Speakerphone IC

GENERAL DESCRIPTION

The XR-T6425 speakerphone IC is a low cost solution for the implementation of a hands-free telephone. It is a convenient way of carrying on conversation without using the handset, while the user is talking into a microphone and listening from a loudspeaker located on the desk. It is ideal for hands-free conference calls.

The XR-T6425 contains most of the circuits to eliminate singing and excessive background noise in a single chip solution.

FEATURES

Low Operating Voltage (4.5 V)
Single Chip Speakerphone
No External Adjustments
Smooth T/R Switching
Background Noise Detection and Suppression
On-chip Hybrid Circuit

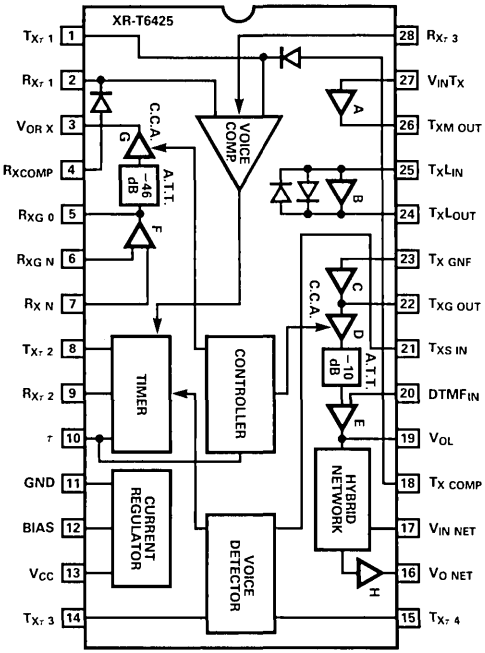
APPLICATIONS

Speakerphones
Intercoms
Voice Operated Switches

ABSOLUTE MAXIMUM RATINGS

Power Supply	16 V
Power Dissipation	700 mW
Operating Temperature	0°C to 70°C
Storage Temperature	-55°C to 150°C

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-T6425CN	Ceramic	0°C to 70°C
XR-T6425CP	Plastic	0°C to 70°C

SYSTEM DESCRIPTION

The XR-T6425 single chip speakerphone IC is designed to operate from the phone line and allows hands-free operation. The chip contains most of the necessary circuits to reduce external component count and performs half-duplex operation. The internal circuits consist of a transmitter, receiver and control logic. DTMF input is provided for Touch Tone operation. An adjustable threshold circuit is provided to separate voice from ambient noise.

ELECTRICAL CHARACTERISTICS

Test Conditions: $T_A = 25°C$, $V_{CC} = 5$ V, f = 1 kHz, unless otherwise specified.

SYMBOL	PARAMETERS	TYPICAL VALUE	UNIT	CONDITIONS
V_{CC}	Operating Voltage	4.5 - 6.5	V	
I_C	Operating Current	8.0	mA	No Input of T/R Signal
R_{XS}	Receiving Sensibility	–64	dBm	
T_{XS}	Transmitting Sensibility	–74	dBm	
G_{VRX}	Receiving Gain	–22.5	dB	Receiving Mode
G_{VTX}	Transmitting Gain	44	dB	Transmitting Mode
V_{INLIM}	Mic Input Level	–55	dBm	THD = 1%
Att_{RX}	Receving Loss	–50	dB	Receiving Transmitting Relative Value
Att_{TX}	Transmitting Loss	–50	dB	Transmitting Receiving Relative Value

