

## Features

- Adjustable DC Characteristics
- Adjustable Transmit and Receive Gain
- Symmetrical Input of Microphone Amplifier
- Anti-clipping in Transmit Direction
- Automatic Line-loss Compensation
- Built-in Ear Protection
- DTMF and MUTE Input
- Adjustable Side Tone Suppression Independent of Sending and Receiving Amplification
- Integrated Amplifier for Loud-hearing 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

## Benefits

- Complete System Integration of Analog Signal Processing on One Chip
- Very Few External Components

## Applications

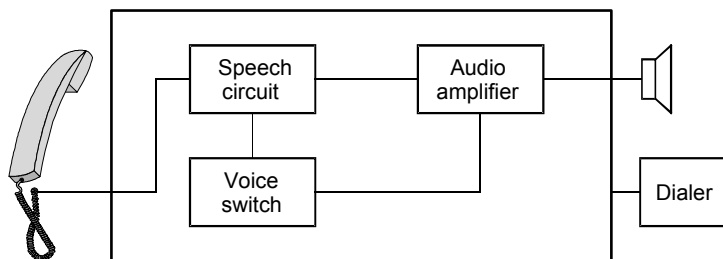
- Feature Phones
- Answering Machines
- Fax Machines
- Speaker Phones

## Description

The telephone circuit U4089B-M is a linear integrated circuit for use in feature phones, answering machines and fax machines. It contains the speech circuit, side tone 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 a loudspeaker amplifier enables 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.

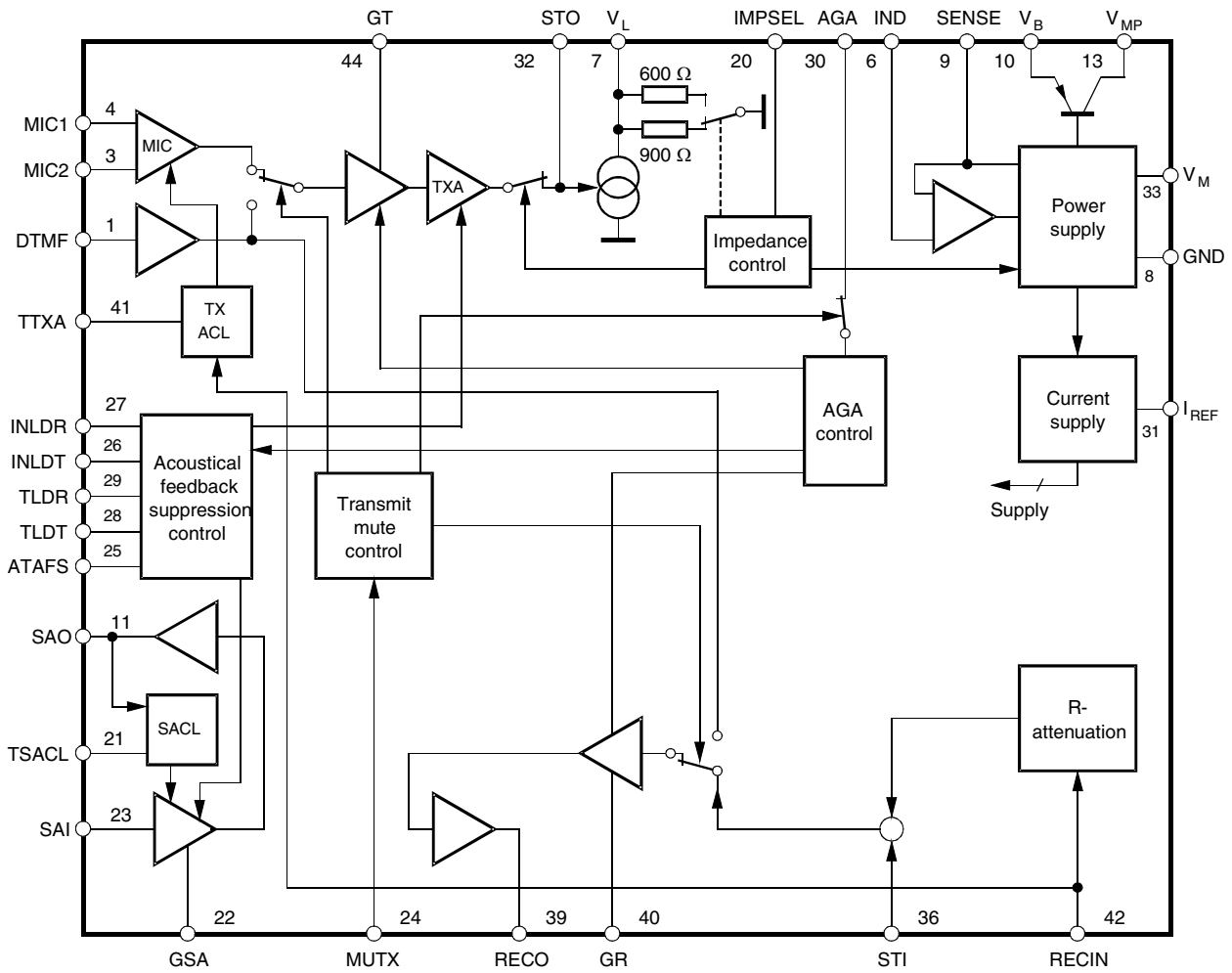
**Figure 1.** Simple Block Diagram



# Monolithic Integrated Feature Phone Circuit

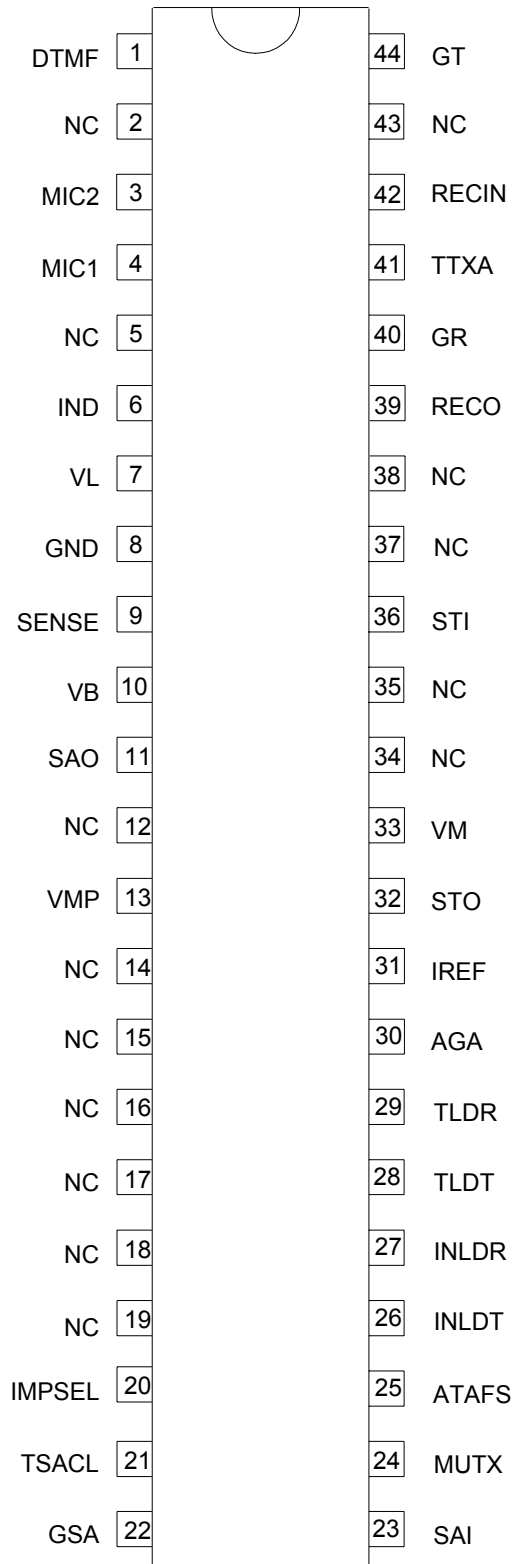
## U4089B-M

Figure 2. Block Diagram



## Pin Configuration

Figure 3. Pinning SSO44



## 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 also 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 7 V
11	SAO	Output of loudspeaker amplifier
13	$V_{MP}$	Regulated 3.3 V supply voltage for peripheral circuits. The maximum output current is 2 mA.
20	IMPSEL	Control input for selection of line impedance 1) 600 $\Omega$ 2) 900 $\Omega$ 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	SA I	Speaker amplifier input (for loudspeaker, tone ringer and hands-free use)
24	MUTX	Three-state input of transmit mute: 1) Speech condition; inputs MIC1/MIC2 active 2) DTMF condition; input DTMF active. A part of the input signal is passed to the receiving amplifier as a confidence signal during dialing. 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 the 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. Max. gain change is 6 dB.
31	IREF	Internal reference current generation; $R_{REF} = 62 \text{ k}\Omega$ ; $I_{REF} = 20 \mu\text{A}$
32	STO	Side tone reduction output. Output resistance is approximately 300 $\Omega$ . Maximum load impedance is 10 k $\Omega$ .
33	$V_M$	Reference node for microphone, earphone and loudspeaker amplifier. Supply for electret microphone ( $I_M \leq 300 \mu\text{A}$ ).
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 k $\Omega$
44	$G_T$	A resistor from this pin to GND sets the amplification of the microphone and DTMF signals; the input amplifier can be muted by applying $V_{MP}$ to $G_T$ .

