## 74HC4016

## Quad single-pole single-throw analog switch

Rev. 3 - 12 December 2016
Product data sheet

## 1. General description

The 74 HC 4016 is a quad single pole, single throw analog switch. Each switch features
 LOW, the analog switch is turned off. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of $\mathrm{V}_{\mathrm{cc}}$.

## 2. Features and benefits

- Input levels nE inputs:
- For 74HC4016: CMOS level
- Typical 'break before make’ built-in
- Low ON resistance:
$160 \Omega$ (typical) at $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$
- $120 \Omega$ (typical) at $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$
- $85 \Omega$ (typical) at $\mathrm{V}_{\mathrm{Cc}}=9.0 \mathrm{~V}$

■ Specified in compliance with JEDEC standard no. 7A

- ESD protection:
- HBM JESD22-A114F exceeds 2000 V
- MM JESD22-A115-A exceeds 200 V
- Specified from $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ and $-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$


## 3. Ordering information

Table 1. Ordering information

| Type number | Package | Version |  |  |
| :--- | :--- | :--- | :--- | :--- |
|  | Temperature range | Name | Description | SOT402-1 |
| 74 HC 4016 D | $-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |
| 74 HC 4016 PW | $-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ | TSSOP14 | plastic thin shrink small outline package; 14 leads; <br> body width 4.4 mm | SOT |

## 4. Functional diagram



Fig 1. Logic symbol

(a)

(b) 001aad270


Fig 3. Schematic diagram (one switch)

## 5. Pinning information

### 5.1 Pinning



Fig 4. Pin configuration for SO14


Fig 5. Pin configuration for TSSOP14

### 5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
| :--- | :--- | :--- |
| $1 Z, 2 Z, 3 Z, 4 Z$ | $2,3,9,10$ | independent input or output |
| $1 Y, 2 Y, 3 Y, 4 Y$ | $1,4,8,11$ | independent input or output |
| GND | 7 | ground $(0 \mathrm{~V})$ |
| $1 E, 2 \mathrm{E}, 3 \mathrm{E}, 4 \mathrm{E}$ | $13,5,6,12$ | enable input (active HIGH) |
| $\mathrm{V}_{\mathrm{CC}}$ | 14 | supply voltage |

## 6. Functional description

Table 3. Function table[1]

| Input nE | Switch |
| :--- | :--- |
| L | OFF |
| H | ON |

[1] $\mathrm{H}=\mathrm{HIGH}$ voltage level; L = LOW voltage level.

## 7. Limiting values

Table 4. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{CC}}$ | supply voltage |  | -0.5 | +11.0 | V |
| $\mathrm{I}_{\mathrm{K}}$ | input clamping current | $\mathrm{V}_{1}<-0.5 \mathrm{~V}$ or $\mathrm{V}_{1}>\mathrm{V}_{\mathrm{CC}}+0.5 \mathrm{~V}$ | - | $\pm 20$ | mA |
| $\mathrm{I}_{\text {SK }}$ | switch clamping current | $\mathrm{V}_{\mathrm{SW}}<-0.5 \mathrm{~V}$ or $\mathrm{V}_{\mathrm{SW}}>\mathrm{V}_{\mathrm{CC}}+0.5 \mathrm{~V}$ | - | $\pm 20$ | mA |
| ISW | switch current | $\mathrm{V}_{\text {SW }}=-0.5 \mathrm{~V}$ to $\mathrm{V}_{\mathrm{CC}}+0.5 \mathrm{~V}$ | - | $\pm 25$ | mA |
| ICC | supply current |  | - | +50 | mA |
| $\mathrm{I}_{\text {GND }}$ | ground current |  | -50 | - | mA |
| $\mathrm{T}_{\text {stg }}$ | storage temperature |  | -65 | +150 | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{P}_{\text {tot }}$ | total power dissipation | $\mathrm{T}_{\text {amb }}=-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ |  |  |  |
|  |  | SO14 and TSSOP14 packages | - | 500 | mW |
| P | power dissipation | per switch | - | 100 | mW |

[1] To avoid drawing $\mathrm{V}_{\mathrm{cc}}$ current out of terminal nZ , when switch current flows in terminals nY , the voltage drop across the bidirectional switch must not exceed 0.4 V . If the switch current flows into terminal nZ , no $\mathrm{V}_{\mathrm{CC}}$ current will flow out of terminals nY . In this case there is no limit for the voltage drop across the switch, but the voltages at nY and nZ may not exceed $\mathrm{V}_{\mathrm{CC}}$ or GND.
[2] For SO14 package: $\mathrm{P}_{\text {tot }}$ derates linearly with $8 \mathrm{~mW} / \mathrm{K}$ above $70^{\circ} \mathrm{C}$.
For TSSOP14 packages: $P_{\text {tot }}$ derates linearly with $5.5 \mathrm{~mW} / \mathrm{K}$ above $60^{\circ} \mathrm{C}$.

