COS/MOS INTEGRATED CIRCUIT

SGS **M 751**

PRELIMINARY DATA

DUAL TONE MULTIFREQUENCY GENERATOR

- 2.5 TO 5V SUPPLY RANGE
- VERY LOW POWER CONSUMPTION
- INTERNAL PULL-UP RESISTOR WITH DIODE PROTECTION ON ALL KEYBOARD INPUTS
- ON-CHIP CRYSTAL CONTROLLED OSCILLATOR (f_o = 4.433619 MHz) WITH INTEGRATED FEEDBACK RESISTOR AND LOAD CAPACITORS
- LOW HARMONIC DISTORTION
- FIXED PRE-EMPHASIS ON HIGH-GROUP TONES
- FAST START-UP TIME

The M751 provides all the tone frequency pairs required for a DTMF Dialling System. Tones are obtained from an inexpensive TV crystal (f_o= 4.433619 MHz) followed by two independent programmable dividers. The dividing ratio is controlled by the selected key. Keyboard format is 4 rows x 4 columns and a key is valid when a column and a row are simultaneously grounded. Internal logic prevents the transmission of illegal tones when more than one key is pressed. Individual tones can be obtained grounding the corresponding row of column input. D/A conversion is accomplished by a capacitive network allowing very low power consumption, very low distortion and an exceptional stability of tone level against temtemperature variations. The tones are mixed in a resistive network; a unity gain amplifier is provided to realize a two pole active filter with only four external passive components. SGS-ATES has also developed the LS342, DTMF line interface, which provides the stabilized supply for the M751 from the telephone line and amplifiers the output tones to the standardized levels. The M751 utilizes low voltage COS/MOS technology and is available in 16 pin dual in-line plastic or ceramic package.

ABSOLUTE MAXIMUM RATINGS*

V_{DD}**	Supply voltage	-0.5 to +5.5	V
V_I	Input voltage	-0.3 to V_{DD} +0.5	V
P_{tot}	Power dissipation	400	mW
T_{op}	Operating temperature range	-25 to +50	°C
T_{stg}	Storage temperature range	-25 to +125	°C

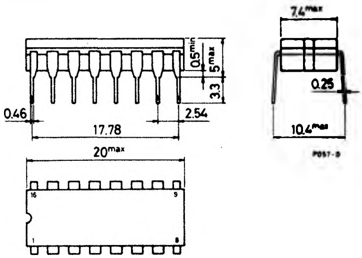
* Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure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

** All voltages are referred to V_{SS} pin voltage.

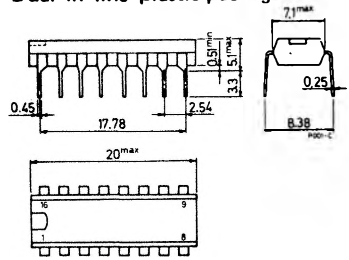
ORDERING NUMBERS: M751 B1 for dual in-line plastic package
M751 F1 for dual in-line ceramic package (frit seal)

MECHANICAL DATA (dimensions in mm)

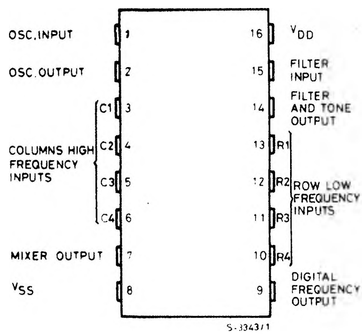
Dual in-line ceramic package, frit seal)

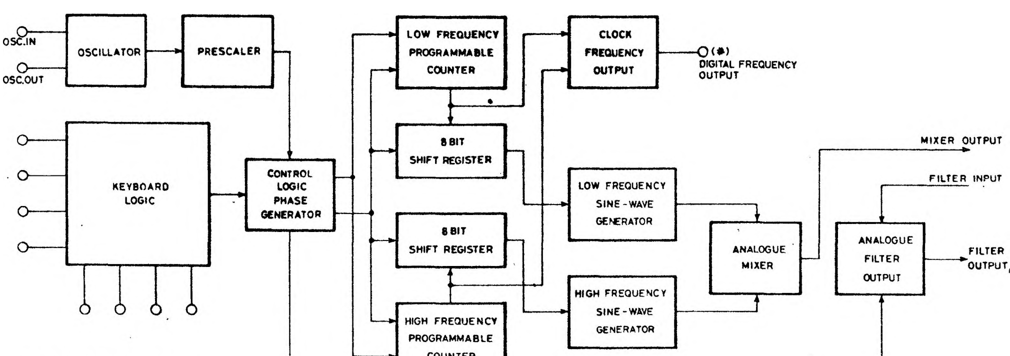


Dual in-line plastic package



PIN CONNECTIONS





* Open drain output for testing only

ELECTRICAL CHARACTERISTICS (All parameters are tested at T_{amb} = 25°C)

