

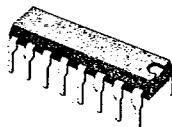


## DTMF GENERATOR

- OPERATES WITH A STANDARD CRYSTAL AT 3.58MHz.
- WIDE OPERATING LINE VOLTAGE AND CURRENT RANGE
- LEVELS FROM THE HIGH AND LOW FREQUENCY GROUP CAN BE ADJUSTED SEPARATELY
- NO INDIVIDUAL LEVEL ADJUSTMENT IS NECESSARY FOR EVERY CIRCUIT
- THE SIGNAL LEVELS ARE STABILIZED AGAINST VARIATIONS IN TEMPERATURE AND LINE VOLTAGE
- SHORT START-UP TIME.
- ALL TONES CAN BE GENERATED SEPARATELY FOR TESTING
- EXTERNAL COMPONENTS ARE MINIMIZED
- EASY PC BOARD LAYOUT; ALL KEYBOARD CONNECTIONS ON ONE SIDE OF THE CHIP

- INTERNAL PROTECTION OF ALL INPUTS
- <sup>2</sup>L PROCESS ENSURES GOOD PARAMETER TOLERANCES

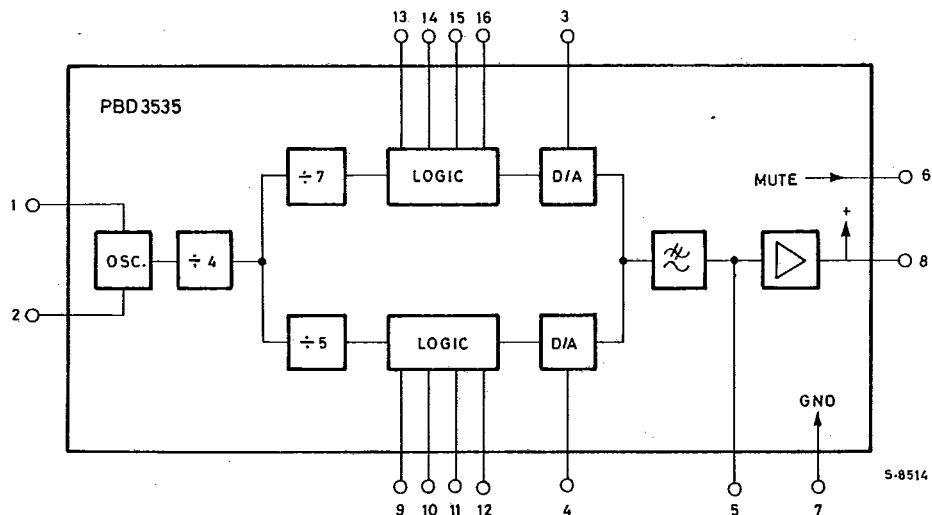
PBD3535 is a monolithic integrated DTMF generator intended for use in a telephone set in parallel with an electronic speech circuit. The DC characteristic to the line is set by the speech circuit. PBD3535 gives a mute signal when sending. The circuit fulfils the CEPT specification. Optional signal levels can be set by resistors. The circuit operates with a single contact matrix keyboard. Interfacing with a computer is also possible.



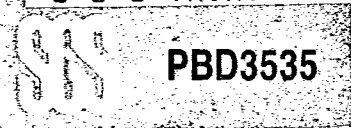
DIP-16 Plastic (0.4)

ORDERING NUMBER: PBD 3535

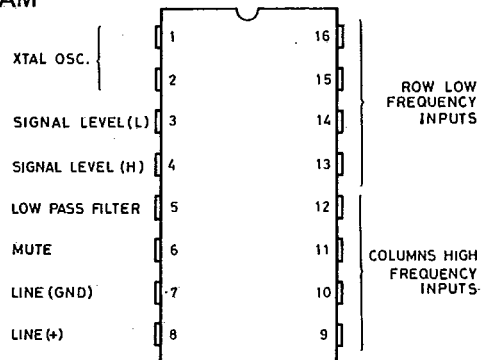
## BLOCK DIAGRAM



This is advanced information on a new product now in development or undergoing evaluation. Details are subject to change without notice.



