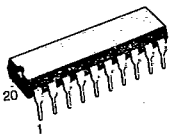
LB1009

PRELIMINARY DATA

AN AT&T PRODUCT

MICROPROCESSOR CONTROLLED, SINGLE-CHIP TELEPHONE INTEGRATED CIRCUIT

- CAPABLE OF SPEECH TRANSMISSION DOWN TO 3mA LOOP CURRENT
- A FEATURE MODE FUNCTION INDICATES POWER PORT (DR) STATUS
- PROVIDES A POWER PORT FOR DRIVING A LED OR A MICROPROCESSOR
- AN ALERTER SELECT OPTION OF 1200 Hz/ 1500 Hz OR 1800 Hz/2250 Hz
- REQUIRES ONLY A 2 CONTACT SWITCH HOOK
- COMPATIBLE WITH ELECTRET MICROPHONES
- OPERATES FROM POWER SUPPLIED BY THE CENTRAL OFFICE

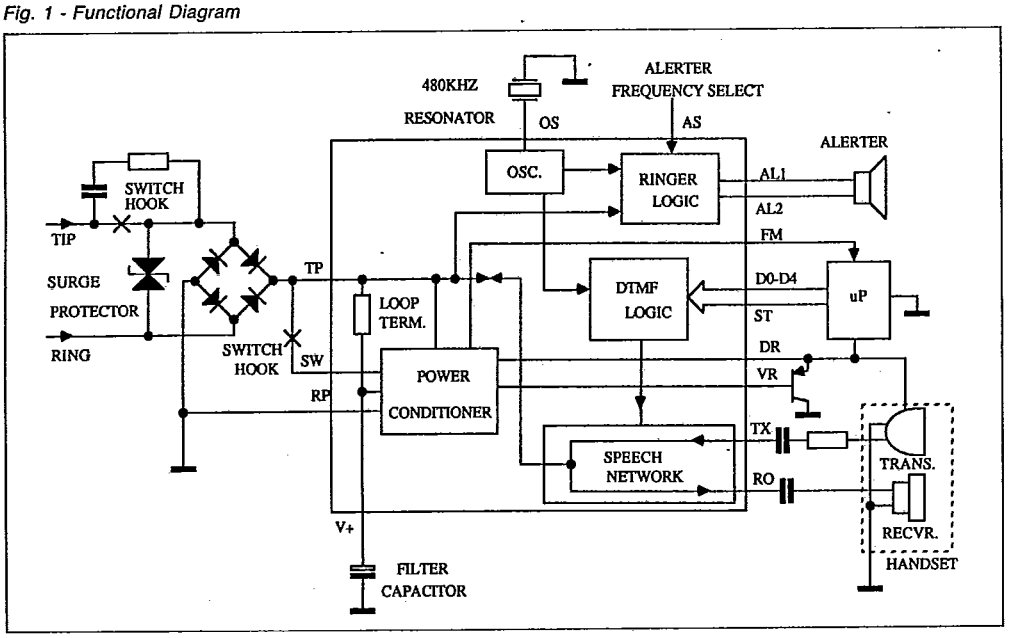


DIP-20 B Plastic

ORDERING NUMBER: LB1009AE

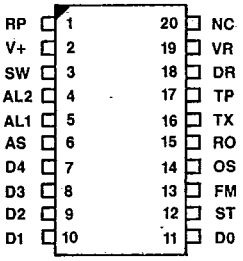
The LB1009 integrated circuit requires only four capacitors, one resistor, a ceramic resonator, a transistor, a surge protection diode, and a polarity guard to provide all of the touch-tone electronic functions. Four basic telephone functions are accomplished: furnishes AC and DC loop termination for both switch hook states; transmits and receives voice signals; provides dual-tone multi-frequency (DTMF) signals to the Central Office; properly distinguishes between spurious noise and genuine ringing signals providing a distinctive audible alerter output.

