

PBL 3726/6 Universal Speech Circuit

Description

PBL 3726/6 is a standard version of the PBL 3726 family of mask-programmable, monolithic integrated speech circuits for use in electronic telephones.

It is designed for use with a low impedance microphone. Transmitting and receiving gain is regulated with line length. Different regulation for various current feeds can be set by external resistors. Typical current feeds as 48 V 2 x 250 ohm, 48 V 2 x 400 ohm and 36 V 2 x 500 ohm can be handled. Application dependent parameters like line balance, side tone level, amplification and frequency response are set by external components. Parameters are set independently which means easy adaption for various market needs. An on-chip amplifier can be used for different purposes for example to provide an additional 20 dB receiving gain with volume control or line regulated side tone balancing.

Key Features

- Minimum number of inexpensive external components, 5 capacitors and 12 resistors.
- Mute function for parallel operation with DTMF-generator.
- Transmit and receive gain regulation for automatic loop loss compensation.
- Side tone balance regulated with line length for good side tone level on all line lengths.
- Differential microphone input for good balance to ground. (Common mode rejection)
- Balanced receiver output stage.
- Amplifier for additional 20 dB receiving gain with volume control.
- Short start-up time.

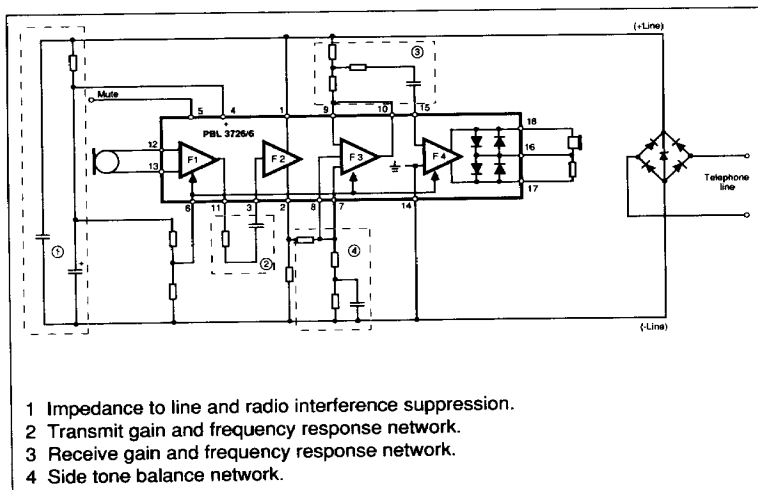
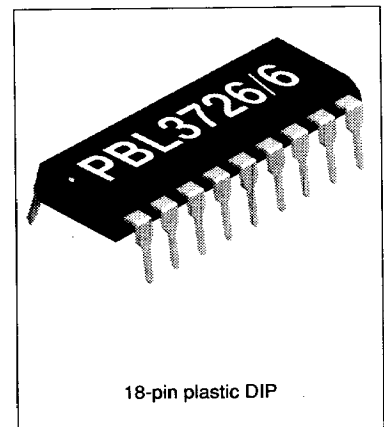


Figure 1. Functional diagram.



Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Line voltage, $t_p = 2\text{ s}$	V_L	0	22	V
Line current, continuous (see note 1)	I_L		100	mA
Operating temperature range	t_{Amb}	-40	70	$^{\circ}\text{C}$
Storage temperature range	t_{Stg}	-55	125	$^{\circ}\text{C}$

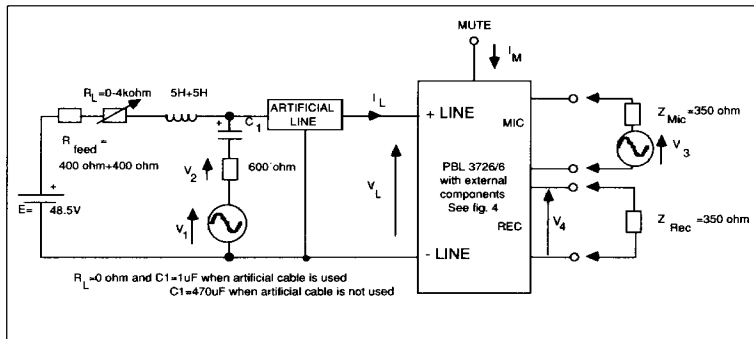


Figure 2. Test setup without rectifier bridge.

