PLESSEY
Semiconductors

CMOS

MV5089

DTMF GENERATOR

The MV5089 is fabricated using Plessey Semiconductors' 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 a 'staircase' approximation of a sinewave with low total distortion.

Frequency stability over operating voltage and temperature range are maintained within industry DTMF standards.

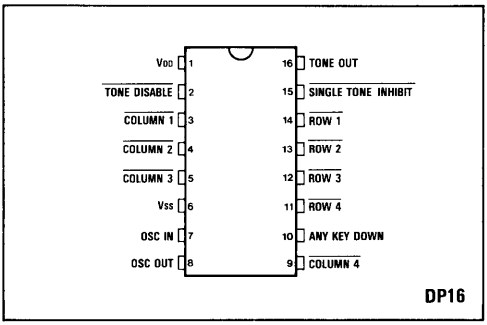

Fig.1 Pin connections - top view

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

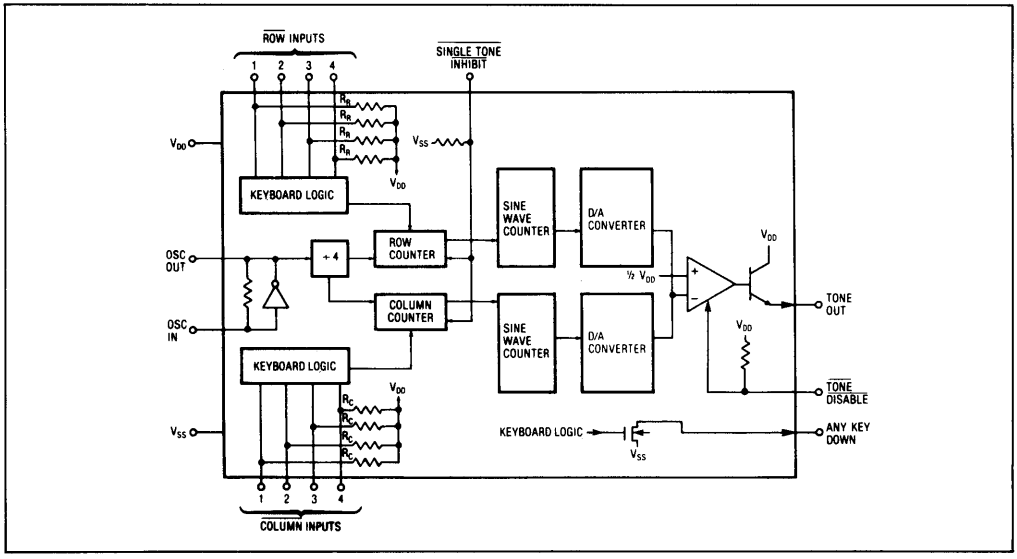

Fig.2 Functional block diagram

ABSOLUTE MAXIMUM RATINGS

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

DC ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):
T_{amb} = +25°C, V_{DD} = 3V 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	uA	V_{DD} = 3V	No Key Depressed
					0.5	200	uA	V_{DD} = 10V	All outputs Unloaded
	Operating Supply Current		I_{DD}		1.0	2.0	mA	V_{DD} = 3V	One Key Depressed
					5.0	10.0	mA	V_{DD} = 10V	All outputs Unloaded
INPUTS	SINGLE TONE INHIBIT. TONE DISABLE	INPUT HIGH VOLTAGE	V_{IH}	0.7V_{DD}		V_{DD}	V		
		INPUT LOW VOLTAGE	V_{IL}	0		0.3V_{DD}	V		
		INPUT RESISTANCE	R_{IN}		60		KΩ		
	ROW 1-4 COLUMN 1-4	INPUT HIGH VOLTAGE	V_{IH}	0.7V_{DD}		V_{DD}	V		
		INPUT LOW VOLTAGE	V_{IL}	0		0.3V_{DD}	V		
OUTPUTS	ANY KEY DOWN	SINK CURRENT	I_{OL}	0.5			mA	V_{DD} = 3V, V_{OL} = 0.5V	
				1.0			mA	V_{DD} = 10V, V_{OL} = 0.5V	
		LEAKAGE CURRENT	I_{OZ}		1		uA	V_{DD} = 3V	

AC ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):
T_{amb} = +25°C, V_{DD} = 3V 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 = 100KΩ
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

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_{DD} 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 3,58 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-down 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 3 and 4 show these input configurations and Fig.5 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.

