

PBL 3786 Voice-switched Speakerphone and Tonerer Circuit

Description

The PBL 3786 contains all the necessary circuitry, amplifiers, detectors, comparators and control functions to implement a high-performance, voice-switched, loud-speaking, "hands-free" telephone. The gain dynamics (attenuation between channels) is continuously adjustable (0 - 50 dB) via a separate pin. A background noise detector in the microphone channel reduces the influence of continuous noise signals.

The PBL 3786 is designed for telephone line powered applications. The circuit contains a transformerless power amplifier with patented current supply circuitry that eliminates the need for inductors. Automatic gain regulation in the power amplifier extends the operating range at low line voltages.

The PBL 3786 incorporates a high-impedance toner circuit with free continuously selectable frequencies that can be set either by capacitors or controlled by a microprocessor powered from the chip. The outputs of the toner and speech power amplifier use the same loudspeaker, which is switched with a built-in automatic change-over function.

Key Features

- Adjustable gain range in the attenuated channel (0 - 50 dB).
- Direct telephone-line powered (patented).
- Low power consumption, 2.2 mA at 3.2 V (typical).
- Direct drive of 25 - 50 ohm loudspeaker.
- On-chip toner circuit with common loudspeaker, automatic switch-over.
- 22-pin dual in-line plastic and 28-pin PLCC encapsulation.
- Background noise compensation with hold.
- Minimum of external components.

*) All pin numbers in this document refer to 22-pin DIP package.

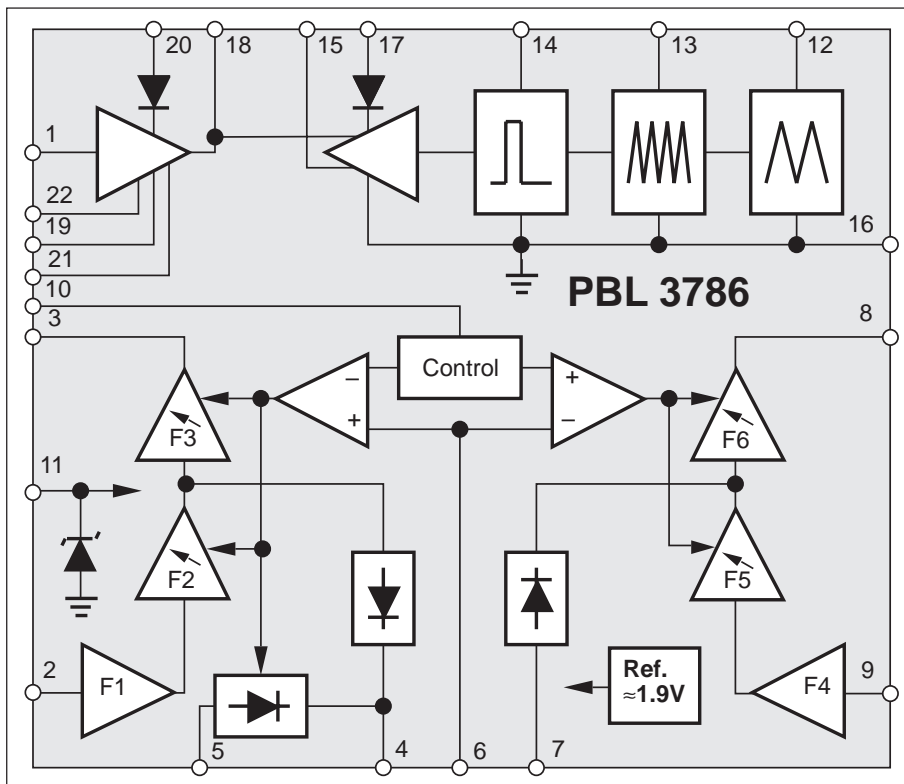
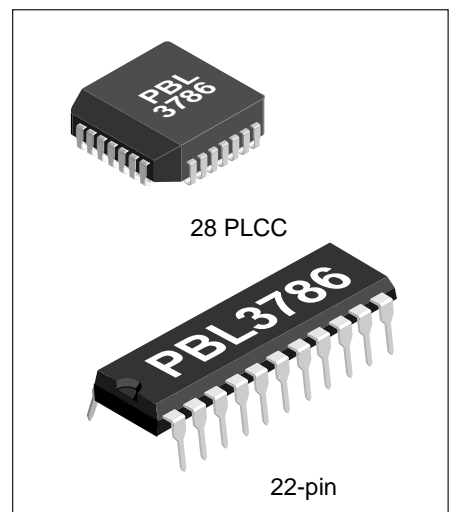


Figure 1. Block diagram.



Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Speech switch supply current	I_D		10	mA
Speaker amp. supply current	I_{+L}		200	mA
Tone ringer supply current	I_{RVI}		100	mA
Tone ringer supply voltage	V_{RVI}		40	V
Inputs HF μ PS, LF μ PA, PWM μ PC max. voltage			6	V
Operating temperature		-20	+70	$^{\circ}$ C
Storage temperature	T_{Stg}	-55	+125	$^{\circ}$ C

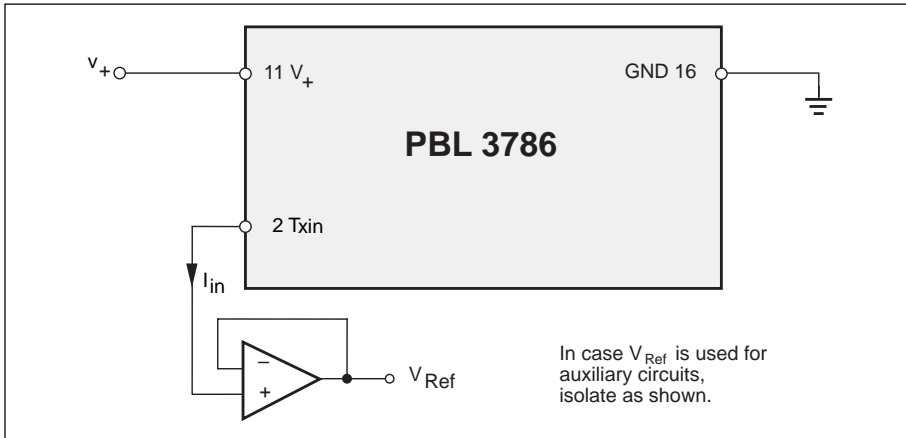


Figure 2. Isolation and measurement of V_{Ref}

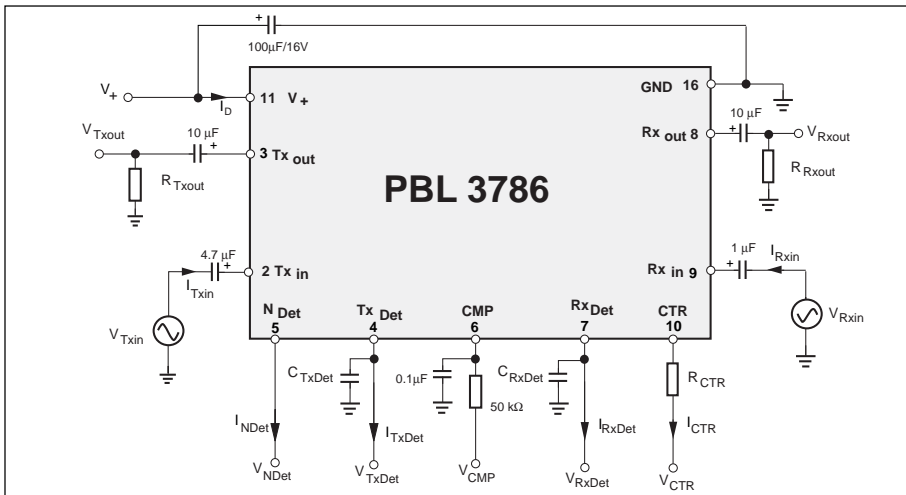


Figure 3. Test circuit. Reference fig. no. 3.

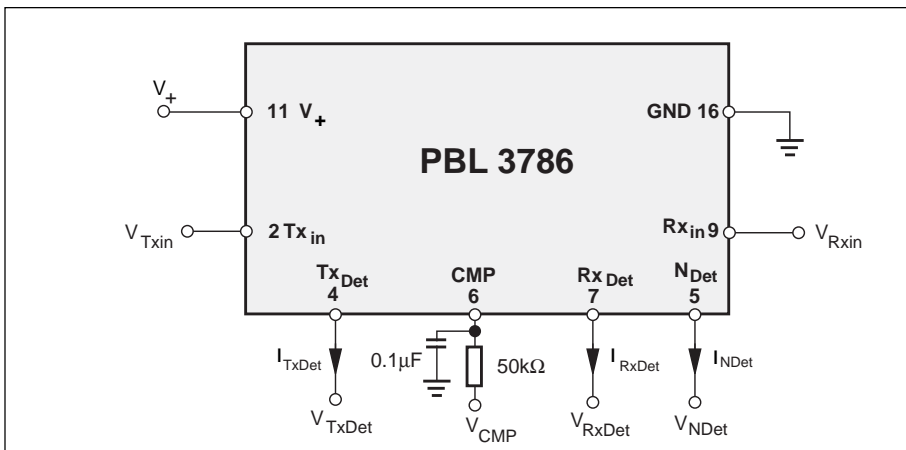


Figure 4. Test circuit. Reference fig. no. 4.

Electrical Characteristics

$V_+ = 3.4 \text{ V}$, $f = 1 \text{ kHz}$, $T = 25^\circ$, $C_{Txdet} = 0$, $C_{Rxdet} = 0$, $R_{TxOut} = \infty$, $R_{RxOut} = \infty$ unless otherwise noted.

