

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

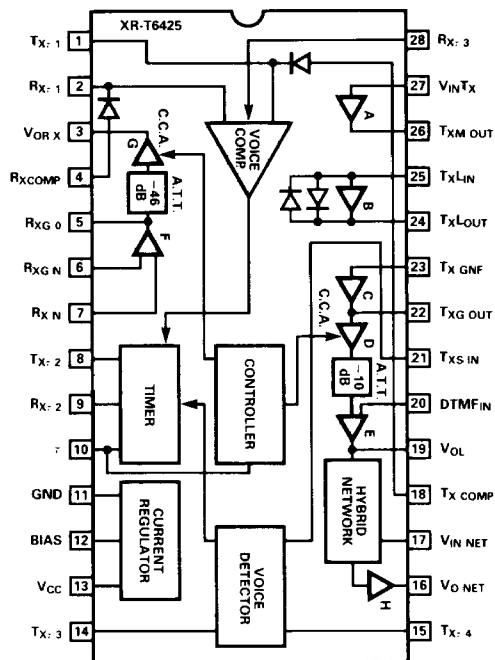
APPLICATIONS

- 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-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.

XR-T6425

ELECTRICAL CHARACTERISTICS

Test Conditions: $T_A = 25^\circ\text{C}$, $V_{CC} = 5\text{ V}$, $f = 1\text{ kHz}$, 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} | Receiving Loss | -50 | dB | Receiving Transmitting Relative Value |
| Att_{TX} | Transmitting Loss | -50 | dB | Transmitting Receiving Relative Value |

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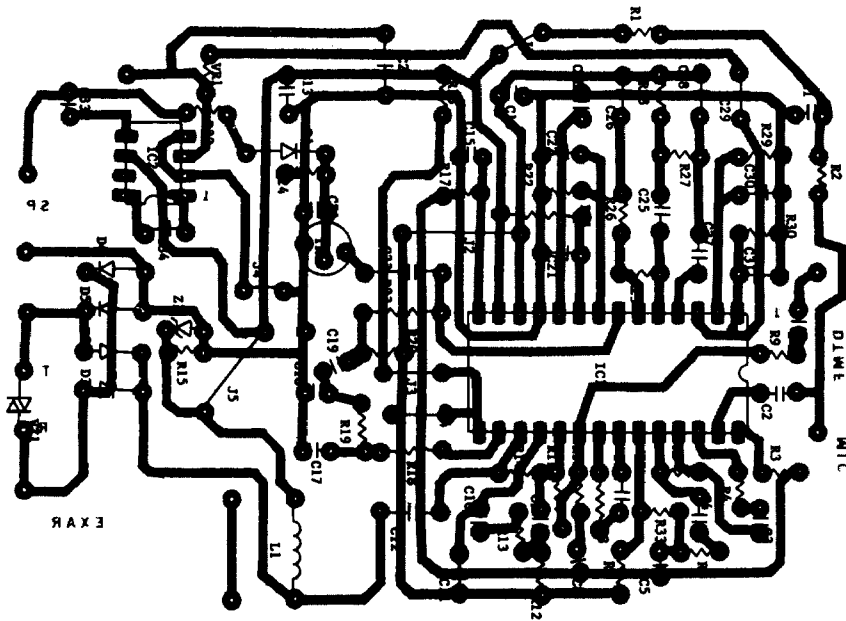


Figure 1. Circuit Board Layout

PIN DESCRIPTIONS

| Pin | Symbol | Description |
|-----|--------------------|--|
| 1 | $T_{X\tau 1}$ | Transmitter stabilization time constant. |
| 2 | $R_{X\tau 1}$ | Receiver stabilization time constant. |
| 3 | V_{ORX} | Receiver output. |
| 4 | $R_X COMP$ | T/R comparator input for receiver. |
| 5 | R_{XGO} | Receive buffer output. |
| 6,7 | R_{XGN}, R_{XIN} | Receive buffer inputs. |
| 8 | $T_{X\tau 2}$ | Transmitter holding time constant. |
| 9 | $R_{X\tau 2}$ | 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 | VCC | Most positive voltage. |
| 14 | $T_{X\tau 3}$ | Voice rectifier time constant. |
| 15 | $T_{X\tau 4}$ | Ambient noise and voice discriminator time constant. |
| 16 | VONE | 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 | DTMF IN | DTMF input terminal. |
| 21 | $T_{XS IN}$ | Voice detector output. |
| 22 | $T_{XG OUT}$ | Transmit amplifier output. |
| 23 | $T_{XG IN}$ | Transmit amplifier input. |
| 24 | $T_{XL OUT}$ | Transmit limiter amplifier output. |
| 25 | $T_{XL IN}$ | Transmit limiter amplifier input. |

| | | |
|----|---------------|-------------------------|
| 26 | T_{XMOUT} | Transmit buffer output. |
| 27 | V_{INTX} | Transmit buffer input. |
| 28 | $R_{X\tau 3}$ | 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 amplifier is capacitor coupled to control logic 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} (680 Ω), 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 transmitting 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 C31, R30, C30, R29, the result is applied to the timer circuit which is triggered with the resistor value of R3 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.