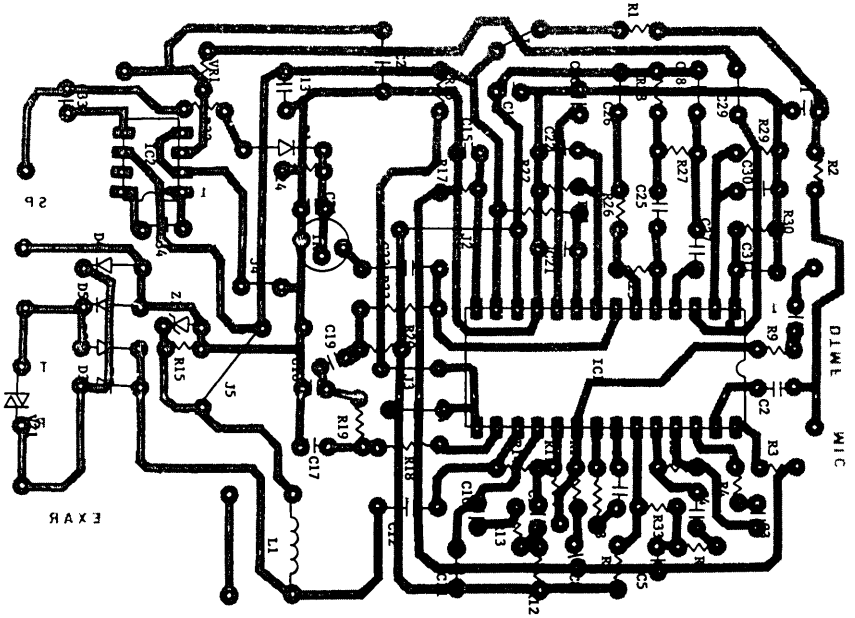


Figure 1. Circuit Board Layout

PIN DESCRIPTIONS

Pin	Symbol	Description
1	$TX_{\tau 1}$	Transmitter stabilization time constant.
2	$RX_{\tau 1}$	Receiver stabilization time constant.
3	$V_O RX$	Receiver output.
4	R_X COMP	T/R comparator input for receiver.
5	$R_X G_O$	Receive buffer output.
6,7	R_{XGN},R_{XIN}	Receive buffer inputs.
8	$TX_{\tau 2}$	Transmitter holding time constant.
9	$RX_{\tau 2}$	Receiver holding time constant.
10	τ	T/R switching time constant
11	GND	Ground
12	BIAS	Mid-point of the supply voltage ($V_{CC}/2$).
13	V_{CC}	Most positive voltage.
14	$TX_{\tau 3}$	Voice rectifier time constant.
15	$TX_{\tau 4}$	Ambient noise and voice discriminator time constant.
16	V_{ONE}	Hybrid network output.
17	V_{IN} NET	Hybrid network input.
18	T_X COMP	T/R comparator input for transmitter.
19	V_{OL}	Transmit signal output.
20	DTMFIN	DTMF input terminal.
21	T_{XS} IN	Voice detector output.
22	T_{XG} OUT	Transmit amplifier output.
23	TXG NF	Transmit amplifier input.
24	$T_X L_{OUT}$	Transmit limiter amplifier output.
25	$T_X L_{IN}$	Transmit limiter amplifier input.
26	$T_X M_{OUT}$	Transmit buffer output.
27	$V_{IN} T_X$	Transmit buffer input.
28	$RX_{\tau 3}$	Receiver stabilizer.

FUNCTION DESCRIPTIONS

Transmitting Sections

The transmit path is divided into five sections: buffer, limiter, bandpass filter and amplifier, current control attenuator and mixer.

Buffer

The buffer is used to do impedance matching and gives 9 dB gain to signal.

Limiter

The output of the buffer is fed to limiting amplifier to increase the signal level. The gain can be set with two external resistors R_4, R_5 to obtain proper signal level.

Bandpass Filter and Amplifier

Filtering is performed in this section to eliminate unwanted signals. Gain of 20 dB is set for this section and output of this amplfier is capacitor coupled to control lgoic to eliminate DC components for decision making.

Current Control Attenuator

The current control attenuator is used to do smooth switching between transmitter and receiver to perform half-duplex operation.

Mixer

Additional input is provided for DIMF signaling and driving transmitting signals to telephone line through impedance matched resistance R_{14} (680Ω), and simultaneously inputs to the hybrid network for cancelling signals to receiving circuit.

Receiving Section

Incoming signals are amplified by AMP H and AMP F after passing through hybrid network. The result is fed to current control attenuator to control output level.

Ambient Noise and Voice Discrimination Section

This section discriminates voice signals from ambient noises of input signals from microphone at transmtting mode and gives the instruction signals to keep transmitting mode or changes the mode to T/R signal attenuator circuit through timer circuit.

Controller Section

This section compares transmit signal level (pin 18) with receive signal level (pin 4) according to the time settled by C_{31}, R_{30}, C_{30}, R_{29}, the result is applied to the timer circuit which is triggered with the resistor value of R_3 connected from Pin 28 to Ground.

Timer Section

This section generates the signals to T/R signal attenuator circuit and provides the time constant for T/R switching.

Transmit time constant is set by pin 8, receive time constant is set by pin 9, and T/R switching time constant is determined by pin 10. Pin 10 outputs 2.5V at transmit mode and +1.2V at receive mode.

