PBL 3780, PBL 3780/02 One-chip Telephone

Description

The PBL 3780 and PBL 3780/02 are bipolar integrated circuits that contain all the necessary functions to form a complete electronic telephone with DTMF signalling.

The circuits operate down to extremely low voltages (1.3 V) which makes it usable when many telephones are connected in parallel.

They are designed for low impedance microphones, but electret microphones can be used as well.

The set-up of basic telephone parameters such as sidetone balance, impedance to the line etc., is very straightforward, using a step-by-step procedure.

The DTMF generator, which fulfils the CEPT specifications, uses a matrix type keyboard, but can also be controlled from a microprocessor.

The tone ringer function uses the oscillator and counter logic of the DTMF generator to provide a ringer signal to an external power amplifier.

The circuits differ in the following aspects:

The PBL 3780 is made to drive low impedance receivers. PBL 3780/02 is made to function with low line current in DTMF- mode and has a higher impedance to the line.

Double functions on several pins, result in a 22-pin package.

Key Features

- Low voltage transmission, down to approx. 1.3 V DC.
- AC voltage swing down to 0.4 V.
- Transmit and receive gain regulator with line length (adjustable).
- Low noise amplifiers.
- On-chip tone ringer function.
- DTMF has combined keyboard/4 bit microprocessor interface with latch.
- Uses low-cost 3.58 MHz ceramic resonator or TV crystal.
- Anti-bounce circuitry on all keyboard inputs.
- Current generator output for powering an external microprocessor or repertory dialler.
- Thermal and current compensation of tone levels.

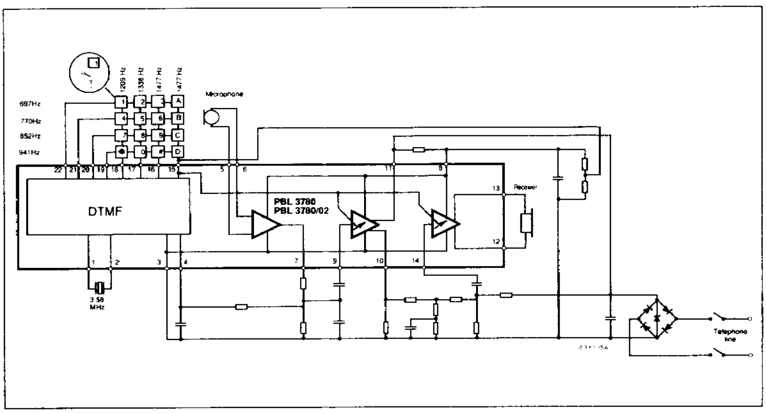
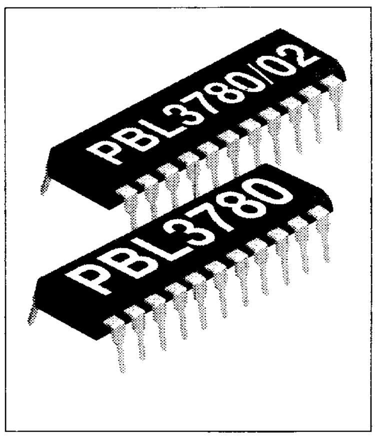


Figure 1. Functional diagram.



Maximum Ratings (Ref. figure 2)

Parameter	Symbol	Min	Max	Unit
Line current, T_{Amb} = 70 °C	I_L		150	mA
Line voltage	V_L			
continuous			15	V
t_p = 2 s			18	V
t_p = 20 ms			20	V
Power dissipation, T_{Amb} = 70 °C			1.5	W
Operating temperature range	T_{Amb}	-20	+70	°C
Storage temperature range	T_{Stg}	-55	+125	°C

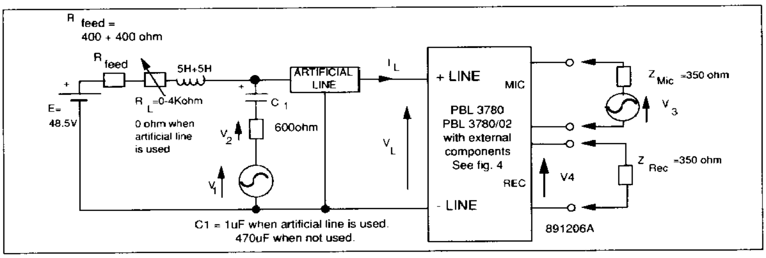


Figure 2. Test Circuit.

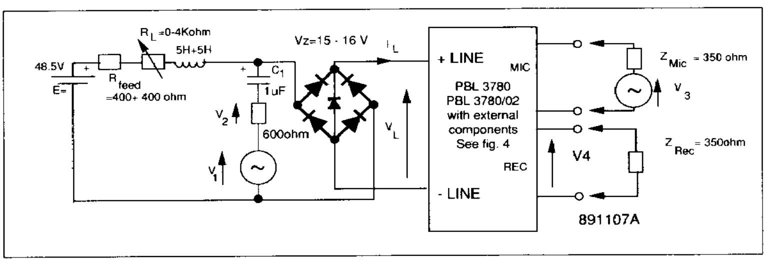


Figure 3. Test circuit with line rectifier.

