

CMOS Dual-Tone Multifrequency Tone Generator

For Use in Dual-Tone Telephone
Dialing Systems

Features

- Mute drivers on chip
- Device power can either be regulated dc or telephone loop current
- Use of an inexpensive 3.579545-MHz TV crystal provides high accuracy and stability for all frequencies

General Description

The RCA-CD22859 is a CMOS dual-tone multifrequency (DTMF) tone generator for use in dual-tone telephone dialing systems. The device can easily be interfaced to a standard pushbutton telephone keyboard, to provide enabling operation directly with the telephone lines.

The CD22859 generates standard DTMF sinusoidal dialing tones from an on-chip reference crystal oscillator. The reference oscillator uses an inexpensive 3.579545-MHz color TV crystal to create highly stable and accurate tones. The sinusoidal tones are digitally synthesized by a stair-step approximation.

One of four low-frequency band row tones and one of four high-frequency band column tones are selected by driving one of the four row inputs and one of the four column inputs low. Simultaneous selection of more than one row input and/or more than one column input will inhibit tone generation, or generate a single-tone sinusoid. These operating modes are described in the functional truth table.

Control logic is included to allow easy interface to standard K500-type telephones. Two CMOS outputs Tx, Rx, capable of driving external p-n-p receiver and transmitter muting transistors are provided. A low input to the CD pin, inhibits tone generation, turns off the reference oscillator, and causes Tx and Rx outputs to logic '0'. During tone generation mode, $\overline{CD} = 1$ and Tx, Rx = logic 1.

All row, column, and \overline{CD} inputs are provided with pull-up resistors to allow the use of SPST switch matrices.

The CD22859 types are supplied in a 16-lead hermetic dual-in-line side-brazed ceramic package (D suffix), and a 16-lead dual-in-line plastic package (E suffix), and in chip form (H suffix).

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY VOLTAGE RANGE ($V_{DD} - V_{SS}$)	- 0.5 to + 12 V
INPUT VOLTAGE RANGE	- 0.5 to $V_{DD} + 0.5$ V
POWER DISSIPATION, P_D :	
At $T_A = -40^\circ\text{C}$ to $+60^\circ\text{C}$	500 mW
At $T_A = +60^\circ\text{C}$ to $+85^\circ\text{C}$	Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW
POWER DISSIPATION PER OUTPUT	100 mW
OPERATING TEMPERATURE RANGE	- 40 $^\circ\text{C}$ to + 85 $^\circ\text{C}$
LEAD TEMPERATURE DURING SOLDERING:	
At distance 1/16 \pm 1/32 in. (1.59 \pm 0.79 mm)	
from case for 10 s max.	+ 265 $^\circ\text{C}$

DTMF Generator Functional Truth Table

Keyboard Mode	Inputs		\overline{CD}	Tone	Outputs		
	Number of Column Inputs Activated "Low"	Number of Row Inputs Activated Low			OSC Running	RX	TX
X	X	X	"0"	None	No	"0"	"0"
No key depressed	0	0	"1"	None	No	"0"	"0"
Normal Dialing One Key Depressed (See Note 1)	0	1	"1"	Dual Tone	Yes	"1"	"1"
	1,2,3, or 4	0	"1"	None	No	"0"	"0"
Two or More Keys In Same Row (See Note 2)	1	1	"1"	Dual Tone	Yes	"1"	"1"
	2,3, or 4	1	"1"	Single Row Tone R_a	Yes	"1"	"1"
Two or More Keys In Same Column	1	2,3, or 4	"1"	Single Column Tone C_b	Yes	"1"	"1"
Two or More Keys In Different Rows & Columns	2,3 or 4	1	"1"	None	Yes	"1"	"1"
	1		1	None	Yes	"1"	"1"

Where:

X = Do Not Care

R_a, C_b refers to Tone Output frequencies corresponding to Row 1, Row 2, Row 3, Row 4, Column 1, Column 2, Column 3, Column 4

a = 1,2,3,4 b = 1,2,3,4 a = b, or a \neq b

1. Corresponds to normal dual-tone operation.
2. Corresponds to single-tone generation mode.

CD22859 Types

STATIC ELECTRICAL CHARACTERISTICS at T_A = -25 °C to +60 °C

CHARACTERISTIC	V _{DD} (V)	V _O (V)	LIMITS		UNITS
			Min.	Max.	
<i>Tone Outputs (R_L = 82)</i>					
V _O ; Dual-Tone Output	3.7-9.3		350	700	mV rms
V _O (CL); Single-Tone Output, Column*	3.7-9.3		300	—	mV rms
V _O (RL); Single-Tone Output, Row**	3.7-9.3		260	—	mV rms
Distortion (Note 1)	3.9-9.3		—	10	%
Rise and Fall Time (Dual-Tone Out) (Note 2)	3.9-9.3		—	5	ms
Pre-Emphasis (Note 3)	3.9-9.3		1	3	dB
Output Frequency (Note 4)	3.9-9.3		(Nom. - 1%)	(Nom. + 1%)	Hz
<i>Mute Output Current</i>					
<i>Transmitter</i>					
I _{OH} (Source)	1.7	1.2	-0.5	—	mA
I _{OL} (Sink)	10	9.5	-3.4	—	μA
I _{OL} (Sink)	10	2.5	—	10	μA
<i>Receiver</i>					
I _{OH} (Source)	1.7	1.2	-0.5	—	mA
I _{OL} (Sink)	10	9.5	-3.4	—	μA
I _{OL} (Sink)	10	2.5	—	10	μA

*Two or more row inputs low, and one column input low.

**Two or more column inputs low, and one row input low.

Notes:

- Distortion is defined as: The ratio of all extraneous frequency components generated in the voiceband 0.5 kHz to 3 kHz, to the power of the dual-tone signal, measure across R_L.

$$= \frac{(V_1^2 + V_2^2 + \dots + V_n^2)}{V_L^2 + V_H^2}$$

where V₁, V₂, . . . V_n are extraneous frequency components in the voiceband 0.5 kHz to 3 kHz, V_L is the low-

band frequency tone, and V_H is the high-band frequency tone.

- Tone rise time is defined as the time for each of the 2 DTMF frequencies to attain 90% of full amplitude, measured from the time when a row and column signal are driven low.
- Pre-emphasis is the ratio of the high-group level to the low-group level.
- Refer to Fig. 1 for standard DTMF frequencies.

DYNAMIC ELECTRICAL CHARACTERISTICS at T_A = -25 °C to +60 °C

All voltages referenced to V_{SS} = 0 V.

CHARACTERISTIC	V _{DD}	LIMITS		UNITS
		Min.	Max.	
<i>DC Supply Voltage</i>				
Tone Generation Mode with Valid Input*		2.5	10	V
Non-Tone Generation**		1.7	10	
<i>Operating Current</i>				
Tone Generation Mode (Outputs Unloaded)	3.7 V		1.7	mA
	9.3 V		13	
No Keydown Mode	3.7 V		100	μA
	9.3 V		200	
Input Pull-Up Current	3-10 V		400	μA
Input Low Voltage (V _{IL}) Max.	3-10 V		0.2 V _{DD}	V
Input High Voltage (V _{IH}) Min.	3-10 V	0.8 V _{DD}		V

*All logic and counters functional.

**Mute switches remain open.

CD22859 Types

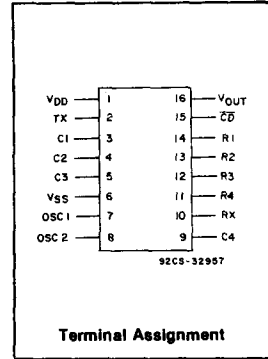
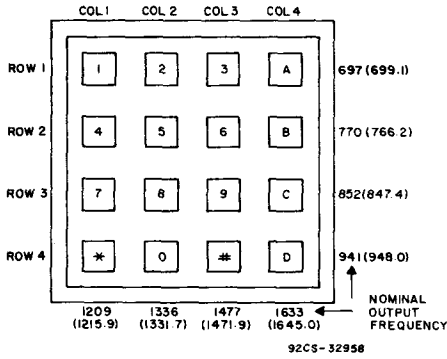


Fig. 1 - Bell and nominal output frequencies (in parenthesis) for 3.579545-MHz crystal.

