

## Features

- DC Characteristic Adjustable
- Transmit and Receive Gain Adjustable
- Symmetrical Input of Microphone Amplifier
- Anti-clipping in Transmit Direction
- Automatic Line-loss Compensation
- Symmetrical Output of Earpiece Amplifier
- Built-in Ear Protection
- DTMF and MUTE Input
- Adjustable Sidetone Suppression Independent of Sending and Receiving Amplification
- Speech Circuit with Two Sidetone Networks
- Built-in Line Detection Circuit
- Integrated Amplifier for Loud-hearing Operation
- Anti-clipping for Loudspeaker Amplifier
- Improved Acoustical Feedback Suppression
- Power Down
- Voice Switch
- Tone Ringer Interface with DC/DC Converter
- Zero Crossing Detection
- Common Speaker for Loud-hearing and Tone Ringer
- Supply Voltages for all Functional Blocks of a Subscriber Set
- Integrated Transistor for Short-circuiting the Line Voltage
- Answering Machine Interface
- Operation Possible from 10 mA Line Currents
- Filters against EMI on Critical I/O

## Applications

- Feature Phone
- Answering Machine
- Fax Machine
- Speaker Phone

## Benefits

- Savings of One Piezoelectric Transducer
- Complete System Integration of Analog Signal Processing on One Chip
- Very Few External Components
- Fewer Components for EMI Protection

## Description

The microcontroller-controlled telephone circuit U4090B-P is a linear integrated circuit for use in feature phones, answering machines and fax machines. It contains the speech circuit, tone ringer interface with DC/DC converter, sidetone equivalent and ear protection rectifiers. The circuit is line powered and contains all components necessary for amplification of signals and adaptation to the line.

An integrated voice switch with loudspeaker amplifier allows loud-hearing or hands-free operation. With an anti-feedback function, acoustical feedback during loud-hearing can be reduced significantly. The generated supply voltage is suitable for a wide range of peripheral circuits.



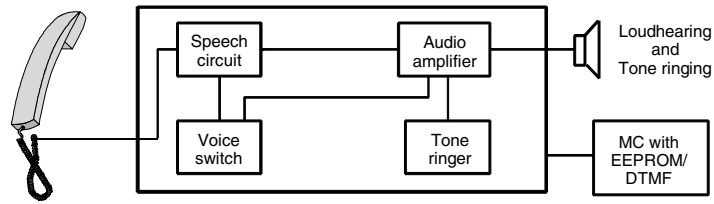
**Monolithic  
Integrated  
Feature Phone  
Circuit EMI  
Improved**

**U4090B-P**

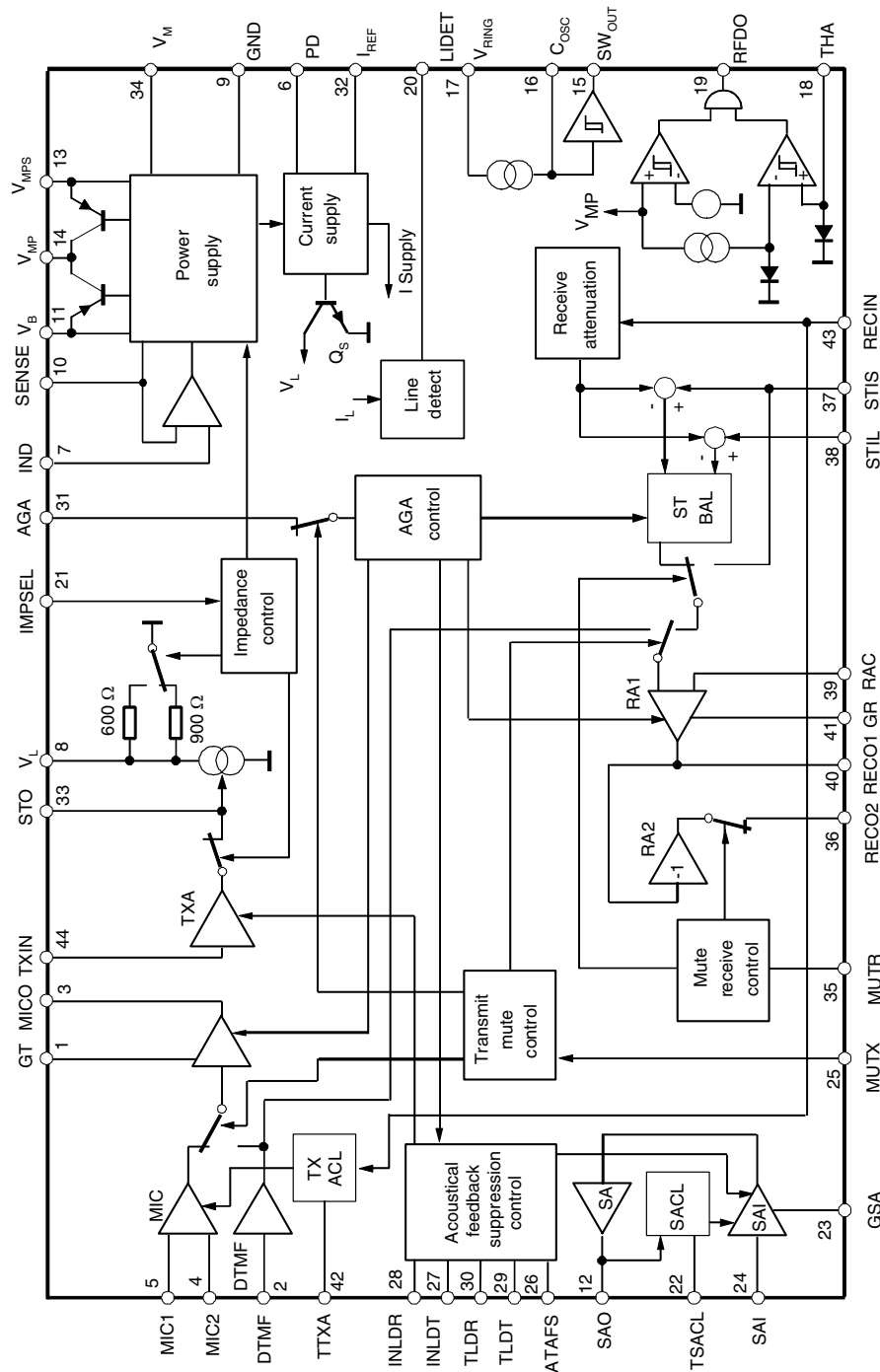
Rev. 4741A-CORD-09/03



**Figure 1. Block Diagram**

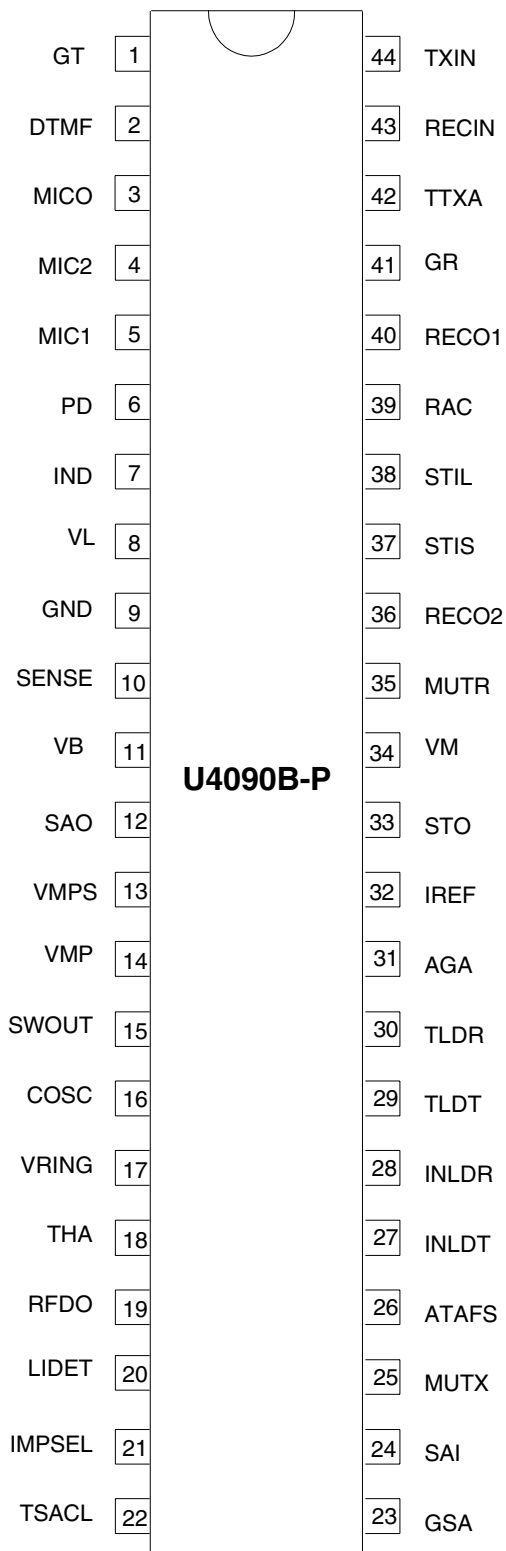


**Figure 2. Detailed Block Diagram**



## Pin Configuration

Figure 3. Pinning SSO44



## Pin Description

| Pin | Symbol | Function                                                                                                                                                                                                                                                                                                                       |
|-----|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | GT     | A resistor from this pin to GND sets the amplification of the microphone and DTMF signals, the input amplifier can be muted by applying VMP to $G_T$                                                                                                                                                                           |
| 2   | DTMF   | Input for DTMF signals, also used for the answering machine and hands-free input                                                                                                                                                                                                                                               |
| 3   | MICO   | Output of microphone preamplifier                                                                                                                                                                                                                                                                                              |
| 4   | MIC 2  | Non-inverting input of microphone amplifier                                                                                                                                                                                                                                                                                    |
| 5   | MIC 1  | Inverting input of microphone amplifier                                                                                                                                                                                                                                                                                        |
| 6   | PD     | Active high input for reducing the current consumption of the circuit, simultaneously $V_L$ is shorted by an internal switch                                                                                                                                                                                                   |
| 7   | IND    | The internal equivalent inductance of the circuit is proportional to the value of the capacitor at this pin, a resistor connected to ground may be used to reduce the DC line voltage                                                                                                                                          |
| 8   | VL     | Line voltage                                                                                                                                                                                                                                                                                                                   |
| 9   | GND    | Reference point for DC- and AC-output signals                                                                                                                                                                                                                                                                                  |
| 10  | SENSE  | A small resistor (fixed) connected from this pin to $V_L$ sets the slope of the DC characteristic and also effects the line-length equalization characteristics and the line current at which the loudspeaker amplifier is switched on                                                                                         |
| 11  | VB     | Unregulated supply voltage for peripheral circuits (voice switch), limited to typically 7 V                                                                                                                                                                                                                                    |
| 12  | SAO    | Output of loudspeaker amplifier                                                                                                                                                                                                                                                                                                |
| 13  | VMPS   | Unregulated supply voltage for micorcontroller, limited to 6.3 V                                                                                                                                                                                                                                                               |
| 14  | VMP    | Regulated supply voltage of 3.3 V for peripheral circuits (especially microprocessors), minimum output current: 2 mA (ringing) 4 mA (speech mode)                                                                                                                                                                              |
| 15  | SWOUT  | Output for driving external switching transistor                                                                                                                                                                                                                                                                               |
| 16  | COSC   | 40-kHz oscillator for ringing power converter                                                                                                                                                                                                                                                                                  |
| 17  | VRING  | Input for ringing signal protected by internal Zener diode                                                                                                                                                                                                                                                                     |
| 18  | THA    | Threshold adjustment for ringing frequency detector                                                                                                                                                                                                                                                                            |
| 19  | RFDO   | Output of ringing frequency detector                                                                                                                                                                                                                                                                                           |
| 20  | LIDET  | Line detect; output is low when the line current is more than 15 mA                                                                                                                                                                                                                                                            |
| 21  | IMPSEL | Control input for selection of line impedance<br>1. 600 $\Omega$<br>2. 900 $\Omega$<br>3. Mute of second transmit stage (TXA); also used for indication of external supply (answering machine); last chosen impedance is stored                                                                                                |
| 22  | TSACL  | Time constant of anti-clipping of speaker amplifier                                                                                                                                                                                                                                                                            |
| 23  | GSA    | Current input for setting the gain of the speaker amplifier, adjustment characteristic is logarithmical, or $RGSA > 2 \text{ M}\Omega$ , the speaker amplifier is switched off                                                                                                                                                 |
| 24  | SA I   | Speaker amplifier input (for loudspeaker, tone ringer and hands-free use)                                                                                                                                                                                                                                                      |
| 25  | MUTX   | Three-state input of transmit mute:<br>1. Speech condition; inputs MIC1/MIC2 active<br>2. DTMF condition; input DTMF active. A part of the input signal is passed to the receiving amplifier as a confidence signal during dialing<br>3. Input DTMF used for answering machine and hands-free use; receive branch not affected |
| 26  | ATAFS  | Attenuation of acoustical feedback suppression, maximum attenuation of AFS circuit is set by a resistor at this pin, without the resistor, AFS is switched off                                                                                                                                                                 |
| 27  | INLDT  | Input of transmit level detector                                                                                                                                                                                                                                                                                               |