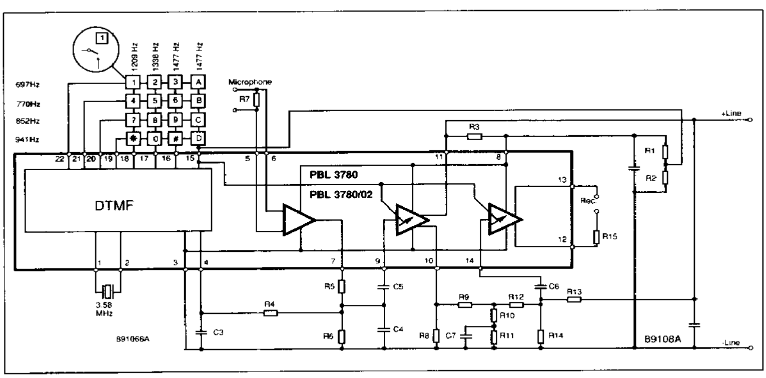


Figure 4. PBL 3780 and PBL 3780 /02 with external components for test circuits in figures 2 and 3

X1=3.58 MHz Crystal

R1 = 141 kΩ	R12= 6.2 kΩ
R2 = 110 kΩ	R13 = 62 kΩ
R3= 900Ω PBL 3780	R14= 8.7 kΩ
R3= 830Ω PBL 3780/02	R15= 310 Ω
R4 = 19.6 kΩ	C1 = 68 µF
R5 = 9.6 kΩ	C2 = 15 nF
R6 = 4.7 kΩ	C3 = 12 nF
R7 = 1.8 kΩ	C4 = 6.8 nF
R8 = 75 Ω	C5 = 150 nF
R9 = 240 Ω	C6 = 47 nF
R10= 47 Ω	C7 = 0.22 µF
R11= 800Ω	

Electrical Characteristics

T_{Amb} = 25 °C. Measured using test circuits of fig. 2 and 3 without artificial cable, unless otherwise noted.

Parameter	Ref fig.	Conditions	Min	Typ	Max	Units
DC-characteristics						
Line voltage, V_L		R_8 = 47 ohm				
	2	I_L = 2.5 mA (PBL 3780)		1.3		V
	2	I_L = 2.5 mA(PBL 3780/02)		1.4		V
	2	I_L = 10 mA (PBL 3780)		3.0		V
	2	I_L = 10 mA(PBL 3780/02)		3.2		V
	2	I_L = 100 mA		8.5		V
		R_8 = 75 ohm				
	2	I_L = 2.5 mA		1.5		V
	2	I_L = 10 mA		3.5	3.9	V
	2	I_L = 100 mA		11.5	13.6	V
DTMF section I_L typ. 13 mA (PBL 3780) I_L typ. 10.5 mA (PBL 3780/02)						
Tone level accuracy , V_2	2	(Adjustable with R4, R6)	-2		+2	dB
Tone level ratio, high/low group	2		1	2	3	dB
Keyboard resistance	4	Contact switch ON			1	kohms
	4	Contact switch OFF	200			kohms
Total harmonic distortion,V_2	2				-31	dBm
Harmonics ,V_2	2	300-3400 Hz			-33	dBm
	2	3.4 kHz-50 kHz			note 1	dBm
	2	50 kHz-100 kHz			-80	dBm
Start-up time	2	Output level within 1 dB from final level		3	5	ms
Output frequency error, Δf_n	6	f_{osc}=3.5795 MHz				
Low group, f_1	6	697 Hz	-1	-0.33	+1	%
f_2	6	770 Hz	-1	+0.02	+1	%
f_3	6	852 Hz	-1	+0.03	+1	%
f_4	6	941 Hz	-1	-0.11	+1	%
High group, f_5	6	1209 Hz	-1	-0.03	+1	%
f_6	6	1336 Hz	-1	-0.03	+1	%
f_7	6	1477 Hz	-1	-0.68	+1	%
f_8	6	1633 Hz	-1	-0.36	+1	%
Debounce	2		1.5		3.7	ms
DC current to external microprocessor,I_{DC}	7	Adjustable	0.3		2.5	mA

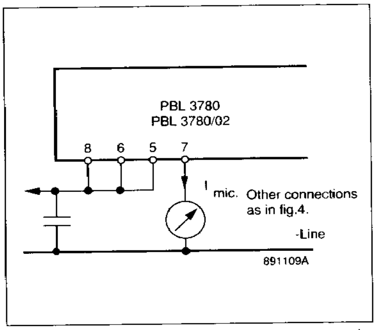


Figure 5. Testing DC current for external microphone amplifier.

