

PBL 38582

Telephone Line interface circuit for DECT, DAM, CT

Unisolated or Isolated

Description

PBL 38582 is a monolithic bipolar integrated circuit for use as telephone line interface in unisolated or isolated DECT and other cordless telephone residential base stations and in analog / digital answering machines or as second line in an unisolated DECT telephone base station.

Transmit and receive gains are set by external components. On / Off switchable gain, related to line, regulation for different current feeds can be set by external resistors. Typical current feeds as 48 V, 2 • 200 ohm, 48 V 2 • 400 ohm and 60 V 2 • 600 ohm can be handled. Application dependent parameters such as line balance, impedance to the line and frequency response are set by external components. Parameters are set independently which results in an easy adoption for various market needs.

Key Features

- Minimum number of inexpensive external components, 5 capacitors and 4 resistors.
- Current range
5 - 130 mA(DIL),
5 - 100 mA(20-pin SO)
5 - 70 mA(16-pin SO) 385 82/2
- Operation voltage range down to 2 V.
- Short start-up time.

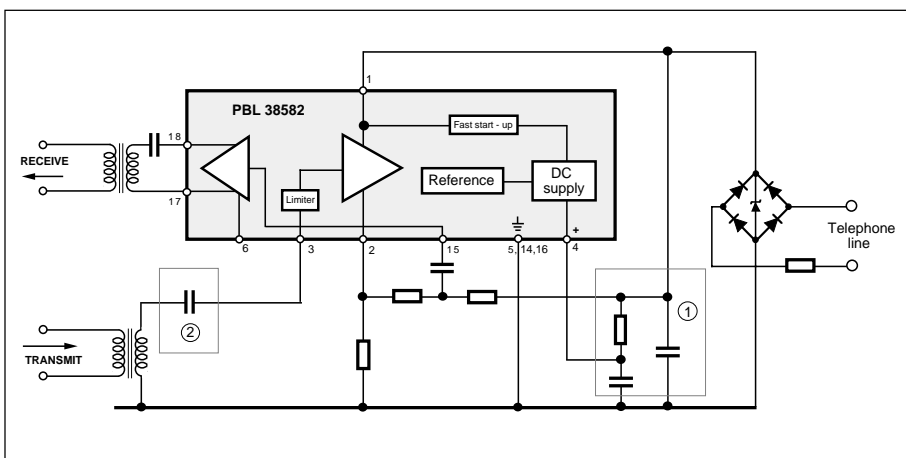
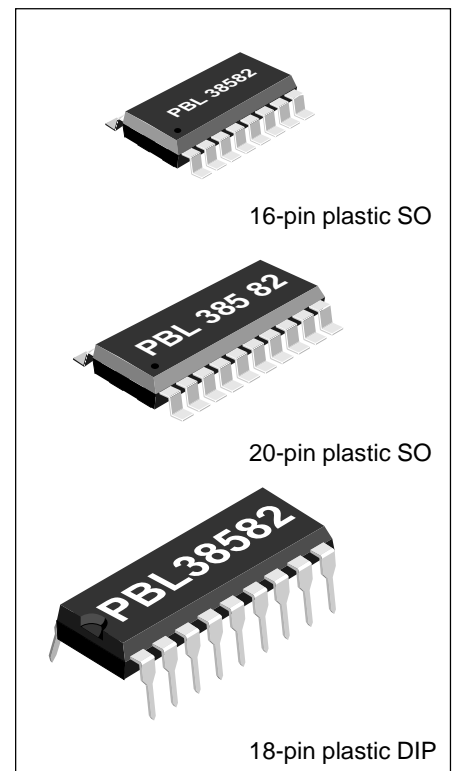


Figure 1. Functional diagram. DIP package.



Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Line voltage, $t_p = 2$ s	V_L	0	18	V
Line current, continuous DIP	I_L	0	130	mA
Line current, continuous SO-20 package	I_L	0	100	mA
Line current, continuous SO-16 package	I_L PBL 38582/2	0	70	mA
Operating temperature range	T_{Amb}	-40	+70	°C
Storage temperature range	T_{Stg}	-55	+125	°C

No input should be set on higher level than pin 15.(+C)

