TS3A5018

## Description

The TS3A5018 is a quad single-pole double-throw (SPDT) analog switch that is designed to operate from 2.3 V to 3.6 V. This device can handle both digital and analog signals, and signals up to $\mathrm{V}_{+}$can be transmitted in either direction.

## Applications

- Sample-and-Hold Circuit
- Battery-Powered Equipment
- Audio and Video Signal Routing
- Communication Circuits

SOIC, SSOP, TSSOP, OR TVSOP PACKAGE
(TOP VIEW)


FUNCTION TABLE

| $\overline{\mathrm{EN}}$ | IN | NO TO COM, <br> COM TO NO | NC TO COM, <br> COM TO NC |
| :---: | :---: | :---: | :---: |
| L | L | OFF | ON |
| L | H | ON | OFF |
| H | X | OFF | OFF |

## Features

- Low ON-State Resistance (10 $\Omega$ )
- Low Charge Injection
- Excellent ON-State Resistance Matching
- Low Total Harmonic Distortion (THD)
- 2.3-V to $3.6-\mathrm{V}$ Single-Supply Operation
- Control Inputs are 5-V Tolerant
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
- 2000-V Human-Body Model (A114-B, Class II)
- 1000-V Charged-Device Model (C101)


## Summary of Characteristics

$\mathrm{V}_{+}=3.3 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$

| Configuration | Quad Single Pole <br> Double Throw <br> $(4 \times$ SPDT $)$ |
| :--- | :---: |
| Number of channels | 4 |
| ON-state resistance (ron) | $7 \Omega$ |
| ON-state resistance match ( $\left.\Delta \mathrm{r}_{\text {on }}\right)$ | $0.3 \Omega$ |
| ON-state resistance flatness (ron(flat)) | $5 \Omega$ |
| Turn-on/turn-of time (ton/toFF) | $3.5 \mathrm{~ns} / 2 \mathrm{~ns}$ |
| Charge injection (QC) | 2 pC |
| Bandwidth (BW) | 300 MHz |
| OFF isolation (OISO) | -48 dB at 10 MHz |
| Crosstalk (XTALK) | -48 dB at 10 MHz |
| Total harmonic distortion (THD) | $0.2 \%$ |
| Leakage current (ICOM(OFF)) | $\pm 5 \mu \mathrm{~A}$ |
| Power-supply current (I+) | $2.5 \mu \mathrm{~A}$ |
| Package option | $16-\mathrm{pin} \mathrm{SOIC}, \mathrm{SSOP}$, <br> TSSOP, or TVSOP |

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## ORDERING INFORMATION

| $\mathrm{T}_{\text {A }}$ | PACKAGE(1) |  | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
| :---: | :---: | :---: | :---: | :---: |
| $-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ | SOIC - D | Tube | TS3A5018D | TS3A5018 |
|  |  | Tape and reel | TS3A5018DR |  |
|  | SSOP (QSOP) - DBQ | Tape and reel | TS3A5018DBQR | YA018 |
|  | TSSOP - PW | Tube | TS3A5018PW | YA018 |
|  |  | Tape and reel | TS3A5018PWR |  |
|  | TVSOP - DGV | Tape and reel | TS3A5018DGVR | YA018 |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

## Absolute Minimum and Maximum Ratings(1)(2)

over operating free-air temperature range (unless otherwise noted)

|  |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{+}$ | Supply voltage range(3) |  | -0.5 | 4.6 | V |
| $\mathrm{V}_{\mathrm{NC}}$, <br> $\mathrm{V}_{\mathrm{NO}}$, <br> $\mathrm{V}_{\mathrm{COM}}$ | Analog voltage range(3)(4) |  | -0.5 | 7 | V |
| IK | Analog port diode current | $\mathrm{V}_{\mathrm{NC}}, \mathrm{V}_{\mathrm{NO}}, \mathrm{V}_{\mathrm{COM}}<0$ | -50 |  | mA |
| INC, ${ }^{1} \mathrm{NO}$, ICOM | On-state switch current | $\mathrm{V}_{\mathrm{NC}}, \mathrm{V}_{\text {NO }}, \mathrm{V}_{\mathrm{COM}}=0$ to 7 V | -64 | 64 | mA |
|  | Digital input voltage range(3)(4) |  | -0.5 | 7 | V |
| IIK | Digital input clamp current | $\mathrm{V}_{1}<0$ | -50 |  | mA |
| $\mathrm{I}_{+}$ | Continuous current through $\mathrm{V}_{+}$ |  | -100 | 100 | mA |
| IGND | Continuous current through GND |  | -100 | 100 | mA |
| ${ }^{\theta} \mathrm{JA}$ | Package thermal impedance(5) | D package |  | 73 | ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |
|  |  | DBQ package |  | 90 |  |
|  |  | DGV package |  | 120 |  |
|  |  | PW package |  | 108 |  |
| $\mathrm{T}_{\text {stg }} \quad$ Storage temperature range | Storage temperature range |  | -65 | 150 | ${ }^{\circ} \mathrm{C}$ |

