

1. Vcc	5. Gnd
2. Rsl	6. Hfo
3. Lfi	7. Hfi
4. Lfo	8. Out

**Operating Voltage 13 to 36V**  
**Ringling Start Voltage 36V (max.)**

The TS31002 is a bipolar integrated circuit designed for telephone bell replacement.

- ✧ Designed for Telephone Bell Replacement
- ✧ Low Current Drain
- ✧ Adjustable 2-frequency Tone
- ✧ Adjustable Warbling Rate
- ✧ Extension Tone Ringer Modules
- ✧ Alarms or Other Alerting Devices
- ✧ Adjustable for Reduced Supply Initiation Current.
- ✧ Built-in hysteresis prevents false triggering and rotary dial 'Chirps'

Part No.	Operating Temp.	Package
TS31002CD	-20 ~ +70 °C	DIP-8
TS31002CS		SOP-8

The diagram shows a multi-frequency oscillator circuit with the following components and connections:

- Power Supply With Hysteresis:** A rectangular block connected to input 1 and output 8. Its output is connected to input 2 and the non-inverting input of the Low Frequency Oscillator.
- Low Frequency Oscillator:** A triangular block with its non-inverting input connected to the Power Supply and its inverting input connected to output 3. Its output is connected to input 4 and the non-inverting input of the High Frequency Oscillator.
- High Frequency Oscillator:** A triangular block with its non-inverting input connected to the Low Frequency Oscillator and its inverting input connected to output 6. Its output is connected to input 5 and the non-inverting input of the AMP.
- AMP (Amplifier):** A triangular block with its non-inverting input connected to the High Frequency Oscillator and its inverting input connected to output 7. Its output is connected to input 1.



## Absolute Maximum Rating

Description	Symbol	Value	Unit
DC Supply Voltage (Referenced to GND)	VCC	+ 36	V
Power Dissipation in Still Air Plastic DIP	PD	400	mW
Switch Collector Voltage	Tstg	-65 to +150	°C

**Note:** \* Maximum Ratings are those values beyond which damage to the device may occur.  
Functional operation should be restricted to the Recommended Operating Conditions.

## Recommended Operating Conditions

Description	Symbol	Min	Max	Unit
Operating Voltage	Vopr	13	36	V
Operating Temperature	T <sub>A</sub>	-45	+65	°C

**Note:** This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V<sub>IN</sub> and V<sub>OUT</sub> should be constrained to the range

$$GND \leq (V_{IN} \text{ or } V_{OUT}) \leq V_{CC}.$$

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or Vcc). Unused outputs must be left open.

## Electrical Characteristics (Voltages Referenced to GND, T<sub>A</sub>=-20 to +70 °C)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Initiation Supply Voltage (1)	V <sub>SI</sub>	See Figure 2	16.8	--	21.2	V
Initiation Supply Current (1)	I <sub>SI</sub>	See Figure 2	1.4	--	4.2	mA
Sustaining Voltage (1)	V <sub>SUS</sub>	See Figure 2	9.5	--	12.2	V
Sustaining Current	I <sub>SUS</sub>	See Figure 2	0.7	--	2.5	mA
High-Level Output Voltage	V <sub>OH</sub>	Vcc=21V, I <sub>OH</sub> =-15mA, Pin6=6V, Pin7=GND	16.7	--	21.0	V
Low-Level Output Voltage	V <sub>OL</sub>	Vcc=21V, I <sub>OL</sub> =15mA, Pin6= GND, Pin7=6V	--	--	1.8	V
Maximun Input Leakage Current	I <sub>IN</sub>	Pin3 =6V, Pin4 =GND, Vcc=21V	--	--	1.0	μA
		Pin7 =6V, Pin6 =GND, Vcc=21V	--	--	1.0	μA
High Frequency 1	F <sub>H1</sub>	R <sub>3</sub> =191KΩ, C <sub>3</sub> =6800pF	461	--	563	H <sub>Z</sub>
High Frequency 2	F <sub>H2</sub>	R <sub>3</sub> =191KΩ, C <sub>3</sub> =6800pF	576	--	704	H <sub>Z</sub>
Low Frequency	F <sub>L</sub>	R <sub>2</sub> =165KΩ, C <sub>2</sub> =0.47uF	9.0	--	11.0	H <sub>Z</sub>
Ringing Start Voltage (4)	V <sub>tr</sub>	See Figure 1	--	--	36	V

- Notes :**
1. Initiation supply voltage (V<sub>SI</sub>) is the supply voltage required to start the tone ringer oscillating.
  2. Sustaining voltage (V<sub>SUS</sub>) is the supply voltage required to maintain oscillation.
  3. Ringing start voltage is the value of AC supply voltage required to start the tone ringer ringing in FIG.3
  4. This product is not designed for protection against radioactive rays.
  5. All data and specifications are subject to change without notice.