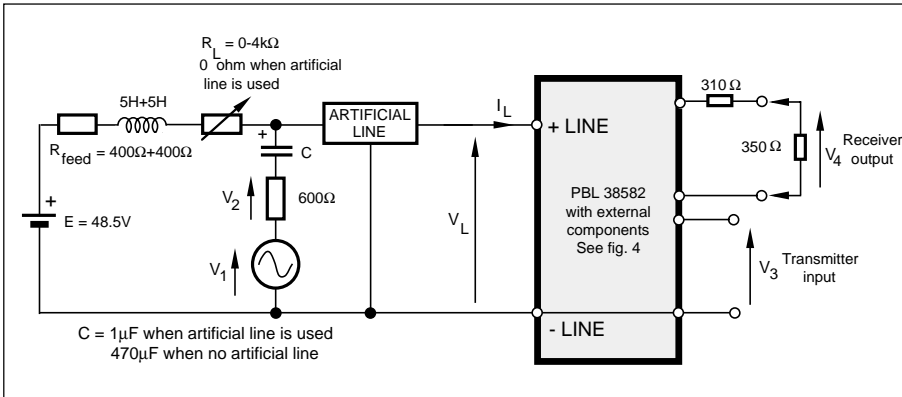


Figure 2. Test set up without rectifier bridge.

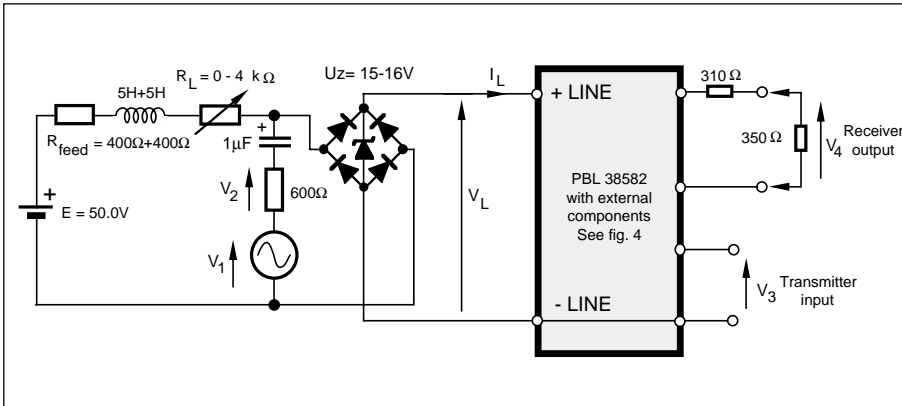


Figure 3. Test set up with rectifier bridge.

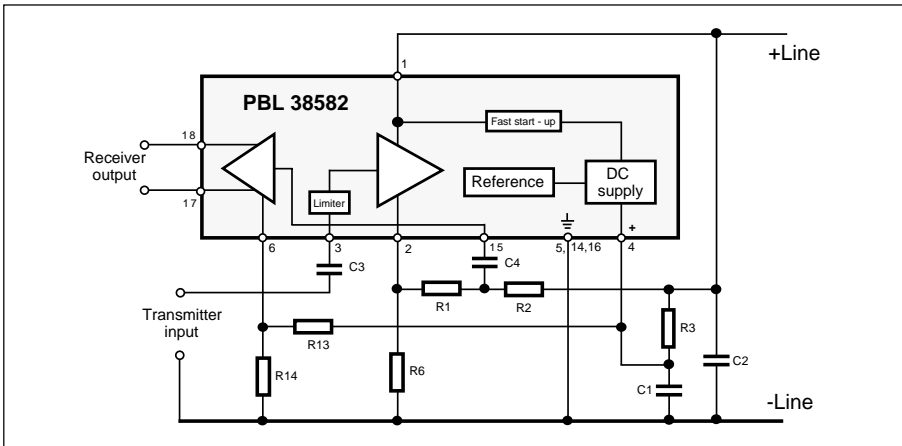


Figure 4. Circuit with external components for test set up.

- $R1 = 6.2\text{ k}$
 - $R2 = 62\text{ k}$
 - $R3 = 909\ \Omega$
 - $R6 = 75\ \Omega$
 - $R14 = 10\text{ k}$
 - $C1 = 68\ \mu\text{F}$
 - $C2 = 15\ \text{nF}$
 - $C3 = 0.1\ \mu\text{F}$
 - $C4 = 47\ \text{nF}$
- DIP package pinning.

Electrical Characteristics

At $T_{Amb} = +25^{\circ}C$. No cable and no line rectifier unless otherwise specified.

$I_L = 100\text{ mA}$ is not valid for 16-pin SO package.

