PBM 3910 Digital Speech Controller

Description

The PBM 3910 Digital Speech Controller is a voice-switch circuit for use in hands-free speakerphones. Two main attenuators D_M and D_{LS} perform soft-switching of a microphone and a loudspeaker channel to prevent audible "clicks" being heard at switch over. To eliminate howling under all conditions, the sum of the attenuation in each channel is kept constant at 50 dB. The two (analogue) attenuators are digitally controlled by a 5-bit word. Each attenuator ramps between 0 dB and 50 dB attenuation in steps of 1.6 dB, under the control of a digital control section. There are three digital inputs; Mic / $\overline{\text{Loudsp}}$. (microphone / loudspeaker channel control), Idle / $\overline{\text{Active}}$ and Rate (attack time for the microphone channel). An external RC-network is used to set the clock frequency.

Two control attenuators provide the signals for an external level detector / comparator circuit. The control attenuators also provide the necessary hysteresis in the operation of the voice switch.

An advanced digital volume control, consisting of a 4-bit A/D converter, controls the volume in the loudspeaker channel as well as adjusting the hysteresis in the voice-switch to compensate for weak signals on the telephone line.

The device is manufactured in a low-power CMOS process and can therefore be used in line-powered applications.

Key Features

- Digitally controlled ramping of the attenuators
- Advanced digital volume control
- 50 dB attenuation range in each channel
- Low power CMOS
- Low voltage operation, down to 3V

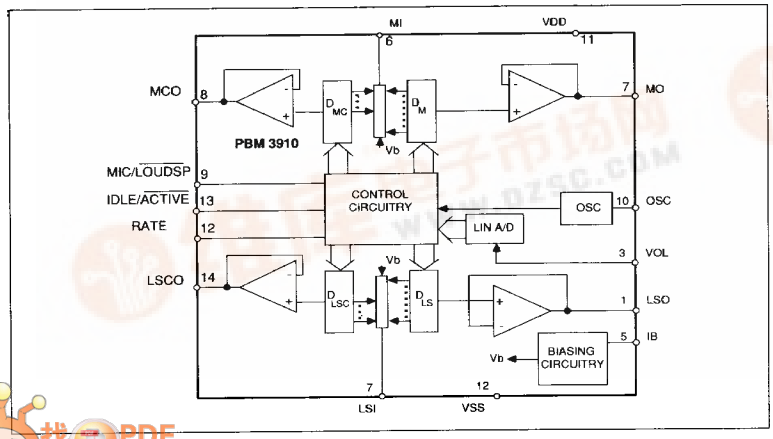
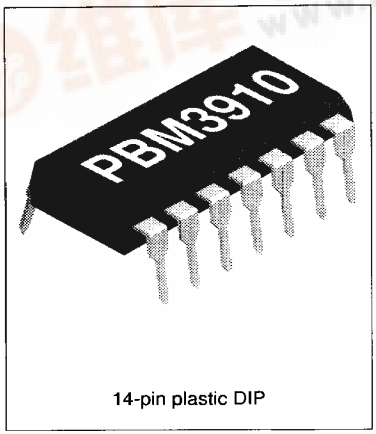


Figure 1. Functional diagram.



14-pin plastic DIP

Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Supply voltage	V_{dd}	0	6.0	V
Storage temperature	T_{Stg}	-55	+125	°C
Operating ambient temperature	T_{Amb}	-15	+70	°C
Voltage on any pin, (Note 1)		V_{SS}-0.3	V_{DD}+0.3	V

Electrical Characteristics

At T_{Amb} = +25 °C unless otherwise noted.