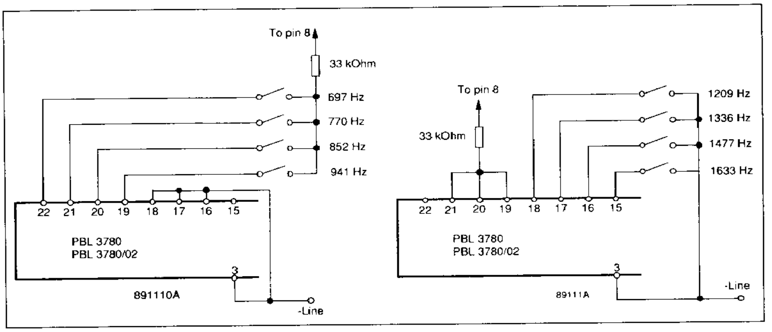


Figure 6. Generating single DTMF tones.

Parameter	Ref fig.	Conditions	Min	Typ	Max	Units
Tone Ringer Generator						
Tone frequencies	8	I_{Pin}14 ≥ 2 mA DC		732/894		Hz
Shift rate	8			6		Hz
Speech Circuit Section						
Maximum Transmitting gain, V_2, V_3		20 • log(V2/V3), f = 1 kHz				
	2, 4	R_L = 0 ohm, R_5 = 3.2 kohm, R_6 = ∞, R_8 = 47 ohm			57	dB
	2, 4	R_L = 900 ohm, R_5 = 3.2 kohm, R_6 = ∞, R_8 = 47 ohm			62	dB
Transmitting gain, V_2, V_3	2	20 • 10 log(V2/V3) f = 1 kHz, (Adjustable with R_5 and R_6)				
		R_L = 0 ohm	41	43	45	dB
		R_L = 400 ohms	43.5	45.5	47.5	dB
		R_L = 900 ohms	46	48	50	dB
Transmitting gain range of regulation	2	f = 1 kHz R_L = 0 to 900 ohms	3	5	7	dB
Transmitting frequency response	2	200-3400 Hz	-1		+1	dB
Maximum receiving gain, V_4, V_1	2	20 • log(V_4/V_1), f = 1 kHz				
		R_L = 0 ohm, R_{14} = ∞			-8	dB
		R_L = 900 ohm, R_{14} = ∞			-3	dB
Receiving gain, V_4, V_1		20 • log(V_4/V_1) f = 1 kHz, (Adjustable with R_{14})				
	2	R_L = 0 ohm	-18.5	-16.5	-14.5	dB
	2	R_L = 400 ohms	-16	-14	-12	dB
		R_L = 900 ohms	-13.5	-11.5	-9.5	dB
Receiving gain range of regulation	2	f = 1 kHz, R_L = 0 to 900 ohms	3	5	7	dB
Receiving frequency response	2	200-3400 Hz	-1		+1	dB
Input impedance, microphone amplifier	2, 4	f = 1 kHz		2.5//1.8		kohms
Transmitter dynamic output level, V_2	2	200-3400 Hz, THD ≤2%, I_L = 20-100 mA		1.5		V_{Peak}
Transmitter maximum output level, V_2	2	200-3400 Hz, I_L=0-100 mA, V_3=0-1 V		3.5		V_{Peak}
Receiver output impedance	2, 4	f = 1 kHz		6(+310)		ohms
Receiver dynamic output level, V_4	2	200-3400 Hz, THD ≤ 2% I_L = 20-100 mA		0.5		V_{Peak}
Receiver maximum output level, V_4	3	200-3400 Hz, I_L = 0-100 mA, V_1 = 0-50 V		1		V_{Peak}
Transmitter noise level V_2	2	Psophometric weighted relative to 1 V_{rms}, R_L=0		-70		dB

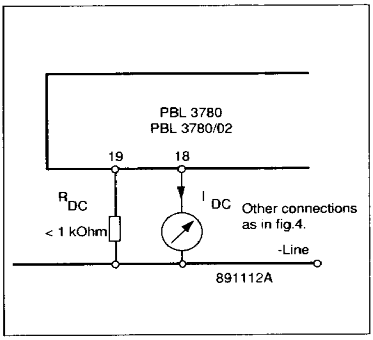


Figure 7. Testing DC current for external microprocessor.