Parameter	Ref. fig.	Conditions	Min.	Typ.	Max.	Unit
Speech control section						
Terminal voltage, V_+	3	$I_D = 1,7\text{mA}$, $V_{CTR} \geq 1,6\text{V}$, $R_{CTR} = 0$ $I_D = 1,5\text{mA}$, $V_{CTR} \geq 1,6\text{V}$, $R_{CTR} = 0$	3.2			V
Internal reference voltage, V_{Ref}	2			1.90		V
Supply current I_D	3	$V_+ = 3.2 \text{ V}$		1.15	1.70	mA
Supply current at cut off, I_D	3	$V_{CTR} < 0.8 \text{ V}$, $V_+ = 3.2 \text{ V}$		0.65	1.30	mA
Frequency response for all amplifiers	3	200 - 3400 Hz, Relative 1 kHz	-1		1	dB
Transmit gain, $20 \cdot^{10}\log(V_{Txout}/V_{Txin})$	3	$V_{CMP} = V_{Ref} + 0.1 \text{ V}$ $V_{CMP} = V_{Ref} - 0.1 \text{ V}$	41.5	44		dB
Receive gain, $20 \cdot^{10}\log(V_{Rxout}/V_{Rxin})$	3	$V_{CMP} = V_{Ref} - 0.1 \text{ V}$ $V_{CMP} = V_{Ref} + 0.1 \text{ V}$	26.5	29		dB
Max transmit detector gain, $20 \cdot^{10}\log(V_{TxDet}/V_{Txin})$	3	$v_{Txdet} < 200 \text{ mV}_p$ $V_{CMP} = V_{Ref} + 0.1 \text{ V}$ $V_{CMP} = V_{Ref} - 0.1 \text{ V}$		67.5		dB
Max receive detector gain, $20 \cdot^{10}\log(V_{RxDet}/V_{Rxin})$	3	$v_{Txdet} < 200 \text{ mV}_p$ $V_{CMP} = V_{Ref} - 0.1 \text{ V}$ $V_{CMP} = V_{Ref} + 0.1 \text{ V}$		53		dB
Noise rectifier gain (Note 1)	3	$V_{CMP} = V_{Ref} + 0.1 \text{ V}$, $C_{Txdet} = 1\mu\text{F}$ $V_{CMP} = V_{Ref} - 0.1 \text{ V}$, $C_{Txdet} = 1\mu\text{F}$		6.0		dB
Dynamics		2% distortion, $R_{Txout} = R_{Rxout} = 25\text{k}\Omega$				
Transmit output, V_{Txout}	3	$V_+ = 3.5 \text{ V}$ $V_+ = 2.9 \text{ V}$		500		mV_p mV_p
Receive output, V_{Rxout}	3	$V_+ = 3.5 \text{ V}$ $V_+ = 2.9 \text{ V}$		500		mV_p mV_p
Noise, n						
Transmit output, v_{Txout}	3	$V_{CMP} = V_{Ref} + 0.1 \text{ V}$, $v_{Txin} = 0 \text{ V}$		-70		dBpsf
Receive output, v_{Rxout}	3	$V_{CMP} = V_{Ref} - 0.1 \text{ V}$, $v_{Rxin} = 0 \text{ V}$		-75		dBa
Tx_{in} input impedance, v_{Txin}/I_{Txin}	3		2.5	3.2	3.9	$\text{k}\Omega$
Rx_{in} input impedance, v_{Rxin}/I_{Rxin}	3		8	10	12	$\text{k}\Omega$
Tx_{Det} source current, I_{Rxdet}	4	$V_{Txin} = V_{Ref} - 0.1 \text{ V}$, $V_{CMP} = V_{Ref} + 0,1\text{V}$, $V_{Txdet} = V_{Ref}$	2.5	6.0		mA
Rx_{Det} sink current, I_{Rxdet}	4	$V_{Rxin} = V_{Ref} + 0,1\text{V}$, $V_{CMP} = V_{Ref} - 0.1 \text{ V}$, $V_{Txdet} = V_{Ref}$		-6.0	-2.5	mA
Tx_{Det} sink current, I_{Txdet}	3	$V_{CMP} = V_{Ref} + 0.1 \text{ V}$, $V_{Txdet} = V_{Ref} + 0.7 \text{ V}$, $V_{Txin} = 0$	-30			μA

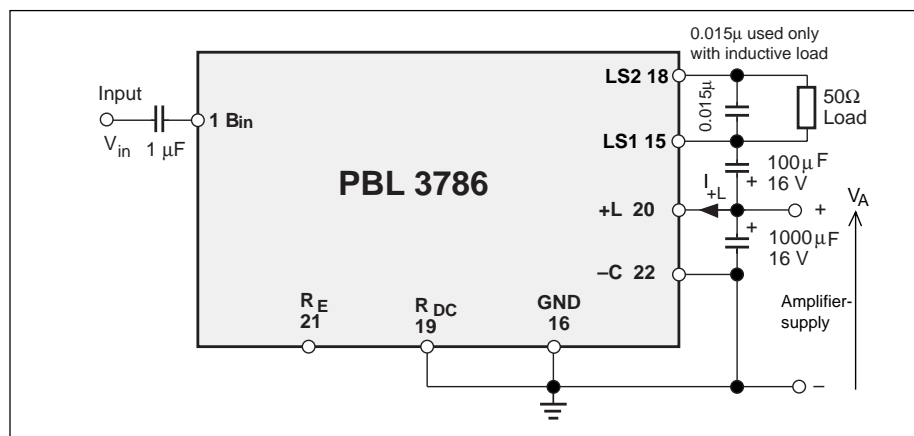


Figure 5. Test circuit. Reference fig. no. 5.

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Parameter	Ref. fig.	Conditions	Min.	Typ.	Max.	Unit
Rx _{Det} source current, I _{RxDet}	3	V _{CMP} = V _{Ref} - 0.1 V, V _{RxDet} = V _{Ref} - 0.7 V, V _{Rxin} = 0			30	μA
Tx _{Det} swing relative to V _{Ref} , V _{TxDet}	4	V _{CMP} = V _{Ref} + 0.1 V, V _{Txin} = V _{Ref} - 0.1 V	(note 2)	+0.7		V
Rx _{Det} swing relative to V _{Ref} , V _{RxDet}	4	V _{CMP} = V _{Ref} - 0.1 V, V _{Rxin} = V _{Ref} + 0.1 V	(note 2)	-0.7		V
N _{Det} source current (fast charge), I _{Ndet}	3	V ₊ = 2.7 V, V _{CMP} = V _{Ref} + 0.1 V, V _{Ndet} = V _{Ref} - 0.45 V, V _{Txin} = 0	1.5	4.5		mA
N _{Det} sink current, I _{Ndet}	4	V _{CMP} = V _{Ref} + 0.1 V, V _{Ndet} = V _{Ref} - 0.2 V, V _{Txin} = V _{Ref} - 0.1 V		-5		μA
N _{Det} leakage current (hold), I _{Ndet}	3	V _{CMP} = V _{Ref} - 0.1 V, V _{Ndet} = V _{Ref} , V _{Txin} = 0		-100		nA
N _{Det} swing relative to V _{Ref} , V _{Ndet}	4	V _{CMP} = V _{Ref} + 0.1 V, V _{Txin} = V _{Ref} - 0.1 V		-0.45		V
CMP (comparator) sensitivity, transmit (Tx) mode to receive (Rx) mode or vice versa	3 11	Tx mode = max Tx gain, Rx mode = max Rx gain V _{CMP} = V _{Ref} ± ΔV _{CMP}	50	100		mV
CTR voltage for full duplex, V _{CTR}	3	V _{CMP} = V _{Ref} ± 0.35 V		V ₊		V
CTR sink current for mute, I _{CTR}	3	V _{CMP} = V _{Ref} ± 0.35 V, R _{CTR} = 1k	50		60	μA
CTR voltage for cutoff, V _{CTR}	3			0.8		V
Loudspeaker amplifier						
Operating voltage, V _A	5		2.5		12	V
Current consumption (no signal), I _A	5	V _A = 3.0 V		1	2.3	mA
	5	V _A = 5.0 V		1.5		mA
	5	V _A = 12.0 V R _E = 1.5 K,		4	9	mA
	20	V _{Line} = 3.0 V, V _{RDC} = 0.35 V (note 3)	1.3	2.4		mA
	20	V _{Line} = 12.0 V, V _{RDC} = 5.0 V (note 3)	7.5	14		mA
Current consumption (output swing at 5% dist.)	5	V _A = 3.0 V		7		mA
	5	V _A = 5.0 V		13		mA
	5	V _A = 12.0 V		30		mA
Swing at 5% dist., V _{out}	5	V _A = 3.0 V	0.6	0.85		V _p
	5	V _A = 5.0 V	1.5	1.7		V _p
	5	V _A = 12.0 V	3.6	4.0		V _p
Gain	5	V _A = 5.0 V	34.5	36.5	38.5	dB
Frequency response	5	200 to 3400 Hz, relative 1kHz, V _A = 5.0 V	-1		1	dB
Amplifier power efficiency (5% dist), η	5	V _A = 3.0 to 12.0 V, η = 100 * P _{Load} / P _{Supply}		40		%
Input impedance pin 1	5		24	30	36	kΩ

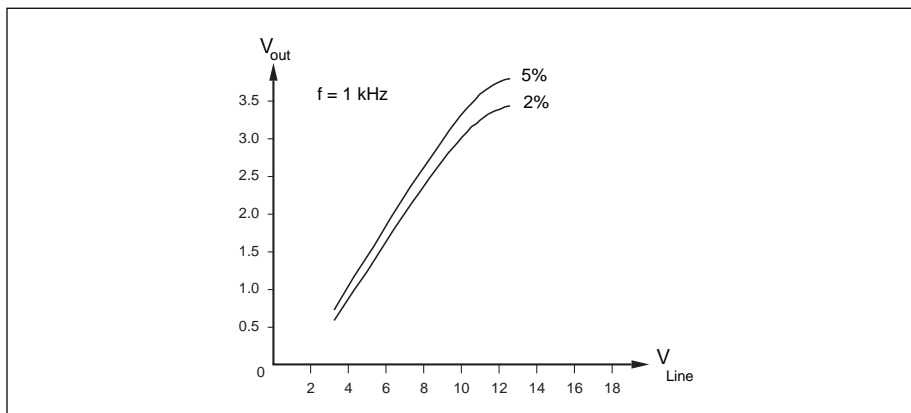


Figure 6. Power amplifier output distortion. Line voltage versus output swing.