**CONNECTION DIAGRAM**



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**ABSOLUTE MAXIMUM RATINGS** (Maximum ratings over operating free-air temperature range unless otherwise stated)

$V_L$	Max continuous line voltage	15	V
$V_L$	Peak line voltage pulse time = 2s pulse time = 20 ms	20	V
$T_j$	Junction temperature	22	V
$T_{amb}$	Operating ambient temperature	150	°C
$T_{stg}$	Storage temperature	-20 to 70	°C
		-55 to 150	°C

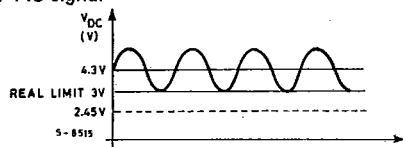
**RECOMMENDED OPERATING CONDITIONS**

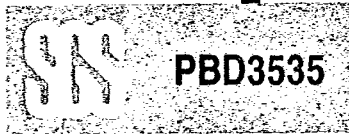
Parameter	Min.	Typ.	Max.	Unit
$V_L$ Line voltage	3		9	V
$T_{amb}$ Ambient temperature	-20		+70	°C

**THERMAL DATA**

$R_{thJ-amb}$	Thermal resistance junction-ambient	max	80	°C/W
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Fig. 1 - Min DC level at 1.3V AC signal

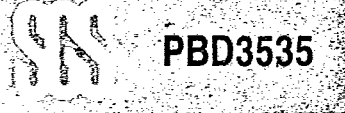




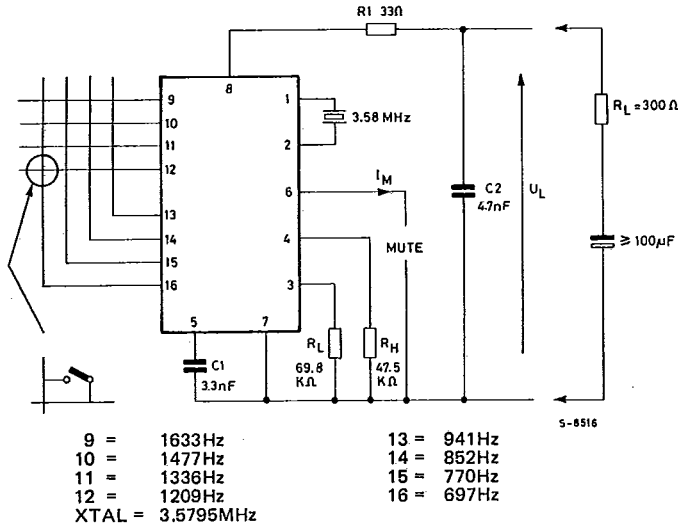
**ELECTRICAL CHARACTERISTICS** (Electrical characteristics over recommended operating conditions)

Parameter	Test Conditions	Min.	Typ.	Max.	Unit		
V <sub>L</sub>	Line voltage	Tone generation DC level at 1.3 V <sub>p</sub> AC signal		4.3	9	V	
V <sub>DC</sub>	DC voltage below AC voltage	At tone generation		3.0		V	
		At tone generation -5°C +45°C		2.45		V	
V <sub>L</sub>	Line voltage	Stand-by DC level at 2.0 V <sub>p</sub> AC signal		4.3	9	V	
I <sub>L</sub>	Line current	Stand-by: no key pressed V <sub>L</sub> = 4.3V			250	μA	
I <sub>L</sub>	Line current	Operating current V <sub>L</sub> = 4.3V			10	mA	
I <sub>M</sub>	Mute current	One or more keys pressed		125		μA	
R <sub>K</sub>	Key resistance	Key circuit closed Key open (16 contacts)		1	1	KΩ MΩ	
f <sub>T</sub>	Frequency Low	f <sub>osc</sub> = 3.5795MHz f <sub>1</sub> = 697Hz f <sub>2</sub> = 770Hz f <sub>3</sub> = 852Hz f <sub>4</sub> = 941Hz		-1 -1 -1 -1	+0.32 +0.02 +0.03 -0.11	+1 +1 +1 +1	% % % %
	Frequency High	f <sub>5</sub> = 1209Hz f <sub>6</sub> = 1336Hz f <sub>7</sub> = 1477Hz f <sub>8</sub> = 1633Hz		-1 -1 -1 -1	-0.03 -0.03 -0.68 -0.36	+1 +1 +1 +1	% % % %
V <sub>H</sub>	Signal Level High	R <sub>H</sub> = 47.5KΩ		-11	-9	-7	dBm
V <sub>L</sub>	Signal Level Low	R <sub>L</sub> = 69.8KΩ		-13	-11	-9	dBm
V <sub>H</sub>	Radio signal level High Freq./Low Freq.	R <sub>H</sub> = 33.2KΩ		-8	-6	-4	dBm
V <sub>L</sub>		R <sub>L</sub> = 48.7KΩ		-10	-8	-6	dBm
V <sub>H</sub>		R <sub>H</sub> = 26.1KΩ		-6	-4	-2	dBm
V <sub>L</sub>		R <sub>L</sub> = 39.2KΩ		-8	-6	-4	dBm
$\frac{V_L}{V_H}$	Radio signal level High Freq./Low Freq.			1	2	3	dB
Z <sub>T</sub>	Impedance to line	At tone generation		6			KΩ
Z <sub>S</sub>		At stand-by		50			KΩ
D	Total harmonic distortion	Normal operation				-31	dBm
		Stand-by				-80	dBm
H	Harmonics *	300-3400Hz 3.4-50KHz > 50KHz				-33 -33/-80	dBm dBm
t <sub>s</sub>	Start-up time	Output level within 1dB from final level			3	5	ms

