SGS

PBD3535

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
- I^2L 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.
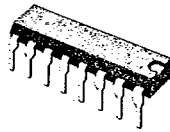
DIP-16 Plastic (0.4)

ORDERING NUMBER: PBD 3535

BLOCK DIAGRAM

S-8514
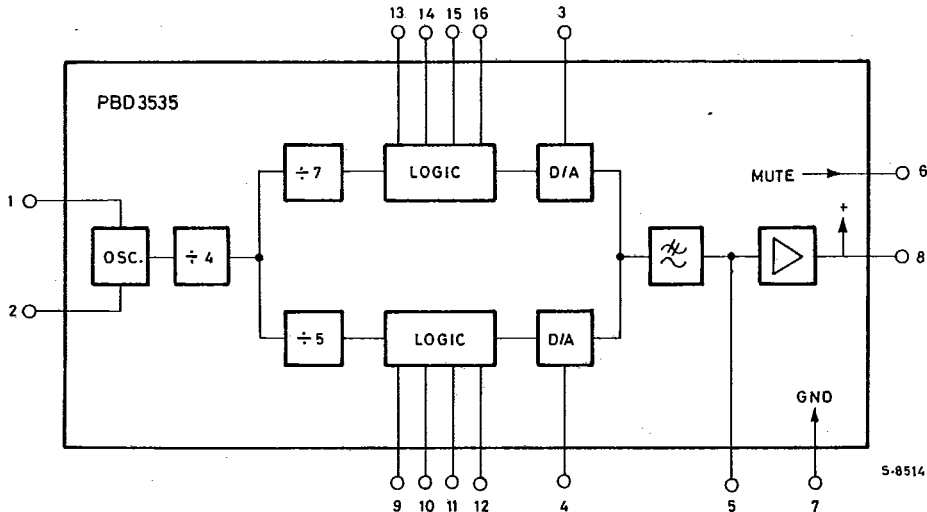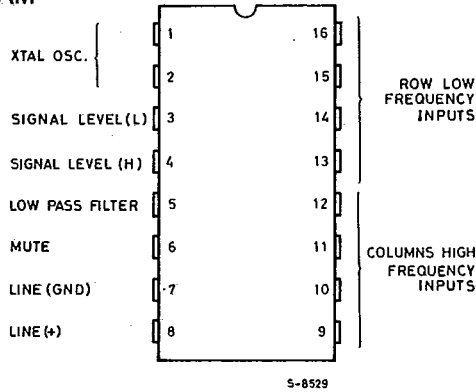
This is advanced information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

589   6/86

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PBD3535

CONNECTION DIAGRAM

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                    ┌────┴────┐
         XTAL OSC. {│ 1    16 │
                    │ 2    15 │  ROW LOW
                    │         │  FREQUENCY
   SIGNAL LEVEL(L)  │ 3    14 │  INPUTS
   SIGNAL LEVEL (H) │ 4    13 │
   LOW PASS FILTER  │ 5    12 │
             MUTE   │ 6    11 │  COLUMNS HIGH
                    │         │  FREQUENCY
         LINE (GND) │ 7    10 │  INPUTS
          LINE (+)  │ 8     9 │
                    └─────────┘
                      S-8529
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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	20	V
	pulse time = 20 ms	22	V
T_J	Junction temperature	150	°C
T_{amb}	Operating ambient temperature	-20 to 70	°C
T_{stg}	Storage temperature	-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