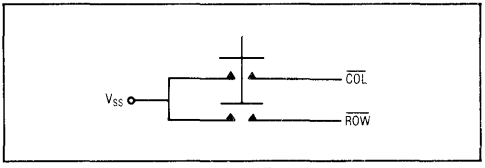

Fig.3 2 of 8 DTMF keyboard

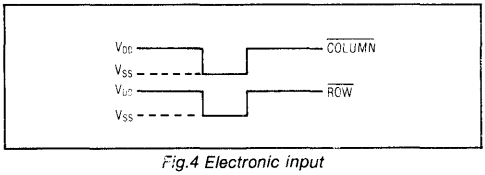

Fig.4 Electronic input

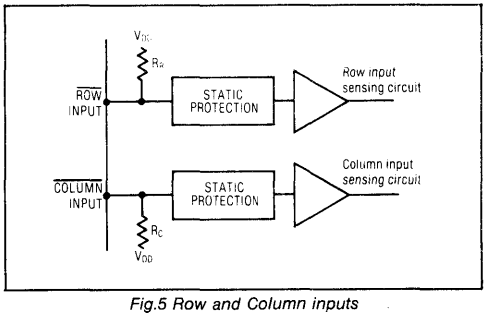

Fig.5 Row and Column inputs

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.6) resulting in staircase approximations to a sinewave. An op-amp 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 3.579545 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	
Column	f_5	1209	1215.9	+0.57	High Group
	f_6	1336	1331.7	−0.32	
	f_7	1477	1471.9	−0.35	
	f_8	1633	1645.0	+0.73	

Table 1 Output frequency deviation

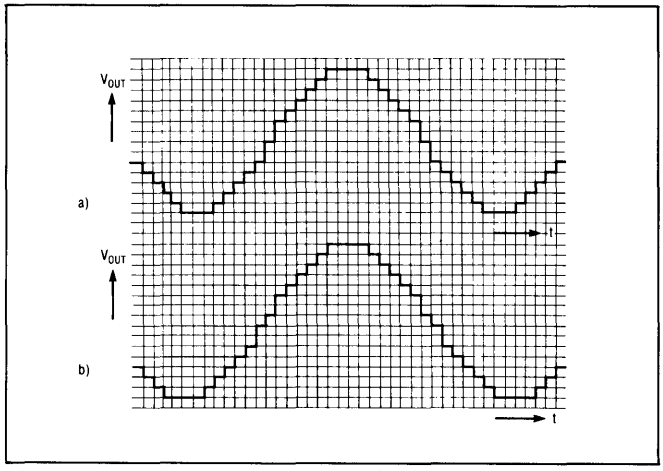

Fig.6 Typical sinewave output (a) Row tones (b) Column tones

DISTORTION MEASUREMENTS

THD for the single tone is defined by:

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

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

THD for the dual tone is defined by:

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

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.

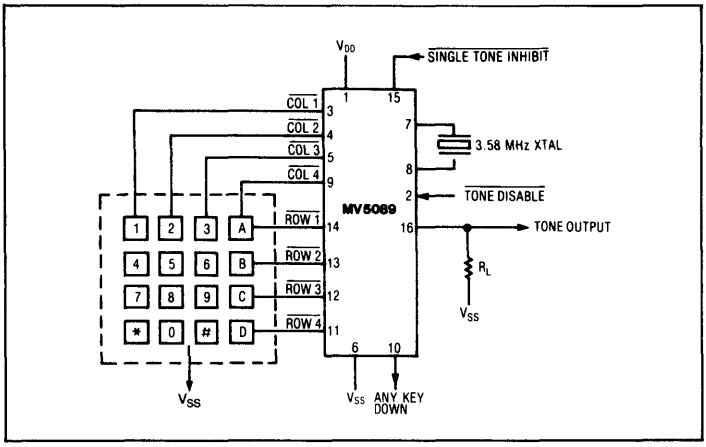

Fig.7 connection diagram