Parameter	Ref.fig.	Conditions	Min	Typ	Max	Unit
Line voltage, V_L	2	$I_L = 15\text{ mA}$	3.3	3.7	4.1	V
	2	$I_L = 100\text{ mA}$	11	13	15	V
Transmitting gain		$20 \cdot 10 \log (V_2 / V_3)$; 1 kHz	24	25	26	dB
Transmitting frequency response	2	200 Hz to 3.4 kHz	-1		1	dB
Transmitter dynamic output	2	200 Hz - 3.4 kHz $\leq 2\%$ distortion, $I_L = 20 - 100\text{ mA}$		1.5		V_p
Transmitter maximum output	2	200 Hz - 3.4 kHz $I_L = 0 - 100\text{ mA}$, $V_3 = 0 - 1\text{ V}$		3		V_p
Transmitter output noise	2	Psof-weighting, Rel 1 V_{rms} , $R_L = 0$		-75		dB _{Psof}
Transmitter input impedance pin 3	2	1 kHz	13.5	17	20.5	kohm
Receiving gain		$20 \cdot 10 \log (V_4 / V_1)$; 1 kHz				
Without gain regulation	2	$R_L = 0 - xxx\text{ ohm}$, R11= 10k	-18.5	-16.5	-14.5	dB
Receiving gain		$20 \cdot 10 \log (V_4 / V_1)$; 1 kHz, R11 not used				
With gain regulation	2	$R_L = 0\text{ ohm}$,	-18.5	-16.5	-14.5	dB
	2	$R_L = 400\text{ ohm}$	-16	-14	-12	dB
	2	$R_L = 900\text{ ohm} - 2.2\text{ kohm}$	-13.5	-11.5	-9.5	dB
Receiving range of regulation	2	1 kHz, $R_L = 0$ to 900 ohm	3	5	7	dB
Receiving frequency response	2	200 Hz to 3.4 kHz	-1		1	dB
Receiver output impedance	2	1 kHz, without 310 Ω resistor		3		ohm
Receiver dynamic output note 1	2	200 Hz - 3.4 kHz $\leq 2\%$ distortion, $I_L = 20 - 100\text{ mA}$		0.5		V_p
Receiver maximum output	3	Measured with line rectifier 200 Hz - 3.4 kHz, $I_L = 0 - 100\text{ mA}$, $V_1 = 0 - 50\text{ V}$		0.9		V_p
Receiver output noise	2	A-weighting, Rel 1 V_{rms} , with cable 0 - 5 km, $\varnothing = 0.5\text{ mm}$, 0 - 3 km, $\varnothing = 0.3\text{ mm}$		-85		dB _A

Notes:

1. The dynamic output can be nearly doubled if the 310 Ω series resistor is omitted.

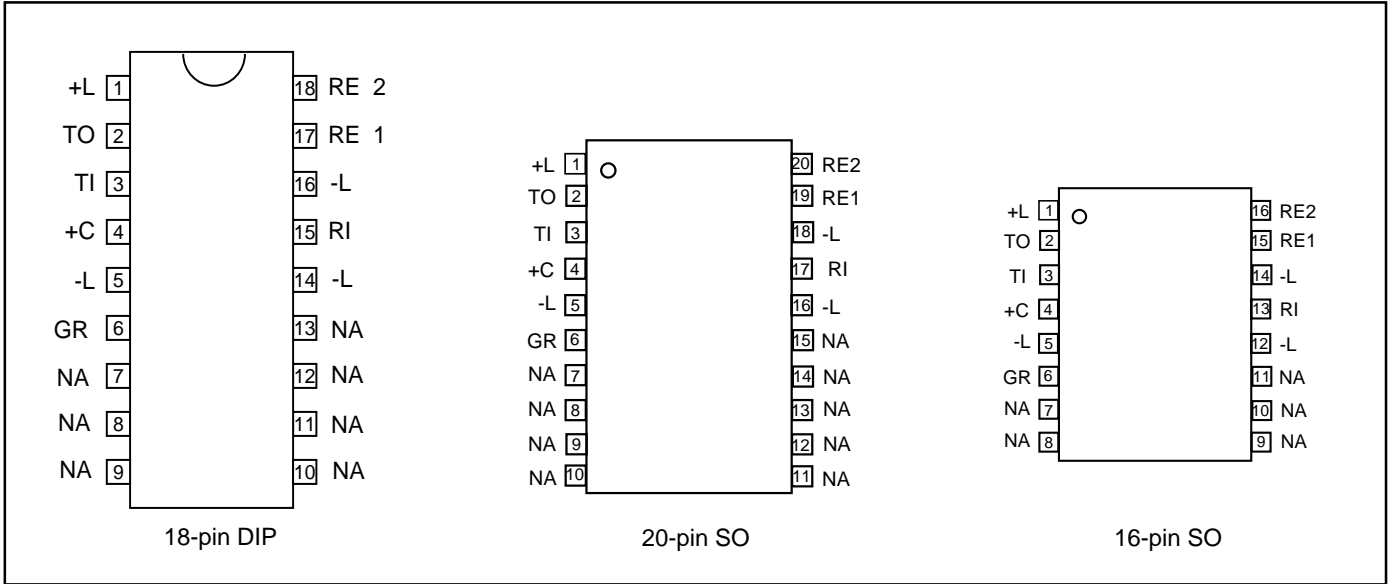


Figure 5. Pin configuration.

