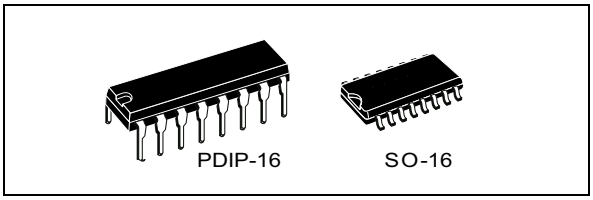
# HCF4051

## Single 8-channel analog multiplexer/demultiplexer

**Datasheet - production data**




## Features

- Low “ON” resistance: 125 Ω (typ.)
- Over 15 V p.p signal-input range for $V_{DD}$ - $V_{EE}$ = 15 V
- High “OFF” resistance, channel leakage: ± 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 $V_{pp}$, $V_{DD}$ - $V_{SS}$ ≥ 10 V, $R_L$ = 10 kΩ
- Very low quiescent power dissipation under all digital control input and supply conditions: 0.2 µW (typ.) $V_{DD}$ - $V_{SS}$ = $V_{DD}$ - $V_{EE}$ = 10 V
- Matched switch characteristics: $R_{ON}$ = 5 Ω (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 $_{VDD}$ - $V_{SS}$ 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(1) | -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.

# Contents

# 1 Pin information

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

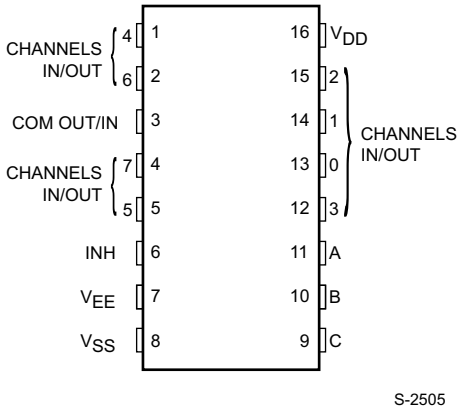



**Table 2. Pin description**

| 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 | $V_{EE}$ | Supply voltage |
| 8 | $V_{SS}$ | Negative supply voltage |
| 16 | $V_{DD}$ | 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**

