

## Features

- Adjustable DC Characteristic
- Transmit and Receive Gain Adjustable
- Symmetrical Input of Microphone Amplifier
- Anti-clipping in Transmit Direction
- Automatic Line-loss Compensation
- Built-in Ear Protection
- DTMF and MUTE Input
- Adjustable Sidetone Suppression Independent of Sending and Receiving Amplification
- Integrated Amplifier for Open-listening Operation
- Anti-clipping for Loudspeaker Amplifier
- Improved Acoustical Feedback Suppression
- Selectable Line Impedance
- Voice Switch
- Supply Voltages for All Functional Blocks of a Subscriber Set
- Operation Possible from 10-mA Line Current
- Filters Against EMI on Critical I/O



## Monolithic Integrated Feature Phone Circuit

**U4089B-P**

## Benefits

- Complete System Integration of Analog Signal Processing on One Chip
- Very Few External Components
- Less Components for EMI protection

## Applications

- Feature Phones
- Answering Machines
- Fax Machines
- Speaker Phones

## 1. Description

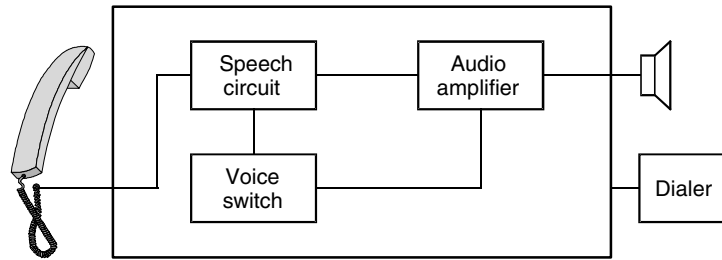
The telephone circuit U4089B-P is a linear integrated circuit for use in feature phones, answering machines and fax machines. It contains the speech circuit, sidetone equivalent and ear protection rectifiers. The circuit is line-powered and contains all components necessary for the amplification of signals and adaptation to the line.

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

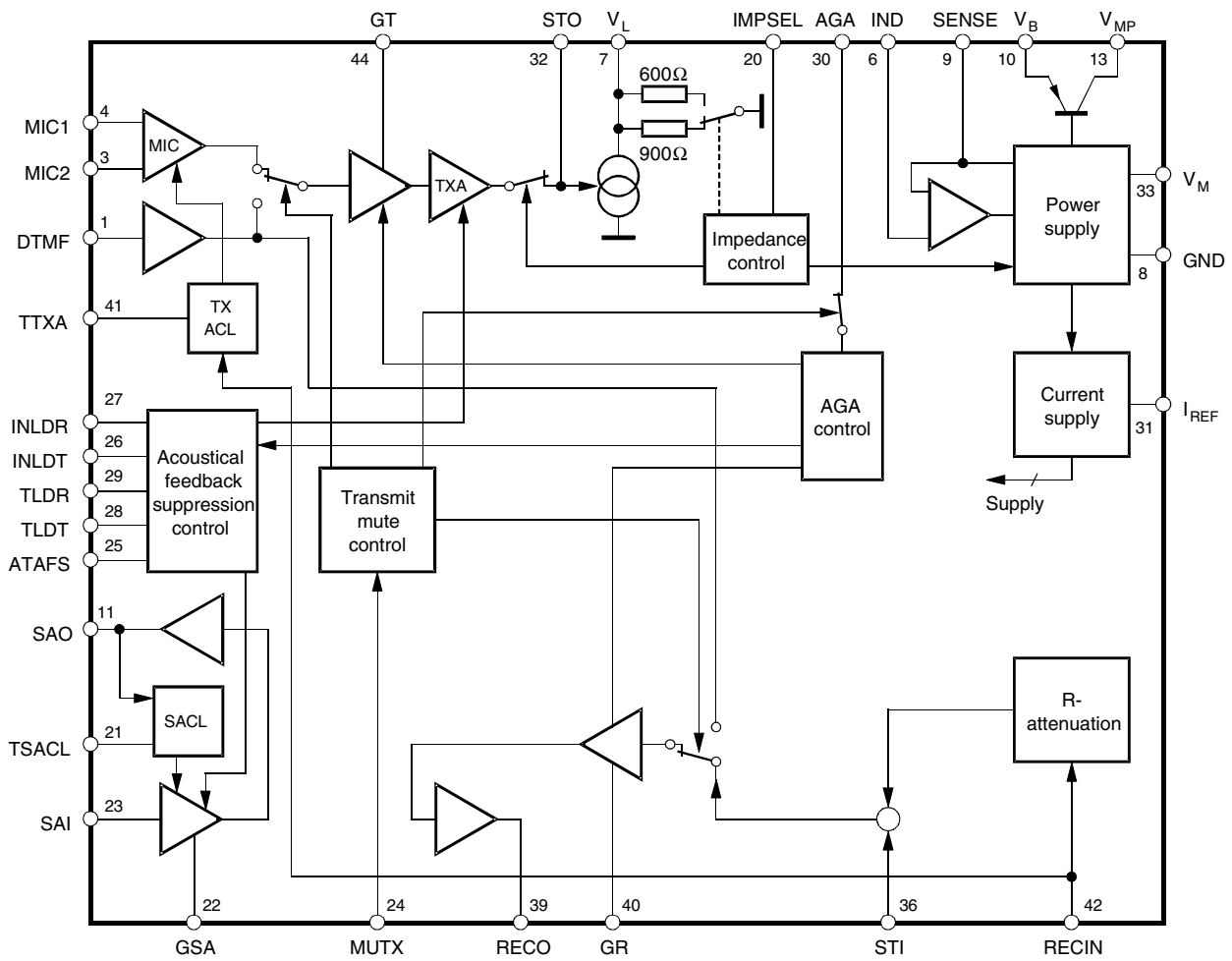
Electrostatic sensitive device.  
Observe precautions for handling.



**Figure 1-1.** Simple Block Diagram



**Figure 1-2.** Block Diagram



## 2. Pin Configuration

Figure 2-1. Pinning SSO44

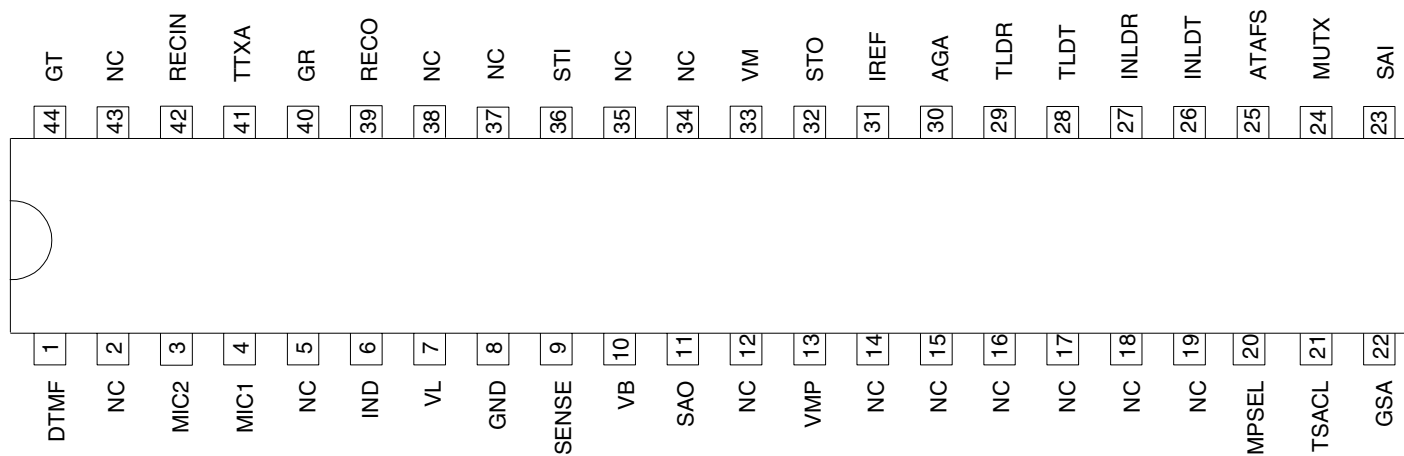


Table 2-1. Pin Description

| Pin | Symbol   | Function                                                                                                                                                                                                                             |
|-----|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | DTMF     | Input for DTMF signals. Also used for the answering machine and hands-free input.                                                                                                                                                    |
| 3   | MIC 2    | Non-inverting input of microphone amplifier.                                                                                                                                                                                         |
| 4   | MIC 1    | Inverting input of microphone amplifier.                                                                                                                                                                                             |
| 6   | 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.                                               |
| 7   | $V_L$    | Line voltage.                                                                                                                                                                                                                        |
| 8   | GND      | Reference point for DC and AC output signals.                                                                                                                                                                                        |
| 9   | SENSE    | A small resistor (fixed) connected from this pin to $V_L$ sets the slope of the DC characteristic, and affects the line-length equalization characteristics, and the line current at which the loudspeaker amplifier is switched on. |
| 10  | $V_B$    | Unregulated supply voltage for peripheral circuits (voice switch); limited to typically 7V.                                                                                                                                          |
| 11  | SAO      | Output of loudspeaker amplifier.                                                                                                                                                                                                     |
| 13  | $V_{MP}$ | Regulated supply voltage 3.3V for peripheral circuits. The maximum output current is 2 mA.                                                                                                                                           |
| 20  | IMPSEL   | Control input for selection of line impedance<br>1) 600Ω<br>2) 900Ω<br>3) Mute of second transmit stage (TXA); also used for indication of external supply (answering machine); last chosen impedance is stored.                     |
| 21  | TSACL    | Time constant of anti-clipping of speaker amplifier.                                                                                                                                                                                 |
| 22  | GSA      | Current input for setting the gain of the speaker amplifier. Adjustment characteristic is logarithmical. For $R_{GSA} > 2 \text{ M}\Omega$ the speaker amplifier is switched off.                                                    |
| 23  | SAI      | Speaker amplifier input (for loudspeaker, tone ringer and hands-free use).                                                                                                                                                           |

Note: Filters against electromagnetic interference (EMI) are located at pins MIC1, MIC2, RECIN and STI.

