

MV5089

DTMF GENERATOR

The MV5089 is fabricated using ISO-CMOS high density technology and offers low power and wide voltage operation. An inexpensive 3.58MHz TV crystal completes the reference oscillator. From this frequency are derived 8 different sinusoidal frequencies which, when appropriately mixed, provide Dual-Tone Multi-Frequency (DTMF) tones.

Inputs are compatible with a standard 2-of-8 active-low keyboard and the keyboard entries determine the correct division of the reference frequency by the row and column counters.

D-to-A conversion, using R-2R ladder networks, results in an staircase approximation of a sine wave with low total distortion.

Frequency and amplitude stability over operating voltage and temperature range are maintained within industry specifications.

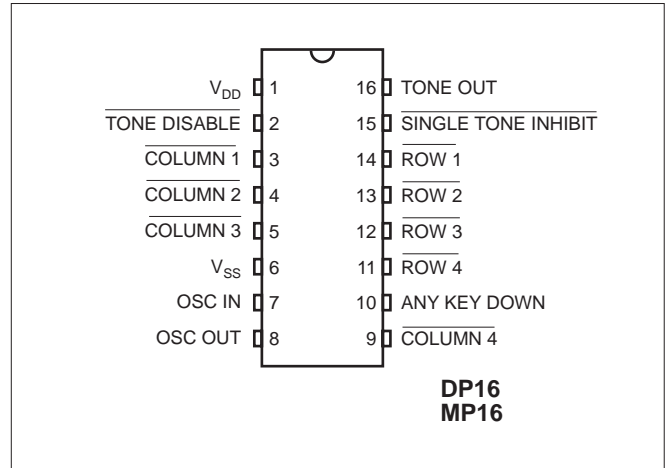


Figure 1: Pin connections - top view

FEATURES

- Pin-for-Pin Replacement for MK5089
- Low Standby Power
- Minimum External Parts Count
- 2.75V to 10V Operation
- 2-of-8 Keyboard Input
- High Accuracy Tones Provided by 3.58MHz Crystal Oscillator
- Pin-Selectable Inhibit of Single Tone Generation

APPLICATIONS

DTMF Signalling for

- Telephone Sets
- Mobile Radio
- Remote Control
- Point-of-Sale and Banking Terminals
- Process Control

