TYPE TL560C
PRECISION LEVEL DETECTOR

BULLETIN NO. DL-S 12400, MAY 1976—REVISED OCTOBER 1979

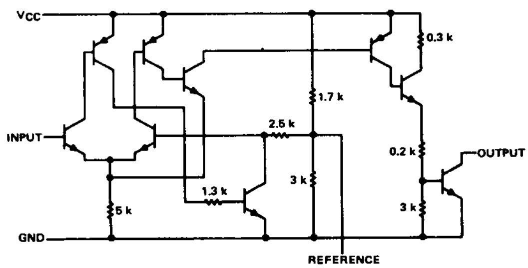
- Stable Threshold Level
- Low Input Current
- High Output Sink Current Capability
- Threshold Hysteresis
- Wide Supply Voltage Range

description

The TL560C is a precision level detector intended for applications that require a Schmitt-trigger function. The detector has excellent voltage and temperature stability and an internal voltage reference for the input threshold level. The reference-voltage pin is available for external adjustment of the positive-going threshold voltage level.

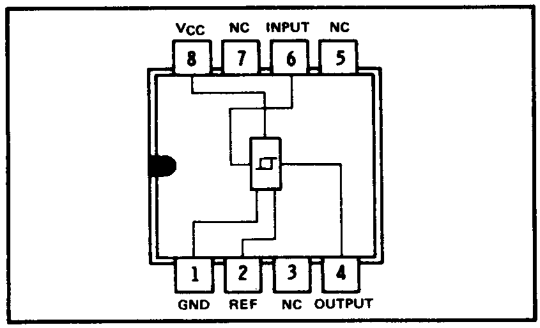
The TL560C is characterized for operation from 0°C to 70°C.

schematic



Resistor values shown are nominal and in ohms.

JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage (see Note 1)	V_{CC}
Output voltage (see Note 1)	25 V
Output sink current	160 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2)	800 mW
Operating free-air temperature range	0°C to 70°C
Storage temperature range	−65°C to 150°C
Lead temperature 1/16 inch (1,6 mm) from case for 60 seconds: JG package	300°C
Lead temperature 1/16 inch (1,6 mm) from case for 10 seconds: P package	260°C

NOTES: 1. All voltage values are with respect to the network ground terminal.
2. For operation above 25°C free-air temperature refer to the Dissipation Derating Table. In the JG package, TL560C chips are glass-mounted.

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DISSIPATION DERATING TABLE

PACKAGE	POWER RATING	DERATING FACTOR	ABOVE T_A
JG (Glass-Mounted Chip)	800 mW	6.6 mW/°C	29°C
P	800 mW	8.0 mW/°C	50°C

Also see Dissipation Derating Curves, Section 2.

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recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	2.5	5	7	V
Low-level output current, I_{OL}			48	mA
Operating free-air temperature, T_A	0		70	°C

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 5V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{T+}	Positive-going threshold voltage†			2.8	3	3.2	V
V_{T+}/V_{CC}	Ratio of positive-going threshold voltage to supply voltage	V_{CC} = 2.5 V to 7 V			0.6		
V_{T-}	Negative-going threshold voltage‡			0.4	0.6	0.8	V
I_{T+}	Input current below positive-going threshold voltage	V_I = 2.75 V,	Output on		2	30	nA
I_{T-}	Input current above negative-going threshold voltage	V_I = 1 V,	Output off		1.2		μA
$I_{O(off)}$	Off-state output current	V_I = 4 V,	V_O = 25 V			10	μA
$V_{O(on)}$	On-state output voltage	V_I = 0,	I_O = 48 mA		0.2	0.4	V
$I_{CC(off)}$	Supply current, output off (each detector)	V_I = 4 V			4.8	6.5	mA
$I_{CC(on)}$	Supply current, output on (each detector)	V_I = 0			10	15	mA

†Positive-going threshold voltage, V_{T+}, is the input voltage level at which the output changes state as the input voltage is increased.
‡Negative-going threshold voltage, V_{T-}, is the input voltage level at which the output changes state as the input voltage is decreased.