**Table 2-1.** Pin Description (Continued)

| Pin | Symbol | Function                                                                                                                                                                                                                                                                                                                             |
|-----|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24  | 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 is not affected. |
| 25  | 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.                                                                                                                                                                      |
| 26  | INLDT  | Input of transmit level detector.                                                                                                                                                                                                                                                                                                    |
| 27  | INLDR  | Input of receive level detector.                                                                                                                                                                                                                                                                                                     |
| 28  | TLDT   | Time constant of transmit level detector.                                                                                                                                                                                                                                                                                            |
| 29  | TLDR   | Time constant of receive level detector.                                                                                                                                                                                                                                                                                             |
| 30  | AGA    | Automatic gain adjustment with line current. A resistor connected from this pin to GND sets the starting point. Maximum gain change is 6 dB.                                                                                                                                                                                         |
| 31  | IREF   | Internal reference current generation; $R_{REF} = 62\text{ k}\Omega$ , $I_{REF} = 20\text{ }\mu\text{A}$                                                                                                                                                                                                                             |
| 32  | STO    | Side-tone reduction output. Output resistance is approximately $300\Omega$ . Maximum load impedance is $10\text{ k}\Omega$ .                                                                                                                                                                                                         |
| 33  | $V_M$  | Reference node for microphone-earphone and loudspeaker amplifier. Supply for electret microphone ( $I_M \geq 300\text{ mA}$ ).                                                                                                                                                                                                       |
| 36  | STI    | Input for side-tone network.                                                                                                                                                                                                                                                                                                         |
| 39  | RECO   | Output of receiving amplifier.                                                                                                                                                                                                                                                                                                       |
| 40  | $G_R$  | A resistor connected from this pin to GND sets the receiving amplification of the circuit; amplifier RA1 can be muted by applying $V_{MP}$ to $G_R$ .                                                                                                                                                                                |
| 41  | TTXA   | Time constant of anti-clipping in transmit path.                                                                                                                                                                                                                                                                                     |
| 42  | RECIN  | Input of receiving path; input impedance is typically $80\text{ k}\Omega$ .                                                                                                                                                                                                                                                          |
| 44  | $G_T$  | A resistor from this pin to GND sets the amplification of microphone and DTMF signals; the input amplifier can be muted by applying $V_{MP}$ to $G_T$ .                                                                                                                                                                              |

Note: Filters against electromagnetic interference (EMI) are located at pins MIC1, MIC2, RECIN and STI.

### 3. DC Line Interface and Supply-voltage Generation

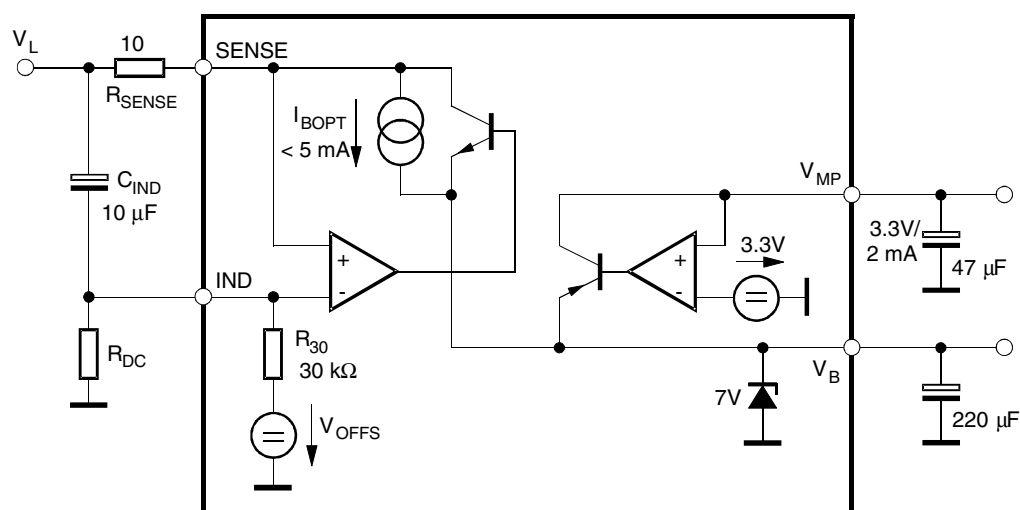
The DC line interface consists of an electronic inductance and an output stage which charges the capacitor at  $V_B$ . The value of the equivalent inductance is given by:

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

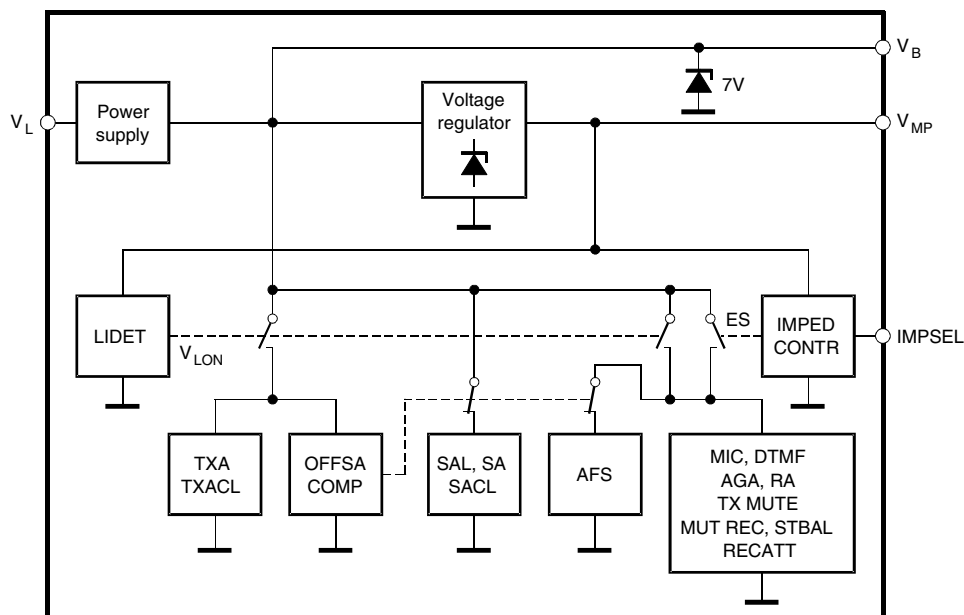
In order to improve the supply during worst-case operating conditions, the PNP current source ( $I_{\text{BOPT}}$ ) supplies an extra amount of current to the supply voltages when the NPN in parallel is unable to conduct current.

The U4089B-P contains a series regulator which provides a supply voltage  $V_{\text{MP}}$  of 3.3V at 2 mA suitable for a microprocessor.

**Figure 3-1.** DC Line Interface With Electronic Inductance and Generation of Regulated and Unregulated Supply



**Figure 3-2.** Functional Blocks for Power 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 (1.9V), the internal signal VLON is activated, thus switching on all blocks of the chip.

For line voltages below 1.9V, the switches remain in their quiescent state as shown in [Figure 3-2](#).

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

2. Selecting IMPSEL = high impedance activates all switches on the ES line.

## 4. Acoustic Feedback Suppression

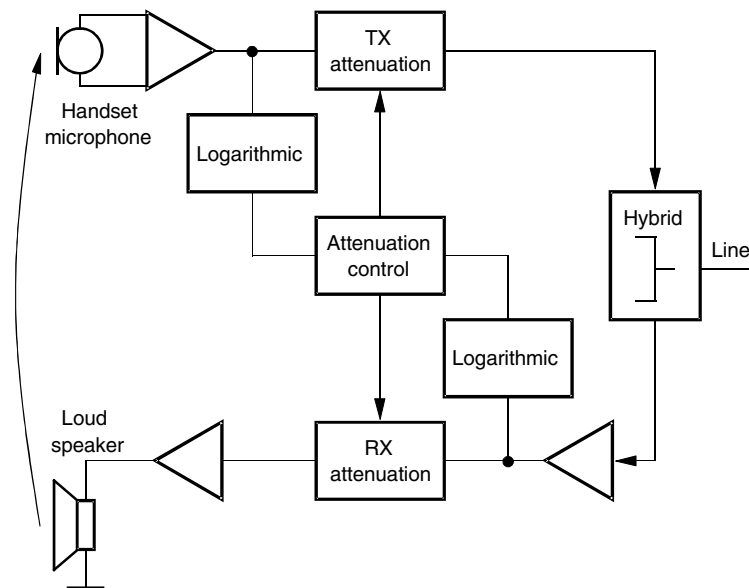
Acoustical feedback from the loudspeaker to the handset microphone may cause instability in the system. The U4089B-P offers a very efficient feedback suppression circuit which uses a modified voice switch topology. [Figure 4-1](#) shows the basic system configuration.

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.

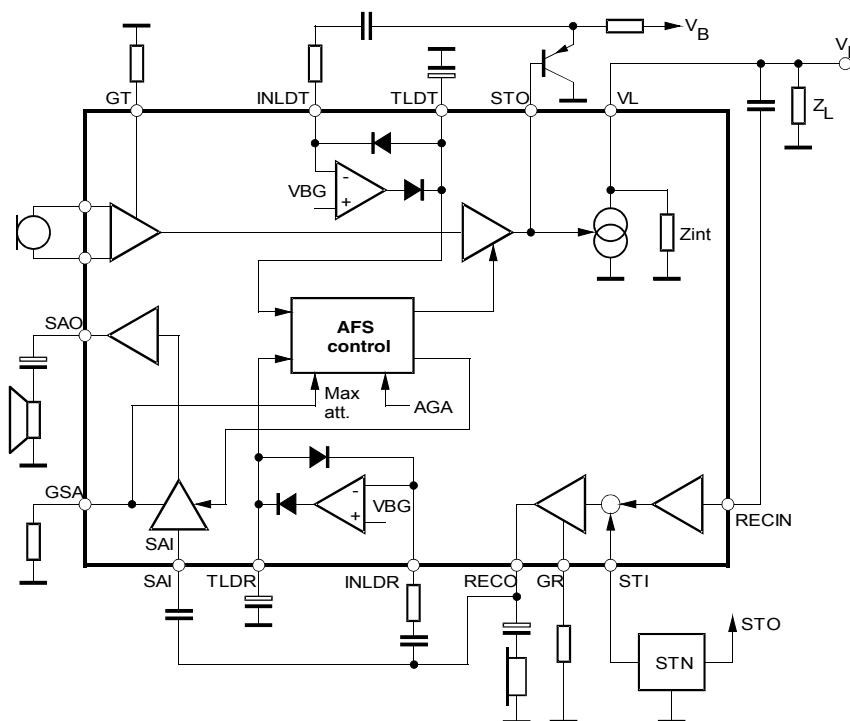
Selection of the active channel is made by comparison of the logarithmically compressed TX and RX envelope curves.