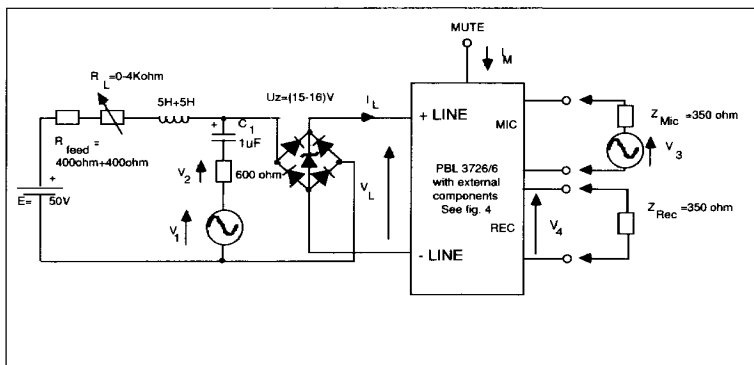


Figure 3. Test setup with rectifier bridge.

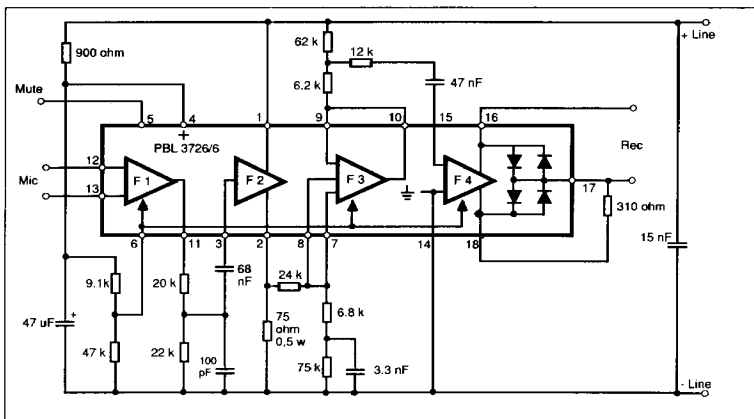


Figure 4. Circuit with external components for test-setup.

Electrical Characteristics

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

Parameter	Ref	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 (see note 2)		$20 \cdot \log(V_2/V_3); 1 \text{ kHz}$				
	2	$R_L = 0$	41	43	45	dB
	2	$R_L = 400 \text{ ohm}$	43.5	45.5	47.5	dB
	2	$R_L = 900 \text{ ohm}-2.2 \text{ kohm}$	46	48	50	dB
Transmitting range of regulation	2	1 kHz				
		$R_L = 0 \text{ to } 900 \text{ ohm}$	3	5	7	dB
Transmitting frequency response	2	200 Hz to 3.4 kHz	-1		1	dB
Receiving gain (see note 2)		$20 \cdot \log(V_4/V_1); 1 \text{ kHz}$				
	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				
		$R_L = 0 \text{ to } 900 \text{ ohm}$	3	5	7	dB
Receiving frequency response	2	200 Hz to 3.4 kHz	-1		1	dB
Microphone amplifier input impedance	2	1 kHz		1.1		kohm
Transmitter dynamic output	2	200 Hz-3.4 kHz		1.5		V_p
		$\leq 2\%$ distortion $I_L = 20-100 \text{ mA}$				
Transmitter max output	2	200 Hz-3.4 kHz		3		V_p
		$I_L = 0-100 \text{ mA}$ $V_1 = 0-1 \text{ V}$				
Receiver output impedance	2	1 kHz (see note 4)		3(+310)		ohm
Receiver dynamic output	2	200 Hz-3.4 kHz (see note 3)				
		$\leq 2\%$ distortion $I_L = 20-100 \text{ mA}$	0.5	0.55		V_p
Receiver max output	3	Measured with line rectifier		0.9		V_p
		200 Hz-3.4 kHz $I_L = 0-100 \text{ mA}$ $V_1 = 0-50 \text{ V}$				
Transmitter output noise	2	Psoph-weighting, Rel 1 V_{rms} $R_L = 0$		-75		dB
Receiver output noise	2	A-weighting, Rel 1 V_{rms}		-85		dB
		with cable, 0-5 km, $\varnothing=0.5 \text{ mm}$, 0-3 km, $\varnothing=0.4 \text{ mm}$				
Mute input current I_M	2		0.1			mA
Extra available current when muted at the same DC-voltage.	2	$I_L = 15-100 \text{ mA}$		10		mA

Note 1: Max current increases linearly up to 130 mA with max operating temperature lowered to $+55^{\circ}\text{C}$.

