

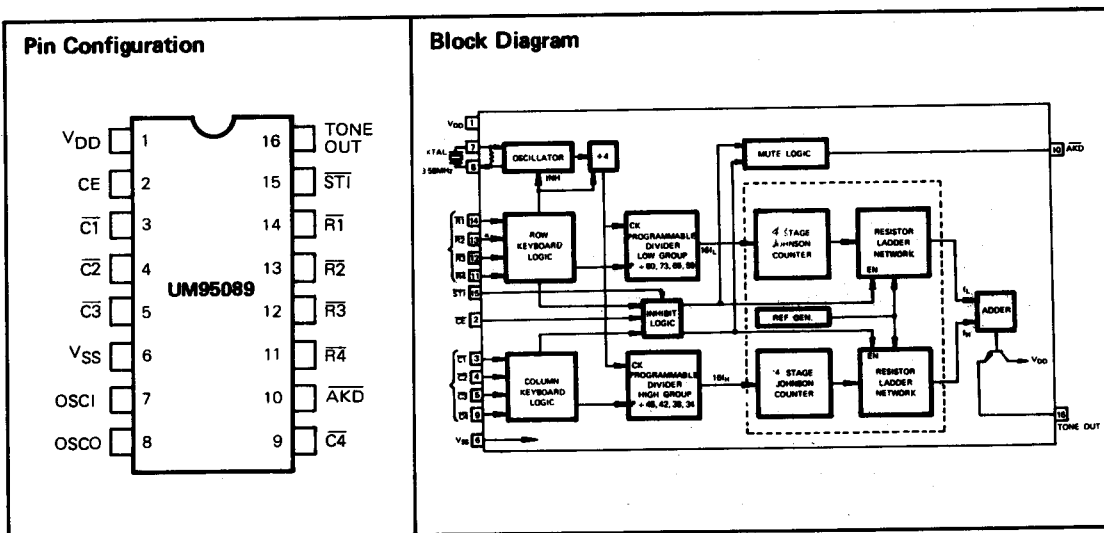
Features

- Wide operating voltage range: 2.5 to 10.0 Volts
- Optimized for constant operating supply voltage, typically 3.5V
- Tone amplitude stability is within $\pm 1.5\text{dB}$ of the operating temperature range
- Low power CMOS circuitry allows device power to be derived directly from the telephone lines or from small batteries
- Uses TV crystal standard (3.58MHz) to derive all frequencies thus providing high accuracy and stability
- Specifically designed for electronic telephone applications
- Serves as an interface directly to a standard telephone push-button keyboard with common terminal
- Low total harmonic distortion
- Dual tone as well as single tone capability
- Direct replacement for AMI S25089 and Mostek MK5089 tone generators.

General Description

The UM95089 DTMF Generator is specifically designed to implement a dual tone telephone dialing system in applications requiring fixed supply operation and high stability tone output level, making it well suited for electronic telephone applications. The device can serve as an interface directly to a standard push-button telephone keyboard with common terminal connected to V_{SS} and operates directly from the telephone lines. All necessary dual-tone frequencies are derived from the widely used

TV crystal standard which provides high accuracy and stability. The required sinusoidal waveform for the individual tones is digitally synthesized on the chip. The waveform so generated has low total harmonic distortion. A voltage reference is generated on the chip which is stable over the operating temperature range and regulates the signal levels of the dual tones to meet recommended telephone industry specifications.



Absolute Maximum Ratings*

DC Supply Voltage ($V_{DD} - V_{SS}$)	.....	+10.5V
Operating Temperature	.....	-25°C to +70°C
Storage Temperature	.....	-65°C to +150°C
Power Dissipation at 25°C	.....	500mW
Input Voltage	.....	$-0.6 \leq V_{IN} \leq V_{DD} + 0.6$
Input/Output Current (except tone output)	.....	15mA
Tone Output Current	.....	50mA