The system configuration for group listening, which is realized in the U4089B-P, is illustrated in [Figure 4-2](#). TXA and SAI represent the two attenuators; the logarithmic envelope detectors are shown in a simplified way (operational amplifiers with two diodes).

**Figure 4-1.** Basic Voice-switch System



**Figure 4-2.** Integration of the Acoustic Feedback-suppression Circuit Into the Speech Circuit Environment



**Figure 4-3.** Acoustic Feedback Suppression by Alternative Control of Transmit and Speaker Amplifier Gain

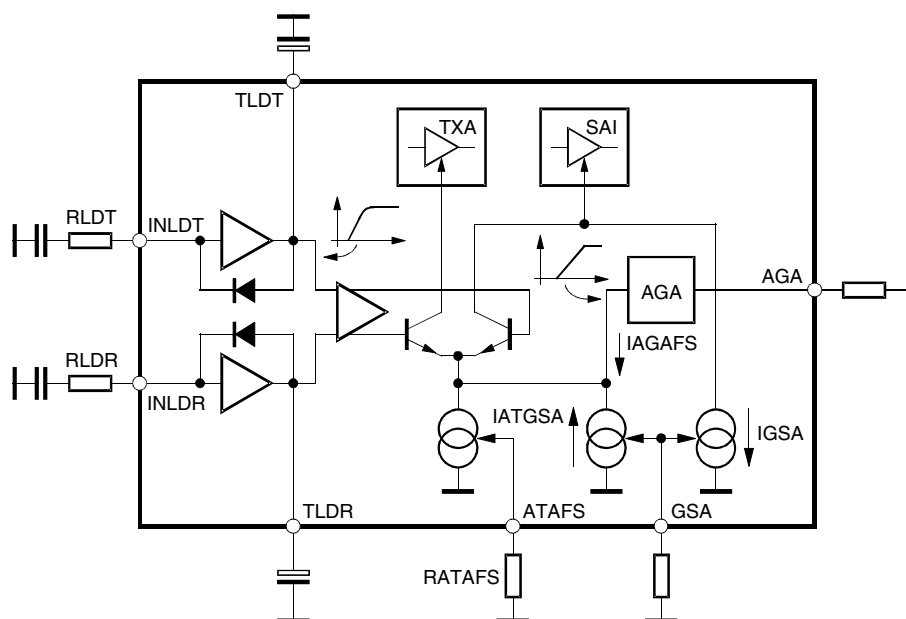


Figure 4-3 on page 7 provides a detailed diagram of the AFS (Acoustic Feedback Suppression). Receive and transmit signals are first processed by logarithmic rectifiers in order to produce the speech envelopes at TLDT and RLDT. After amplification, a decision is made by the differential pair which direction should be transmitted.

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

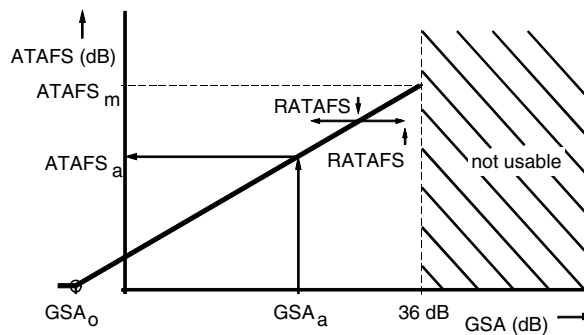
|             |                                                                                           |
|-------------|-------------------------------------------------------------------------------------------|
| $I_{ATAFS}$ | sets maximum attenuation                                                                  |
| $I_{ATGSA}$ | 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 4-4 illustrates the principal 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 GSA value to be used 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 the 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  $GSA \geq GSA_0 = 36 \text{ dB} - ATAFS_m$ .

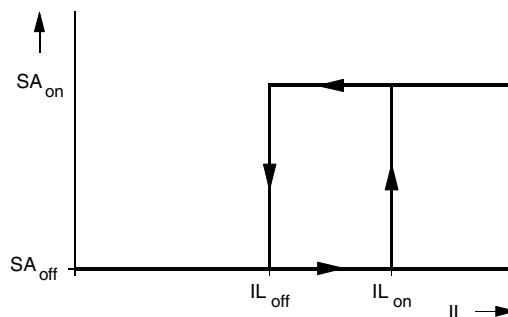
**Figure 4-4.** Reducing Speaker Amplifier Gain Results in an Equal Reduction of AFS Attenuation



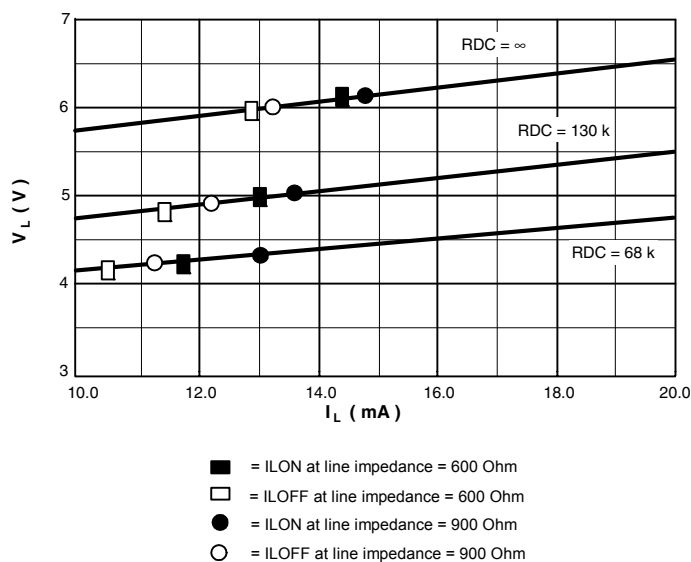
## 5. Operating Range of Speaker Amplifier

The basic behavior is illustrated in Figure 5-1. Actual values of  $IL_{ON}/IL_{OFF}$  vary slightly with the adjustment of the DC characteristics and the selection of the internal line impedance.

**Figure 5-1.** Threshold of Speaker Amplifier



**Figure 5-2.** Comparator Thresholds Depend on DC Mask and Line Impedance



## 6. Absolute Maximum Ratings

| Parameters                                                    | Symbol    | Value       | Unit |
|---------------------------------------------------------------|-----------|-------------|------|
| Line current                                                  | $I_L$     | 140         | mA   |
| DC line voltage                                               | $V_L$     | 12          | V    |
| Junction temperature                                          | $T_j$     | 125         | °C   |
| Ambient temperature                                           | $T_{amb}$ | -25 to +75  | °C   |
| Storage temperature                                           | $T_{stg}$ | -55 to +150 | °C   |
| Total power dissipation, $T_{amb} = 60^\circ\text{C}$ , SSO44 | $P_{tot}$ | 0.9         | W    |
| ESD (Human Body Model), ESD S 5.1 Standard                    | $V_{ESD}$ | 1.5         | kV   |
| ESD (Machine Model), JEDEC A115A                              | $V_{ESD}$ | 150         | V    |

## 7. Thermal Resistance

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

## 8. Electrical Characteristics

$f = 1\text{ kHz}$ ,  $0\text{ dBm} = 775\text{ mV}_{rms}$ ,  $I_M = 0.3\text{ mA}$ ,  $I_{MP} = 2\text{ mA}$ ,  $RDC = 130\text{ k}\Omega$ ,  $T_{amb} = 25^\circ\text{C}$ ,  $RGSA = 560\text{ k}\Omega$ ,  $Z_{ear} = 68\text{ nF} + 100\Omega$ ,  $Z_M = 68\text{ nF}$ , Pin 30 open (AGA),  $V_{MUTX} = \text{GND}$ , see [Figure 8-11 on page 22](#) (AC tests), unless otherwise specified.

| Parameters                                                                                                            | Test Conditions                                                           | Pin | Symbol            | Min.       | Typ.     | Max.       | Unit |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-----|-------------------|------------|----------|------------|------|
| DC Characteristics (see <a href="#">Figure 8-8 on page 19</a> )                                                       |                                                                           |     |                   |            |          |            |      |
| DC voltage drop over circuit                                                                                          | I <sub>L</sub> = 2 mA                                                     |     | V <sub>L</sub>    | 4.6        | 2.4      | 5.4        | V    |
|                                                                                                                       | I <sub>L</sub> = 14 mA                                                    |     |                   |            | 5.0      |            | V    |
|                                                                                                                       | I <sub>L</sub> = 60 mA                                                    |     |                   |            | 7.5      |            | V    |
|                                                                                                                       | I <sub>L</sub> = 100 mA                                                   |     |                   |            | 9.4      |            | V    |
| <b>Transmission Amplifier, I<sub>L</sub> = 14 mA, V<sub>MIC</sub> = 2 mV, RGT = 27 kΩ, unless otherwise specified</b> |                                                                           |     |                   |            |          |            |      |
| Adjustment range of transmit gain                                                                                     |                                                                           |     | G <sub>T</sub>    | 40         | 45       | 50         | dB   |
| Transmitting amplification                                                                                            | RGT = 12 kΩ<br>RGT = 27 kΩ                                                |     | G <sub>T</sub>    | 47<br>39.8 | 48       | 49<br>41.8 | dB   |
| Frequency response                                                                                                    | I <sub>L</sub> ≥ 14 mA,<br>f = 300Hz to 3400Hz                            |     | ΔG <sub>T</sub>   |            |          | ±0.5       | dB   |
| Gain change with current                                                                                              | Pin 30 open (AGA),<br>I <sub>L</sub> = 14 mA to 100 mA                    |     | ΔG <sub>T</sub>   |            |          | ±0.5       | dB   |
| Gain deviation                                                                                                        | T <sub>amb</sub> = −10° C to +60° C                                       |     | ΔG <sub>T</sub>   |            |          | ±0.5       | dB   |
| CMRR of microphone amplifier                                                                                          |                                                                           |     | CMRR              | 60         | 80       |            | dB   |
| Input resistance of MIC amplifier                                                                                     | RGT = 12 kΩ<br>RGT = 27 kΩ                                                |     | R <sub>i</sub>    | 45         | 50<br>75 | 110        | kΩ   |
| Distortion at line                                                                                                    | I <sub>L</sub> > 14 mA<br>V <sub>L</sub> = 700 mV <sub>rms</sub>          |     | d <sub>t</sub>    |            |          | 2          | %    |
| Maximum output voltage                                                                                                | I <sub>L</sub> > 19 mA, d < 5%<br>V <sub>mic</sub> = 25 mV<br>CTXA = 1 μF |     | V <sub>Lmax</sub> | 1.8        | 3        | 4.2        | dBm  |