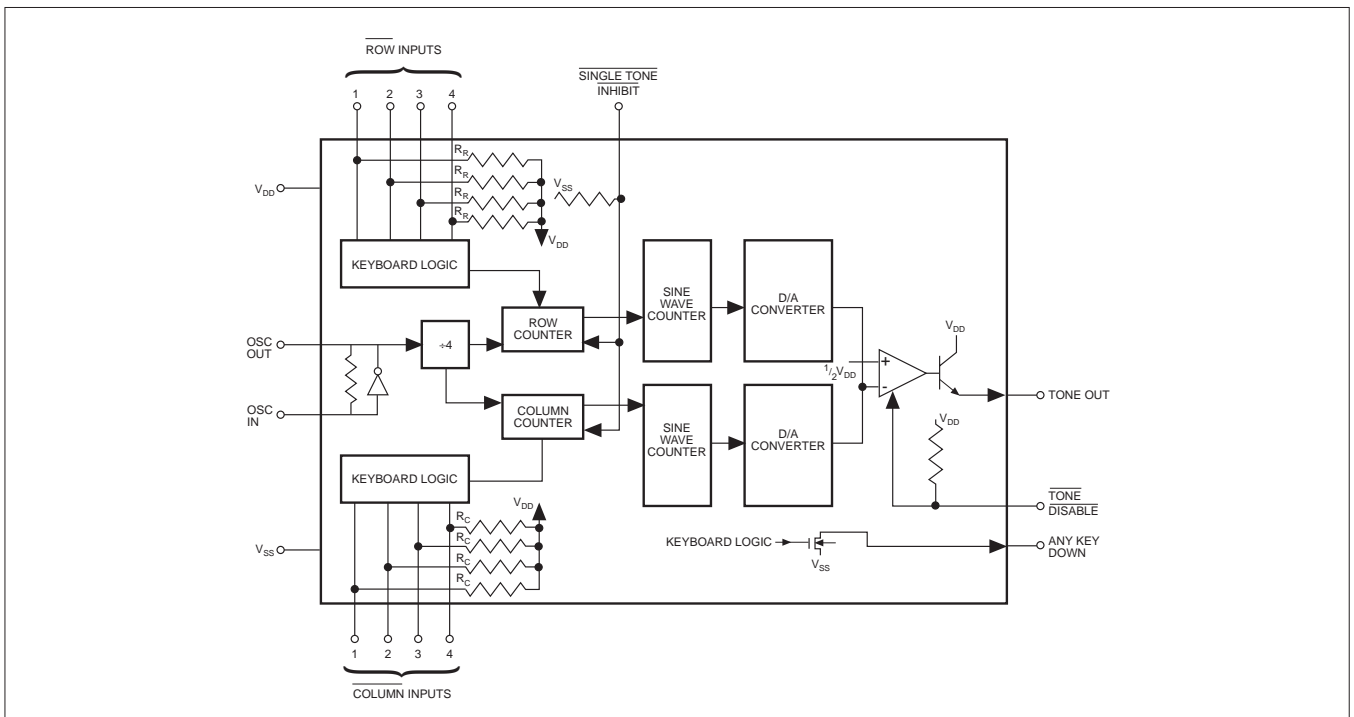


Figure 2: Functional block diagram

OUTPUT FREQUENCY

Table 1 shows the output frequency deviation from the standard DTMF frequencies when a 3.58MHz crystal is used as the reference.

The row and column output waveforms are digitally synthesised using R-2R D-to-A converters (see Fig.3), resulting in staircase approximations to a sinewave. An opamp mixes these tones to produce a dual-tone waveform. Single tone distortion is typically better than 7% and all distortion components of the mixed dual-tone should be 30dB relative to the strongest fundamental (column tone).

| | Standard DTMF (Hz) | Tone Output Frequency Using 3.5795545 MHz Crystal | % Deviation from Standard | |
|--------|---------------------|---------------------------------------------------|---------------------------|------------|
| Row | f ₁ 697 | 701.3 | +0.62 | Low Group |
| | f ₂ 770 | 771.4 | +0.19 | |
| | f ₃ 852 | 857.2 | +0.61 | |
| | f ₄ 941 | 935.1 | -0.63 | |
| | f ₅ 1209 | 1215.9 | +0.57 | |
| Column | f ₆ 1336 | 1331.7 | -0.32 | High Group |
| | f ₇ 1477 | 1471.9 | -0.35 | |
| | f ₈ 1633 | 1645.0 | +0.73 | |