Parameter	Ref. fig.	Conditions	Min.	Typ.	Max.	Unit
Tone ringer (Load = 50 ohm resistive, $V_{Rvin} = 30\text{ V}$ unless otherwise noted)						
Supply current pin 17, I_{Rvin}	7	$V_{Rvin} = 5\text{ V}$		1	10	μA
	7	$V_{Rvin} = 10\text{ V}$		100	200	μA
	7			2.1	3.3	mA
	7	Inductive load (50 ohm loudspeaker)		1.2		mA
Threshold voltage on pin 17, V_{Rvin}						
Trigger on	7		22	25	28	V
Trigger off	7		16	19	22	V
Hysteresis trigger on/trigger off	7		3	5.5	8	V
Pulsewidth pin 18, t_{pw}	7			12	25	μs
Frequency modulation (see fig.24), $f2/f1$	7		1.12	1.25	1.38	
Output current on pin 14, $I_{\mu P}$	8	Set by resistor on pin 12		0 to 3.5		mA
Logic levels when interfaced with a microprocessor (at pin 13)						
High logic input level, V_{in}	8	Resistor on pin 13 = 100k Ω	4.2		6.0	V
Low logic input level, V_{in}	8	Resistor on pin 13 = 100k Ω	0.0		0.45	V
Current at high level, I_{in}	8	Resistor on pin 12 = 5k Ω	3.0	5.5	8.5	μA
Current at low level, I_{in}	8	Resistor on pin 12 = 5k Ω	-8.5	-5.5	-3.0	μA

Notes

1. $20 \cdot 10 \log \left(\frac{V_{Ndet} - V_{Ref}}{V_{Txdet} - V_{Txdett}} \right)$

V_{Ndet} = voltage at noise detector output

V_{Ref} = reference voltage (about 1.9V)

V_{TxDet} = voltage at transmit detector output

V_{TxDet} = voltage at transmit detector output at the point where the voltage at the noise detector output starts moving when a signal at transmit channel input is gradually increased (threshold, typical value 50 mV)

2. Depends on V_+ . Channels are tracking.

3. $V_{Line} = V_A + V_{RDC}$

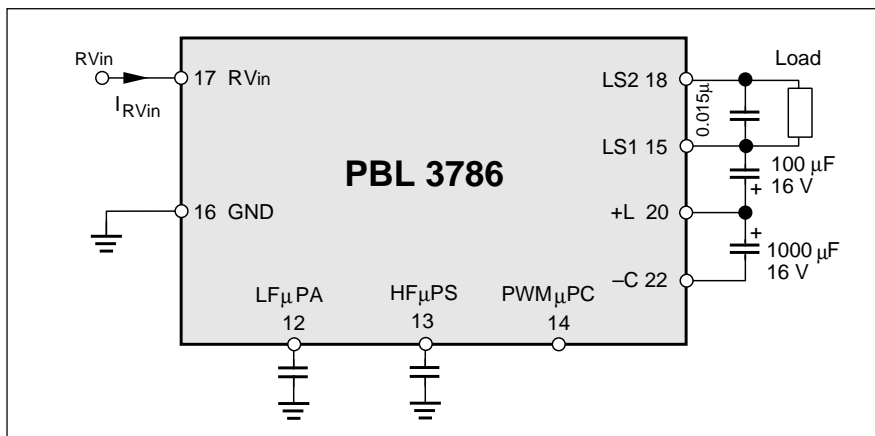


Figure 7. Toneringer fixed frequency control mode.

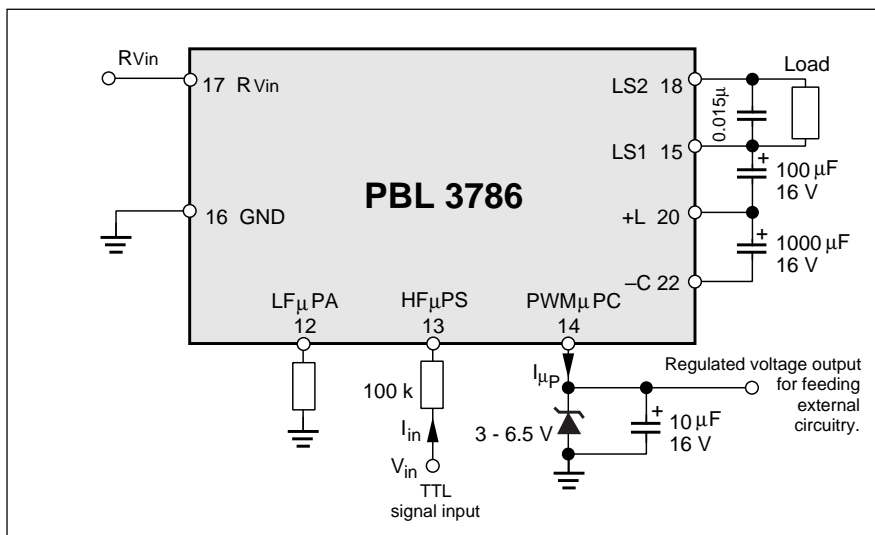


Figure 8. Toneringer μP -control mode.

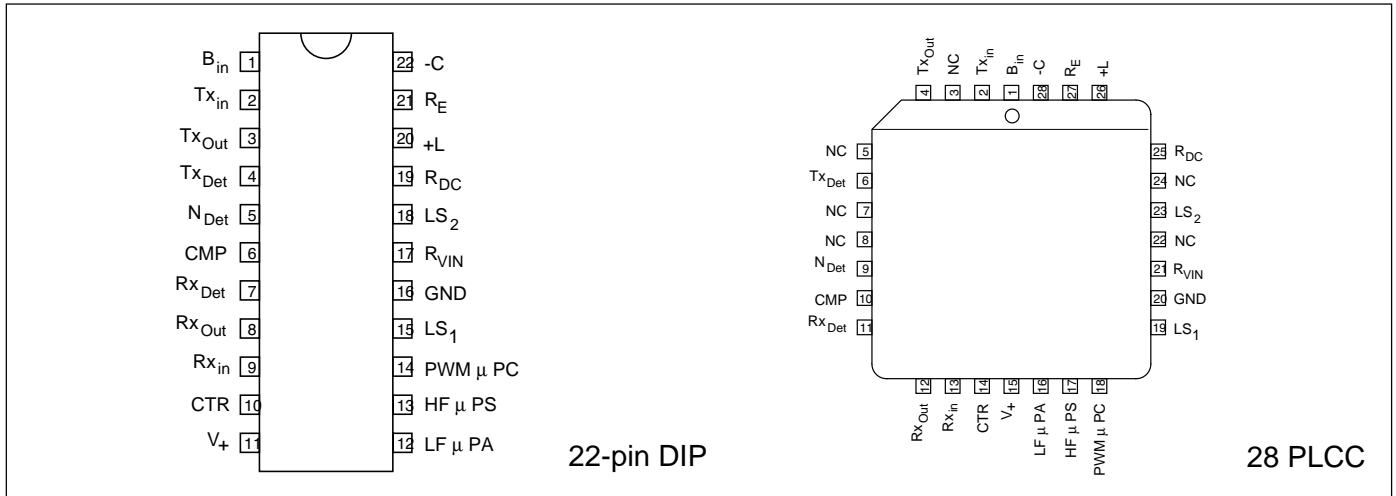


Figure 9. Pin configurations.