***Comments**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics

(Specifications apply over the operating temperature range of -25°C to 70°C unless otherwise noted. Absolute values of measured parameters are specified.)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
OPERATING VOLTAGE						
Tone Out Mode	V_{DD}	2.5		10.0	V	Valid Key Pressed
Non-Tone Out Mode	V_{DD}	1.6		10.0	V	AKD Outputs Vary With Key Pressed
OPERATING CURRENT						
Standby Mode	I_{DD}		1	20	μ A	$V_{DD} = 3.0V$ No Key Selected, Tone and AKD Outputs Unloaded
	I_{DD}		5	100	μ A	$V_{DD} = 10.0V$ No Key Selected, Tone and AKD Outputs Unloaded
Operating Mode	I_{DD}		0.9	1.40	mA	$V_{DD} = 3.0V$ One Key Selected, Tone and AKD Outputs Unloaded
	I_{DD}		4.5	10.0	mA	$V_{DD} = 10.0V$ One Key Selected, Tone and AKD Outputs Unloaded
TONE OUTPUT						
Dual Tone Mode Row Tone Output	V_{OR}	-11.0		-8.0	dBm	$V_{DD} = 3.0V$ $R_L = 10K$ ohm
	V_{OR}	-10.0		-7.0	dBm	$V_{DD} = 3.5V$ $R_L = 100K$ ohm
Ratio of Column to Row Tone	dB_{CR}	2.4	2.7	3.0	dB	$V_{DD} = 2.5 \sim 10.0V$
Distortion	%DIS			10	%	$V_{DD} = 2.5 \sim 10.0V$
Tone Output-No Key Down	NKD			-80	dBm	
AKD OUTPUT						
Output On Sink Current	I_{OL}	0.5	1.0		mA	$V_{DD} = 3.0V$ $V_{OL} = 0.5V$
Output Off Leakage Current	I_{OH}		1	10	μ A	$V_{DD} = 10.0V$
OSCILLATOR INPUT/OUTPUT						
One Key Selected Output Sink Current	I_{OL}	0.21	0.52		mA	$V_{DD} = 3.0V$ $V_{OL} = 0.5V$
	I_{OL}	0.80	2.1		mA	$V_{DD} = 10.0V$ $V_{OL} = 0.5V$
One Key Selected Output Source Current	I_{OH}	0.13	0.31		mA	$V_{DD} = 3.0V$ $V_{OH} = 2.5V$
	I_{OH}	0.42	1.1		mA	$V_{DD} = 10.0V$ $V_{OH} = 9.5V$
Oscillator Startup Time	t_{START}		2	5	mS	$V_{DD} = 3.0 \sim 10.0V$
Input/Output Capacitance	$C_{I/O}$		12	16	pF	$V_{DD} = 3.0V$
	$C_{I/O}$		10	14	pF	$V_{DD} = 10.0V$
ROW, COLUMN AND CHIP ENABLE INPUTS						
Input Voltage Low	V_{IL}	V_{SS}		$2(V_{DD} - V_{SS})$	V	
Input Voltage High	V_{IH}	$0.8(V_{DD} - V_{SS})$		V_{DD}	V	
Input Current (Pull-up)	I_{IH}	30	90	150	μ A	$V_{DD} = 3.0V$ $V_{IH} = 0.0V$
	I_{IH}	100	300	500	μ A	$V_{DD} = 10.0V$ $V_{IH} = 0.0V$

Crystal Specification

A standard TV color burst crystal is specified to have much tighter tolerance than necessary for tone generation application. By relaxing the tolerance specification, the cost of the crystal can be reduced. The recommended crystal specification is as follows:

Frequency: 3.58 MHz $\pm 0.02\%$
 $R_S \leq 100\Omega$, $L_M = 96\text{mH}$, $C_M = 0.02\text{pF}$, $C_H = 5\text{pF}$,
 $C_L = 12\text{pF}$

Reference Voltage

The structure of the reference voltage employed in the UM95089 is shown in Fig. 1. It has the following characteristics:

- V is proportional to the supply voltage. Output tone amplitude, which is a function of $(V_{DD} - V_{REF})$, increases with supply voltage (Fig. 2).
- The temperature coefficient of V_{REF} is low due to a single V_{BE} drop. Use of a resistive divider also provides an accuracy of better than 10%. As a result, tone amplitude variations over temperature and unit to unit differences are held to less than $\pm 1.0\text{dB}$ over normal.
- Resistor values in the divider network are so chosen that V_{REF} is above the V_{BE} drop of the tone output transistor even at the low end of the supply voltage range. The tone output clipping at low supply voltage is thus eliminated, which improves distortion performance.

Pin Description

Oscillator (OSCI, OSCO)

UM95089 contains an oscillator circuit with the necessary parasitic capacitances and feedback resistor on chip so that it is only necessary to connect a standard 3.58MHz TV crystal across the OSCI and OSCO terminals to implement the oscillator function. The oscillator functions whenever a row input is activated.

Keyboard ($R_1, R_2, R_3, R_4, C_1, C_2, C_3, C_4$)

UM95089 has internal pull-up resistors present on the row and column inputs (20Kohm-10Kohm). Low levels on a row and a column input corresponds to a key closure. UM95089 can serve as an interface with the standard telephone push-button keyboard (See Fig. 3). The common of the keyboard must be connected to V_{SS} .

Tone Output (TONE)

UM95089 uses the Johnson counters and resistor ladder network (see block diagram) to synthesize the two desired frequencies in sinewaves (see Fig. 4) and then uses the ladder network to mix the two. It then drives a bipolar NPN transistor, connected as emitter follower, to allow proper impedance transformation and at the same time preserve signal level.

Inhibiting Single Tones (STI)

The STI input is used to inhibit generation other than dual tones. It has an internal pull-down to V_{SS} . When this input is left unconnected or connected to V_{SS} , Single Tone Mode is disabled. When this input is connected to V_{DD} , Single Tone Mode as well as Dual Tone Mode may be generated as follows:

Dual Tone Mode: When one row and one column is selected, dual tone output consisting of an appropriate low group and high group tone is generated. If two-digit keys that are not in the same row or in the same column are pressed, the dual tone mode is disabled and no output is provided.