Parameter	Ref. fig.	Conditions	Min	Typ	Max	Unit
Attenuators D_M, D_{LS}, D_{MC}, D_{LSC}						
Maximum input voltage V_I, Note 2		V_{DD} = 5V, R_{Bias} = 120 kohm				
		THD < 2% (D_M, D_{LS}), R_L = 10 kohm		3.0		V_{pp}
		V_{DD} = 3.5 V, R_{Bias} = 120 kohm				
		THD < 2% (D_M, D_{LS}), R_L = 10 kohm		1.5		V_{pp}
Input impedance MI, LSI (Note 2)			30			kohm
Range of attenuation (Table 1)		V_{VOLI} = 0 V				
D_M, D_{LS}				0-50		dB
D_{MC}				0-18		dB
D_{LSC}				0-25		dB
Nominal attenuation		0 dB setting, R_L = 10 kohm	0	0.1	0.3	dB
Total Harmonic Distortion, D_M, D_{LS}		V_{DD} = 3.0 V, I_{Bias} = 16 µA		1		%
		V_I = 1.0 V_{pp}, R_L = 10 kohm				
Output noise voltage at MO, LSO, MCO, LSCO Psophometric weighted relative to 1 V_{rms}				-90	-80	dB
Volume control VOLI						
Control range D_{LS} attenuator		Idle / Active ="0", Mic / Loudsp ="0"				
See table 1		V_{VOLI} = 0 - V_{DD}/2		0-22.6		dB
0 dB voltage		V_{VOLI}		0	0.01•V_{DD}	
-22.6 dB voltage		V_{VOLI}		0.5•V_{DD}		
Equivalent input resistance		f_{Osc} = 12.5 kHz		50		Mohm
Input Capacitance					20	pF
Logic inputs, Idle / Active, Mic / Loudsp, Rate						
Logic "1" voltage (logic high)			V_{DD}-1			V
Logic "0" voltage (logic low)					V_{SS}+1	V
Input capacitance					20	pF
Clock oscillator						
Oscillator frequency		R_{GL} = 680 kohm, V_{DD} = 5.0 V	11.6	12.5	13.4	kHz
		C_{GL} = 150 pF, V_{DD} = 3.0 - 5.5 V	10.2		13.5	kHz
Temperature coefficient				-300		ppm
Power supply						
Recommended supply voltage			3		5.5	V
DC supply current		V_{DD} = 5 V, R_{Bias} = 220 kohm		0.6	0.9	mA
		V_{DD} = 3 V, R_{Bias} = 120 kohm		0.5	0.8	mA

Notes: 1. Should never exceed 6.0 volts

2. The inputs MI and LSI are internally biased to V_{DD}/2 and should therefore be AC-coupled.

Pin Descriptions

Refer to figure 5

DIP	Name	Description
1	LSO	Output to loudspeaker amplifier from D_{LS} attenuator. Output impedance is approx 1 ohm.
2	LSI	Input to loudspeaker channel attenuator D_{LS}. Input impedance is typically 65 kohm.
3	VOLI	DC-input for the internal volume control. A DC-voltage on this pin of $V_{DD}/2$ corresponds to minimum volume (max attenuation 22.6 dB) when the loudspeaker channel is open. 0 V DC input corresponds to maximum volume. Careful design necessary due to very high input impedance.
4	V_{SS}	The most negative supply voltage on the chip.
5	Bias	The resistance between this input and ground (V_{SS}) determines the bias currents for the internal amplifiers. A bias resistance of 220 kohm is recommended at V_{DD} = +5 V.
6	MI	Input to the microphone channel attenuator D_M. Input impedance is typically greater than 65 kohm.
7	MO	Output to the telephone circuit from D_M attenuator. Output impedance is approx 1 ohm.
8	MCO	Output of the control attenuator D_{MC}. This output is used to feed an external level detector/comparator section. Output impedance approx. 1 ohm.
9	Mic/$\overline{\text{Loudsp}}$	A logic high on this input opens the microphone channel, a logic low opens the loudspeaker channel. Idle/Active (pin 13) must be low to open any channel. The input to this pin is derived from an external level detector/comparator section.
10	OSC	This input is the oscillator input. A resistor of 680 kohms to V_{DD} and a capacitor of 150 pF to ground (V_{SS}) set the oscillator frequency to 12.5 kHz (nominal) The oscillator pin can also be driven from an external clock.
11	V_{DD}	The most positive supply voltage on the chip
12	Rate	A logic high on this input sets the attack time for the microphone channel to 2.5 ms (from idle state to fully open). A logic low sets the attack time to 20 ms.
13	Idle / $\overline{\text{Active}}$	A logic high on this input sets all attenuators to their idle position, regardless of the Mic/Loudsp or VOLI inputs. When Idle / Active is low, the Mic / Loudsp input is used to open the microphone or loudspeaker channel respectively.
14	LSCO	Output of the control attenuator D_{LSC}. This output is used to feed and external level detector comparator section. Output impedance approx. 1 ohm.

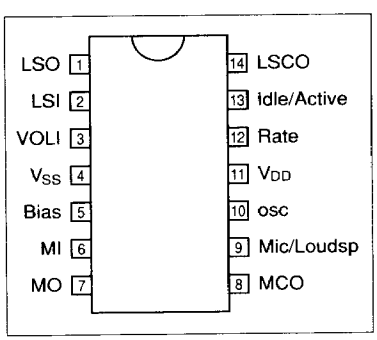


Figure 2. Pin configurations.

