

# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

D2161, JUNE 1976—REVISED OCTOBER 1986

- Switch  $\pm 10\text{-V}$  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  $r_{off}/r_{on}$  ratio and no offset voltage. The p-channel enhancement-type MOS switches accept analog signals up to  $\pm 10\text{ V}$  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.

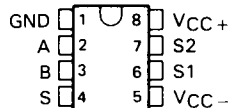
These switches are particularly useful in military, industrial, and commercial applications such as data acquisition, multiplexers, A/D and D/A converters, MODEMS, sample-and-hold systems, signal multiplexing, integrators, programmable operational amplifiers, programmable voltage regulators, crosspoint 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  $r_{off}/r_{on}$  ratio than the other members of the family.

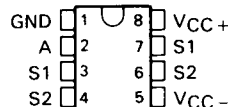
The TL601M, TL604M, TL607M, and TL610M are characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ , the TL601I, TL604I, TL607I, and TL610I are characterized for operation from  $-25^\circ\text{C}$  to  $85^\circ\text{C}$ , and the TL601C, TL604C, TL607C, and TL610C are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

## JG OR P PACKAGE (TOP VIEW)

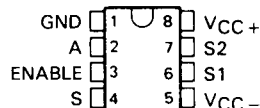
### TL601



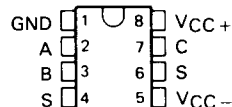
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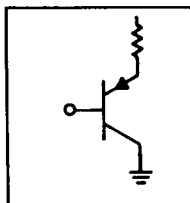
### TL607



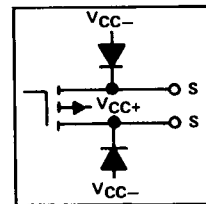
### TL610



TYPICAL OF  
ALL INPUTS



TYPICAL OF  
ALL SWITCHES



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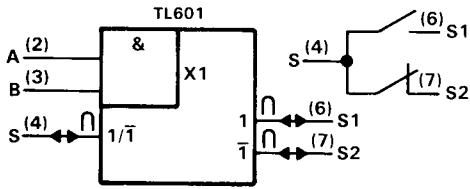
**TEXAS  
INSTRUMENTS**

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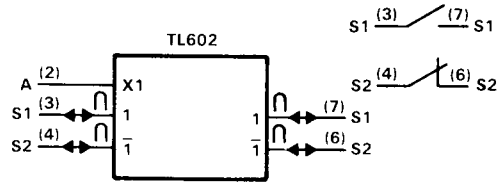
# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

logic symbols† and switch diagrams



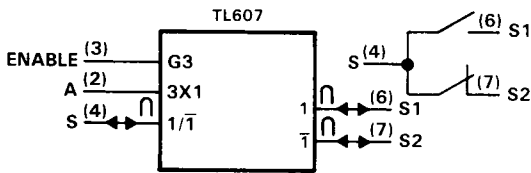
FUNCTION TABLE

LOGIC INPUTS		ANALOG SWITCH	
A	B	S1	S2
L	X	OFF (OPEN)	ON (CLOSED)
X	L	OFF (OPEN)	ON (CLOSED)
H	H	ON (CLOSED)	OFF (OPEN)



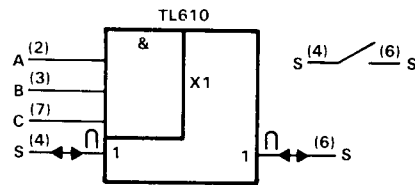
FUNCTION TABLE

LOGIC INPUT	ANALOG SWITCH	
A	S1	S2
H	ON (CLOSED)	OFF (OPEN)
L	OFF (OPEN)	ON (CLOSED)



FUNCTION TABLE

INPUTS		ANALOG SWITCH	
A	ENABLE	S1	S2
X	L	OFF (OPEN)	OFF (OPEN)
L	H	OFF (OPEN)	ON (CLOSED)
H	H	ON (CLOSED)	OFF (OPEN)

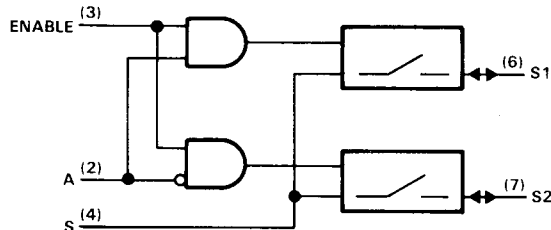


FUNCTION TABLE

INPUTS			ANALOG SWITCH
A	B	C	S
L	X	X	OFF (OPEN)
X	L	X	OFF (OPEN)
X	X	L	OFF (OPEN)
H	H	H	ON (CLOSED)

†These symbols are in accordance with ANSI/IEEE Std 91-1984.

