

# PBD 3551 DTMF Generator

## Description

The PBD 3551 is a bipolar integrated circuit implemented in I<sup>2</sup>L technology. The circuit uses the standard TV-crystal at 3.58 MHz or a ceramic resonator to synthesize the frequencies used in DTMF signalling. The CEPT specification is fulfilled. Internal DC-regulator and voltage reference makes the direct connection to subscriber line possible. The generator uses a matrix type 4 X 4 keyboard, but can also be controlled from a 4-bit microprocessor bus. Latch function is provided for the microprocessor interface.

## Key Features

- Uses low cost 3.58 MHz TV-crystal or a ceramic resonator
- Has combined keyboard / 4-bit microprocessor interface with latch
- Anti-bounce circuitry on all keyboard inputs

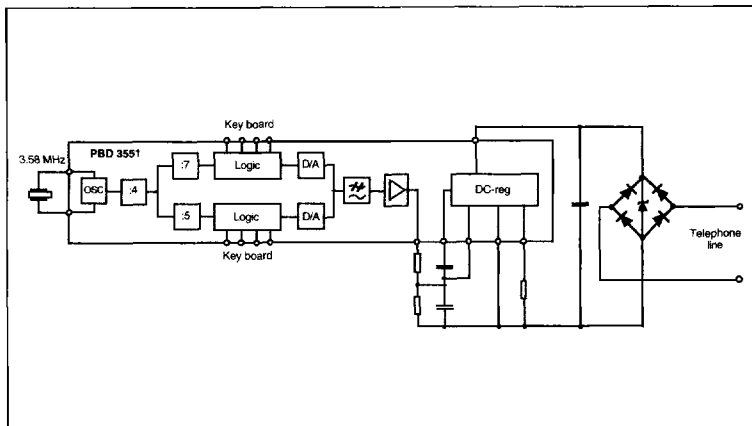
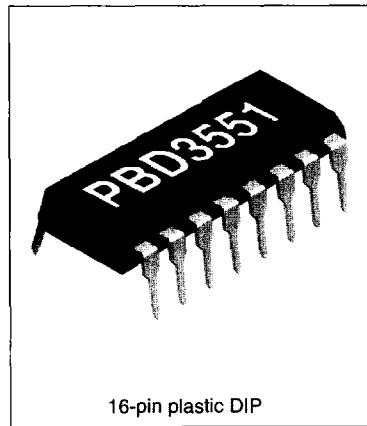
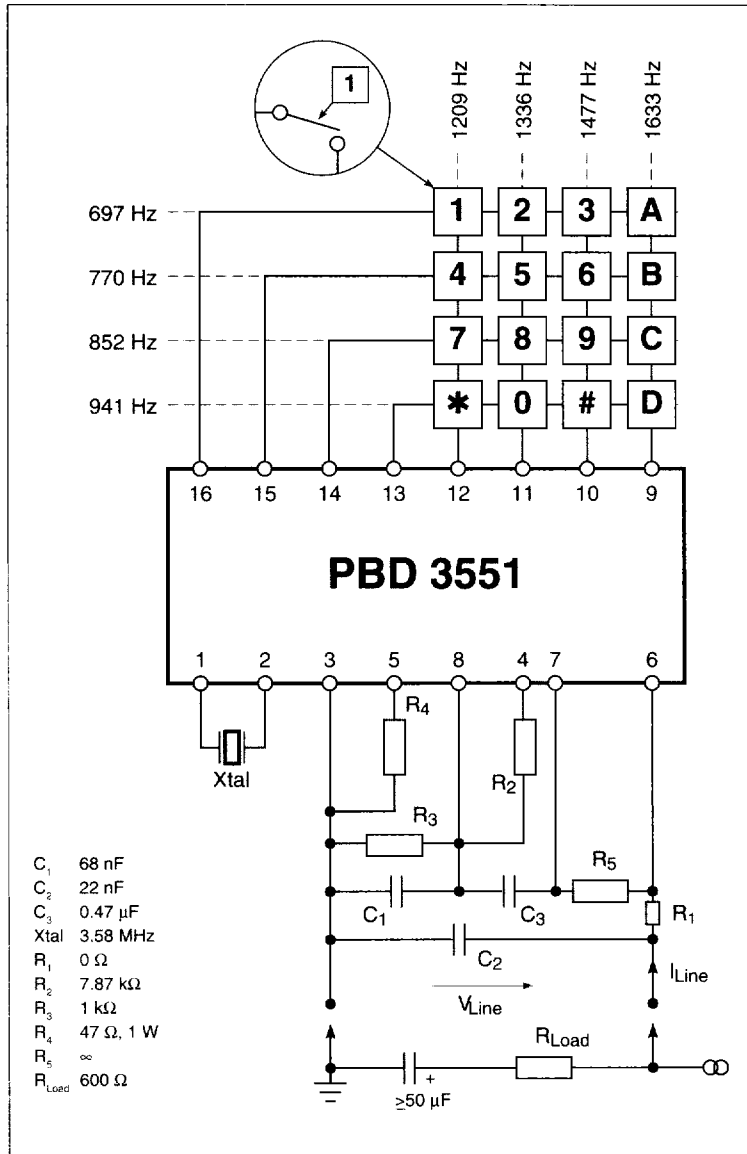