## 8. Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ \text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100\Omega$ ,  $Z_M = 68 \text{ nF}$ , Pin 30 open (AGA),  $V_{\text{MUTX}} = \text{GND}$ , see Figure 8-11 on page 22 (AC tests), unless otherwise specified.

| Parameters                                                                                                                                                                    | Test Conditions                                                                                                                               | Pin | Symbol           | Min.  | Typ.      | Max.      | Unit             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------|-------|-----------|-----------|------------------|
| Noise at line<br>psophometrically weighted                                                                                                                                    | $I_L > 14 \text{ mA}$<br>$G_T = 48 \text{ dB}$                                                                                                |     | $n_o$            |       | -80       | -72       | dBmp             |
| Anti-clipping<br>attack time<br>release time                                                                                                                                  | $CTXA = 1 \mu\text{F}$<br>each 3 dB overdrive                                                                                                 |     |                  |       | 0.5<br>9  |           | ms<br>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>$I_M = 300 \mu\text{A}$  |     | $G_T$            | 40    |           | 42.5      | dB               |
| Distortion at low operating<br>current                                                                                                                                        | $I_L = 10 \text{ mA}$<br>$I_M = 300 \mu\text{A}$<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>$RAGA = 20 \text{ k}\Omega$                                                                                       |     | $\Delta G_{TI}$  | -6.4  | -5.8      | -5.2      | dB               |
| Mute suppression<br>a) MIC muted<br>(microphone<br>preamplifier)                                                                                                              | $I_L \geq 14 \text{ mA}$<br>$\text{Mutx} = \text{open}$                                                                                       |     | $G_{TM}$         | 60    | 80        |           | dB               |
| <b>Receiving Amplifier, <math>I_L = 14 \text{ mA}</math>, <math>RGR = 62 \text{ k}\Omega</math>, unless otherwise specified, <math>V_{\text{GEN}} = 300 \text{ mV}</math></b> |                                                                                                                                               |     |                  |       |           |           |                  |
| Adjustment range of<br>receiving gain                                                                                                                                         | $I_L \geq 14 \text{ mA}$ ,<br>single ended                                                                                                    |     | $G_R$            | -8    |           | +2        | dB               |
| Receiving amplification                                                                                                                                                       | $RGR = 62 \text{ k}\Omega$<br>$RGR = 22 \text{ k}\Omega$                                                                                      |     | $G_R$            | -7.75 | -7<br>1.5 | -6.25     | dB               |
| Amplification of DTMF signal<br>from DTMF IN to RECO                                                                                                                          | $I_L \geq 14 \text{ mA}$<br>$V_{\text{MUTX}} = V_{MP}$                                                                                        |     | $G_{RM}$         | 1     | 4         | 7         | dB               |
| Frequency response                                                                                                                                                            | $I_L > 14 \text{ mA}$ ,<br>$f = 300\text{Hz}$ to $3400\text{Hz}$                                                                              |     | $\Delta G_{RF}$  |       |           | $\pm 0.5$ | dB               |
| Gain change with current                                                                                                                                                      | $I_L = 14 \text{ mA}$ to $100 \text{ mA}$                                                                                                     |     | $\Delta G_R$     |       |           | $\pm 0.5$ | dB               |
| Gain deviation                                                                                                                                                                | $T_{\text{amb}} = -10^\circ \text{C}$ to $+60^\circ \text{C}$                                                                                 |     | $\Delta G_R$     |       |           | $\pm 0.5$ | dB               |
| Ear protection                                                                                                                                                                | $I_L \geq 14 \text{ mA}$<br>$V_{\text{GEN}} = 11V_{\text{rms}}$                                                                               |     | EP               |       |           | 1.1       | $V_{\text{rms}}$ |
| MUTE suppression<br>DTMF operation                                                                                                                                            | $I_L \geq 14 \text{ mA}$<br>$V_{\text{MUTX}} = V_{MP}$                                                                                        |     | $\Delta G_R$     | 60    |           |           | dB               |
| Output voltage $d \leq 2\%$                                                                                                                                                   | $I_L = 14 \text{ mA}$<br>$Z_{\text{ear}} = 68 \text{ nF}$                                                                                     |     |                  | 0.5   |           |           | $V_{\text{rms}}$ |
| Maximum output current<br>$d \leq 2\%$                                                                                                                                        | $Z_{\text{ear}} = 100\Omega$                                                                                                                  |     |                  | 4     |           |           | mA<br>(peak)     |
| Receiving noise<br>psophometrically weighted                                                                                                                                  | $Z_{\text{ear}} = 68 \text{ nF} + 100\Omega$<br>$I_L \geq 14 \text{ mA}$                                                                      |     | $n_i$            |       | -80       | -77       | dBmp             |
| Output resistance                                                                                                                                                             | Output against GND                                                                                                                            |     | $R_o$            |       |           | 10        | $\Omega$         |
| Line-loss compensation                                                                                                                                                        | $RAGA = 20 \text{ k}\Omega$<br>$I_L = 100 \text{ mA}$                                                                                         |     | $\Delta G_{RI}$  | -7.0  | -6.0      | -5.0      | dB               |
| AC impedance                                                                                                                                                                  |                                                                                                                                               |     | $Z_{\text{imp}}$ | 840   | 900       | 960       | $\Omega$         |

## 8. Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ \text{C}$ ,  $RGSA = 560 \text{ k}\Omega$

$Z_{\text{ear}} = 68 \text{ nF} + 100\Omega$ ,  $Z_M = 68 \text{ nF}$ , Pin 30 open (AGA),  $V_{\text{MUTX}} = \text{GND}$ , see [Figure 8-11 on page 22](#) (AC tests), unless otherwise specified.

| Parameters                                                                                                                                             | Test Conditions                                                                                                                                | Pin | Symbol                             | Min. | Typ.       | Max.      | Unit                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------|------|------------|-----------|------------------------------|
| 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>$RDC = 68 \text{ k}\Omega$ |     | $G_R$                              | -8   | -7         | -6        | dB                           |
| Distortion at low operating current                                                                                                                    | $I_L = 10 \text{ mA}$<br>$I_{MP} = 1 \text{ mA}$<br>$V_{\text{GEN}} = 560 \text{ mV}$<br>$RDC = 68 \text{ k}\Omega$                            |     | $d_R$                              |      |            | 5         | %                            |
| <b>Speaker Amplifier</b>                                                                                                                               |                                                                                                                                                |     |                                    |      |            |           |                              |
| Minimum line current for operation                                                                                                                     | No AC signal                                                                                                                                   |     | $I_{L\text{min}}$                  |      |            | 15        | mA                           |
| Input resistance                                                                                                                                       |                                                                                                                                                | 23  |                                    | 14   |            | 22        | $\text{k}\Omega$             |
| Gain from SAI to SAO                                                                                                                                   | $V_{\text{SAI}} = 3 \text{ mV}$ ,<br>$I_L = 15 \text{ mA}$ ,<br>$RGSA = 560 \text{ k}\Omega$<br>$RGSA = 20 \text{ k}\Omega$                    |     | $G_{\text{SA}}$                    | 35.5 | 36.5<br>-3 | 37.5      | dB<br>dB                     |
| Output power                                                                                                                                           | Load resistance<br>$R_L = 50 \Omega$ $d < 5\%$<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<br>mW                     |
| Output noise (input SAI open) psophometrically weighted                                                                                                | $I_L > 15 \text{ mA}$                                                                                                                          |     | $n_{\text{SA}}$                    |      |            | 200       | $\mu\text{V}_{\text{psoph}}$ |
| Gain deviation                                                                                                                                         | $I_L = 15 \text{ mA}$<br>$T_{\text{amb}} = -10^\circ \text{C}$ 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                                                                                                                               | $I_L = 15 \text{ mA}$ to $100 \text{ mA}$                                                                                                      |     | $\Delta G_{\text{SA}}$             |      |            | $\pm 1$   | dB                           |
| Resistor for turning off speaker amplifier                                                                                                             | $I_L = 15 \text{ mA}$ to $100 \text{ mA}$                                                                                                      |     | $RG_{\text{SA}}$                   | 0.8  | 1.3        | 2         | $\text{M}\Omega$             |
| Gain change with frequency                                                                                                                             | $I_L = 15 \text{ mA}$<br>$f = 300\text{Hz}$ to $3400\text{Hz}$                                                                                 |     | $\Delta G_{\text{SA}}$             |      |            | $\pm 0.5$ | dB                           |
| Attack time of anti-clipping                                                                                                                           | 20 dB overdrive                                                                                                                                |     | $t_r$                              |      | 5          |           | ms                           |
| Release time of anti-clipping                                                                                                                          |                                                                                                                                                |     | $t_f$                              |      | 80         |           | ms                           |
| <b>TMF 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                                                                                                                          | $I_L = 15 \text{ mA}$<br>Mute active                                                                                                           |     | $G_D$                              | 40   |            | 50        | dB                           |
| DTMF amplification                                                                                                                                     | $I_L = 15 \text{ mA}$ ,<br>$V_{\text{DTMF}} = 8 \text{ mV}$<br>Mute active:<br>$\text{MUTX} = \text{VMP}$                                      |     | $G_D$                              | 40.7 | 41.7       | 42.7      | dB                           |
| Gain deviation                                                                                                                                         | $I_L = 15 \text{ mA}$<br>$T_{\text{amb}} = -10^\circ \text{C}$ to $+60^\circ \text{C}$                                                         |     | $G_D$                              |      |            | $\pm 0.5$ | dB                           |

## 8. Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{\text{amb}} = 25^\circ \text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{\text{ear}} = 68 \text{ nF} + 100\Omega$ ,  $Z_M = 68 \text{ nF}$ , Pin 30 open (AGA),  $V_{\text{MUTX}} = \text{GND}$ , see [Figure 8-11 on page 22](#) (AC tests), unless otherwise specified.

