Monolithic Integrated Feature Phone Circuit EMI Improved

U4090B-P

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.

Rev. 4741B–CORD–10/03

Figure 1. Block Diagram

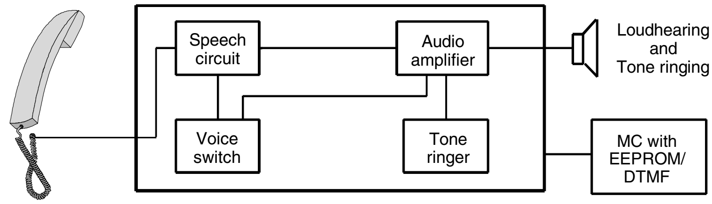
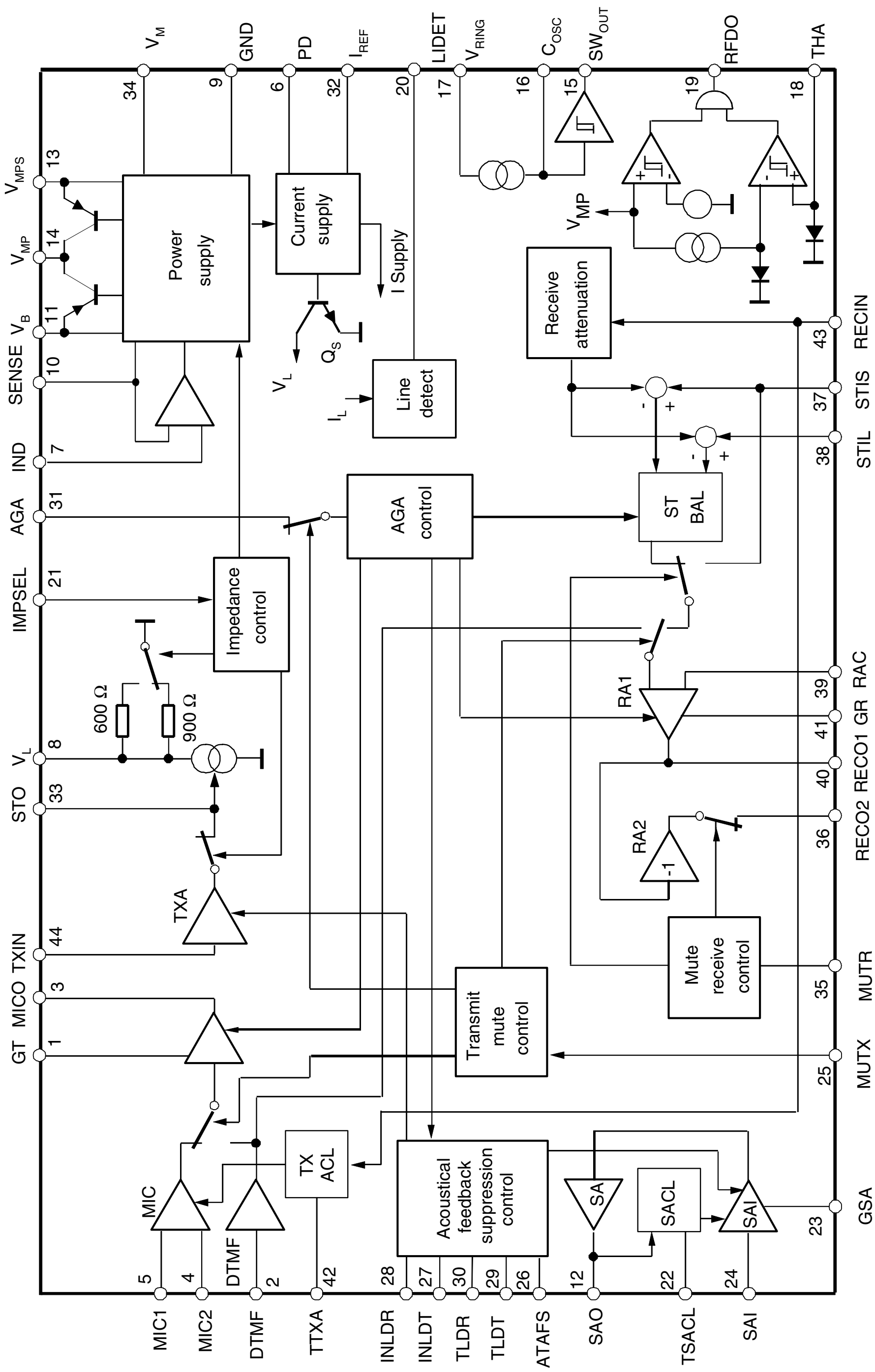