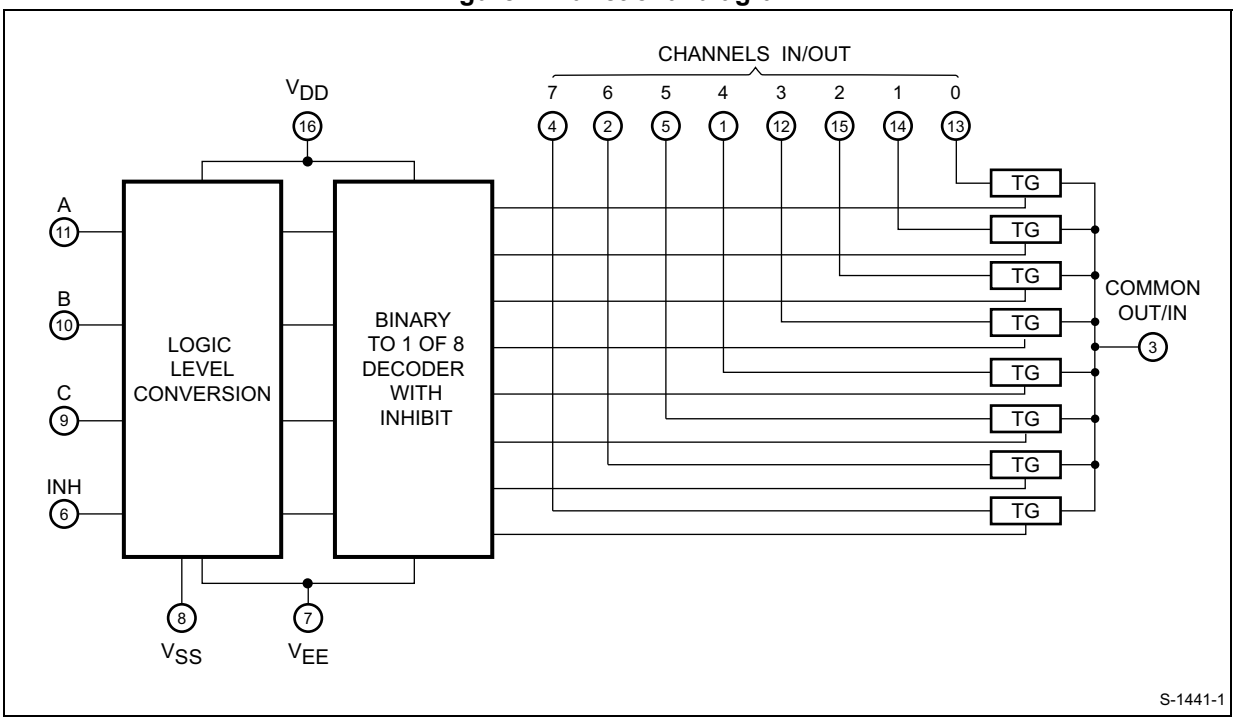
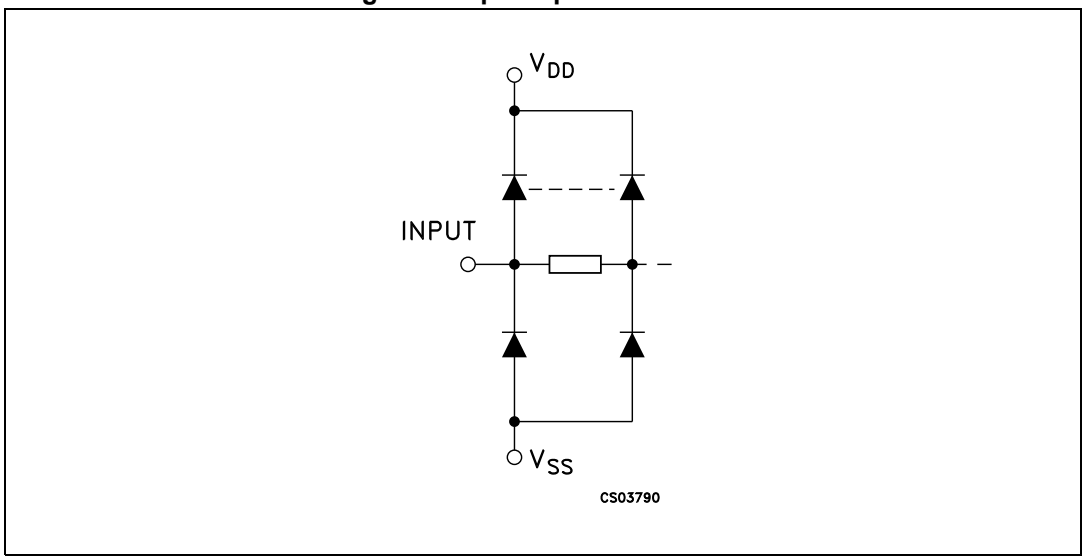