TYPICAL CHARACTERISTICS

POSITIVE-GOING THRESHOLD VOLTAGE vs SUPPLY VOLTAGE

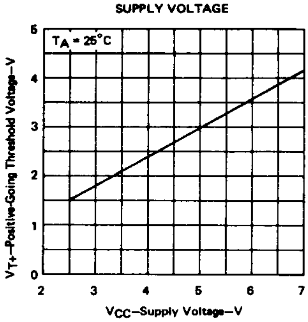

FIGURE 1

ON-STATE OUTPUT VOLTAGE vs ON-STATE OUTPUT CURRENT

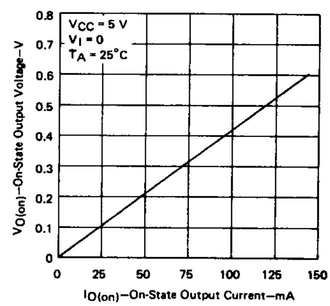

FIGURE 2

TYPICAL APPLICATION DATA

The TL560C performs the function of a Schmitt-trigger circuit. The logic function is noninverting and has a wide hysteresis between the positive-going and negative-going threshold voltage levels (see Figure 3).

Operation of the TL560C is specified at a V_{CC} of 5 V, although 2.5-V to 7-V supply operation is possible. The device can be used with popular logic systems (such as Series 54/74 TTL) and standard battery voltages.

Figure 4 is used to illustrate operation of the TL560C circuit. The input stage is a differential amplifier composed of Q1, Q2, Q3, and Q4. The input signal is applied at the base of Q1 while the base of Q2 is connected to an internal reference voltage determined by resistors R4 and R5 and V_{CC}; $V_{ref} = V_{CC} \cdot R5/(R4+R5)$.