## Pin Description (Continued)

| Pin | Symbol | Function                                                                                                                                    |
|-----|--------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 28  | INLDR  | Input of receive level detector                                                                                                             |
| 29  | TLDT   | Time constant of transmit level detector                                                                                                    |
| 30  | TLDR   | Time constant of receive level detector                                                                                                     |
| 31  | AGA    | Automatic gain adjustment with line current, a resistor connected from this pin to GND sets the starting point, maximum gain change: 6 dB.  |
| 32  | IREF   | Internal reference current generation; RREF = 62 k $\Omega$ ; IREF = 20 $\mu$ A                                                             |
| 33  | STO    | Sidetone reduction output<br>Output resistance approximate: 300 $\Omega$ ,<br>Maximum load impedance: 10 k $\Omega$ .                       |
| 34  | VM     | Reference node for microphone-earphone and loudspeaker amplifier, supply for electret microphone (IM $\leq$ 700 mA)                         |
| 35  | MUTR   | Three-state mute input<br>1. Normal operation<br>2. Mute for ear piece<br>3. Mute for RECIN signal<br>Condition of earpiece mute is stored  |
| 36  | RECO 2 | Inverting output of receiving amplifier                                                                                                     |
| 37  | STI S  | Input for sidetone network (short loop) or for answering machine                                                                            |
| 38  | STI L  | Input for sidetone network (long loop)                                                                                                      |
| 39  | RAC    | Input of receiving amplifier for AC coupling in feedback path                                                                               |
| 40  | RECO 1 | Output of receiving amplifier                                                                                                               |
| 41  | GR     | A resistor connected from this pin to GND sets the receiving amplification of the circuit; amplifier RA1 can be muted by applying VMP to GR |
| 42  | TTXA   | Time constant of anti-clipping in transmit path                                                                                             |
| 43  | RECIN  | Input of receiving path; input impedance is typically 80 k $\Omega$                                                                         |
| 44  | TXIN   | Input of intermediate transmit stage, input resistance is typically 20 k $\Omega$                                                           |

Note: Filters against electromagnetic interference (EMI) are located at following pins: MIC1, MIC2, RECIN, TXIN, STIS, STIL and RAC.

## DC Line Interface and Supply-voltage Generation

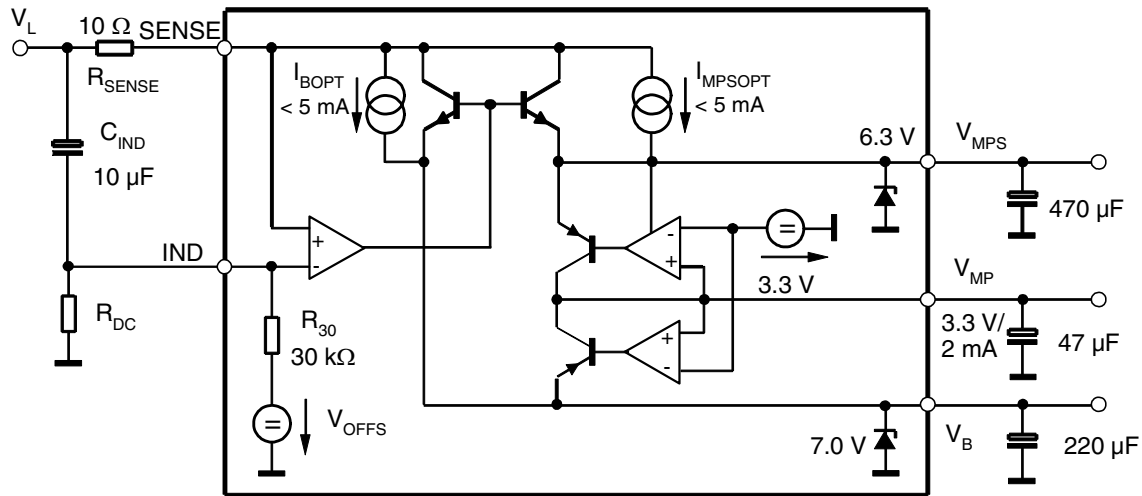
The DC line interface consists of an electronic inductance and a dual-port output stage which charges the capacitors at  $V_{MPS}$  and  $V_B$ . The value of the equivalent inductance is given by:

$$L = R_{SENSE} \times C_{IND} \times ((R_{DC} \times R_{30}) / (R_{DC} + R_{30}))$$

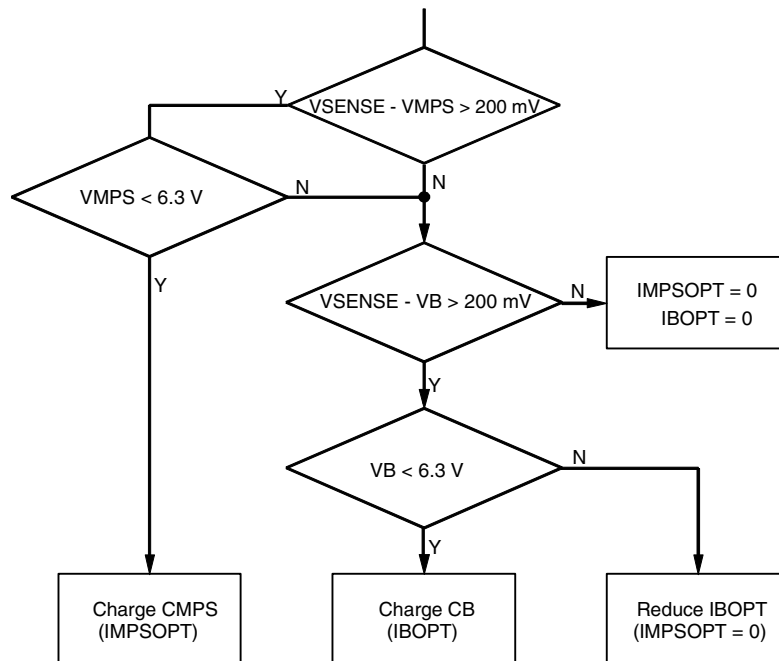
In order to improve the supply during worst-case operating conditions, two PNP current sources -  $I_{BOPT}$  and  $I_{MPSOPT}$  - hand an extra amount of current to the supply voltages when the NPNs in parallel are unable to conduct current.

A flowchart for the control of the current sources (Figure 5) shows how a priority for supply VMPS is achieved.

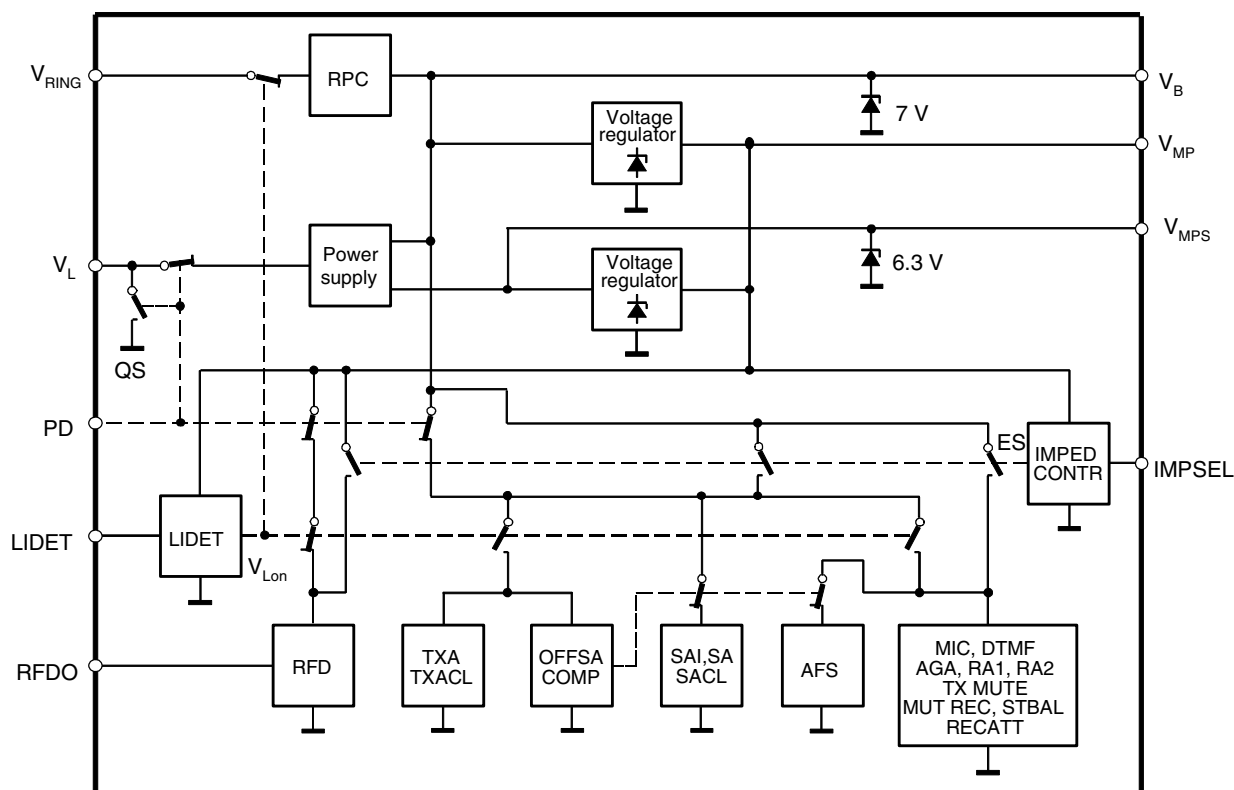
**Figure 4.** DC Line Interface with Electronic Inductance and Generation of a Regulated and an Unregulated Supply



**Figure 5.** Supply Capacitors CMPS and CB Are Charged with Priority on CMPS



**Figure 6.** Supply of Functional Blocks Controlled by Input Voltages  $V_L$ ,  $V_B$ ,  $V_{RING}$  and by Logic Inputs PD and IMPSEL



The U4090B-P contains two identical series regulators which provide a supply voltage  $V_{MP}$  of 3.3 V suitable for a microprocessor. In speech mode, both regulators are active because  $V_{MPS}$  and  $V_B$  are charged simultaneously by the DC-line interface. Output current is 4 mA. The capacitor at  $V_{MPS}$  is used to provide the microcomputer with sufficient power during long-line interruptions. Thus, long flash pulses can be bridged or an LCD display can be turned on for more than 2 seconds after going on hook. When the system is in ringing mode,  $V_B$  is charged by the on-chip ringing power converter. In this mode only one regulator is used to supply  $V_{MP}$  with a maximum of 2 mA.