Fig. 1 - Functional Diagram



LB1009

PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Description
1	RP	The Ring Prime terminal is the more negative input connected to Tip-Ring on the negative side of the polarity guard bridge. It is also the logic common (ground) point.
2	V+	The most positive DC voltage (filtered) on the device. This voltage is derived from the Tip-Ring inputs. It is used to supply internal circuits.
3	SW	Turns on Transmit/Receive circuitry when connected through switch hook contact to TP.
4 5	AL2 AL1	Output terminals for driving an alerter. The ringer logic distinguishes between genuine ringing and other noise signals present on the telephone loop, and provides a distinctive audible output. The alerter can be driven differentially or single ended. If the alerter is driven single ended to RP, the second output can be used to drive a visible indicator to RP. Volume can be adjusted by placing a resistor in series with terminals AL1 or AL2.
6	AS	Logic input used to determine alerter frequency. This pin can be programmed via a microprocessor or mechanically set to provide an output frequency of 1200 Hz shifted to 1500 Hz, (AS pin set to logic low or left open), or 1800 Hz frequency shifted to 2250 Hz, (AS pin set to logic high or pulled up to V+ through a 100kΩ resistor).
7 8 9 10 11	D4 D3 D2 D1 D0	DTMF signals are controlled by these inputs via a microprocessor. These inputs are disabled when the telephone goes on-hook and in the low power mode (FM open). These inputs are CMOS and TTL compatible (See Table 1)
12	ST	Data Strobe from microprocessor. It loads the DTMF inputs on a rising edge pulse.
13	FM	Feature Mode is an open collector output which shorts to RP when the telephone goes off-hook. Long loops (with two telephones off-hook) can result in a "speech only, low power" mode of operation. FM will "open circuit" under these conditions.
14	OS	Resonator connection. This logic is designed to operate with a some 480 KHz ceramic resonator. The resonator frequency is divided down to perform various synchronous clock tasks.
15	RO	Output to 600Ω receiver, capacitively coupled.
16	TX	Input from the transmitter, capacitively coupled.
17	TP	The Tip Prime terminal is the more positive input to the Power Conditioner and Speech Network. It connects to Tip-Ring on the positive side of the polarity guard bridge.
18	DR	A low impedance regulated port for powering a microprocessor and transmitter. Currents (in the full feature mode) will provide a minimum of 800μA for a maximum of 3.3 volts. Excess set current not used by internal circuits will appear on DR to power external circuits. Current not used by external circuits will be passed to RP via an external PNP transistor.
19	VR	This voltage is a reference when the set is off-hook. When connected to DR via PNP transistor (see Fig. 4), a regulated voltage is produced on DR.
20	NC	No connection. This pin may not be use as a tie point for external circuitry.

LB1009

ABSOLUTE MAXIMUM RATINGS (at 25°C unless otherwise specified)

Symbol	Parameter	Value	Unit
V_{TP}	Circuit Voltage	20	V
I_{TP}	Circuit Current	120	mA
P_{tot}	Total Power Dissipation	0.5	W
T_{op}	Operating Temperature	0 to 60	°C
T_{stg}, T_j	Storage and Junction Temps.	−45 to 125	°C
—	Pin temperature (soldering 15 sec)	300	°C

THERMAL DATA

R_{TH}	Thermal impedance, junction to ambient	61	°C/W

ELECTRICAL CHARACTERISTICS (at 25°C unless otherwise specified)