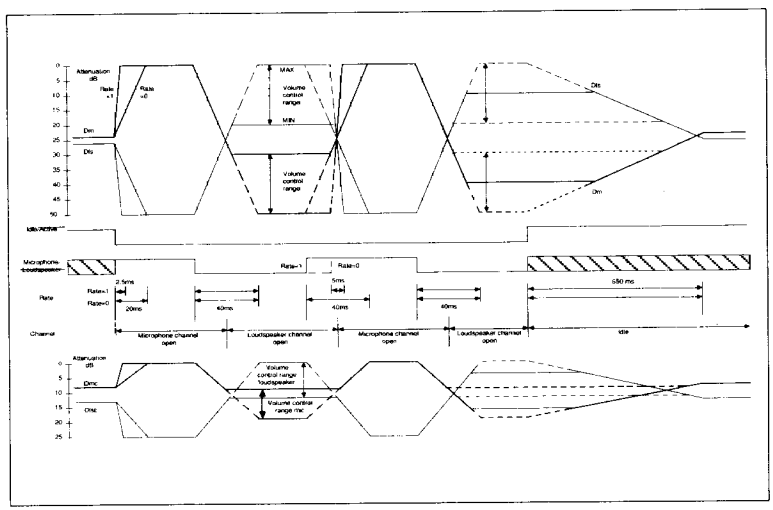


Figure 3. Timing diagram.

Functional Description

The two main attenuators D_M and D_{LS}, one in each direction, transmit and receive, attenuate the signals in complementary fashion, under the control of a digital control section.

Three steady states exist, microphone channel open, loudspeaker channel open and idle. The attenuation is 0 dB in an open state, 50 dB in a closed state and 25 dB in the idle state in each channel. See table 2.

All switching times are derived from an on-chip oscillator. Th nominal switching times (f_{osc} = 12.5 kHz) are shown in figure 3. The Rate input provides an option to select the attack time for the microphone channel of 2.5 ms or 20 ms (from idle to microphone channel open). If no signal is present in either channel (Idle / Active =1 the attenuators ramp slowly (650 ms) back to the idle state. If required, it is possible to change the timings by selecting another clock-frequency.

The two control attenuators D_{MC} and D_{LSC} provide two attenuated signals for an external level detector / comparator circuit. These attenuators also provide hysteresis in the operation of the voice switch.

An advanced digital volume control is incorporated. A DC-voltage is used to set the attenuation level in the loudspeaker channel when open. The sum of attenuation in both channels is kept constant at 50 dB to prevent howling at any volume setting.

The volume control will also adjust the attenuation in the control attenuators, in such way that the hysteresis will increase when compensating (i.e. increasing the volume) for weak incoming signals.

The volume control covers a range of approx 22 dB, see table 1.

Applications information

A typical application of the PBM 3910 is shown in figure 4.

Two operational amplifiers are used as peak-detectors for each channel, while a dual comparator is used as level detector. The comparator circuitry is arranged to interface with the logic inputs (Mic / Loudsp. and Idle / Active) of the PBM 3910.

The operation of the level detector/ comparator section is as follows: A signal

	D_M dB	D_{LS} dB	D_{MC} dB	D_{LSC} dB	$D_{LSC} - D_{MC}$ dB
	0.0	50	0.0	25.0	25.0
	1.6	48.4	0.0	25.0	
	3.2	46.8	1.2	23.3	24.5
	4.8	45.2	1.2	23.3	
	6.5	43.5	2.4	21.7	24.1
	8.1	41.9	2.4	21.7	
	9.7	40.3	3.6	20.0	23.6
	11.3	38.7	3.6	20.0	
	12.9	37.1	4.8	18.3	23.1
	14.5	35.5	4.8	18.3	
	16.1	33.9	6.0	16.7	22.7
	17.7	32.3	6.0	16.7	
	19.4	30.6	7.2	15.0	22.2
	21.0	29.0	7.2	15.0	
	22.6	27.4	8.4	13.3	21.7
Idle state	24.2	25.8	8.4	13.3	
	25.8	24.2	9.6	11.7	21.3
	27.4	22.6	9.6	11.7	
	29.0	21.0	10.8	10.0	20.8
	30.6	19.4	10.8	10.0	
	32.3	17.7	12.0	8.3	20.3
Volume	33.9	16.1	12.0	8.3	
control	35.5	14.5	13.2	6.7	19.9
range	37.1	12.9	13.2	6.7	
(when D_{LS}	38.7	11.3	14.4	5.0	19.4
is open)	40.3	9.7	14.4	5.0	
	41.9	8.1	15.6	3.3	18.9
	43.5	6.5	15.6	3.3	
	45.2	4.8	16.8	1.7	18.5
	46.8	3.2	16.8	1.7	
	48.4	1.6	18.0	0.0	18.0
	50.0	0.0	18.0	0.0	

