SLAS042 − 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**

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.

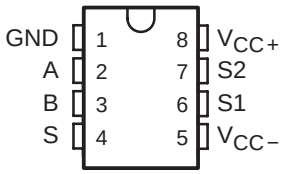
These switches are particularly useful in military, industrial, and commercial applications such as data acquisition, multiplexers, A/D and D/A converters, MODEMS, sample-and-hold systems, signal multiplexing, integrators, programmable operational amplifiers, programmable voltage regulators, crosspoint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

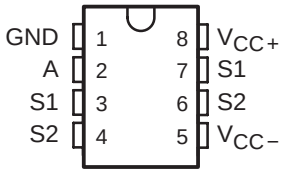
The TL601C, TL604C, TL607C, and TL610C are characterized for operation from 0°C to 70°C, the TL601I, TL604I, TL607I, and TL610I are characterized for operation from −25°C to 85°C, and theTL601M, TL604M, TL607M, and TL610M are characterized for operation over the full military temperature range of −55°C to 125°C.

JG OR P PACKAGE
(TOP VIEW)

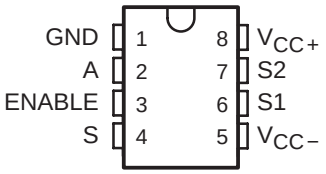
TL601



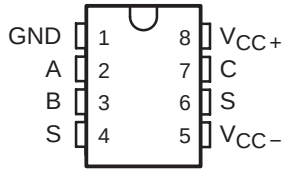
TL604



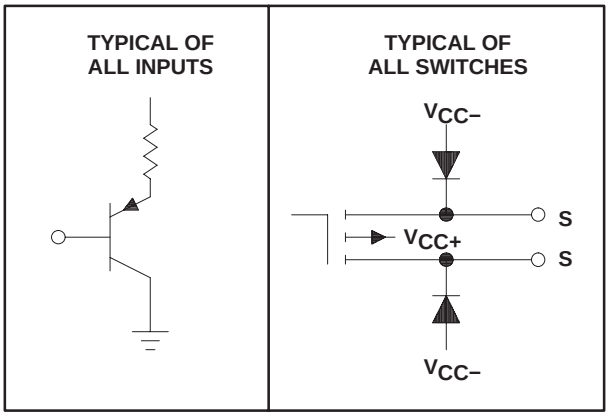
TL607



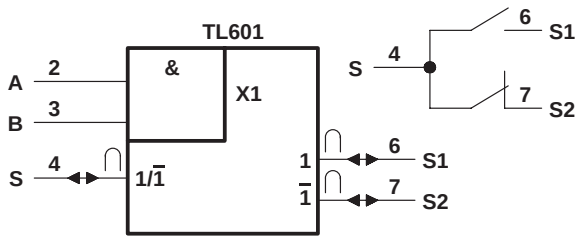
TL610



schematics of inputs and outputs

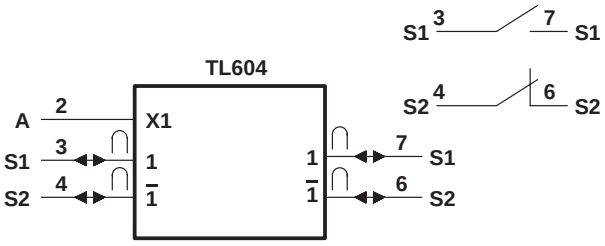


logic symbols† and switch diagrams



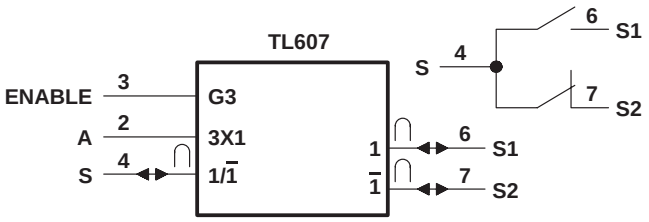
FUNCTION TABLE

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)