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {CC }}$ | supply voltage |  | 2.0 | 5.0 | 10.0 | V |
| $V_{1}$ | input voltage |  | GND | - | $\mathrm{V}_{\text {CC }}$ | V |
| $V_{\text {Sw }}$ | switch voltage |  | GND | - | $\mathrm{V}_{\mathrm{Cc}}$ | V |
| $\mathrm{T}_{\text {amb }}$ | ambient temperature |  | -40 | +25 | +125 | ${ }^{\circ} \mathrm{C}$ |
| $\Delta \mathrm{t} / \Delta \mathrm{V}$ | input transition rise and fall rate | $\mathrm{V}_{\mathrm{cc}}=2.0 \mathrm{~V}$ | - | - | 625 | $\mathrm{ns} / \mathrm{V}$ |
|  |  | $\mathrm{V}_{C C}=4.5 \mathrm{~V}$ | - | 1.67 | 139 | $\mathrm{ns} / \mathrm{V}$ |
|  |  | $\mathrm{V}_{\mathrm{cc}}=6.0 \mathrm{~V}$ | - | - | 83 | $\mathrm{ns} / \mathrm{V}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | 35 | $\mathrm{ns} / \mathrm{V}$ |

## 9. Static characteristics

Table 6. Ron resistance per switch
$V_{I}=V_{I H}$ or $V_{I L}$; for test circuit see Figure 6.
$V_{\text {is }}$ is the input voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.
For 74HC4016: $V_{C C}-G N D=2.0 \mathrm{~V}, 4.5 \mathrm{~V}, 6.0 \mathrm{~V}$ and 9.0 V .

| Symbol | Parameter | Conditions | $+25^{\circ} \mathrm{C}$ |  | $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  | $-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Typ | Max | Min | Max | Min | Max |  |
| $\mathrm{R}_{\text {ON( }}$ (peak) | ON resistance (peak) | $\mathrm{V}_{\text {is }}=\mathrm{V}_{\mathrm{Cc}}$ to GND |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V} ; \mathrm{I}_{\text {SW }}=0.1 \mathrm{~mA} \quad \underline{\text { [1] }}$ | - | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 160 | 320 | - | 400 | - | 480 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V} ; \mathrm{I}_{\text {SW }}=1 \mathrm{~mA}$ | 120 | 240 | - | 300 | - | 360 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 85 | 170 | - | 213 | - | 255 | $\Omega$ |
| $\mathrm{R}_{\text {ON(rail) }}$ | ON resistance (rail) | $\mathrm{V}_{\text {is }}=$ GND |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=0.1 \mathrm{~mA} \quad$ [1] | 160 | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 80 | 160 | - | 200 | - | 240 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 70 | 140 | - | 175 | - | 210 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 60 | 120 | - | 150 | - | 180 | $\Omega$ |
|  |  | $\mathrm{V}_{\text {is }}=\mathrm{V}_{\mathrm{Cc}}$ |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V} ; \mathrm{I}_{\text {SW }}=0.1 \mathrm{~mA} \quad \underline{\text { [1] }}$ | 170 | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 90 | 180 | - | 225 | - | 270 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V} ; \mathrm{I}_{\mathrm{SW}}=1 \mathrm{~mA}$ | 80 | 160 | - | 200 | - | 240 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V} ; \mathrm{I}_{\text {SW }}=1 \mathrm{~mA}$ | 65 | 135 | - | 170 | - | 205 | $\Omega$ |
| $\Delta R_{\mathrm{ON}}$ | ON resistance mismatch between channels | $\mathrm{V}_{\text {is }}=\mathrm{V}_{\mathrm{Cc}}$ to GND |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V}$ | - | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | 16 | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | 12 | - | - | - | - | - | $\Omega$ |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | 9 | - | - | - | - | - | $\Omega$ |