## Supply Structure of the Chip

A major benefit of the chip is that it uses a very flexible supply structure which allows simple realization of numerous applications such as:

- Group listening phone
- Hands-free phone
- Ringing with the built in speaker amplifier
- Answering machine with external supply

The special supply topology for the various functional blocks is illustrated in Figure 6.

There are four major supply states:

1. Speech condition
2. Power down (pulse dialing)
3. Ringing
4. External supply

1. In speech condition the system is supplied by the line current. If the LIDET-block detects a line voltage above the fixed threshold (1.9 V), the internal signal VLON is activated, thus switching off RFD and RPC and switching on all other blocks of the chip.

At line voltages below 1.9 V, the switches remain in their quiescent state as shown in Figure 7.

OFFSACOMP disables the group listening feature (SAI, SA, SACL, AFS) below line currents of approximately 10 mA.

2. When the chip is in power-down mode (PD = high), e.g., during pulse dialing, the internal switch QS shorts the line and all amplifiers are switched off. In this condition, LIDET, voltage regulators and IMPED CONTR are the only active blocks.
3. During ringing, the supply for the system is fed into  $V_B$  via the ringing power converter (RPC). The only functional amplifiers are in the speaker amplifier section (SAI, SA, SACL).
4. In an answering machine, the chip is powered by an external supply via pin  $V_B$ . This application allows the possibility to activate all amplifiers (except the transmit line interface TXA). Selecting IMPSEL = high impedance activates all switches at the ES line.

## Acoustic Feedback Suppression

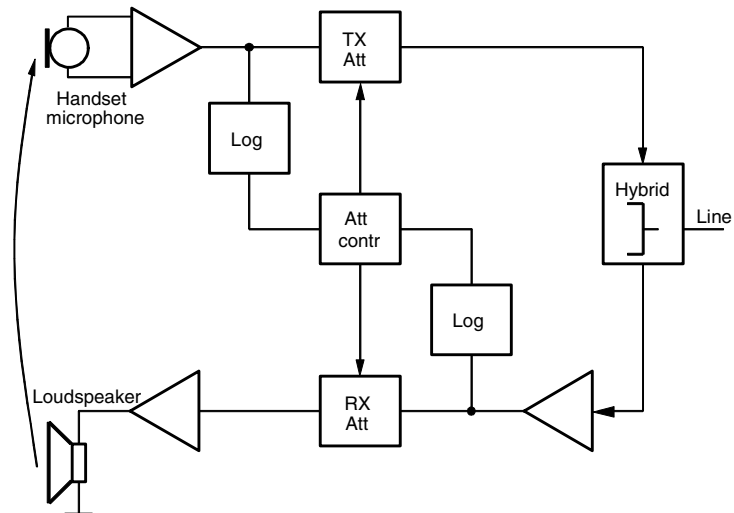
Acoustical feedback from the loudspeaker to the handset microphone may cause instability in the system. The U4090B-P offers a very efficient feedback suppression circuit, which uses a modified voice switch topology. Figure 7 shows the basic system configuration.

Two attenuators (TX ATT and RX ATT) reduce the critical loop gain by introducing an externally adjustable amount of loss either in the transmit or in the receive path. The sliding control in block ATT CONTR determines, whether the TX or the RX signal has to be attenuated. The overall loop gain remains constant under all operating conditions.

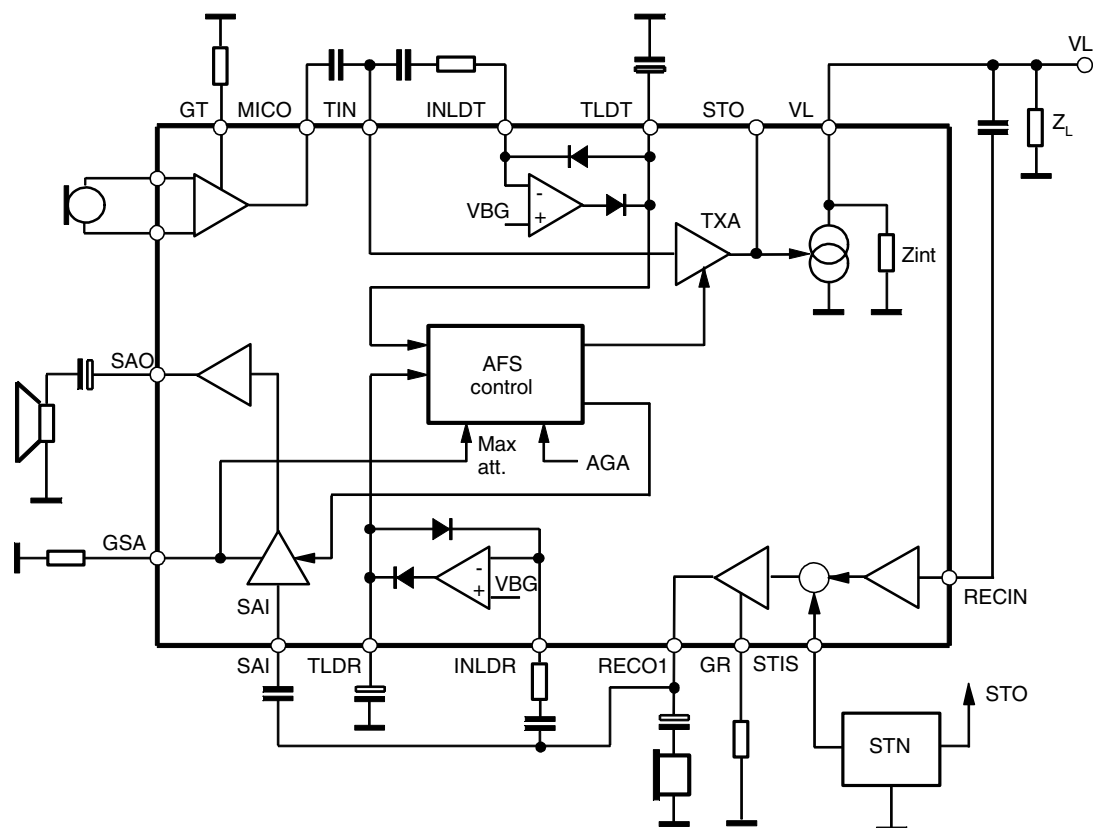
Selection of the active channel is made by comparison of the logarithmically compressed TX- and RX- envelope curve.

The system configuration for group listening, which is realized in the U4090B-P, is illustrated in Figure 9. TXA and SAI represent the two attenuators, the logarithmic envelope detectors are shown in a simplified way (operational amplifiers with two diodes).

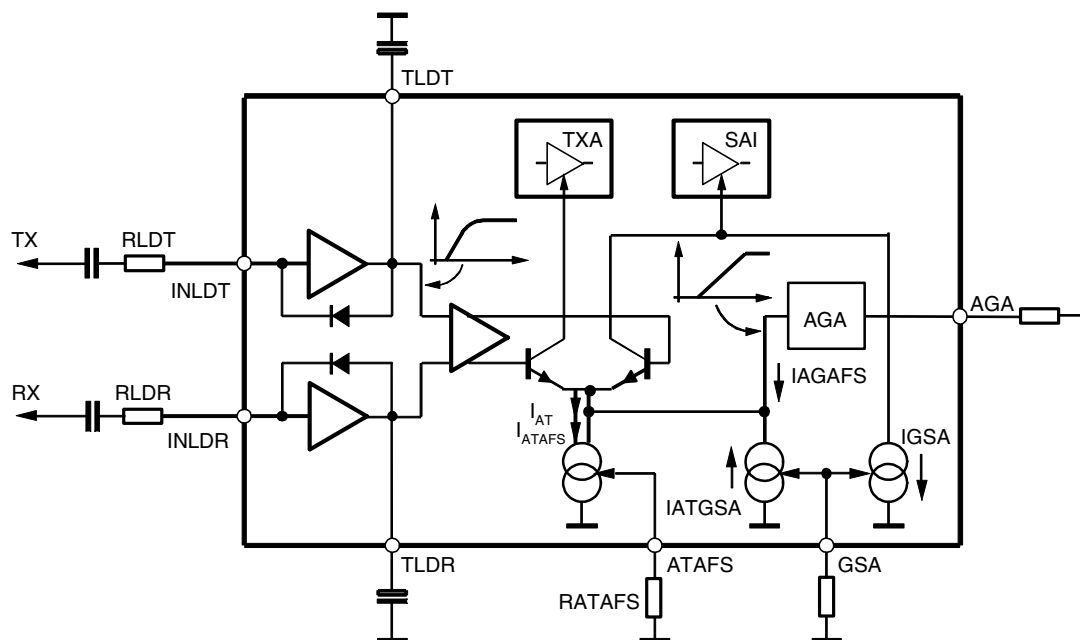
**Figure 7.** Basic Voice Switch System



**Figure 8.** Integration of the Acoustic Feedback Suppression Circuit into the Speech Circuit Environment



**Figure 9.** Acoustic Feedback Suppression by Alternative Control of Transmit and Speaker Amplifier Gain



A detailed diagram of the AFS (acoustic feedback suppression) is given in Figure 9. Receive and transmit signals are first processed by logarithmic rectifiers in order to produce the envelopes of the speech at TLDT and RLDT. After amplification, a decision is made by the differential pair which direction should be transmitted.

The attenuation of the controlled amplifiers TXA and SAI is determined by the emitter current  $I_{AT}$  which consists of three parts:

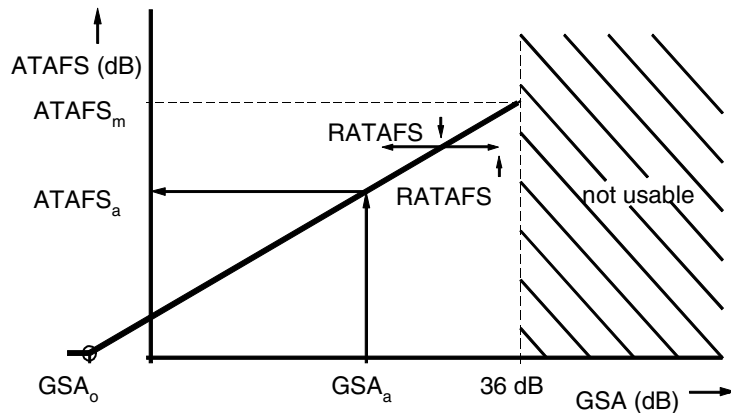
|             |                                                                                           |
|-------------|-------------------------------------------------------------------------------------------|
| $I_{ATAS}$  | sets maximum attenuation                                                                  |
| $I_{ATGSA}$ | decreases the attenuation when speaker amplifier gain is reduced                          |
| $I_{AGAFS}$ | decreases the attenuation according to the loop gain reduction caused by the AGA function |

$$I_{AT} = I_{ATAFS} - I_{ATGSA} - I_{AGAFS}$$

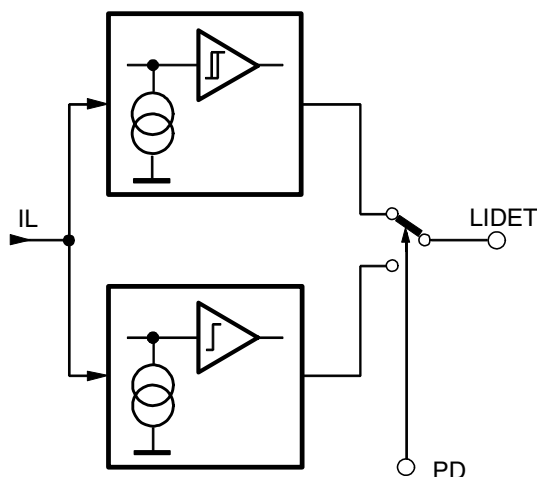
$$\Delta G = I_{AT} \times 0.67 \text{ dB}/\mu\text{A}$$

Figure 10 illustrates the principle relationship between speaker amplifier gain (GSA) and attenuation of AFS (ATAFS). Both parameters can be adjusted independently, but the internal coupling between them has to be considered. The maximum usable value of GSA is 36 dB. The shape of the characteristic is moved in the x-direction by adjusting resistor  $R_{ATAFS}$ , thus changing  $ATAFS_m$ . The actual value of attenuation ( $ATAFS_a$ ), however, can be determined by reading the value which belongs to the actual gain  $GSA_a$ . If the speaker amplifier gain is reduced, the attenuation of AFS is automatically reduced by the same amount in order to achieve a constant loop gain. Zero attenuation is set for speaker gains  $GSA \leq GSA_0 = 36 \text{ dB} - ATAFS_m$ .