[^0]Electrical Characteristics for 3.3-V Supply ${ }^{(1)}$
$\mathrm{V}_{+}=3 \mathrm{~V}$ to $3.6 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS |  | $\mathrm{T}_{\mathrm{A}}$ | $\mathrm{V}_{+}$ | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Analog Switch |  |  |  |  |  |  |  |  |  |
| Analog signal range | $\mathrm{V}_{\mathrm{COM}}$, $\mathrm{V}_{\mathrm{NC}}, \mathrm{V}_{\mathrm{NO}}$ |  |  |  |  | 0 |  | $\mathrm{V}_{+}$ | V |
| ON-state resistance | $\mathrm{r}_{\text {on }}$ | $\begin{aligned} & 0 \leq\left(\mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}\right) \leq \mathrm{V}_{+}, \\ & \mathrm{I} \mathrm{COM}=-32 \mathrm{~mA}, \end{aligned}$ | Switch ON, <br> See Figure 13 | $25^{\circ} \mathrm{C}$ | 3 V |  | 7 | 10 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 12 |  |
| ON-state resistance match between channels | $\Delta r_{\text {on }}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=2.1 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{COM}}=-32 \mathrm{~mA}, \end{aligned}$ | Switch ON, See Figure 13 | $25^{\circ} \mathrm{C}$ | 3 V |  | 0.3 | 0.8 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 1 |  |
| ON-state resistance flatness | $r_{\text {on(flat) }}$ | $\begin{aligned} & 0 \leq\left(\mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}\right) \leq \mathrm{V}_{+}, \\ & \mathrm{I} \operatorname{COM}=-32 \mathrm{~mA}, \end{aligned}$ | Switch ON, <br> See Figure 13 | $25^{\circ} \mathrm{C}$ | 3 V |  | 5 | 7 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 8 |  |
| NC, NO OFF leakage current | $\begin{aligned} & \text { INC(OFF) } \\ & \text { INO(OFF) } \end{aligned}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=1 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=3 \mathrm{~V}, \\ & \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=1 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 3.6 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
|  |  | $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=0$ to 3.6 V , $\mathrm{V}_{\mathrm{COM}}=3.6 \mathrm{~V}$ to 0 , <br> $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=3.6 \mathrm{~V}$ to 0 , $\mathrm{V}_{\mathrm{COM}}=0$ to 3.6 V , | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 0 V | -2 | 0.05 | 2 |  |
|  |  |  |  | Full |  | -10 |  | 10 |  |
| COM OFF leakage current | ICOM(OFF) | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=1 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=3 \mathrm{~V}, \\ & \text { or } \\ & \mathrm{V}_{\mathrm{COM}}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=3 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 3.6 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=0 \text { to } 3.6 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \\ & \mathrm{V}_{\mathrm{NO}}=3.6 \mathrm{~V} \text { to } 0, \\ & \text { or } \\ & \mathrm{V}_{\mathrm{COM}}=3.6 \mathrm{~V} \text { to } 0, \mathrm{~V}_{\mathrm{NC}} \text { or } \\ & \mathrm{V}_{\mathrm{NO}}=0 \text { to } 3.6 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 0 V | -2 | 0.05 | 2 |  |
|  |  |  |  | Full |  | -10 |  | 10 |  |
| NC, NO ON leakage current | InC(ON) <br> INO(ON) | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=1 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=\text { Open, } \\ & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=\text { Open, } \end{aligned}$ | Switch ON, <br> See Figure 15 | $25^{\circ} \mathrm{C}$ | 3.6 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
| COM <br> ON leakage current | ICOM(ON) | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=1 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=\text { Open }, \\ & \mathrm{V}_{\mathrm{COM}}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=\text { Open }, \end{aligned}$ | Switch ON, <br> See Figure 15 | $25^{\circ} \mathrm{C}$ | 3.6 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
| Digital Control Inputs (IN, $\overline{\mathrm{EN}}$ ) $(2)$ |  |  |  |  |  |  |  |  |  |
| Input logic high | $\mathrm{V}_{\mathrm{IH}}$ |  |  | Full |  | 2 |  | $\mathrm{V}_{+}$ | V |
| Input logic low | VIL |  |  | Full |  | 0 |  | 0.8 | V |
| Input leakage current | ${ }_{\text {IIH, IIL }}$ | $\mathrm{V}_{\mathrm{I}}=5.5 \mathrm{~V}$ or 0 |  | $25^{\circ} \mathrm{C}$ | 3.6 V | -1 | 0.05 | 1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -1 |  | 1 |  |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum
(2) All unused digital inputs of the device must be held at $\mathrm{V}_{+}$or GND to ensure proper device operation. Refer to the TI application report, Implications of Slow or Floating CMOS Inputs, literature number SCBA004.