**Figure 3. Input equivalent circuit**



# 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 | ±10 | mA |
| $P_D$ | Power dissipation per package | 500(1) | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{IS}$ (V) | $V_{EE}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | $T_A$ = 25 °C | | | -55 to 125 °C | | |
| | | | | | | Min. | Typ. | Max. | Min. | Max. | |
| $I_L$ | Quiescent device current (all switches ON or all switches OFF) | | | | 5 | | 0.04 | 5 | | 150 | µA |
| | | | | | 10 | | 0.04 | 10 | | 300 | |
| | | | | | 15 | | 0.04 | 20 | | 600 | |
| | | | | | 20 | | 0.08 | 100 | | 3000 | |
| **Switch** | | | | | | | | | | | |
| $R_{ON}$ | Resistance | $0 \le V_I \le V_{DD}$ | 0 | 0 | 5 | | 470 | 1050 | | 1200 | Ω |
| | | | | | 10 | | 180 | 400 | | 520 | |
| | | | | | 15 | | 125 | 280 | | 360 | |
| $D_{ON}$ | Resistance $\Delta_{RON}$ (between any 2 of 4 switches) | $0 \le V_I \le V_{DD}$ | 0 | 0 | 5 | | 10 | | | | |
| | | | | | 10 | | 10 | | | | |
| | | | | | 15 | | 5 | | | | |
| $OFF^{(1)}$ | Channel leakage current (all channels OFF) (COMMON O/I) | | 0 | 0 | 18 | | ±0.1 | 100 | | 1000 | nA |
| $OFF^{(1)}$ | Channel leakage current (any channel OFF) | | 0 | 0 | 18 | | ±0.1 | 100 | | 1000 | |
| $C_I$ | Input capacitance | | -5 | -5 | 5 | | 5 | | | | pF |
| $C_O$ | Output capacitance | | | | | | 30 | | | | |
| $C_{IO}$ | Feedthrough | | | | | | 0.2 | | | | |
| **Control (address or inhibit)** | | | | | | | | | | | |
| $V_{IL}$ | Input low voltage | = $V_{DD}$ through 1 KΩ | $V_{EE}$ = $V_{SS}$ $R_L$ = 1KΩ to $V_{SS}$ $I_{IS}$ < 2µA (on all OFF channels) | | 5 | | | 1.5 | | 1.5 | V |
| | | | | | 10 | | | 3 | | 3 | |
| | | | | | 15 | | | 4 | | 4 | |
| $V_{IH}$ | Input high voltage | | | | 5 | 3.5 | | | 3.5 | | |
| | | | | | 10 | 7 | | | 7 | | |
| | | | | | 15 | 11 | | | 11 | | |
| $I_{IH}$, $I_{IL}$ | Input leakage current | $V_I$ = 0/18 V | | | 18 | | $\pm 10^{-3}$ | ±0.1 | | ±1 | µA |
| $C_I$ | Input capacitance | | | | | | 5 | 7.5 | | | pF |

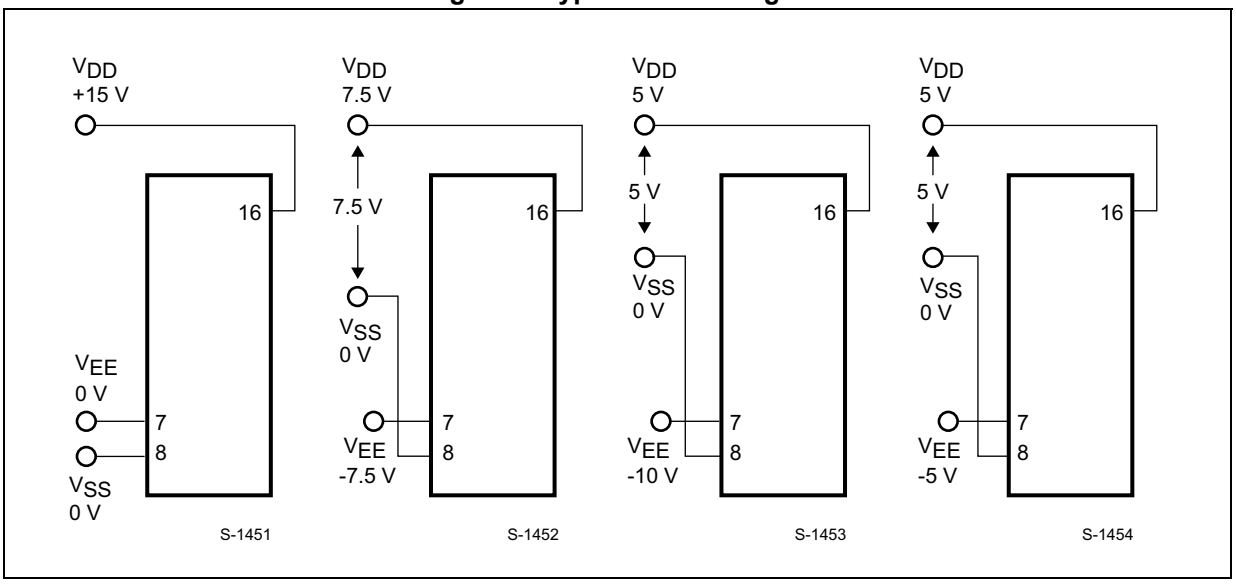
1. Determined by minimum feasible leakage measurement for automating testing.

