RIFA

integrated circuits

PBD 3551

Data Sheet

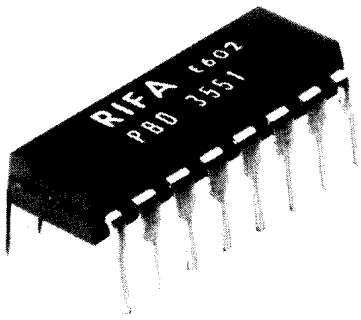
DTMF-Generator

The PBD 3551 is a bipolar integrated circuit implemented in I^2L 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.

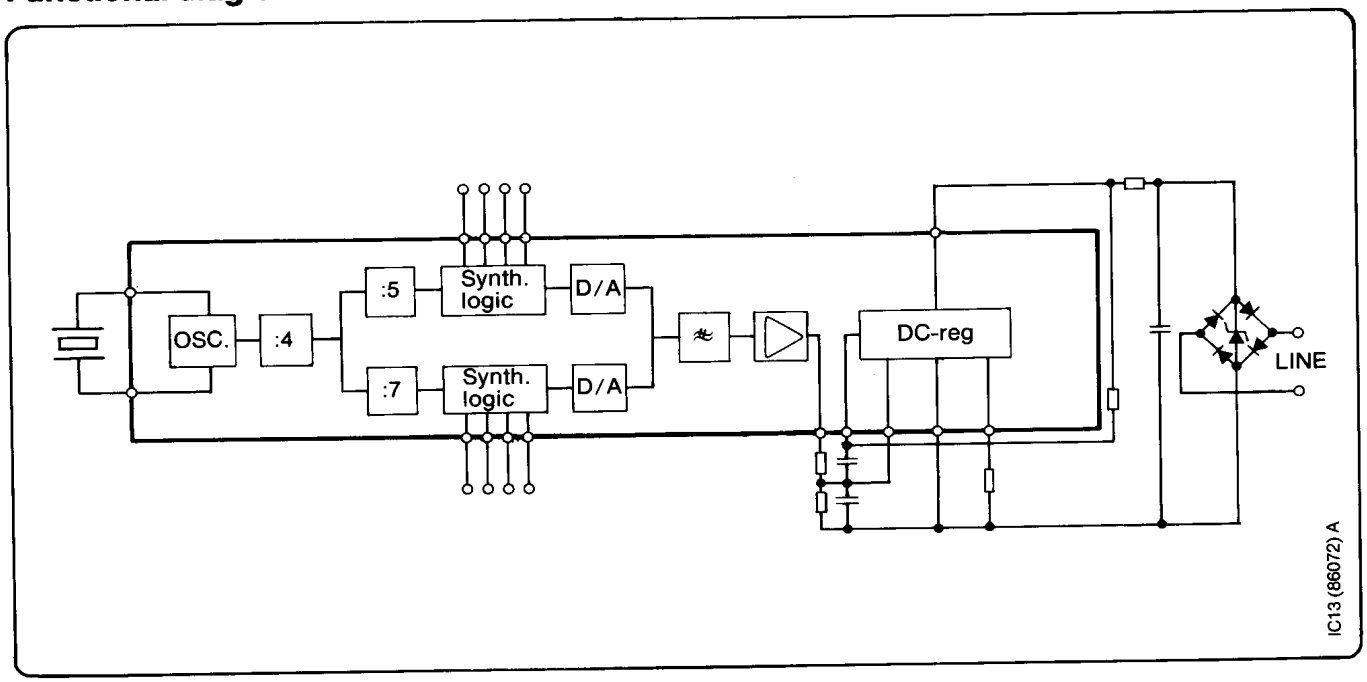
The generator uses a maxtrix type 4×4 keyboard, but can also be controlled from a 4-bit microprocessor bus. Latch function is provided for the microprocessor interface.



