- Switch $\pm 10-\mathrm{V}$ Analog Signals
- TTL Logic Capability
- 5-to 30-V Supply Ranges
- Low (100 $\Omega$ ) On-State Resistance
- High ( $10^{11} \Omega$ ) Off-State Resistance
- 8-Pin Functions


## description

The TL601, TL604, TL607, and TL610 are a family of monolithic P-MOS analog switches that provide fast switching speeds with high $r_{\text {off }} / r_{\text {on }}$ ratio and no offset voltage. The p-channel enhancement-type MOS switches accept analog signals up to $\pm 10 \mathrm{~V}$ and are controlled by TTL-compatible logic inputs. The monolithic structure is made possible by BI-MOS technology, which combines p-channel MOS with standard bipolar transistors.

These switches are particularly useful in military, industrial, and commercial applications such as data acquisition, multiplexers, $A / D$ and $D / A$ converters, MODEMS, sample-and-hold systems, signal multiplexing, integrators, programmable operational amplifiers, programmable voltage regulators, crosspoint switching networks, logic interface, and many other analog systems.

The TL601 is an SPDT switch with two logic control inputs. The TL604 is a dual complementary SPST switch with a single control input. The TL607 is an SPDT switch with one logic control input and one enable input. The TL610 is an SPST switch with three logic control inputs. The TL610 features a higher $r_{\text {off }} / r_{\text {on }}$ ratio than the other members of the family.
The TL601C, TL604C, TL607C, and TL610C are characterized for operation from $0^{\circ} \mathrm{C}$ to $70^{\circ} \mathrm{C}$, the TL601I, TL604I, TL607I, and TL610I are characterized for operation from $-25^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$, and theTL601M, TL604M, TL607M, and TL610M are characterized for operation over the full military temperature range of $-55^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$.


TL604


TL607

schematics of inputs and outputs


## TL601, TL604, TL607, TL610

 P-MOS ANALOG SWITCHESD2161, JUNE 1976 — REVISED OCTOBER 1986
logic symbols $\dagger$ and switch diagrams


FUNCTION TABLE

| INPUTS |  | ANALOG SWITCHES |  |
| :---: | :--- | :--- | :--- |
| A | B | S1 | S2 |
| $L$ | $X$ | Off (open) | On (closed) |
| X | L | Off (open) | On (closed) |
| $H$ | $H$ | On (closed) | Off (open) |


| INPUT | ANALOG SWITCHES |  |
| :---: | :--- | :--- |
| A | S1 | S2 |
| $H$ | On (closed) | Off (open) |
| L | Off (open) | On (closed) |



| FUNCTION TABLE |  |  |  |
| :---: | :---: | :---: | :---: |
| INPUTS |  |  | ANALOG SWITCHES |
| A | B | C | S |
| L | X | X | Off (open) |
| X | L | X | Off (open) |
| X | X | L | Off (open) |
| X | H | H | On (closed) |

† These symbols are in accordance with ANSI/IEEE Std 91-1984.
TL607 logic diagram (positive logic)


## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

| Supply voltage, $\mathrm{V}_{\mathrm{CC}}^{+}$( (ee Note 1) |  | 30 V |
| :---: | :---: | :---: |
| Supply voltage, $\mathrm{V}_{\text {CC- }} \ldots \ldots \ldots .$. |  | -30 V |
| $\mathrm{V}_{\text {CC+ }}$ to $\mathrm{V}_{\text {CC- }}$ supply voltage differential |  | 35 V |
| Control input voltage |  | $\mathrm{V}_{\mathrm{CC}+}$ |
| Switch off-state voltage |  | 30 V |
| Switch on-state current |  | 10 mA |
| Operating free-air temperature range: | TL601C, TL604C, TL607C, TL610C | $0^{\circ} \mathrm{C}$ to $70^{\circ} \mathrm{C}$ |
|  | TL601I, TL604I, TL607I, TL610I | $-25^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ |
|  | TL601M, TL604M, TL607M, TL610M | $-55^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$ |
| Storage temperature range |  | $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ |
| Lead temperature (1,6 mm) 1/16 inch from case for 60 seconds: JG package |  | $300^{\circ} \mathrm{C}$ |
| Lead temperature (1,6 mm) 1/16 inch | $m$ case for 10 seconds: P package | $260^{\circ} \mathrm{C}$ |

NOTE 1: All voltage values are with respect to network ground terminal.
recommended operating conditions