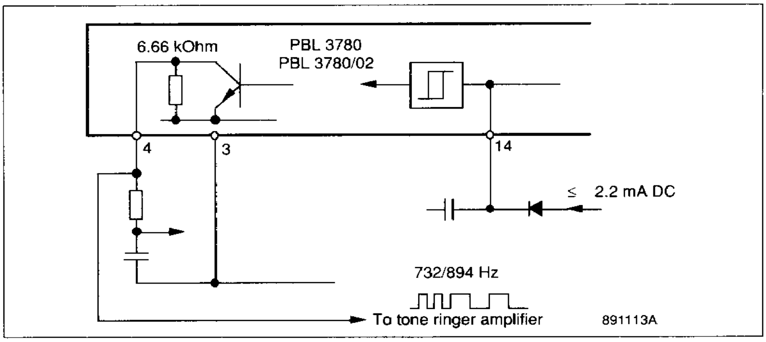


Figure 8. Toneringer function

Parameter	Ref fig.	Conditions	Min	Typ	Max	Units
Receiver noise level ,V_4	2	A-weighted, relative to 1 V_{rms}, with articel cable: 0-5 km, Ø=0.5 mm 0-3 km, Ø=0.4 mm		-80		dB
DC current to external microphone amplifier I_{Mic}	5	Pins 5 and 6 to 8, I_L=10-150 mA, DC-current at pin 7	300			µA
Receiver mute current $I_{REC\ mute}$ Pin 14	4	Line current=10 mA	250			µA
		Line current=100mA	350			µA

Warning. It is important to use a receiver which is not too sensitive. Otherwise the internal clipping network will not function properly, and acoustic shocks may cause permanent damage to the human ear.

Pin Desciptions

Pin	Name	Function
1	X1, X2	Crystal terminals. The circuit is intended for operation with a standard 3.58 MHz TV crystal
2		or a ceramic resonator.
3	-L	The negative power terminal, connected to the line through a polarity guard diode bridge.
4	MFO/TRO	Output of the DTMF generator in the dialling mode. Also output of the tone ringer, when activated.
5 6	MI1, I2	Inputs of the microphone amplifier. The input impedance at these pins is approx. 2.5 kohms. Connecting pins 5 and 6 to pin 8, (+C) switched pin 7 (MO) to a current generator output, that sources about 300 uA for an external electret buffer amplifier.
7	MO	Output from the microphone amplifier. When electret microphones are used, this pin can be
8	+C	This pin is the positive power supply terminal for most of the circuitry (about 1 mA current consumption). The majority of the line current however, passes through the TO and +L pins (see below). The +C pin shall be connected to a decoupling capacitor, C1, of 47 to 100 uF.
9	TI	Input of the transmit amplifier.
10	TO	Output of the transmit amplifier. This pin is connected to a resistor R8 of 47 ohms to 100 ohms to -L, which in practice sets the DC series-resistance of the circuit. The output has a low AC output impedance, and the signal is used to drive a sidetone balancing network R9, R10, R11 and C7.
11	+L	Output of the DC-regulator and transmit amplifier. This pin is connected to the line through a polarity guard diode bridge.
12 13	RE1 RE2	Receiver amplifier output. The output is intended to drive low impedance receivers (>150 Ω for PBL 3780, >200 Ω for PBL 3780/02).
14	RI/TRI	Input of receiver amplifier which also is control input for the tone ringer function. In the normal speech mode, this input is connected through a coupling capacitor C6 for the receive signal. Input impedance is approx. 35 kohms. Forcing about 2 mA DC current into this initiates (and feeds) the tone ringer generator.
15		This pin is control input for the gain regulation circuitry.
15-18	C1-C4	Keyboard inputs for the high group of frequencies (column 1 to 4).
19-22	R1-R4	Keyboard inputs for the low group of frequencies (row 1 to 4).

When using the microprocessor interface of the DTM logic, pins 16 to 22 are used in the following way:

18	This pin will provide 0-3 to 3 mA DC current, for the DC supply of external devices.
19	Connecting a resistor of less than 1 kohms to -L (pin 3) sets the DTMF in the µP-interface mode. The resistor value will also determine the output current from pin 18.
16, 17,20, 21	Data inputs for a 4 bit code that determines the DTMF tone combination.
22	Latch control. When this input is low, the data register can be loaded with data. When high, theDTMF generator is activated and starts to generate the dialling tones.

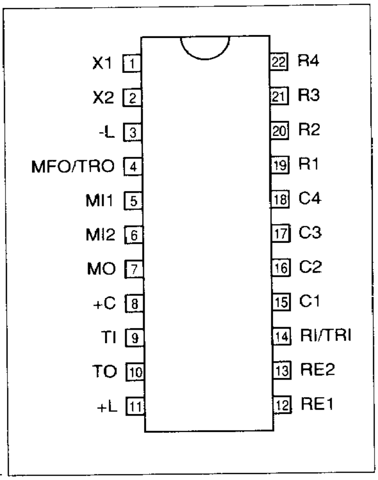


Figure 9. Pin configuration.

Functional Description

Speech circuitry and DC-regulator

The speech circuit section of PBL 3780, PBL 3780/02 contains a DC-regulator, a microphone amplifier, a transmit amplifier and a receiver amplifier.

The DC-regulator determines the voltage/current characteristics of the circuit. Looking from the line, the circuit acts as a reference voltage of approx. 2 Volts in series with a resistor (externally set). The voltage reference is derived from a bandgap reference, which provides temperature-stable DC-characteristics. To maintain operation even when the line voltage (inside polarity guard diode bridge) drops below 2 Volts, the circuit automatically switches to a lower reference voltage.