[1] At supply voltages ( $\mathrm{V}_{\mathrm{Cc}}-\mathrm{GND}$ ) approaching 2 V , the analog switch ON resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital signals only, when using these supply voltages.


$$
\begin{aligned}
& \mathrm{V}_{\text {is }}=0 \mathrm{~V} \text { to } \mathrm{V}_{\mathrm{cc}} \\
& R_{O N}=\frac{V_{S W}}{I_{S W}}
\end{aligned}
$$

Fig 6. Test circuit for measuring $\mathrm{R}_{\mathrm{ON}}$


$$
V_{\text {is }}=0 \mathrm{~V} \text { to } \mathrm{V}_{\mathrm{cc}}
$$

Fig 7. Typical $R_{\text {ON }}$ as a function of input voltage $V_{\text {is }}$

Table 7. Static characteristics
At recommended operating conditions; voltages are referenced to GND (ground = 0 V ).
$V_{i s}$ is the input voltage at a $n Y$ or terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.

| Symbol | Parameter | Conditions | Min | Typ[1] | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{Tamb}^{\text {a }}=+25^{\circ} \mathrm{C}$ |  |  |  |  |  |  |
| $\mathrm{V}_{\mathrm{IH}}$ | HIGH-level input voltage | $\mathrm{V}_{C C}=2.0 \mathrm{~V}$ | 1.5 | 1.2 | - | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | 3.15 | 2.4 | - | V |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | 4.2 | 3.2 | - | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | 6.3 | 4.3 | - | V |
| $\mathrm{V}_{\text {IL }}$ | LOW-level input voltage | $\mathrm{V}_{C C}=2.0 \mathrm{~V}$ | - | 0.8 | 0.5 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | - | 2.1 | 1.35 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | 2.8 | 1.80 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | - | 4.3 | 2.70 | V |
| 1 | input leakage current | $\mathrm{V}_{1}=\mathrm{V}_{\mathrm{CC}}$ or GND |  |  |  |  |
|  |  | $\mathrm{V}_{\text {CC }}=6.0 \mathrm{~V}$ | - | - | $\pm 0.1$ | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | $\pm 0.2$ | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {(OFF) }}$ | OFF-state leakage current | $\begin{aligned} & V_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \left\|\mathrm{V}_{\mathrm{SW}}\right\|=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} ; \text { see Figure } 8 \end{aligned}$ |  |  |  |  |
|  |  | per channel | - | - | $\pm 0.1$ | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {(ON })}$ | ON-state leakage current | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \left\|\mathrm{V}_{\mathrm{SW}}\right\|=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} ; \text {; see Figure 9 } \end{aligned}$ | - | - | $\pm 0.1$ | $\mu \mathrm{A}$ |

Table 7. Static characteristics
At recommended operating conditions; voltages are referenced to GND (ground = 0 V ).
$V_{i s}$ is the input voltage at a $n Y$ or terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.