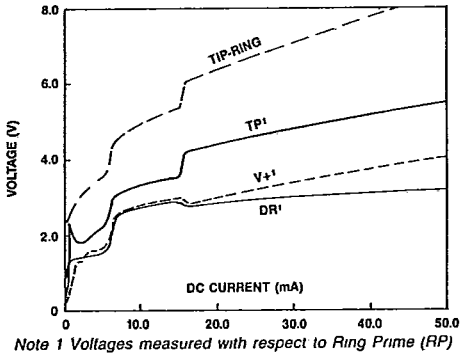
Parameter	Test Conditions	Min	Typ	Max	Unit
OFF-HOOK DC TESTS					
V_{TP}	I_{TP} = 8mA, speech	3.00	—	3.35	V
	I_{TP} = 20mA, speech	3.80	—	4.30	
	I_{TP} = 90mA, speech	5.35	—	6.75	
	I_{TP} = 20mA, dialing	4.10	—	4.56	
V_{V+}	I_{TP} = 8mA, speech	2.66	—	2.78	
	I_{TP} = 20mA, speech	2.75	—	3.20	
	I_{TP} = 90mA, speech	4.50	—	5.60	
$V_{TP} - V_{V+}$	I_{TP} = 20mA, dialing	1.20	—	1.55	
I_{DR}	I_{TP} = 20mA, speech	9.0	—	11.0	mA
	I_{TP} = 90mA, speech	70.5	—	73.5	
	I_{TP} = 20mA, dialing	7.5	—	9.7	
	I_{TP} = 90mA, dialing	69.0	—	72.0	
$I_{TP,u,s}$	Upper Switch Point, speech	15.5	—	19.5	
$I_{TP,l,s}$	Lower Switch Point, speech	11.5	—	15.0	
$I_{hys,s}$	$I_{TP,u,s} - I_{TP,l,s}$	4.5	—	—	
$I_{TP,l,d}$	Lower Switch Point, dialing	12.0	—	16.0	
$I_{hys,d}$	$I_{TP,u,s} - I_{TP,l,d}$	3.5	—	—	
$V_{RO} - V_{SG}$	I_{TP} = 20mA, speech	−0.1	—	0.1	V
	I_{TP} = 20mA, dialing	−0.1	—	0.1	
OFF-HOOK AC TESTS					
$G_{XMIT} = v_{TP}/v_{TX}$	I_{TP} = 8mA	4.3	—	6.2	—
	I_{TP} = 20mA v_{TX} = 0.1Vrms	6.2	—	8.9	
	I_{TP} = 90mA	4.3	—	6.2	
$G_{RCV} = v_{RCV}/v_{CO}$	I_{TP} = 20mA	0.21	—	0.30	
	I_{TP} = 90mA v_{CO} = 0.5Vrms	0.21	—	0.30	

LB1009

ELECTRICAL CHARACTERISTICS (Continued)

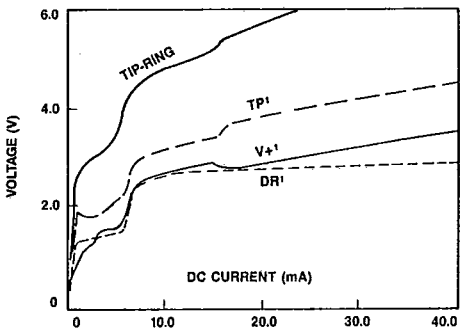
Parameter	Test Conditions	Min	Typ	Max	Unit
OFF-HOOK AC TESTS (Continued)					
$R_{TX} = v_{TX}/i_{TX}$	I_{TP} = 20mA v_{TX} = 0.1Vrms	—	30K	—	Ω
$R_{RO} = v_{RO}/i_{RO}$	I_{TP} = 20mA v_{RO} = 0.1Vrms	—	600	—	Ω
$R_{TP} = v_{TP}/i_{TP}$	I_{TP} = 20mA I_{TP} = 90mA v_{CO} = 0.5Vrms	650 650	— —	950 850	Ω
$G_{SDT} = v_{RCV}/v_{TX}$	I_{TP} = 8mA I_{TP} = 20mA v_{TX} = 0.1Vrms I_{TP} = 90mA	0.3 0.3 0.3	— — —	0.6 0.6 0.6	—
$v_{TP,l}$, low group out	I_{TP} = 20mA	0.291	—	—	Vrms
$v_{TP,h}$, high group out	I_{TP} = 20mA	0.367	—	—	Vrms
$v_{TP,e}$ Extraneous voice-band signals	I_{TP} = 20mA, dialing	—	—	0.045	Vrms
$v_{TP,l,h}$ total DTMF, both groups	I_{TP} = 90mA, dialing	—	—	0.869	Vrms
$G_{XMIT} = v_{TP}/v_{TX}$	I_{TP} = 20mA, v_{TX} = 0.1Vrms dialing	—	—	0.03	—
ON-HOOK DC TESTS					
I_{TP}	V_{TP} = 3V	—	—	35	μA
$V_{TP,th}$, Threshold of detection	Ringing detected	5.9	—	6.7	V
I_{TP}	V_{TP} = 10V V_{TP} = 20V	1.5 1.5	— —	2.0 2.5	mA
ON-HOOK AC TESTS					
$v_{AL} = v_{AL2} - v_{AL1}$	V_{TP} = 10V V_{TP} = 20V	5.0 15.0	— —	7.0 17.0	V_{p-p}