Pin Descriptions

Refer to figure 9. (22-pin dual-in-line package and 28-pin PLCC package)

22-Pin DIL	28-Pin PLCC	Symbol	Description
1	1	B _{in}	Signal input loudspeaker amplifier. Input impedance 30 kohm.
2	2	Tx _{in}	Transmit channel input. Input impedance 3.2 kohm.
3	4	Tx _{Out}	Transmit channel output. Minimum load impedance 25 kohm.
4	6	Tx _{Det}	Transmit channel detector output. Goes positive in reference to the internal reference voltage when signal is present at Tx _{in} , approximately 1.9 V.
5	9	N _{Det}	Background noise detector output. Goes negative when a noise of longer duration appears at Tx _{in} .
6	10	CMP	Comparator input. External resistance to this input should be 50 kohm. Summing point to the different detector outputs.
7	11	Rx _{Det}	Receive channel detector output. Goes negative in reference to the internal reference voltage when signal is present at Rx _{in} , approximately 1.9 V.
8	12	Rx _{Out}	Receive channel output. Minimum load impedance 25 kohm.
9	13	Rx _{in}	Receive channel input. Input impedance 10 kohm.
10	14	CTR	Control input for gain dynamics and mute.
11	15	V ₊	Supply for the speech-switching circuitry. A shunt regulator sets the voltage to approx. 3.2 V at 1mA.
12	16	LFμPA	Low-frequency tone ringer oscillator set by a capacitor (shift frequency), μP-mode, see text.
13	17	HFμPS	High-frequency tone ringer oscillator set by a capacitor. μP-mode, see text.
14	18	PWMμPC	Tone ringer volume control. μP-mode, see text.
15	19	LS1	Loudspeaker ground switch for tone ringer.
16	20	GND	Ground for the whole system (-line).
17	21	R _{Vin}	Supply for the tone ringer and it's output stage.
18	23	LS2	Common output for loudspeaker and tone ringer power amplifiers.
19	25	R _{DC}	Pins for the loudspeaker amplifier supply options described in text.
21	27	R _E	
22	28	-C	
20	26	+L	
	3,5,7,8	NC	
	22,24	NC	

Functional Description Speech Control Section

Transmit and receive channels

The transmit and receive channels consist of three amplifying stages each, F1, F2, F3 and F4, F5, F6. The inputs and outputs of the amplifiers must be AC-coupled.

F1 and F4 are fixed-gain amplifiers of 30 dB and 20 dB respectively, while the others are of controlled-gain type.

The gain of F2 and F3, as well as F5 and F6, is controlled by comparators. The comparators receive their information partly from the summing point of the transmit, receive, and noise detectors; the CMP input; and partly through the control input CTR, which controls the dynamics range. Amplifiers F2 and F3 have the maximum gain when the transmit channel is fully open, consequently F5 and F6 will have minimum gain. When F5 and F6 have maximum gain, the receive channel is fully open and the amplifiers F2 and F3 are at minimum gain. See figure 10 and 11.

Signal detectors and comparators

The signal detectors sense and rectify the signals to opposite polarities, referenced to the internal reference voltage of approximately 1.9 V. The voltage at R_{x_Det} will go negative and at T_{x_Det} positive, in the presence of a signal at the respective channel input, T_{x_in} and R_{x_in} .

In the idle (no signal) position, the voltage at R_{x_Det} , T_{x_Det} , and consequently CMP is equal to the internal reference voltage. The inputs at pins 2, 6 and 9 as well as the outputs at pins 3, 4, 5, 7 and 8 are biased DC wise to the reference voltage.

The voltages R_{x_Det} and T_{x_Det} are used to control the gain setting in the respective channel through comparators, where the CMP input is the summing point.

A signal at T_{x_in} will result in an increased level at T_{x_Det} and hence also at CMP. The comparators will now increase the gain in the transmit channel and decrease it in the receive channel. Signal at R_{x_in} will affect the levels and gain setting in the opposite way. Maximum input current to CMP is 1 μ A.

The attack and decay times of the transmit and receive channels are set

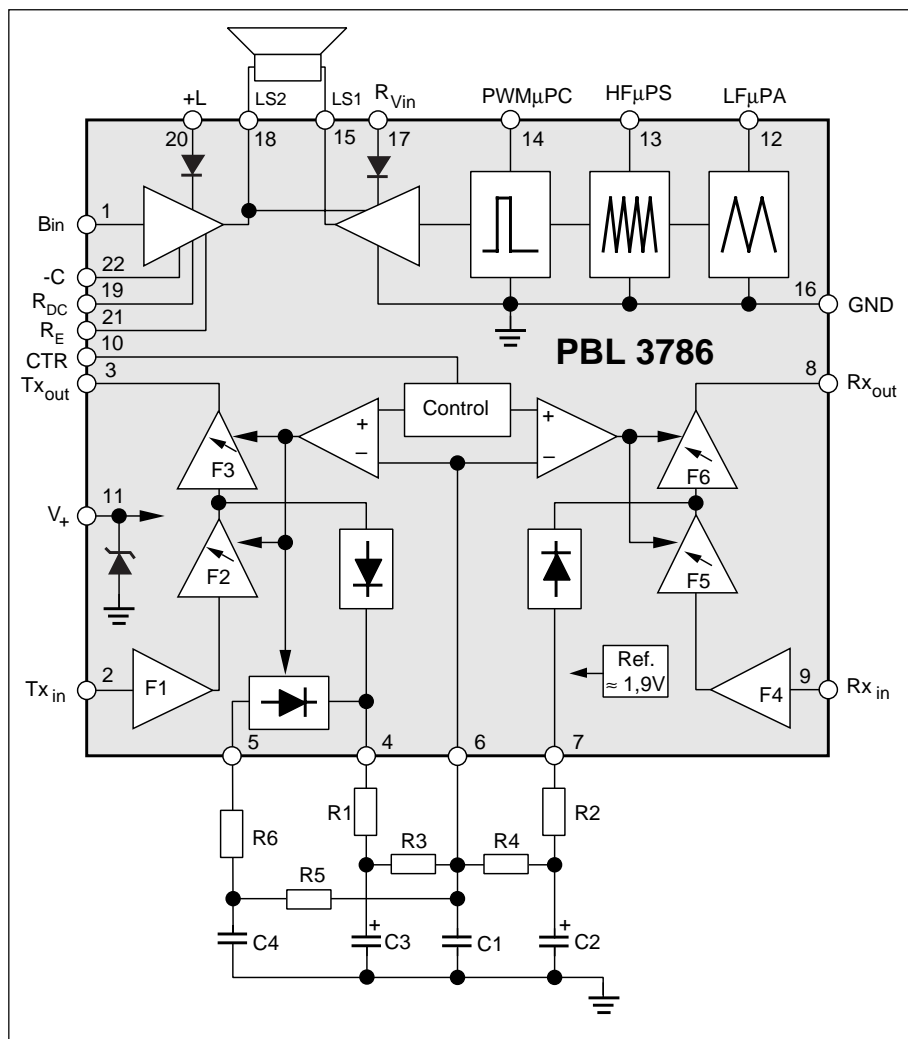


Figure 10. Block diagram.

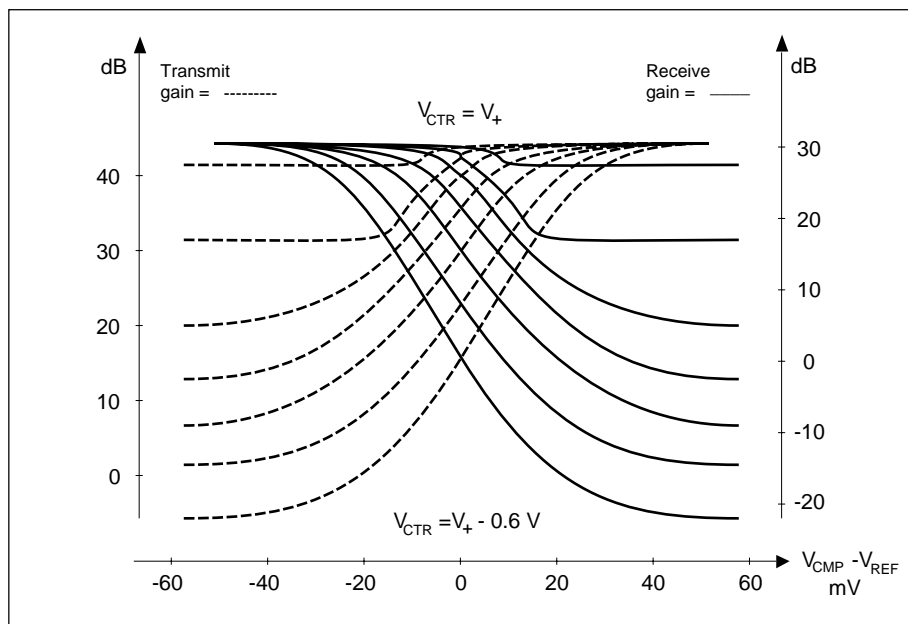


Figure 11. Transmit- and receive- channel gain.

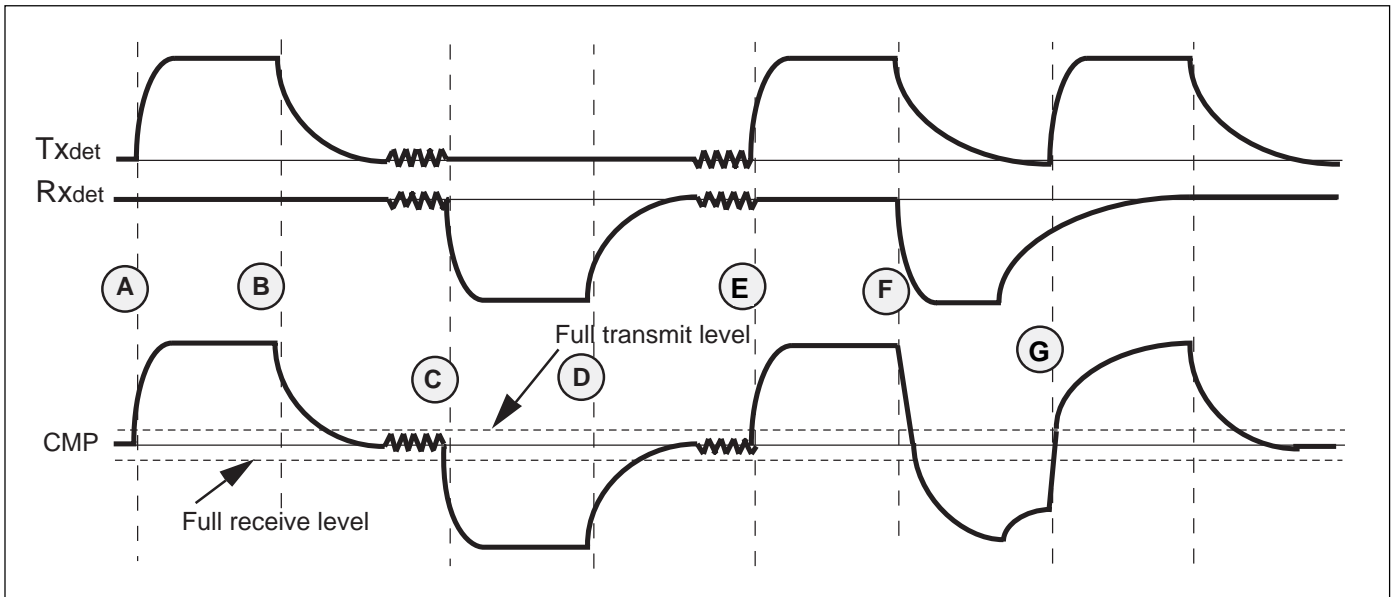


Figure 12. Transmit and receive detector output and comparator input CMP timing wave forms.