DESCRIPTION OF AMPLIFIERS

| Type | Application | Gain | Remarks |
|------|--------------|--------------------------------------|---|
| A | TX amplifier | 0 dB | For the impedance conversion (emitter-follower microphone) ($Z_{in} = 20\text{ k}\Omega$) |
| B | TX amplifier | R5/R 4 | Negative input limiter amplifier, clamping at $\frac{1}{\sqrt{2}} V_F$ of Pin 24 output. ($V_0 = 700\text{ mVrms}$) |
| C | TX amplifier | 20 dB | Fixed gain amplifier. |
| D | TX amplifier | 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 receiving (RX) side. |

Hybrid Network

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

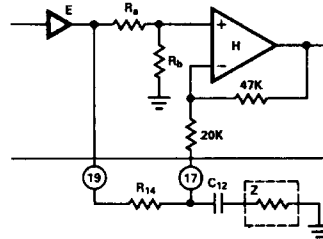


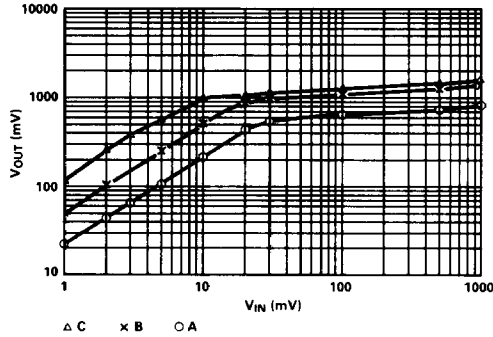
Figure 2. Equivalent Circuit

TIMING CALCULATIONS

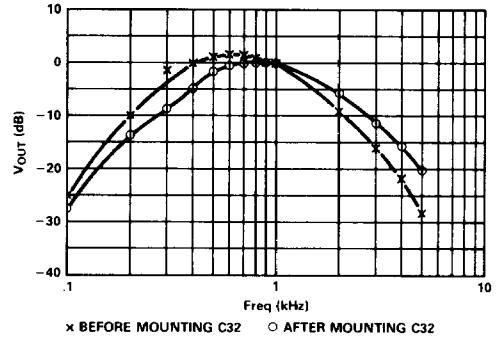
| | |
|---|---|
| Transmit Rise Time = $C_{22} \times 10^4$ | $4.7\ \mu\text{F}, \tau = 47\ \text{ms}$ |
| Transmit Hold Time = $C_{22} \times R_{22}$ | $4.7\ \mu\text{F}, 470\text{K}, \tau = 2.2\text{S}$ |
| Receive Rise Time = $C_{21} \times 10^3$ | $47\ \mu\text{F}, \tau = .47\ \text{ms}$ |
| Receive Hold Time = $C_{21} \times R_{21}$ | $47\ \mu\text{F}, 470\text{K}, \tau = .22\text{S}$ |

TYPICAL CHARACTERISTICS

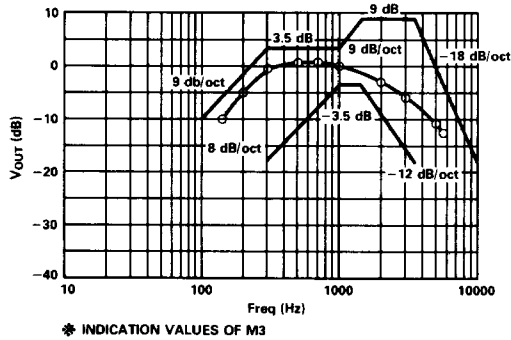
XR-T6425 RECEIVING ALC CHARACTERISTICS
 $V_{CC} = 5.6V$, APPLYING 12V BETWEEN L1 AND L2