## Electrical Characteristics for 3.3-V Supply(1) (continued)

$\mathrm{V}_{+}=3 \mathrm{~V}$ to $3.6 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS |  | $\mathrm{T}_{\mathrm{A}}$ | $\mathrm{V}_{+}$ | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Dynamic |  |  |  |  |  |  |  |  |  |
| Turn-on time | ton | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=2 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=300 \Omega, \end{aligned}$ | $\mathrm{C}_{\mathrm{L}}=35 \mathrm{pF},$ <br> See Figure 17 | $25^{\circ} \mathrm{C}$ | 3.3 V | 2.5 | 3.5 | 8 |  |
|  |  |  |  | Full | 3 V to 3.6 V | 2.5 |  | 9 | ns |
| Turn-off time | tofF | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=2 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=300 \Omega, \end{aligned}$ | $\mathrm{C}_{\mathrm{L}}=35 \mathrm{pF},$ <br> See Figure 17 | $25^{\circ} \mathrm{C}$ | 3.3 V | 0.5 | 2 | 6.5 | ns |
|  |  |  |  | Full | 3 V to 3.6 V | 0.5 |  | 7 |  |
| Charge injection | $Q_{C}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{GEN}}=0, \text { RGEN }=0 \\ & \mathrm{C}_{\mathrm{L}}=0.1 \mathrm{nF}, \end{aligned}$ | See Figure 22 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 2 |  | pC |
| NC, NO OFF capacitance | $\begin{aligned} & \mathrm{C}_{\mathrm{NC}(\mathrm{OFF})} \\ & \mathrm{C}_{\mathrm{NO}(\mathrm{ON})} \\ & \hline \end{aligned}$ | $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=\mathrm{V}_{+}$or GND, Switch OFF, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 4.5 |  | pF |
| COM OFF capacitance | CCOM(OFT) | $\mathrm{V}_{\mathrm{COM}}=\mathrm{V}_{+} \text {or } \mathrm{GND},$ Switch OFF, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 9 |  | pF |
| NC, NO ON capacitance | $\begin{aligned} & \mathrm{C}_{\mathrm{NC}(\mathrm{ON})} \\ & \mathrm{C}_{\mathrm{NO}(\mathrm{ON})} \end{aligned}$ | $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=\mathrm{V}_{+}$or GND, Switch ON, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 16 |  | pF |
| COM <br> ON capacitance | CCOM(ON) | $\mathrm{V}_{\mathrm{COM}}=\mathrm{V}_{+}$or GND, Switch ON, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 16 |  | pF |
| Digital input capacitance | CI | $\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{+}$or GND, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 3 |  | pF |
| Bandwidth | BW | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=50 \Omega, \\ & \text { Switch ON, } \end{aligned}$ | See Figure 18 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 300 |  | MHz |
| OFF isolation | OISO | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch OFF, <br> See Figure 19 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | -48 |  | dB |
| Crosstalk | XTALK | $\begin{aligned} & R_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch ON, <br> See Figure 20 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | -48 |  | dB |
| Crosstalk <br> Adjacent | XTALK(ADJ) | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch ON, <br> See Figure 21 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | -81 |  | dB |
| Total harmonic distortion | THD | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=600 \Omega, \\ & \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF}, \end{aligned}$ | $\begin{aligned} & f=20 \mathrm{~Hz} \text { to } 20 \mathrm{kHz}, \\ & \text { See Figure } 23 \end{aligned}$ | $25^{\circ} \mathrm{C}$ | 3.3 V |  | 0.21 |  | \% |
| Supply |  |  |  |  |  |  |  |  |  |
| Positive supply current | $I_{+}$ | $\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{+}$or GND, | Switch ON or OFF | $25^{\circ} \mathrm{C}$ | 3.6 V |  | 2.5 | 7 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  |  |  | 10 |  |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum

INSTRUMENTS
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10- $\Omega$ QUAD SPDT ANALOG SWITCH

Electrical Characteristics for 2.5-V Supply(1)
$\mathrm{V}_{+}=2.3 \mathrm{~V}$ to $2.7 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS |  | $\mathrm{T}_{\text {A }}$ | $\mathrm{V}_{+}$ | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Analog Switch |  |  |  |  |  |  |  |  |  |
| Analog signal range | $\mathrm{V}_{\mathrm{COM}}$, $\mathrm{V}_{\mathrm{NC}}, \mathrm{V}_{\mathrm{NO}}$ |  |  |  |  | 0 |  | $V_{+}$ | V |
| ON-state resistance | $\mathrm{r}_{\text {on }}$ | $\begin{aligned} & 0 \leq\left(\mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}\right) \leq \mathrm{V}_{+}, \\ & \mathrm{I} \mathrm{COM}=-24 \mathrm{~mA}, \end{aligned}$ | Switch ON, <br> See Figure 13 | $25^{\circ} \mathrm{C}$ | 2.3 V |  | 12 | 20 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 22 |  |
| ON-state resistance match between channels | $\Delta r_{\text {on }}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=1.6 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{COM}}=-24 \mathrm{~mA}, \end{aligned}$ | Switch ON, See Figure 13 | $25^{\circ} \mathrm{C}$ | 2.3 V |  | 0.3 | 1 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 2 |  |
| ON-state resistance flatness | $r_{\text {on(flat) }}$ | $\begin{aligned} & 0 \leq\left(\mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}\right) \leq \mathrm{V}_{+}, \\ & \mathrm{I} \operatorname{COM}=-24 \mathrm{~mA}, \end{aligned}$ | Switch ON, <br> See Figure 13 | $25^{\circ} \mathrm{C}$ | 2.3 V |  | 14 | 18 | $\Omega$ |
|  |  |  |  | Full |  |  |  | 20 |  |
| NC, NO OFF leakage current | INC(OFF), <br> INO(OFF) | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=0.5 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=2.2 \mathrm{~V}, \\ & \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=2.2 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=0.5 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 2.7 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=0 \text { to } 3.6 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=3.6 \\ & \mathrm{~V}^{\text {to } 0,} \\ & \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=3.6 \mathrm{~V} \text { to } 0, \mathrm{~V}_{\mathrm{COM}}=0 \\ & \text { to } 3.6 \mathrm{~V} \text {, } \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 0 V | -2 | 0.05 | 2 |  |
|  |  |  |  | Full |  | -10 |  | 10 |  |
| COM OFF leakage current | ICOM(OFF) | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=0.5 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=2.2 \mathrm{~V}, \\ & \mathrm{~V}_{\mathrm{COM}}=2.2 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=0.5 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 2.7 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=0 \text { to } 3.6 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}}=3.6 \mathrm{~V} \text { to } 0, \\ & \text { or } \\ & \mathrm{V}_{\mathrm{COM}}=3.6 \mathrm{~V} \text { to } 0, \mathrm{~V}_{\mathrm{NC}}=0 \text { to } 3.6 \mathrm{~V}, \end{aligned}$ | Switch OFF, <br> See Figure 14 | $25^{\circ} \mathrm{C}$ | 0 V | -2 | 0.05 | 2 |  |
|  |  |  |  | Full |  | -10 |  | 10 |  |
| NC, NO ON leakage current | ${ }^{\text {I }} \mathrm{NC}(\mathrm{ON})$ INO(ON) | $\begin{aligned} & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=0.5 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=\text { Open, } \\ & \mathrm{V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=2.2 \mathrm{~V}, \mathrm{~V}_{\mathrm{COM}}=\text { Open, } \end{aligned}$ | Switch ON, <br> See Figure 15 | $25^{\circ} \mathrm{C}$ | 2.7 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
| COM <br> ON leakage current | ICOM(ON) | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=0.5 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=\text { Open, } \\ & \mathrm{V}_{\mathrm{COM}}=2.2 \mathrm{~V}, \mathrm{~V}_{\mathrm{NC}} \text { or } \mathrm{V}_{\mathrm{NO}}=\text { Open }, \end{aligned}$ | Switch ON, See Figure 15 | $25^{\circ} \mathrm{C}$ | 2.7 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -0.2 |  | 0.2 |  |
| Digital Control Inputs (IN, ENN) ${ }^{(2)}$ |  |  |  |  |  |  |  |  |  |
| Input logic high | $\mathrm{V}_{\mathrm{IH}}$ |  |  | Full |  | 1.7 |  | $\mathrm{V}_{+}$ | V |
| Input logic low | $\mathrm{V}_{\text {IL }}$ |  |  | Full |  | 0 |  | 0.7 | V |
| Input leakage current | ${ }_{\text {IH. }}$ IIL | $\mathrm{V}_{\mathrm{I}}=5.5 \mathrm{~V}$ or 0 |  | $25^{\circ} \mathrm{C}$ | 2.7 V | -0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  | -1 |  | 1 |  |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum
(2) All unused digital inputs of the device must be held at $\mathrm{V}_{+}$or GND to ensure proper device operation. Refer to the TI application report, Implications of Slow or Floating CMOS Inputs, literature number SCBA004.