\* Single tone distortion is less than  $(-33 - 12 \times \log \frac{f}{3400})$  dBm



TEST CIRCUIT



FUNCTIONAL DESCRIPTION

Two tones are generated by connecting one input from the high-frequency group and one input from the low-frequency group.

If two or more keys are pressed, no tones other than the basic eight are generated.

All tones can be generated separately. When testing a circuit by connecting one input from the high-frequency group to one input in the low-frequency group plus shorting pin 3 or pin 4 to the ground pin 7, one single tone is generated (low and high frequency, respectively).

The absolute signal level can be adjusted with  $R_L$  and  $R_H$ , but there is no need for individual adjustment on every circuit. The signal level is stabilized against variations in temperature and line current.

Pause time and signal time are determined externally from the keyboard.

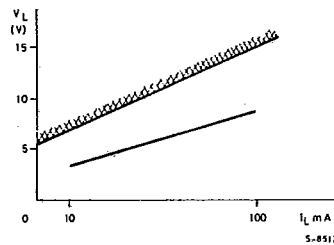
Allowed leakage in keyboard 1M $\Omega$ .  
 Typical threshold is 100K $\Omega$ .

The circuit is made to work properly with electronic speech circuits such as PBL 3726.

Component function:

- $R_1$ : Protecting resistor;
- $R_L$ : Signal level (low);
- $R_H$ : Signal level (high);
- $C_1$ : Low pass filter;
- $C_2$ : Radio frequency suppression (if used together with speech circuit with radio suppression built in, like PBL 3726,  $C_2$  is not necessary).

Fig. 2 - DC characteristics with speech circuit PBL3726/6





To find suitable resistor values for  $R_H$  and  $R_L$  to get the desired tone levels the following formula can be used for a preliminary calculation. Please note that in  $R_{LOAD}$  ( $f = 1.4\text{KHz}$ ) and  $R_{LOAD}$  ( $f = 800\text{Hz}$ ) both the impedance of the line and the impedance of the speech circuit are included.  $V_H$  and  $V_L$  are the desired high and

low frequency levels, in dBm.