A microphone amplifier with a differential input stage, and hence good common mode rejection, is provided for low-sensitivity magnetic or dynamic microphones. The microphone amplifier is muted by DTMF logic during dialling.

The transmit amplifier receives its input signal either from the microphone amplifier or from a separate electret buffer amplifier (that can be powered directly from the circuit). The output stage contains the previously described DC-regulator. The AC-gain is regulated with the line length (selectable), and the output level is amplitude limited to eliminate sidetone distortion at high transmitting levels.

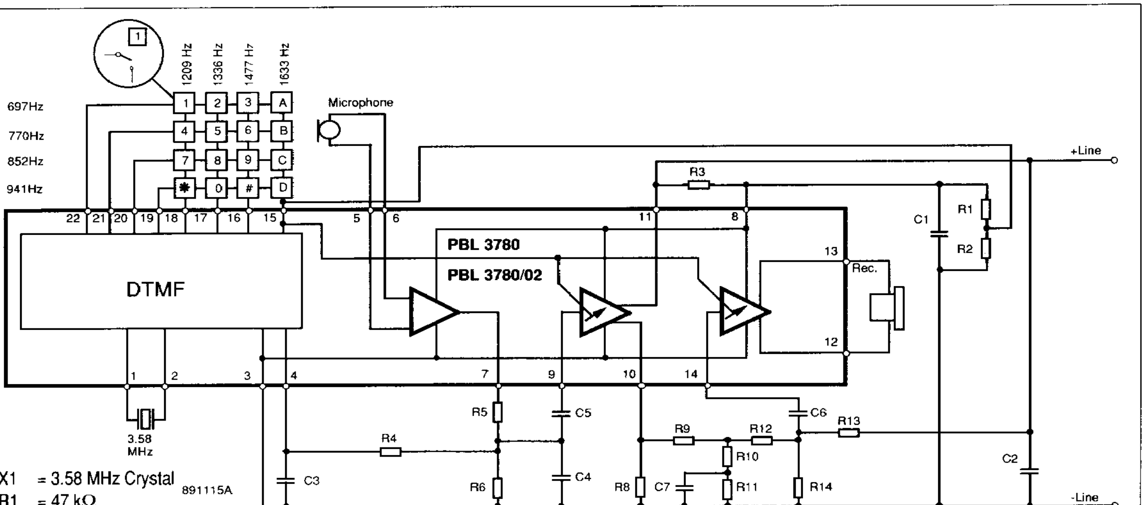
The sidetone cancellation (hybrid function) works as follows: A signal, opposite in phase from the transmit signal on the line, is taken from the transmit amplifier and fed through a sidetone balancing network into the summing junction of the receiver amplifier. There the signal is mixed with a signal taken from the line, and since the two transmit signals are opposite in phase, they will cancel each other. Only the receive signal, together with a much weaker sidetone signal, is left at the input of the receiver amplifier. The sidetone level will be dependent on the line characteristics.

The AC-gain of the receiver amplifier may be regulated with the line length. The output from the receiver amplifier is intended to drive low-impedance receivers. An internal clipping network limits the signal to the receiver, and thus prevents acoustic shocks. During dialling, the DTMF tones are monitored in the receiver. The level can be adjusted by external resistors.

DTMF section

The DTMF oscillator uses a standard 3.58 MHz TV crystal, or a ceramic resonator to digitally synthesize all frequencies.

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 tones will be generated if two keys are pressed. Single tones (for testing) can be produced by a very simple arrangement.



X1 = 3.58 MHz Crystal
R1 = 47 kΩ
R2 = 36 kΩ
R3 = 900 Ω
R4 = 19.6 kΩ (3780), 30.1 kΩ (3780/02)
R5 = 9.6 kΩ (3780), 11 kΩ (3980/02)
R6 = 4.7 kΩ
R8 = 75 Ω
R9 = 240 Ω (3780), 300 Ω (3780/02)
R10 = 47 Ω (3980), 82 Ω (3780(02)
R11 = 820Ω
R12 = 6.2 kΩ
R13 = 62 kΩ
R14 = 8.7 kΩ (3780), 8.2 kΩ (3780/02)
C1 = 68 μF
C2 = 15 nF
C3 = 12 nF
C4 = 6.8 nF
C5 = 68 nF
C6 = 47 nF
C7 = 0.22 μF

Characteristic:The circuit is intended for dynamic microphones and receivers. DTMF tone output levels are -6 dBm and -8 dBm. Good return loss against both 600 ohms and 900 ohms line impedances.

Figure 10. Telephone design for 48V, 2x400Ω battery feeding systems.

All keyboard inputs are protected against short interruptions by a debounce circuit.

The DTMF generator may be controlled by a repetrory dialler, such as Ericsson Components' PBM 3915 or a microprocessor. An internal 4 bit register with latch can be loaded with data (that determines the DTMF tone combinations) using the ordinary keyboard input pins. An on-chip current generator facilitates the powering of external devices. The output amplitude from the DTMF generator is stabilized against variations in temperature and line current.