TYPICAL APPLICATION DATA

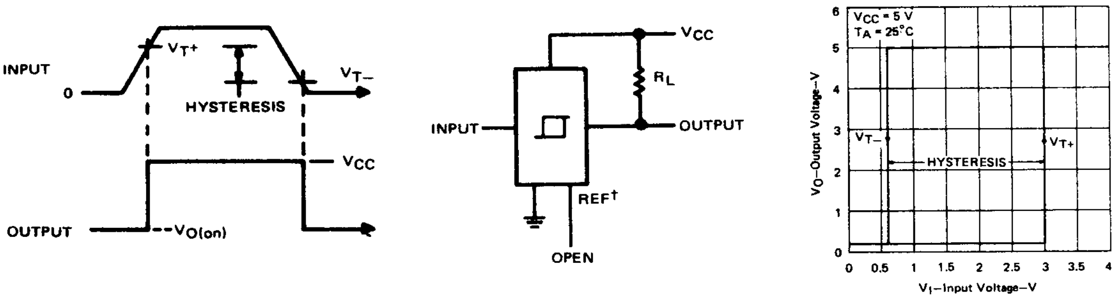

FIGURE 3—INPUT-OUTPUT TRANSFER FUNCTION

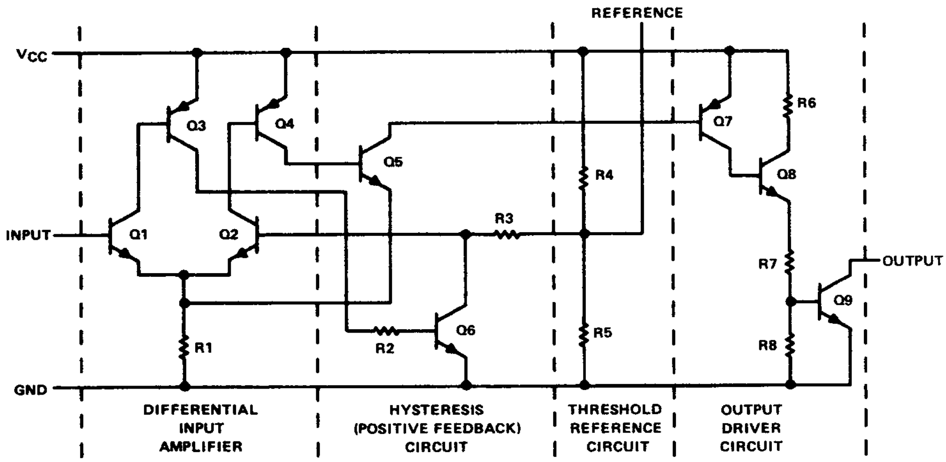

FIGURE 4—FUNCTIONAL CIRCUIT DIAGRAM

If the base of Q1 is less positive than the base of Q2, Q2 conducts and causes Q4, Q5, Q7, Q8, and the output transistor, Q9, to conduct. Transistors Q2 and Q5 share the current in emitter resistor R1. Since Q1 does not conduct, Q3 and Q6 do not conduct. There is no base current in Q1, and therefore no current required from the input source. A very high input impedance therefore exists. Since Q2 is conducting, a small voltage drop exists across R3 due to Q2 base current.

If the input voltage is increased, Q1 does not conduct until the input voltage (base voltage of Q1) approaches the base voltage of Q2. Current is then switched from the emitters of Q2 and Q5 to the emitter of Q1. Conduction in Q1 causes current to flow in Q3 and Q6 which results in additional voltage drop in R3 and therefore a reduction in the base voltage of Q2. This positive feedback accelerates switching action and causes conduction to rapidly cease in Q2, Q4, Q5, Q7, Q8, and the output transistor, Q9. Conduction in Q6 causes the base of Q2 to assume a voltage (approximately 0.6 V) much lower than the original reference voltage (approximately 3 V). This results in hysteresis between the positive-going and negative-going threshold levels.

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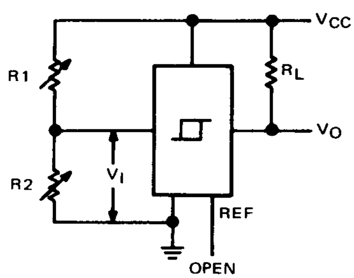
TYPICAL APPLICATION DATA

After switching occurs, the base current of Q1 increases to a somewhat higher value than just below threshold because of higher Q1 operating currents. Once the positive-going threshold level (≈3 V) has been reached, the input voltage must be reduced to the negative-going threshold level (≈0.6 V) before switching back to the original state will occur. Figure 3 illustrates the threshold levels of the TL560C. Because the input current increases after the positive-going threshold voltage level has been exceeded, the input voltage will be reduced by an amount dependent on the source resistance. If the reduced input voltage is not below the negative-going threshold voltage level, a stable state will exist. If the source resistance is too high, oscillation or periodic switching may occur.

The positive-going threshold voltage level (V_{T+}) is guaranteed to be 3.00 ± 0.20 volts at a V_{CC} of 5 V. It is also approximately 60% of the supply voltage over the supply voltage range of 2.5 V to 7 V. With a resistor-capacitor network as illustrated in Figure 6, a V_{T+}/V_{CC} ratio of 60% results in a timed interval of approximately RC seconds, independent of the V_{CC} level. Since the input current is nominally 2 nA just below the V_{T+} level, very large values of R and/or large values of C may be used to achieve long-timed intervals. The duration of the timed interval may be greatly increased (at the expense of accuracy) by using a P-N-P transistor as shown in Figure 10 in a capacitance-multiplication technique. The timed interval is, however, sensitive to variations in the h_{FE} of the P-N-P transistor. Also for any of the timing applications, very-low-leakage capacitors are necessary for accurate operation.

The low input current (30 nA maximum for I_{T+}) and high output sink current (160 mA maximum) make the TL560C excellent in applications of interfacing between low-level systems and TTL systems where precision level detection is required. The output is capable of sinking up to a maximum of 160 mA with a TTL-compatible on-state voltage of 0.4 V maximum guaranteed at a sink current of 48 mA. With an appropriate output pull-up resistor (R_L ≈ 2 kΩ to 5 V), a fan-out of approximately 30 Series 74 TTL loads can be accomodated.

In addition to applications interfacing with TTL systems, the TL560C finds application in driving relays, lamps, solenoids, thyristors (SCRs and triacs), and other peripheral devices.



