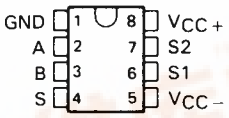
TL601, TL604, TL607, TL610
P-MOS ANALOG SWITCHES

D2161, JUNE 1976—REVISED OCTOBER 1986

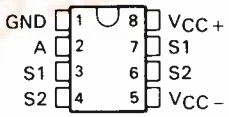
- Switch ±10-V Analog Signals
- TTL Logic Capability
- 5- to 30-V Supply Ranges
- Low (100 Ω) On-State Resistance
- High (10^{11} Ω) Off-State Resistance
- 8-Pin Functions

JG OR P PACKAGE
(TOP VIEW)

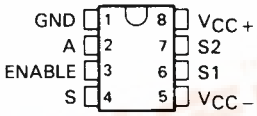
TL601



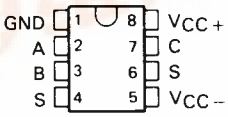
TL604



TL607



TL610



description

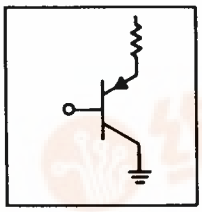
The TL601, TL604, TL607, and TL610 are a family of monolithic P-MOS analog switches that provide fast switching speeds with high r_{off}/r_{on} ratio and no offset voltage. The p-channel enhancement-type MOS switches accept analog signals up to ±10 V and are controlled by TTL-compatible logic inputs. 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.

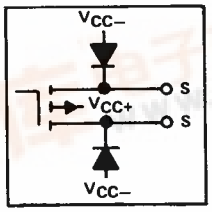
The TL601 is an SPDT switch with two logic control inputs. The TL604 is a dual complementary SPST switch with a single control input. The TL607 is an SPDT switch with one logic control input and one enable input. The TL610 is an SPST switch with three logic control inputs. The TL610 features a higher 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°C to 125°C, the TL601I, TL604I, TL607I, and TL610I are characterized for operation from −25°C to 85°C, and the TL601C, TL604C, TL607C, and TL610C are characterized for operation from 0°C to 70°C.

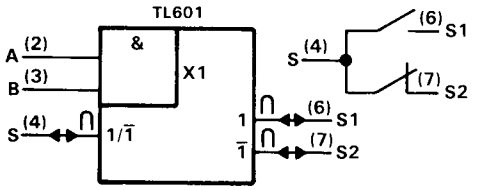
TYPICAL OF ALL INPUTS



TYPICAL OF ALL SWITCHES

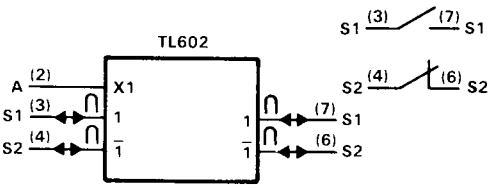


logic symbols† and switch diagrams



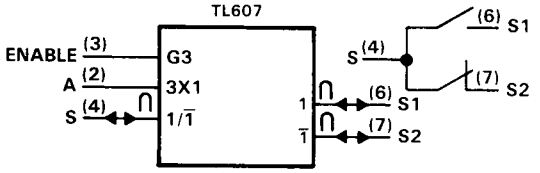
FUNCTION TABLE

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)



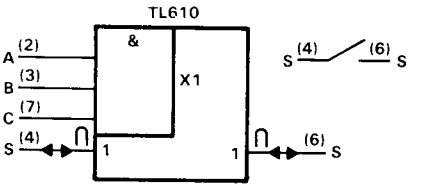
FUNCTION TABLE

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)

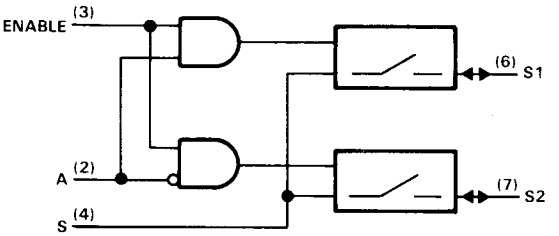


FUNCTION TABLE

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)



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

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

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

†MAX is 125°C for M-suffix types, 85°C for I-suffix types, and 70°C for C-suffix types.
‡All typical values are at T_A = 25°C except for I_{off} at T_A = MAX.
NOTE 2: The other terminal of the switch under test is at V_{CC+} = 10 V.

switching characteristics, V_{CC+} = 10 V, V_{CC-} = −20 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{off}	Switch turn-off time	R_L = 1 kΩ, C_L = 35 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.