|  | $\begin{aligned} & \text { TL601C, TL604C } \\ & \text { TL607C, TL610C } \end{aligned}$ |  |  | $\begin{aligned} & \hline \text { TL601I, TL604I } \\ & \text { TL607I, TL610I } \end{aligned}$ |  |  | $\begin{aligned} & \text { TL601M, TL604M } \\ & \text { TL607M, TL610M } \end{aligned}$ |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX |  |
| Supply voltage, $\mathrm{V}_{\mathrm{CC}+}$ (see Figure 1) | 5 | 10 | 25 | 5 | 10 | 25 | 5 | 10 | 25 | V |
| Supply voltage, $\mathrm{V}_{\text {CC }}$ - (see Figure 1) | -5 | -20 | -25 | -5 | -20 | -25 | -5 | -20 | -25 | V |
| $\mathrm{V}_{\mathrm{CC}}+$ to $\mathrm{V}_{\mathrm{CC}}$ supply voltage differential (see Figure 1) | 15 |  | 30 | 15 |  | 30 | 15 |  | 30 | V |
| High-level control input voltage, $\mathrm{V}_{\mathrm{IH}}$ | 2 |  | 5.5 | 2 |  | 5.5 | 2 |  | 5.5 | V |
| Low-level control input voltage, $\mathrm{V}_{\mathrm{IL}}$ All inputs |  |  | 0.8 |  |  | 0.8 |  |  | 0.8 |  |
| Voltage at any analog switch (S) terminal | $\mathrm{V}_{\mathrm{CC}-+8}$ |  | $\mathrm{V}_{\text {CC+ }}$ | $\mathrm{V}_{\mathrm{CC}-+8}$ |  | VCC+ | $\mathrm{V}_{\mathrm{CC}-+8}$ |  | VCC+ | V |
| Switch on-state current |  |  | 10 |  |  | 10 |  |  | 10 | mA |
| Operating free-air temperature, $\mathrm{T}_{\mathrm{A}}$ | 0 |  | 70 | 25 |  | 85 | -55 |  | 125 | ${ }^{\circ} \mathrm{C}$ |

## TL601, TL604, TL607, TL610

P-MOS ANALOG SWITCHES

D2161, JUNE 1976 — REVISED OCTOBER 1986
electrical characteristics over recommended operating free-air temperature range, $\mathrm{V}_{\mathrm{CC}}^{+}, 10 \mathrm{~V}$, $\mathrm{V}_{\mathrm{CC}}=\mathbf{- 2 0} \mathrm{V}$, analog switch test current $=1 \mathrm{~mA}$ (unless otherwise noted)

$\dagger$ MAX is $70^{\circ} \mathrm{C}$ for C-suffix types, $85^{\circ} \mathrm{C}$ for I-suffix types, and $125^{\circ} \mathrm{C}$ for M-suffix types.
$\ddagger$ All typical values are at $T_{A}=25^{\circ} \mathrm{C}$ except for $\mathrm{l}_{\text {off }}$ at $\mathrm{T}_{A}=\mathrm{MAX}$.
NOTE 2: The other terminal of the switch under test is at $\mathrm{V}_{\mathrm{CC}}^{+},=10 \mathrm{~V}$.
switching characteristics, $\mathrm{V}_{\mathrm{CC}_{+}}=10 \mathrm{~V}, \mathrm{~V}_{\mathrm{CC}-}=-20 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$

| PARAMETER | TEST CONDITIONS |  |  | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| toff Switch turn-off time | $\mathrm{R}_{\mathrm{L}}=1 \mathrm{k} \Omega, \quad \mathrm{C}_{\mathrm{L}}=35 \mathrm{pF}, \quad$ See Figure 2 |  |  |  | 400 | 500 | ns |
| ton Switch turn-on time |  |  |  |  | 100 | 150 |  |

## PARAMETER MEASUREMENT INFORMATION

Figure 1 shows power supply boundary conditions for proper operation of the TL601 Series. The range of operation for supply $\mathrm{V}_{\mathrm{CC}}+$ from 5 V to 25 V is shown on the vertical axis. The range of $\mathrm{V}_{\mathrm{CC}}$ - from -5 V to -25 V is shown on the horizontal axis. A recommended $30-\mathrm{V}$ maximum voltage differential from $\mathrm{V}_{\mathrm{CC}}$ to $\mathrm{V}_{\mathrm{CC}}$ governs the maximum $\mathrm{V}_{\mathrm{CC}}$ for a chosen $\mathrm{V}_{\mathrm{CC}}$ ( (or vice versa). A minimum recommended difference of 15 V from $\mathrm{V}_{\mathrm{CC}+}$ to $\mathrm{V}_{\mathrm{CC}}$ and the boundaries shown in Figure 1 allow the designer to select the proper combinations of the two supplies.
The designer-selected $\mathrm{V}_{\mathrm{CC}}$ supply value for a chosen $\mathrm{V}_{\mathrm{CC}}$ supply value limits the maximum input voltage that can be applied to either switch terminal; that is, the input voltage should be between $\mathrm{V}_{\mathrm{CC}-}+8 \mathrm{~V}$ and $\mathrm{V}_{\mathrm{CC}}$ to keep the on-state resistance within specified limits.


Figure 1

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


VOLTAGE WAVEFORMS

NOTES: A. The pulse generator has the following characteristics: $Z_{o}=50 \Omega, \mathrm{t}_{\mathrm{r}} \geq 15 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \geq 15 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=500 \mathrm{~ns}$.
B. $C_{L}$ includes probe and jig capacitance.

Figure 2

## TYPICAL CHARACTERISTICS



Figure 3

M-SUFFIX DEVICES I-SUFFIX DEVICES SWITCH ON-STATE RESISTANCE VS
FREE-AIR TEMPERATURE


Figure 4

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