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

Functional diagram



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May 1986

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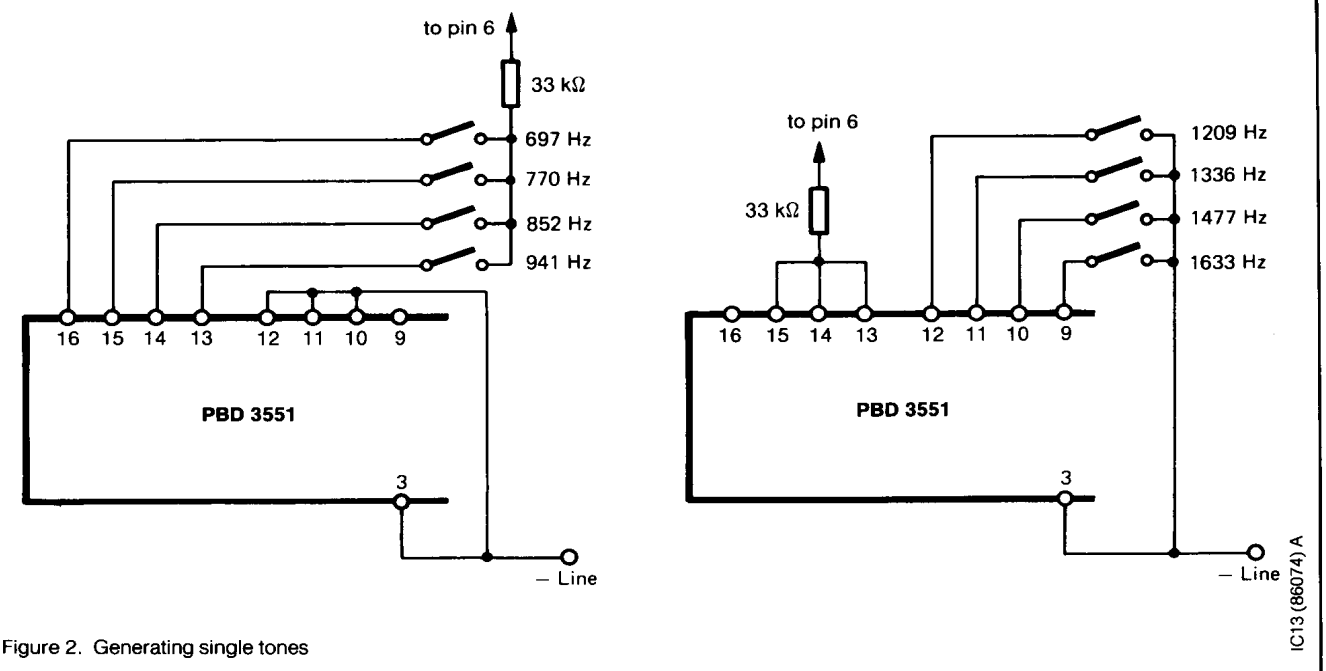


Figure 2. Generating single tones

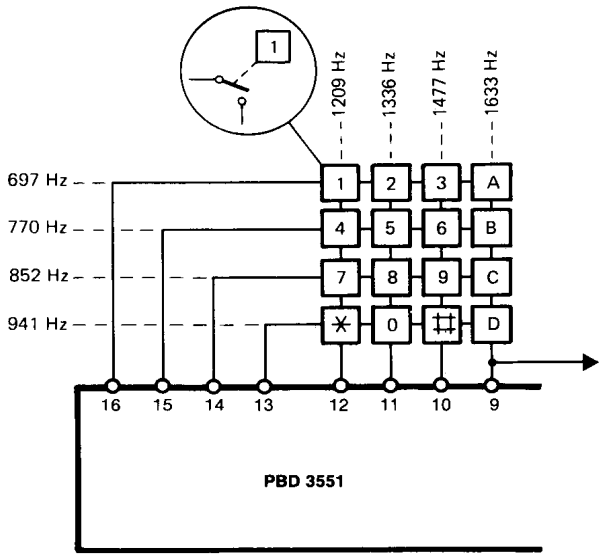


Figure 3. Keyboard connections

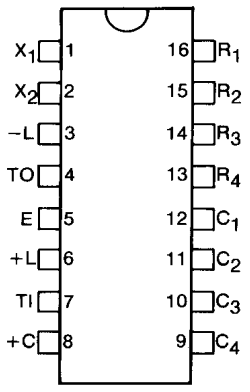


Figure 4. Pin Configuration

Functional description

The circuit generates through digital synthesis the 8-tones which are needed for DTMF-signalling on a telephone line. A 3.5795 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^2L logic. Each digital signal is fed into an 4-bit digital/analog converter that generates a sinusshaped signal 15 steps in amplitude and 30 steps in time for each cycle.

The steplength is varied for each step but also for each tone to obtain a sinus signal with a 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 filterstage.

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.

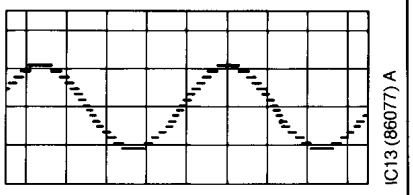


Figure 5. Single tone unfiltered (Exist only internally in the circuit).