| Symbol | Parameter | Conditions | Min | Typ[1] | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ICC | supply current | $\begin{aligned} & V_{1}=V_{\mathrm{CC}} \text { or } \mathrm{GND} ; \mathrm{V}_{\text {is }}=\mathrm{GND} \text { or } \mathrm{V}_{\mathrm{Cc}} ; \\ & \mathrm{V}_{\mathrm{os}}=\mathrm{V}_{\mathrm{CC}} \text { or } \mathrm{GND} \end{aligned}$ |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | - | 2.0 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | 4.0 | $\mu \mathrm{A}$ |
| $\mathrm{C}_{1}$ | input capacitance |  | - | 3.5 | - | pF |
| $\mathrm{C}_{\text {sw }}$ | switch capacitance |  | - | 5 | - | pF |
| $\mathrm{T}_{\text {amb }}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  |  |  |  |  |  |
| $\mathrm{V}_{\mathrm{IH}}$ | HIGH-level input voltage | $\mathrm{V}_{\mathrm{cc}}=2.0 \mathrm{~V}$ | 1.5 | - | - | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | 3.15 | - | - | V |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | 4.2 | - | - | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | 6.3 | - | - | V |
| VIL | LOW-level input voltage | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V}$ | - | - | 0.50 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | - | - | 1.35 | V |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | - | - | 1.80 | V |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | - | - | 2.70 | V |
| 1 | input leakage current | $\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{CC}}$ or GND |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{C C}=10.0 \mathrm{~V}$ | - | - | $\pm 2.0$ | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {S(OFF) }}$ | OFF-state leakage current | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \left\|\mathrm{V}_{\mathrm{SW}}\right\|=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} \text {; see Figure } 8 \end{aligned}$ |  |  |  |  |
|  |  | per channel | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
| $\mathrm{IS}_{\text {(ON })}$ | ON-state leakage current | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \left\|\mathrm{V}_{\mathrm{SW}}\right\|=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} \text {; see Figure } 9 \end{aligned}$ | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
| ICC | supply current | $\begin{aligned} & \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{CC}} \text { or } \mathrm{GND} ; \mathrm{V}_{\text {is }}=\mathrm{GND} \text { or } \mathrm{V}_{\mathrm{Cc}} ; \\ & \mathrm{V}_{\mathrm{os}}=\mathrm{V}_{\mathrm{CC}} \text { or } \mathrm{GND} \end{aligned}$ |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | - | 20.0 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | 40.0 | $\mu \mathrm{A}$ |
| $\mathrm{T}_{\text {amb }}=-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ |  |  |  |  |  |  |
| $\mathrm{V}_{\mathrm{IH}}$ | HIGH-level input voltage | $\mathrm{V}_{C C}=2.0 \mathrm{~V}$ | 1.5 | - | - | V |
|  |  | $\mathrm{V}_{C C}=4.5 \mathrm{~V}$ | 3.15 | - | - | V |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | 4.2 | - | - | V |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | 6.3 | - | - | V |
| VIL | LOW-level input voltage | $\mathrm{V}_{C C}=2.0 \mathrm{~V}$ | - | - | 0.50 | V |
|  |  | $\mathrm{V}_{C C}=4.5 \mathrm{~V}$ | - | - | 1.35 | V |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | - | - | 1.80 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | - | - | 2.70 | V |
| 1 | input leakage current | $\mathrm{V}_{1}=\mathrm{V}_{\mathrm{CC}}$ or GND |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | $\pm 2.0$ | $\mu \mathrm{A}$ |

Table 7. Static characteristics
At recommended operating conditions; voltages are referenced to GND (ground = 0 V ).
$V_{\text {is }}$ is the input voltage at a $n Y$ or terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.

| Symbol | Parameter | Conditions | Min | Typ[1] | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Is(OFF) | OFF-state leakage current | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \mid \mathrm{V}_{\mathrm{SW}}=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} ; \text {; see Figure } 8 \end{aligned}$ |  |  |  |  |
|  |  | per channel | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
| $\mathrm{IS}_{\mathrm{S}(\mathrm{ON})}$ | ON-state leakage current | $\begin{aligned} & V_{\mathrm{CC}}=10.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\mathrm{IL}} ; \\ & \left\|V_{\mathrm{SW}}\right\|=\mathrm{V}_{\mathrm{CC}}-\mathrm{GND} ; \text {; see Figure } 9 \end{aligned}$ | - | - | $\pm 1.0$ | $\mu \mathrm{A}$ |
| Icc | supply current | $\begin{aligned} & \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{CC}} \text { or } \mathrm{GND} ; \mathrm{V}_{\text {is }}=\mathrm{GND} \text { or } \mathrm{V}_{\mathrm{Cc}} ; \\ & \mathrm{V}_{\mathrm{os}}=\mathrm{V}_{\mathrm{CC}} \text { or } \mathrm{GND} \end{aligned}$ |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | - | - | 40 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=10.0 \mathrm{~V}$ | - | - | 80 | $\mu \mathrm{A}$ |

[1] Typical values are measured at $\mathrm{T}_{\mathrm{amb}}=25^{\circ} \mathrm{C}$.