| Parameters                                                                                                                                   | Test Conditions                                                                                                                                                    | Pin | Symbol                                 | Min.                   | Typ.       | Max.       | Unit                           |
|----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------------------------|------------------------|------------|------------|--------------------------------|
| Input resistance                                                                                                                             | $RGT = 27 \text{ k}\Omega$<br>$RGT = 15 \text{ k}\Omega$                                                                                                           |     | $R_i$                                  | 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                                                                                                                  | $I_L = 15 \text{ mA to } 100 \text{ mA}$                                                                                                                           |     | $\Delta GD$                            |                        |            | $\pm 0.5$  | dB                             |
| <b>AFS Acousting Feedback Suppression</b>                                                                                                    |                                                                                                                                                                    |     |                                        |                        |            |            |                                |
| 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>$I_{\text{INLDR}} = 10 \text{ }\mu\text{A}$   |     | $\Delta G_{SA}$                        |                        | 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^\circ \text{C to } +60^\circ \text{C}</math></b> |                                                                                                                                                                    |     |                                        |                        |            |            |                                |
| $V_{MP}$                                                                                                                                     | $I_L = 14 \text{ mA}$ ,<br>$RDC = 68 \text{ k}\Omega$<br>$I_{MP} = 2 \text{ mA}$                                                                                   |     | $V_{MP}$                               | 3.1                    | 3.3        | 3.5        | V                              |
| $V_M$                                                                                                                                        | $I_L \geq 14 \text{ mA}$ ,<br>$I_M = 300 \text{ }\mu\text{A}$<br>$RDC = 130 \text{ k}\Omega$                                                                       |     | $V_M$                                  | 1.4                    |            | 3.3        | V                              |
| $V_B$                                                                                                                                        | $I_B = +20 \text{ mA}$ ,<br>$I_L = 0 \text{ mA}$                                                                                                                   |     | $V_B$                                  |                        | 7          | 7.6        | V                              |
| <b>MUTX Input (see <a href="#">Figure 8-9 on page 20</a>)</b>                                                                                |                                                                                                                                                                    |     |                                        |                        |            |            |                                |
| Input current                                                                                                                                | $V_{\text{MUTX}} = V_{MP}$<br>$V_{\text{MUTX}} = \text{GND}$                                                                                                       |     | $I_{\text{MUTX}}$<br>$I_{\text{MUTX}}$ |                        | +20<br>-20 | +30<br>-30 | $\mu\text{A}$<br>$\mu\text{A}$ |
| Input voltage                                                                                                                                | Input high                                                                                                                                                         |     | $V_{\text{MUTX}}$                      | $V_{MP} - 0.3\text{V}$ |            |            | V                              |
|                                                                                                                                              | Input low                                                                                                                                                          |     | $V_{\text{MUTX}}$                      |                        |            | 0.3        | V                              |

**Table 8-1.** U4089B-P Control

| MUTX |                                                                                       | MODE                  |
|------|---------------------------------------------------------------------------------------|-----------------------|
| 0    | MIC1, MIC2 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 DTMF to receive enable<br>AFS = off<br>AGA = off<br>TXACL = off | DTMF dialling         |

| IMPSEL |                                               | MODE          |
|--------|-----------------------------------------------|---------------|
| 0      | Line impedance = 600Ω<br>TXA = on<br>ES = off | Speech        |
| 0 to Z | Line impedance = 600Ω<br>TXA = off<br>ES = on | Transmit mute |
| 1 to Z | Line impedance = 900Ω<br>TXA = off<br>ES = on | Transmit mute |
| 1      | Line impedance = 900Ω<br>TXA = on<br>ES = off | Speech        |

| Logic level                                                                                 |
|---------------------------------------------------------------------------------------------|
| 0 = < (0.3V)<br>Z = > (1V) < ( $V_{MP} - 1V$ ) or (open input)<br>1 = > ( $V_{MP} - 0.3V$ ) |

AFS = Acoustical feedback-suppression control  
AGA = Automatic gain adjustment  
TXACL = Transmit anti-clipping control  
ES = External supply

Figure 8-1. Typical DC Characteristic

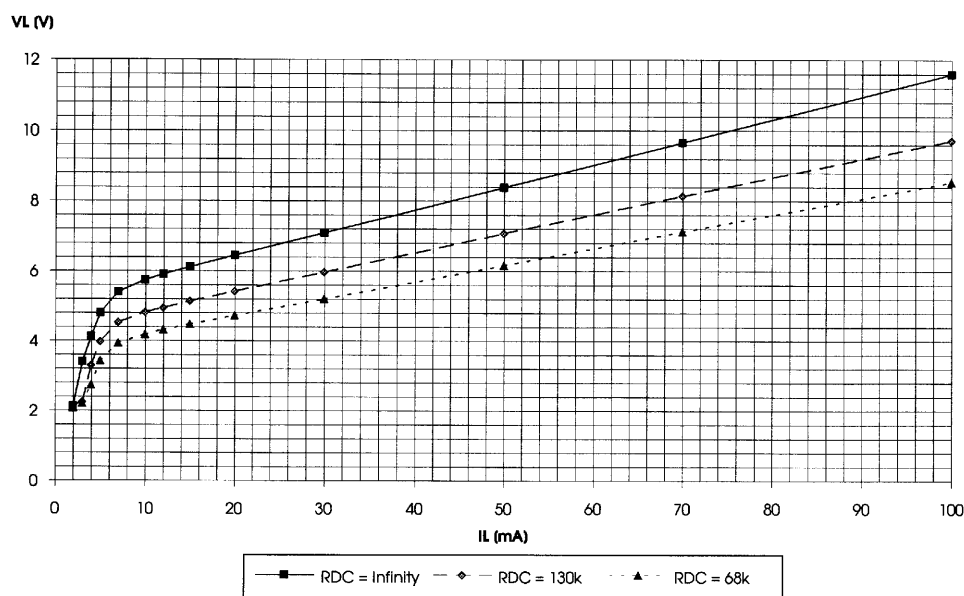
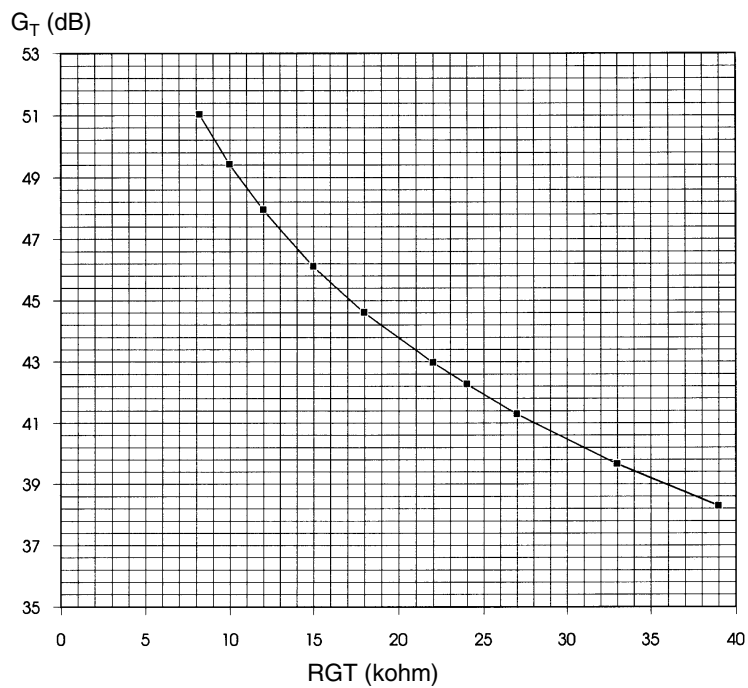
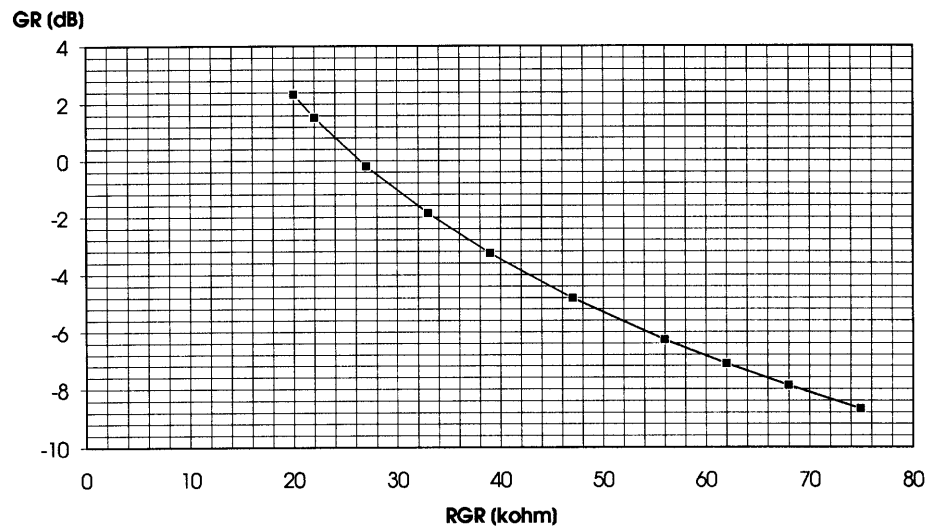


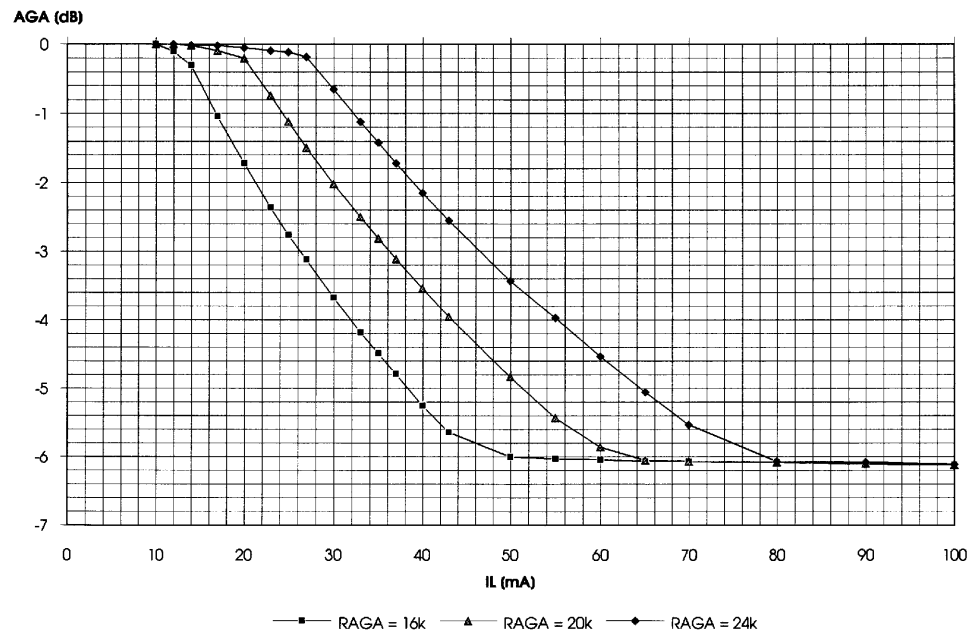
Figure 8-2. Typical Adjustment Range of the Transmit Gain