## DC Line Interface and Supply-voltage Generation

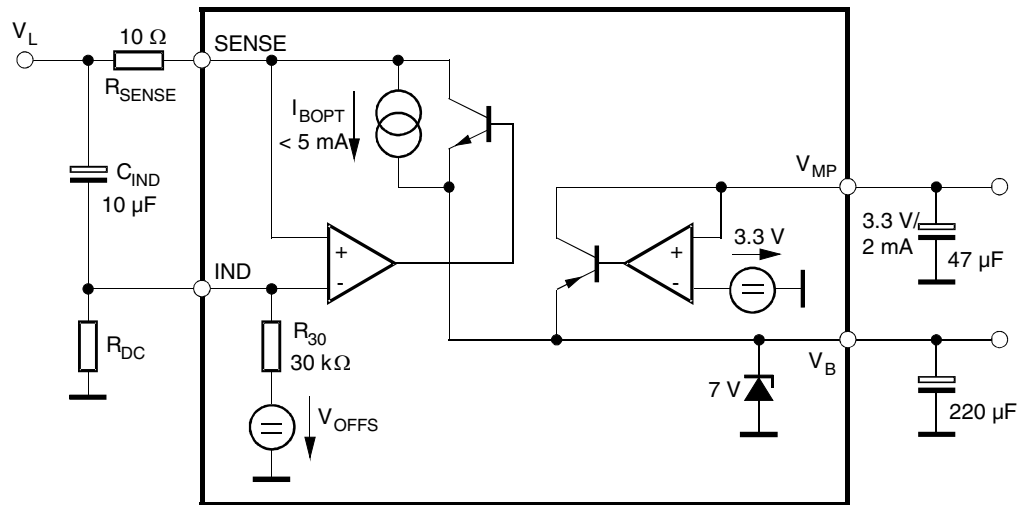
The DC line interface consists of an electronic inductance and an output stage which charges the capacitor at  $V_B$ . The value of the equivalent inductance is given by:  

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

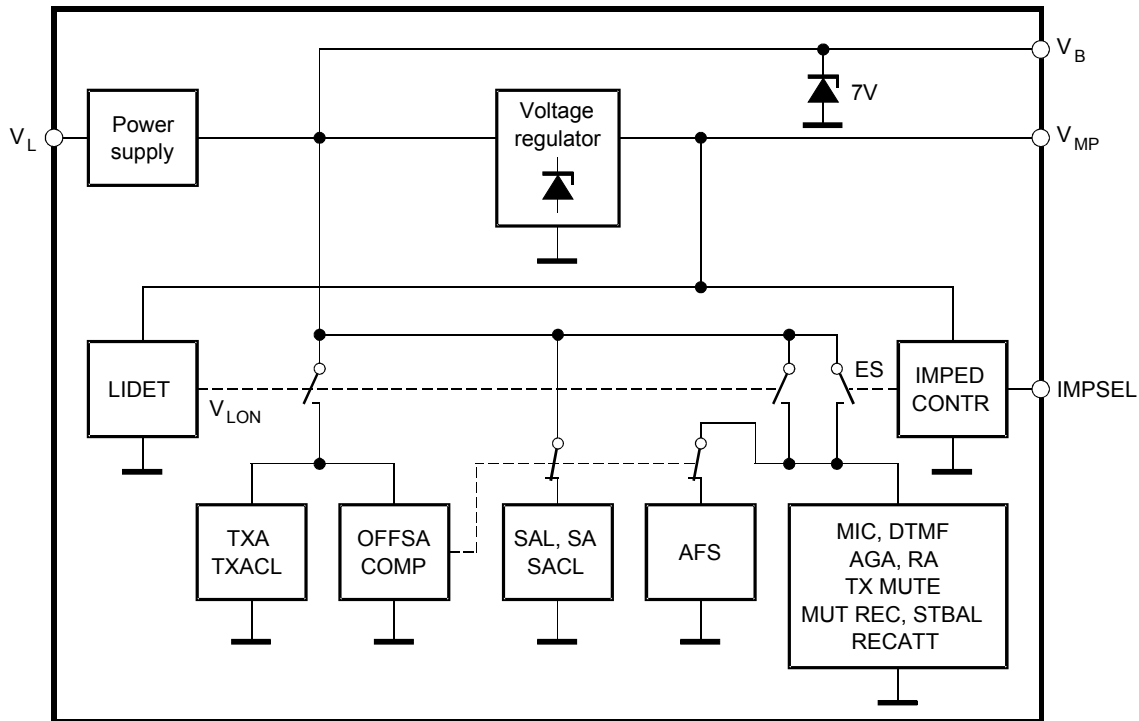
In order to improve the supply during worst-case operating conditions, the PNP current source ( $I_{BOPT}$ ) supplies an extra amount of current to the supply voltages when the NPN in parallel is unable to conduct current.

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

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



**Figure 5.** 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 (1.9 V), the internal signal VLON is activated, thus switching on all blocks of the chip.  
For line voltages below 1.9 V, the switches remain in their quiescent state as shown in Figure 5.  
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 at the ES line.

## Acoustic Feedback Suppression

Acoustical feedback from the loudspeaker to the handset microphone may cause instability in the system. The U4089B-M offers a very efficient feedback suppression circuit which uses a modified voice switch topology. Figure 6 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-M, is illustrated in Figure 7. TXA and SAI represent the two attenuators; the logarithmic envelope detectors are shown in a simplified way (operational amplifiers with two diodes).

Figure 6. Basic Voice-switch System

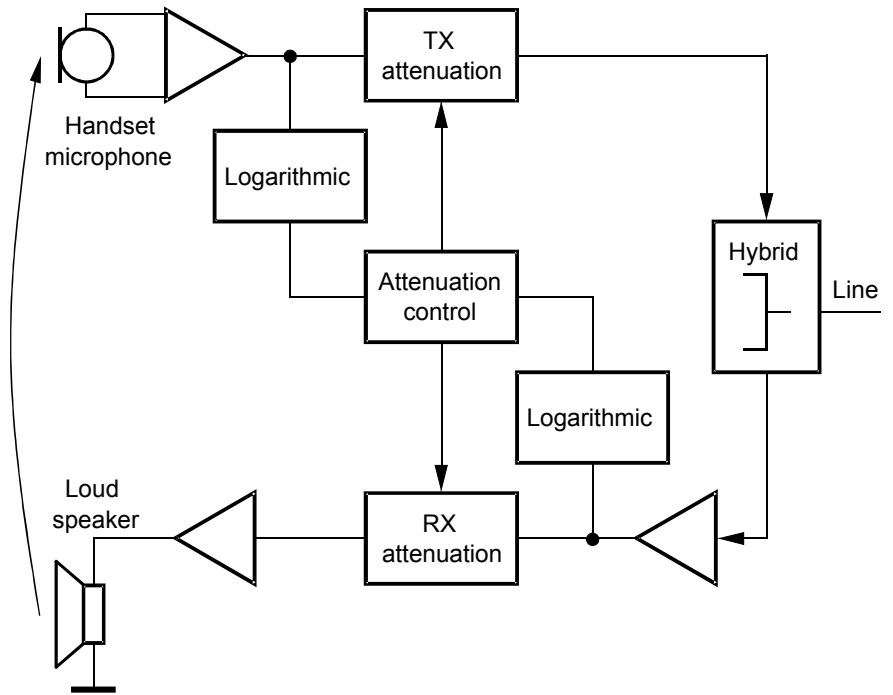
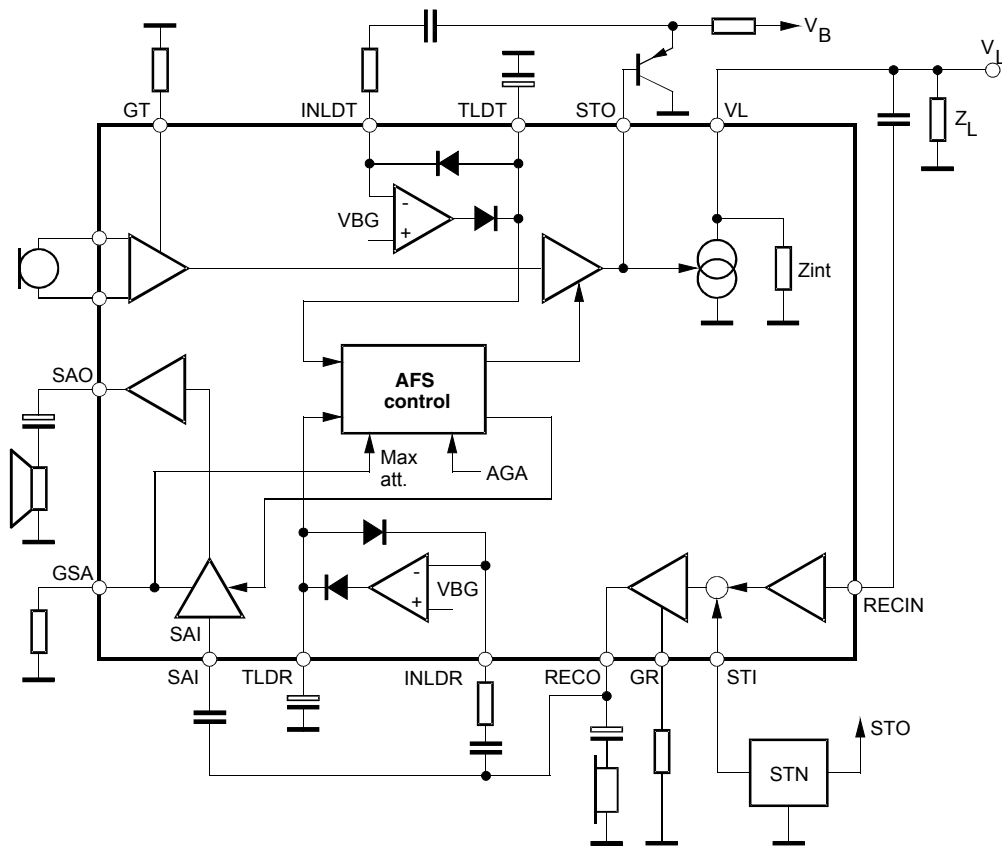
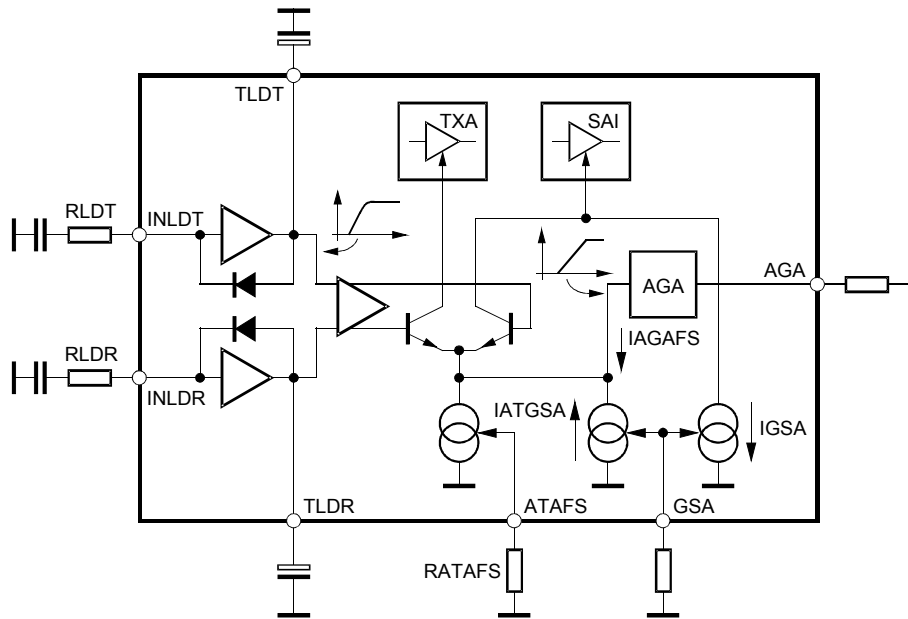