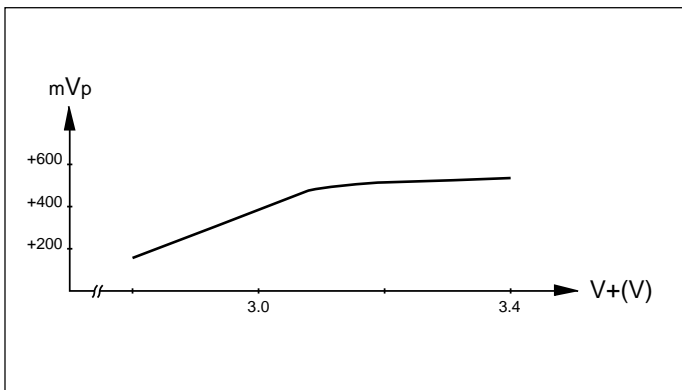


Figure 13. Transmit and receiver detector output dynamics versus V_+ .

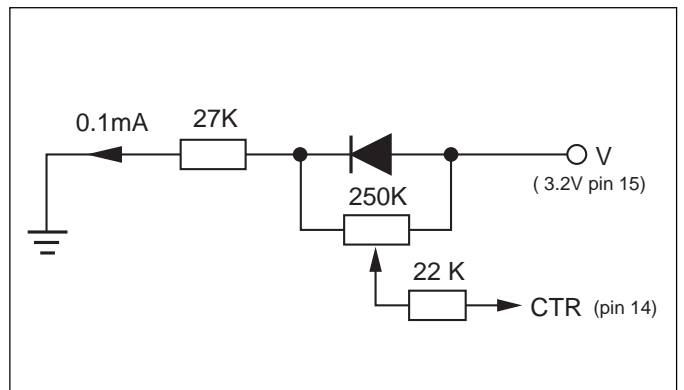


Figure 14. The control input voltage $V_{CTR'}$ from full duplex to full speech control.

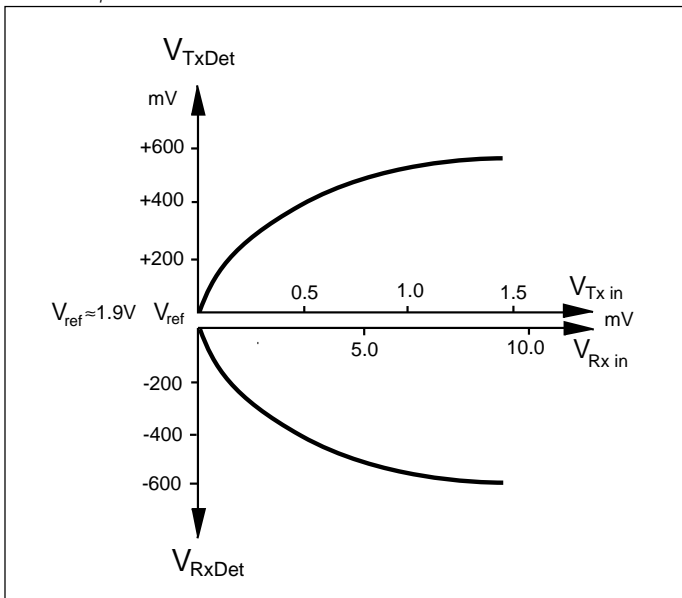


Figure 15. Transmit- and receive-channel rectifier characteristics.

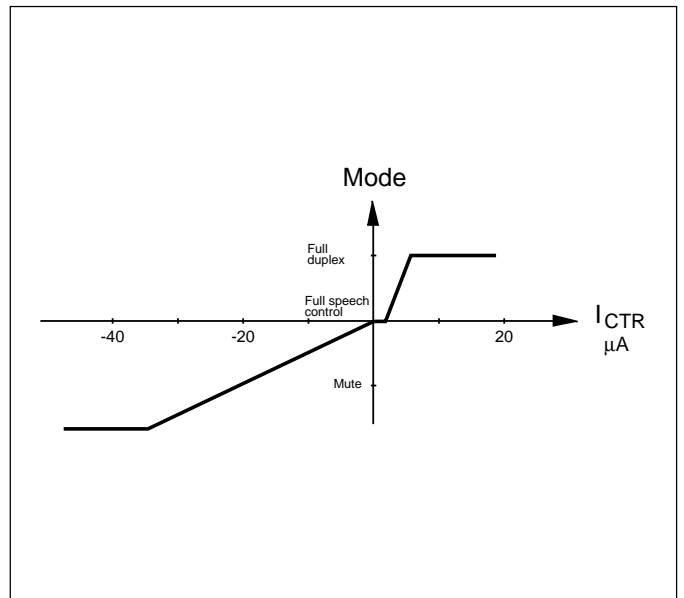


Figure 16. Control input modes, at pin 10.

primarily by the RC-networks, by which the detectors are connected to the CMP-input. The attack time is set by the external capacitor and either the maximum current driving capability of the detector output or limited by the external resistor at the DET-output pins. The decay time is set by the external capacitor and an internal resistor of 100 kΩ in parallel with the external resistor connected to the CMP-input. This is the case only when one channel is active at a time and there is a long quiet pause before the other channel gets an input signal. See points A to E in fig. 12. If one of the channels gets an input signal immediately after the disappearance of the signal in the other channel, the effective decay time as the CMP-input sees it, is shorter than in the first case. See points F and G in fig. 12. The C₁ capacitor at CMP-input helps to set the speed for the gain change in the transmit and receive channels.

The total impedance at CMP input should be kept around 50 kΩ because of temperature and balance consideration to the internal impedance value of the comparator. This is why the resistors R3 and R4 are set to 100 kΩ.

A hysteresis effect is achieved in the switching, since the level detectors sense the signals after F2 and F5 respectively (F2 and F5 are affected by the gain setting). For example, if the transmit channel is open (maximum gain), a smaller signal at Tx_{in} is needed to keep the channel open than would be needed to open it when the receive channel was open.

The output swing of the level detectors is matched for variations in the supply voltage. The detectors have a logarithmic rectifier characteristic, the gain, and thereby the sensitivity, is high at low signals. There is a break point, at about 200 mV from the reference, where the sensitivity for increasing input signals decreases by a factor of 10. This gives increased dynamic range for the detectors. See figure 15.

Background noise detector

The general function of the background noise detector is to create a negative signal (in respect to the reference) that, when coupled to the summing point at the CMP input, will counteract the signal from the transmit level detector to an extent, representing the actual noise

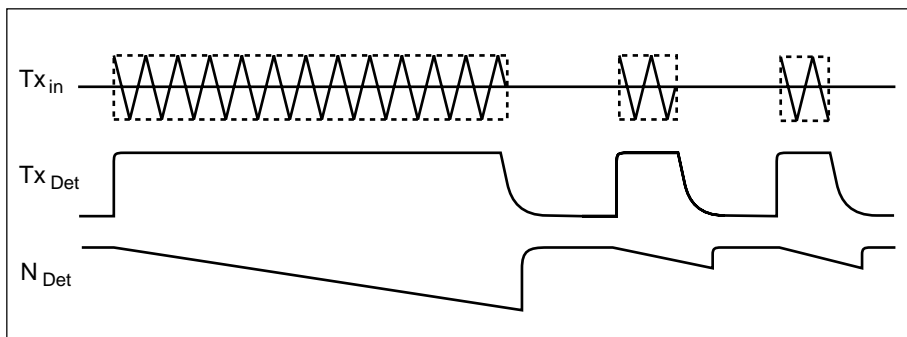


Figure 17. Principal function of background noise detector.

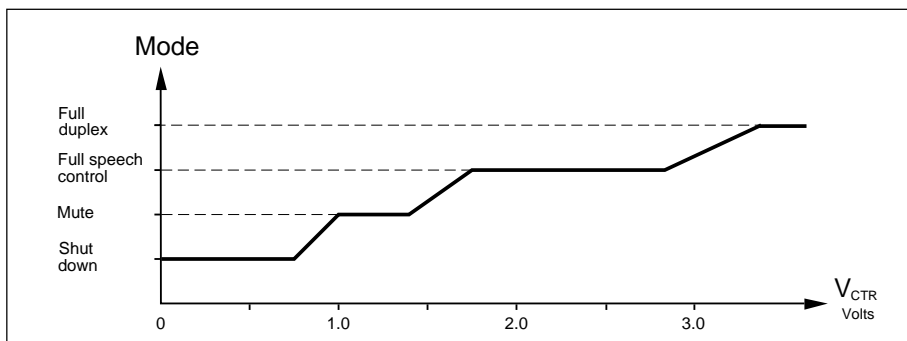


Figure 18. Control input modes V₊ = 3.4 V.