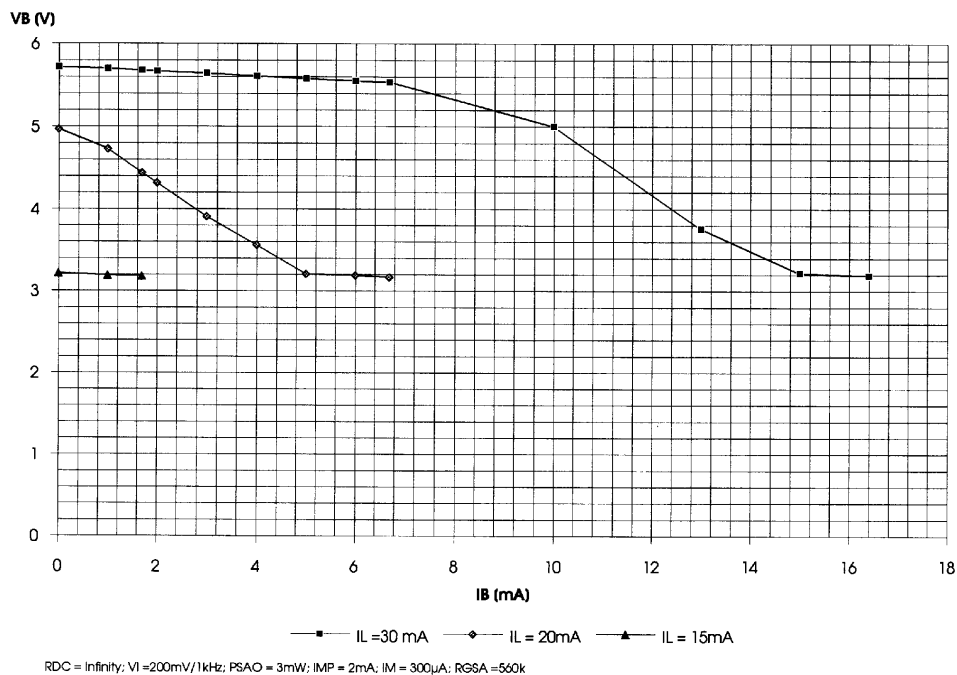
**Figure 8-3.** Typical Adjustment Range of the Receive Gain



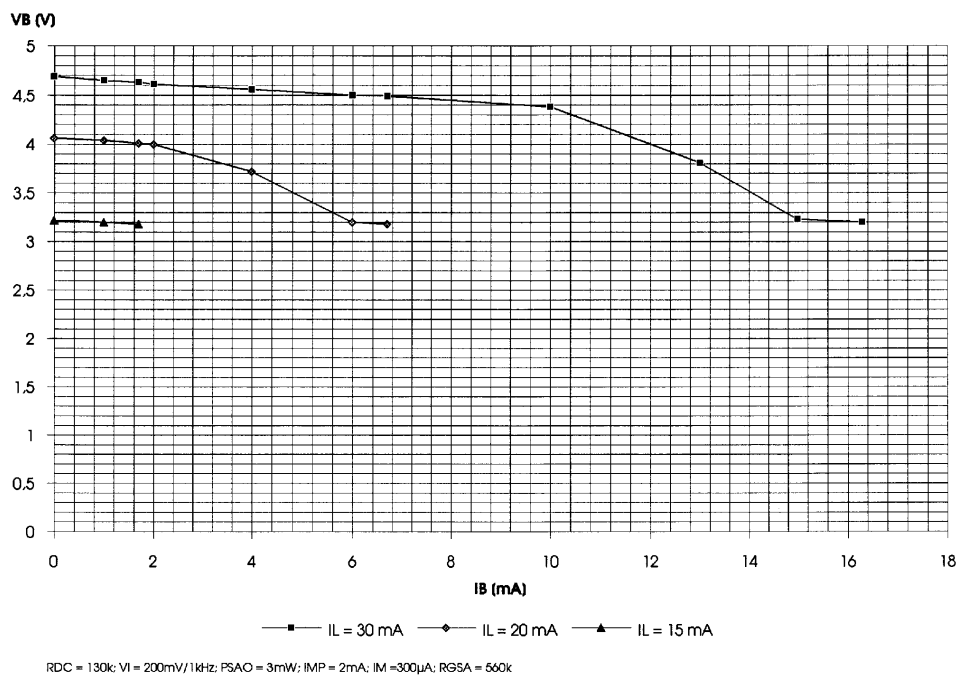
**Figure 8-4.** Typical AGA Characteristic



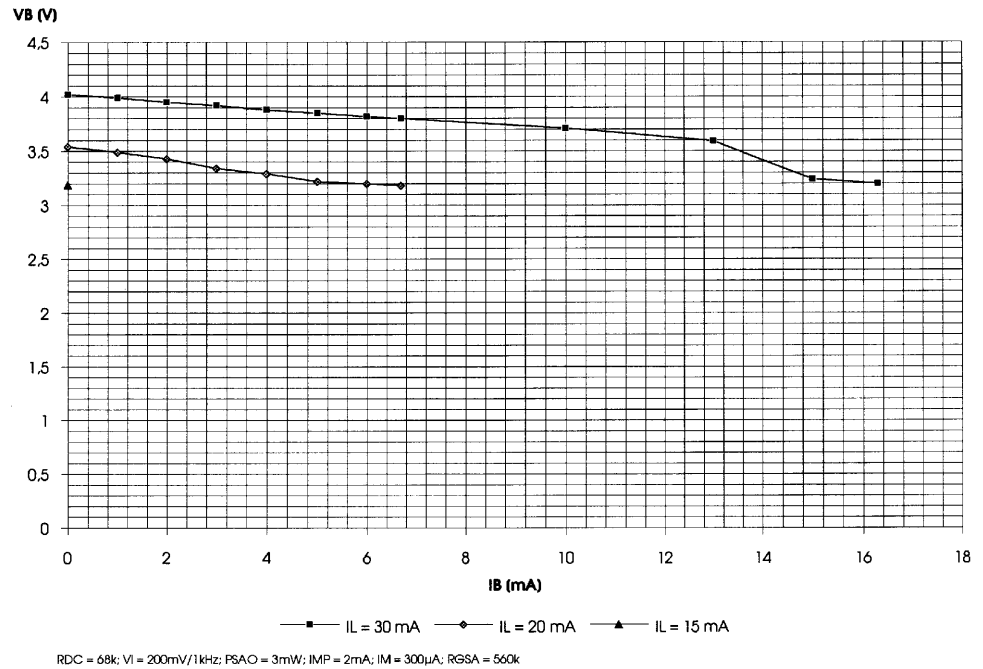
**Figure 8-5.** Typical Load Characteristic of  $V_B$  for a Maximum (RDC = infinity) DC Characteristic and a 3-mW Loudspeaker Output



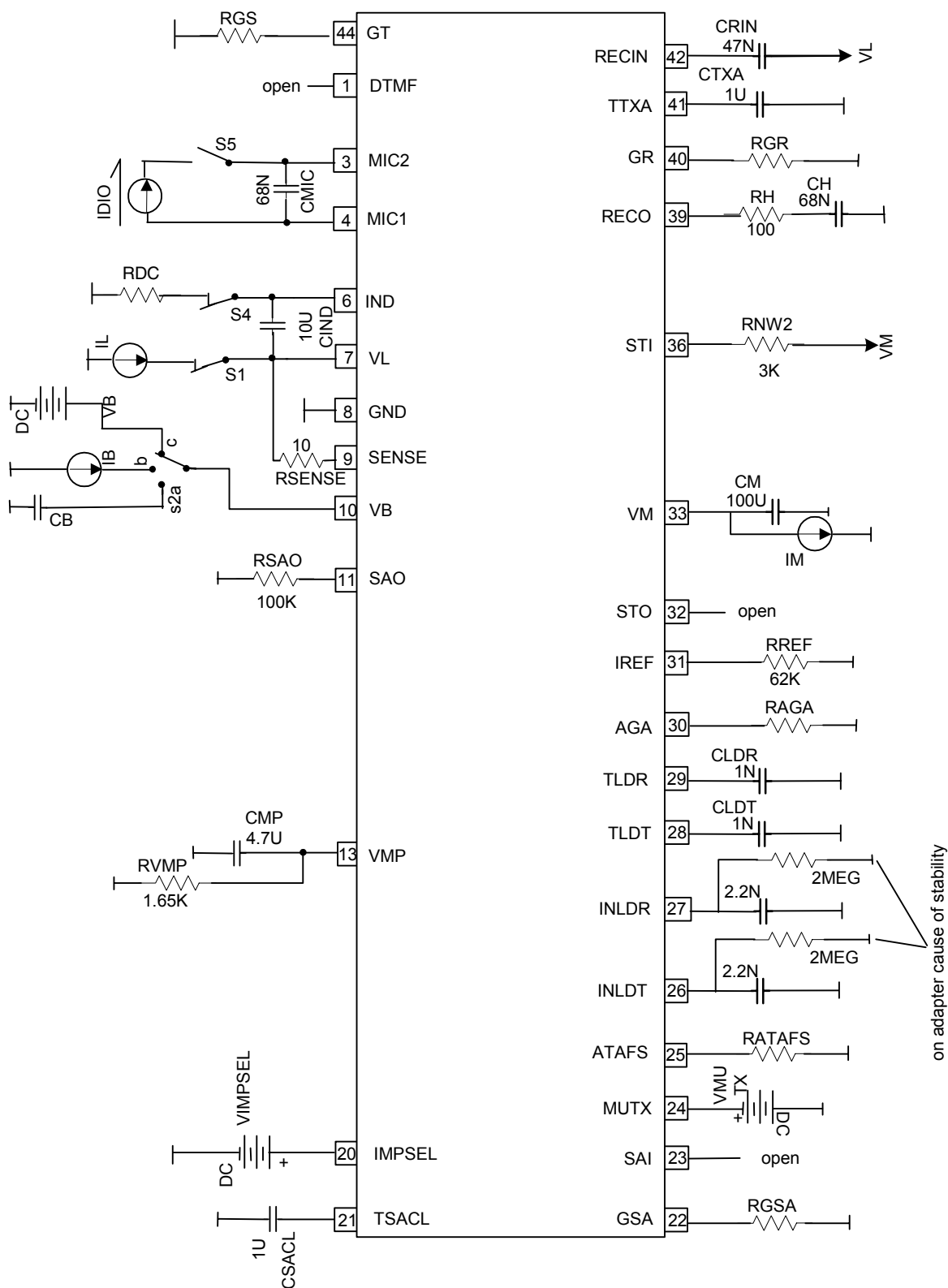
**Figure 8-6.** Typical Load Characteristic of  $V_B$  for a Medium DC Characteristic (RDC = 130 k $\Omega$ ) and a 3-mW Loudspeaker Output