Fig. 2 - Typical DC V-I Characteristics (Dial Mode)



Note 1 Voltages measured with respect to Ring Prime (RP)

Fig. 3 - Typical DC V-I Characteristics (Speech Mode)



APPLICATION

(Refer to Functional Diagram, Fig. 1)

Polarity Guard:
An external bridge rectifier (see Figure 4) ensures proper voltage polarity on the device, with a minimum voltage drop across the bridge rectifier.

Oscillator:
An external 480 KHz ceramic resonator, in conjunction with an internal oscillator control circuit, is used to provide timing functions for the logic circuits.

DTMF Generation Logic:
This circuit connects to a microprocessor. The logic circuitry decodes the microprocessor input states to generate accurately timed digital control signals for a D/A converter.

Ringer Logic:
This circuit determines the presence of a true incoming ringing signal by up or down counting, depending upon the instantaneous magnitude of an incoming transient. After a positive decision, the logic provides suitable timed inputs to an external alerter device. Volume can be controlled by placing resistors in series with leads AL1 or AL2. See "AS" pin description for alerter frequency-select capability.

Power Conditioner:
This set of circuits provides accurate temperature compensated current and voltage references for the other circuit blocks. It also sets the loop loading and digital reset states for the various types of operation, i.e., on-hook, off-hook, and multiple telephone sets.

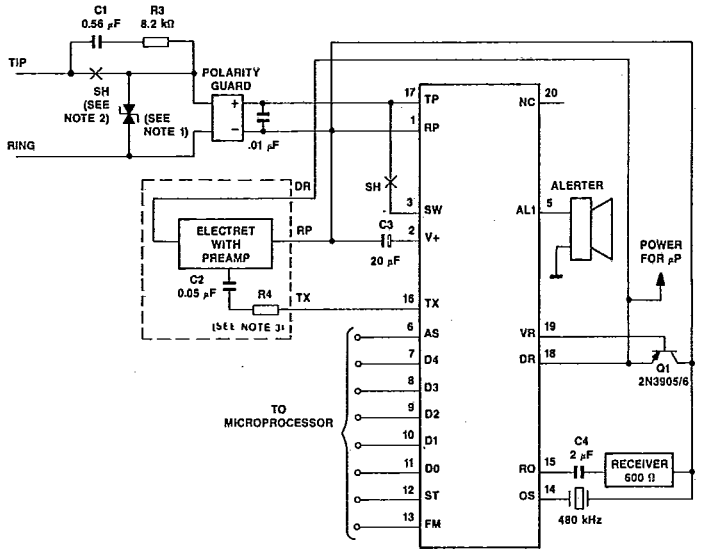
Speech Network:
This analog circuit block provides proper transmission levels in both directions. Since the local talker's signal is normally larger than the received signal at the telephone set terminals, an out-of-phase portion of the transmitted signal is also sent to the receiver. This proportion is designed to provide a level in the talker's ear (the "sidetone") between "too hot" and "dead". The DTMF D/A converter is placed in the transmit path during dialing, while the receive-gain path is simultaneouly attenuated. Transmit mute is provided independently of receive mute and is under control of the microprocessor. Transmit mute is not functional in the speech only mode (telephone set current is below approximately 16mA). When transmit mute is functional, it provides a minimum of 40 dB attenuation.