Figure 2. Detailed Block Diagram



Pin Configuration

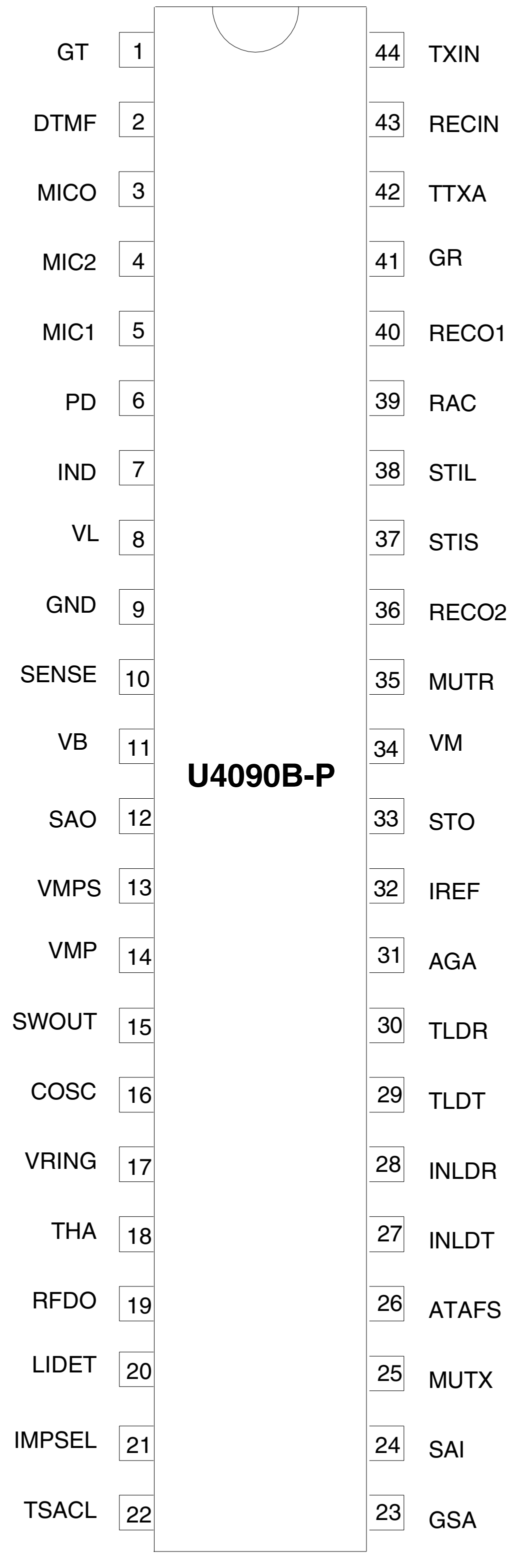


Figure 3. Pinning SSO44

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 1. 600 Ω 2. 900 Ω 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 MΩ, 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: 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 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 kΩ; IREF = 20 µA
33	STO	Sidetone reduction output Output resistance approximate: 300 Ω, Maximum load impedance: 10 kΩ.
34	VM	Reference node for microphone-earphone and loudspeaker amplifier, supply for electret microphone (IM ≤ 700 mA)
35	MUTR	Three-state mute input 1. Normal operation 2. Mute for ear piece 3. Mute for RECIN signal 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 kΩ
44	TXIN	Input of intermediate transmit stage, input resistance is typically 20 kΩ