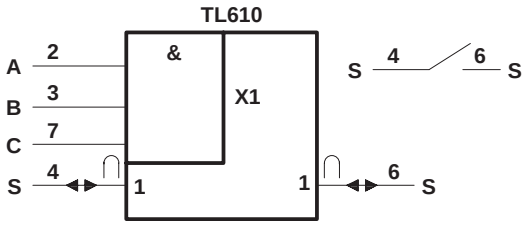
FUNCTION TABLE

INPUT	ANALOG SWITCHES	
A	S1	S2
H	On (closed)	Off (open)
L	Off (open)	On (closed)



FUNCTION TABLE

INPUTS		ANALOG SWITCHES	
A	ENABLE	S1	S2
X	L	Off (open)	Off (open)
L	H	Off (open)	On (closed)
H	H	On (closed)	Off (open)

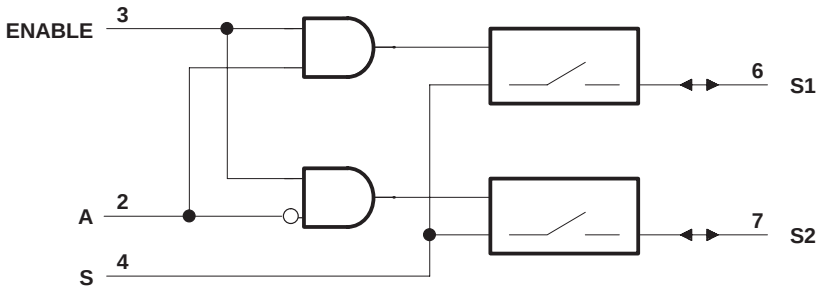


FUNCTION TABLE

INPUTS			ANALOG 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, 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: TL601C, TL604C, TL607C, TL610C . . . . . 0°C to 70°C
TL601I, TL604I, TL607I, TL610I . . . . . −25°C to 85°C
TL601M, TL604M, TL607M, TL610M . . . . . −55°C to 125°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

		TL601C, TL604C TL607C, TL610C			TL601I, TL604I TL607I, TL610I			TL601M, TL604M TL607M, TL610M			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	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		0		70	25		85	−55		125	°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 _ _ C			TL6 _ _ M TL6 _ _ I			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
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		−500			−400		pA
				T_A = MAX†		−10	−20		−50	−100	nA
r_{on}	Switch on-state resistance	$V_{I(sw)}$ = 10 V, $I_{O(sw)}$ = −1 mA		TL601 TL604 TL607		75	200		55	100	Ω
				TL610		40	100		40	80	
		$V_{I(sw)}$ = −10 V, $I_{O(sw)}$ = −1 mA		TL601 TL604 TL607		220	600		220	400	
				TL610		120	300		120	300	
r_{off}	Switch off-state resistance					20			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 high	TL607		5	10		5	10	
			ENABLE 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 high	TL607		−2.5	−5		−2.5	−5	
			ENABLE low			−0.05	−0.5		−0.05	−0.5	
				TL610		−1.2	−2.5		−1.2	−2.5	

† MAX is 70°C for C-suffix types, 85°C for I-suffix types, and 125°C for M-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	

PARAMETER MEASUREMENT INFORMATION

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.