There is a fixed 2 dB pre-emphasis on the tones from the high group of frequencies.

To fulfil the CEPT CS203 specifications on harmonic distortion, two capacitors and one resistor are required for filtering. In many cases however, only one capacitor is sufficient. The filtered signal from the DTMF generator is transmitted to the line by the transmit amplifier.

Tone ringer

By using the oscillator and counter logic of the DTMF generator, a tone ringer signal can be produced without the need for additional RC networks. The tones produced shift between two pre-determined frequencies (732 and 894 Hz) at 6 Hz rate. The signal appears at the output of the DTMF generator, and needs to be amplified before being applied to an acoustic transducer (loudspeaker or piezo element), see figure 8.

Applications Information

Using the PBL 3780, PBL 3780/02 in a telephone design makes it possible to adjust the basic transmission parameters almost independently of each other. DC-characteristics, gain and frequency responses are determined simply by selecting the values of a few external components. Figure 10 shows a typical design. Only a polarity guard diode bridge and a zenar diode need to be added to form a complete telephone with DTMF dialling. The component values chosen suit a feeding system of 48 V, 2 x 400 ohms.

Starting with this design, it is very straightforward to modify the circuit provided that the adjustments are made in the correct order:

1 Impedance to the line
2 DC-characteristics
3 Microphone selection, transmitting gain and frequency response
4 DTMF levels
5 Gain regulation
6 Sidetone level, receiving gain and frequency response
7 DTMF interfacing
8 Protection and interference suppression

Impedance to the line

Since the transmitter amplifier of PBL 3780, PBL 3780/02 has a high-impedance output stage for speech signals, the impedance seen from the line is set directly by R3, C1 and C2. C1 is a decoupling capacitor in the DC-feedback loop of the regulator and should be large enough to prevent distortion at low frequencies. When power is applied, C1 is charged rapidly to give a fast turn-on. If C1 is large, C2 and R3 effectively determines the impedance to the line. C2 also suppresses radio signals that may be picked up by the line and cause interference. C1 has the additional function of stabilizing the DC-voltage at pin 8, which is the supply terminal for most of the circuitry inside PBL 3780, PBL 3780/02. The suggested values of R3, C1 and C2 in figure 10, gives a good return loss against line impedance of both 600 ohms and 900 ohms in parallel with 30 nF.

DC-characteristics

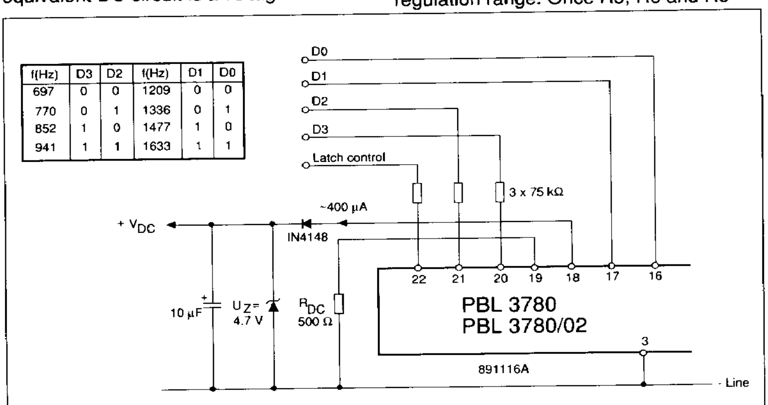
For line currents above 10 mA, the equivalent DC circuit is a voltage reference of approx. 2 V in series with a resistor (R8). The minimum working voltage is around 1.3 V which corresponds to 2.5 mA line current with R8 = 47 ohms.

R8 effectively determines the DC-resistance of the circuit, and it will consume most of the supplied power. The value of R8 should be selected to give a safe DC-operating point at very short line lengths. It should be large enough to limit the maximum current, but low enough to keep the voltage across the circuit down. R8 will also determine the slope of the gain regulation in the amplifiers. Suitable values are from 47 to 100 ohms, depending on the battery feeding system.

Microphone selection, transmitting gain and frequency response

The microphone amplifier inside PBL 3780, PBL 3780/02 is intended to be used for low sensitivity, dynamic or magnetic type of microphones and will provide about 26 dB voltage gain. A differential input stage (at pins 5 and 6) gives good common mode rejection. The input impedance is approx. 2.5 kohms. Dynamic microphones are normally connected directly to the the input terminals, while a magnetic type may require an additional loading resistor as shown in figure 9. The microphone amplifier is switched off during dialling (muting).

R5, R6 and R4 form a voltage divider which, once R8 is set, will determine the overall gain in the transmit path. The values in figure 10 give a typical transmitting gain of 43 to 48 dB over the regulation range. Once R5, R6 and R8



f(Hz)	D3	D2	f(Hz)	D1	D0
697	0	0	1209	0	0
770	0	1	1336	0	1
852	1	0	1477	1	0
941	1	1	1633	1	1

Figure 11. Microprocessor interface connections and DC supply.