Table 1: Output frequency deviation

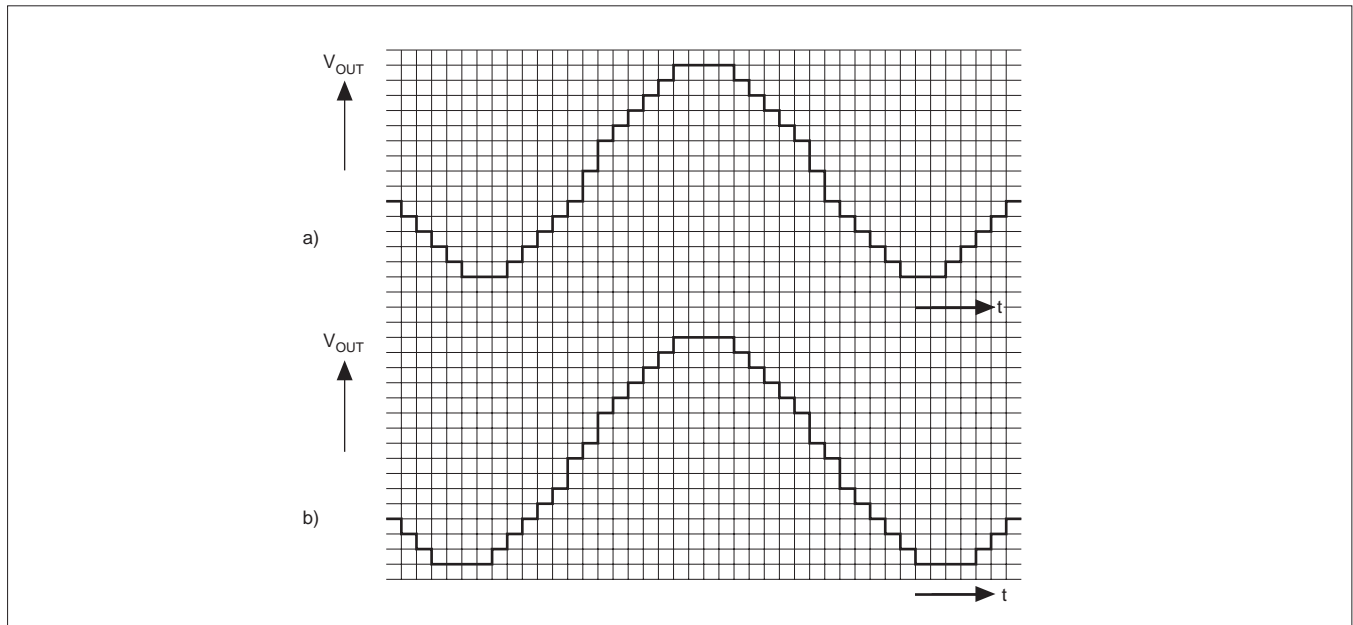


Figure 3: Typical sinewave output (a) Row tones (b) Column tones

DISTORTION MEASUREMENTS

THD for the single tone is defined by:

$$100 \left(\frac{\sqrt{V_{2f}^2 + V_{3f}^2 + V_{4f}^2 + \dots + V_{nf}^2}}{V_{\text{fundamental}}} \right) \%$$

Where V_{2f} --- V_{nf} are the Fourier components of the waveform.

THD for the dual tone is defined by:

$$100 \left(\frac{\sqrt{V_{2R}^2 + V_{3R}^2 + V_{nR}^2 + V_{2C}^2 + V_{3C}^2 + \dots + V_{nC}^2 + V_{\text{IMD}}^2}}{\sqrt{V_{\text{ROW}}^2 + V_{\text{COL}}^2}} \right)$$

- where V_{ROW} is the row fundamental amplitude
- V_{COL} is the column fundamental amplitude
- V_{2R}—V_{nR} are the Fourier component amplitudes of the row frequencies
- V_{2C}—V_{nC} are the Fourier component amplitudes of the column frequencies
- V_{IMD} is the sum of all intermodulation components.

PIN FUNCTIONS

| PIN | NAME | DESCRIPTION |
|-------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | V _{DD} | Positive Power Supply |
| 2 | $\overline{\text{TONE DISABLE}}$ | This input has an internal pull-up resistor to V _{DD} . When connected to V _{SS} no tones are generated by any key depression allowing the keyboard to be used for purposes other than DTMF signalling. |
| 3,4,5,9 | $\overline{\text{Column 1-4}}$ | These CMOS inputs are held at V _{SS} by an internal pull-up resistor and are activated by the application of V _{SS} . |
| 6 | V _{SS} | Negative Power Supply (OV) |
| 7,8 | OSC In, OSC Out | On-chip inverter completes the oscillator when a 3,579545 MHz crystal is connected to these pins. OSC In is the inverter input and OSC Out is the output. |
| 10 | Any Key Down | This is an NMOS transistor output which switches to V _{SS} while any key is depressed. Otherwise this output is high impedance. Switching is independent of Tone Disable and Single Tone Inhibit. |
| 11,12,13,14 | $\overline{\text{Row 1-4}}$ | As $\overline{\text{Column 1-4}}$ inputs. |
| 15 | $\overline{\text{Single Tone Inhibit}}$ | This input has a pull-up resistor to V _{SS} . When left unconnected or tied to V _{SS} , dual tones may be generated, but keyboard input combinations resulting in single tone generation are inhibited. When V _{DD} is applied single or dual tones may be generated. |
| 16 | Tone Out | Emitter output of a bipolar NPN transistor whose collector is tied to V _{DD} . Input to this transistor is from an op-amp which mixes the row and column tones. |

ROW AND COLUMN INPUTS

These inputs are compatible with the standard 2-of-8 keyboard or with an electronic input. Figures 4 and 5 show these input configurations and Fig.6 shows the internal chip structure of these inputs.

When operating with a keyboard, dual tones are generated when any single button is pushed.

With Single Tone Inhibit at V_{DD}, connection of V_{SS} to a single column causes the generation of that Column tone. Connection of V_{SS} to more than one Column will result in no Column tones being generated. Connection of V_{SS} to Rows only generates no tone - a Column must be connected to V_{SS}.

A single Row tone only may be generated by connecting 2 columns, and the desired row, to V_{SS}.

OUTPUT TONE LEVEL

The output tone level of the MV5089 is proportional to the applied DC supply voltage.

A regulated supply will normally be used which may be designed to provide stability over the temperature range.