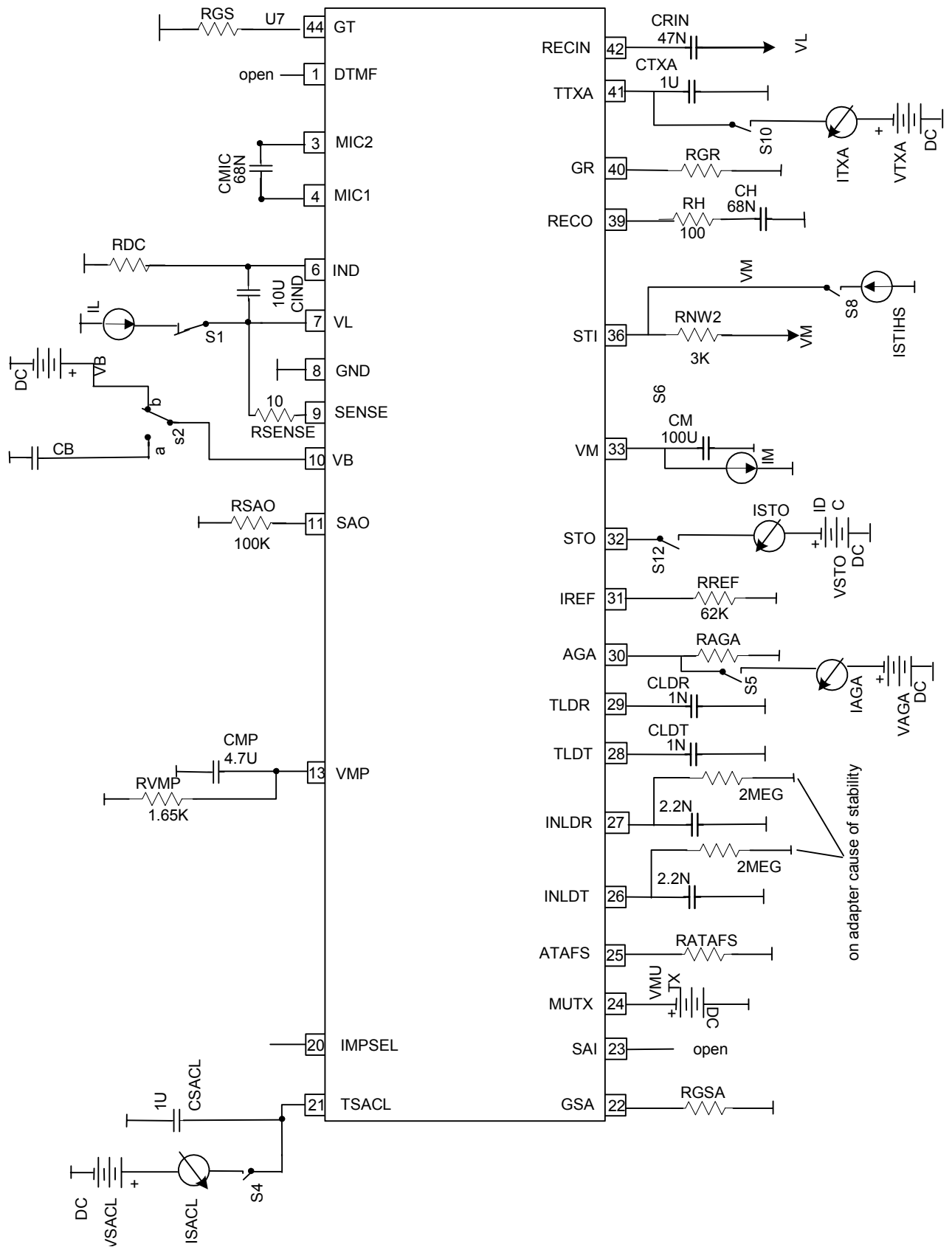
**Figure 8-7.** Typical Load Characteristic of  $V_B$  for a Minimum DC Characteristic ( $RDC = 68\text{ k}\Omega$ ) and a 3-mW Loudspeaker Output