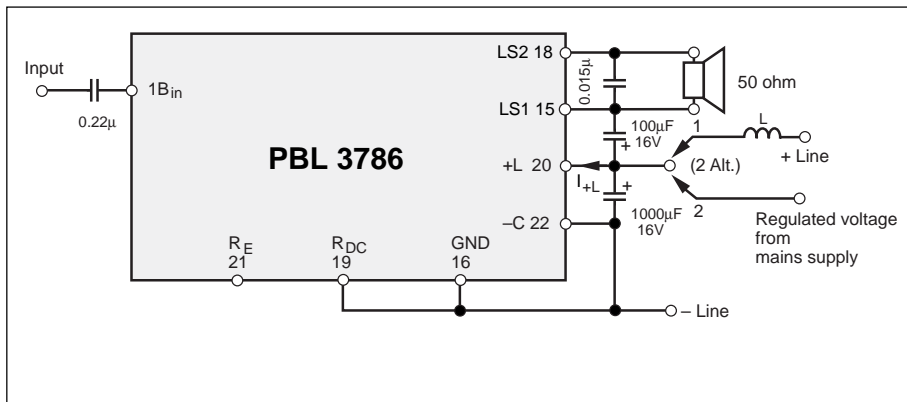


Figure 19. Power amplifier DC supply system without speech circuit control.

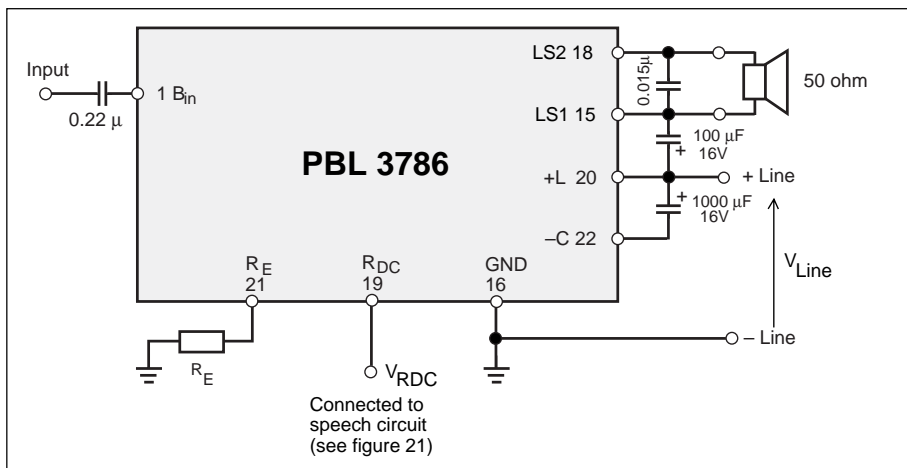


Figure 20. Power amplifier DC-supply system with speech circuit control.

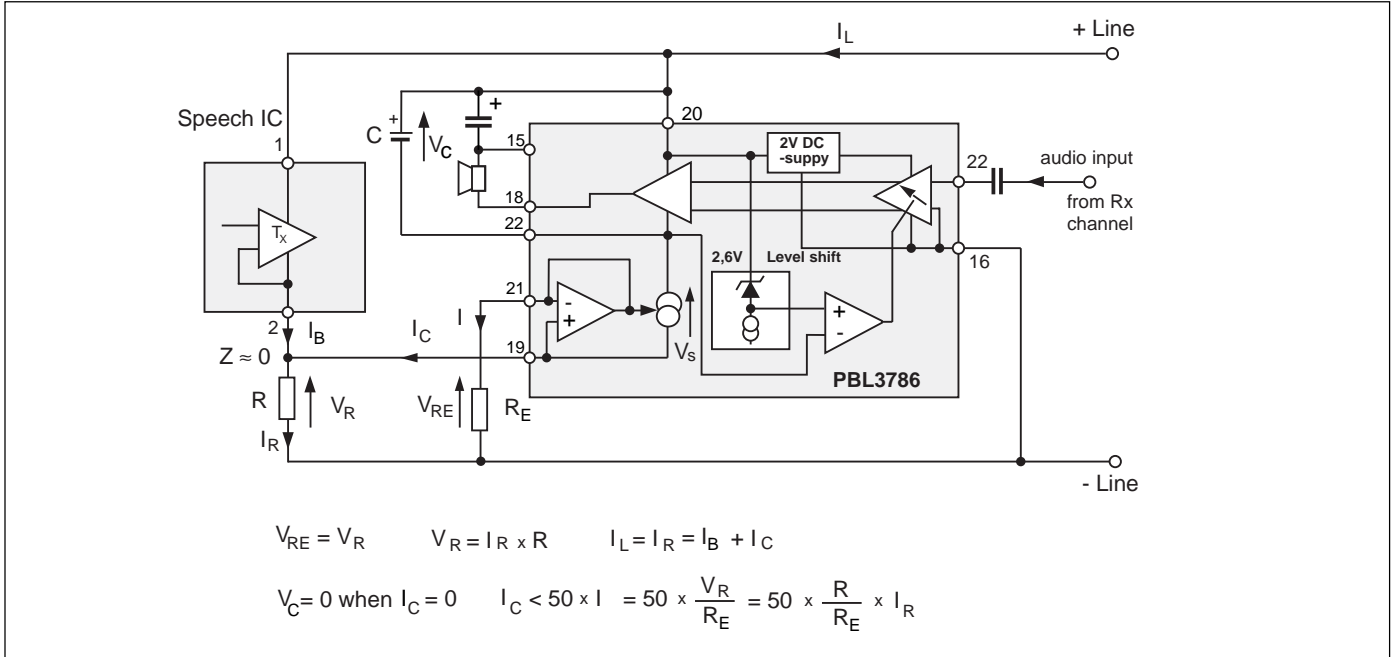


Figure 21. Current biasing regulated by the speech circuit working in parallel with PBL 3786.

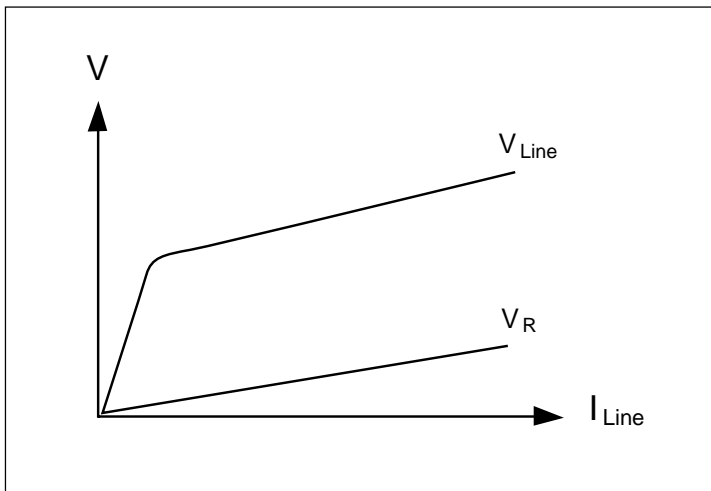


Figure 22. Speech circuit DC characteristics.

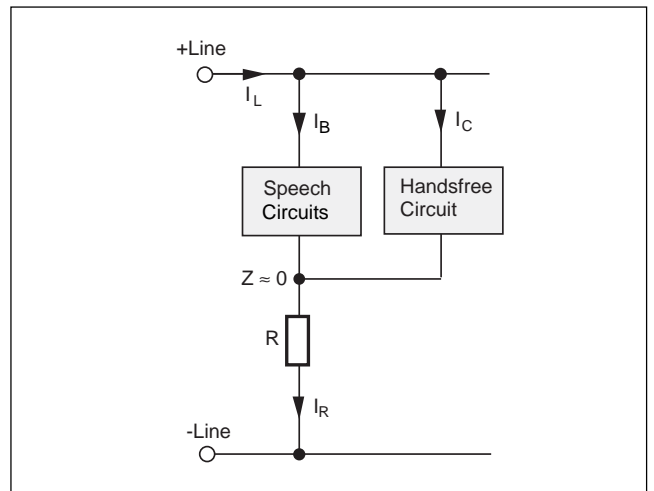


Figure 23. Schematic of parallel operation.

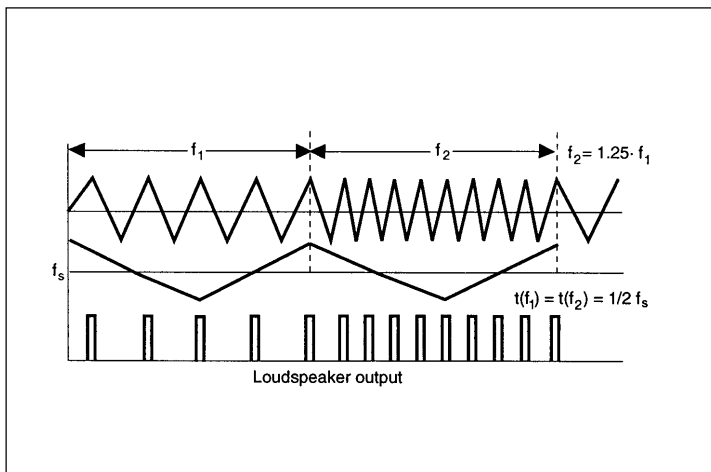


Figure 24. Toner frequency generation diagram.