$\mathrm{V}_{\text {is }}=\mathrm{V}_{\mathrm{CC}}$ and $\mathrm{V}_{\text {os }}=\mathrm{GND}$
$\mathrm{V}_{\text {is }}=\mathrm{GND}$ and $\mathrm{V}_{\mathrm{os}}=\mathrm{V}_{\mathrm{cc}}$
Fig 8. Test circuit for measuring OFF-state leakage current

$V_{\text {is }}=V_{C C}$ and $V_{\text {os }}=$ open
$V_{\text {is }}=G N D$ and $V_{\text {os }}=$ open
Fig 9. Test circuit for measuring ON-state leakage current

## 10. Dynamic characteristics

Table 8. Dynamic characteristics 74HC4066
GND $=0 \mathrm{~V} ; t_{r}=t_{f}=6 \mathrm{~ns} ; C_{L}=50 \mathrm{pF}$ unless specified otherwise; for test circuit see Figure 12.
$V_{\text {is }}$ is the input voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.

| Symbol | Parameter | Conditions | +25 ${ }^{\circ} \mathrm{C}$ |  | $-40{ }^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  | $-40^{\circ} \mathrm{C} \text { to }+125^{\circ} \mathrm{C}$ |  | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Typ | Max | Min | Max | Min | Max |  |
| $\mathrm{t}_{\mathrm{pd}}$ | propagation delay | nY to nZ or nZ to nY ; <br> $R_{L}=\infty \Omega$; see Figure 10 |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V}$ | 17 | 60 | - | 75 | - | 90 | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | 6 | 12 | - | 15 | - | 18 | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | 5 | 10 | - | 13 | - | 15 | ns |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | 4 | 8 | - | 10 | - | 12 | ns |
| $\mathrm{t}_{\text {on }}$ | turn-on time | nE to $n Y$ or $n Z$; <br> see Figure 11 |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V}$ | 52 | 190 | - | 240 | - | 235 | ns |
|  |  | $\mathrm{V}_{\text {CC }}=4.5 \mathrm{~V}$ | 19 | 38 | - | 48 | - | 57 | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=5.0 \mathrm{~V} ; \mathrm{C}_{\mathrm{L}}=15 \mathrm{pF}$ | 16 | - | - | - | - | - | ns |
|  |  | $\mathrm{V}_{C C}=6.0 \mathrm{~V}$ | 15 | 32 | - | 41 | - | 48 | ns |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | 11 | 28 | - | 35 | - | 42 | ns |
| $\mathrm{t}_{\text {off }}$ | turn-off time | nE to nY or nZ; see Figure 11 |  |  |  |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.0 \mathrm{~V}$ | 47 | 145 | - | 180 | - | 220 | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | 17 | 29 | - | 36 | - | 44 | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=5.0 \mathrm{~V} ; \mathrm{C}_{\mathrm{L}}=15 \mathrm{pF}$ | 14 | - | - | - | - | - | ns |
|  |  | $\mathrm{V}_{\mathrm{CC}}=6.0 \mathrm{~V}$ | 14 | 25 | - | 31 | - | 38 | ns |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | 13 | 22 | - | 28 | - | 33 | ns |
| $\mathrm{C}_{\text {PD }}$ | power dissipation capacitance | per switch; $\mathrm{V}_{\mathrm{I}}=\mathrm{GND}$ to $\mathrm{V}_{\mathrm{CC}} \quad \underline{[4]}$ | 12 | - | - | - | - | - | pF |

[1] $t_{p d}$ is the same as $t_{\text {PHL }}$ and $t_{\text {PLH }}$.
[2] $t_{\text {on }}$ is the same as $t_{\text {PHz }}$ and tpLz.
[3] $t_{\text {off }}$ is the same as $t_{\text {PzH and }} t_{\text {PzL }}$.
[4] $C_{P D}$ is used to determine the dynamic power dissipation ( $\mathrm{P}_{\mathrm{D}}$ in $\mu \mathrm{W}$ ).
$P_{D}=C_{P D} \times V_{C C}{ }^{2} \times f_{i}+\sum\left\{\left(C_{L}+C_{s w}\right) \times V_{C C}{ }^{2} \times f_{0}\right\}$ where:
$\mathrm{f}_{\mathrm{i}}=$ input frequency in MHz ;
$\mathrm{f}_{\mathrm{o}}=$ output frequency in MHz ;
$\Sigma\left\{\left(\mathrm{C}_{\mathrm{L}}+\mathrm{C}_{\mathrm{sw}}\right) \times \mathrm{V}_{\mathrm{Cc}}{ }^{2} \times \mathrm{f}_{\mathrm{o}}\right\}=$ sum of outputs;
$\mathrm{C}_{\mathrm{L}}=$ output load capacitance in pF ;
$\mathrm{C}_{\mathrm{sw}}=$ switch capacitance in pF ;
$\mathrm{V}_{\mathrm{CC}}=$ supply voltage in V .