Driver (DR) and Voltage Regulator (VR) Ports: (see Pin Description Key)

External Components:
Only two switch hook contacts are required with this device. In going off-hook, the contact connected to the SW pin should open simultaneously with, or before the other switch hook contact. As shown in the functional diagram (see Figure 1), the LB1009 needs only four capacitors, one resistor, a ceramic resonator, a transistor, a surge protection diode, and a polarity guard to provide all of the basic touch-tone electronic functions. An alerter, a telephone handset (containing the transmitter and receiver), and a microprocessor are also illustrated.

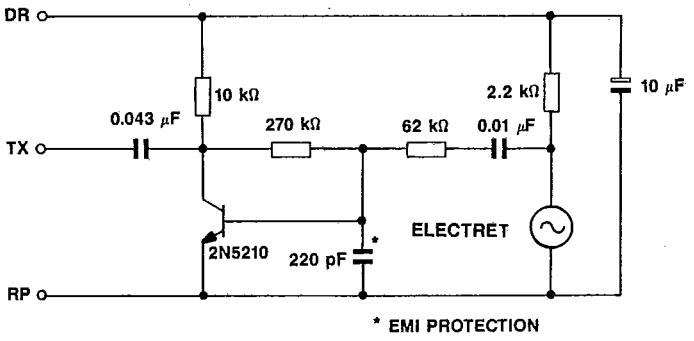
The application diagram (see Figure 4) contains detailed information. The LB1009 can be used in a 4-wire handset application.
A preamplifier circuit which can be used with a microphone is shown in Fig. 5.

Fig. 4 - Typical Application Diagram



NOTES:
1. 18 volt, 150 amp surge protector. (LS5018)
2. SH denotes switch hook.
3. Value of R4 adjusts transmit gain for various applications.

Fig. 5 - Electret Interface Circuitry



NOTE: This interface circuit may be used for some commercially available electrets.

Table 1 - Microprocessor Control Logic table.

DTMF Signal Inputs					Mode of Operation	Tones (Design Value)	
D4	D3	D2	D1	D0			
1	0	0	0	*	Dial	L1 (697 Hz)	Single Tones
1	0	1	0	*	Dial	L2 (770 Hz)	
1	1	0	1	0	Dial	L3 (825 Hz)	
1	1	1	1	0	Dial	L4 (941 Hz)	
1	1	*	0	0	Dial	H1 (1209 Hz)	
1	1	*	0	1	Dial	H2 (1336 Hz)	
1	0	*	1	0	Dial	H3 (1477 Hz)	
0	0	0	0	0	Dial	H1, L1	
0	0	0	0	1	Dial	H2, L1	DTMF Tones
0	0	0	1	0	Dial	H3, L1	
0	0	1	0	0	Dial	H1, L2	
0	0	1	0	1	Dial	H2, L2	
0	0	1	1	0	Dial	H3, L2	
0	1	0	0	0	Dial	H1, L3	
0	1	0	0	1	Dial	H2, L3	
0	1	0	1	0	Dial	H3, L3	
0	1	1	0	0	Dial	H1, L4	
0	1	1	0	1	Dial	H2, L4	
0	1	1	1	0	Dial	H3, L4	
*	0	0	1	1	Speech, Transmit Mute		Special Functions
*	0	1	1	1	Speech		
*	1	0	1	1	Dial, No Tone		

* = Don't Care