Hybrid Network

Hybrid network is used to attenuate transmit signal going to the receive path. Equivalent circuit is shown below.

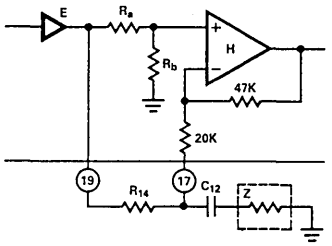


Figure 2. Equivalent Circuit

TIMING CALCULATIONS

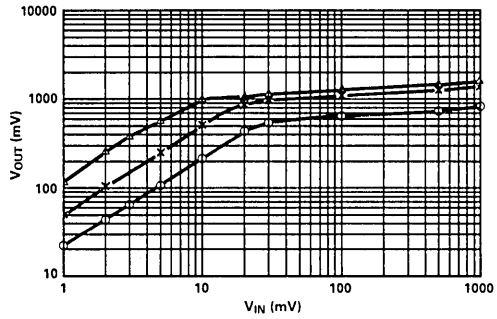
Transmit Rise Time = $C_{22} \times 10^4$	4.7 μF, τ = 47 ms
Transmit Hold Time = $C_{22} \times R_{22}$	4.7 μF, 470K, τ = 2.2S
Receive Rise Time = $C_{21} \times 10^3$	.47 μF, τ = .47 ms
Receive Hold Time = $C_{21} \times R_{21}$	.47 μF, 470K, τ = .22S

DESCRIPTION OF AMPLIFIERS

Type	Application	Gain	Remarks
A	TX amplifier	0 dB	For the impedance conversion (emitter-follower microphone) (Zin = 20 kΩ)
B	TX amplifier	R5/R 4	Negative input limiter amplifier, clamping at $\frac{1\ VF}{\sqrt{2}}$ of Pin 24 output. (V0 = 700 mVrms)
C	TX amplifier	20 dB	Fixed gain amplifier.
D	TX amplfier	TX: 20 dB ST: −5 dB RX: −23 dB	Gain varies with transmitting (TX), receiving (RX) and standby (ST).
E	TX amplifier	R11/R10	Output gain - the signal applied as a negative input when DTMF is used.
F	RX amplifier	R25/R26	Differential input amplifier. Its output is connected to C.C.A. (amp G) through pin 5 and ATT.
G	RX amplifier	TX: −23 dB ST: −5 dB RX: 20 dB	Gain varies with transmitting (TX), receiving (RX) and standby (ST).
H	RX amplifier	7.5 dB	For the network loss correction of receving (RX) side.

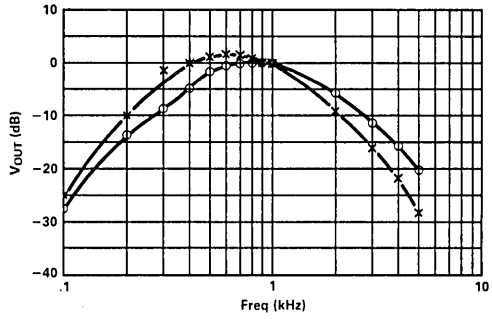
TYPICAL CHARACTERISTICS

XR-T6425 RECEIVING ALC CHARACTERISTICS
V_{CC} = 5.6V, APPLYING 12V BETWEEN L1 AND L2



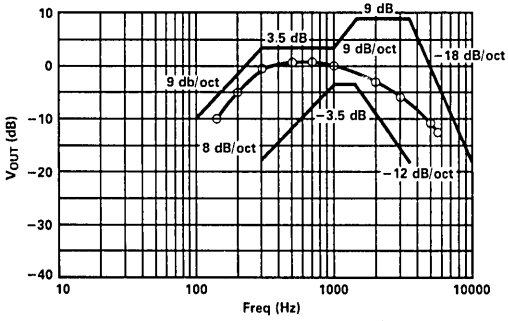
△ C × B ○ A

XR-T6425 RECEIVING FREQUENCY CHARACTERISTICS
V_{CC} = 5.6V, APPLYING 12V BETWEEN L1 AND L2



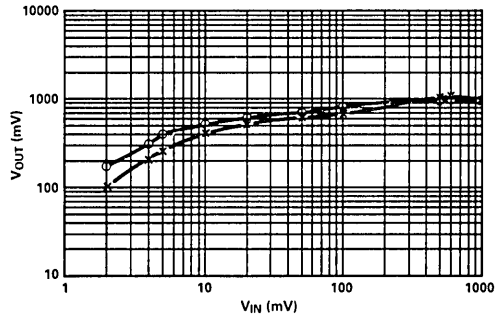
× BEFORE MOUNTING C32 ○ AFTER MOUNTING C32