## TL607 logic diagram (positive logic)



# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

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

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

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

## recommended operating conditions

	TL601M, TL604M TL607M, TL610M			TL601I, TL604I TL607I, TL610I			TL601C, TL604C TL607C, TL610C			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC+}$ (see Figure 1)	5	10	25	5	10	25	5	10	25	V
Supply voltage, $V_{CC-}$ (see Figure 1)	-5	-20	-25	-5	-20	-25	-5	-20	-25	V
$V_{CC+}$ to $V_{CC-}$ supply voltage differential (see Figure 1)	15		30	15		30	15		30	V
High-level control input voltage, $V_{IH}$	2		5.5	2		5.5	2		5.5	V
Low-level control input voltage, $V_{IL}$ All inputs			0.8			0.8			0.8	
Voltage at any analog switch (S) terminal	$V_{CC-} + 8$	$V_{CC+}$		$V_{CC-} + 8$	$V_{CC+}$		$V_{CC-} + 8$	$V_{CC+}$		V
Switch on-state current			10			10			10	mA
Operating free-air temperature, $T_A$	-55		125	-25		85	0		70	°C

# TL601, TL604, TL607, TL610

## P-MOS ANALOG SWITCHES

electrical characteristics over recommended operating free-air temperature range,  $V_{CC+} = 10\text{ V}$ ,  $V_{CC-} = -20\text{ V}$ , analog switch test current = 1 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>†</sup>	TL6__M TL6__I			TL6__C			UNIT
		MIN	TYP <sup>‡</sup>	MAX	MIN	TYP <sup>‡</sup>	MAX	
$I_{IH}$ High-level input current	$V_I = 5.5\text{ V}$	0.5		10	0.5		10	$\mu\text{A}$
$I_{IL}$ Low-level input current	$V_I = 0.4\text{ V}$	-50		-250	-50		-250	$\mu\text{A}$
$I_{off}$ Switch off-state current	$V_{I(sw)} = -10\text{ V}$ , See Note 2	$T_A = 25^\circ\text{C}$		-400	$T_A = 25^\circ\text{C}$		-500	$\mu\text{A}$
		$T_A = \text{MAX}^\ddagger$		-50	$T_A = \text{MAX}^\ddagger$		-10	$\mu\text{A}$
$r_{on}$ Switch on-state resistance	$V_{I(sw)} = 10\text{ V}$ , $I_{O(sw)} = -1\text{ mA}$	TL601	55	100	75	200	$\Omega$	
		TL604						
	TL607							
	TL610	40	80	40	100			
	$V_{I(sw)} = -10\text{ V}$ , $I_{O(sw)} = -1\text{ mA}$	TL601	220	400	220	600		
		TL604						
		TL607						
		TL610	120	300	120	400		
$r_{off}$ Switch off-state resistance		25			20			$\text{G}\Omega$
$C_{on}$ Switch on-state input capacitance	$V_{I(sw)} = 0\text{ V}$ , $f = 1\text{ MHz}$	16			16			$\text{pF}$
$C_{off}$ Switch off-state input capacitance	$V_{I(sw)} = 0\text{ V}$ , $f = 1\text{ MHz}$	8			8			$\text{pF}$
$I_{CC+}$ Supply current from $V_{CC+}$	Logic input(s) at 5.5 V, All switch terminals open	TL601	5	10	5	10	$\text{mA}$	
		TL604						
		TL607	Enable input high	5	10	5		10
			Enable input low	3	5	3		5
		TL610	5	10	5	10		
$I_{CC-}$ Supply current from $V_{CC-}$	Logic input(s) at 5.5 V, All switch terminals open	TL601	-1.2	-2.5	-1.2	-2.5	$\text{mA}$	
		TL604						
		TL607	Enable input high	-2.5	-5	-2.5		-5
			Enable input low	-0.05	-0.5	-0.05		-0.5
		TL610	-1.2	-2.5	-1.2	-2.5		

<sup>†</sup>MAX is 125°C for M-suffix types, 85°C for I-suffix types, and 70°C for C-suffix types.

<sup>‡</sup>All typical values are at  $T_A = 25^\circ\text{C}$  except for  $I_{off}$  at  $T_A = \text{MAX}$ .

NOTE 2: The other terminal of the switch under test is at  $V_{CC+} = 10\text{ V}$ .