Pin Descriptions

Refer to figure 5.

DIP	SO 20	SO 16	Name	Function
1	1	1	+L	Output of the transmitter amplifier. Connected to the line through a polarity guard diode bridge.
2	2	2	TO	Output of the transmitter amplifier. Connected through a resistor of 47 to 100 ohm to -L. Sets the DC-characteristic of the circuit. The output has a low AC output impedance and the signal is used to drive a side tone balancing network.
3	3	3	TI	Input of transmit amplifier. Input impedance 17 kΩ ± 20 %.
4	4	4	+C	The positive power supply terminal for most of the circuitry inside the PBL 385 82 (about 1 mA current consumption). The +C-pin is to be connected to a decoupling capacitor of 47 μF to 150 μF.
6	6	6	GR	The control input for the gain regulation in the receiver.
5	5	5	-L	} The negative power terminal, connected to the line through a polarity guard diode bridge.
14	16	12		
16	18	14		
15	17	13	RI	Input of the receive signal amplifier. Input impedance is 38 kohm ± 20 %.
17	19	15	RE2	} The receive signal amplifier outputs. Output impedance is approximately 3 ohm.
18	20	16	RE1	
7	7	7	NA	
8	8	8	NA	
9	9	9	NA	
10	10	10	NA	
11	11	11	NA	
12	12		NA	
13	13		NA	
	14		NA	
	15		NA	

Functional description

Design procedure; ref. to fig.4.

The design is made easier through that all settable parameters are returned to ground (-line), this feature differs it from bridge type solutions. To set the parameters in the following order will result in that the interaction between the same is minimized.

1. Set the circuit impedance to the line, either 600Ω or complex. (R3 and C1). C1 should be big enough to give low impedance compared with R3 in the telephone speech frequency band. Too large C1 will make the start-up slow. See fig. 10.

2. Set the DC-characteristic that is required in the PTT specification or in case of a system telephone, in the PBX specification (R6). There are also internal circuit dependent requirements like supply voltages etc.

3. Set the attac point where the line length regulation (if used) is supposed to cut in. Note that in some countries the line length regulation is not allowed. In most cases the end result is better and more readily achieved by using the line length regulation (line loss compensation) than without.

4. Set the transmitter gain and frequency response.

5. Set the receiver gain and frequency response. See text how to limit the max. swing.

6. Adjust the side tone balancing network if used. The network in most cases is just a coarse resistive divider to take care of the first order of balancing. The fine balancing is done by the DSP in the system.

7. Set the RFI suppression components in case necessary.

8. Circuit protection. Apart from any other protection devices used in the design a good practice is to connect a 15V 1W zener diode across the circuit, from pin 1 to -Line.

Impedance to the line

The AC- impedance to the line is set by R3, C1 and C2. Fig.6. The circuits relatively high parallel impedance will not influence the line impedance to any noticeable extent. At low frequencies the influence of C1 can not be neglected. Series resistance of C1 that

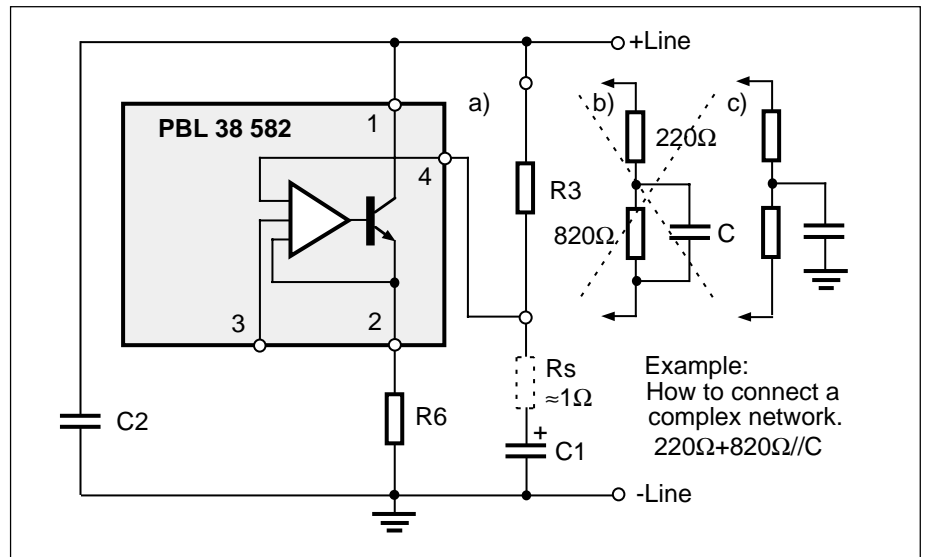


Figure 6. AC-impedance.

is dependent on the temperature and the quality of the component will cause some of the line signal to enter pin 4. This generates a closed loop in the transmitter amplifier that in it's turn will create an active impedance thus lowering the impedance to the line. The impedance at high frequencies is set by C2 that also acts as a RFI suppressor.