**Figure 10.** Reducing Speaker Amplifier Gain Results in an Equal Reduction of AFS Attenuation



**Figure 11.** Line Detection with Two Comparators for Speech Mode and Pulse Dialing

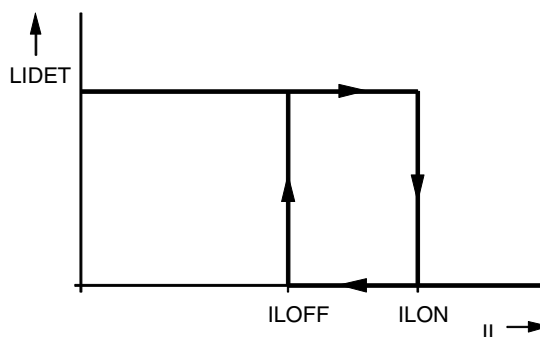


## Line Detection (LIDET)

The line current supervision is active under all operating conditions of the U4090B-P. In speech mode ( $PD = \text{inactive}$ ), the line-current comparator uses the same thresholds as the comparator for switching off the entire speaker amplifier. The basic behavior is illustrated in Figure 12. Actual values of  $I_{LON}/I_{LOFF}$  vary slightly with the adjustment of the DC characteristics and the selection of the internal line impedance.

When Power Down is activated (during pulse dialing), the entire line current flows through the short-circuiting transistor  $Q_S$  (see Figure 6). As long as  $I_L$  is above typically 1.6 mA, output  $LIDET$  is low. This comparator does not use hysteresis.

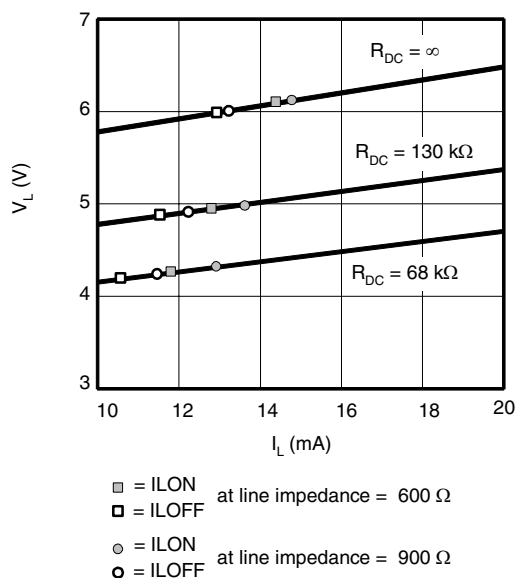
**Figure 12.** Line Detection in Speech Mode with Hysteresis



## Ring Power Converter (RPC)

The RPC transforms the input power at  $V_{RING}$  (high voltage/low current) into an equivalent output power at  $V_B$  (low voltage/high current) which is capable of driving the low-ohmic loudspeaker. Input impedance at  $V_{RING}$  is fixed at 5 k $\Omega$  and the efficiency of the step-down converter is approximate 65%.

**Figure 13.** Comparator Thresholds Depending on DC Mask and Line Impedance



## Ringling Frequency Detector (RFD)

The U4090B-P offers an output signal for the microcontroller, which is a digital representation of the double ringing frequency. It is generated by a current comparator with hysteresis. The input voltage  $V_{RING}$  is transformed into a current via RTHA. The thresholds are 8  $\mu\text{A}$  and 24  $\mu\text{A}$ . RFDO and  $V_{RING}$  are in phase. A second comparator with hysteresis is used to enable the output RFDO as long as the supply voltage for the microprocessor VMP is above 2.0 V.

## Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Parameters                                              | Symbol     | Value       | Unit               |
|---------------------------------------------------------|------------|-------------|--------------------|
| Line current                                            | $I_L$      | 140         | mA                 |
| DC line voltage                                         | $V_L$      | 12          | V                  |
| Maximum input current, pin 17                           | $I_{RING}$ | 15          | mA                 |
| Junction temperature                                    | $T_j$      | 125         | $^{\circ}\text{C}$ |
| Ambient temperature                                     | $T_{amb}$  | -25 to +75  | $^{\circ}\text{C}$ |
| Storage temperature                                     | $T_{stg}$  | -55 to +150 | $^{\circ}\text{C}$ |
| Total power dissipation, $T_{amb} = 60^{\circ}\text{C}$ | $P_{tot}$  | 0.9         | W                  |

## Thermal Resistance

| Parameters             | Symbol     | Value | Unit |
|------------------------|------------|-------|------|
| Junction ambient SSO44 | $R_{thJA}$ | 70    | K/W  |

## Electrical Characteristics

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100 \text{ }\Omega$ ,  $Z_M = 68 \text{ nF}$ , pin 31 open,  $V_{\text{IMPSEL}} = \text{GND}$ ,  $V_{\text{MUTX}} = \text{GND}$ ,  $V_{\text{MUTR}} = \text{GND}$ , unless otherwise specified

| Parameters                                                                                                                                                                               | Test Conditions                                                                                                                                       | Symbol                 | Min.               | Typ.                     | Max.                | Unit             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------|--------------------------|---------------------|------------------|
| <b>DC Characteristics</b>                                                                                                                                                                |                                                                                                                                                       |                        |                    |                          |                     |                  |
| DC voltage drop over circuit                                                                                                                                                             | $I_L = 2 \text{ mA}$<br>$I_L = 14 \text{ mA}$<br>$I_L = 60 \text{ mA}$<br>$I_L = 100 \text{ mA}$                                                      | $V_L$                  | 4.6<br><br><br>8.8 | 2.4<br>5.0<br>7.5<br>9.4 | 5.4<br><br><br>10.0 | V                |
| <b>Transmission Amplifier, <math>I_L = 14 \text{ mA}</math>, <math>V_{\text{MIC}} = 2 \text{ mV}</math>, <math>R_{\text{GT}} = 27 \text{ k}\Omega</math>, Unless Otherwise Specified</b> |                                                                                                                                                       |                        |                    |                          |                     |                  |
| Range of transmit gain                                                                                                                                                                   |                                                                                                                                                       | $G_T$                  | 40                 | 45                       | 50                  | dB               |
| Transmitting amplification                                                                                                                                                               | $R_{\text{GT}} = 12 \text{ k}\Omega$<br>$R_{\text{GT}} = 27 \text{ k}\Omega$                                                                          | $G_T$                  | 47<br>39.8         | 48                       | 49<br>41.8          | dB               |
| Frequency response                                                                                                                                                                       | $I_L \geq 14 \text{ mA}$<br>$f = 300 \text{ to } 3400 \text{ Hz}$                                                                                     | $\Delta G_T$           |                    |                          | $\pm 0.5$           | dB               |
| Gain change with current                                                                                                                                                                 | Pin 31 open<br>$I_L = 14 \text{ to } 100 \text{ mA}$                                                                                                  | $\Delta G_T$           |                    |                          | $\pm 0.5$           | dB               |
| Gain deviation                                                                                                                                                                           | $T_{\text{amb}} = -10 \text{ to } +60^\circ\text{C}$                                                                                                  | $\Delta G_T$           |                    |                          | $\pm 0.5$           | dB               |
| CMRR of microphone amplifier                                                                                                                                                             |                                                                                                                                                       | CMRR                   | 60                 | 80                       |                     | dB               |
| Input resistance of MIC amplifier                                                                                                                                                        | $R_{\text{GT}} = 12 \text{ k}\Omega$<br>$R_{\text{GT}} = 27 \text{ k}\Omega$                                                                          | $R_i$                  | 45                 | 50<br>75                 | 110                 | $\text{k}\Omega$ |
| Distortion at line                                                                                                                                                                       | $I_L > 14 \text{ mA}$<br>$V_L = 700 \text{ mV}_{\text{rms}}$                                                                                          | $d_t$                  |                    |                          | 2                   | %                |
| Maximum output voltage                                                                                                                                                                   | $I_L > 19 \text{ mA}$ , $d < 5\%$<br>$V_{\text{MIC}} = 25 \text{ mV}$<br>$\text{CTXA} = 1 \text{ }\mu\text{F}$                                        | $V_{L\text{max}}$      | 1.8                | 3                        | 4.2                 | dBm              |
|                                                                                                                                                                                          | IMPSEL = open<br>$R_{\text{GT}} = 12 \text{ k}\Omega$                                                                                                 | $V_{\text{MICOMax}}$   |                    | -5.2                     |                     | dBm              |
| Noise at line psophometrically weighted                                                                                                                                                  | $I_L > 14 \text{ mA}$<br>$G_T = 48 \text{ dB}$                                                                                                        | no                     |                    | -80                      | -72                 | dBmp             |
| Anti-clipping attack time<br>release time                                                                                                                                                | $\text{CTXA} = 1 \text{ }\mu\text{F}$<br>each 3 dB overdrive                                                                                          |                        |                    | 0.5<br>9                 |                     | ms               |
| Gain at low operating current                                                                                                                                                            | $I_L = 10 \text{ mA}$<br>$I_{MP} = 1 \text{ mA}$<br>$RDC = 68 \text{ k}\Omega$<br>$V_{\text{MIC}} = 1 \text{ mV}$<br>$I_M = 300 \text{ }\mu\text{A}$  | $G_T$                  | 40                 |                          | 42.5                | dB               |
| Distortion at low operating current                                                                                                                                                      | $I_L = 10 \text{ mA}$<br>$I_M = 300 \text{ }\mu\text{A}$<br>$I_{MP} = 1 \text{ mA}$<br>$RDC = 68 \text{ k}\Omega$<br>$V_{\text{MIC}} = 10 \text{ mV}$ | $d_t$                  |                    |                          | 5                   | %                |
| Line loss compensation                                                                                                                                                                   | $I_L = 100 \text{ mA}$<br>$R_{\text{AGA}} = 20 \text{ k}\Omega$                                                                                       | $\Delta G_{\text{TI}}$ | -6.4               | -5.8                     | -5.2                | dB               |
| Mute suppression<br>a) MIC muted<br>(microphone preamplifier)<br>b) TXA muted (second stage)                                                                                             | $I_L \geq 14 \text{ mA}$<br>$\text{MUTX} = \text{open}$                                                                                               | $G_{\text{TM}}$        | 60                 | 80                       |                     | dB               |
|                                                                                                                                                                                          | IMPSEL = open                                                                                                                                         | $G_{\text{TTX}}$       | 60                 |                          |                     | dB               |

## Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $R_{GSA} = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100 \Omega$ ,  $Z_M = 68 \text{ nF}$ , pin 31 open,  $V_{\text{IMPSEL}} = \text{GND}$ ,  $V_{\text{MUTX}} = \text{GND}$ ,  $V_{\text{MUTR}} = \text{GND}$ , unless otherwise specified

| Parameters                                                                                                                                                                 | Test Conditions                                                                                                                                | Symbol                               | Min.       | Typ.       | Max.       | Unit                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------|------------|------------|----------------------|
| <b>Receiving Amplifier, <math>I_L = 14 \text{ mA}</math>, <math>R_{GR} = 62 \text{ k}</math>, Unless Otherwise Specified, <math>V_{\text{GEN}} = 300 \text{ mV}</math></b> |                                                                                                                                                |                                      |            |            |            |                      |
| Adjustment range of receiving gain                                                                                                                                         | $I_L \geq 14 \text{ mA}$ , single ended<br>differential MUTR = GND                                                                             | $G_R$                                | -8<br>-2   |            | +2<br>+8   | dB                   |
| Receiving amplification                                                                                                                                                    | $R_{GR} = 62 \text{ k}\Omega$ differential<br>$R_{GR} = 22 \text{ k}\Omega$ differential                                                       | $G_R$                                | -1.75      | -1<br>7.5  | -0.25      | dB                   |
| Amplification of DTMF signal from DTMF IN to RECO 1, 2                                                                                                                     | $I_L \geq 14 \text{ mA}$<br>$V_{\text{MUTX}} = V_{MP}$                                                                                         | $G_{RM}$                             | 7          | 10         | 13         | dB                   |
| Frequency response                                                                                                                                                         | $I_L > 14 \text{ mA}$ ,<br>$f = 300 \text{ to } 3400 \text{ Hz}$                                                                               | $\Delta G_{RF}$                      |            |            | $\pm 0.5$  | dB                   |
| Gain change with current                                                                                                                                                   | $I_L = 14 \text{ to } 100 \text{ mA}$                                                                                                          | $\Delta G_R$                         |            |            | $\pm 0.5$  | dB                   |
| Gain deviation                                                                                                                                                             | $T_{\text{amb}} = -10 \text{ to } +60^\circ\text{C}$                                                                                           | $\Delta G_R$                         |            |            | $\pm 0.5$  | dB                   |
| Ear-protection differential                                                                                                                                                | $I_L \geq 14 \text{ mA}$ , $V_{\text{GEN}} = 11 V_{\text{rms}}$                                                                                | EP                                   |            |            | 2.2        | $V_{\text{rms}}$     |
| MUTE suppression<br>a) RECAT<br>b) RA2<br>c) DTMF operation                                                                                                                | $I_L \geq 14 \text{ mA}$<br>MUTR = open<br>$V_{\text{MUTR}} = V_{MP}$<br>$V_{\text{MUTX}} = V_{MP}$                                            | $\Delta G_R$                         | 60         |            |            | dB                   |
| Output voltage $d \leq 2\%$ differential                                                                                                                                   | $I_L = 14 \text{ mA}$ , $Z_{\text{ear}} = 68 \text{ nF} + 100 \Omega$                                                                          |                                      | 0.775      |            |            | $V_{\text{rms}}$     |
| Maximum output current $d \leq 2\%$                                                                                                                                        | $Z_{\text{ear}} = 100 \Omega$                                                                                                                  |                                      | 4          |            |            | mA<br>(peak)         |
| Receiving noise psophometrically weighted                                                                                                                                  | $Z_{\text{ear}} = 68 \text{ nF} + 100 \Omega$<br>$I_L \geq 14 \text{ mA}$                                                                      | ni                                   |            | -80        | -77        | dBmp                 |
| Output resistance                                                                                                                                                          | Each output against GND                                                                                                                        | $R_o$                                |            |            | 10         | $\Omega$             |
| Line loss compensation                                                                                                                                                     | $R_{AGA} = 20 \text{ k}\Omega$ , $I_L = 100 \text{ mA}$                                                                                        | $\Delta G_{RI}$                      | -7.0       | -6.0       | -5.0       | dB                   |
| Gain at low operating current                                                                                                                                              | $I_L = 10 \text{ mA}$<br>$I_{MP} = 1 \text{ mA}$<br>$I_M = 300 \mu\text{A}$<br>$V_{\text{GEN}} = 560 \text{ mV}$<br>$RDC = 68 \text{ k}\Omega$ | $G_R$                                | -2         | -1         | 0          | dB                   |
| AC impedance                                                                                                                                                               | $V_{\text{IMPSEL}} = \text{GND}$<br>$V_{\text{IMPSEL}} = V_{MP}$                                                                               | $Z_{\text{imp}}$<br>$Z_{\text{imp}}$ | 570<br>840 | 600<br>900 | 640<br>960 | $\Omega$<br>$\Omega$ |
| Distortion at low operating current                                                                                                                                        | $I_L = 10 \text{ mA}$<br>$I_{MP} = 1 \text{ mA}$<br>$V_{\text{GEN}} = 560 \text{ mV}$<br>$RDC = 68 \text{ k}\Omega$                            | dR                                   |            |            | 5          | %                    |
| <b>Speaker Amplifier</b>                                                                                                                                                   |                                                                                                                                                |                                      |            |            |            |                      |
| Minimum line current for operation                                                                                                                                         | No AC signal                                                                                                                                   | $I_{L\text{min}}$                    |            |            | 15         | mA                   |
| Input resistance                                                                                                                                                           | Pin 24                                                                                                                                         |                                      | 14         |            | 22         | $\text{k}\Omega$     |
| Gain from SAI to SAO                                                                                                                                                       | $V_{\text{SAI}} = 3 \text{ mV}$<br>$I_L = 15 \text{ mA}$<br>$R_{GSA} = 560 \text{ k}\Omega$<br>$R_{GSA} = 20 \text{ k}\Omega$                  | $G_{SA}$                             | 35.5       | 36.5<br>-3 | 37.5       | dB                   |

## Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100 \text{ }\Omega$ ,  $Z_M = 68 \text{ nF}$ , pin 31 open,  $V_{\text{IMPSEL}} = \text{GND}$ ,  $V_{\text{MUTX}} = \text{GND}$ ,  $V_{\text{MUTR}} = \text{GND}$ , unless otherwise specified

| Parameters                                                                                                                                              | Test Conditions                                                                                                                                                  | Symbol                             | Min.     | Typ.      | Max.       | Unit                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|----------|-----------|------------|------------------------------|
| Output power                                                                                                                                            | Load resistance<br>$R_L = 50 \text{ }\Omega$ , $d < 5\%$<br>$V_{\text{SAI}} = 20 \text{ mV}$<br>$I_L = 15 \text{ mA}$<br>$I_L = 20 \text{ mA}$                   | $P_{\text{SA}}$<br>$P_{\text{SA}}$ | 3        | 7<br>20   |            | mW                           |
| Output noise (Input SAI open)<br>psophometrically weighted                                                                                              | $I_L > 15 \text{ mA}$                                                                                                                                            | $n_{\text{SA}}$                    |          |           | 200        | $\mu\text{V}_{\text{psoph}}$ |
| Gain deviation                                                                                                                                          | $I_L = 15 \text{ mA}$ , $T_{\text{amb}} = -10 \text{ to } +60^\circ\text{C}$                                                                                     | $\Delta G_{\text{SA}}$             |          |           | $\pm 1$    | dB                           |
| Mute suppression                                                                                                                                        | $I_L = 15 \text{ mA}$<br>$V_L = 0 \text{ dBm}$<br>$V_{\text{SAI}} = 4 \text{ mV}$<br>Pin 23 open                                                                 | $V_{\text{SAO}}$                   |          |           | -60        | dBm                          |
| Gain change with current                                                                                                                                | $I_L = 15 \text{ to } 100 \text{ mA}$                                                                                                                            | $\Delta G_{\text{SA}}$             |          |           | $\pm 1$    | dB                           |
| Resistor for turning off speaker<br>amplifier                                                                                                           | $I_L = 15 \text{ to } 100 \text{ mA}$                                                                                                                            | $R_{\text{GSA}}$                   | 0.8      | 1.3       | 2          | $\text{M}\Omega$             |
| Gain change with frequency                                                                                                                              | $I_L = 15 \text{ mA}$ , $f = 300 \text{ to } 3400 \text{ Hz}$                                                                                                    | $\Delta G_{\text{SA}}$             |          |           | $\pm 0.5$  | dB                           |
| Attack time of anti-clipping                                                                                                                            | 20 dB over drive                                                                                                                                                 | $t_r$                              |          | 5         |            | ms                           |
| Release time of anti-clipping                                                                                                                           |                                                                                                                                                                  | $t_f$                              |          | 80        |            | ms                           |
| <b>DTMF Amplifier Test Conditions: <math>I_{MP} = 2 \text{ mA}</math>, <math>I_M = 0.3 \text{ mA}</math>, <math>V_{\text{MUTX}} = \text{VMP}</math></b> |                                                                                                                                                                  |                                    |          |           |            |                              |
| Adjustment range of DTMF gain                                                                                                                           | $I_L = 15 \text{ mA}$ mute active                                                                                                                                | $G_D$                              | 40       |           | 50         | dB                           |
| DTMF amplification                                                                                                                                      | $I_L = 15 \text{ mA}$<br>$V_{\text{DTMF}} = 8 \text{ mV}$<br>Mute active: $\text{MUTX} = V_{\text{MP}}$                                                          | $G_D$                              | 40.7     | 41.7      | 42.7       | dB                           |
| Gain deviation                                                                                                                                          | $I_L = 15 \text{ mA}$ , $T_{\text{amb}} = -10 \text{ to } +60^\circ\text{C}$                                                                                     | $G_D$                              |          |           | $\pm 0.5$  | dB                           |
| Input resistance                                                                                                                                        | $R_{\text{GT}} = 27 \text{ k}\Omega$<br>$R_{\text{GT}} = 15 \text{ k}\Omega$                                                                                     | $R_i$                              | 60<br>26 | 180<br>70 | 300<br>130 | $\text{k}\Omega$             |
| Distortion of DTMF signal                                                                                                                               | $I_L \geq 15 \text{ mA}$<br>$V_L = 0 \text{ dBm}$                                                                                                                | $d_D$                              |          |           | 2          | %                            |
| Gain deviation with current                                                                                                                             | $I_L = 15 \text{ to } 100 \text{ mA}$                                                                                                                            | $\Delta G_D$                       |          |           | $\pm 0.5$  | dB                           |
| <b>AFS Acoustic Feedback Suppression</b>                                                                                                                |                                                                                                                                                                  |                                    |          |           |            |                              |
| Adjustment range of attenuation                                                                                                                         | $I_L \geq 15 \text{ mA}$                                                                                                                                         |                                    | 0        |           | 50         | dB                           |
| Attenuation of transmit gain                                                                                                                            | $I_L \geq 15 \text{ mA}$<br>$I_{\text{INLDT}} = 0 \text{ }\mu\text{A}$<br>$R_{\text{ATAFS}} = 30 \text{ k}\Omega$<br>$I_{\text{INLDR}} = 10 \text{ }\mu\text{A}$ | $\Delta G_T$                       |          | 45        |            | dB                           |
| Attenuation of speaker amplifier                                                                                                                        | $I_L \geq 15 \text{ mA}$<br>$I_{\text{INLDP}} = 0 \text{ }\mu\text{A}$<br>$R_{\text{ATAFS}} = 30 \text{ k}\Omega$<br>$I_{\text{INLDR}} = 10 \text{ }\mu\text{A}$ | $\Delta G_{\text{SA}}$             |          | 50        |            | dB                           |
| AFS disable                                                                                                                                             | $I_L \geq 15 \text{ mA}$                                                                                                                                         | $V_{\text{ATAFS}}$                 | 1.5      |           |            | V                            |
| <b>Supply Voltages, <math>V_{\text{MIC}} = 25 \text{ mV}</math>, <math>T_{\text{amb}} = -10 \text{ to } +60^\circ\text{C}</math></b>                    |                                                                                                                                                                  |                                    |          |           |            |                              |
| $V_{\text{MP}}$                                                                                                                                         | $I_L = 14 \text{ mA}$<br>$RDC = 68 \text{ k}\Omega$<br>$I_{\text{MP}} = 2 \text{ mA}$                                                                            | $V_{\text{MP}}$                    | 3.1      | 3.3       | 3.5        | V                            |

## Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100 \text{ }\Omega$ ,  $Z_M = 68 \text{ nF}$ , pin 31 open,  $V_{\text{IMPSEL}} = \text{GND}$ ,  $V_{\text{MUTX}} = \text{GND}$ ,  $V_{\text{MUTR}} = \text{GND}$ , unless otherwise specified

| Parameters                                                                               | Test Conditions                                                                                                          | Symbol                                     | Min.                            | Typ.                 | Max.      | Unit                           |
|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------|----------------------|-----------|--------------------------------|
| $V_{\text{MPS}}$                                                                         | $I_L = 100 \text{ mA}$<br>$RDC = \text{infinite}$<br>$I_{MP} = 0 \text{ mA}$                                             | $V_{\text{MPS}}$                           |                                 |                      | 6.7       | V                              |
| $V_M$                                                                                    | $I_L = 14 \text{ mA}$<br>$I_M = 700 \text{ }\mu\text{A}$<br>$RDC = 130 \text{ k}\Omega$                                  | $V_M$                                      | 1.3                             |                      | 3.3       | V                              |
| $V_B$                                                                                    | $I_B = +20 \text{ mA}$<br>$I_L = 0 \text{ mA}$                                                                           | $V_B$                                      |                                 | 7                    | 7.6       | V                              |
| <b>Ringing Power Converter, <math>I_{MP} = 1 \text{ mA}</math>, <math>I_M = 0</math></b> |                                                                                                                          |                                            |                                 |                      |           |                                |
| Maximum output power                                                                     | $V_{\text{RING}} = 20.6 \text{ V}$                                                                                       | $P_{\text{SA}}$                            |                                 | 20                   |           | mW                             |
| Threshold of ring frequency detector                                                     | RFDO: low to high<br>$V_{\text{HYST}} = V_{\text{RINGON}} - V_{\text{RINGOFF}}$                                          | $V_{\text{RINGON}}$<br>$V_{\text{HYST}}$   |                                 | 17.5<br>11.0         |           | V                              |
| Input impedance                                                                          | $V_{\text{RING}} = 30 \text{ V}$                                                                                         | $R_{\text{RING}}$                          | 4                               | 5                    | 6         | $\text{k}\Omega$               |
| Input impedance in speech mode                                                           | $f = 300 \text{ Hz}$ to $3400 \text{ Hz}$ $I_L > 15 \text{ mA}$<br>$V_{\text{RING}} = 20 \text{ V} + 1.5 V_{\text{rms}}$ | $R_{\text{RINGSP}}$                        | 150                             |                      |           | $\text{k}\Omega$               |
| Logic level of frequency detector                                                        | $V_{\text{RING}} = 0 \text{ V}$<br>$V_B = 4 \text{ V}$<br>$V_{\text{RING}} = 25 \text{ V}$                               | $V_{\text{RFDO}}$                          |                                 | 0<br>$V_{\text{MP}}$ |           | V                              |
| Ring detector enable                                                                     | $V_{\text{RING}} = 25 \text{ V}$ , RFDO high                                                                             | $V_{\text{MPON}}$                          | 1.8                             | 2.0                  | 2.2       | V                              |
| Zener diode voltage                                                                      | $I_{\text{RING}} = 25 \text{ mA}$                                                                                        | $V_{\text{RINGmax}}$                       | 30.8                            |                      | 33.3      | V                              |
| <b>MUTR Input</b>                                                                        |                                                                                                                          |                                            |                                 |                      |           |                                |
| MUTR input current                                                                       | $V_{\text{MUTR}} = \text{GND}$<br>$I_L > 14 \text{ mA}$<br>$V_{\text{MUTR}} = V_{\text{MP}}$                             | $I_{\text{MUTE}}$                          |                                 | -20<br>+10           | -30       | $\mu\text{A}$                  |
| MUTR input voltage                                                                       | Mute low; $I_L > 14 \text{ mA}$                                                                                          | $V_{\text{MUTE}}$                          |                                 |                      | 0.3       | V                              |
|                                                                                          | Mute high; $I_L > 14 \text{ mA}$                                                                                         | $V_{\text{MUTE}}$                          | $V_{\text{MP}} - 0.3 \text{ V}$ |                      |           | V                              |
| <b>PD Input</b>                                                                          |                                                                                                                          |                                            |                                 |                      |           |                                |
| PD input current                                                                         | PD active, $I_L > 14 \text{ mA}$ $V_{\text{PD}} = V_{\text{MP}}$                                                         | $I_{\text{pd}}$                            |                                 | 9                    |           | $\mu\text{A}$                  |
| Input voltage                                                                            | PD = active<br>PD = inactive                                                                                             | $V_{\text{pd}}$<br>$V_{\text{pd}}$         | 2                               |                      | 0.3       | V                              |
| Voltage drop at $V_L$                                                                    | $I_L = 14 \text{ mA}$ , PD = active<br>$I_L = 100 \text{ mA}$ , PD = active                                              | $V_L$                                      |                                 | 1.5<br>1.9           |           | V                              |
| <b>Input Characteristics of IMPSEL</b>                                                   |                                                                                                                          |                                            |                                 |                      |           |                                |
| Input current                                                                            | $I_L \geq 14 \text{ mA}$<br>$V_{\text{IMPSEL}} = V_{\text{MP}}$<br>$V_{\text{IMPSEL}} = \text{GND}$                      | $I_{\text{IMPSEL}}$<br>$I_{\text{IMPSEL}}$ |                                 | 18<br>-18            |           | $\mu\text{A}$<br>$\mu\text{A}$ |
| Input voltage                                                                            | Input high                                                                                                               | $V_{\text{IMPSEL}}$                        | $V_{\text{MP}} - 0.3 \text{ V}$ |                      |           | V                              |
|                                                                                          | Input low                                                                                                                | $V_{\text{IMPSEL}}$                        |                                 |                      | 0.3       | V                              |
| <b>MUTX Input</b>                                                                        |                                                                                                                          |                                            |                                 |                      |           |                                |
| Input current                                                                            | $V_{\text{MUTX}} = V_{\text{MP}}$<br>$V_{\text{MUTX}} = \text{GND}$                                                      | $I_{\text{MUTX}}$<br>$I_{\text{MUTX}}$     |                                 | 20<br>-20            | 30<br>-30 | $\mu\text{A}$<br>$\mu\text{A}$ |

## Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100 \text{ }\Omega$ ,  $Z_M = 68 \text{ nF}$ , pin 31 open,  $V_{\text{IMPSEL}} = \text{GND}$ ,  $V_{\text{MUTX}} = \text{GND}$ ,  $V_{\text{MUTR}} = \text{GND}$ , unless otherwise specified

| Parameters                          | Test Conditions                   | Symbol            | Min.                            | Typ. | Max. | Unit |
|-------------------------------------|-----------------------------------|-------------------|---------------------------------|------|------|------|
| Input voltage                       | Input high                        | $V_{\text{MUTX}}$ | $V_{\text{MP}} - 0.3 \text{ V}$ |      |      | V    |
|                                     | Input low                         | $V_{\text{MUTX}}$ |                                 |      | 0.3  | V    |
| <b>Line Detection</b>               |                                   |                   |                                 |      |      |      |
| Line current for LIDET active       | PD = inactive                     | ILON              |                                 | 12.6 |      | mA   |
| Line current for LIDET inactive     | PD = inactive                     | ILOFF             |                                 | 11.0 |      | mA   |
| Current threshold during power down | $V_B = 5 \text{ V}$ , PD = active | ILONPD            | 0.8                             | 1.6  | 2.4  | mA   |

## U4090B-P Control

**Table 1.** Selection of TX Mute and Line Impedance

| Logic Level | IMPSEL                                                        | MODE          |
|-------------|---------------------------------------------------------------|---------------|
| 0           | Line impedance = $600 \text{ }\Omega$<br>TXA = on<br>ES = off | Speech        |
| 0 to Z      | Line impedance = $600 \text{ }\Omega$<br>TXA = off<br>ES = on | Transmit-mute |
| 1 to Z      | Line impedance = $900 \text{ }\Omega$<br>TXA = off<br>ES = on | Transmit-mute |
| 1           | Line impedance = $900 \text{ }\Omega$<br>TXA = on<br>ES = off | Speech        |

**Table 2.** Selection of Earpiece Mute and Answering Machine Mode

| Logic Level | MUTR                                                                   | MODE                   |
|-------------|------------------------------------------------------------------------|------------------------|
| 0           | RA2 = on<br>RECATT = on<br>STIS + STIL = on                            | Speech                 |
| 0 to Z      | RA2 = on<br>RECATT = off<br>STIS = on, STIL = off                      | For answering machine  |
| 1 to Z      | RA2 = off<br>RECATT = off<br>STIS = on, STIL = off<br>AGA off for STIS | For answering machine  |
| 1           | RA2 = off<br>RECATT = on<br>STIS + STIL = on                           | Speech + earpiece mute |

**Table 3.** Selection of Transmit Mute

| Logic Level | MUTX                                                                                     | MODE                  |
|-------------|------------------------------------------------------------------------------------------|-----------------------|
| 0           | MIC 1/2 transmit enabled receive enable<br>AFS = on<br>AGA = on<br>TXACL = on            | Speech                |
| Z           | DTMF transmit enabled receive enable<br>AFS = on<br>AGA = on<br>TXACL = on               | For answering machine |
| 1           | DTMF transmit enabled<br>DTMF to receive enable<br>AFS = off<br>AGA = off<br>TXACL = off | DTMF dialling         |

**Table 4.** Specification of Logic Levels

| Logic Level                               |
|-------------------------------------------|
| 0 = < (0.3 V)                             |
| Z = > (1 V) < (VMP - 1 V) or (open input) |
| 1 = > (VMP - 0.3 V)                       |

## Explanation of Abbreviations

RECATT = Receive attenuation  
 STIS, STIL = Inputs of sidetone balancing amplifiers  
 ES = External supply  
 AFS = Acoustic feedback suppression control  
 AGA = Automatic gain adjustment  
 RA2 = Inverting receive amplifier  
 TXACL = Transmit anti-clipping control