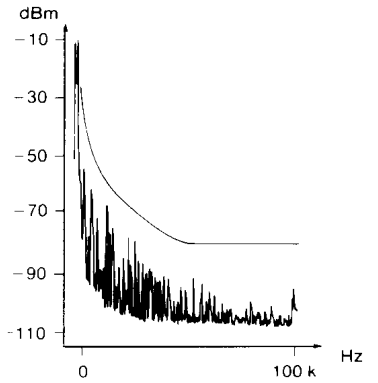


Figure 6. Frequency spectrum of the tone pairs at the output.

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 4×4 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 unvalid tones are generated when two or more contacts are activated simultaneously. Single tones for testing can be separated as shown in fig. All keyboard inputs are protected against short interruption by a debounce circuit (<1.5 ms). This does not apply when controlling with u-processor.

The absolute signal level can be adjusted with R2 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.

Pin functions

Pin	Name	Function
1.2	X1, X2	Crystal terminals. The circuit is intended for operation with a standard 3.58 MHz TV-crystal, or a ceramic resonator.
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-characteristics, output impedance and amplification.
6	+L	Output and DC feed for the circuit R1 lifts the voltage over the line when necessary. This pin is connected to he 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.
9–12	C1–C4	Keyboard inputs for the high group of frequencies (column 1–4).
13–16	R1–R4	Keyboard inputs for the low group of frequencies (row 1–4)

Maximum Ratings

Parameter	Conditions	Min	Max	Units
Line current I_{Line}	$R_5 = \infty$ R_5 = 1.6 Mohm	−120 −120	100 130	mA mA
Line voltage V_{Line}	tp = 2 s tp = 20 ms continuous		20 22	V V
Power dissipation			600	mW
Operating temperature range T_{amb}		−20	+70	°C
Storage temperature range T_{stg}		−55	+125	°C