$R_{th\,j\text{-}amb}$	Thermal resistance junction-ambient	max	80	°C/W

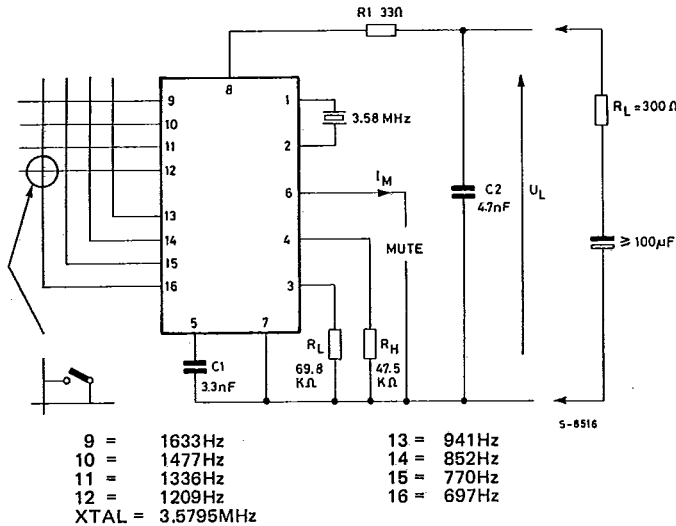Fig. 1 – Min DC level at 1.3V AC signal

PBD3535
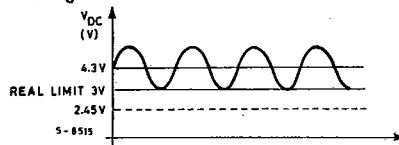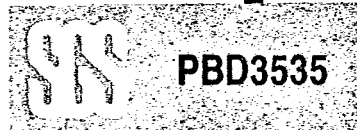
ELECTRICAL CHARACTERISTICS (Electrical characteristics over recommended operating conditions)

	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_L	Line voltage	Tone generation DC level at 1.3 V_p AC signal	4.3		9	V
V_{DC}	DC voltage below AC voltage	At tone generation	3.0			V
		At tone generation -5°C +45°C	2.45			V
V_L	Line voltage	Stand-by DC level at 2.0 V_p AC signal	4.3		9	V
I_L	Line current	Stand-by: no key pressed $V_L = 4.3V$			250	µA
I_L	Line current	Operating current $V_L = 4.3V$			10	mA
I_M	Mute current	One or more keys pressed	125			µA
R_K	Key resistance	Key circuit closed Key open (16 contacts)	1		1	KΩ MΩ
f_T	Frequency Low	$f_{osc} = 3.5795MHz$ $f_1 = 697Hz$ $f_2 = 770Hz$ $f_3 = 852Hz$ $f_4 = 941Hz$	-1 -1 -1 -1	+0.32 +0.02 +0.03 -0.11	+1 +1 +1 +1	% % % %
	Frequency High	$f_5 = 1209Hz$ $f_6 = 1336Hz$ $f_7 = 1477Hz$ $f_8 = 1633Hz$	-1 -1 -1 -1	-0.03 -0.03 -0.68 -0.36	+1 +1 +1 +1	% % % %
V_H V_L	Signal Level High Signal Level Low	$R_H = 47.5KΩ$ $R_L = 69.8KΩ$	-11 -13	-9 -11	-7 -9	dBm dBm
V_H V_L V_H V_L		$R_H = 33.2KΩ$ $R_L = 48.7KΩ$ $R_H = 26.1KΩ$ $R_L = 39.2KΩ$	-8 -10 -6 -8	-6 -8 -4 -6	-4 -6 -2 -4	dBm dBm dBm dBm
$\dfrac{V_L}{V_H}$	Radio signal level High Freq./Low Freq.		1	2	3	dB
Z_T	Impedance to line	At tone generation	6			KΩ
ZS		At stand-by	50			KΩ
D	Total harmonic distortion	Normal operation Stand-by			-31 -80	dBm dBm
H	Harmonics *	300-3400Hz 3.4-50KHz > 50KHz			-33 -33/-80	dBm dBm
t_s	Start-up time	Output level within 1dB from final level		3	5	ms