In many specifications the impedance towards the line is specified as a complex network. See fig. 6. In case a). the error signal entering pin 4 is set by the ratio $\approx R_s/R_3$ (909Ω), where in case b), the ratio at high frequencies will be $R_s/220\Omega$ because the 820Ω resistor is bypassed by a capacitor. To help up this situation the complex network capacitor is connected directly to ground, case c). making the ratio $R_s/220\Omega+820\Omega$ and thus lessening the error signal. Conclusion: Connect like in case c) when complex impedance is specified.

DC - characteristic

The DC - characteristic that a telephone set has to fulfill is mainly given by the network administrator. Following parameters are useful to know when the DC behaviour of the telephone is to be set:

- The voltage of the feeding system
- The line feeding resistance 2 x..... ohms.
- The maximum current from the line at zero line length.
- The min. current at which the telephone has to work (basic function).

- The lowest and highest voltage permissible across the telephone set.
- The highest voltage that the telephone may have at different line currents. Normally set by the network owners specification. The lowest voltage for the telephone is normally set by the voltages that are needed for the different parts of the telephone to function. For ex. for transmitter output amplifier, receiver output amplifier, dialler, speech switching. R6 will set the slope of the DC-char. and the rest of the level is set by some constants in the circuit as shown in the equation below. The slope of the DC-char. will also influence the line length regulation (when used) and thus the gain of both transmitter and receiver. See the table under gain regulation. R6 also acts as power protection for the circuit, this must be kept in mind when low values of R6 are considered. See fig. 7.

$$V_{Line} \approx 2 + 1.5 \cdot R6 \cdot I_{line}$$

$$V_{telephoneline} \approx 1.5 V + V_{line}$$

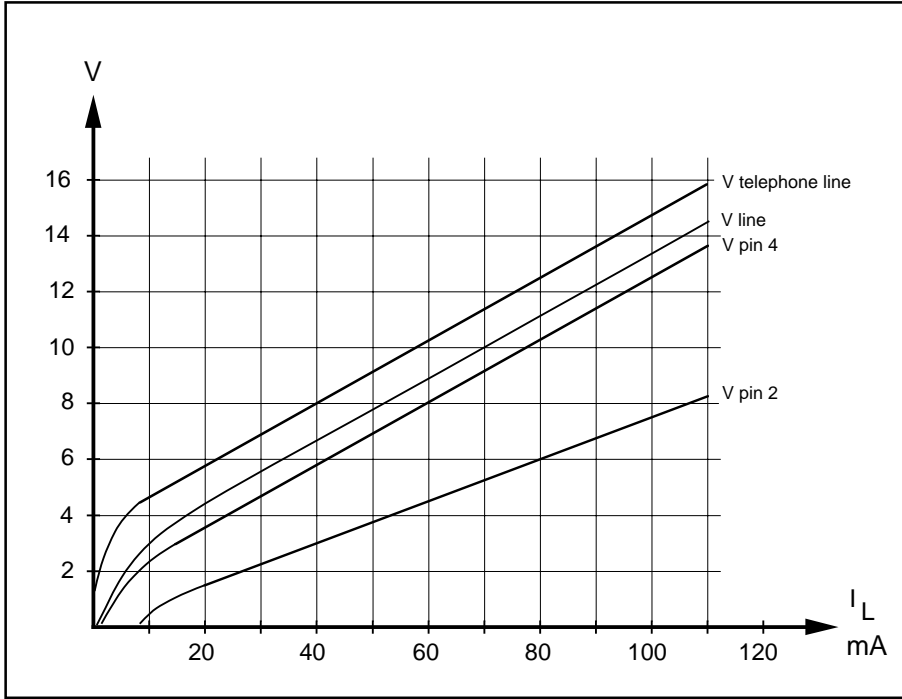


Figure 7. DC - characteristics. ($R_6 = 75\Omega$)

signal to the earphone and thus preventing an acoustical shock. A resistor in series with the output can very well be used to increase the protection level. Note, that the noise in the receiver is always transmitter noise that has been more or less well balanced out by the side tone network.

The RC - network (optional) at the output is to stabilize against the inductive load that an earphone represents.

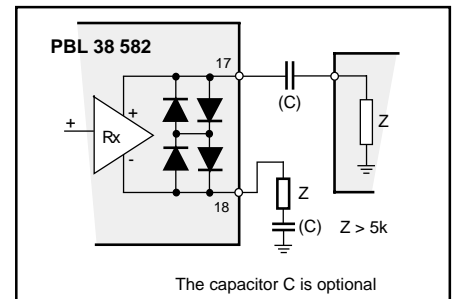


Figure 8. Unbalanced Rx loading.