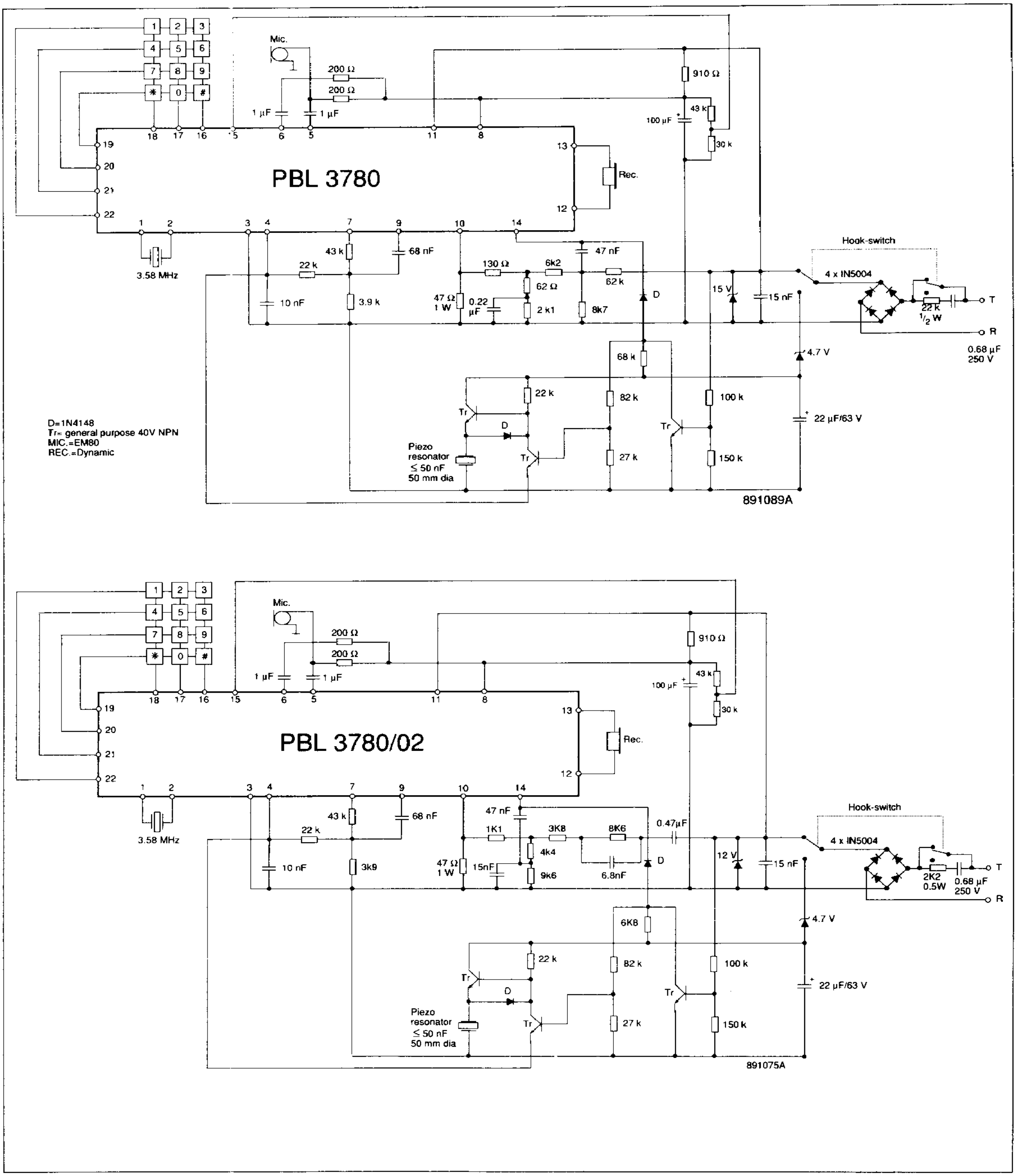


Figure 12. Complete telephone with tone ringer for 48V, 2 x 200 ohm battery feeding systems (U.S.A.).

are set, R4 will determine the levels from the DTMF generator.

The values of R4, R5 and R6 should be chosen to give about 3 kohms drive impedance at the input terminal of the transmit amplifier. C5 is a coupling capacitor that shall be inserted to give a low-frequency roll-off, while C4 gives high-frequency roll-off (if needed).

Electret microphones usually have higher output amplitude than dynamic ones, and can therefore be connected directly to the transmit amplifier input. Since the output signal from the microphone then may be mixed with the DTMF tones during dialling, it is recommended to use the internal current generator of PBL 3780, PBL 3780/02 for powering the electret buffer amplifier. The current generator gives around 300 µA at pin 7, and is selected by connecting the input terminals of the microphone amplifier to pin 8. The current will automatically be switched off during dialling.