## Application Circuit

### . HOW TO USE THE RSL PIN

In the IC, the supply initiation current ( $I_{si}$ ) can be changed using the RSL Pin. As show is the diagram, the RSL (Pin 2) is grounded through resistor  $R_s$ . By changing the  $R_s$  value, supply initiation current can be changed.

Supply voltage ( $V_{cc}$ ) vs. supply current ( $I_{cc}$ ) characteristics resulting from changes in the value of  $R_s$  are shown in the following diagram.

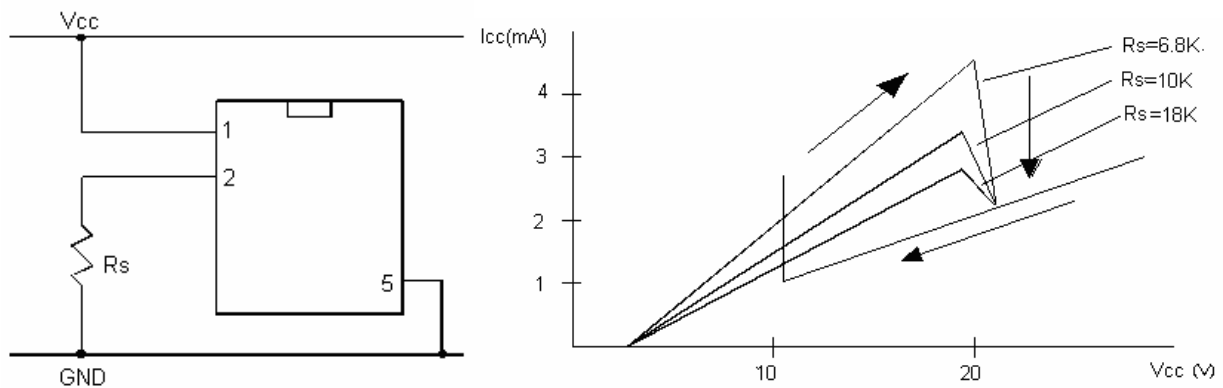


Figure 1. Ringing Start Voltage Test Circuit

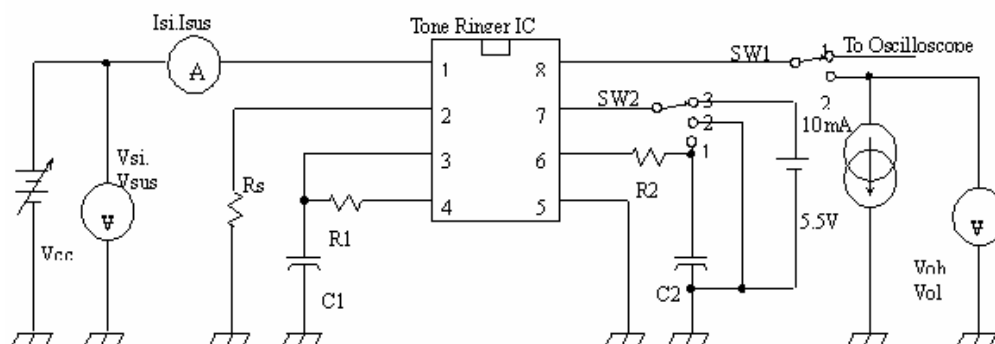


Figure 2. Test Circuit (1)

## Application Circuit

SWITCH POSITION IS THE FOLLOWING TABLE :

PARAMETER	SW1	SW2
V <sub>si</sub> , I <sub>si</sub>	1	1
V <sub>sus</sub> , I <sub>sus</sub>	1	1
V <sub>oh</sub>	2	2
V <sub>ol</sub>	2	3

$R1 = 165\text{ K (+/-) } 1\%$   
 $R2 = 191\text{ K (+/-) } 1\%$   
 $C1 = 0.47\text{ }\mu\text{F (+/-) } 5\%$   
 $C2 = 0.0068\text{ }\mu\text{F (+/-) } 5\%$