## Electrical Characteristics for 2.5-V Supply(1) (continued)

$\mathrm{V}_{+}=2.3 \mathrm{~V}$ to $2.7 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS |  | $\mathrm{T}_{\mathrm{A}}$ | $\mathrm{V}_{+}$ | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Dynamic |  |  |  |  |  |  |  |  |  |
| Turn-on time | ton | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=1.5 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=300 \Omega, \end{aligned}$ | $C_{L}=35 \mathrm{pF},$ <br> See Figure 17 | $25^{\circ} \mathrm{C}$ | 2.5 V | 2.5 | 5 | 9.5 | ns |
|  |  |  |  | Full | 2.3 V to 2.7 V | 2.5 |  | 10.5 |  |
| Turn-off time | toFF | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=1.5 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=300 \Omega, \end{aligned}$ | $C_{L}=35 \mathrm{pF},$ <br> See Figure 17 | $25^{\circ} \mathrm{C}$ | 2.5 V | 0.5 | 3 | 7.5 | ns |
|  |  |  |  | Full | 2.3 V to 2.7 V | 0.5 |  | 9 |  |
| Charge injection | $Q_{C}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{GEN}}=0, \mathrm{RGEN}=0 \\ & \mathrm{C}_{\mathrm{L}}=0.1 \mathrm{nF}, \end{aligned}$ | See Figure 22 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 1 |  | pC |
| NC, NO OFF capacitance | $\begin{array}{\|l\|} \hline \mathrm{C}_{\mathrm{NC}}(\mathrm{OFF}) \\ \mathrm{C}_{\mathrm{NO}}(\mathrm{OFF}) \\ \hline \end{array}$ | $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=\mathrm{V}_{+}$or GND, Switch OFF, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 3 |  | pF |
| COM OFF capacitance | CCOM(OFT) | $\begin{aligned} & \mathrm{V}_{\mathrm{COM}}=\mathrm{V}_{+} \text {or GND, } \\ & \text { Switch OFF, } \end{aligned}$ | See Figure 16 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 9 |  | pF |
| NC, NO ON capacitance | CNC(ON) <br> $\mathrm{C}_{\mathrm{NO}(\mathrm{ON})}$ | $\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=\mathrm{V}_{+}$or GND, Switch ON, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 16 |  | pF |
| COM ON capacitance | $\mathrm{C}^{\text {COM (ON) }}$ | $\mathrm{V}_{\mathrm{COM}}=\mathrm{V}_{+} \text {or GND, }$ Switch ON, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 16 |  | pF |
| Digital input capacitance | Cl | $\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{+}$or GND, | See Figure 16 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 3 |  | pF |
| Bandwidth | BW | $\mathrm{R}_{\mathrm{L}}=50 \Omega \text {, }$ Switch ON, | See Figure 18 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 300 |  | MHz |
| OFF isolation | OISO | $\begin{aligned} & R_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch OFF, <br> See Figure 19 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | -48 |  | dB |
| Crosstalk | X TALK | $\begin{aligned} & R_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch ON, See Figure 20 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | -48 |  | dB |
| Crosstalk Adjacent | $\mathrm{X}_{\text {TALK(ADJ) }}$ | $\begin{aligned} & R_{\mathrm{L}}=50 \Omega, \\ & \mathrm{f}=10 \mathrm{MHz}, \end{aligned}$ | Switch ON, <br> See Figure 21 | $25^{\circ} \mathrm{C}$ | 3.3 V |  | -81 |  | dB |
| Total harmonic distortion | THD | $\begin{aligned} & \mathrm{R}_{\mathrm{L}}=600 \Omega, \\ & \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF}, \end{aligned}$ | $\mathrm{f}=20 \mathrm{~Hz} \text { to } 20 \mathrm{kHz},$ <br> See Figure 23 | $25^{\circ} \mathrm{C}$ | 2.5 V |  | 0.33 |  | \% |
| Supply |  |  |  |  |  |  |  |  |  |
| Positive supply current | $I_{+}$ | $\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{+}$or GND, | Switch ON or OFF | $25^{\circ} \mathrm{C}$ | 2.7 V |  | 2.5 | 7 | $\mu \mathrm{A}$ |
|  |  |  |  | Full |  |  |  | 10 |  |