DC CHARACTERISTICS

	Parameter		Test conditions (see note 1)		Min.	Typ.	Max.	Unit
Supply	V_{DD}	Voltage supply range			2.5	3	5	V
Supply	I_{DD}	Operating supply current	V_{DD}= 2.5V				2	mA
Row and column inputs	I_{IH}	High level input current	V_{DD}= 3V	V_{IH}= 3V			1	μA
Row and column inputs	I_{IL}	Low level input current	V_{DD}= 3V	V_{IL}= 0V		-60	-80	μA
Row and column inputs	V_{IH}	High level input voltage			0.7V_{DD}			V
Row and column inputs	V_{IL}	Low Level input voltage					0.3V_{DD}	V
Oscillator	I_{IH}	High level input current	V_{DD}= 3V	V_{IH}= 3V			1	μA
Oscillator	I_{IL}	Low level input current	V_{DD}= 3V	V_{IL}= 0V			1	μA
Oscillator	I_{OH}	High level output current	V_{DD}= 2.5V	V_{OH}= 2V	-300	-500		μA
Oscillator	I_{OL}	Low level output current	V_{DD}= 2.5V	V_{OL}= 0.5V	300	500		μA
Digital freq. output	I_{OL}	Low level output current (open drain output)	V_{DD}= 3V	V_{OL}= 1V	200			μA
Filter	V_O	Output DC voltage without tones	V_{DD}= 2.5V				200	mV
Filter	V_O	Output DC voltage with 2 tones	V_{DD}= 2.5V (see fig. 1)	(see note 2)	0.81	0.84	0.87	V
Oscillator	R_F	Feedback oscillator resistance			4	4.5		MΩ
Oscillator	C_I	Input capacitance to V_{DD}				9.5	10.5	pF
Oscillator	C_O	Output capacitance to V_{DD}				10.5	11.5	pF
Mixer	Z_{O1}	Output dynamic impedance with 2 tones	V_{DD}= 2.5V			10		kΩ
Filter	Z_{O2}	Output dynamic impedance with 2 tones	V_{DD}= 2.5V			2.5		kΩ
Tone characteristics	$\frac{\Delta F}{F}$	Max. output tone deviation from standard	At crystal frequency f_o= 4.433619 MHz					
		R_1 697 Hz					+0.5	%
		R_2 770 Hz					-0.2	%
		R_3 852 Hz					+0.5	%
		R_4 941 Hz					-0.6	%
		C_1 1209 Hz					+0.6	%
		C_2 1336 Hz					-0.4	%
		C_3 1477 Hz					-0.3	%
		C_4 1633 Hz					+1.1	%

ELECTRICAL CHARACTERISTICS (continued)

Parameter			Test conditions (see note 1)	Min.	Typ.	Max.	Unit
Tone characteristics	V_{LF}	Low frequency tones amplitude at pin 14	V_{DD}= 2.5V (see fig. 2) (see fig. 3) (see note 3)	150	175	200	mVpp
	V_{HF}	High frequency tones amplitude at pin 14		195	220	245	mVpp
		Pre-emphasis		1	2	3	dB
		Unwanted frequency components at f = 3.4 kHz at f = 50 kHz				 -33 -80	 dBm dBm
		Total harmonis distortion for a single frequency	V_{DD}= 2.5V (see fig. 3)			2	%
	t_s	Start up time	V_{DD}= 2.5V (see fig. 4) (see fig. 5)		3	5	ms
	t_r	Supply voltage rise time	V_{DD}= 2.5V			250	ms

Note 1: This device has been designed to be connected to LS342 MF tone dialler line interface, from which it takes a V_{DD}= 2.5V min. therefore many parameters are tested at this value.