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

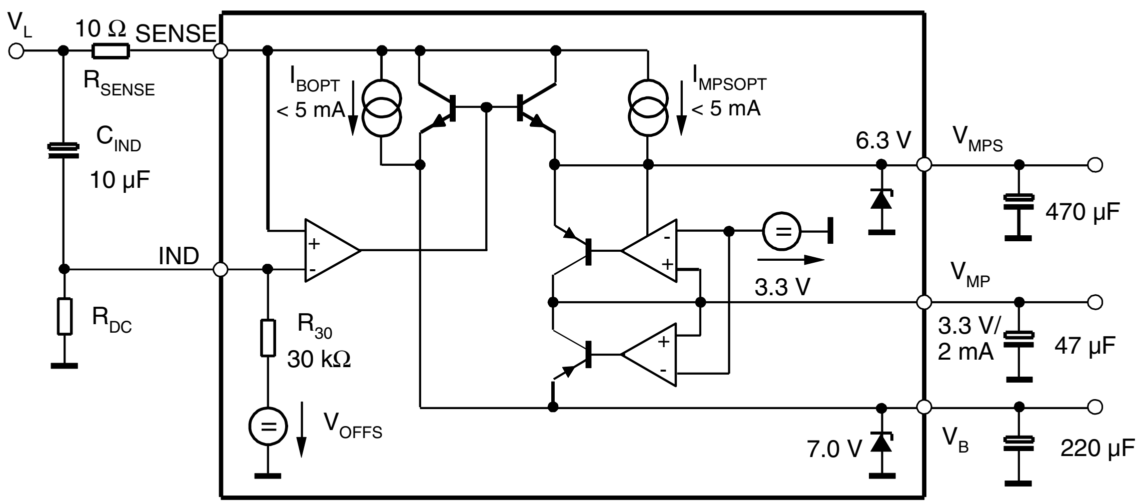


Figure 5. Supply Capacitors CMPS and CB Are Charged with Priority on CMPS