$$R_H = 56.2 \times R_{LOAD} (f = 1.4\text{KHz}) \times 10^{-\frac{V_H}{20}}$$

$$R_L = 65.6 \times R_{LOAD} (f = 800\text{Hz}) \times 10^{-\frac{V_L}{20}}$$

Fig. 3 - Tone level vs. line current

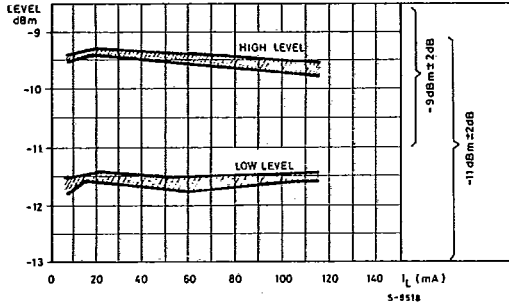
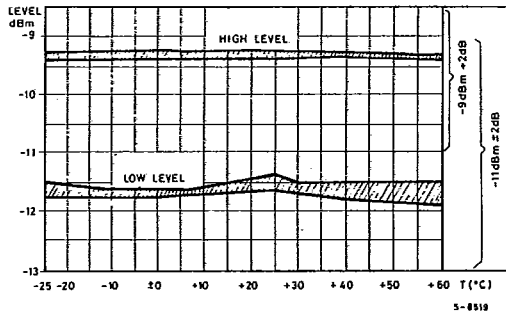


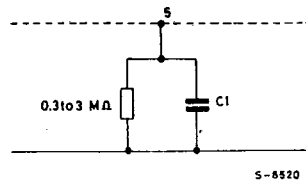
Fig. 4 - Tone level vs. temperature



The current consumption within PBD 3535 can be reduced with a resistor connected in parallel with C1 (see fig. 5). If the current reduction is made too large, the output signal can be distorted by clipping.

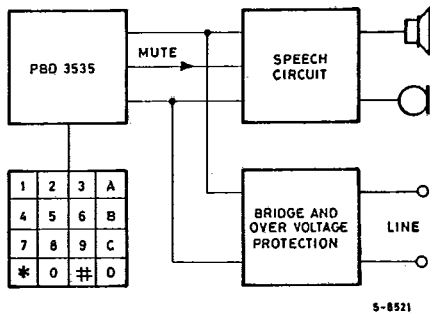
In applications where a DTMF generator directly powered from the telephone line is wanted (the generator is not working in parallel with any kind of speech network), PBD3535 can be used with a DC regulator as described in fig. 7.

Fig. 5



**PBD3535**

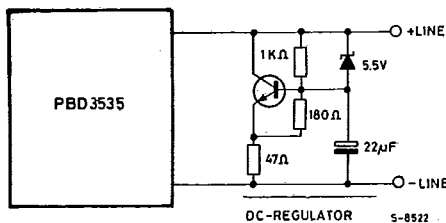
Fig. 6 - Typical application



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These schematics give a DC regulator for the range 16-100mA with an output impedance that is a compromise between 600Ω and 900Ω in parallel with 30nF. The zener diode is used to ensure a fast start-up time.

Fig. 7 - DC regulator



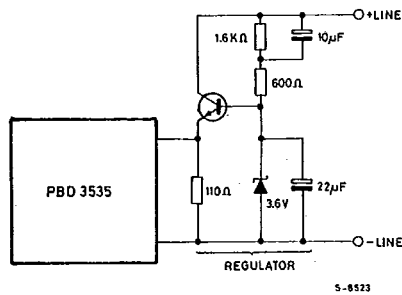
DC-REGULATOR 5-8522

For telephone systems with voltage supply instead of current supply) for the telephone line and where the telephone set is supposed to work as a current source, PBD 3535 can be connected with a series regulator as shown in fig. 8.

These schematics are working in the area 5-36V and the output impedance is matched against 600Ω.

PBD 3535 can also be controlled by a microprocessor (see fig. 8). The negative branch of the microprocessor voltage supply is connected to pin 7 of PBD 3535 and the inputs (8) are connected with resistors. For tone-generating one input of the low group (pins 13-16) is con-

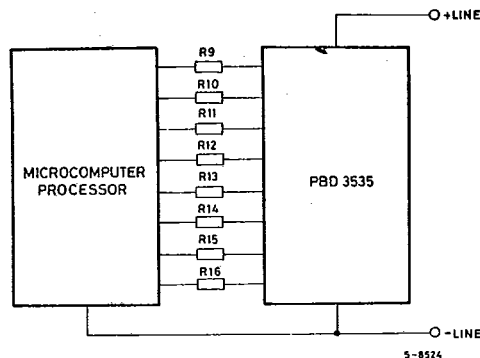
Fig. 8 - DC series regulator



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ected to the positive voltage and one input of the high group (pins 9-12) is connected to the negative voltage. When an input of the high group (pins 9-12) is connected to the negative voltage, PBD is activated and the mute output is put in high state.