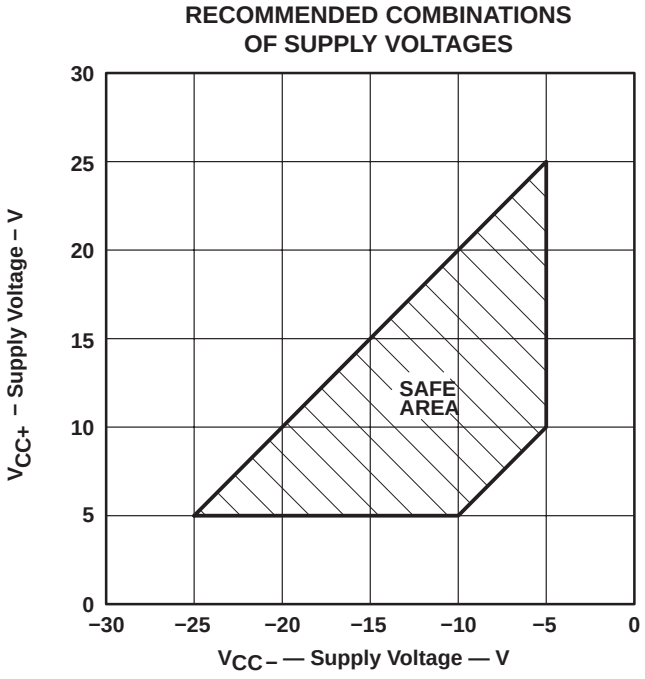
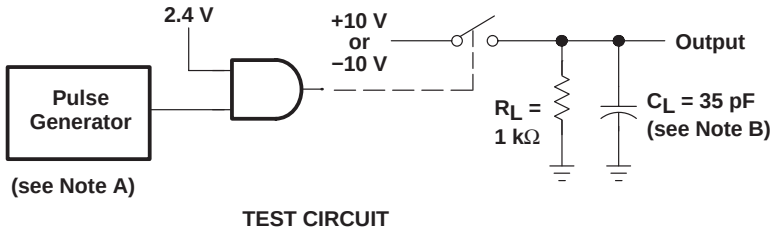
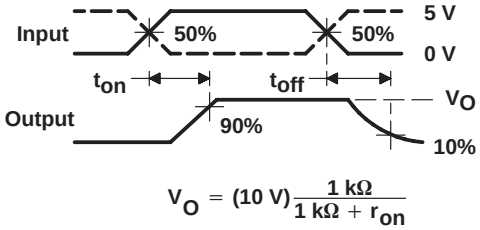


Figure 1

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The pulse generator has the following characteristics: Z_O = 50 Ω, $t_r \geq$ 15 ns, $t_f \geq$ 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