Figure 14. Typical DC Characteristic

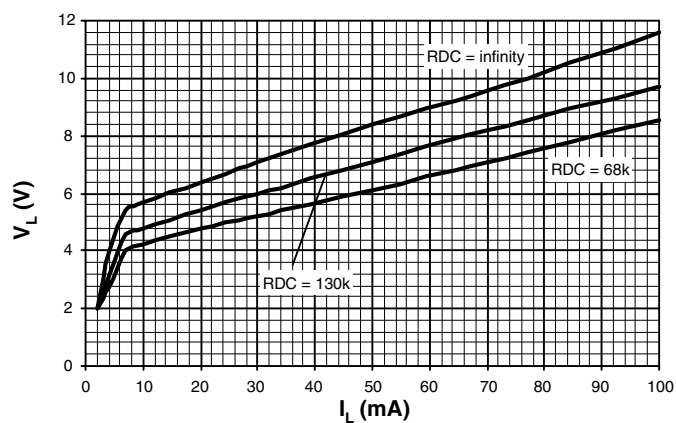


Figure 15. Typical Adjustment Range of Transmit Gain

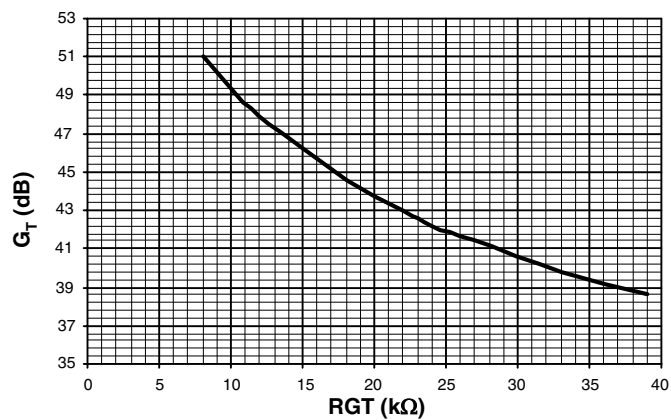
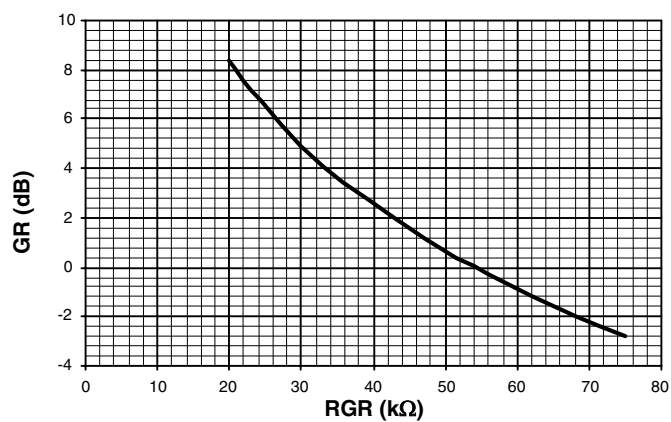
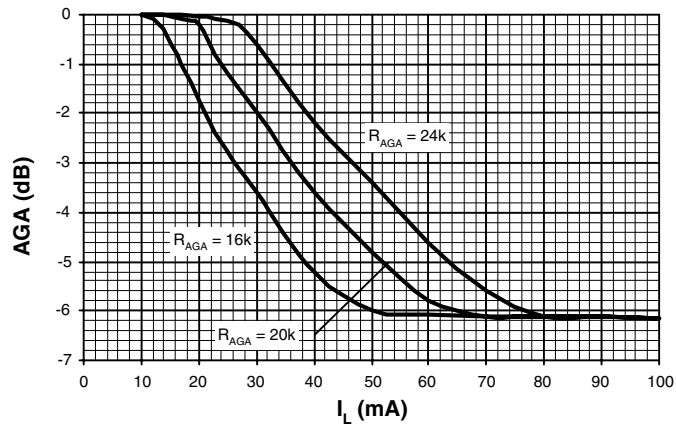


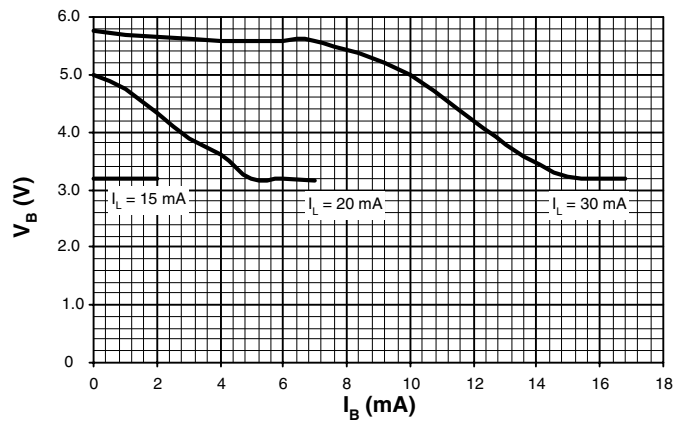
Figure 16. Typical Adjustment Range of Receive Gain (Differential Output)



**Figure 17.** Typical AGA Characteristic

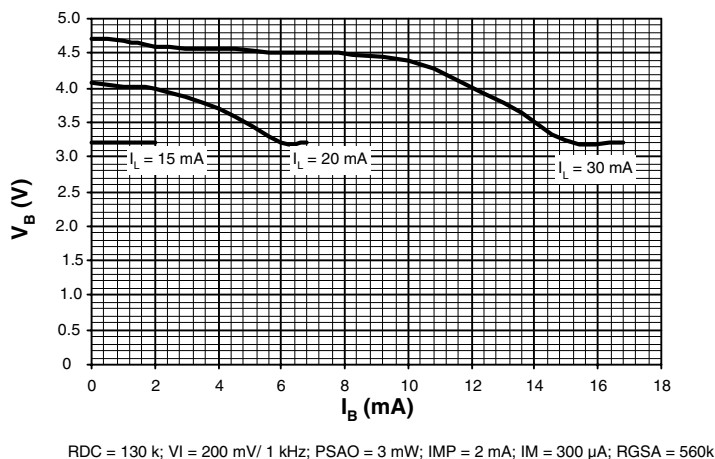


**Figure 18.** Typical Load Characteristic of  $V_B$  for a Maximum (RDC = Infinity) DC-characteristic and 3-mW Loudspeaker Output

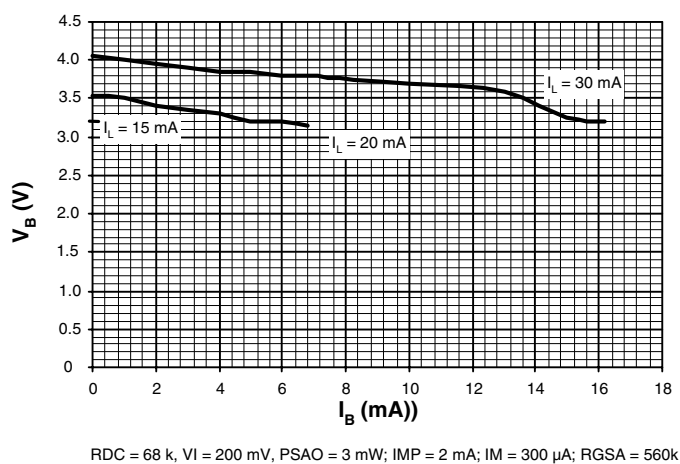


RDC = Infinity;  $V_I = 200$  mV/1 kHz; PSAO = 3 mW; IMP = 2 mA; IM = 300  $\mu$ A; RGSA = 560k

**Figure 19.** Typical Load Characteristic of  $V_B$  for a Medium DC-characteristic (RDC = 130 k $\Omega$ ) and 3-mW Loudspeaker Output

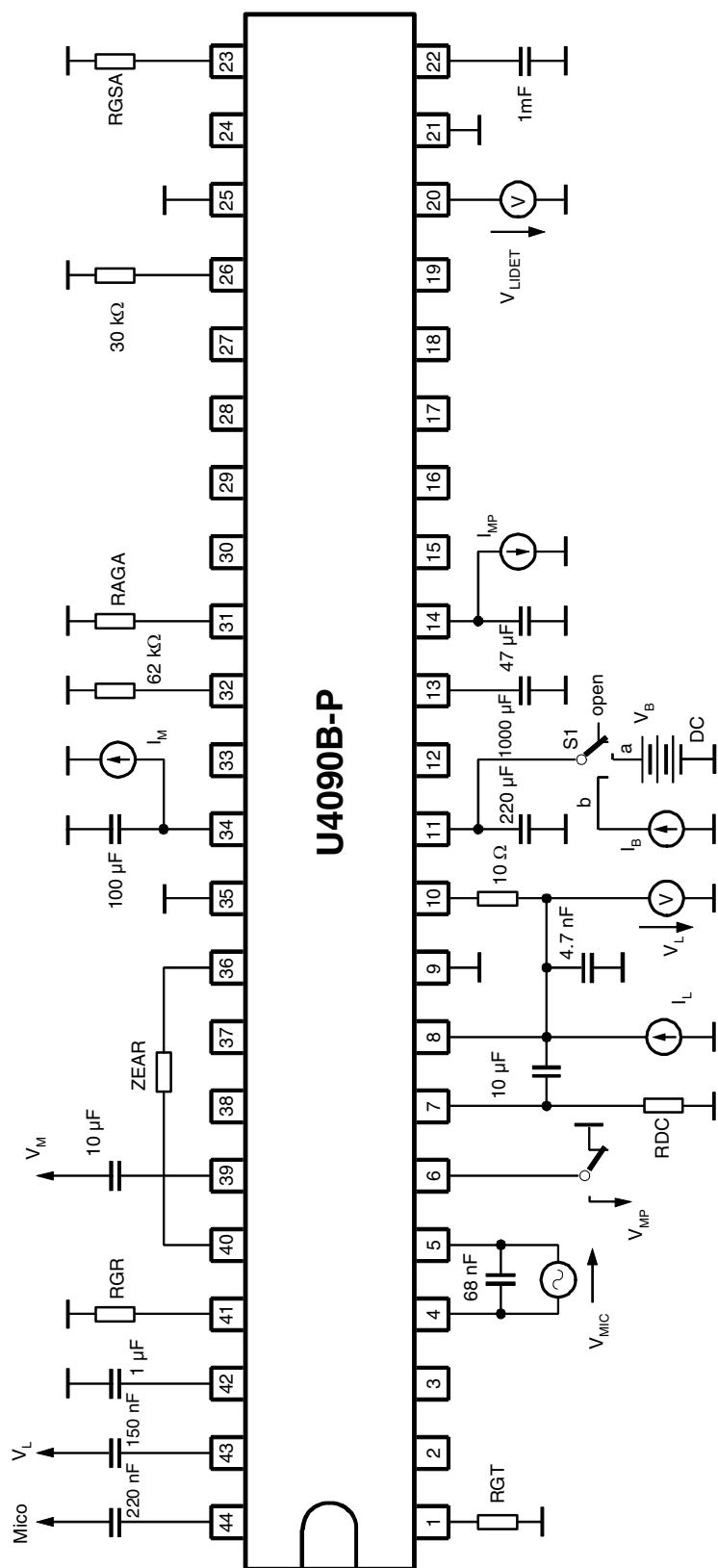


**Figure 20.** Typical Load Characteristic of  $V_B$  for a Minimum DC-characteristic (RDC = 68 k $\Omega$ ) and 3-mW Loudspeaker Output