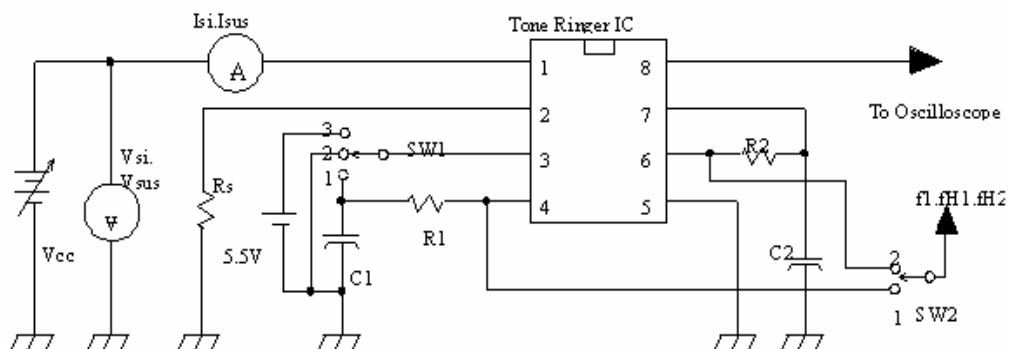


Figure 3. Test Circuit (2)

SWITCH POSITION IS THE FOLLOWING TABLE :

PARAMETER	SW1	SW2
FL	1	1
fH1	3	2
fH2	2	2

$R1 = 165\text{ K (+/-) } 1\%$   
 $R2 = 191\text{ K (+/-) } 1\%$   
 $C1 = 0.47\text{ }\mu\text{F (+/-) } 5\%$   
 $C2 = 0.0068\text{ }\mu\text{F (+/-) } 5\%$

## Application Note

The application circuit illustrates the use of the TS31002 devices in typical telephone or extension tone ringer application.

The AC ringer signal voltage appears across the TIP and RING inputs of the circuit and is attenuated by capacitor C1 and resistor R1.

C1 also provides isolation from DC voltages (48V) on the exchange line.

After full wave rectification by the bridge diode, the waveform is filtered by capacitor C4 to provide a DC supply for the tone ringer chip. As this voltage exceeds the initiation voltage (V<sub>SI</sub>), oscillation starts.

With the components shown, the output frequency chops between 512Hz (f<sub>H1</sub>) and 640Hz (f<sub>H2</sub>) at a 10Hz (f<sub>L</sub>) rate.

The loudspeaker load is coupled through a 1300W to 8W transformer.

The output coupling capacitor C5 is required with transformer coupled loads.

When driving a piezo-ceramic transducer type load, the coupling C5 and transformer (1300W:8W) are not required. However, a current limiting resistor is required.

The low frequency oscillator oscillates at a rate (f<sub>L</sub>) controlled by an external resistor (R2) and capacitor (C2).

The frequency can be determined using the relation  $f_L = 1/1.289R_2 \cdot C_2$ . The high frequency oscillates at a f<sub>H1</sub>, f<sub>H2</sub> controlled by an external resistor (R3) and capacitor (C3). The frequency can be determined using the relation  $f_{H1} = 1/1.504R_3 \cdot C_3$ ,  $f_{H2} = 1/1.203R_3 \cdot C_3$ .

## Application Note

Pin 2 allows connection of an external resistor RSL, which is used to program the slope of the supply current vs supply voltage characteristics (see Fig2), and hence the supply current up to the initiation voltage ( VSI ). This initiation voltage remains constant independent of RSL.

The supply current drawn prior to triggering varies inversely with RSL, decreasing for increasing value of resistance. Thus, increasing the value of RSL will decrease the amount of AC ringing current required to trigger the device. As such, longer subscriber loops are possible since less voltage is dropped per unit length of loop wire due to the lower current level. RSL can also be used to compensated for smaller AC couplin capacitors (C5 on Fig 3) (higher impedance) to the line which can be used to alter the ringer equivalence number of a tone ringer circuit. The graph in Fig2 illustrates the variation of supply current with supply voltage. Three curves are drawn to show the variation of initiation current with RSL. Curve B( RSL=6.8KW) shows the I-V characteristic for the TS31002 tone ringer.

Curve A is a plot with  $R_{SL} < 6.8KW$  and shows an increase in the current drawn up to the initiation voltage VSI. The I-V characteristic after initiation remains unchanged. Curve C illustrates the effect of increasing RSL above 6.8KW initiation current decreases but again current after triggering is unchanged.

## Characteristics Curve

CIRCUIT CURRENT-SUPPLY VOLTAGE (NO LOAD)

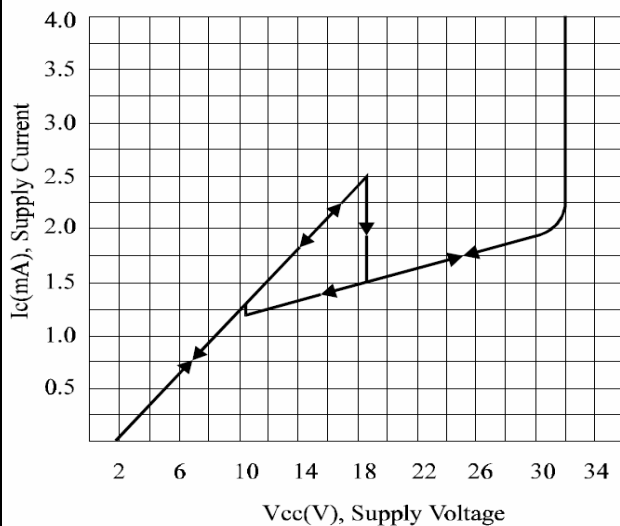


Figure 4.