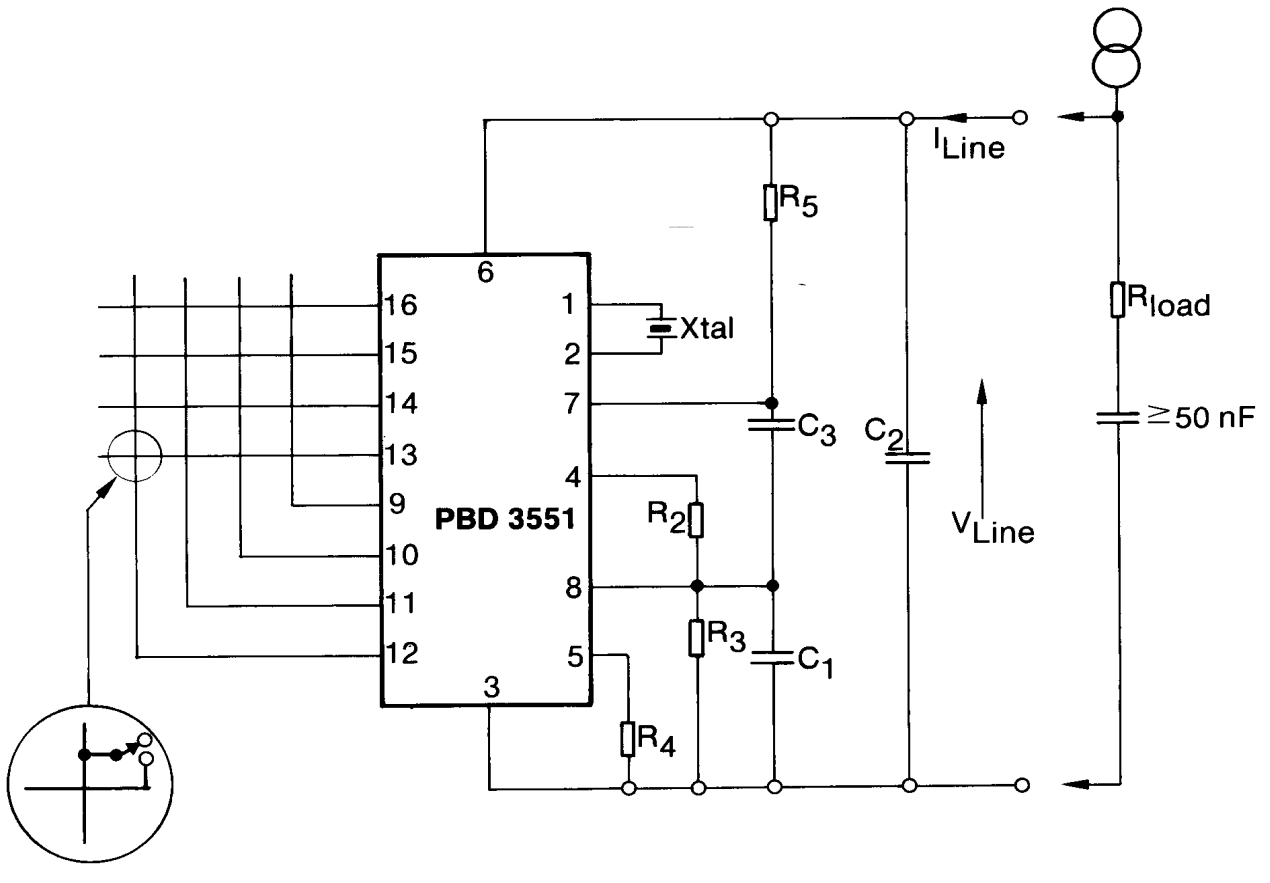
Electrical Characteristics

Electrical characteristics at T_{amb} = −20 °C to 50 °C, I_{Line} = 10−100 mA, R = ∞ unless otherwise specified.

Parameter		Conditions	Min	Typ	Max	Units
DC-characteristics						
Line voltage	V_{Line} V_{Line} V_{Line} V_{Line}	I_{Line} = 10 mA I_{Line} = 100 mA I_{Line} = 20 mA, R_5 = 1.6 Mohm I_{Line} = 130 mA, R_5 = 1.6 Mohm		4.3 9.7 4.3 9.7	4.5 10.6	V V V V
Return loss		Z = 600 ohm, 300−3,400 Hz Z = 900 ohm//30 nF, 300−3,400 Hz	14 14			dB dB
Tone level accuracy	V_{High} and V_{Low}	(Adjustable with R_2)	−2		+2	dB
Tone level ratio, high/low group	V_{High} and V_{Low}		1	2	3	dB
Keyboard resistance		Contact switch ON Contact switch OFF	200		1	kohms kohms
Total harmonic distortion Harmonics		 300−3,400 Hz 3.4 kHz − 50 kHz 50 kHz − 100 kHz			 −31 −33 * −80	 dBm dBm dBm dBm
Start-up time		Output level within 1 dB from final level		3	5	ms
Output frequency error fn		fosc = 3.5795 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	%

Parameter		Conditions	Min	Typ	Max	Units
Debounce			1.5		3.7	ms
Total signal level	V_P	Allowed interpored AC-voltage across the line, peak-value $I_L \geqq 10$ mA $I_L \leqq 20$ mA			 1.45 1.85	 Vpeak Vpeak
Signal level high Signal level low	V_{High} V_{Low} V_{High} V_{Low} V_{High} V_{Low}	R_2 = 7.87 kohm R_2 = 7.87 kohm R_2 = 5.36 kohm R_2 = 5.36 kohm R_2 = 4.12 kohm R_2 = 4.12 kohm	−11 −13	−9 −11 −6 −8 −4 −6	−7 −9	dBm dBm

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



C_1 = 68 nF
C_2 = 22 nF
C_3 = 0.47 µF

$R_5 = \infty$
R_{load} = 600 Ω

Xtal = 3.5795 MHz
R_2 = 7.87 kΩ
R_3 = 1 kΩ
R_4 = 47 Ω 1 W

Figure 1. Ref. circuit

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 interposted AC-voltage across the line.)
C_2	Radio frequency suppression and a post of the impedance to the line. A decrease to 15 uF gives more optimum balancing to 600 Ω.
C_3	Coupling capacitor and filter for DC stabilization.

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, see figure 7. 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.

The circuit may also be controlled by external devices such as, RIFA's repetory dialler PBM 3915* or a microprocessor. An internal 4 bit register with latch can be loaded with data (determines the DTMF tone combinations) using the ordinary keyboard input pins. Fig when the latch input is low the tone signal code is applied to the inputs, when the latch goes by the code is stored into the circuit which starts sending the appropriate tones. The circuit indifferent 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 programmed into the microprocessor.