Figure 7. Integration of the Acoustic Feedback-suppression Circuit Into the Speech Circuit Environment



**Figure 8.** 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 8. 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 of 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

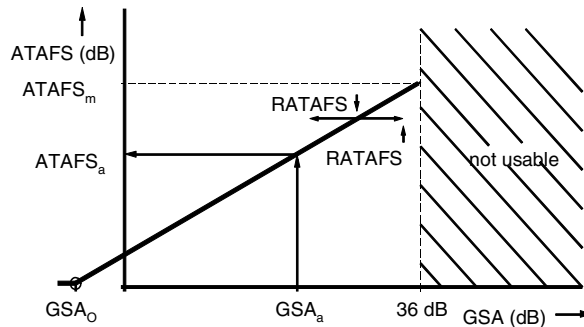
$$I_{AT} = I_{ATAFS} - I_{ATGSA} - I_{AGAFS}$$

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

Figure 9 illustrates the principal relationship between the 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 RATAFS, 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  $GSA \geq GSA_0 = 36 \text{ dB} - ATAFS_m$ .



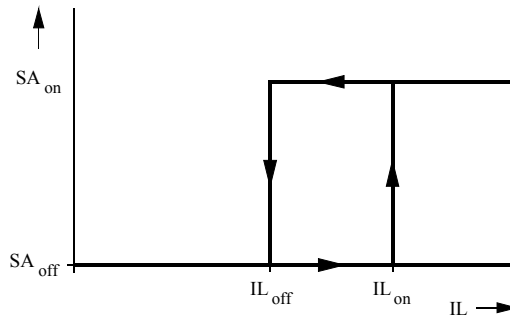
**Figure 9.** Reducing Speaker Amplifier Gain Results in an Equal Reduction of AFS Attenuation



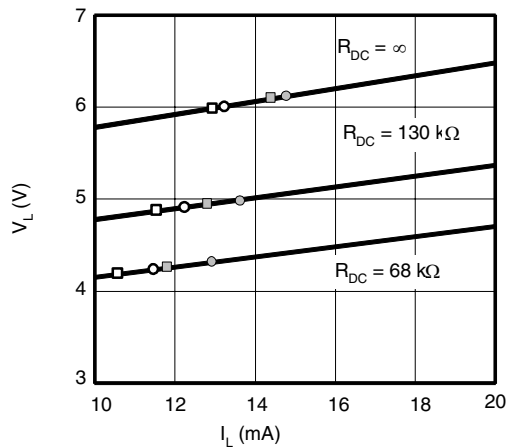
### Operating Range of Speaker Amplifier

The basic behavior is illustrated in Figure 10. Actual values of ILON/ILOFF vary slightly with the adjustment of the DC characteristics and the selection of the internal line impedance.

**Figure 10.** Threshold of Speaker Amplifier



**Figure 11.** Comparator Thresholds Depend on the DC Mask and Line Impedance



- ILON at line impedance = 600 Ω
- ILOFF at line impedance = 600 Ω
- ILON at line impedance = 900 Ω
- ILOFF at line impedance = 900 Ω

## 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

## Thermal Resistance

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

## Electrical Characteristics

$f = 1 \text{ kHz}$ ,  $0 \text{ dBm} = 775 \text{ mV}_{rms}$ ,  $I_M = 0.3 \text{ mA}$ ,  $I_{MP} = 2 \text{ mA}$ ,  $RDC = 130 \text{ k}\Omega$ ,  $T_{amb} = 25^\circ\text{C}$ ,  $RGSA = 560 \text{ k}\Omega$ ,  $Z_{ear} = 68 \text{ nF} + 100 \text{ }\Omega$ ,  $Z_M = 68 \text{ nF}$ , Pin 20 open,  $V_{MUTX} = \text{GND}$ , unless otherwise specified.

Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
<b>DC Characteristics</b>							
DC voltage drop over circuit	$I_L = 2 \text{ mA}$		$V_L$	4.6	2.4	5.4	V
	$I_L = 14 \text{ mA}$						V
	$I_L = 60 \text{ mA}$						V
	$I_L = 100 \text{ mA}$						V
<b>Transmission Amplifier, <math>I_L = 14 \text{ mA}</math>, <math>V_{MIC} = 2 \text{ mV}</math>, <math>RGT = 27 \text{ k}\Omega</math>, Unless Otherwise Specified</b>							
Adjustment range of transmit gain			$G_T$	40	45	50	dB
Transmitting amplification	$RGT = 12 \text{ k}\Omega$ $RGT = 27 \text{ k}\Omega$		$G_T$	47 39.8	48	49 41.8	dB
Frequency response	$I_L \geq 14 \text{ mA}$ , $f = 300 \text{ to } 3400 \text{ Hz}$		$\Delta G_T$			$\pm 0.5$	dB
Gain change with current	Pin 20 open (AGA), $I_L = 14 \text{ to } 100 \text{ mA}$		$\Delta G_T$			$\pm 0.5$	dB
Gain deviation	$T_{amb} = -10 \text{ to } +60^\circ\text{C}$		$\Delta G_T$			$\pm 0.5$	dB
CMRR of microphone amplifier			CMRR	60	80		dB
Input resistance of MIC amplifier	$RGT = 12 \text{ k}\Omega$ $RGT = 27 \text{ k}\Omega$		$R_i$	45	50 75	110	$\text{k}\Omega$
Distortion at line	$I_L > 14 \text{ mA}$ $V_L = 700 \text{ mV}_{rms}$		$d_t$			2	%
Maximum output voltage	$I_L > 19 \text{ mA}$ , $d < 5\%$ $V_{mic} = 25 \text{ mV}$ $CTXA = 1 \text{ }\mu\text{F}$		$V_{Lmax}$	1.8	3	4.2	dBm
Noise at line psophometrically weighted	$I_L > 14 \text{ mA}$ $G_T = 48 \text{ dB}$		$n_o$		-80	-72	dBmp

## Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV<sub>rms</sub>, I<sub>M</sub> = 0.3 mA, I<sub>MP</sub> = 2 mA, RDC = 130 kΩ, T<sub>amb</sub> = 25°C, RGSA = 560 kΩ, Z<sub>ear</sub> = 68 nF + 100 Ω, Z<sub>M</sub> = 68 nF, Pin 20 open, V<sub>MUTX</sub> = GND, unless otherwise specified.

Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
Anti-clipping attack time release time	CTXA = 1 μF each 3 dB overdrive				0.5 9		ms ms
Gain at low operating current	I <sub>L</sub> = 10 mA I <sub>MP</sub> = 1 mA RDC = 68 kΩ V <sub>mic</sub> = 1 mV I <sub>M</sub> = 300 μA		G <sub>T</sub>	40		42.5	dB
Distortion at low operating current	I <sub>L</sub> = 10 mA I <sub>M</sub> = 300 μA I <sub>MP</sub> = 1 mA RDC = 68 kΩ V <sub>mic</sub> = 10 mV		d <sub>t</sub>			5	%
Line-loss compensation	I <sub>L</sub> = 100 mA, RAGA = 20 kΩ		ΔG <sub>TI</sub>	-6.4	-5.8	-5.2	dB
Mute suppression, MIC muted (microphone preamplifier)	I <sub>L</sub> ≥ 14 mA Mutx = open		G <sub>TM</sub>	60	80		dB
<b>Receiving Amplifier, I<sub>L</sub> = 14 mA, RGR = 62 kΩ, Unless Otherwise Specified, V<sub>GEN</sub> = 300 mV</b>							
Adjustment range of receiving gain	I <sub>L</sub> ≥ 14 mA, single-ended		G <sub>R</sub>	-8		+2	dB
Receiving amplification	RGR = 62 kΩ RGR = 22 kΩ		G <sub>R</sub>	-7.75	-7 1.5	-6.25	dB
Amplification of DTMF signal from DTMF IN to RECO	I <sub>L</sub> ≥ 14 mA V <sub>MUTX</sub> = V <sub>MP</sub>		G <sub>RM</sub>	1	4	7	dB
Frequency response	I <sub>L</sub> > 14 mA, f = 300 Hz to 3400 Hz		ΔG <sub>RF</sub>			±0.5	dB
Gain change with current	I <sub>L</sub> = 14 to 100 mA		ΔG <sub>R</sub>			±0.5	dB
Gain deviation	T <sub>amb</sub> = -10 to +60°C		ΔG <sub>R</sub>			±0.5	dB
Ear protection	I <sub>L</sub> ≥ 14 mA V <sub>GEN</sub> = 11 V <sub>rms</sub>		EP			1.1	V <sub>rms</sub>
MUTE suppression DTMF operation	I <sub>L</sub> ≥ 14 mA V <sub>MUTX</sub> = V <sub>MP</sub>		ΔG <sub>R</sub>	60			dB
Output voltage d ≤ 2%	I <sub>L</sub> = 14 mA Z <sub>ear</sub> = 68 nF			0.5			V <sub>rms</sub>
Maximum output current d ≤ 2%	Z <sub>ear</sub> = 100 Ω			4			mA (peak)
Receiving noise psophometrically weighted	Z <sub>ear</sub> = 68 nF + 100 Ω I <sub>L</sub> ≥ 14 mA		n <sub>i</sub>		-80	-77	dBmp
Output resistance	Output against GND		R <sub>o</sub>			10	Ω
Line-loss compensation	RAGA = 20 kΩ, I <sub>L</sub> = 100 mA		ΔG <sub>RI</sub>	-7.0	-6.0	-5.0	dB
AC impedance			Z <sub>imp</sub>	840	900	960	Ω

## 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 20 open,  $V_{\text{MUTX}} = \text{GND}$ , unless otherwise specified.

Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
Gain at low operating current	$I_L = 10 \text{ mA}$ $I_{MP} = 1 \text{ mA}$ $I_M = 300 \text{ }\mu\text{A}$ $V_{\text{GEN}} = 560 \text{ mV}$ $RDC = 68 \text{ k}\Omega$		$G_R$	-8	-7	-6	dB
Distortion at low operating current	$I_L = 10 \text{ mA}$ $I_{MP} = 1 \text{ mA}$ $V_{\text{GEN}} = 560 \text{ mV}$ $RDC = 68 \text{ k}\Omega$		$d_R$			5	%
<b>Speaker Amplifier</b>							
Minimum line current for operation	No AC signal		$I_{L\text{min}}$			15	mA
Input resistance		24		14		22	k $\Omega$
Gain from SAI to SAO	$V_{\text{SAI}} = 3 \text{ mV}$ , $I_L = 15 \text{ mA}$ , $RGSA = 560 \text{ k}\Omega$ $RGSA = 20 \text{ k}\Omega$		$G_{\text{SA}}$	35.5	36.5 -3	37.5	dB dB
Output power	Load resistance $R_L = 50 \text{ }\Omega$ , $d < 5\%$ $V_{\text{SAI}} = 20 \text{ mV}$ $I_L = 15 \text{ mA}$ $I_L = 20 \text{ mA}$		$P_{\text{SA}}$ $P_{\text{SA}}$	3	7 20		mW mW
Output noise (input SAI open) psopho-metrically 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	$I_L = 15 \text{ mA}$ , $V_L = 0 \text{ dBm}$ , $V_{\text{SAI}} = 4 \text{ mV}$ 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 amplifier	$I_L = 15 \text{ to } 100 \text{ mA}$		$RG_{\text{SA}}$	0.8	1.3	2	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	$I_L = 15 \text{ mA}$ , $V_{\text{DTMF}} = 8 \text{ mV}$ Mute active: $\text{MUTX} = \text{VMP}$		$G_D$	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

## Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV<sub>rms</sub>, I<sub>M</sub> = 0.3 mA, I<sub>MP</sub> = 2 mA, RDC = 130 kΩ, T<sub>amb</sub> = 25°C, RGSA = 560 kΩ, Z<sub>ear</sub> = 68 nF + 100 Ω, Z<sub>M</sub> = 68 nF, Pin 20 open, V<sub>MUTX</sub> = GND, unless otherwise specified.

Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
Input resistance	RGT = 27 kΩ, RGT = 15 kΩ		R <sub>i</sub>	60 26	180 70	300 130	kΩ
Distortion of DTMF signal	I <sub>L</sub> ≥ 15 mA V <sub>L</sub> = 0 dBm		d <sub>D</sub>			2	%
Gain deviation with current	I <sub>L</sub> = 15 to 100 mA		ΔGD			±0.5	dB
<b>AFS Acousting Feedback Suppression</b>							
Range of attenuation	I <sub>L</sub> ≥ 15 mA			0		50	dB
Attenuation of transmit gain	I <sub>L</sub> ≥ 15 mA, I <sub>INLDT</sub> = 0 μA R <sub>ATAFS</sub> = 30 kΩ I <sub>INLDR</sub> = 10 μA		ΔG <sub>T</sub>		45		dB
Attenuation of speaker amplifier	I <sub>L</sub> ≥ 15 mA I <sub>INLDP</sub> = 0 μ R <sub>ATAFS</sub> = 30 kΩ I <sub>INLDR</sub> = 10 μ		ΔG <sub>SA</sub>		50		dB
AFS disable	I <sub>L</sub> ≥ 15 mA		V <sub>ATAFS</sub>	1.5			V
<b>Supply Voltages, V<sub>mic</sub> = 25 mV, T<sub>amb</sub> = -10 to +60°C</b>							
V <sub>MP</sub>	I <sub>L</sub> = 14 mA, RDC = 68 kΩ I <sub>MP</sub> = 2 mA		V <sub>MP</sub>	3.1	3.3	3.5	V
V <sub>M</sub>	I <sub>L</sub> ≥ 14 mA, I <sub>M</sub> = 300 μA RDC = 130 kΩ		V <sub>M</sub>	1.4		3.3	V
V <sub>B</sub>	I <sub>B</sub> = +20 mA, I <sub>L</sub> = 0 mA		V <sub>B</sub>		7	7.6	V
<b>MUTX Input (see Figure 20)</b>							
Input current	V <sub>MUTX</sub> = V <sub>MP</sub> V <sub>MUTX</sub> = GND		I <sub>MUTX</sub> I <sub>MUTX</sub>		+20 -20	+30 -30	μA μA
Input voltage	Input high		V <sub>MUTX</sub>	V <sub>MP</sub> - 0.3 V			V
	Input low		V <sub>MUTX</sub>			0.3	V

## U4089B-M Control

MUTX		MODE
0	MIC 1/2 transmit enabled receive enable AFS = on AGA = on TXACL = on	Speech
Z	DTMF transmit enabled receive enable AFS = on AGA = on TXACL = on	For answering machine
1	DTMF transmit enabled DTMF to receive enable AFS = off AGA = off TXACL = off	DTMF dialling

IMPSEL		MODE
0	Line impedance = 600 $\Omega$ TXA = on ES = off	Speech
0 to Z	Line impedance = 600 $\Omega$ TXA = off ES = on	Transmit mute
1 to Z	Line impedance = 900 $\Omega$ TXA = off ES = on	Transmit mute
1	Line impedance = 900 $\Omega$ TXA = on ES = off	Speech