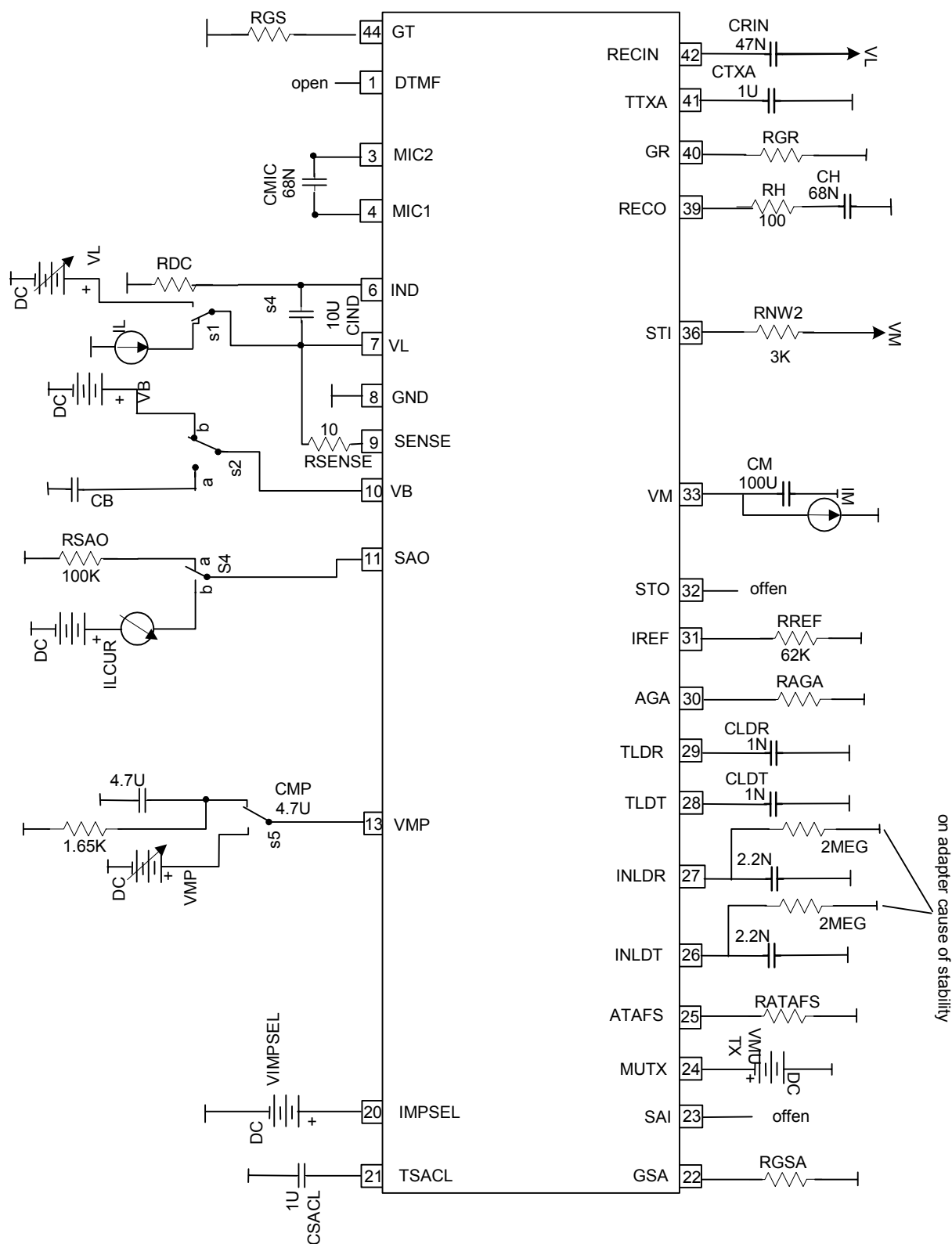
**Figure 8-8.** DC Voltage Absolute



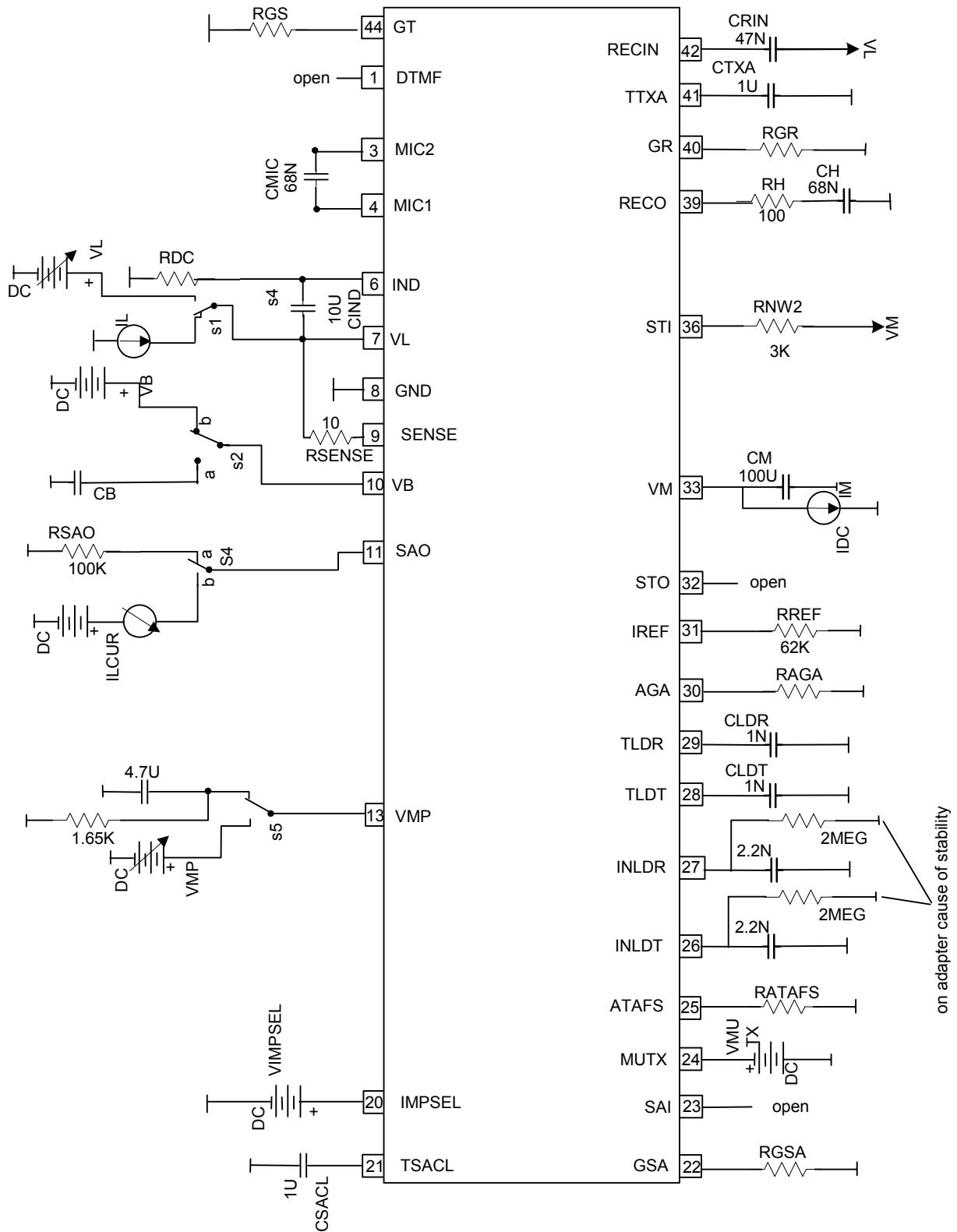
**Figure 8-9.** DC Voltage Current Test



**Figure 8-10. DC Ramps**



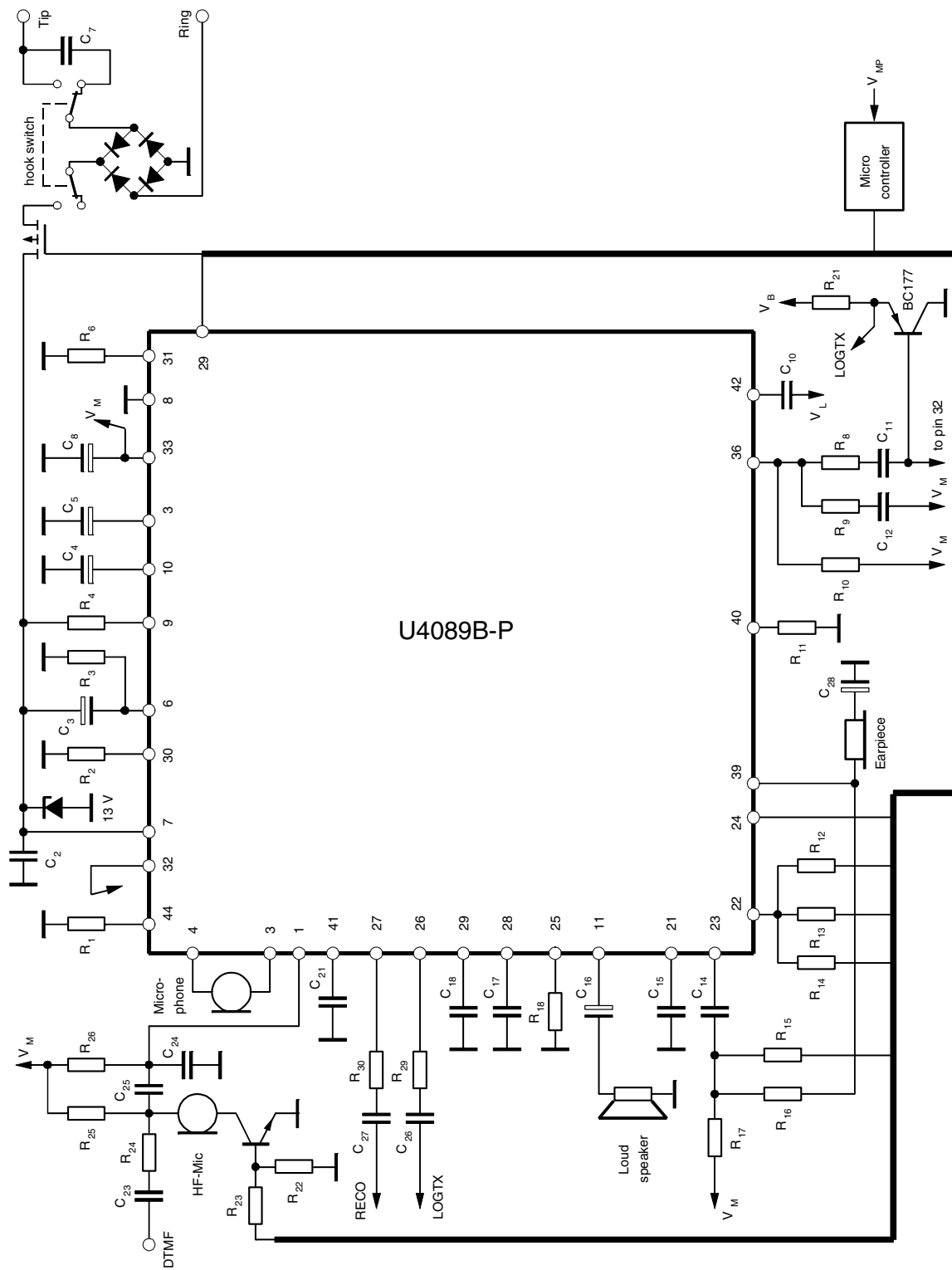
**Figure 8-11. AC Tests**



**Table 8-2.** Typical Values of External Components (see [Figure 8-12 on page 24](#))

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

**Figure 8-12.** Application for Hands-free Operation



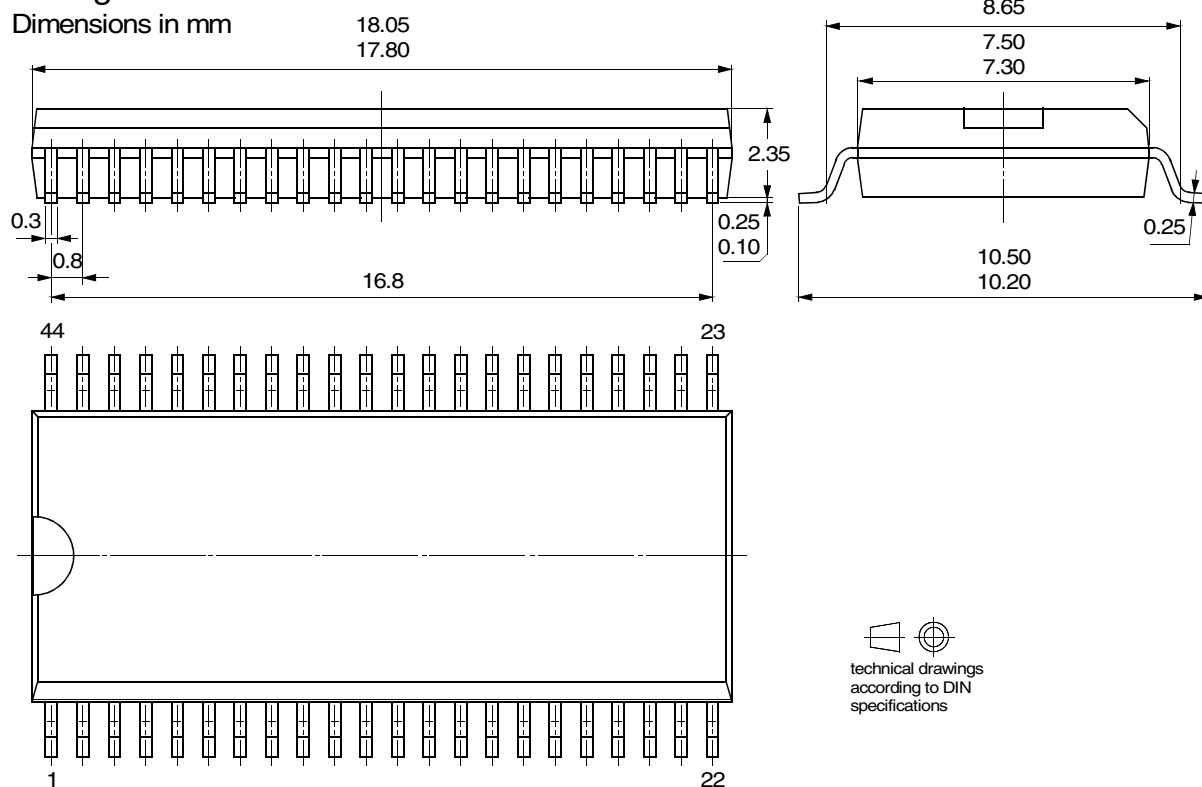
## 9. Ordering Information

| Extended Type Number | Package | Remarks                   |
|----------------------|---------|---------------------------|
| U4089B-PFNY          | SSO44   | Tubes, Pb-free            |
| U4089B-PFNG3Y        | SSO44   | Taped and reeled, Pb-free |

## 10. Package Information

### Package SSO44

Dimensions in mm





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