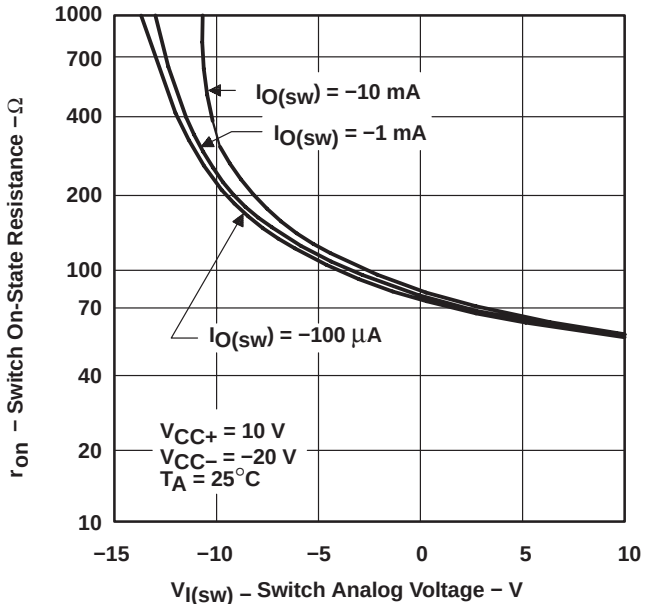


Figure 3

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

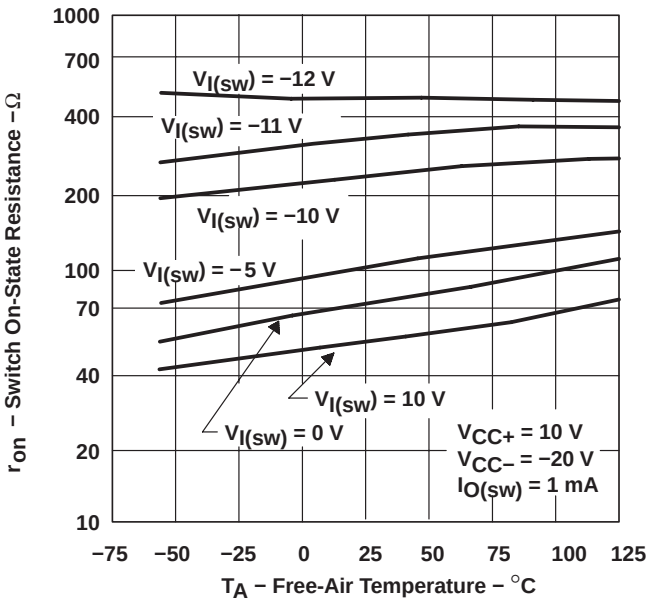


Figure 4

PACKAGING INFORMATION

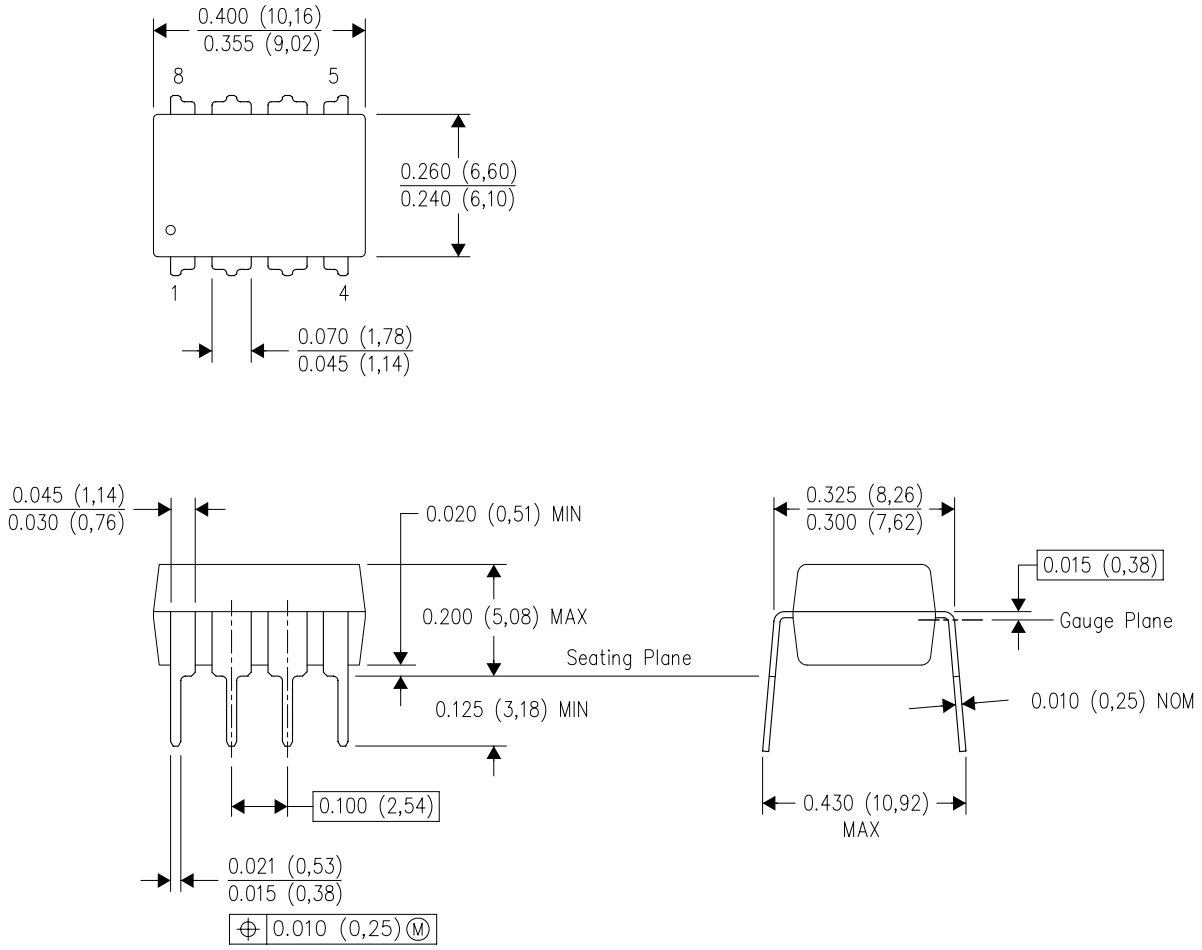
Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL601CP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TL601IP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TL604CP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TL607CP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TL610CP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

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