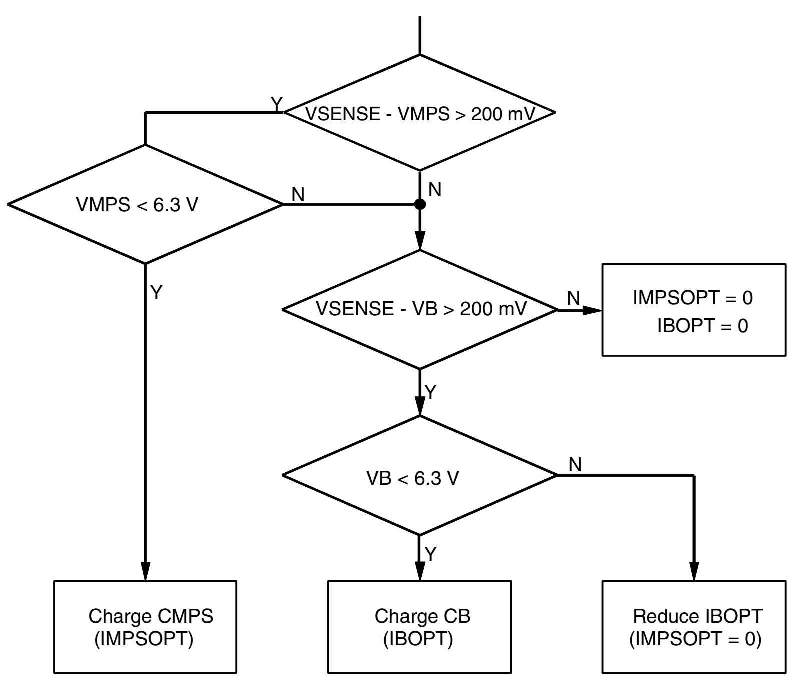
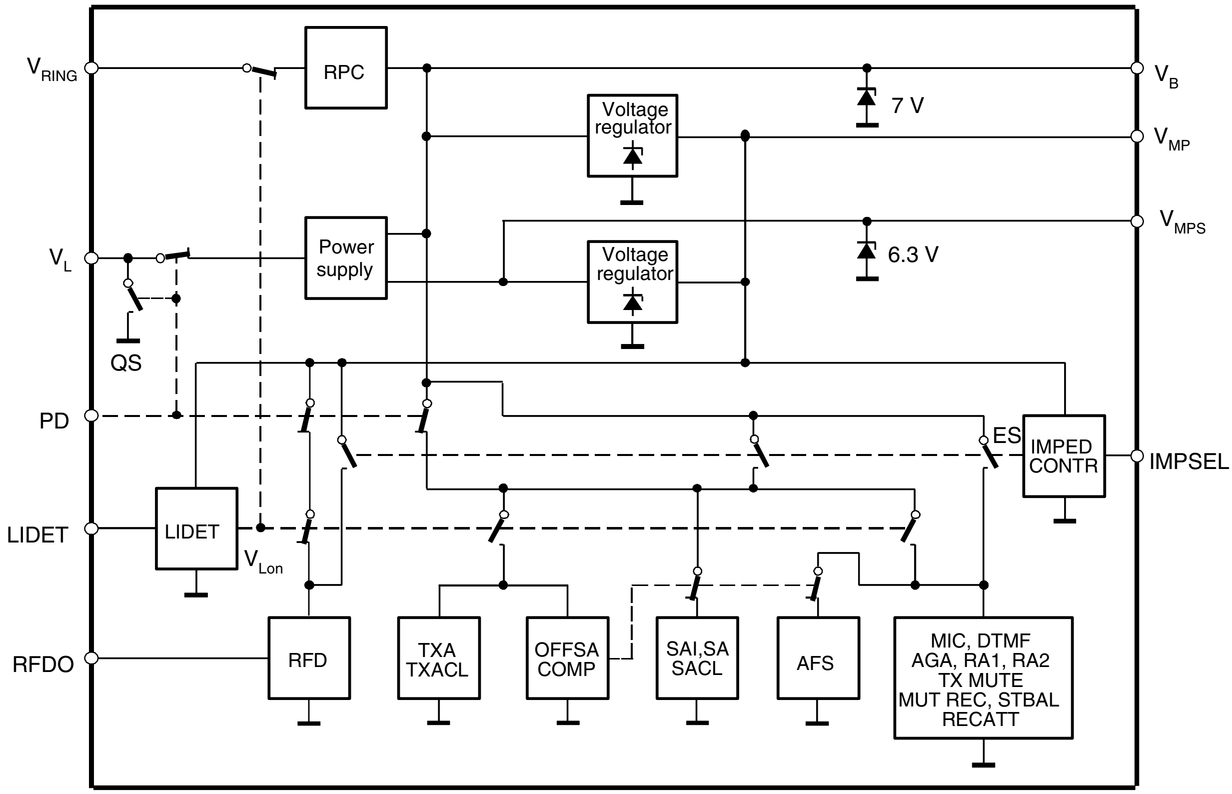


Figure 6. Supply of Functional Blocks Controlled by Input Voltages V_L, V_B, V_{RING} and by Logic Inputs PD and IMPSEL