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

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

Figure 12. Typical DC Characteristic

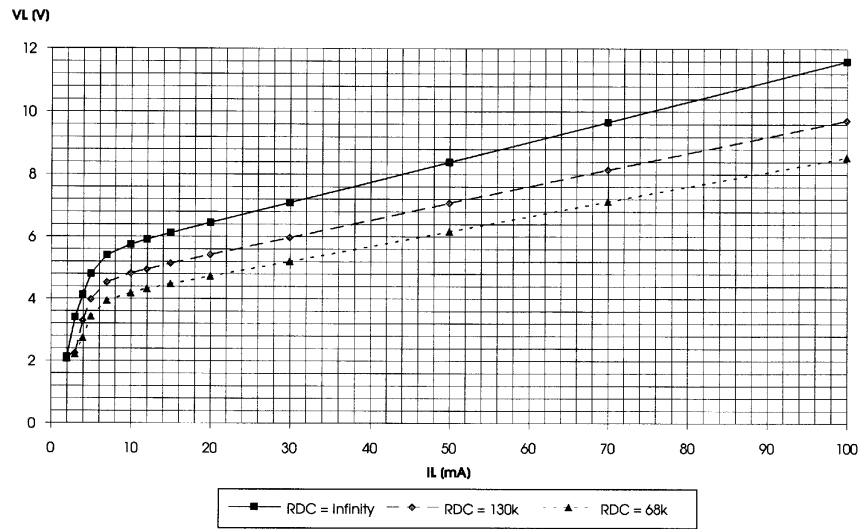
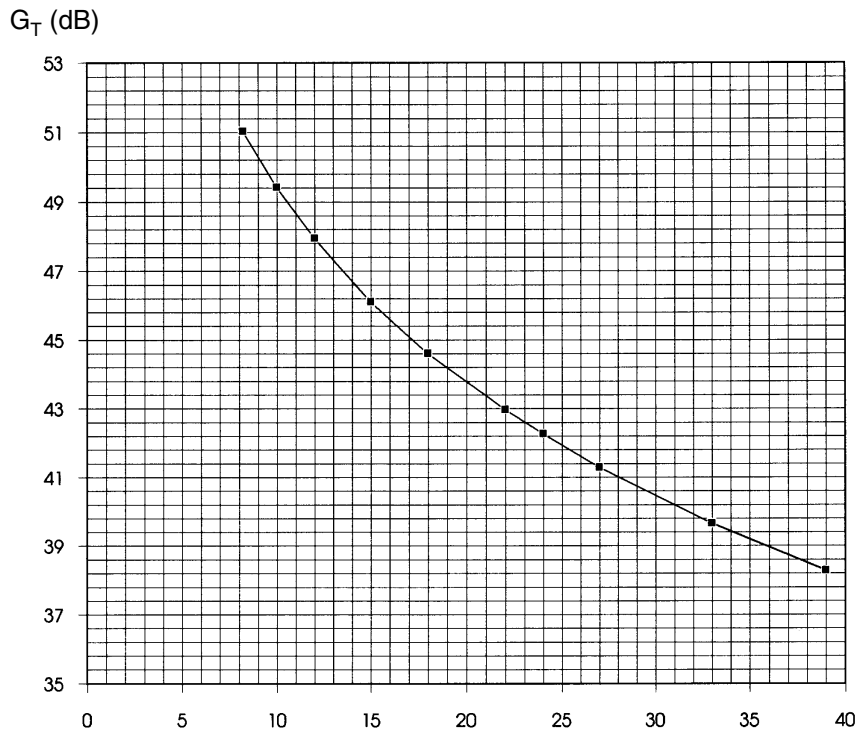
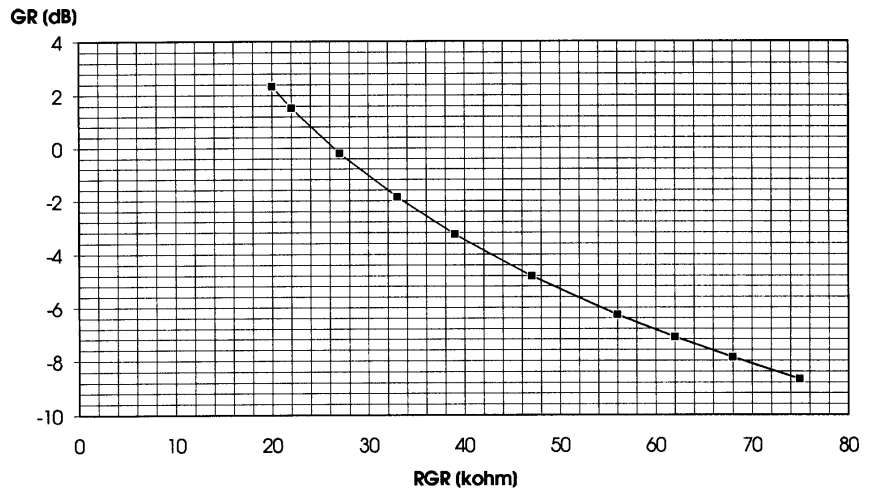


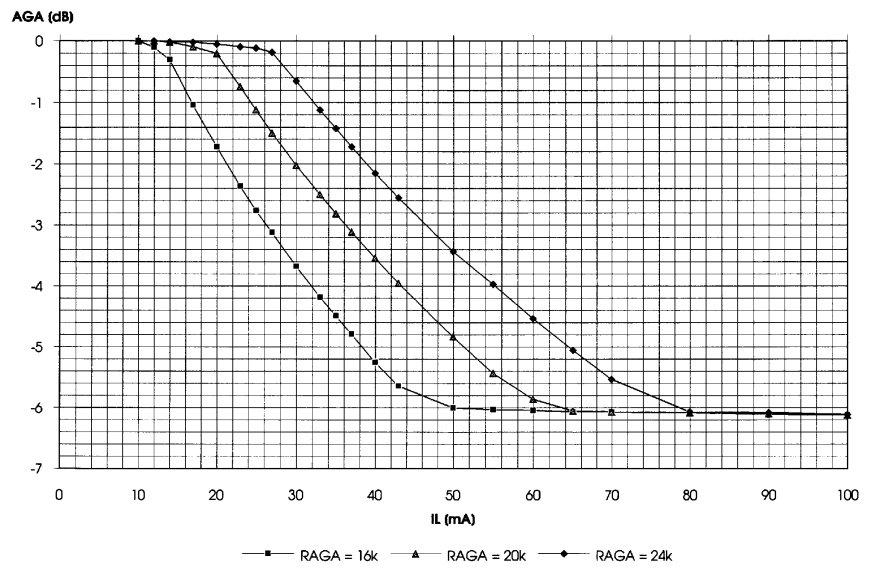
Figure 13. Typical Adjustment Range of the Transmit Gain