## 11. Waveforms



Fig 10. Input $\left(\mathrm{V}_{\mathrm{is}}\right)$ to output $\left(\mathrm{V}_{\mathrm{os}}\right)$ propagation delays


Measurement points are shown in Table 9.
Fig 11. Turn-on and turn-off times

Table 9. Measurement points

| $\mathbf{V}_{\mathbf{I}}$ | $\mathbf{V}_{\mathbf{M}}$ |
| :--- | :--- |
| $\mathrm{V}_{\mathrm{CC}}$ | $0.5 \mathrm{~V}_{\mathrm{CC}}$ |



Test data is given in Table 10.
Definitions test circuit:
$\mathrm{R}_{\mathrm{T}}=$ Termination resistance should be equal to output impedance $\mathrm{Z}_{\mathrm{o}}$ of the pulse generator.
$C_{L}=$ Load capacitance including jig and probe capacitance.
$\mathrm{R}_{\mathrm{L}}=$ Load resistance.
S1 = Test selection switch.
Fig 12. Test circuit for measuring switching times

Table 10. Test data

| Test | Input |  |  | Output |  | S1 position |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Control nE | Switch nY (nZ) | $t_{r}, t_{f}$ | Switch nZ (nY) |  |  |
|  | $V_{1}$ | $\mathrm{V}_{\text {is }}$ |  | $\mathrm{C}_{\mathrm{L}}$ | $\mathbf{R}_{\mathrm{L}}$ |  |
| $\mathrm{t}_{\text {PHL, }} \mathrm{t}_{\text {PLH }}$ | GND | GND to $\mathrm{V}_{\mathrm{CC}}$ | 6 ns | 50 pF | - | open |
| $\mathrm{t}_{\text {PHZ }}, \mathrm{t}_{\text {PZ }}$ | GND to $\mathrm{V}_{\mathrm{Cc}}$ | $\mathrm{V}_{\text {CC }}$ | 6 ns | $50 \mathrm{pF}, 15 \mathrm{pF}$ | $1 \mathrm{k} \Omega$ | GND |
| $\mathrm{t}_{\text {PLZ }}, \mathrm{t}_{\text {PZL }}$ | GND to $V_{C C}$ | GND | 6 ns | $50 \mathrm{pF}, 15 \mathrm{pF}$ | $1 \mathrm{k} \Omega$ | $\mathrm{V}_{\mathrm{CC}}$ |

## 12. Additional dynamic characteristics

Table 11. Additional dynamic characteristics
Recommended conditions and typical values; GND $=0 \mathrm{~V} ; T_{\text {amb }}=25^{\circ} \mathrm{C}$.
$V_{\text {is }}$ is the input voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an input.
$V_{\text {os }}$ is the output voltage at a $n Y$ or $n Z$ terminal, whichever is assigned as an output.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| THD | total harmonic distortion | $\mathrm{f}_{\mathrm{i}}=1 \mathrm{kHz} ; \mathrm{R}_{\mathrm{L}}=10 \mathrm{k} \Omega ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF} ;$ <br> see Figure 13 |  |  |  | \% |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=4.0 \mathrm{~V}(\mathrm{p}-\mathrm{p})$ | - | 0.80 | - | \% |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=8.0 \mathrm{~V}$ (p-p) | - | 0.40 | - | \% |
|  |  | $\begin{aligned} & \mathrm{f}_{\mathrm{i}}=10 \mathrm{kHz} ; \mathrm{R}_{\mathrm{L}}=10 \mathrm{k} \Omega ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF} ; \\ & \text { see Figure } 13 \end{aligned}$ |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=4.0 \mathrm{~V}$ (p-p) | - | 2.4 | - | \% |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V} ; \mathrm{V}_{\mathrm{I}}=8.0 \mathrm{~V}(\mathrm{p}-\mathrm{p})$ | - | 1.2 | - | \% |
| $\mathrm{f}_{(-3 \mathrm{~dB})}$ | -3 dB frequency response | $\mathrm{R}_{\mathrm{L}}=50 \Omega ; \mathrm{C}_{\mathrm{L}}=10 \mathrm{pF}$; see Figure 14 [2] |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | - | 150 | - | MHz |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | - | 160 | - | MHz |
| $\alpha_{\text {iso }}$ | isolation (OFF-state) | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=600 \Omega ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF} ; \mathrm{f}_{\mathrm{i}}=1 \mathrm{MHz} ; \\ & \text { see Figure } 15 \end{aligned}$ |  |  |  |  |
|  |  | $\mathrm{V}_{\text {CC }}=4.5 \mathrm{~V}$ | - | -50 | - | dB |
|  |  | $\mathrm{V}_{C C}=9.0 \mathrm{~V}$ | - | -50 | - | dB |
| $\mathrm{V}_{\text {ct }}$ | crosstalk voltage | between digital input and switch (peak to peak value); $\mathrm{R}_{\mathrm{L}}=600 \Omega ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF}$; $\mathrm{f}_{\mathrm{i}}=1 \mathrm{MHz}$; see Figure 16 |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | - | 110 | - | mV |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | - | 220 | - | mV |
| Xtalk | crosstalk | between switches; $\mathrm{R}_{\mathrm{L}}=600 \Omega ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF} ; \quad \underline{[1]}$ $\mathrm{f}_{\mathrm{i}}=1 \mathrm{MHz}$; see Figure 17 |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V}$ | - | -60 | - | dB |
|  |  | $\mathrm{V}_{\mathrm{CC}}=9.0 \mathrm{~V}$ | - | -60 | - | dB |