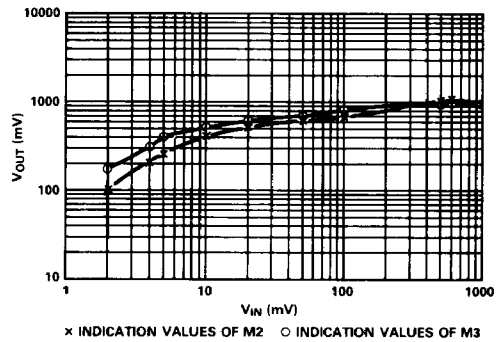
XR-T6425 RECEIVING FREQUENCY CHARACTERISTICS
 $V_{CC} = 5.6V$, APPLYING 12V BETWEEN L1 AND L2

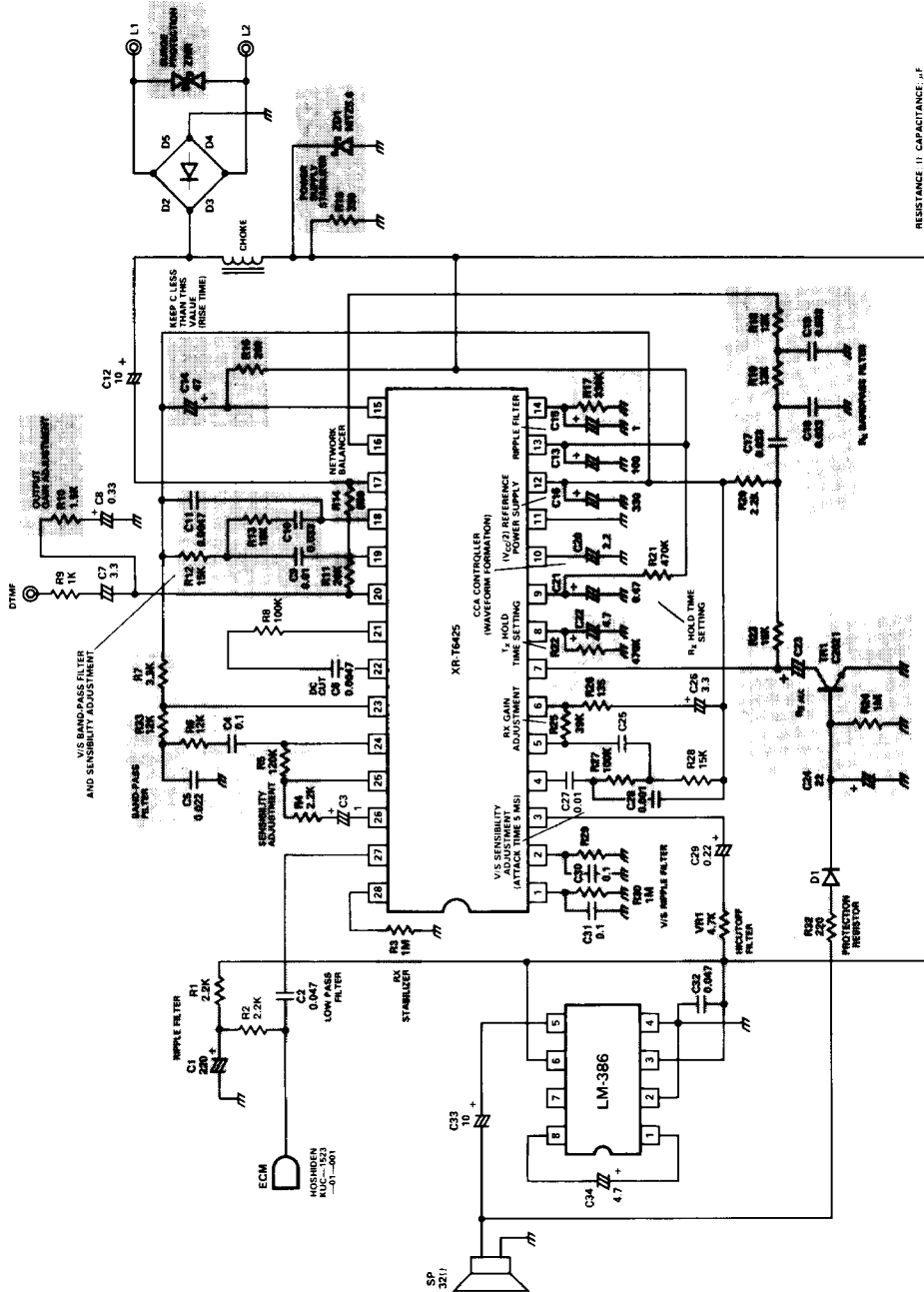


XR-T6425 TRANSMITTING FREQUENCY CHARACTERISTICS
 $V_{CC} = 5.6V$, APPLYING 12V BETWEEN L1 AND L2



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





RESISTANCE, Ω CAPACITANCE, μF

Figure 3. Typical Line Powered Application Circuit