Output turns off when $V_I \geq V_{T+}$
Output turns on when $V_I \leq V_{T-}$

where $V_I = V_{CC}\frac{R2}{R1+R2}$

FIGURE 5–BASIC SENSOR CIRCUIT

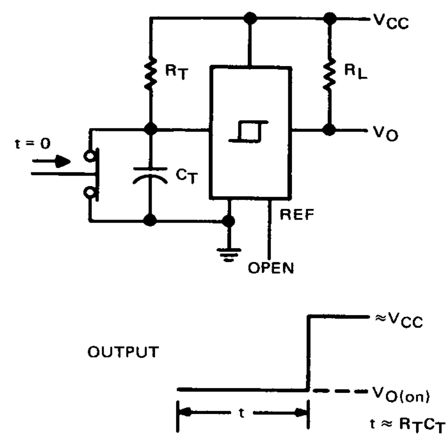


FIGURE 6–BASIC TIMED-INTERVAL CIRCUIT

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TYPICAL APPLICATION DATA

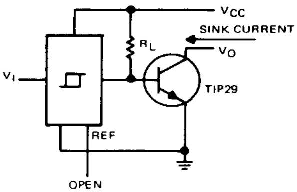


FIGURE 7—EXTERNAL N-P-N TRANSISTOR FOR INCREASING SINK CURRENT

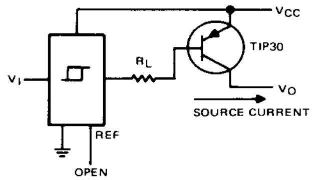


FIGURE 8—EXTERNAL P-N-P TRANSISTOR FOR INCREASING SOURCE CURRENT

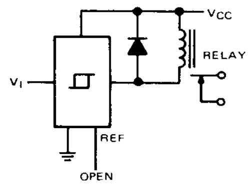


FIGURE 9—RELAY DRIVER

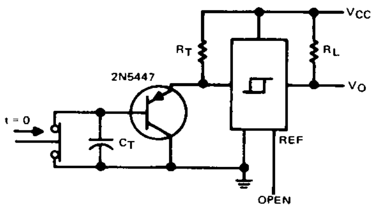


FIGURE 10—LONG-TIMED-INTERVAL CIRCUIT

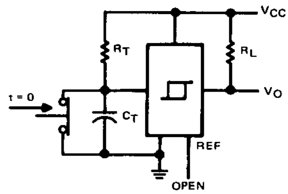
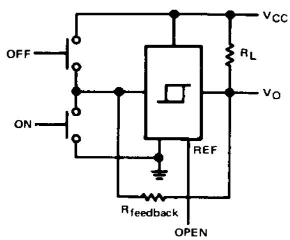


FIGURE 11—BOUNCELESS SWITCH



NOTE A: This circuit can be used as a touch-control switch with $R_{feedback} \approx 10\ M\Omega$.

FIGURE 12—SWITCH WITH TWO STABLE STATES

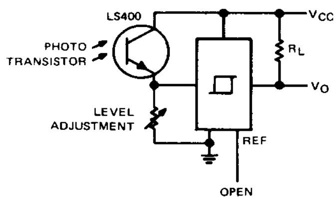


FIGURE 13—LIGHT-LEVEL SENSOR

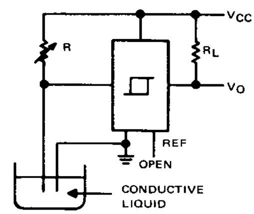


FIGURE 14—LIQUID-LEVEL SENSOR

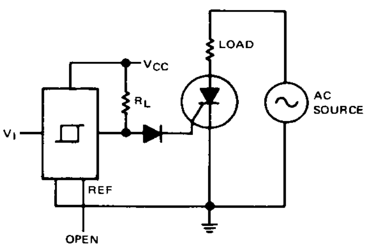


FIGURE 15—THYRISTOR DRIVER CIRCUIT

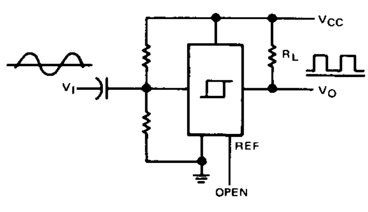


FIGURE 16—SINE-WAVE-TO-SQUARE-WAVE CONVERTER

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