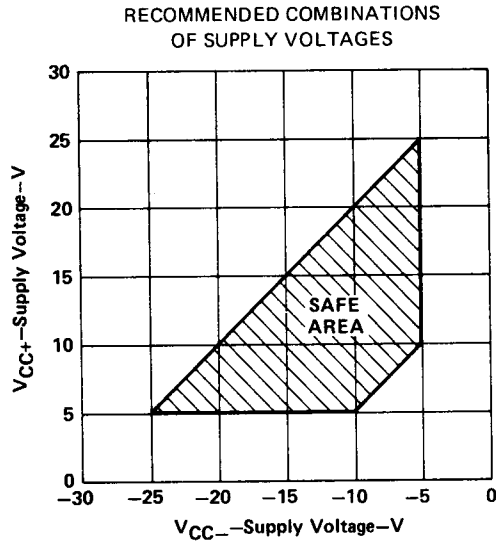
### switching characteristics, $V_{CC+} = 10\text{ V}$ , $V_{CC-} = -20\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{off}$ Switch turn-off time	$R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ , See Figure 2	400	500		ns
$t_{on}$ Switch turn-on time		100	150		



Figure 1 shows power supply boundary conditions for proper operation of the TL601 Series. The range of operation for supply  $V_{CC+}$  from +5 V to +25 V is shown on the vertical axis. The range of  $V_{CC-}$  from -5 V to -25 V is shown on the horizontal axis. A recommended 30-V maximum voltage differential from  $V_{CC+}$  to  $V_{CC-}$  governs the maximum  $V_{CC+}$  for a chosen  $V_{CC-}$  (or vice versa). A minimum recommended difference of 15 V from  $V_{CC+}$  to  $V_{CC-}$  and the boundaries shown in Figure 1 allow the designer to select the proper combinations of the two supplies.

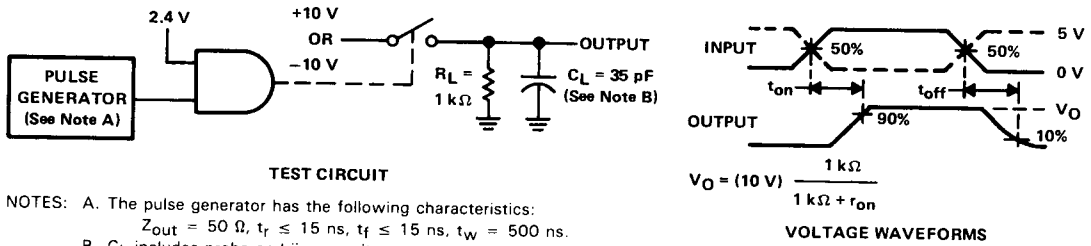
The designer-selected  $V_{CC+}$  supply value for a chosen  $V_{CC-}$  supply value limits the maximum input voltage that can be applied to either switch terminal; that is, the input voltage should be between  $V_{CC-} + 8$  V and  $V_{CC+}$  to keep the on-state resistance within specified limits.



**FIGURE 1**

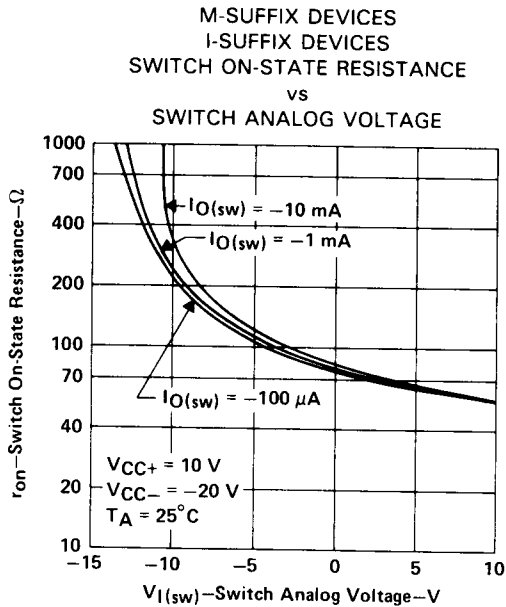
**TL601, TL604, TL607, TL610**  
**P-MOS ANALOG SWITCHES**

**PARAMETER MEASUREMENT INFORMATION**

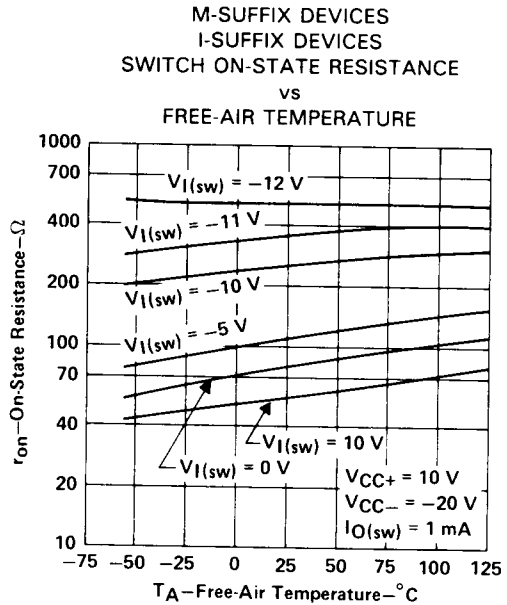


**FIGURE 2**

**TYPICAL CHARACTERISTICS**



**FIGURE 3**



**FIGURE 4**

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