(1) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum

## TYPICAL PERFORMANCE



Figure 1. $\mathrm{r}_{\mathrm{on}}$ vs $\mathrm{V}_{\mathrm{COM}}$


Figure 3. $\mathrm{r}_{\text {on }}$ vs $\mathrm{V}_{\mathrm{COM}}\left(\mathrm{V}_{+}=3.3 \mathrm{~V}\right)$


Figure 5. Charge-Injection ( $\mathrm{Q}_{\mathrm{C}}$ ) vs $\mathrm{V}_{\mathrm{COM}}$


Figure 2. $\mathrm{r}_{\text {on }}$ vs $\mathrm{V}_{\text {COM }}\left(\mathrm{V}_{+}=3.3 \mathrm{~V}\right)$


Figure 4. Leakage Current vs Temperature $\left(V_{+}=3.6 \mathrm{~V}\right)$


Figure 6. ton and toff vs Supply Voltage

## TYPICAL PERFORMANCE



Figure 7. $\mathrm{t}_{\mathrm{ON}}$ and $\mathrm{t}_{\text {OFF }}$ vs Temperature $\left(\mathrm{V}_{+}=5 \mathrm{~V}\right)$

Figure 9. Gain vs Frequency Bandwidth $\left(\mathrm{V}_{+}=3.3 \mathrm{~V}\right)$


Figure 11. Total Harmonic Distortion vs Frequency


Figure 8. Logic-Level Threshold vs $\mathrm{V}_{\boldsymbol{+}}$


Figure 10. OFF Isolation vs Frequency ( $\mathrm{V}_{+}=3.3 \mathrm{~V}$ )


Figure 12. Power-Supply Current vs Temperature $\left(\mathrm{V}_{+}=3.3 \mathrm{~V}\right)$

## PIN DESCRIPTION

| PIN <br> NUMBER | NAME | DESCRIPTION |
| :---: | :---: | :--- |
| 1 | IN | Digital control pin to select between NC and NO |
| 2 | NC1 | Normally closed |
| 3 | NO1 | Normally open |
| 4 | COM1 | Common |
| 5 | NC2 | Normally closed |
| 6 | NO2 | Normally open |
| 7 | COM2 | Common |
| 8 | GND | Digital ground |
| 9 | COM3 | Common |
| 10 | NO3 | Normally open |
| 11 | NC3 | Normally closed |
| 12 | COM4 | Common |
| 13 | NO4 | Normally open |
| 14 | NC4 | Normally closed |
| 15 | $\overline{\text { EN }}$ | Chip Enable (active low) |
| 16 | V | Power supply |