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

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PBD3535

TEST CIRCUIT


```
R1  33Ω
3.58 MHz
R_L = 300Ω
I_M
C2  4.7nF   U_L
≥ 100µF
MUTE
C1  3.3nF
R_L  69.8 KΩ
R_H  47.5 KΩ
S-8516
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9 = 1633Hz	13 = 941Hz
10 = 1477Hz	14 = 852Hz
11 = 1336Hz	15 = 770Hz
12 = 1209Hz	16 = 697Hz
XTAL = 3.5795MHz	

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 1MΩ.
Typical threshold is 100KΩ.

The circuit is made to work properly with electronic speech circuits such as PBL 3726.
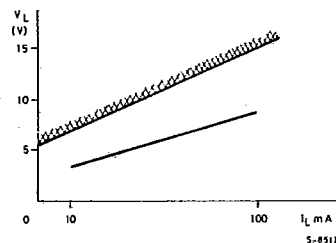
Component function:
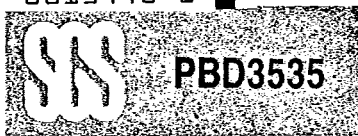
R_1: Protecting resistor;
R_L: Signal level (low);
R_H: Signal level (high);
C_1: Low pass filter;
C_2: Radio frequency suppression (if used together with speech circuit with radio suppression built in, like PBL 3726, C_2 is not necessary.

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 = 1.4KHz) and R_{LOAD} (f = 800Hz) 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.

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

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

Fig. 3 - Tone level vs. line current
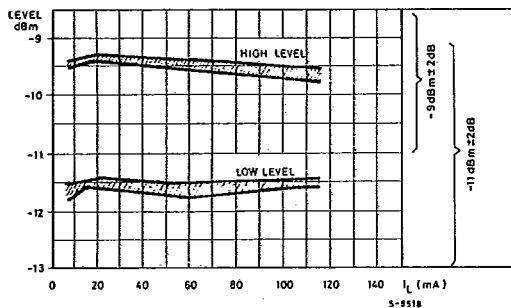
Fig. 4 - Tone level vs. temperature
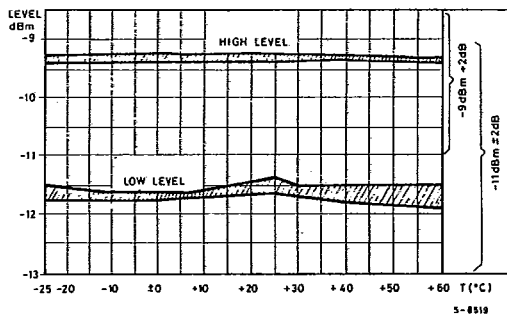
The current consumption within PBD 3535 can be reduced with a resistor connected in parallel with C1 (see fig. 5). If the current reduction is made too large, the output signal can be distorted by clipping.

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.
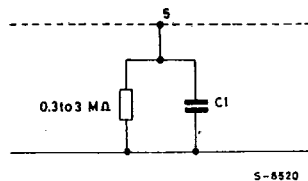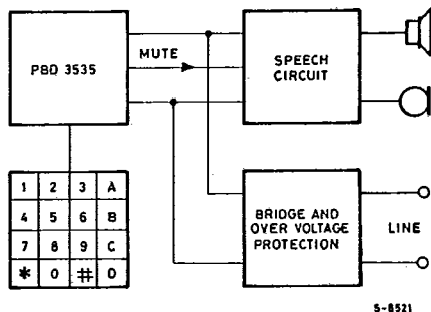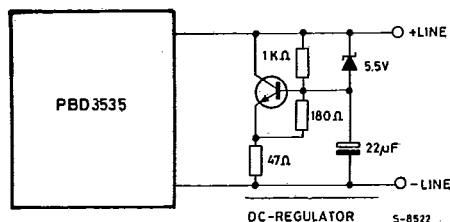
Fig. 5

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Fig. 6 - Typical application

S-8521

Fig. 8 - DC series regulator

S-8523

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.