Fig. 9 - Microcomputer interface



5-8524

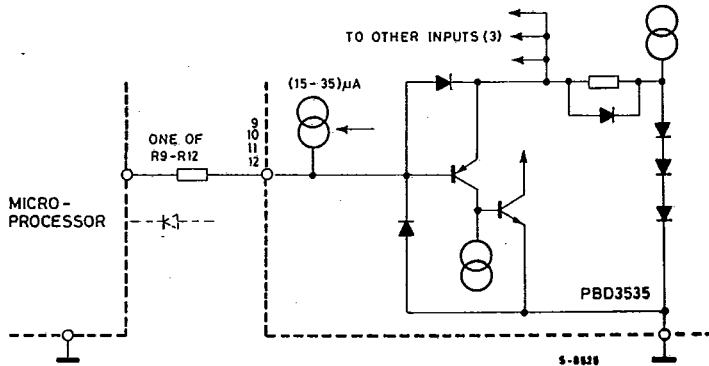
R<sub>9</sub>, R<sub>10</sub>, R<sub>11</sub> and R<sub>12</sub>

The resistors have two functions:

- When at low input level, ensure that the input does not get below +0.2V. This must not occur.
- When the input level is high, limit the current. Too high current will interfere with the functions of the other three inputs (the resistors can be exchanged with diodes directly away from PBD 3535).



Fig. 10 - High-frequency group resistors to microcomputer



Example: The logic states vary from 0V to +3V. Suitable resistor value is 68KΩ (see fig. 11).

Example: The logic states vary from 0V to +3V. Suitable resistor value is 27KΩ (see fig. 11).

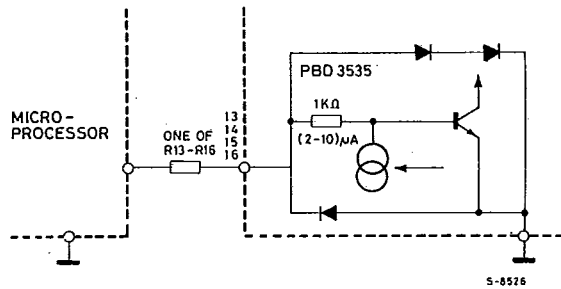
R<sub>13</sub>, R<sub>14</sub>, R<sub>15</sub> and R<sub>16</sub>

The two functions of the resistors are:

- To raise the OFF/ON Voltage
- To limit the current when the input levels are high

In some telephone instrument designs a click can be heard in the receiver when a button is pressed down for tone signalling. In some applications this has been found desirable as a feedback but in others the effect is not so desirable.

Fig. 11 - Low-frequency group resistors to microcomputer



To suppress the click effect an RC network as seen in fig. 12 can be applied. A capacitor of 47nF halves the loudness of the click and a capacitor of 1.7µF totally cancels the click effect (see fig. 13).

tone generator. Besides full and independent programmability of both sending and receiving gains when muted the speech circuit reduces its consumption by about 10mA (available to the DTMF circuit), still providing the proper DC and AC (600ohm) impedance to the line.

The LS588 speech circuit is specifically developed by SGS for use with the PBD3535 DTMF



The external capacitor at pin 16 of LS588 has been reduced from the standard  $10\mu\text{F}$ , usually shown in the SGS application, down to  $4.7\mu\text{F}$

to optimize the DTMF start up without affecting the normal speech operation. (see fig. 14).

Fig. 12 - Click suppression

Fig. 13 - Click effect in relative sound pressure

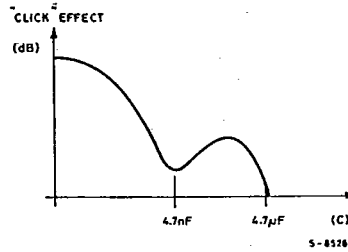
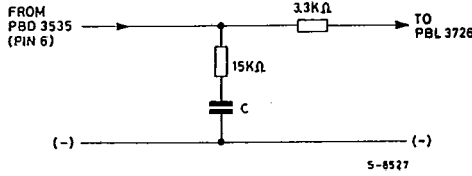


Fig. 14 - PBD3535 application with LS588