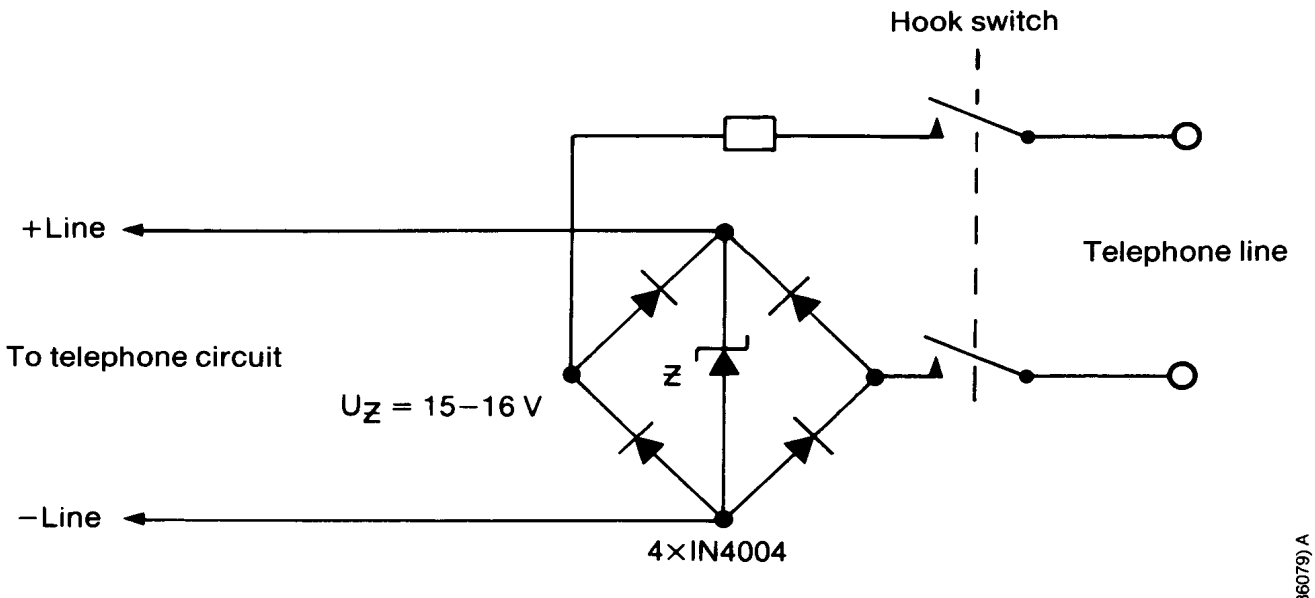
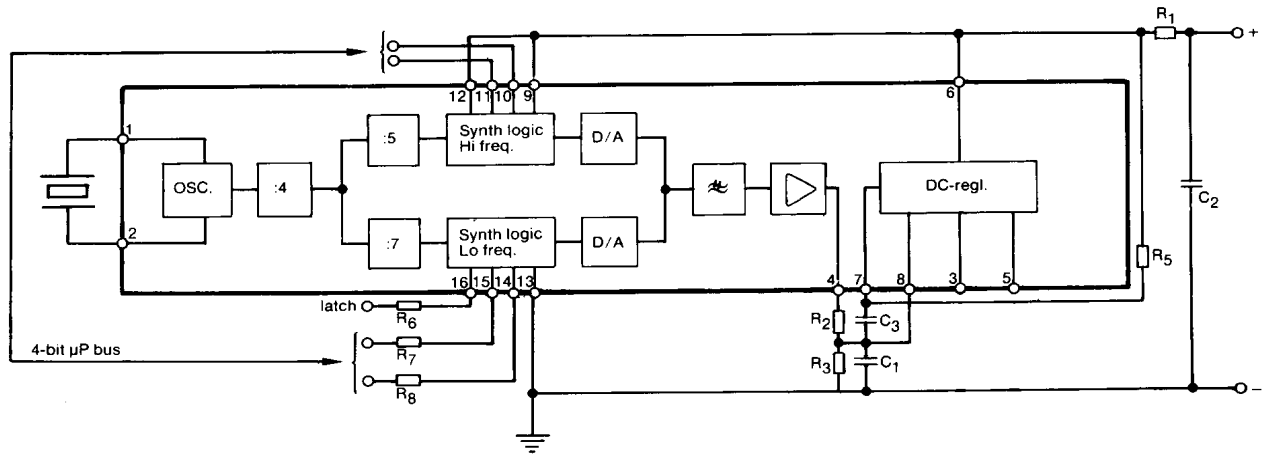


Figure 7. Polarity guard diode bridge and zener diode overvoltage protection.