nected 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. 7 - DC regulator

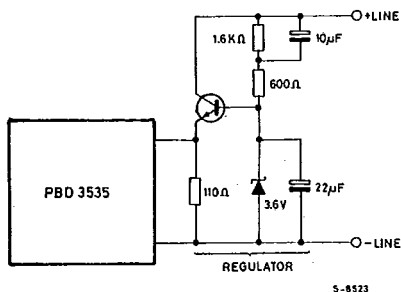DC-REGULATOR   S-8522

Fig. 9 - Microcomputer interface

S-8524

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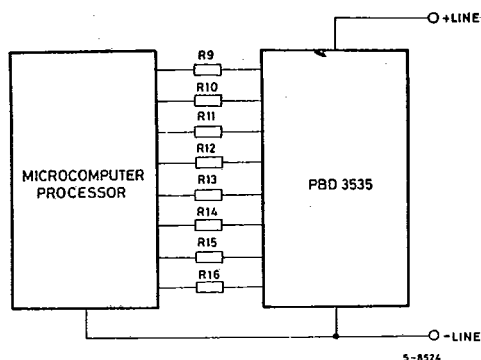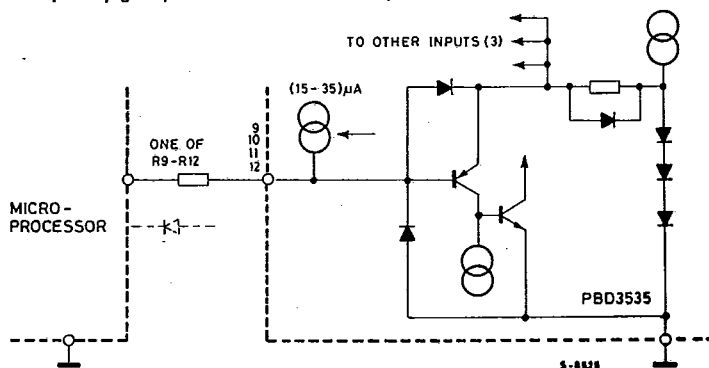
PBD 3535 can also be controlled by a microprocessor (see fig. 8). The negative branch of the microprocessor voltage supply is connected to pin 7 of PBD 3535 and the inputs (8) are connected with resistors. For tone-generating one input of the low group (pins 13-16) is con-

R_9, R_{10}, R_{11} and R_{12}

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 very from 0V to +3V. Suitable resistor value is 68KΩ (see fig. 11).

R_{13}, R_{14}, R_{15} and R_{16}

The two functions of the resistors are:

— To raise the OFF/ON Voltage

— To limit the current when the input levels are high

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

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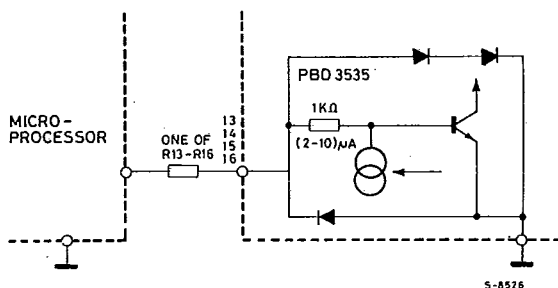
To suppress the click effect an RC network as seen in fig. 12 can be applied. A capacitor of 47nF halves the loudness of the click and a capacitor of 1.7μF totally cancels the click effect (see fig. 13).

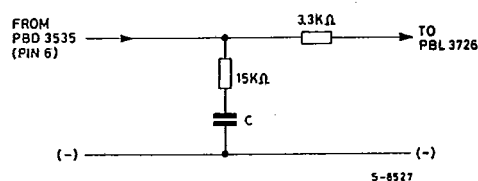The LS588 speech circuit if specifically developed by SGS for use with the PBD3535 DTMF

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.
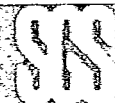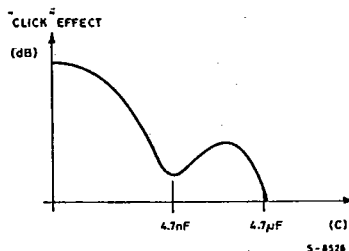
PBD3535

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

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

Fig. 12 - Click suppression

FROM
PBD 3535 ————————→ 3.3KΩ ————————→ TO
(PIN 6)   PBL 3726

15KΩ

C

(-) ———————————————————— (-)

S-8527

Fig. 13 - Click effect in relative sound pressure

CLICK EFFECT

(dB)

4.7nF   4.7μF   (C)

S-8526

Fig. 14 - PBD3535 application with LS588

S-8604