Figure 1. Functional diagram.



**Maximum Ratings**

Parameter	Symbol	Min	Max	Unit
Line Current	$R_s = \infty$	-120	100	mA
	$R_s = 1.6 \text{ Mohm}$	-120	130	mA
Line Voltage	$t_p = 2 \text{ s}$	0	20	V
	$t_p = 10 \text{ ms}$	0	22	V
Power dissipation	$P_d$		600	mW
Operating ambient temperature	$T_{\text{Amb}}$	-20	+70	°C
Storage temperature	$T_{\text{Stg}}$	-55	+125	°C



**Component Function**

Name	Function
$R_1$	Increases the DC-voltage over the circuit (if wanted)
$R_2$	Adjusts the signal level
$R_3 / C_1$	Low pass filter
$R_4$	Sets the DC-characteristic and output impedance
$R_5$	Decreases DC-voltage over the circuit if wanted (reduces allowed interposed AC-voltage across the line.)
$C_2$	Radio frequency suppression and a part of the impedance to the line. A decrease to 15 nF gives more optimum balancing to 600Ω.
$C_3$	Coupling capacitor and filter for DC stabilization.

Table 1. Component function for figure 2.

Figure 2. Reference circuit.

## Electrical Characteristics

Electrical characteristics at  $T_{Amb} = -20\text{ }^{\circ}\text{C}$  to  $+50\text{ }^{\circ}\text{C}$ ,  $I_{Line} = 10\text{-}100\text{ mA}$ ,  $R_s = \infty$  unless otherwise specified. Test circuit see fig. 2.