SUPPLY CURRENT (NO LOAD) VC. SUPPLY VOLTAGE

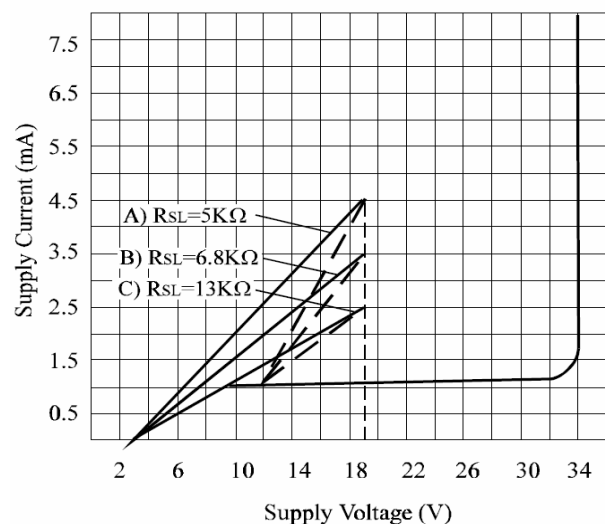
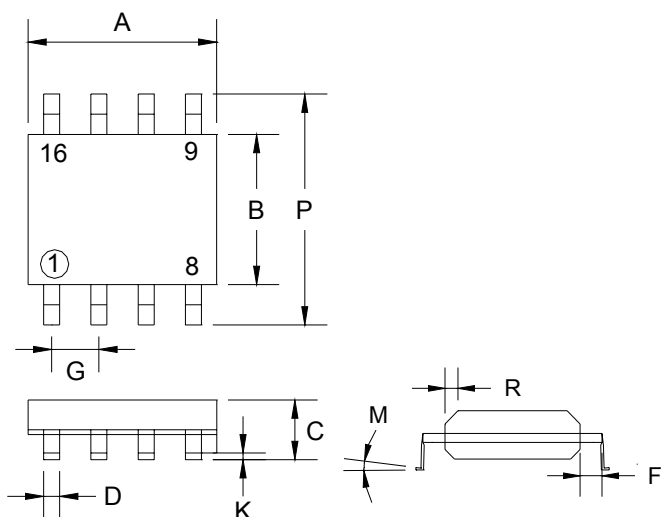


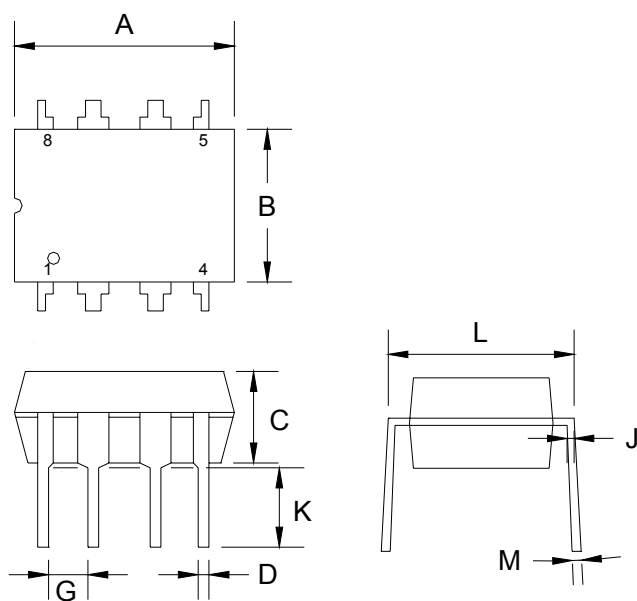
Figure 5.

## SOP-8 Mechanical Drawing



DIM	SOP-8 DIMENSION			
	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 (typ)		0.05 (typ)	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

## DIP-8 Mechanical Drawing



DIM	DIP-8 DIMENSION			
	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.32	0.357	0.367
B	6.22	6.48	0.245	0.255
C	3.18	4.45	0.125	0.135
D	0.35	0.55	0.019	0.020
G	2.54 (typ)		0.10 (typ)	
J	0.29	0.31	0.011	0.012
K	3.25	3.35	0.128	0.132
L	7.75	8.00	0.305	0.315
M	-	10°	-	10°