Transmitter amplifier

The transmitter amplifier in PBL38582 consists of three stages. The first stage is an amplitude limiter for the input signal at TI, in order to prevent the transmitted signal to exceed a certain set level and cause distortion. The second stage amplifies further the signal from the first and adds it to a DC level from an internal DC-regulation loop in order to give the required DC characteristic to the telephone set. The output of this stage is TO. The third stage is a current generator that presents a high impedance towards the line and has its gain from TO to +L. The gain of this amplifier is Z_L/R_6 where Z_L is the impedance across the telephone line. Hence, the absolute maximum signal amplitude that can be transmitted to the line undistorted is dependent of R_6 . (amplitude limiting)

The transmitter gain is set by the analog (transmitter) signal from the pass-band circuit and the frequency response is set by the capacitors at input circuit at pin 3, the low end being influenced by C3 and the high end by C6. The input signal source impedance to the transmitter amplifier input TI should be reasonably low in order to keep the gain spread down.

Receiver amplifier

The receiver amplifier consists of three stages, the first stage being an input buffer that renders the input a high impedance. The second stage is a gain regulated differential amplifier and the third stage a balanced power amplifier. The power amplifier has a differential output with low DC- offset voltage, therefore a series capacitor with the load is normally not necessary. The receiver amplifier uses at max. swing 4-6 mA peak. This current is drawn from the +Line. The gain and frequency response is set at the input RI with a RC-network. The receiver gain can be regulated. The range of regulation from the input to the output is 5 ± 2 dB (19 to 24dB). The balanced earphone amplifier can not be loaded to full (both current and signal level) single ended. The signal would be distorted when returned to ground. A method is shown in fig.8 how to connect a light load (5k ac. or DC wise) to the output. It is preferred that both outputs are loaded the same. The receiver has, as a principal protection, two series diodes anti parallel across its output to limit the

Gain regulation.

The receiver is gain regulated (line loss compensated).

There is a fixed default compensation on the chip that can be adjusted or set to constant high or low gain mode. The input impedance at the gain regulation pin 6 is $5.5k \pm 20\%$. The default regulation pattern is valid when the input is left open. Fig. 9 shows a typical receiver gain pattern versus line length. The following will show, what to alter, to change the look of the curve.

- a). Adjustable with R12 for the receiver.
- b). The attack point of the regulator can be adjusted with resistors R13 or R14 to either direction, up or down, on the line current axis.
- c). The angle of elevation of the curve is mainly set by the value of R6. If the DC-characteristics is set according to the line parameters and a correct value for R6 is chosen the angle is mostly correct but it can be adjusted with R6. The adjustment will affect the DC-characteristics as well as most of the other parameters. This is why the DC-characteristic is set early in the design phase.

Battery feed	R13	R14	R6
Regulation:			
48V, 2 • 200Ω	∞	∞	47Ω
48V, 2 • 400Ω	∞	∞	75Ω
48V, 2 • 800Ω	∞	180k	100Ω
No regulation:			
Set for low gain			
All feedings	∞	<22k	47 - 100Ω
Set for high gain	18k	∞	47Ω
Set for high gain	22k	∞	75 - 100Ω

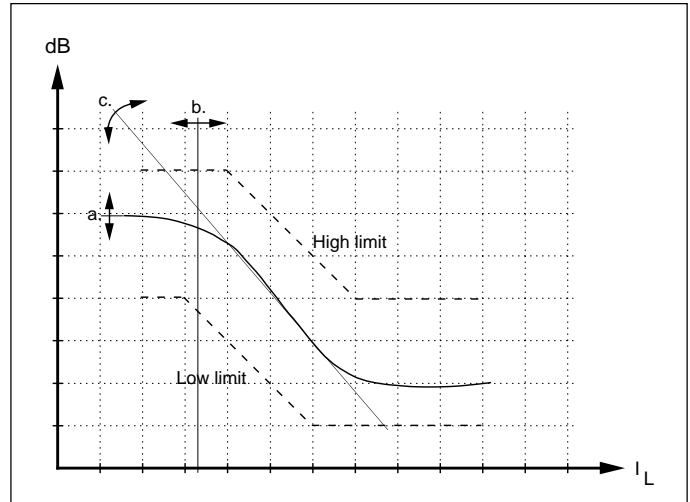


Figure 9. Gain regulation principle.

What is balancing the side tone?

To understand that side tone balancing is to counteract the signal, that is transmitted via the microphone and transmitter to the line, returning to the earphone via the receiver.