**Table 7. Dynamic electrical characteristics**
**($T_{amb}$ = 25 °C, $C_L$ = 50 pF, all input square wave rise and fall time = 20 ns)(1)**

| Parameter | Test condition | | | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_{EE}$ (V) | $R_L$ (KΩ) | $f_I$ (KHz) | $V_I$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | | Min. | Typ. | Max. | |
| Propagation delay time (signal input to output) | | 200 | | $V_{DD}$ | | 5 | | | 30 | 60 | ns |
| | | | | | | 10 | | | 15 | 30 | |
| | | | | | | 15 | | | 11 | 20 | |
| Frequency response channel "ON" (sine wave input) at 20 log $V_O/V_I$ = -3 dB | = $V_{SS}$ | 1 | | 5(2) | | 10 | $V_O$ at common OUT/IN | | 20 | | MHz |
| | | | | | | | $V_O$ at any channel | | 60 | | |
| Feedthrough (all channels OFF) at 20 log $V_O/V_I$ = - 40 dB | = $V_{SS}$ | 1 | | 5(2) | | 10 | $V_O$ at common OUT/IN | | 12 | | |
| | | | | | | | $V_O$ at any channel | | 8 | | |
| Frequency signal crosstalk at 20 log $V_O/V_I$ = -40 dB | = $V_{SS}$ | 1 | | 5(2) | | 10 | Between any 2 channels | | 3 | | |
| Sine wave distortion $f_{IS}$ = 1 KHz sine wave | = $V_{SS}$ | 10 | 1 | 2(2) | | 5 | | | 0.3 | | % |
| | | | | 3(2) | | 10 | | | 0.2 | | |
| | | | | 5(2) | | 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 | |
| | 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 | |
| | 0 | | | | | 10 | | | 90 | 210 | |
| | 0 | | | | | 15 | | | 70 | 160 | |
| | -10 | | | | | 5 | | | 130 | 300 | |
| Address or inhibit to signal crosstalk | 0 | 10 (1) | | | 0 | 10 | $V_C = V_{DD} - V_{SS}$ (square wave) | | 65 | | mV peak |

1. Both ends of channel.
2. Peak-to-peak voltage symmetrical about ($V_{DD}$ - $V_{EE}$ ) /2.

**Figure 4. Typical bias voltages**



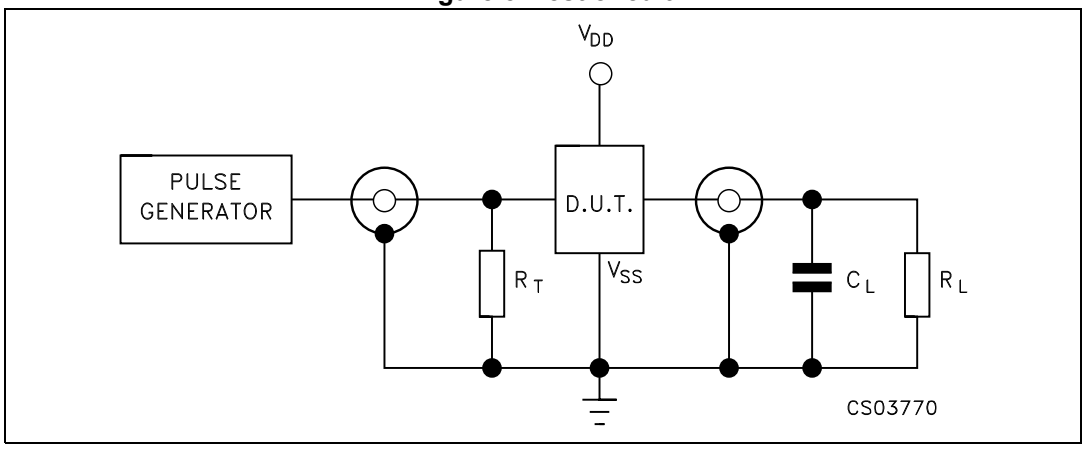

1. The ADDRESS (digital-control inputs) and INHIBIT logic levels are : “0” = $V_{SS}$ and “1” = $V_{DD}$. The analog signal (through the TG) may swing from $V_{EE}$ to $V_{DD}$.

## 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**




1. $C_L$ = 50 pF or equivalent (includes jig and probe capacitance)
   $R_L$ = 200 KΩ
   $R_T$ = $Z_{OUT}$ of pulse generator (typically 50 Ω).