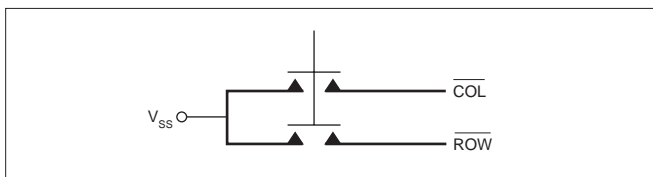


Figure 4: 2 of 8 DTMF keyboard

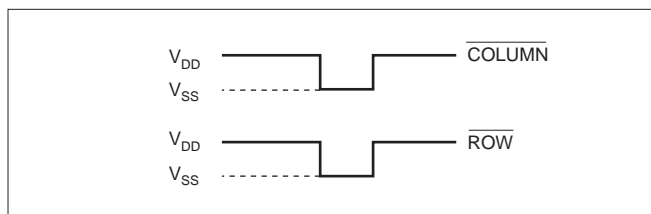


Figure 5: Electronic input

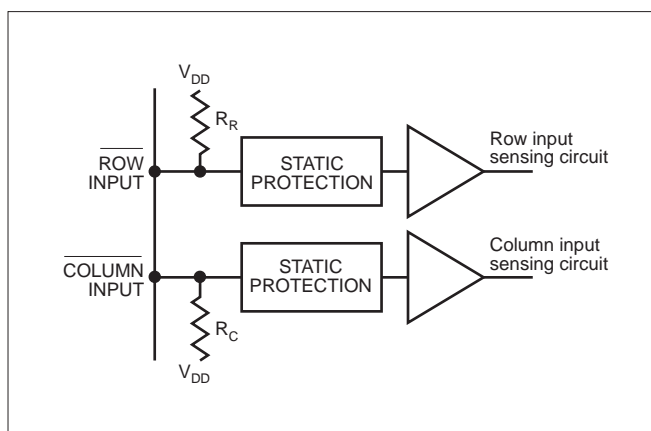


Figure 6: Row and Column inputs

MV5089

ABSOLUTE MAXIMUM RATINGS

| | Min. | Max. | | Min. | Max. |
|---------------------------------------------------------------------------------------------------------------|--------------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------|------|--------|
| $V_{DD} - V_{SS}$ Voltage on any pin Current on any pin Operating temperature Storage temperature | -0.3V $V_{SS} - 0.3V$ -40°C -65°C | 10.5V $V_{DD} + 0.3V$ 10 mA +85°C +150°C | Power dissipation Derate 16 mW/°C above 75°C (All leads soldered to PCB) | | 850 mW |

DC ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):

$$T_{amb} = +25^{\circ}C, V_{DD} = 3V \text{ to } 10V$$

| Characteristics | | Symbol | Min. | Typ. | Max. | Units | |
|-----------------|--------------------------|---------------------------------|----------------------|-------------|------|-------------|--------------------------------------------------------------------|
| SUPPLY | Operating Supply Voltage | V_{DD} | 2.75 | | 10 | V | Ref. to V_{SS} |
| | Standby Supply Current | I_{DDs} | | 0.2 | 100 | μA | $V_{DD} = 3V$ No Key Depressed All outputs Unloaded |
| | Operating Supply Current | I_{DD} | | 0.5 | 200 | μA | $V_{DD} = 10V$ All outputs Unloaded |
| INPUTS | SINGLE TONE | Input High Voltage | V_{IH} | $0.7V_{DD}$ | | V_{DD} | V |
| | INHIBIT | Input Low Voltage | V_{IL} | 0 | | $0.3V_{DD}$ | V |
| | TONE DISABLE | Input Resistance | R_{IN} | | 60 | | K Ω |
| | ROW 1-4 | Input High Voltage | V_{IH} | $0.7V_{DD}$ | | V_{DD} | V |
| | COLUMN 1-4 | Input Low Voltage | V_{IL} | 0 | | $0.3V_{DD}$ | V |
| OUTPUTS | ANY KEY | | | 0.5 | | | mA $V_{DD} = 3V, V_{OL} = 0.5V$ |
| | DOWN | Sink Current Leakage Current | I_{OL} I_{OZ} | 1.0 | 1 | | mA μA $V_{DD} = 10V, V_{OL} = 0.5V$ $V_{DD} = 3V,$ |