That presence of a strong side tone signal is disturbing in a way that one quite instinctively lowers ones own voice level thus lowering the signal level for the other party. But again, if the balance is too good (seldom the case) the earphone will feel "dead". In practical terms what is expected is the same amplitude of ones own voice in the ear as when not talking in a telephone. The need to lower the side tone level

where no balancing has been done is in the order of 6 - 12 dB.

To understand that the side tone is influenced by other factors like, the impedance of the line and the signal that enters the ear acoustically directly from the mouth and from the mouth through the material in the handset. The signal that enters the microphone from the earphone acoustically will also influence the return loss factor to the telephone line.

To understand that the side tone network can be trimmed to form a veritable "distortion analyser", so that the distortion that is present from the microphone, will be the only signal entering the earphone and this signal even being small will sound very bad. It is better to induce some of the fundamental frequency back by making

the balance less perfect at that frequency. This is valid for a network that is trimmed to only one frequency. It is to strive to trim the network such that it will attenuate the fundamental and the harmonic frequencies alike throughout the different line combinations.

To understand that if one of the two signals entering the balancing system from either direction, direct from microphone or via the line, is clipped, will result in a very distorted signal entering the receiver amplifier and thus the earphone. Further, to remember that side tone is a small signal that is the difference of two large signals and that the amplitude of the distortion can be up to ten times the amplitude of the fundamental frequency.

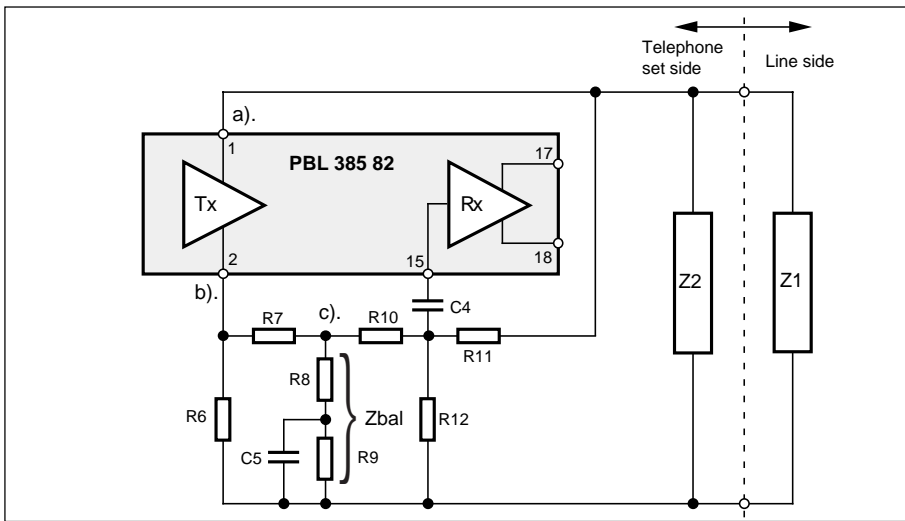


Figure 10. The side tone suppression principle.

A short guidance for understanding the side tone principle. (See fig. 10.)

Assuming the line impedance to be 600Ω. (theoretical value)
 Z1 = Line impedance
 Z2 = The telephone set impedance 600Ω
 $Z1 // Z2 = 300Ω$
 R6 will have a certain value 39 - 100Ω to give the telephone a specified DC-characteristic and overcurrent protection. Assuming that this DC-characteristic requires R6=60Ω, hence it will be 1/5 of the Z1//Z2. This will in transmitting mode result that 1/5 of the ac-signal that is on the line to appear across R6.

Note that the signals at points a. and b. are 180 degrees off phase.

$10 \times R6 \approx R7 + Z_{bal}$ Note #1
 $R7 \approx Z_{bal}$ Note#2

The ac-signal at point c. is now 1/10 of the signal on the line because it is further divided by two from point b. ($R7 \approx Z_{bal}$). Hence $10 \times R1 \approx R2$ to satisfy the balancing criteria. R12 is to set the receiver gain. (can also be a volume control potentiometer).

Note #1 These values ensure that the frequency behaviour of the transmitter is not influenced. With the ratio 1/10 the influence is 1 dB, and with ratio 1/20 it's 0.5 dB.

Note #2 If the R7 is made low ohmic compared with Z_{bal} , it will load the latter and result in a bad side tone performance, again if the R7 is made high ohmic compared with Z_{bal} will result in a

low signal to balance the side tone with and make the balancing difficult. Making any of the impedances unnecessary high will make the circuit sensitive to RFI. All values given here are approximate and serve as starting entities only. The final trimming of side tone network is a cut and try proposition because a part of the balance lies in the acoustical path between the microphone and earphone.