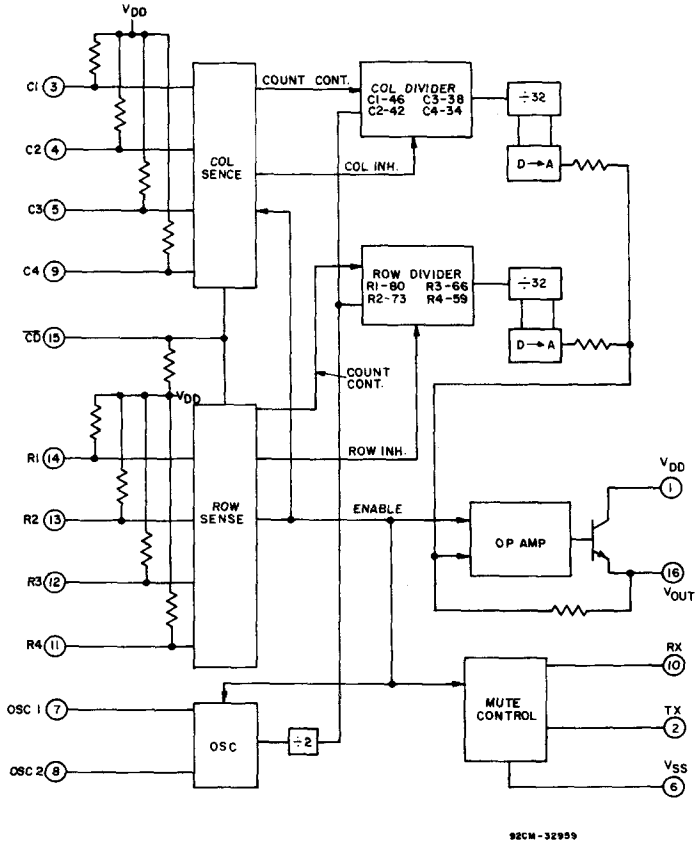


Fig. 2 - Touch-tone generator.

CD22859 Types

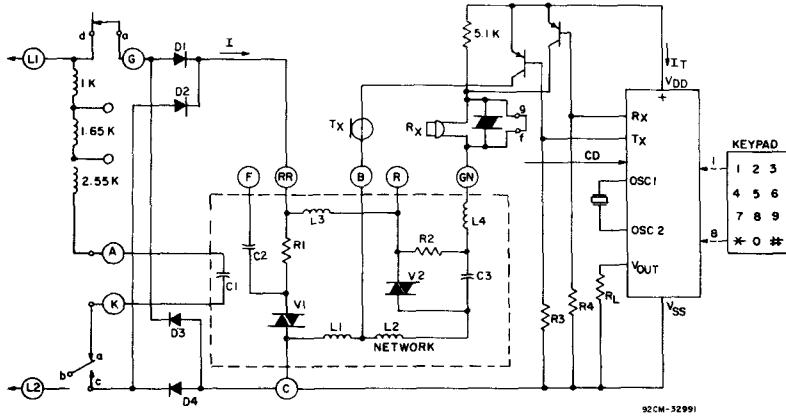
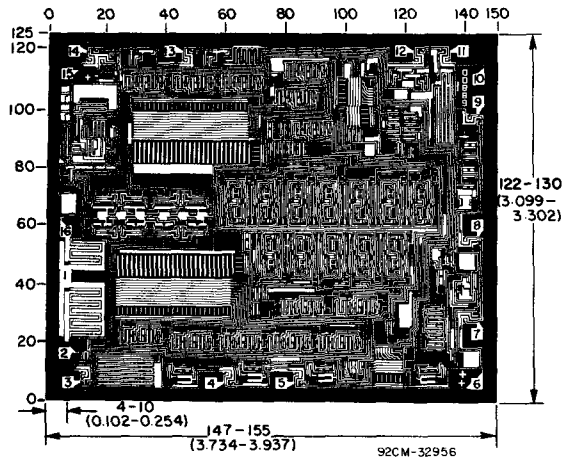


Fig. 3 - Interface with standard K500 telephone network.



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10⁻³ inch).

The photographs and dimensions of each CMOS chip represent a chip when it is part of the wafer. When the wafer is separated into individual chips, the angle of cleavage may vary with respect to the chip face for different chips. The actual dimensions of the isolated chip, therefore, may differ slightly from the nominal dimensions shown. The user should consider a tolerance of -3 mils to +16 mils applicable to the nominal dimensions shown.

Dimensions and pad layout for CD22859H chip.