Note 2 : The value of DC output component at two different conditions of supply voltages, with two tones activated, can be related as follows:

$$V_{DC'} = V_{DC} \frac{V_{DD'}}{V_{DD}}$$

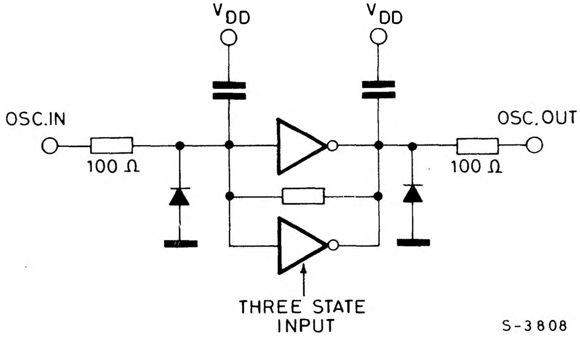
Note 3 : The value of AC output components (V_{LF}, V_{HF}) at two different conditions of supply voltages can be related as follows:

$$V_{LF'} = V_{LF} \frac{V_{DD'}}{V_{DD}} \qquad V_{HF'} = V_{HF} \frac{V_{DD'}}{V_{DD}}$$

FUNCTIONAL DESCRIPTION

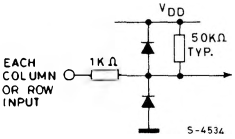
Oscillator (OSC. IN pin 1 – OSC. OUT pin 2)

The oscillator circuit has been designed to work with a 4.433619 MHz crystal ensuring both fast start-up time and low current consumption.
When V_{DD} is applied and a key is activated two inverters are paralleled (see figure below) to decrease the total r_{on} resistance.
After oscillations have started one of the two buffers is switched off and the current consumption is reduced to 2/3 of the initial value.
Feedback resistance and load capacitances are integrated on the chip ensuring good temperature performance.



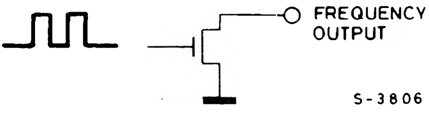
Keyboard inputs (Columns: pins 3 – 6 – Rows: pins 10 – 13)

Each input has a protection circuit and a pull-up resistance (see fig. below).
If only one of these inputs is grounded a single tone will appear at the output.
If a column and a row input are grounded two tones will appear at the output.
If two inputs of the same group are grounded no tones will be generated.



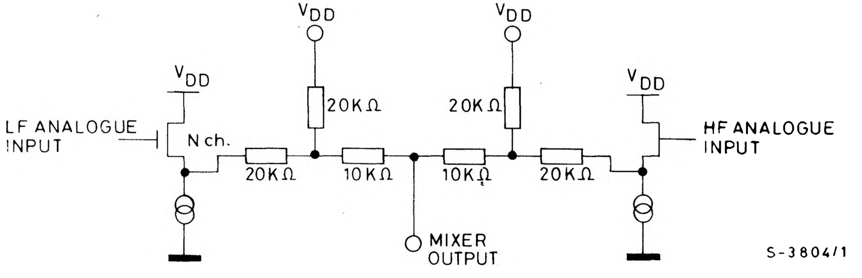
Digital frequency output (pin 9)

This output is intended for testing only; when a single tone is activated, at this output is available a digital signal whose frequency is 16 times the selected output tone frequency. This output is an open collector N-channel transistor.



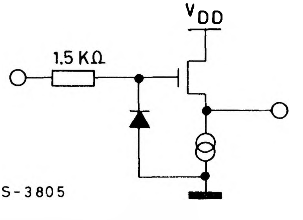
Mixer output (pin 7)

The two reconstructed sine waves are buffered then mixed in a resistive array network that also restores the DC output level.

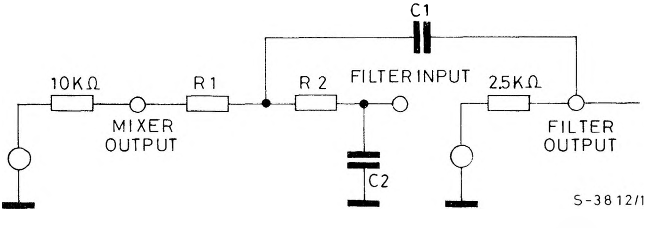


Filter (Filter input pin 15, Filter output pin 14)

A unity gain amplifier is available to realize a two pole active filter (see fig. below).
The output of this amplifier is held low until tones are valid, it than rises to about 0.85V at V_{DD}= 2.5V. Tone are superimposed on this DC.
The output DC component is very precise and stable to allow DC coupling with the LS342 DTMF line interface.