**Figure 22.** Test Circuit for DC Characteristics and Line Detection



Line detection: S1a

VB (external supply): S1b

Open pins should be connected as shown in Figure 27

24





26



Open pins should be connected as shown in Figure 27

4741A-CORD-09/03



Input resistance:  $(VL50K/(VL - VL50k)) \times 50\text{ k}\Omega$

Open pins should be connected as shown in Figure 27

**28**



**Figure 28.** Test Circuit for Input Characteristics of I/O Ports

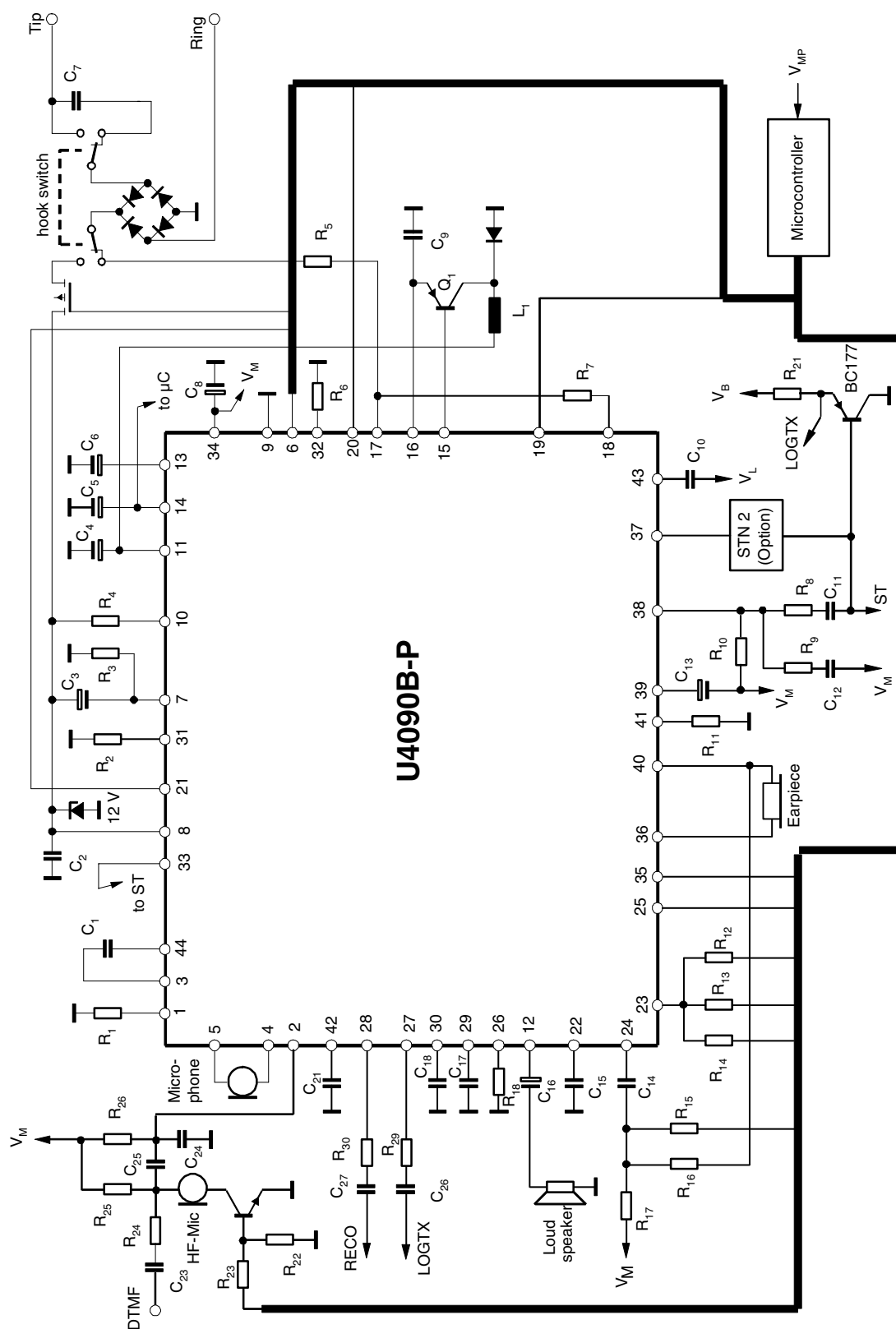


Open pins should be connected as shown in figure 27

30



Figure 30. Application for Hands-free Operation



**Table 5.** Typical Values of External Components (Figure 29 and Figure 30)

| Name            | Value       | Name            | Value         | Name            | Value           | Name            | Value          |
|-----------------|-------------|-----------------|---------------|-----------------|-----------------|-----------------|----------------|
| C <sub>1</sub>  | 100 nF      | C <sub>16</sub> | 47 $\mu$ F    | R <sub>3</sub>  | > 68 k $\Omega$ | R <sub>18</sub> | 30 k $\Omega$  |
| C <sub>2</sub>  | 4.7 nF      | C <sub>17</sub> | 10 $\mu$ F    | R <sub>4</sub>  | 10 k $\Omega$   | R <sub>19</sub> | 6.8 k $\Omega$ |
| C <sub>3</sub>  | 10 $\mu$ F  | C <sub>18</sub> | 10 $\mu$ F    | R <sub>5</sub>  | 1.5 k $\Omega$  | R <sub>20</sub> | 6.8 k $\Omega$ |
| C <sub>4</sub>  | 220 $\mu$ F | C <sub>19</sub> | 68 nF         | R <sub>6</sub>  | 62 k $\Omega$   | R <sub>21</sub> | 15 k $\Omega$  |
| C <sub>5</sub>  | 47 $\mu$ F  | C <sub>20</sub> | 68 nF         | R <sub>7</sub>  | 680 k $\Omega$  | R <sub>22</sub> | 330 k $\Omega$ |
| C <sub>6</sub>  | 470 $\mu$ F | C <sub>21</sub> | 1 $\mu$ F     | R <sub>8</sub>  | 22 k $\Omega$   | R <sub>23</sub> | 220 k $\Omega$ |
| C <sub>7</sub>  | 820 nF      | C <sub>22</sub> | 100 nF        | R <sub>9</sub>  | 330 k $\Omega$  | R <sub>24</sub> | 68 k $\Omega$  |
| C <sub>8</sub>  | 100 $\mu$ F | C <sub>23</sub> | 6.8 nF        | R <sub>10</sub> | 3 k $\Omega$    | R <sub>25</sub> | 2 k $\Omega$   |
| C <sub>9</sub>  | 100 nF      | C <sub>24</sub> | 10 nF         | R <sub>11</sub> | 62 k $\Omega$   | R <sub>26</sub> | 3.3 k $\Omega$ |
| C <sub>10</sub> | 150 nF      | C <sub>25</sub> | 100 nF        | R <sub>12</sub> | 30 k $\Omega$   | R <sub>27</sub> | 18 k $\Omega$  |
| C <sub>11</sub> | 86 nF       | C <sub>26</sub> | 470 nF        | R <sub>13</sub> | 62 k $\Omega$   | R <sub>28</sub> | 2 k $\Omega$   |
| C <sub>12</sub> | 33 nF       | C <sub>27</sub> | 33 nF         | R <sub>14</sub> | 120 k $\Omega$  | R <sub>29</sub> | 1 k $\Omega$   |
| C <sub>13</sub> | 10 $\mu$ F  | L <sub>1</sub>  | 2.2 mH        | R <sub>15</sub> | 47 k $\Omega$   | R <sub>30</sub> | 12 k $\Omega$  |
| C <sub>14</sub> | 100 nF      | R <sub>1</sub>  | 27 k $\Omega$ | R <sub>16</sub> | 1 k $\Omega$    | R <sub>31</sub> | 56 k $\Omega$  |
| C <sub>15</sub> | 1 $\mu$ F   | R <sub>2</sub>  | 20 k $\Omega$ | R <sub>17</sub> | 1.2 k $\Omega$  |                 |                |

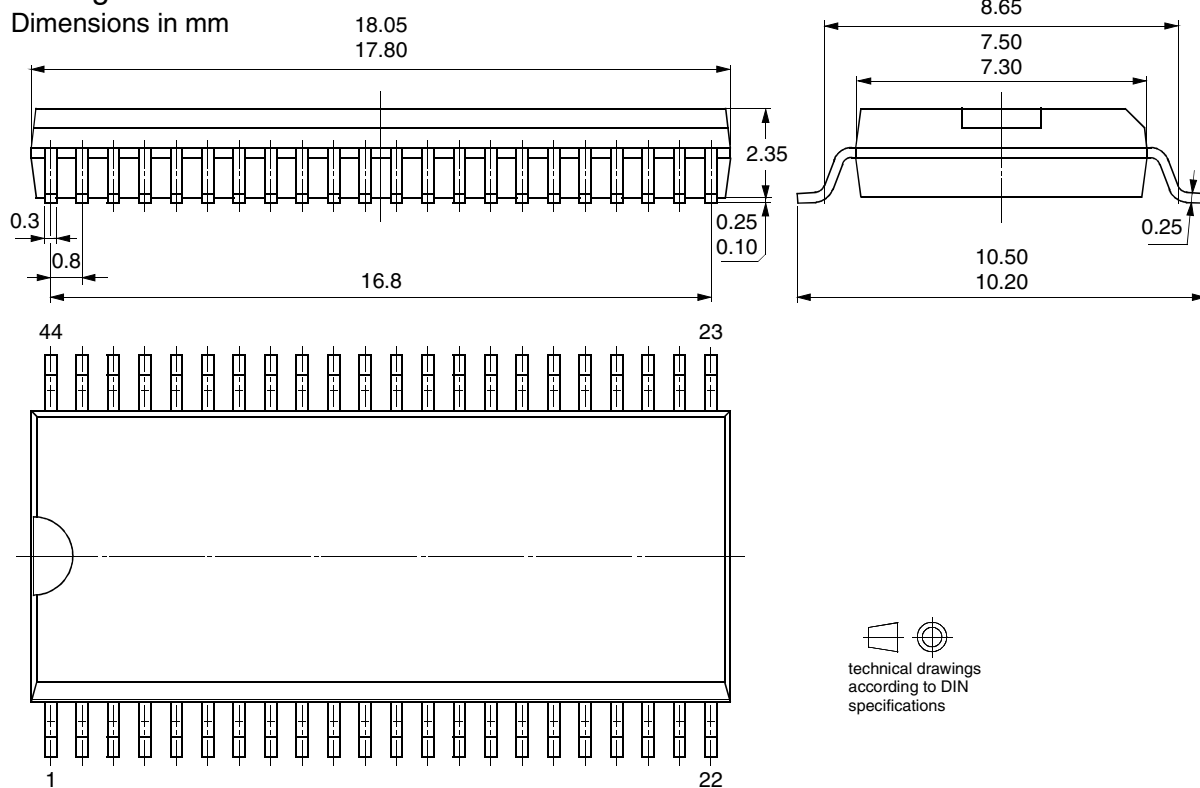
## Ordering Information

| Extended Type Number | Package | Remarks          |
|----------------------|---------|------------------|
| U4090B-PFN           | SSO44   | –                |
| U4090B-PFNG3         | SSO44   | Taped and reeled |

## Package Information

### Package SSO44

Dimensions in mm



technical drawings  
according to DIN  
specifications



## Atmel Corporation

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 487-2600

## Regional Headquarters

### Europe

Atmel Sarl  
Route des Arsenaux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
Tel: (41) 26-426-5555  
Fax: (41) 26-426-5500

### Asia

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimshatsui  
East Kowloon  
Hong Kong  
Tel: (852) 2721-9778  
Fax: (852) 2722-1369

### Japan

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
Tel: (81) 3-3523-3551  
Fax: (81) 3-3523-7581

## Atmel Operations

### Memory

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### Microcontrollers

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

La Chantryerie  
BP 70602  
44306 Nantes Cedex 3, France  
Tel: (33) 2-40-18-18-18  
Fax: (33) 2-40-18-19-60

### ASIC/ASSP/Smart Cards

Zone Industrielle  
13106 Rousset Cedex, France  
Tel: (33) 4-42-53-60-00  
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
Tel: (44) 1355-803-000  
Fax: (44) 1355-242-743

### RF/Automotive

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
Tel: (49) 71-31-67-0  
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
Tel: (33) 4-76-58-30-00  
Fax: (33) 4-76-58-34-80

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