RECOMMENDED COMBINATIONS
OF SUPPLY VOLTAGES

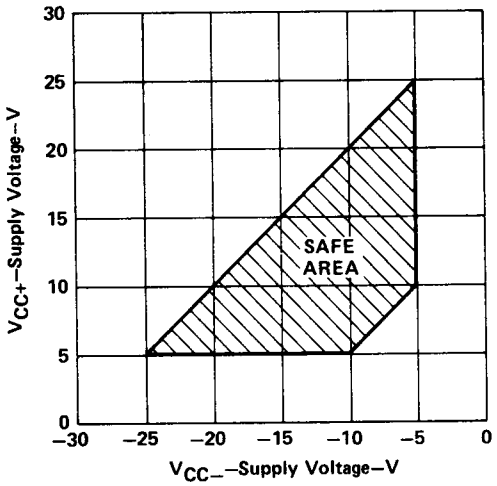
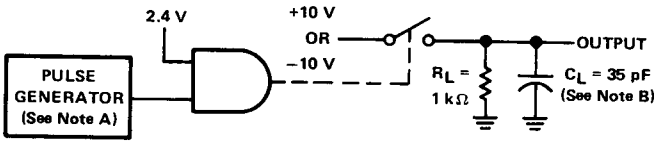
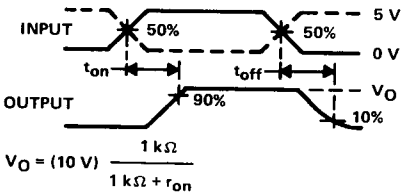


FIGURE 1

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The pulse generator has the following characteristics: Z_{out} = 50 Ω, $t_r \leq 15$ ns, $t_f \leq 15$ ns, t_w = 500 ns.
B. C_L includes probe and jig capacitance.

FIGURE 2

TYPICAL CHARACTERISTICS

M-SUFFIX DEVICES
I-SUFFIX DEVICES
SWITCH ON-STATE RESISTANCE
vs
SWITCH ANALOG VOLTAGE

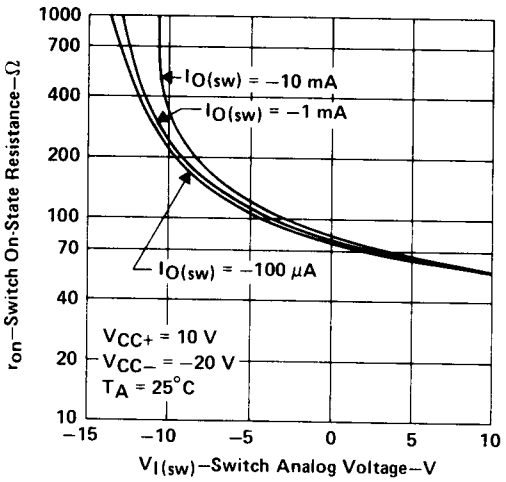


FIGURE 3

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

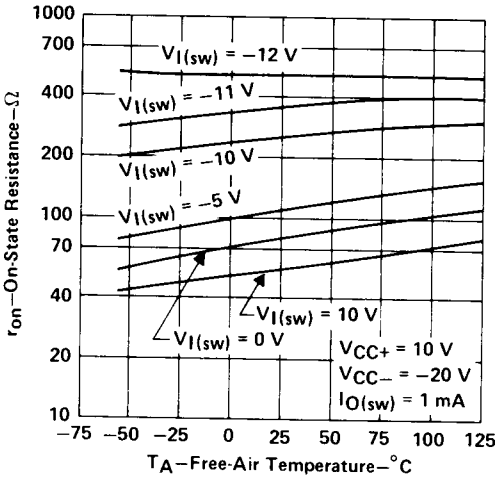


FIGURE 4