**Figure 14.** Typical Adjustment Range of the Receive Gain

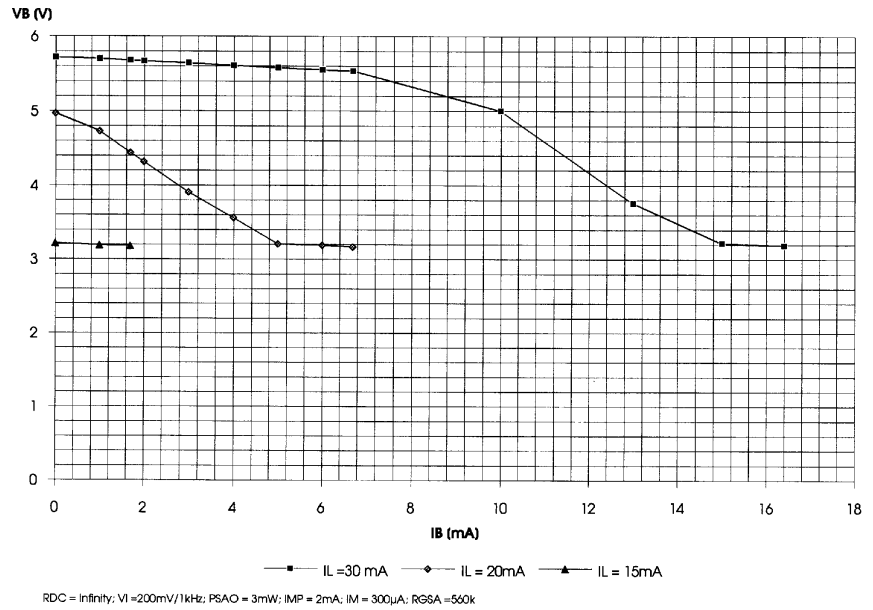


**Figure 15.** Typical AGA Characteristic

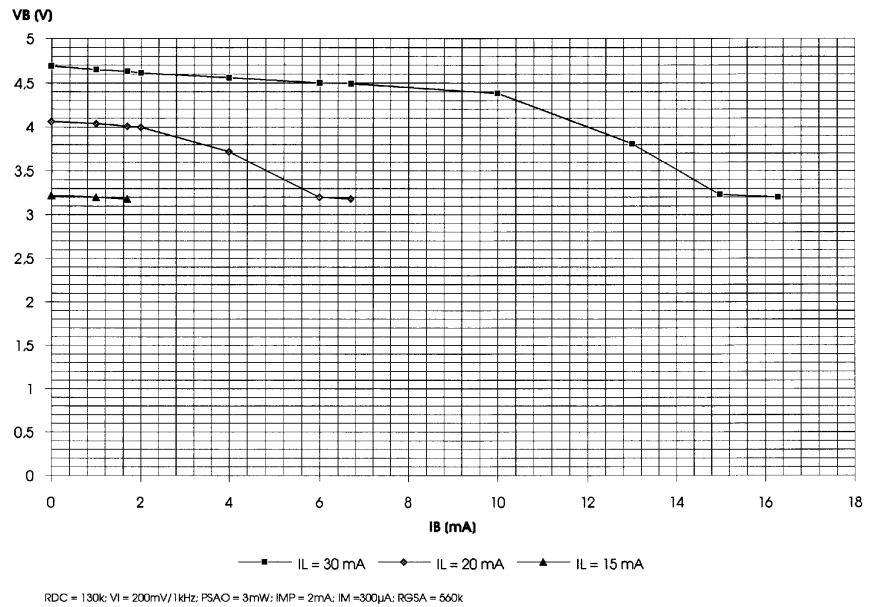




**Figure 16.** Typical Load Characteristic of  $V_B$  for a Maximum (RDC = infinity) DC Characteristic and a 3-mW Loudspeaker Output



**Figure 17.** Typical Load Characteristic of  $V_B$  for a Medium DC Characteristic (RDC = 130 k $\Omega$ ) and a 3-mW Loudspeaker Output



**Figure 18.** Typical Load Characteristic of  $V_B$  for a Minimum DC Characteristic (RDC = 68 k $\Omega$ ) and a 3-mW Loudspeaker Output