Note 2: Adjustable to both higher and lower values with external components.

Note 3: The dynamic output can be doubled. See application notes.

Note 4: External resistor in the test set up.

Pin Descriptions

Pin	Name	Function
1	+L	Output of the DC-regulator and transmit amplifier. This pin is connected to the line through a polarity guard and diode bridge.
2	TO	Output of the transmit amplifier. This pin is connected through a resistor of 56 to 100 ohm to -L, which sets the DC-resistance of the circuit. The output has a low AC output impedance and the signal is used to drive a side tone balancing network.
3	TI	Input of transmit amplifier.
4	+C	This pin is the positive power supply terminal for most of the circuitry inside the PBL 3726/6 (about 1 mA current consumption). The +C-pin shall be connected to a decoupling capacitor of 47 μ F to 150 μ F.
5	Mute	The mute input which requires min 100 uA to mute microphone and receiver amplifier.
6	GR	This pin is control input for the gain regulation circuitry.
7	AI 1	These pins are positive inputs to a line-length-controlled separate amplifier where at short lines pin 7 is active and at long lines pin 8 is active. Going from short lines to long lines input pin 7 is deactivated and input pin 8 is activated in a continuous way. When pin 8 and 7 are interconnected the amplifier is line length independent.
8	AI 2	
9	AI 3	This pin is a line length independent negative input to the separate amplifier.
10	AO	This pin is the output of the separate amplifier.
11	MO	Output of the microphone amplifier.
12	MI 1	Inputs to the microphone amplifier.
13	MI 2	Input impedance 1.1 kohm \pm 20 %.
14	-L	The negative power terminal, connected to the line through a polarity guard diode bridge.
15	RI	Input of receiver amplifier. Input impedance is approximately 38 kohm \pm 20%.
16	RE 3	Receiver amplifier outputs. Output impedance approximately 3 ohm. Pin 17 is only connected to the center tap of the amplitude limiting diodes. Connect a dynamic earphone to pin 16 and 18. Connect a magnetic earphone to pin 16 and 17 and connect a 310 ohm resistor to pin 17 and 18.
17	RE 2	
18	RE 1	

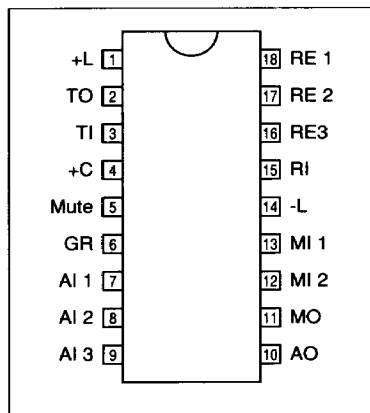


Figure 5. Pin configuration.

Functional Description

General

The gain of the transmitting and receiving amplifiers are continuously and equally changed with the line length. The starting point for the gain regulation is externally set. The gain regulation can be cut-off externally, and the gain will then be the maximum gain normally used at long lines.

The outputs of the transmitting and receiving amplifiers have internal limitations of the output amplitudes.

The circuit includes a temperature independent voltage reference used for regulation of the DC line voltage and for the transmitting and receiving gain regulation. At turn-on, the DC voltage settles rapidly to its final value with a minimum of overshoot.

The circuit uses a minimum of external components. In a normal, practical case only 5 external capacitors are needed, of which only one is an electrolytic or tantalum filter capacitor. The other capacitors are; radio interference suppression capacitor across the line, one capacitor in the side-tone balancing network and one capacitor for low frequency cut-off in each of the transmitting and receiving amplifiers. The frequency response is, except for that, flat for both amplifiers.

The circuit offers good return loss characteristics, both against purely resistive lines as for instance 600 ohm

and against complex networks such as 900 ohms in parallel with 30 nF.

The microphone input is balanced for good CMRR.