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PARAMETER DESCRIPTION

| SYMBOL | DESCRIPTION |
| :---: | :---: |
| $\mathrm{V}_{\mathrm{COM}}$ | Voltage at COM |
| $\mathrm{V}_{\mathrm{NC}}$ | Voltage at NC |
| VNO | Voltage at NO |
| $\mathrm{r}_{\mathrm{O}}$ | Resistance between COM and NC or NO ports when the channel is ON |
| $\Delta r_{\text {on }}$ | Difference of $r_{\text {on }}$ between channels in a specific device |
| ron(flat) | Difference between the maximum and minimum value of $r_{\text {on }}$ in a channel over the specified range of conditions |
| INC(OFF) | Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the OFF state |
| ${ }^{\text {I }} \mathrm{NC}(\mathrm{ON})$ | Leakage current measured at the NC port, with the corresponding channel (NC to COM) in the ON state and the output (COM) open |
| INO(OFF) | Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the OFF state |
| $\mathrm{l} \mathrm{NO}(\mathrm{ON})$ | Leakage current measured at the NO port, with the corresponding channel (NO to COM) in the ON state and the output (COM) open |
| $\mathrm{I} \mathrm{COM}(\mathrm{OFF})$ | Leakage current measured at the COM port, with the corresponding channel (COM to NC or NO) in the OFF state |
| ${ }^{\text {I COM }}$ (ON) | Leakage current measured at the COM port, with the corresponding channel (COM to NC or NO) in the ON state and the output (NC or NO) open |
| $\mathrm{V}_{\text {IH }}$ | Minimum input voltage for logic high for the control input (IN, $\overline{\mathrm{EN}}$ ) |
| $\mathrm{V}_{\text {IL }}$ | Maximum input voltage for logic low for the control input (IN, $\overline{\mathrm{EN}}$ ) |
| $\mathrm{V}_{1}$ | Voltage at the control input (IN, EN ) |
| $\mathrm{I}_{\mathrm{IH}}, \mathrm{IIL}^{\text {L }}$ | Leakage current measured at the control input (IN, $\overline{\mathrm{EN}}$ ) |
| ton | Turn-on time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control (IN) signal and analog output (NC or NO) signal when the switch is turning ON. |
| tOFF | Turn-off time for the switch. This parameter is measured under the specified range of conditions and by the propagation delay between the digital control ( IN ) signal and analog output ( NC or NO ) signal when the switch is turning OFF. |
| $Q_{C}$ | Charge injection is a measurement of unwanted signal coupling from the control (IN) input to the analog (NC or NO) output. This is measured in coulomb $(\mathrm{C})$ and measured by the total charge induced due to switching of the control input. Charge injection, $Q_{C}=C_{L} \times \Delta V_{C O M}, C_{L}$ is the load capacitance, and $\Delta V_{C O M}$ is the change in analog output voltage. |
| CNC(OFF) | Capacitance at the NC port when the corresponding channel (NC to COM) is OFF |
| $\mathrm{C}_{\mathrm{NC}(\mathrm{ON})}$ | Capacitance at the NC port when the corresponding channel (NC to COM) is ON |
| $\mathrm{C}_{\mathrm{NO}}$ (OFF) | Capacitance at the NC port when the corresponding channel (NO to COM) is OFF |
| $\mathrm{CNO}(\mathrm{ON})$ | Capacitance at the NC port when the corresponding channel (NO to COM) is ON |
| $\mathrm{C}_{\text {COM }}(\mathrm{OFF})$ | Capacitance at the COM port when the corresponding channel (COM to NC) is OFF |
| $\mathrm{CCOM}_{(\mathrm{ON})}$ | Capacitance at the COM port when the corresponding channel (COM to NC) is ON |
| $\mathrm{C}_{1}$ | Capacitance of control input (IN, $\overline{\mathrm{EN}}$ ) |
| OISO | OFF isolation of the switch is a measurement of OFF-state switch impedance. This is measured in dB in a specific frequency, with the corresponding channel (NC to COM) in the OFF state. |
| XTALK | Crosstalk is a measurement of unwanted signal coupling from an ON channel to an OFF channel (NC1 to NO1). Adjacent crosstalk is a measure of unwanted signal coupling from an ON channel to an adjacent ON channel (NC1 to NC2). This is measured in a specific frequency and in dB . |
| BW | Bandwidth of the switch. This is the frequency in which the gain of an ON channel is -3 dB below the DC gain. |
| THD | Total harmonic distortion describes the signal distortion caused by the analog switch. This is defined as the ratio of root mean square (RMS) value of the second, third, and higher harmonic to the absolute magnitude of the fundamental harmonic. |
| $\mathrm{I}_{+}$ | Static power-supply current with the control (IN) pin at $\mathrm{V}_{+}$or GND |

## PARAMETER MEASUREMENT INFORMATION



Figure 13. ON-State Resistance ( $\mathrm{r}_{\mathrm{on}}$ )