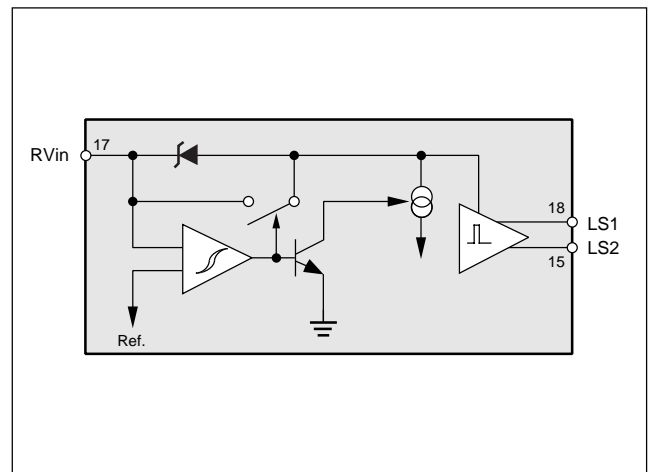


Figure 25. Toner threshold circuit.

level. This prevents the continuous noise at transmit channel input from influencing the switching balance.

The input signal to the background noise detector is taken from the output of the transmit detector, a signal representing the sound pressure envelope at the microphone input. This signal is phase shifted and amplified by a factor of 2 during the transmit period. The capacitor C4 at the output is discharged (relative to the reference) each time when in transmit mode. The time constant for discharging C4 is formed by an internal resistor of $100k + R6$. C4 is charged each time when the absolute voltage level across C3 at the Tx_{det} output reaches half of the value across C4 during one transmit period. The charge time constant is $C4 \times R6$. R6 is there to limit the charging current of C4 that otherways could cause signals in the ground leads and thus disturbing the switching performance. A sample and hold function will retain the voltage level across C4 over periods when the receive channel is active.

The voltage across C4 is connected to the CMP input via R5. The extent to which the N_{det} will influence the switching level at CMP input is set by the gain of the detectors (balance level), the maximum signal swing and R5.

The function in detail: When a constant input signal, without any longer breaks, is received from the microphone, it is treated as noise. The level across C4 is pulled negative (relative reference) with a time constant $100k \times R4$. This time constant should be round 5-10 sec. Since the output of N_{det} is going negative it counteracts the Tx_{det} signal (or helps the receive channel to break through by having the same

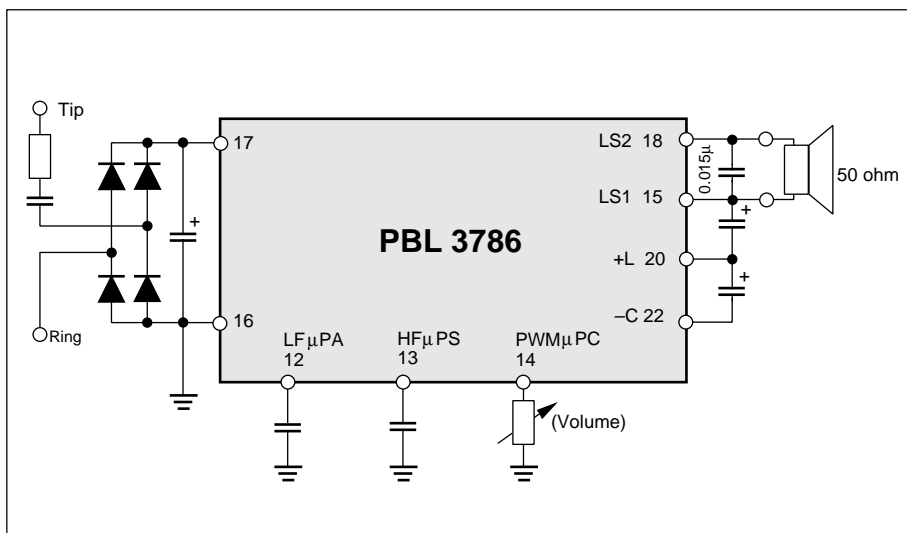


Figure 26. Toneriger basic application.

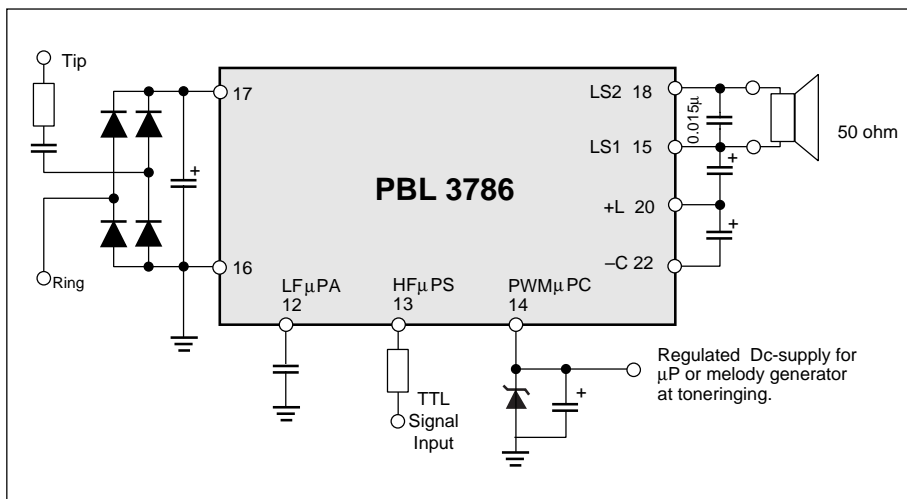


Figure 27. Toneriger application with external microprocessor.

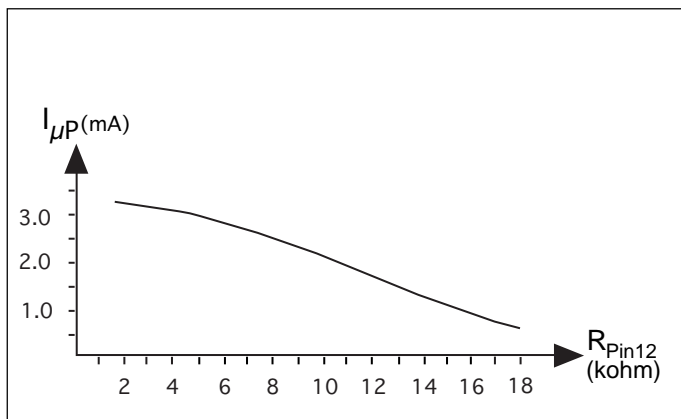


Figure 28. Output current on pin 14, toneriger μ-processor

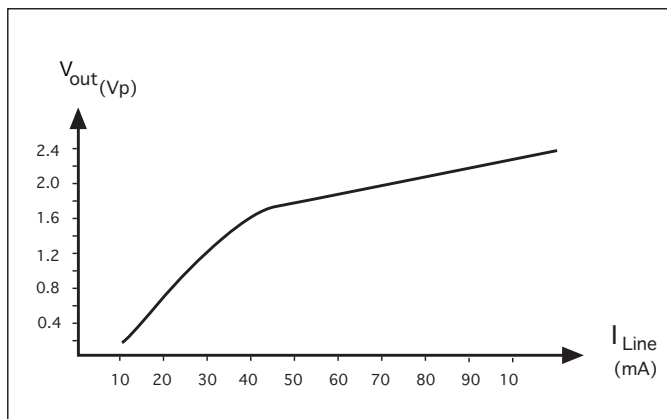


Figure 29. Typical loudspeaker output swing for application 2.

polarity as Rx_{det}) at the CMP input.

If the microphone input signal contains breaks as breath pauses and such, the voltage at Tx_{det} decreases. If the voltage at any one time during a transmit period becomes less than one half of the level across C4 (absolute values) the circuit will start a rapid charge of C4 towards the reference voltage. The negative charge of C4 caused by normal speech because its many breaks does not affect the speech switching. See fig. 17.

The activation of noise detection in noiseless environment is prevented by a threshold (50mV) in the Tx_{det}.

In the receive mode some of the loudspeaker output signal will be sensed by the microphone. In order not to treat this as noise, the background noise detector goes into a hold state thus remembering the level of previous transmit or standby period.

CTR input

A voltage at this input (normally V₊ - 600 mV) controls the comparators that set the gain in the receive and transmit channels continuously from full speech control mode (50 dB attenuation between channels) to duplex mode (both channels fully open). Input left open renders full speech control. See figures 14 and 16.

In full duplex mode, the CMP input is clamped to the reference voltage in order to avoid anything at this input to interfere with the function.

If current is drained out of the CTR input, the gain is reduced in both channels channels, and a mute mode is achieved (at approx. 35 - 40 µA). See fig. 16.

Decreasing the voltage at the input below 0.9 V, a shut-down state is reached, where the transmit and receive amplifiers are switched off and the current consumption is reduced. See fig. 18.

Loudspeaker Amplifier

The loudspeaker amplifier drives directly the 50 ohm loudspeaker, which is also used by the tone ringer. The amplifier is designed to work under a number of different biasing conditions.

The highest output swing is obtained if pin -C is connected to ground and pin +L is connected to a stable supply. The biasing in that case could be provided either from a mains supply or via a coil from the telephone line. See figure 19. Current consumption is directly proportional to the voltage between pins +L and -C.

When using the application according to figure 19, pin -C is used as a negative floating-point supply for the amplifier. The output signal of the loudspeaker amplifier is referred to +L. The capacitor, C, makes it possible for the amplifier to handle high peaks which are above its constant-drive capability.