It is possible to add a push-button controlled cut-off of the transmitting amplifier to the circuit without any disturbance of the other circuit functions.

A mute input is included in the circuit. It gives:

1. Cut-off of the microphone amplifier. (F1).
2. Reduced gain in the receiving amplifier. (F4).
3. Power down to reduce the current consumption.

When mute signal is applied on the circuit it reduces its power consumption and adjusts the DC regulation accordingly.

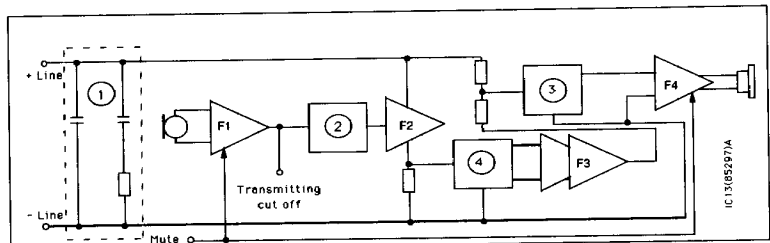


Figure 6. Block interconnections.

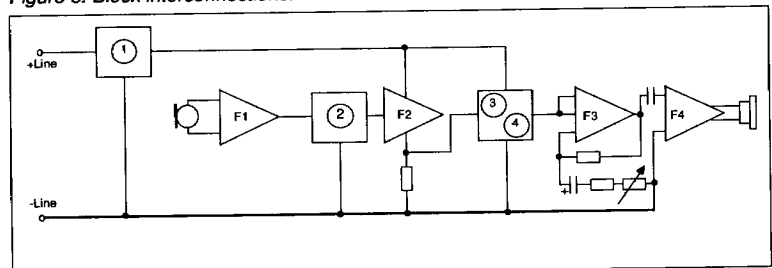


Figure 7. Alternative block interconnections.

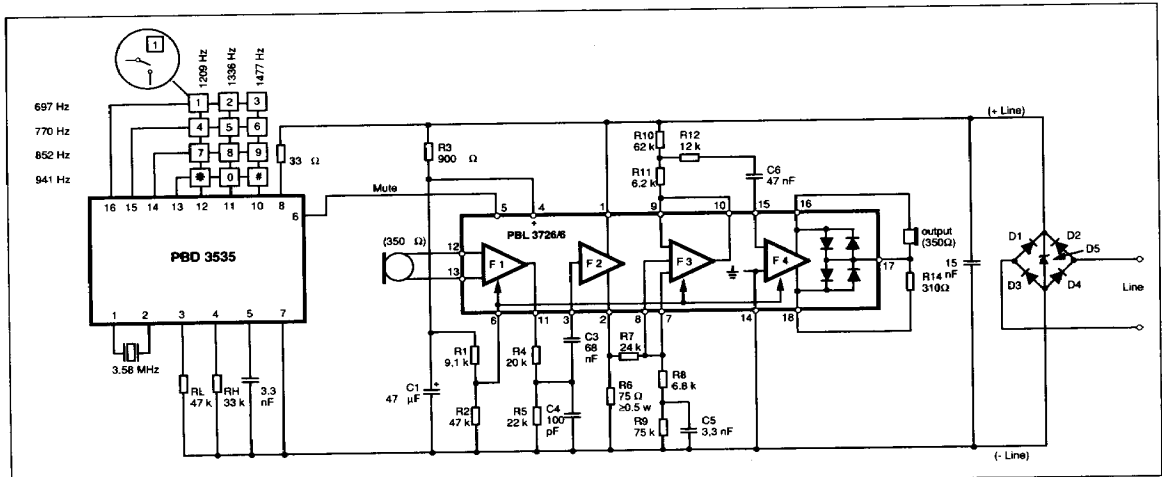


Figure 8. Typical tone dialling telephone.

This makes it possible to use a DTMF generator like Ericsson's PBD 3535 and still have the same DC characteristics during dialling.

The receiver amplifier is equipped with a high impedance input stage. This gives a less expensive RC-network on the input.

Only resistive elements are used to set the receiving gain.

A push-pull power stage in the receiving amplifier gives a high output swing.

The side-tone balance can be set by an RC-network without influence on other parameters. An inexpensive solution requires only one capacitor while more capacitors can give better performance. The side-tone can be regulated with

respect to line length.