OFF-State Leakage Current Channel OFF
$\mathrm{V}_{\text {I }}=\mathrm{V}_{\text {IH }}$ or $\mathrm{V}_{\text {IL }}$
$\mathrm{V}_{\mathrm{NC}}$ or $\mathrm{V}_{\mathrm{NO}}=0$ to $\mathrm{V}_{+}$
and
$\mathrm{V}_{\mathrm{COM}}=\mathrm{V}_{+}$to 0



ON-State Leakage Current
Channel ON
$\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}}$ or $\mathrm{V}_{\mathrm{IL}}$

Figure 15. ON-State Leakage Current (ICOM(ON), $\left.\mathrm{I}_{\mathrm{NC}(\mathrm{ON})}\right)$

$\mathrm{V}_{\text {BIAS }}=\mathrm{V}_{+}$or GND
$\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}}$ or $\mathrm{V}_{\mathrm{IL}}$
Capacitance is measured at NC, NO, COM, and IN inputs during ON and OFF conditions.

Figure 16. Capacitance ( $\left.\mathrm{C}_{\mathrm{l}}, \mathrm{C}_{\mathrm{COM}(\mathrm{OFF})}, \mathrm{C}_{\mathrm{COM}(\mathrm{ON})}, \mathrm{C}_{\mathrm{NC}(\mathrm{OFF})}, \mathrm{C}_{\mathrm{NC}(\mathrm{ON})}\right)$

(1) All input pulses are supplied by generators having the following characteristics: $\mathrm{PRR} \leq 10 \mathrm{MHz}, \mathrm{Z}_{\mathrm{O}}=50 \Omega, \mathrm{t}_{\mathrm{r}}<5 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<5 \mathrm{~ns}$.
(2) $C_{L}$ includes probe and jig capacitance.
(3) See Electrical Characteristics for $\mathrm{V}_{\mathrm{COM}}$.

Figure 17. Turn-On (ton) and Turn-Off Time (toff)


Figure 18. Bandwidth (BW)


Channel OFF: NC to COM
$\mathrm{V}_{\mathrm{I}}=\mathrm{V}_{+}$or GND

Network Analyzer Setup
Source Power = 0 dBm ( $632-\mathrm{mV}$ P-P at $50-\Omega$ load)
DC Bias $=350 \mathrm{mV}$

Figure 19. OFF Isolation ( $\mathrm{O}_{\mathrm{ISO}}$ )


Figure 20. Crosstalk ( $\mathrm{X}_{\text {TALK }}$ )


Figure 21. Crosstalk Adjacent

(1) $C_{L}$ includes probe and jig capacitance.
(2) All input pulses are supplied by generators having the following characteristics: PRR $\leq 10 \mathrm{MHz}, \mathrm{Z}_{\mathrm{O}}=50 \Omega, \mathrm{t}_{\mathrm{r}}<5 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<5 \mathrm{~ns}$.

Figure 22. Charge Injection $\left(\mathbf{Q}_{\mathrm{C}}\right)$

(1) $C_{L}$ includes probe and jig capacitance.

Figure 23. Total Harmonic Distortion (THD)


| PIM ** | $\mathbf{1 4}$ | $\mathbf{1 6}$ | $\mathbf{2 0}$ | $\mathbf{2 4}$ | $\mathbf{3 8}$ | $\mathbf{4 8}$ | $\mathbf{5 6}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A MAX | 3,70 | 3,70 | 5,10 | 5,10 | 7,90 | 9,80 | 11,40 |
| A MIN | 3,50 | 3,50 | 4,90 | 4,90 | 7,70 | 9,60 | 11,20 |

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: $24 / 48$ Pins - MO-153

14/16/20/56 Pins - MO-194

D (R-PDSO-G16)

## PLASTIC SMALL-OUTLINE PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed $0.006(0,15)$.
D. Falls within JEDEC MS-012 variation AC.

DBQ (R-PDSO-G16)

## PLASTIC SMALL-OUTLINE PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed $0.006(0,15)$ per side.
D. Falls within JEDEC MO-137 variation AB.


| PIMS $^{* *}$ | $\mathbf{8}$ | $\mathbf{1 4}$ | $\mathbf{1 6}$ | $\mathbf{2 0}$ | $\mathbf{2 4}$ | $\mathbf{2 8}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15 .
D. Falls within JEDEC MO-153

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