**Figure 6. Waveform 1: channel turned ON ($R_L$ = 1 KΩ, f = 1 MHz; 50 % duty cycle)**

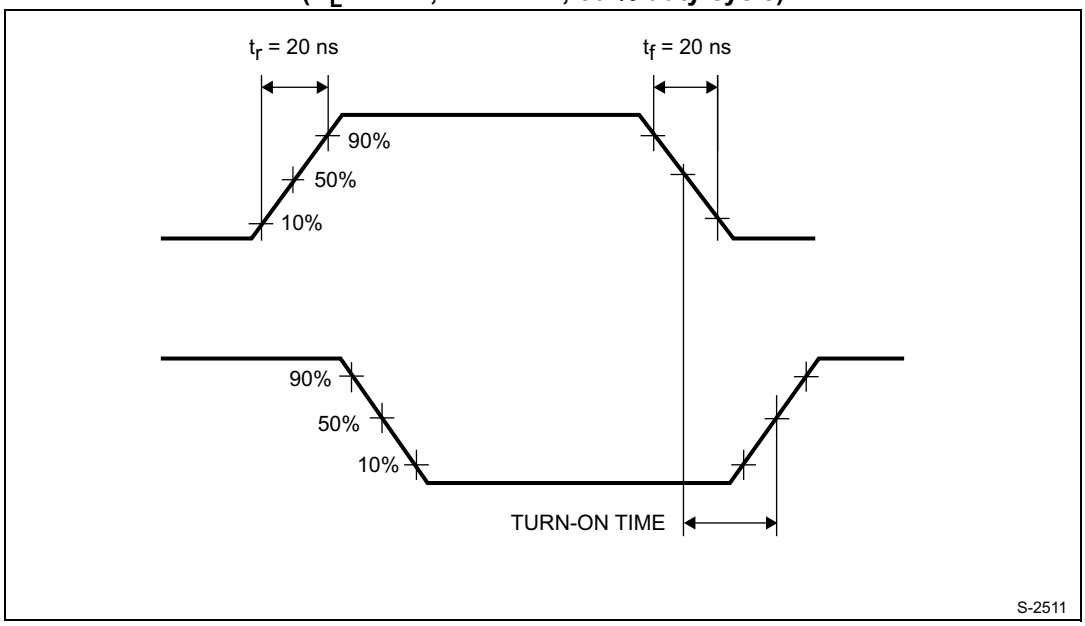
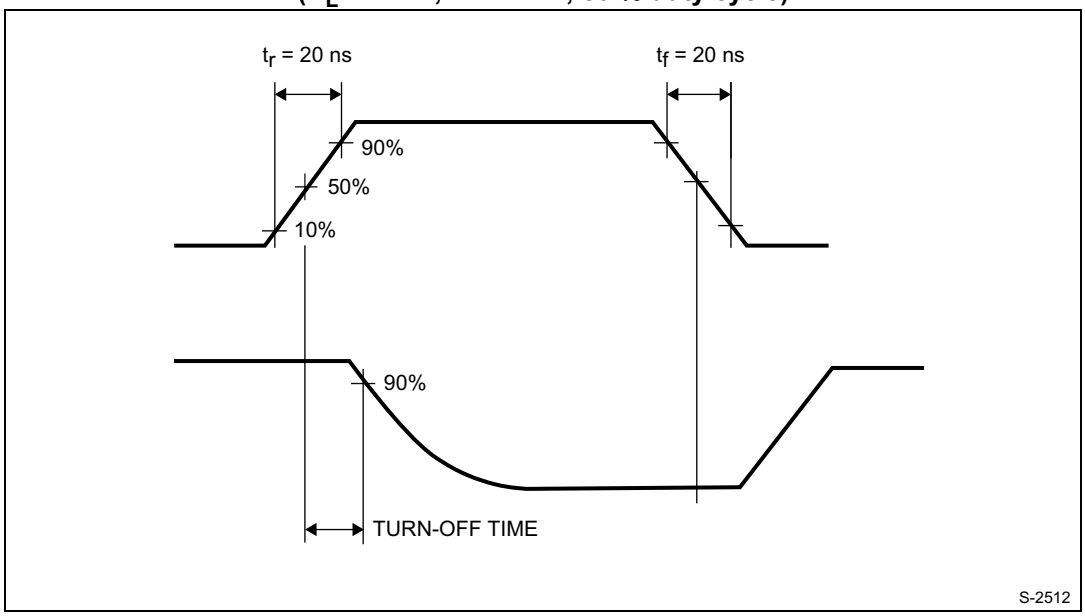