A separate amplifier stage (F3) can be used in several different ways, for instance

1. Separating the side-tone balancing network.
2. Line length compensation of side tone level. (See fig.10).
3. Give an extra 20 dB gain with volume control for the receiving amplification etc (See fig. 13).

The number of possibilities the F3 amplifier gives are very large. In fig. 6 and fig. 7 ①②③ and ④ are RC-links with the following functions:

- 1 Radio interference suppression and return loss adjustment.

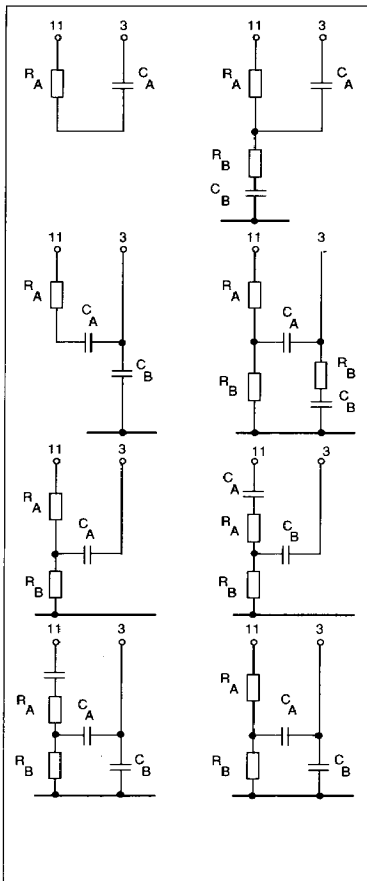


Figure 9. Examples of network ②.

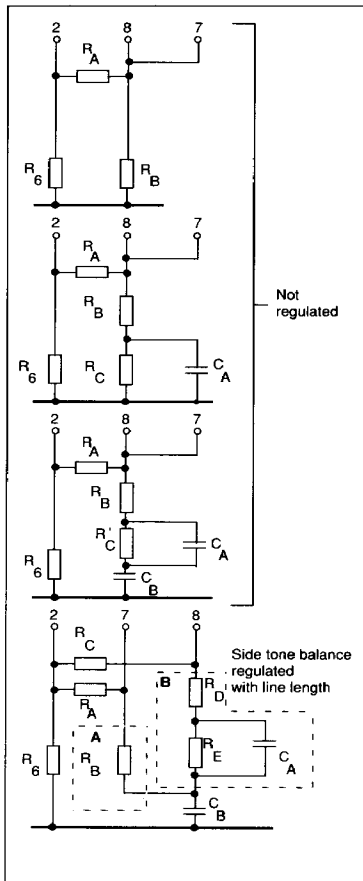


Figure 10. Examples of network ④.

- 2 To set the gain and frequency response for transmitting.
- 3 To set the gain and frequency response for receiving.
- 4 To set the side-tone level (regulation with line length is possible).

Applications Information

Refer to Figure 8.

Gain regulation (R1, R2):

These resistors set the starting point for the gain- and side tone regulation.

Input impedance at pin 6 is 52 kohm $\pm 20\%$.

Below are some typical values for R1 and R2, for some different supplies from telephone stations.

Battery feed	R1	R2
No regulation	∞	0
all feedings		
48 V, 2 x 250 ohm	15 kohm	47 kohm
48 V, 2 x 400 ohm	9.1 kohm	47 kohm
36 V, 2 x 500 ohm	0	∞

Impedance to line (R3, C1, C2):

C1 in series with R3 and those in parallel with C2 give the impedance to the line from the set.

C2 also acts as a radio interference suppressor.

The network is optimized with regard to the return loss.

The time constant R3, C1 is not allowed to be too small. This can generate distortion at low frequencies.

R3 affects the DC characteristics which is set by the voltage at pin 4. The input current at pin 4 is about 1 mA.

Microphone selection (M1):

The microphone can be either dynamic or magnetic.

The input impedance between pins 12 and 13 is about 1.1 kohm with typical variation $\pm 20\%$.