Single Tone Mode: Single tones either in the low or high group can be generated as follows — A low group tone can be generated by pressing two-digit keys in the appropriate row. A high group tone can be generated by pressing two-digit keys in the appropriate column, i.e., selecting the appropriate column input and two-row inputs in that column.

Chip Enable Input (CE)

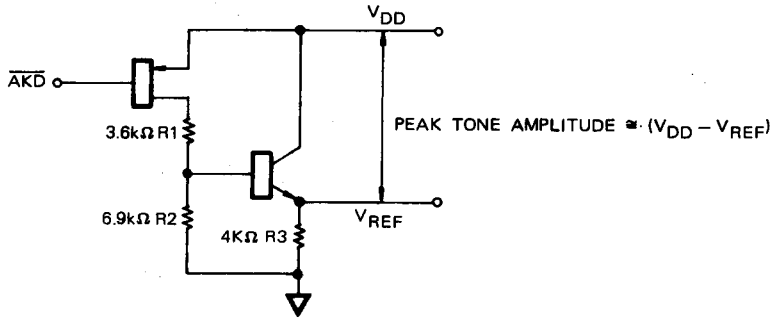
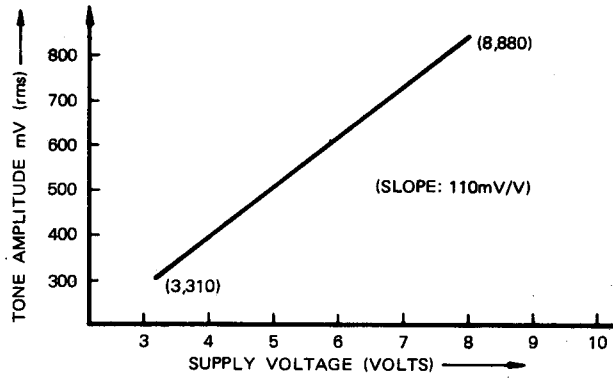
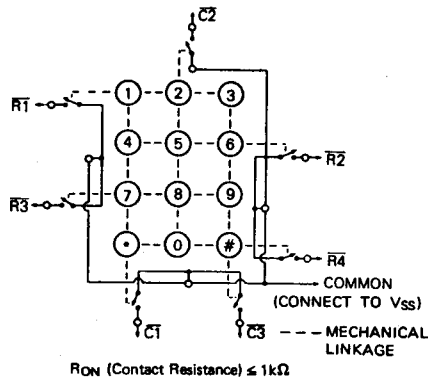
The Chip Enable input has an internal pull-up to V_{DD} . When this pin is left unconnected or connected to V_{DD} , this chip operates normally. When connected to V_{SS} , tone generation is inhibited. All other chip functions operate normally.

Any Key Down (Mute) Output ($\overline{\text{AKD}}$)

The $\overline{\text{AKD}}$ output consists of an open drain N channel device (see Fig. 5). When no keys are pressed, the AKD output is open. When a key is pressed, the AKD output goes to V_{SS} .

Power (V_{DD}, V_{SS})

These are the power supply inputs. UM95089 is designed to operate from 2.5 to 10.0 Volts.


Figure 1. Structure of the Reference Voltage

Figure 2. Typical Single Tone Output Amplitude V_S Supply Voltage ($R_L = 10K$)

Figure 3. Standard Telephone Push-Button Keyboard

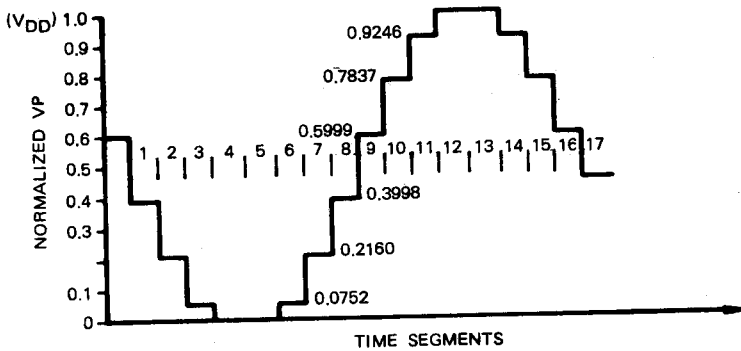


Figure 4. Staircase Waveform of Digitally Synthesized Sinewave

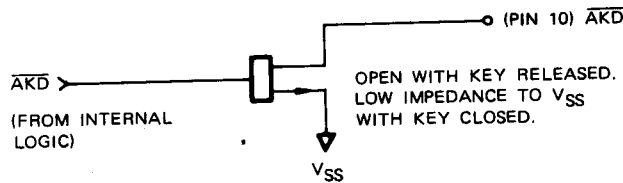


Figure 5. \overline{AKD} Output Structure

Typical Application