**Figure 7. Waveform 2: channel turned OFF ($R_L$ = 1 KW, f = 1 MHz; 50 % duty cycle)**



# 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*. ECOPACK is an ST trademark.

## 4.1 PDIP-16 (0.25) package information

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

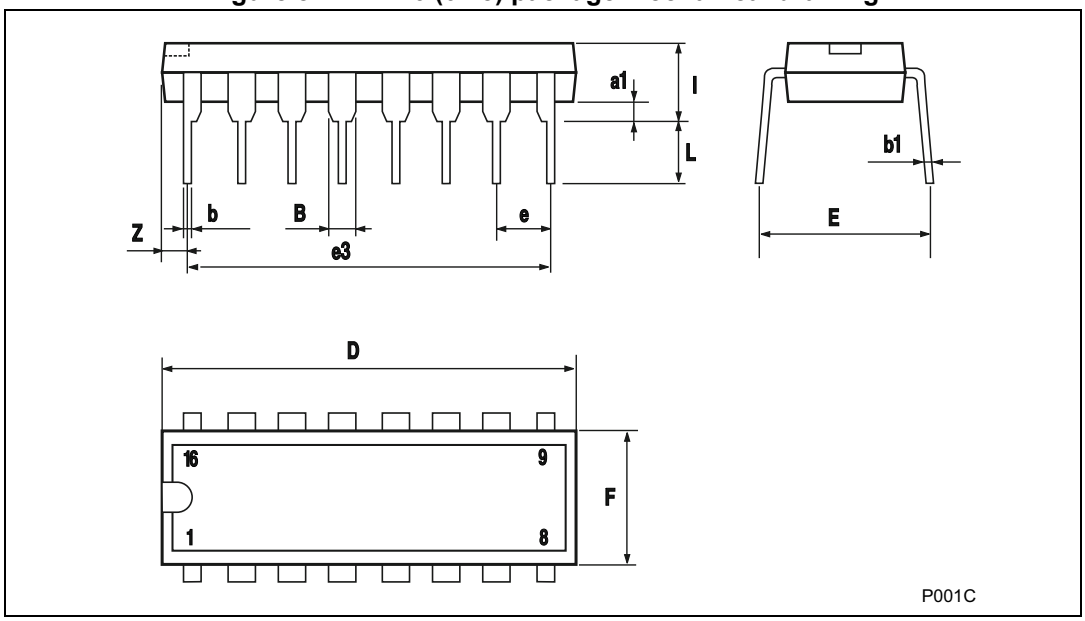



Table 8. PDIP-16 (0.25) package mechanical data

| 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

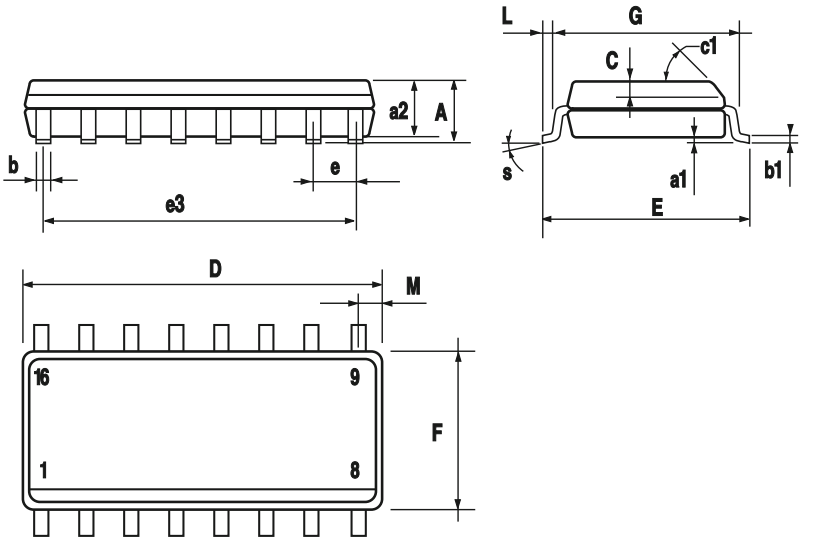



Table 9. SO-16 package mechanical data

| 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(1) | -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.

# 6 Revision history

**Table 11. Document revision history**

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

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