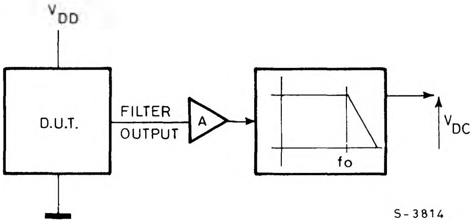
The output dynamic impedance of the filter is about 2.5 kΩ.
The following equivalent circuit should be applied during filter design:



It is evident that R_1 and R_2 should be kept high to avoid undue influence of Mixer and Filter output impedances.
The following values are suggested:

R_1= 430 kΩ ± 2% R_2= 82 kΩ ± 2% C_1= 820 pF ± 10% C_2= 120 pF ± 10%

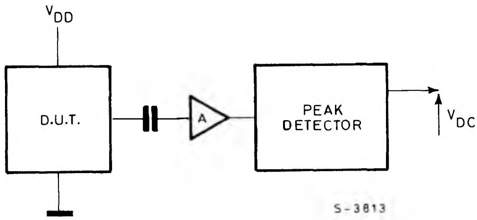
Fig. 1 - DC filter output level measurement test set.



Low pass filter characteristics:
f_o = 100 Hz 40 dB/dec

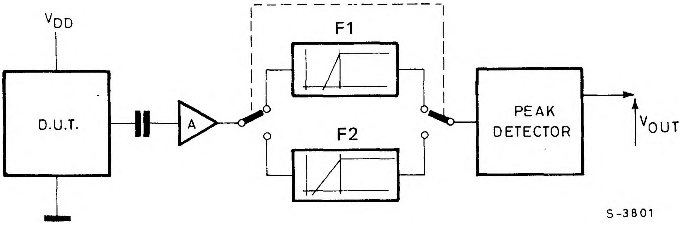
This measurements is performed with only one tone available at the output.

Fig. 2 - Output tone level measurement test set.



This measurement is performed with one tone present at the output.

Fig. 3 - THD measurement test set.



High pass filter characteristics:
F1: f_o= 1400 Hz 100 dB/dec
F2: f_o= 2500 Hz 100 dB/dec

THD measurement is made sensing the level of harmonic components after suppression of the fundamental. Two different high pass filters are used for low and high frequency tones.

Fig. 4 - Start-up time measurement test set

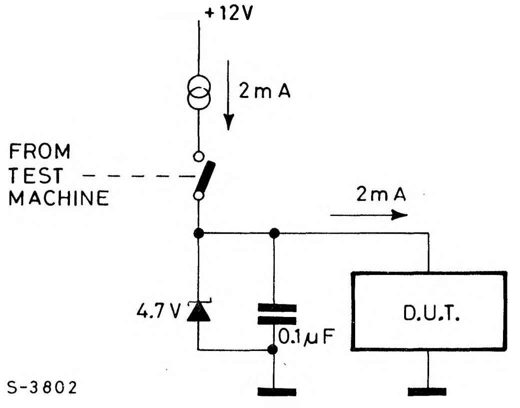
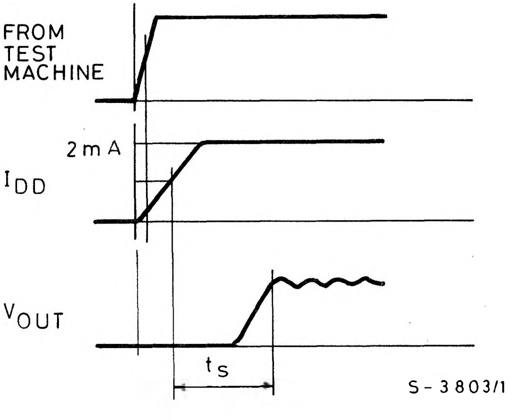


Fig. 5 - Start-up time definition



APPLICATION CIRCUIT