a href="#">Applications</a> .<br>Updated <a href="#">Table 1</a> (reformatted table, added order codes, temperature range, marking, updated package and packaging).<br>Updated <a href="#">Description</a> (unified part numbers, moved to page 2).<br>Updated <a href="#">Section 2</a> to <a href="#">Section 4</a> (added titles and numbering).<br>Updated <a href="#">Table 6</a> (removed -40/+85° temperature range).<br>Reformatted <a href="#">Section 4</a> (added ECOPACK text, <a href="#">Figure 8</a> , <a href="#">Figure 9</a> , <a href="#">Table 8</a> , and <a href="#">Table 9</a> ).<br>Minor corrections throughout document. |
| 30-Apr-2013 | 3        | Updated <a href="#">Features</a> (ESD values)<br>Added <a href="#">Section 5: Ordering information</a>  |

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