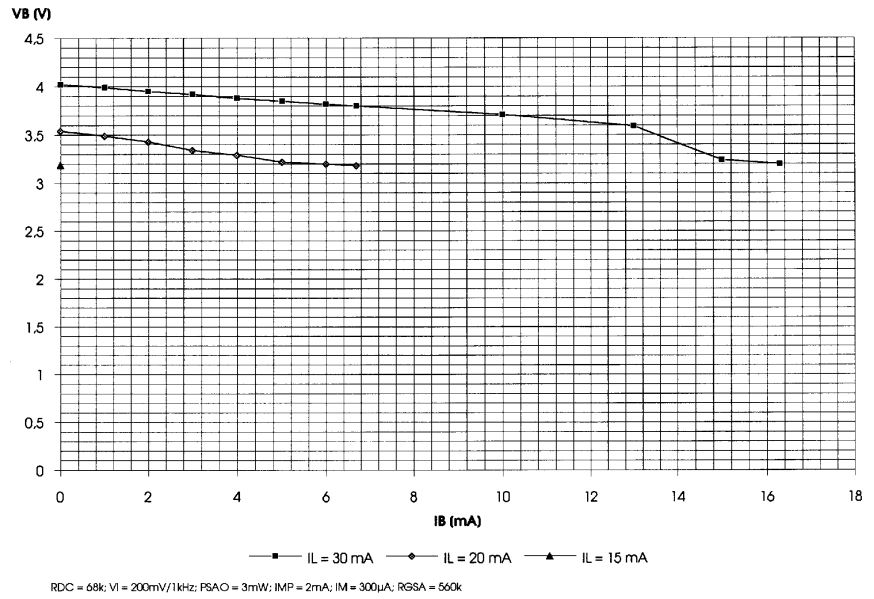


Figure 19. DC Voltage Absolute

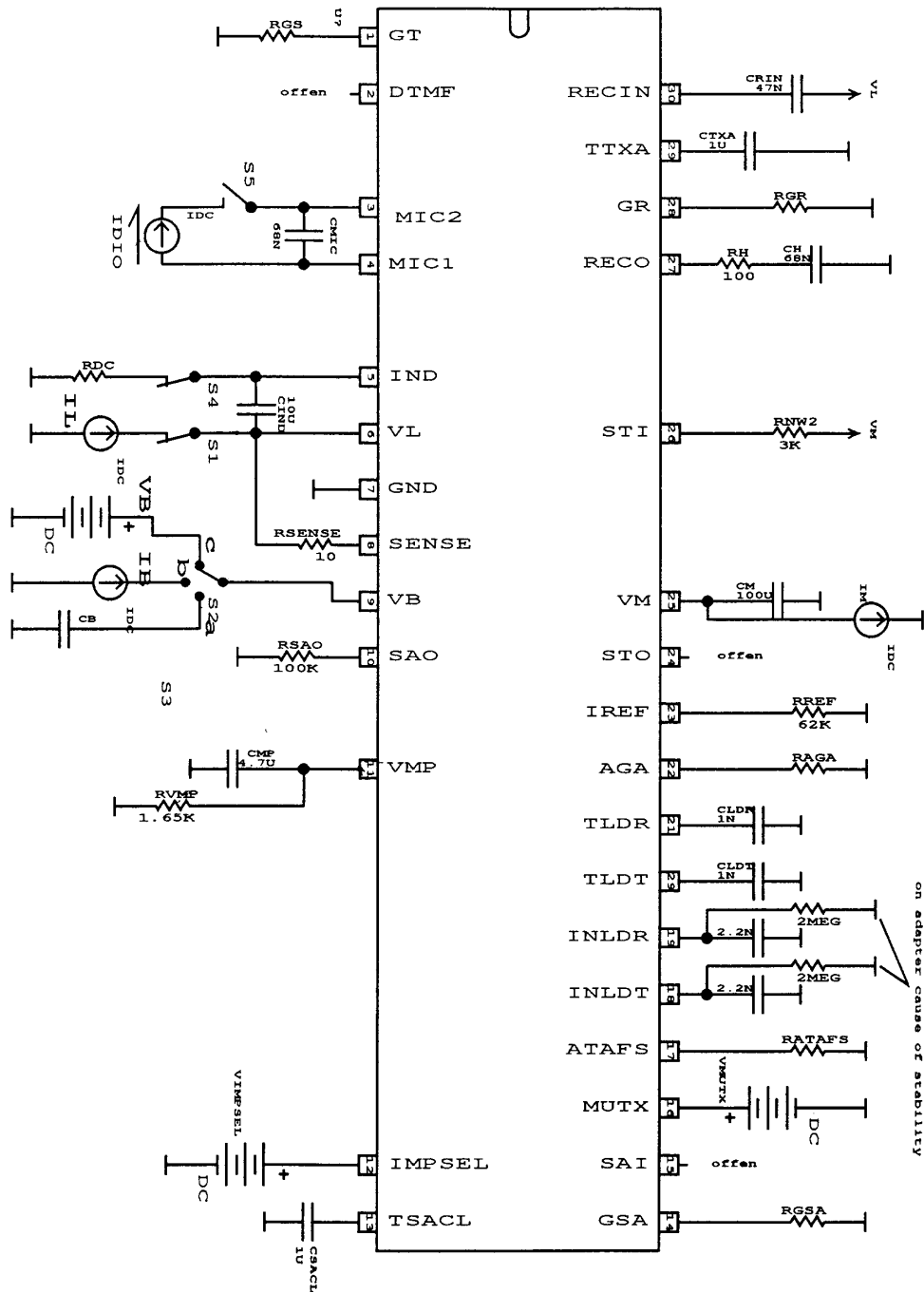


Figure 20. DC Voltage Current Test

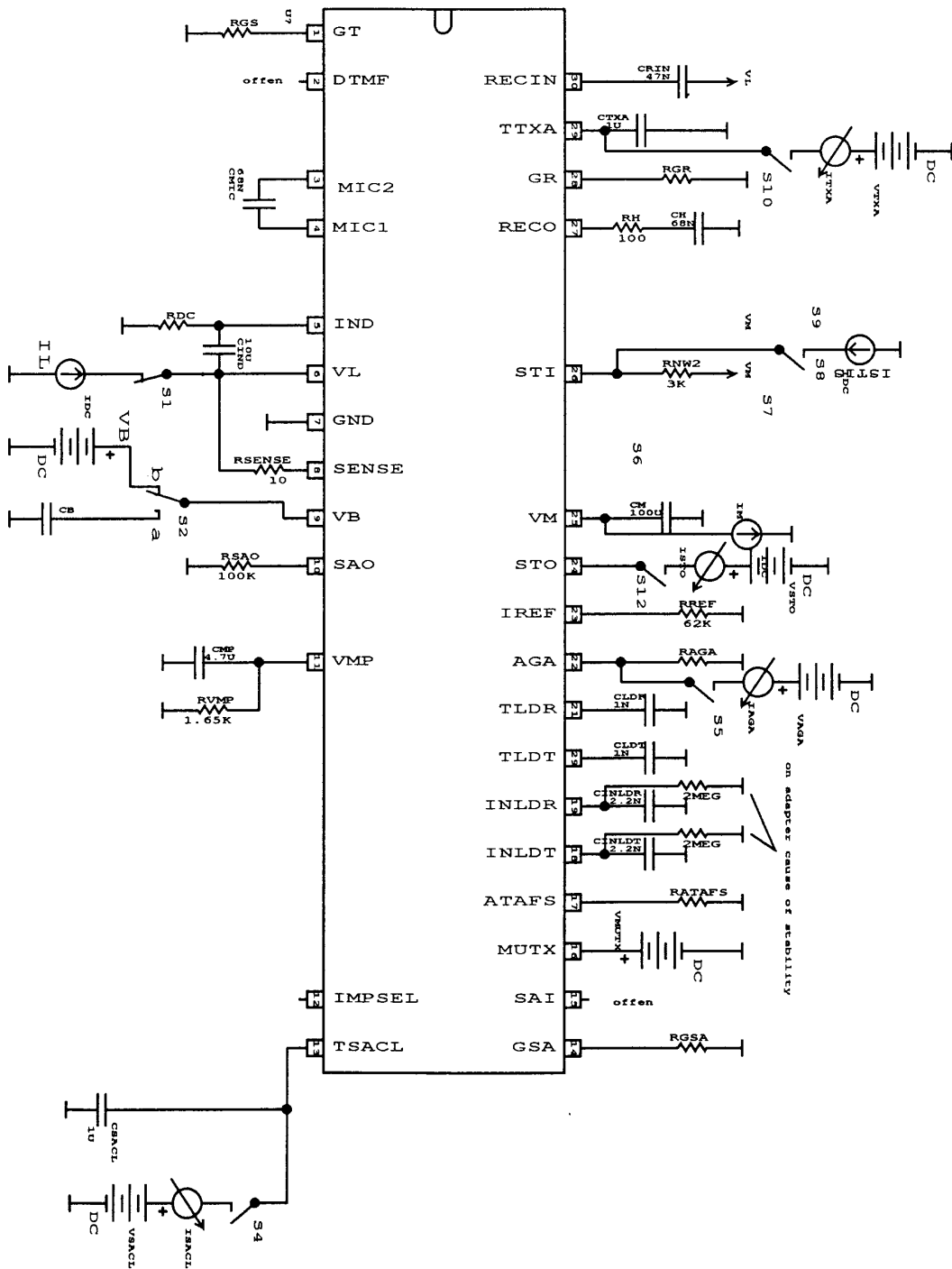


Figure 21. DC Ramps

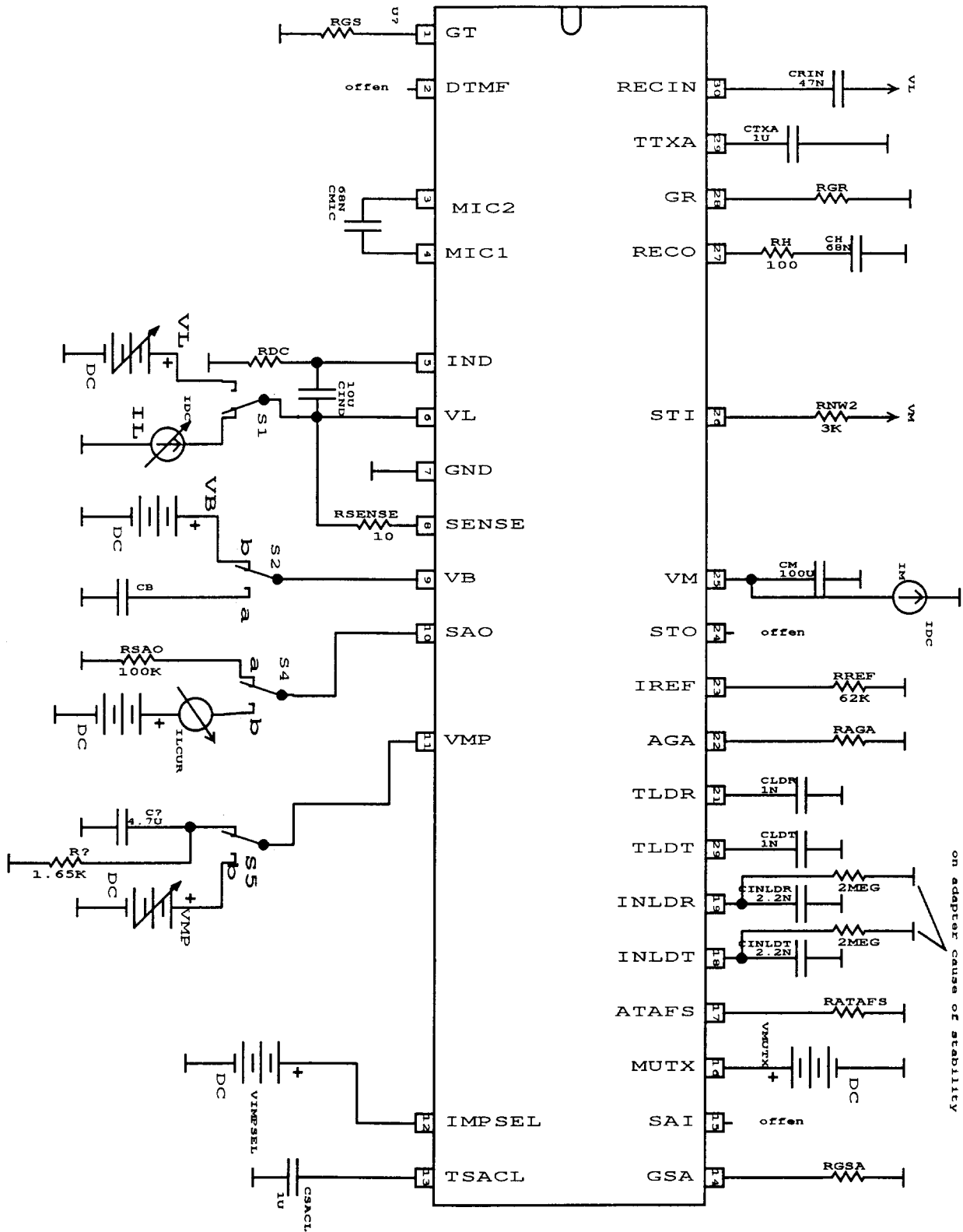


Figure 22. AC Tests

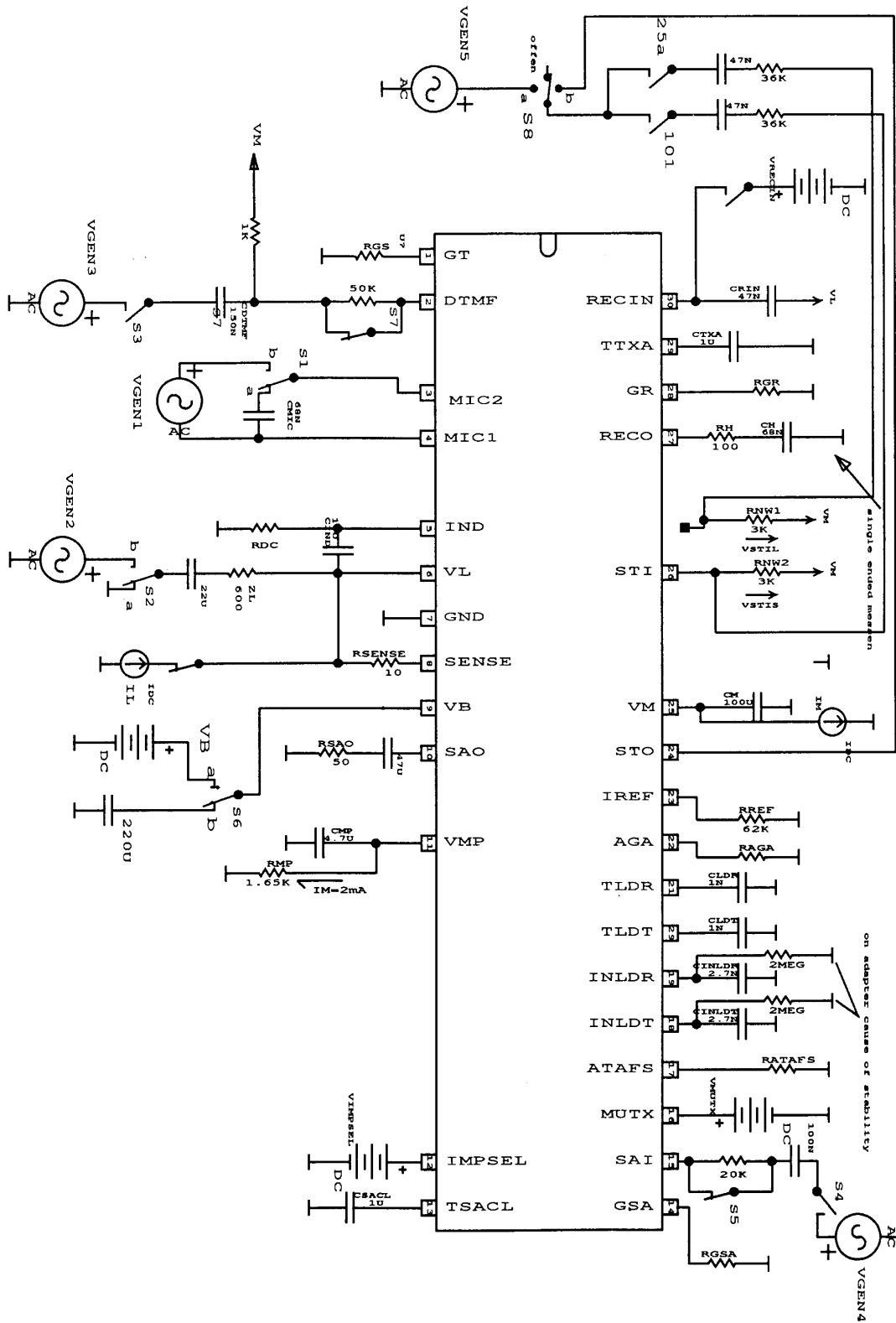
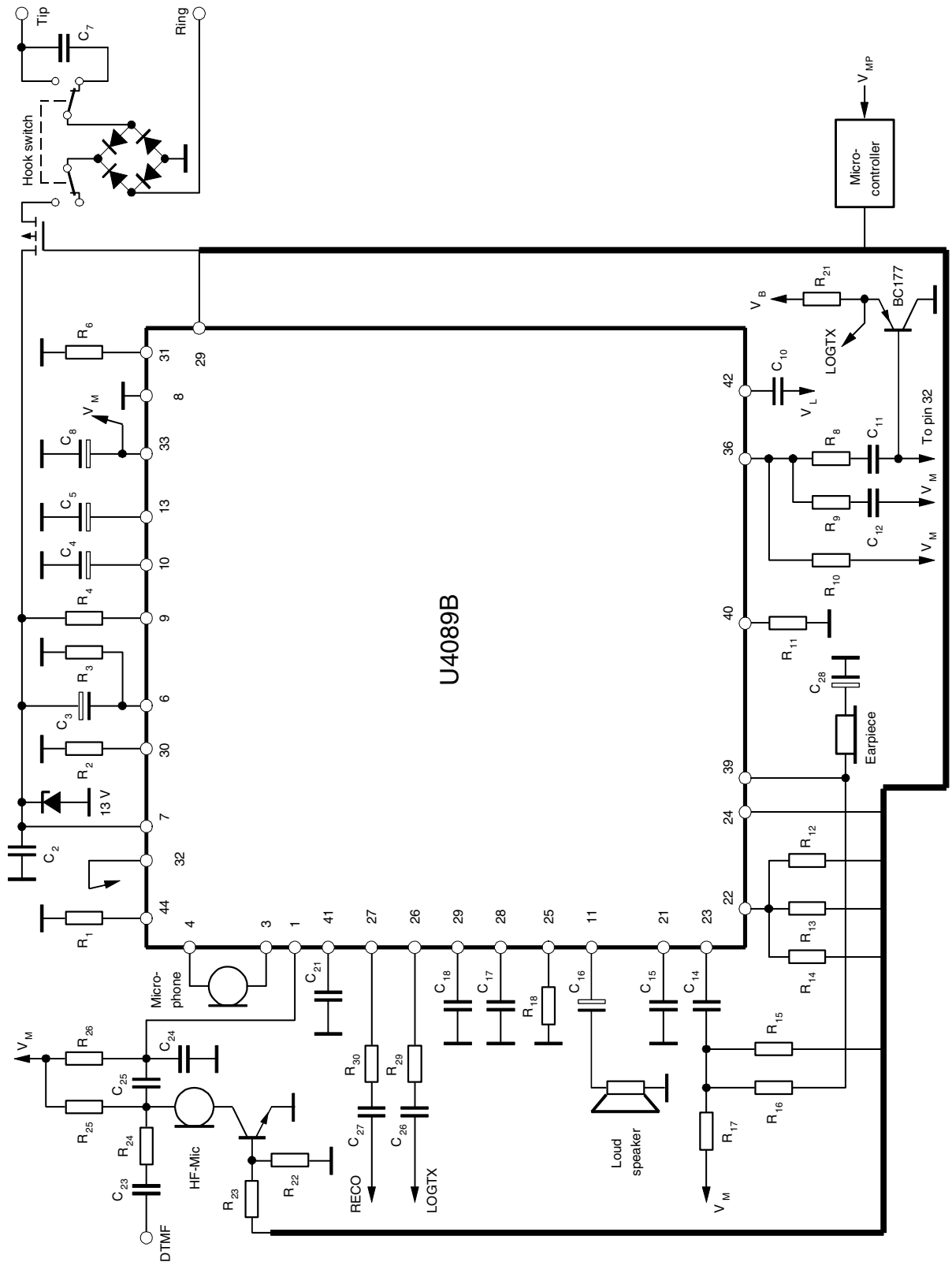


Figure 23. Application for Hands-free Operation



**Table 1.** Typical Values of External Components (see Figure 23)

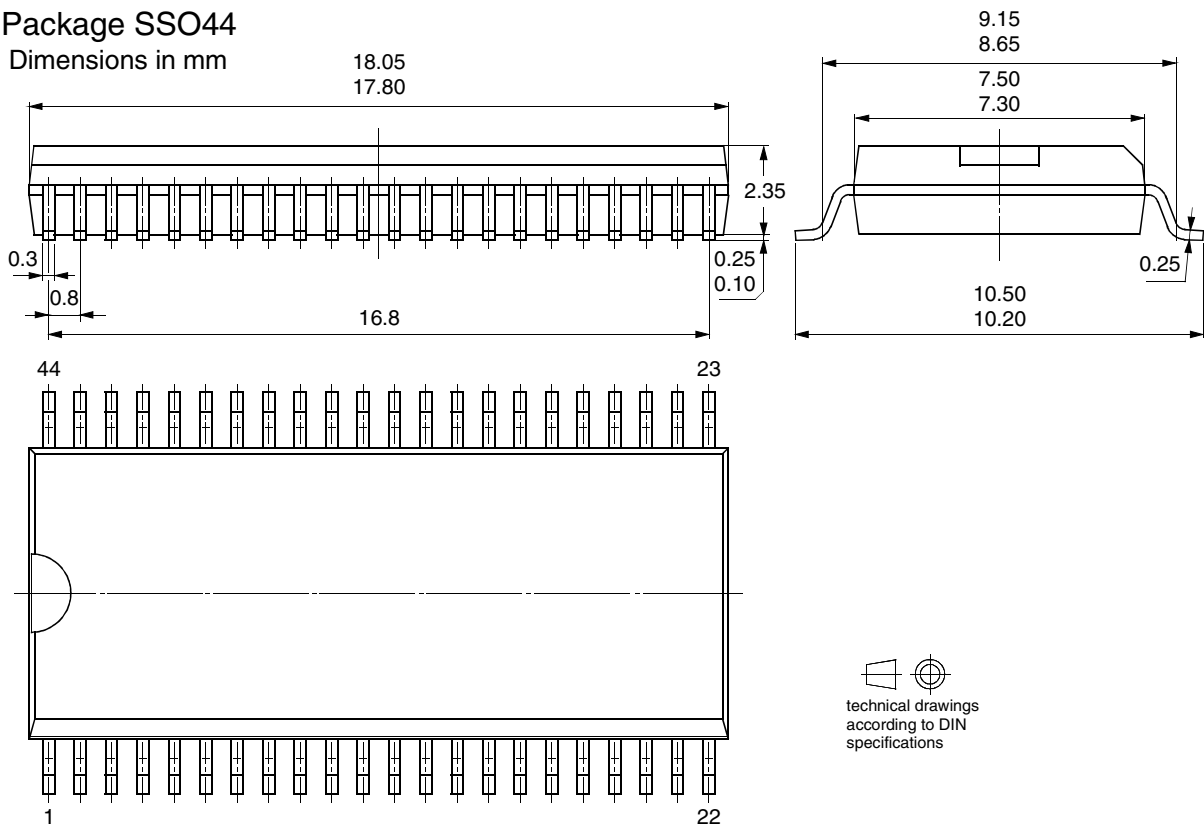
Name	Value	Name	Value	Name	Value	Name	Value
C <sub>2</sub>	4.7 nF	C <sub>16</sub>	47 μF	R <sub>3</sub>	>68 kΩ	R <sub>16</sub>	1 kΩ
C <sub>3</sub>	10 μF	C <sub>17</sub>	10 μF	R <sub>4</sub>	10 kΩ	R <sub>17</sub>	1.2 kΩ
C <sub>4</sub>	220 μF	C <sub>18</sub>	10 μF	R <sub>6</sub>	62 kΩ	R <sub>18</sub>	30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

## Ordering Information

Extended Type Number	Package	Remarks
U4089B-MFN	SSO44	Tubes
U4089B-MFNG3	SSO44	Taped and reeled

## Package Information

Package SSO44  
Dimensions in mm







## Atmel Headquarters

### *Corporate Headquarters*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 487-2600

### *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 Tsimhatsui  
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  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

### *Microcontrollers*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

La Chantrerie  
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  
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  
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

---

### *e-mail*

literature@atmel.com

### *Web Site*

<http://www.atmel.com>

### © Atmel Corporation 2003.

Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

Atmel® is the registered trademark of Atmel.

Other terms and product names may be the trademarks of others.



Printed on recycled paper.