The optimal design, without using a stable supply, is to balance the biasing of the circuit against the DC characteristics of the speech circuit working in parallel. See fig. 20. The capacitor C is a charge reservoir for the loudspeaker amplifier.

Function of the current feed system for the audio power amplifier

The impedance in the speech circuit transmitter output is low because of the feedback loop. This low impedance causes when a current is added to the output the dc level is not affected and the current through R is unchanged. If this added current is taken from the line V_L, the line current I_L is not influenced as the current through R is not changed i.e. the current through R is constant. See fig. 21 and 23.

$$I_L = I_R = I_B + I_C$$

This added current + I_C in our case is the charge current to the capacitor C and functions in the system as explained above.

To set the minimum current needed for undistorted function of the speech circuit at the lowest line voltage I_{Bmin} is done as follows:

The current through R_E • 50 • I_E = I_C is the charge current of the capacitor C under the charge condition. (logic state). The control logic enables charge when V_C - V_{RE} ≤ 0 and cuts the charge current when V_C - V_{RE} > 0

I_C + I_B = I_R I_{Cmax} + I_{Bmin} = I_R is the lowest specified current the telephone must work.

$$\frac{I_B}{I_R} = \frac{I_{Bmin}}{I_{Bmin} + I_{Cmax}} = \frac{1 - 50R}{R}$$

The I_{Bmin} has to be calculated taking into account both the quiescent dc. level and the highest specified swing at the lowest line voltage. x 50 is the internal current mirror factor.

The single-ended loudspeaker amplifier has an internal gain regulation that prevents distortion in case when not enough current from the line is available.

Tone Ringer

The tone ringer drives directly a 50 ohm loudspeaker without an output transformer. This is done by using short, high-current pulses. A threshold in the activation of the circuit prevents LD-dialling from starting the ringing (anti-tinkle). See fig. 25.

Basic mode: The ringing tone in the basic mode is set by capacitors; the main frequency at pin 13 and the shift frequency, f_s at pin 12 (see figure 26). Smaller adjustments in the frequencies can be made by a series resistor to the capacitors. The approximate frequency calculation formula is:

$$f = 1/(1.3 \cdot 10^6 \cdot C)$$

Tone ringer sound output

The volume control resistor (see fig. 26) on pin 14 controls the width of the output pulses, hence the energy to the loudspeaker. The lower the resistance, the wider the pulse and the higher the energy.

Microprocessor mode: The toneringer circuit (see fig. 27) can be programmed to interface a microprocessor. It will feed the processor with power during the presence of ringing signal on the line. Two different configurations can be used:

1. With volume control at pin 14. The TTLsignal, 1-4 Vpp (referred to groud) is fed into pin 13 through a 100 kΩ resistor. Pin 12 is connected to pin 17 through a 1MΩ resistor to lift it up. The DC supply to the processor has to be solved in an alternative way.
2. Providing the processor with DC power. The TTL signal 1-4 Vpp is fed into pin 13 through a 100 kohm resistor. A resistor to ground at pin 12 programs how much DC supply current is available at pin 14. In this case the output volume can be optimized by connecting a capacitor across the loudspeaker output, it increases the output pulse width.

Note: The capacitor across the loud speaker influences the frequency characteristics of the power amplifier for speech. The maximum DC supply current that can be taken out of pin 14 is dependent of the amplitude and impedance of the ringing signal on the line.

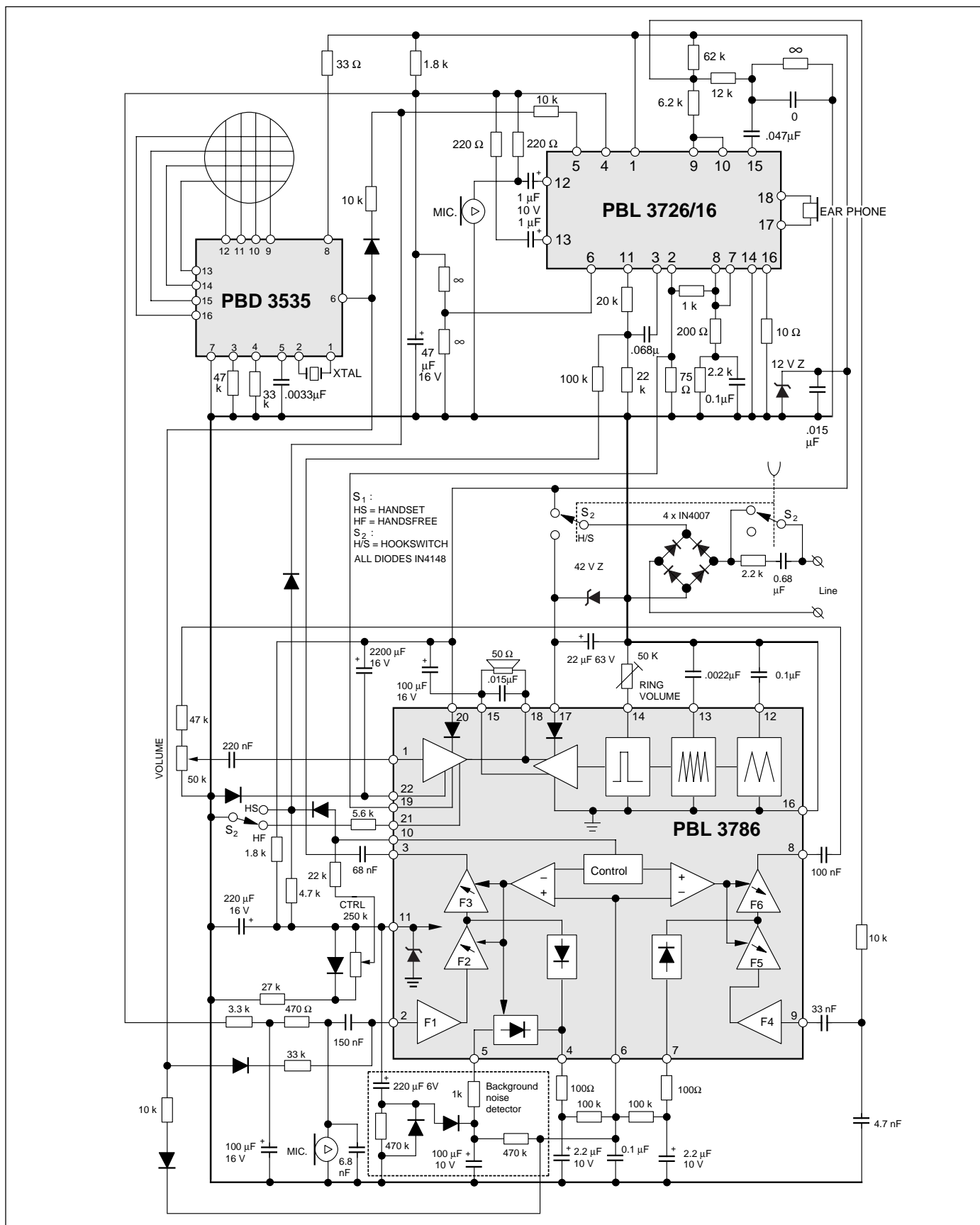


Figure 30. Application 1.

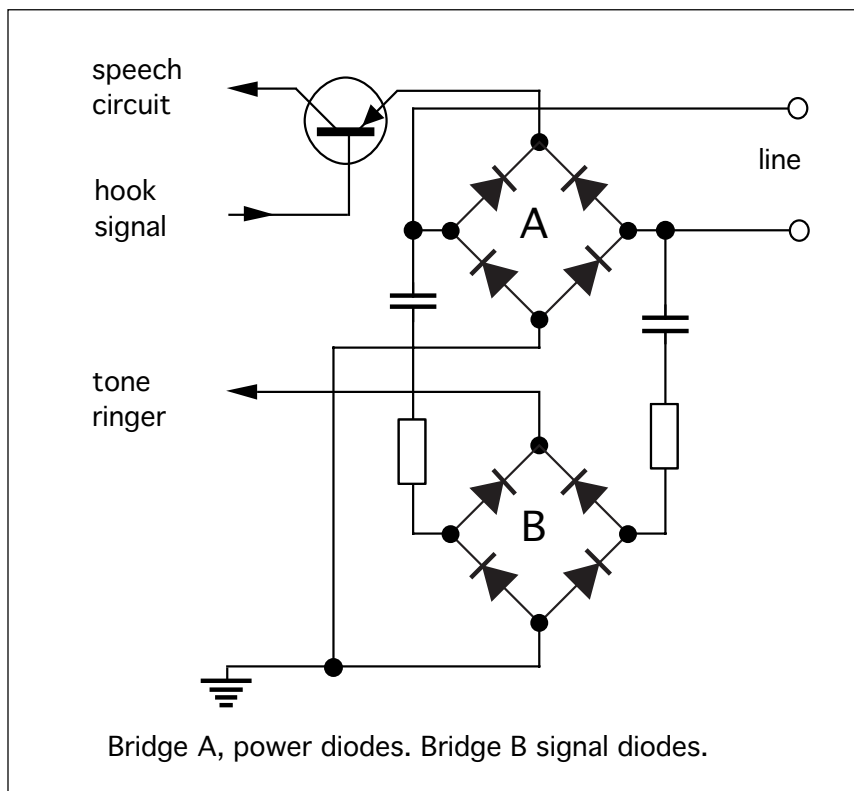


Figure 32. Electronic hook switch.

PBL 3786

Ordering Information

Package	Temp. Range	Part No.
Plastic DIL	-20 to 70°C	PBL 3786
PLCC	-20 to 70°C	PBL 3786QN
PLCC	-20 to 70°C	PBL 3786QN-T

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