AC ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):

$$T_{amb} = +25^{\circ}C, V_{DD} = 3V \text{ to } 10V$$

| Characteristics | | Symbol | Min. | Typ. | Max. | Units | |
|-----------------|-------------------------------|-----------|------|------|------|-------|-----------------------------------------------------------------------------------------|
| TONE OUT | OUTPUT LEVEL, ROW | V_{OUT} | -10 | -8 | -7 | dBm | $V_{DD} = 3V$. Single Tone. $R_L = 100k\Omega$ |
| | PRE EMPHASIS, High Band | | 2.4 | 2.7 | 3.0 | dB | |
| | OUTPUT DISTORTION (Dual Tone) | | | | -20 | dB | Total out-of-band power relative to sum of row and column fundamental power |
| | Tone Output Rise Time | t_r | | 3 | 5 | ms | Time for waveform to reach 90% of magnitude of either frequency from initial key stroke |

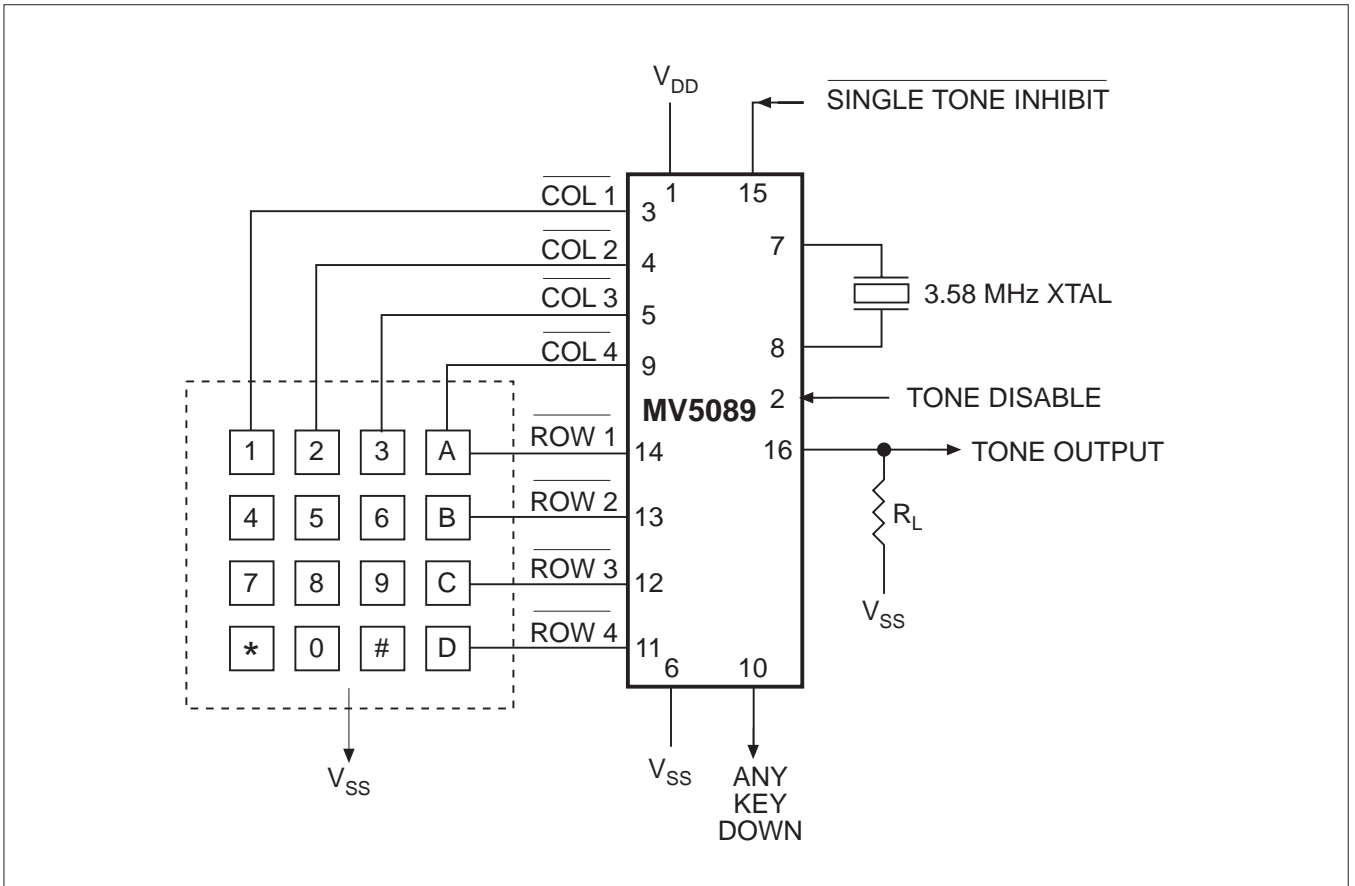


Figure 7: Connection diagram



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