XR-T6425 TRANSMITTING FREQUENCY CHARACTERISTICS
V_{CC} = 5.6V, APPLYING 12V BETWEEN L1 AND L2



❋ INDICATION VALUES OF M3

XR-T6425 MICROPHONE AMPLIFIER LIMITER CHARACTERISTICS
V_{CC} = 5.6V, APPLYING 12V BETWEEN L1 AND L2



× INDICATION VALUES OF M2 ○ INDICATION VALUES OF M3

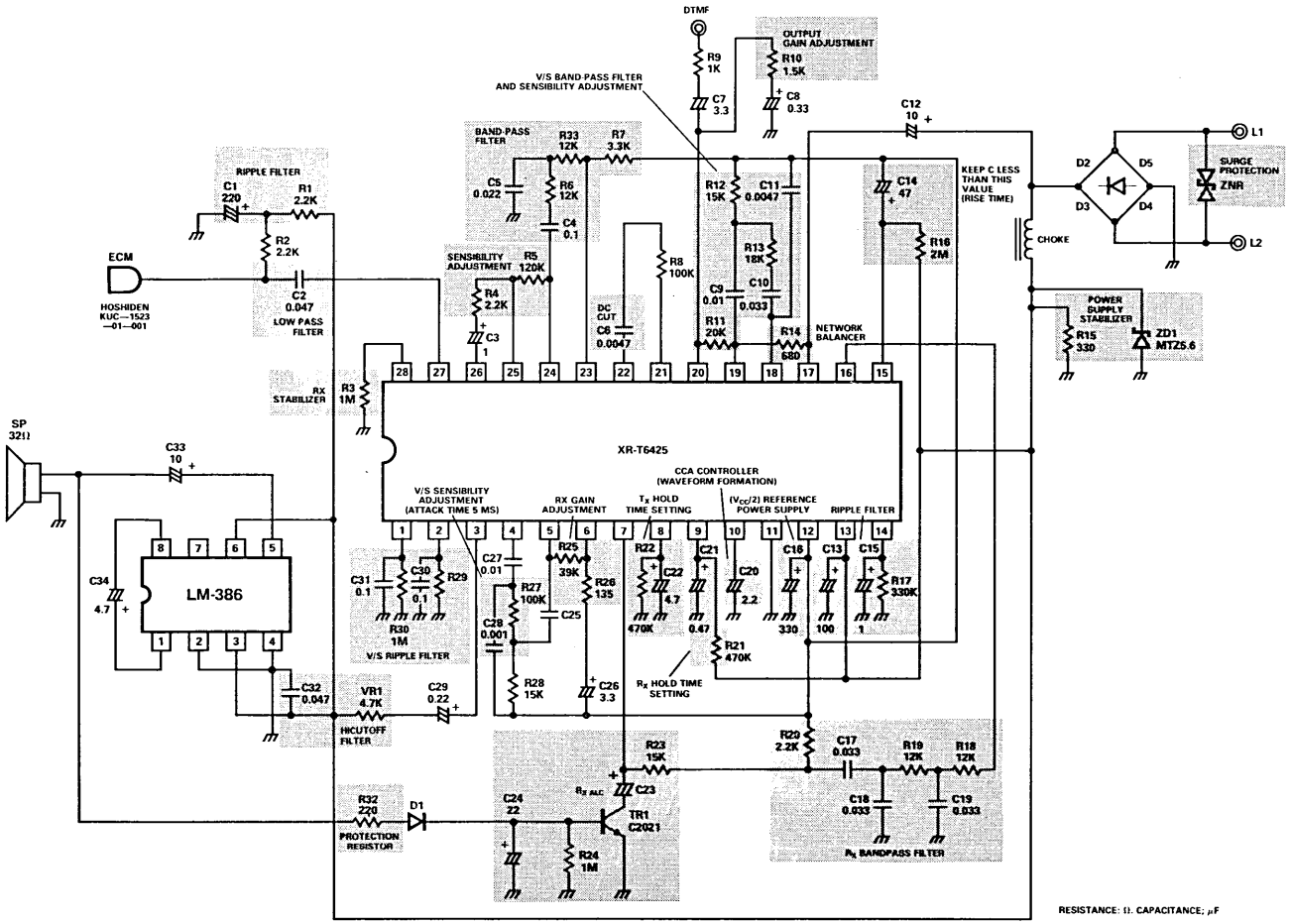


Figure 3. Typical Line Powered Application Circuit

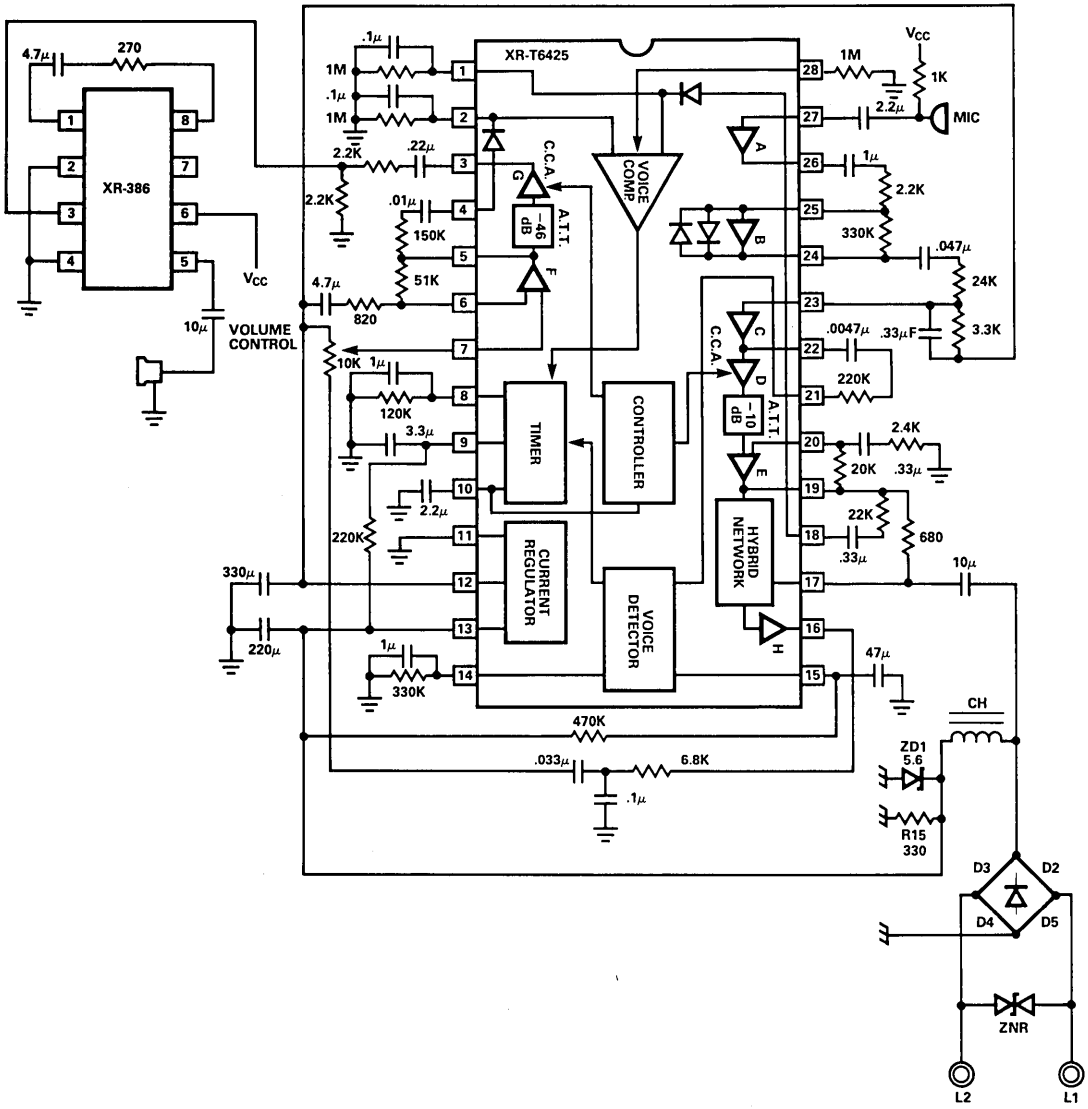


Figure 4. Simplified Application Schematic