DMTF Levels

The levels from the DTMF generator can be adjusted by R4. There is a 2 dB fixed ratio between the tones from the high and low group. The amplitudes are stabilized against variations in temperature and line current. To achieve line current independent levels, the gain regulation in the transmit amplifier is switched off during dialling. C3 (10-12 nF) and the output impedance of the DTMF (6.66 kohms) form a low-pass filter that reduces harmonic distortion. A capacitor C4 needs to be added to give further rejection of harmonics to meet the CEPT requirements. Using the values of R4 and R8 given in figure 10 the amplitude of the high and low group tones will be -6dBm and -8dBm respectively.

Gain regulation

The amount of gain in the transmit and receiver amplifiers can be varied over a range of 5 dB by a DC control voltage at pin 15. This function is used for automatic gain adjustments to compensate for losses on long lines. R1 and R2 set the starting point for the regulation. The control voltage is taken from pin 8, which is an accurate measure of the line current and thus the line length. The slope of the regulation curve is determined by R8.

Since pin 15 also is input terminal for the keyboard, R1 and R2 must give a correct drive impedance. 20 kohms is recommended. If the gain regulation must be disabled, 100 kohms to pin 2 or 47 kohms to pin 8 will set the gain of the transmit and receive-amplifier to its minimum or maximum value respectively.

Sidetone level, receiving gain and frequency response

The input signal to the receiver amplifier, is taken from two sources. The signal from the line, which is attenuated by R13 and R14, and a signal from the transmitter which is fed through a sidetone balancing network, consisting of R9, R10, R11 and C7.

A practical sequence for determining the components in the sidetone network and the receiving path is given in the following text. Observe that some iterations and experimental work usually have to be carried out to find an optimum solution.

1. The sidetone network consist of R9, R10, R11 and C7. R9 should not be too small compared with R8. The actual balancing network consisting of R10, R11 and C7, simulates a first order approximation of the drive and line impedances. The values given in figure 10 correspond to a compromise between a 0.4 mm and 0.5 mm cable used in a typical local network.
2. The ratio between R13 and R12 is set to make the signals coming from the line and the sidetone network equal, thus cancelling each other. The value of R12 should be about an order of magnitudeof the sidetone network.
3. R14 is set to give the desired receiving gain. The values of R12, R13 and R14 given i figure 10 is a good starting point in most cases.
4. The sidetone network may then have to be adjusted, by changing the values of R10, R11 and C7.
5. Finally, R14 is adjusted to give the exact receiving gain.

A coupling capacitor C6 at the input of the receiver amplifier is needed for low-frequency roll-off. Input impedance is approx. 35 kohms. The output stage is balanced for good driving capabilities, even at low supply voltages. It is intended to drive low impedance receives. A resistor R15 of 310 ohms is inserted when magnetic types are used. Internal clamping diodes prevent excessive acoustic shocks. During dialling, the receiver amplifier is switched off but the tones will be monitored in the receiver since internal resistors are connected between pin 13 and the -Line, (pin 3) and pin 12 and +Line (pin 11). The monitoring signal may be balanced out, by connecting two additional resistors of approx. 47 kohms between pins 13 and 11, and pins 12 and 3.

DTMF interfacing

The DTMF generator uses a single contact, matrix-type keyboard as shown in figure 4. The contact resistance must be lower than 1 kohms (contact switch on), and higher than 200 kohms (contact switch off). A debounce function on all keyboard inputs, prevents false triggering on short interruptions from the keyboard switches.

The DTMF inputs can be selected to interface directly with a microprocessor. As shown in figure 11, the microprocessor mode is selected by connecting a resistor, RDC of less than 1 kohms (500 ohms suggested value) between pin 19 and pin 3 (ground and -Line).

With RDC set to 500 ohms, pin 18 will provide approximately 400µA for an external device, but if necessary, up to 2.5 mA can be supplied by lowering the value of RDC. However, at currents greater than 400µA excessive distortion may occur if the voltage between pin 11 and pin 18 is too low.

The four bit data port consist of pins 16, 17, 20 and 21. Pin 22 is a latch control, when low, data can be loaded into the port. When pin 22 goes high, the data is latched and the DTMF generator produces the tones corresponding to the latched data.

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 11. Protection against voltage transients from the line must be applied. A 15 V zener diode such as 1N4744 and a series resistor of 5-10 ohms is sufficient in most cases. Radio interference is suppressed by a 15nF capacitor in paralell with the zener diode. Care must be taken to avoid radio signal pickup from parts of the circuits especially from the wires to the handset. Ceramic decoupling capacitors may be needed. Ground loops and long tracks on the PC board should be avoided.

Ordering Information

Package	Temp. Range	Part No.
Plastic DIP	-20 to 70°C	PBL 3780N
Plastic DIP	-20 to 70°C	PBL 3780/02N

Specifications subject to change without notice.

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