Table 1. Relationships between the four attenuator settings

	Attenuation level, dB			
State	D_M	D_{LS}	D_{MC}	D_{LSC}
Idle	25	25	9	12.5
Microphone channel open	0	50	0	25
Loudspeaker channel open	50-X	X	$[\frac{50-X}{50}] \cdot 18$	$\frac{X}{50} \cdot 25$

X is controlled by the DC-voltage at the V_{VOLI} input. X - 0 to 22.6 when V_{VOLI} = 0 to $V_{DD}/2$

Table 2. Attenuation levels for the three steady states.

in the microphone channel produces an increased DC-level at "A" while a signal in the loudspeaker channel produces an increased DC-level at "B". Comparator B senses which of the two signals is the strongest and generates the logic signal Mic / Loudsp. The Idle/ Active signal is generated either by c omparator A or by comparator B. Once a channel is opened, the hysteresis causes the signal from that channel to increase to prevent random cut-off during normal speech. When no signal is present (Idle / Active = logic high) there will be 25 dB attenuation in each of the main attenuators, corresponding to the idle state.

The threshold level of the microphone channel is set by Vref 1, while the threshold level of the loudspeaker channel is set by the difference Vref 2 - Vref 1. The reference voltages are derived from a simple circuit consisting of a forward-biased diode. The gain in the microphone pre-amplifier should be adjusted to give an idle-to-send turn on at an appropriate sound pressure level. A suitable gain in the microphone pre-amplifier is 35-40 dB if a general purpose electret microphone is used.

All signal inputs and outputs at the PBM 3910 are AC-coupled.

A linear potentiometer is used for the volume control. The volume control covers a range of approximately 22 dB when the loudspeaker channel is open.

A speech network consisting of a DC-coupled transformer and an active two to four wire hybrid forms the interface to the telephone line.

Due to the low power consumption of the PBM 3910, the complete speaker-phone can be powered directly from the telephone line.

Ordering Information

Package	Temp. Range	Part No.
Plastic DIP	-15 to 70°C	PBM 3910N

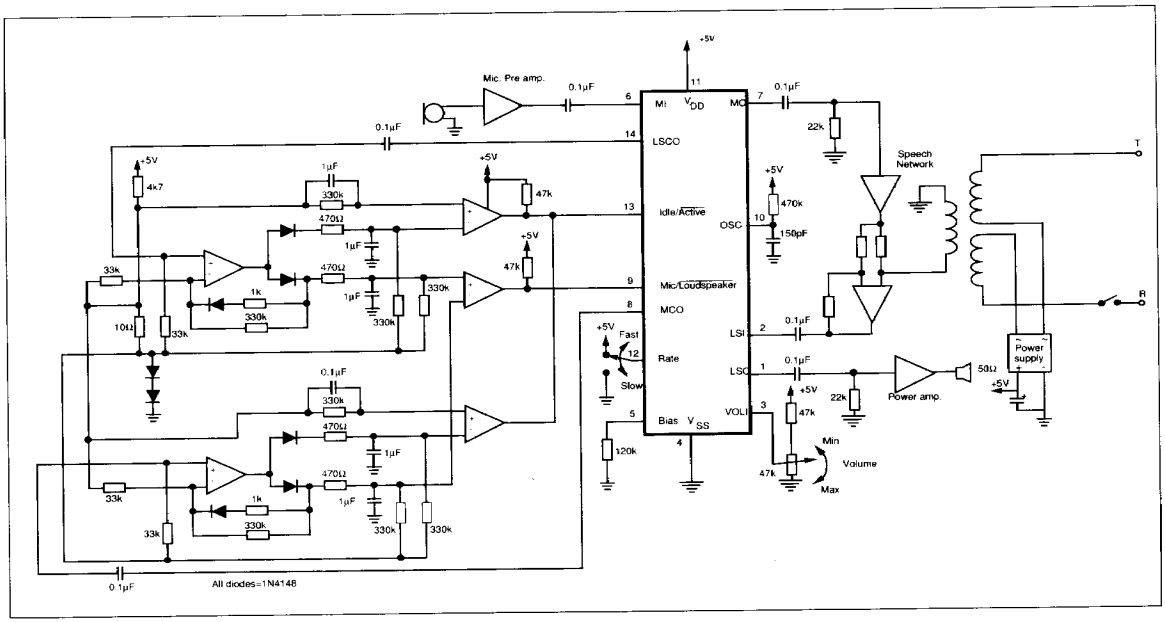


Figure 4. Typical application.