$R_1 = 0$
$R_2 = 7.87$ k
$R_3 = 1$ k
$R_4 = 47\ \Omega/1$ W
$R_5 = \infty$

$R_6 = 75$ k
$R_7 = 75$ k
$R_8 = 75$ k

$C_1 = 68$ nF
$C_2 = 22$ nF
$C_3 = 0.47$ µF

Xtal = 3.58 MHz

Figure 8. Microprocessor controlled PBD 3551

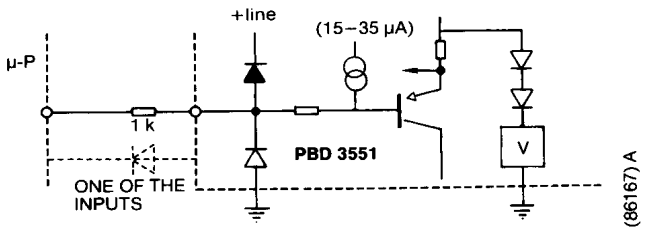


Figure 9. High frequency group resistors or diode to µ-P.

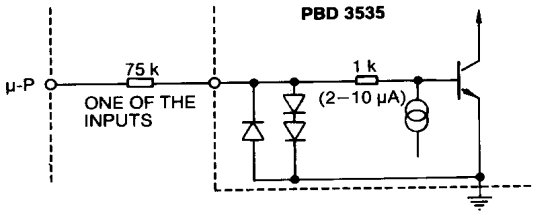


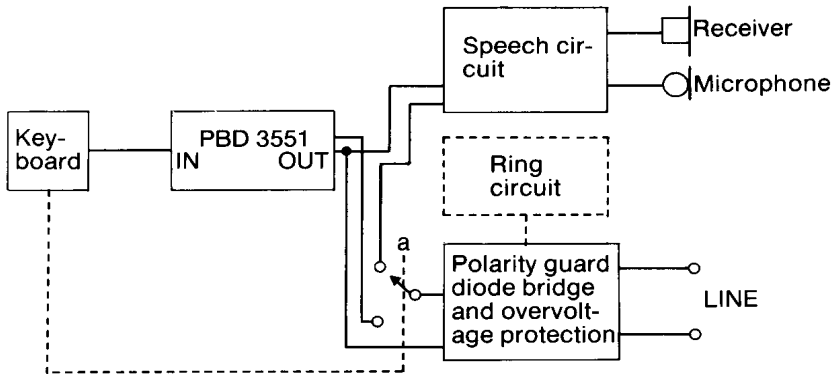
Figure 10. Low frequency group resistors.

Inputs connected to the µ-P

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 interaction between other functions connected to the same bus.

Truthtable for µ-P bus generating the DTMF-tones.

		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		

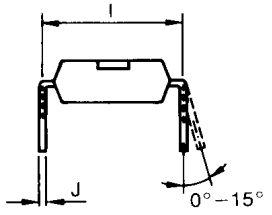


The keyboard used in this configuration must have the necessary switch to switch over the speech circuit when sending DTMF signals.

Figure 11. PBD 3551 together with speech circuit.

IC13 (86080) A

Mechanical data



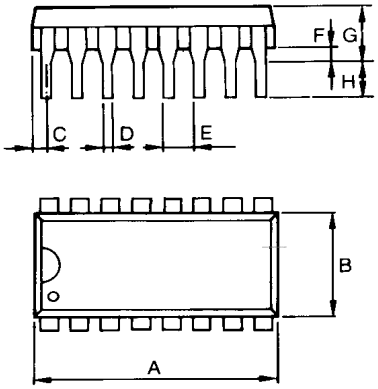


Figure 12. Dimensions

PBD 3551

	Inches		Millimeters	
	Min	Max	Min	Max
A		0.795		20.19
B	0.220	0.280	5.59	7.11
C	0.015	0.060	0.38	1.52
D	0.015	0.020	0.38	0.51
E	0.100		2.54	
F	0.020		0.51	
G		0.200		5.08
H	0.100	0.160	2.54	4.06
I	0.290	0.310	7.37	7.87
J	0.008	0.012	0.20	0.30

IC13 (86081) A

Ordering information

RIFA Order Number	Function	Encapsulation
PBD 3551	DTMF-generator	16 pin plastic DIP

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