Parameter	Conditions	Min	Typ	Max	Unit	
Line voltage, $V_{Line}$	$I_{Line} = 10\text{ mA}$		4.3	4.5	V	
	$I_{Line} = 100\text{ mA}$		9.7	10.6	V	
	$I_{Line} = 20\text{ mA}$ , $R_s = 1.6\text{ Mohm}$		4.3		V	
	$I_{Line} = 130\text{ mA}$ , $R_s = 1.6\text{ Mohm}$		9.7		V	
Return loss	$Z = 600\text{ ohm}$ , 300-3400 Hz	14			dB	
	$Z = 900\text{ ohm}/30\text{nF}$ , 300-3400 Hz	14			dB	
Tone level accuracy, $V_{High}$ , $V_{Low}$	(Adjustable with $R_2$ )	-2		+2	dB	
Tone level ratio, high/low group $V_{High}$ , $V_{Low}$		1	2	3	dB	
Keyboard resistance	Contact switch ON			1	kohm	
	Contact switch OFF	200			kohm	
Total harmonic distortion				-31	dBm	
Harmonics	300-3400 Hz			-33	dBm	
	3.4 kHz - 50 kHz			( Note 1 )	dBm	
	50 kHz - 100 kHz			-80	dBm	
Start-up time	Output level within 1dB of final level		3	5	ms	
Output frequency error, $f_n$	$f_{osc} = 3.58\text{ MHz}$					
Low group,	$f_1$	697 Hz	-1	-0.32	+1	%
	$f_2$	770 Hz	-1	+0.02	+1	%
	$f_3$	852 Hz	-1	+0.03	+1	%
	$f_4$	941 Hz	-1	-0.11	+1	%
High group,	$f_5$	1209 Hz	-1	-0.03	+1	%
	$f_6$	1336 Hz	-1	-0.03	+1	%
	$f_7$	1477 Hz	-1	-0.68	+1	%
	$f_8$	1633 Hz	-1	-0.36	+1	%
Debounce		1.5		3.7	ms	
Total signal level, $V_p$	Allowed interposed AC-voltage across the line, peak value					
	$I_L \geq 10\text{ mA}$			1.45	$V_{Peak}$	
	$I_L \geq 20\text{ mA}$			1.85	$V_{Peak}$	
Signal level high, $V_{High}$	$R_2 = 7.87\text{ kohm}$	-11	-9	-7	dBm	
	$R_2 = 5.36\text{ kohm}$		-6			
	$R_2 = 4.12\text{ kohm}$		-4			
Signal level low, $V_{Low}$	$R_2 = 7.87\text{ kohm}$	-13	-11	-9	dBm	
	$R_2 = 5.36\text{ kohm}$		-8			
	$R_2 = 4.12\text{ kohm}$		-6			

### Note:

1. Single tone distortion is less than  $(-33-40 \log \frac{f}{3400})$  dBm.

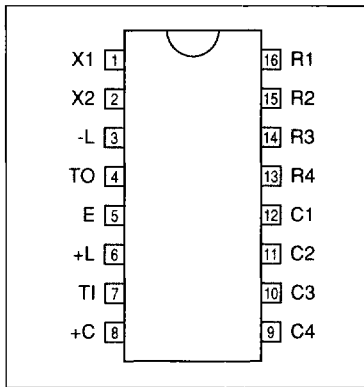


Figure 3. Pin configuration.

### Pin Descriptions

Refer to figure 2 and figure 3.

DIP	Symbol	Description
1	X1	Crystal terminals. The circuit is intended to operate with a standard 3.58 MHz TV-crystal, or a ceramic resonator.
2	X2	
3	-L	The negative power terminal, connected to the line through a polarity guard diode bridge.
4	To	Output of the oscillator
5	E	Emitter of the output transistor. R4 sets the DC-characteristic, output impedance and amplification.
6	+L	Output and DC feed for the circuit. R1 increases the voltage over the line when necessary. This pin is connected to the line through a polarity guard diode bridge.
7	TI	Input of the transmit amplifier
8	+C	Fast Charge for the capacitor C3 which affects the start-up time.
9	C4	Keyboard inputs for the high group of frequencies (column 1-4).
10	C3	
11	C2	
12	C1	
13	R4	Keyboard inputs for the low group of frequencies (row 1-4)
14	R3	
15	R2	
16	R1	

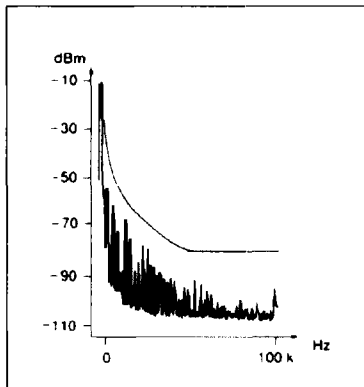


Figure 4. Frequency spectrum of the tone pairs at the output.