Start up circuit

The circuit contains a start up device which function is to fast charge capacitor C1 when the circuit goes into hook-off condition. The fast charge circuit is a thyristor function between pins 1 and 4 that will stop conducting when the current drain at pin 4 is lower than $\approx 700 \mu A$ + the

internal current consumption (about 1 mA). Care must be taken when connecting external load to pin 4 in order not to exceed the $\approx 700 \mu A$ limit. Should this happen, it would result in an inoperative speech funktion. This circuit can not retrigger before the voltage level at C1 drops below 2V or the line voltage is below 1V. See fig. 10.

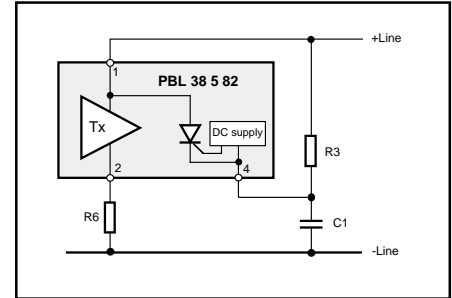


Figure 11. Fast startup function.

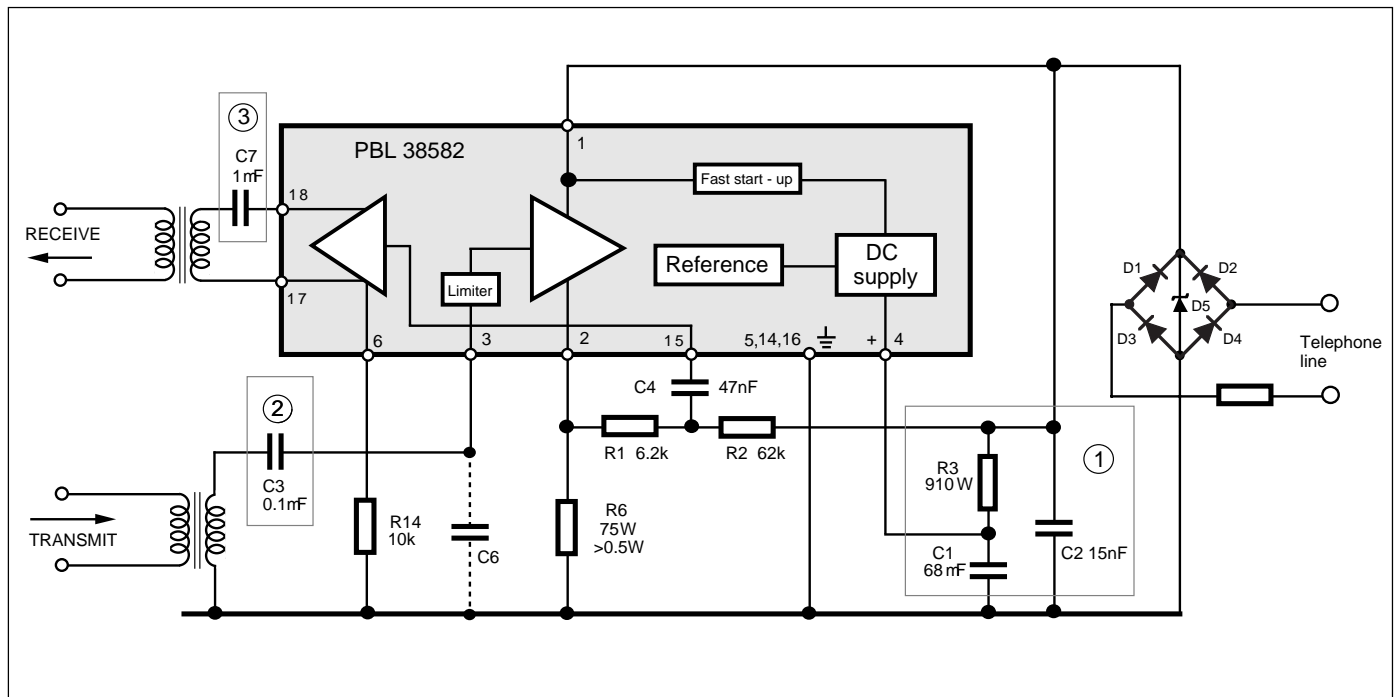


Figure 12. Typical insulated DECT-set line interface. DIP package.

Ordering Information

Package	Temp. Range	Part No.	
Plastic DIP	-40 to +70°C	PBL 385 82/1NS	
Plastic SO20	-40 to +70°C	PBL 385 82/1SOS	
Plastic SO20	-40 to +70°C	PBL 385 82/1SOT	Tape & Reel
Plastic SO16	-40 to +70°C	PBL 385 82/2SOS	
Plastic SO16	-40 to +70°C	PBL 385 82/2SOT	Tape & Reel

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