[1] Adjust input voltage $V_{\text {is }}$ to 0 dBm level ( $0 \mathrm{dBm}=1 \mathrm{~mW}$ into $600 \Omega$ ).
[2] Adjust input voltage $V_{\text {is }}$ to 0 dBm level at $V_{\text {os }}$ for $f_{i}=1 \mathrm{MHz}(0 \mathrm{dBm}=1 \mathrm{~mW}$ into $50 \Omega)$. After set-up, $f_{i}$ is increased to obtain a reading of -3 dB at $\mathrm{V}_{\text {os }}$.


Fig 13. Test circuit for measuring total harmonic distortion

a. Typical -3 dB frequency response

b. Test circuit

$$
\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{GND}=0 \mathrm{~V} ; \mathrm{R}_{\mathrm{L}}=50 \Omega ; \mathrm{R}_{\text {source }}=1 \mathrm{k} \Omega
$$

Fig 14. -3 dB frequency response

a. Isolation (OFF-state)

b. Test circuit

$$
\mathrm{V}_{\mathrm{CC}}=4.5 \mathrm{~V} ; \mathrm{GND}=0 \mathrm{~V} ; \mathrm{R}_{\mathrm{L}}=600 \Omega ; \mathrm{R}_{\text {source }}=1 \mathrm{k} \Omega .
$$

Fig 15. Isolation (OFF-state) as a function of frequency

a. Circuit

b. Crosstalk voltage

Fig 16. Test circuit for measuring crosstalk voltage (between the digital input and the switch)


Fig 17. Test circuit for measuring crosstalk (between the switches)

## 13. Package outline



DIMENSIONS (inch dimensions are derived from the original $\mathbf{m m}$ dimensions)