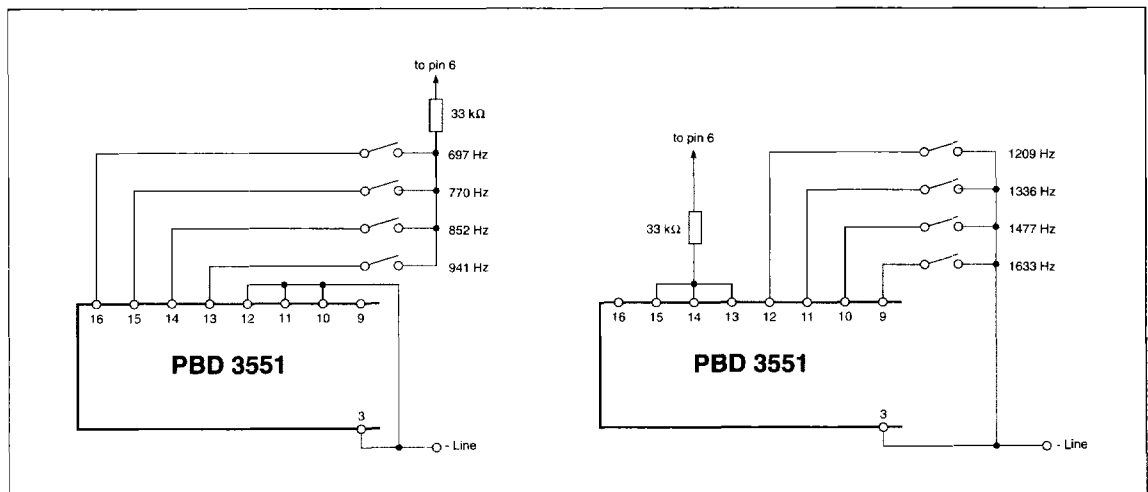


Figure 5. Generating single tones.

**Functional Description**

The circuit generates through digital synthesis the 8-tones which are needed for DTMF-signalling on a telephone line. A 3.58 MHz TV crystal is used as frequency standard.

The crystal oscillator frequency is divided first by 4 and then by 7 for the low frequency group and by 5 for the high frequency group.

The generation of the two tones which signify the specific digit is activated by connecting one input in one group to an input in the other group. Each tone is generated digitally with I<sup>2</sup>L logic. Each digital signal is fed into a 4-bit digital / analog converter that generates a sinus shaped signal 15 steps in amplitude and 30 steps in time for each cycle.

The step length is varied for each step and for each tone to obtain a sinus signal with as low overtone content as possible

and using as simple filter as possible. The result is according to the CEPT specification.

Reference to the signal amplitude is a band gap-reference voltage of 1.22 V. The additive signal from the two D/A converters is filtered in an internal filter and after that in an external filter stage.

The power amplifier consist of circuits for quick start up and defined DC-characteristic for 8-100 mA current, it also has an active output impedance to give correct matching to the line within frequency range of 300-3400 Hz.

The circuit is powered by current generators from the + line. The keyboard is sensed by DC-currents which gives good possibilities to use effective RFI suppression methods.

A 4 X 4 matrix type keyboard with single contacts is connected to the row and column input pins. When contact is

made between a row and a column input, the two corresponding frequencies are generated. No invalid tones are generated when two or more contacts are activated simultaneously. Single tones for testing can be generated separately as shown in fig. 5. All keyboard inputs are protected against short interruptions by a debounce circuit (<1.5 ms). This does not apply when controlling with u-processor.

The absolute signal level can be adjusted with R<sub>2</sub> but there is no need for individual adjustment on every circuit. The relative signal level high/low is internally determined to 2 dB ± 1 dB.

The signal level is stabilized against variations in temperature and line current. Pause and signal time is determined from the keyboard.