Transmitting gain and frequency response R4, R5, C3, C4:

The network gives the amplification and frequency response for the transmitter. R5 is used when a greater reduction of the gain is needed. Input impedance at pin 3 is about 17 kohm with typical variation $\pm 20\%$. The sum of the resistors R4 and R5 must not be less than 42 kohm

because of DC-current to ground. Below are some variations of this network. (See fig.9.)

DC-characteristics (R6):

R6 sets the DC-characteristic and takes care of some of the supplied power. R6 also affects the protection of the circuit, the transmitter, the gain regulation and the side tone. Common values are 68 ohms to 82 ohms.

Side tone level, receiving gain and frequency response (R7, R8, R9, R10, R11, C5):

This network sets the side tone balance. The network in the application is one of many possibilities. R10 and R11 balance together the signals that go two different ways from the transmitter output stage. One signal is taken from pin 1 and the other (in opposite phase) from pin 2 via F3. The balancing network consist of R8, R9 and C5.

The example is not optimized to any specified line, it is only given to show the principle. The inputs of the amplifier F3 is high ohmic. For some different side-tone networks, see fig. 10.

Design of a side tone network with regulation according to above can be done as follows. (Fig. 10).

The balance impedance A is optimized at a short line where the regulation starts. The balance impedance B is optimized at a long line there the regulation stops. The circuit generates a continuous change between the two balancing impedances.

Fig. 11 and 12 are two examples of balancing networks without F3. F3 can then be used for other purpose.

By breaking up between pin 9 and 10, F3 can be used as an amplifier with amplification higher than one. (See fig.13).

R12, R13, C6, (R10, R11):

This networks gives the gain and frequency response of the receiver.

R13 is used when a greater reduction of the gain is wanted. For different possibilities regarding design of the network, see the network for the transmitter (R4, R5, C3).

R14:

Adjusts the output impedance to drive a magnetic earphone. If a dynamic earphone is used it should be connected between pins 16 and 18. Pin 17 is not used in this case.

This will double the available swing voltage (at the same output current).

D1, D2, D3, D4, D5:

Rectifier bridge and overvoltage protector. The zener voltage at D5 should be as low as possible. Common values are between 12 V - 16 V.

Design procedure:

1. Impedance to the line.
2. DC-characteristics.
3. Gain regulation.
4. Transmitter gain and frequency response.
5. Receiver gain and frequency response.
6. Side-tone.
7. Components to suppress radio interference (in particular at the wires up to the handset).

Others:

The circuit can be placed either in the telephone or in the handset.

The circuit can be provided with an unbalanced input according to figure 14.

Cut off of the transmitter can be done at F1 without interference of other functions of the circuit.

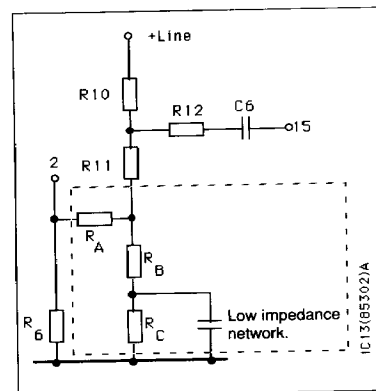


Figure 11. Connections without using F3 as buffer for side-tone network.

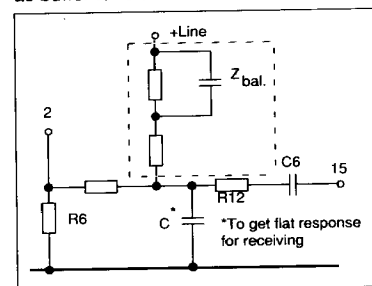


Figure 12. Alternative connections without using F3.

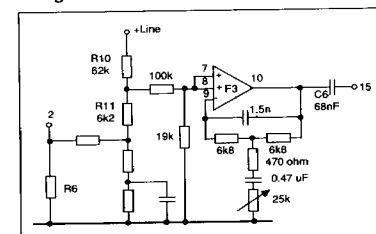


Figure 13. Used as an amplifier for an additional 20 dB receiving gain.

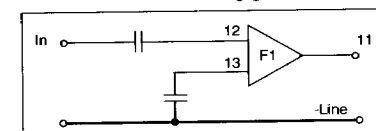


Figure 14. Single-ended microphone input.

Ordering Information

Package
Plastic DIP

Temp. Range
-40 to 70°C

Part No.
PBL 3726/6N