| UNIT | A max. | $\mathrm{A}_{1}$ | $\mathrm{A}_{2}$ | $\mathrm{A}_{3}$ | $\mathrm{b}_{\mathrm{p}}$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $\mathrm{H}_{\mathrm{E}}$ | L | $\mathrm{L}_{\mathrm{p}}$ | Q | v | w | y | $\mathrm{Z}^{(1)}$ | $\theta$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| mm | 1.75 | $\begin{aligned} & 0.25 \\ & 0.10 \end{aligned}$ | $\begin{aligned} & 1.45 \\ & 1.25 \end{aligned}$ | 0.25 | $\begin{aligned} & 0.49 \\ & 0.36 \end{aligned}$ | $\begin{aligned} & 0.25 \\ & 0.19 \end{aligned}$ | $\begin{aligned} & 8.75 \\ & 8.55 \end{aligned}$ | $\begin{aligned} & 4.0 \\ & 3.8 \end{aligned}$ | 1.27 | $\begin{aligned} & 6.2 \\ & 5.8 \end{aligned}$ | 1.05 | $\begin{aligned} & 1.0 \\ & 0.4 \end{aligned}$ | $\begin{aligned} & 0.7 \\ & 0.6 \end{aligned}$ | 0.25 | 0.25 | 0.1 | $\begin{aligned} & 0.7 \\ & 0.3 \end{aligned}$ | $8^{\circ}$ |
| inches | 0.069 | $\begin{aligned} & 0.010 \\ & 0.004 \end{aligned}$ | $\begin{aligned} & 0.057 \\ & 0.049 \end{aligned}$ | 0.01 | $\begin{aligned} & 0.019 \\ & 0.014 \end{aligned}$ | $\begin{array}{\|l\|} \hline 0.0100 \\ 0.0075 \end{array}$ | $\begin{aligned} & 0.35 \\ & 0.34 \end{aligned}$ | $\begin{aligned} & 0.16 \\ & 0.15 \end{aligned}$ | 0.05 | $\begin{aligned} & 0.244 \\ & 0.228 \end{aligned}$ | 0.041 | $\begin{aligned} & 0.039 \\ & 0.016 \end{aligned}$ | $\begin{aligned} & 0.028 \\ & 0.024 \end{aligned}$ | 0.01 | 0.01 | 0.004 | $\begin{aligned} & 0.028 \\ & 0.012 \end{aligned}$ | $0^{\circ}$ |

Note

1. Plastic or metal protrusions of 0.15 mm ( 0.006 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES |  |  | EUROPEAN PROJECTION | ISSUE DATE |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | IEC | JEDEC | JEITA |  |  |
| SOT108-1 | 076E06 | MS-012 |  | $\square$ ¢ | $\begin{aligned} & 99-12-27 \\ & 03-02-19 \end{aligned}$ |

Fig 18. Package outline SOT108-1 (SO14)


DIMENSIONS (mm are the original dimensions)

| UNIT | $\mathbf{A}$ <br> max. | $\mathbf{A}_{\mathbf{1}}$ | $\mathbf{A}_{\mathbf{2}}$ | $\mathbf{A}_{\mathbf{3}}$ | $\mathbf{b}_{\mathbf{p}}$ | $\mathbf{c}$ | $\mathbf{D}^{(\mathbf{1})}$ | $\mathbf{E}^{(\mathbf{2})}$ | $\mathbf{e}$ | $\mathbf{H}_{\mathbf{E}}$ | $\mathbf{L}$ | $\mathbf{L}_{\mathbf{p}}$ | $\mathbf{Q}$ | $\mathbf{v}$ | $\mathbf{w}$ | $\mathbf{y}$ | $\mathbf{Z}^{(\mathbf{1})}$ | $\boldsymbol{\theta}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| mm | 1.1 | 0.15 | 0.95 | 0.25 | 0.30 | 0.2 | 5.1 | 4.5 | 0.65 | 6.6 | 1 | 0.75 | 0.4 | 0.2 | 0.13 | 0.1 | 0.72 | $8^{\circ}$ |
|  | 0.05 | 0.80 | 0.25 | 0.19 | 0.1 | 4.9 | 4.3 | 0.6 | 6.2 | 1 | 0.50 | 0.3 | 0.2 | 0.38 | $0^{\circ}$ |  |  |  |

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included

| OUTLINE VERSION | REFERENCES |  |  | EUROPEAN PROJECTION | ISSUE DATE |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | IEC | JEDEC | JEITA |  |  |
| SOT402-1 |  | MO-153 |  | $\square \oplus$ | $\begin{gathered} \hline-99-12-27 \\ 03-02-18 \end{gathered}$ |

Fig 19. Package outline SOT402-1 (TSSOP14)

## 14. Abbreviations

Table 12. Abbreviations

| Acronym | Description |
| :--- | :--- |
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |

## 15. Revision history

Table 13. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
| :--- | :--- | :--- | :--- | :--- |
| 74HC4016 v.3 | 20161212 | Product data sheet | - | 74HC_HCT4016_CNV v.2 |
| Modifications: | $\bullet$ - Type numbers | 74HC4016N, 74HCT4016N | and 74HCT4016D removed. |  |
| 74HC_HCT4016_CNV v.2 | 19901201 | Product specification | - | - |

## 16. Legal information

### 16.1 Data sheet status

| Document status $\underline{[1][2]}$ | Product status $[3]$ | Definition |
| :--- | :--- | :--- |
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
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