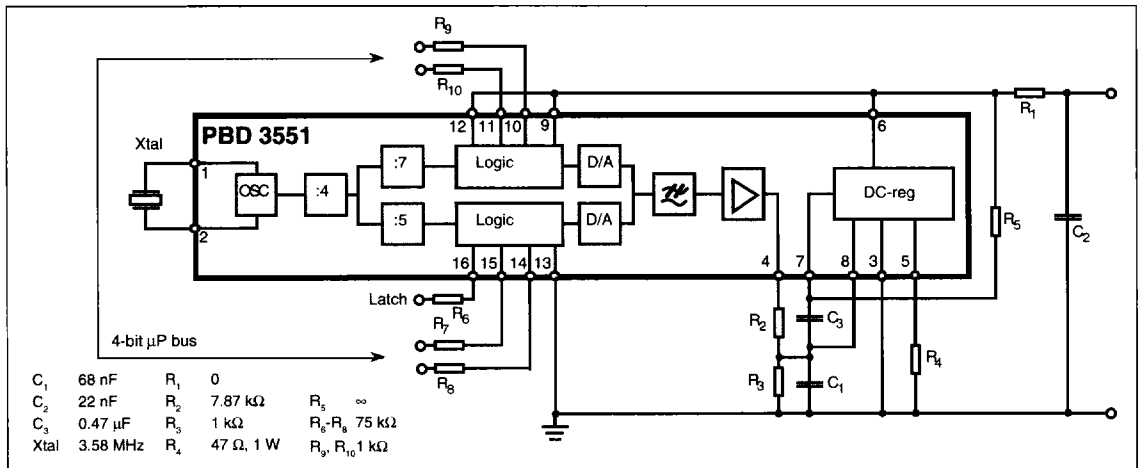


Figure 6. Microprocessor controlled PBD 3551.

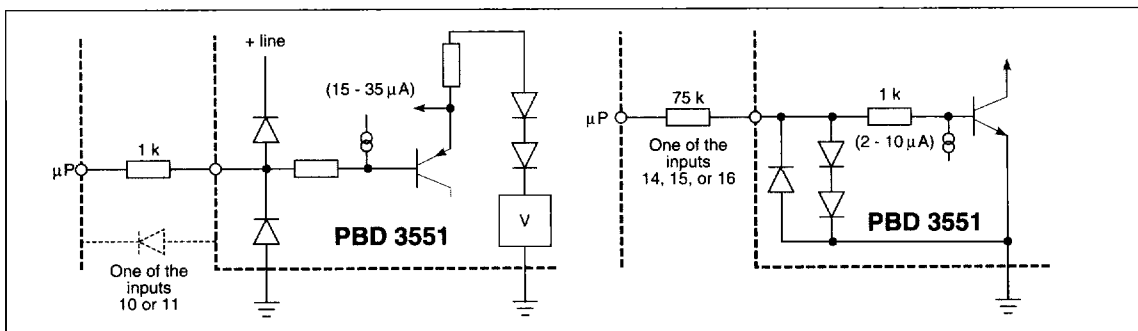


Figure 7. Bus interfacing resistors high frequency group (left) and low frequency group (right).

## Protection and Interference Suppression

The electrical circuit of the telephone instrument is completed by a polarity-guard diode bridge at the +Line and -Line terminals. Protection against voltage transients from the line must also be applied. A 15 V zener diode such as 1N 4744 and a series resistor of 5-10 ohms is sufficient in most cases. Radio interference is suppressed by  $C_2$  which must be of good quality.

## Microprocessor Control

The circuit may be controlled by external devices such as, Ericsson Components' repertory dialer PBM 3915 or a micropro-

cessor. An internal 4 bit register with latch can be loaded with data (determines the DTMF tone combinations) using the ordinary keyboard input pins. Fig 8.

When the latch input is low the tone signal code is applied to the inputs, and when the latch goes high the code is stored into the circuit which starts sending the appropriate tones. The circuit is different to changes on the inputs as long as the latch input is high. When using the circuit together with microprocessor connect pins 9 and 12 to pin 6 and pin 13 to pin 3. Pause and signal ratio time is controlled by the microprocessor.

## Inputs Connected to the $\mu$ -Processor

Resistors are needed for the low frequency group inputs and for the latch input but may also be needed for the high frequency group inputs in order to prevent inter-action between other functions connected to the same bus.

## Ordering Information

Package	Temp. Range	Part No.
Plastic DIP	-20 to +70°C	PBD 3551N

		High Frequency Group				Pin		
		Hz	1209	1336	1477	1633	14	15
Low Frequency Group	697	1	2	3	A	0	0	
	770	4	5	6	B	0	1	
	852	7	8	9	C	1	0	
	941	*	0	#	D	1	1	
Pin	10	0	1	0	1			
	11	0	0	1	1			

Figure 8. Truthtable for  $\mu$ -P bus generating the DTMF- tones.

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