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

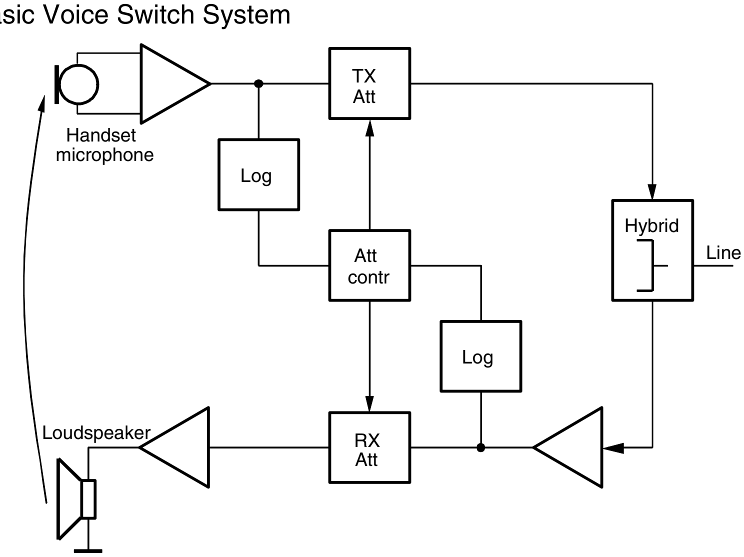


Figure 8. Integration of the Acoustic Feedback Suppression Circuit into the Speech Circuit Environment

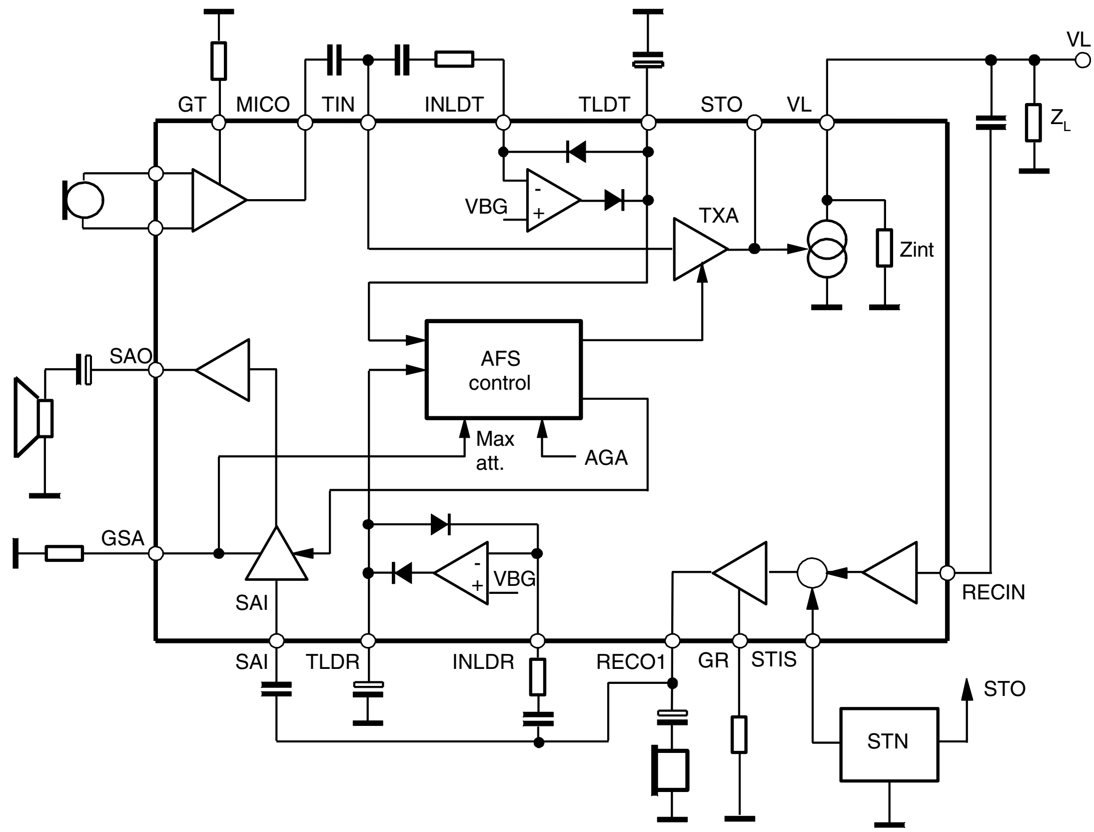
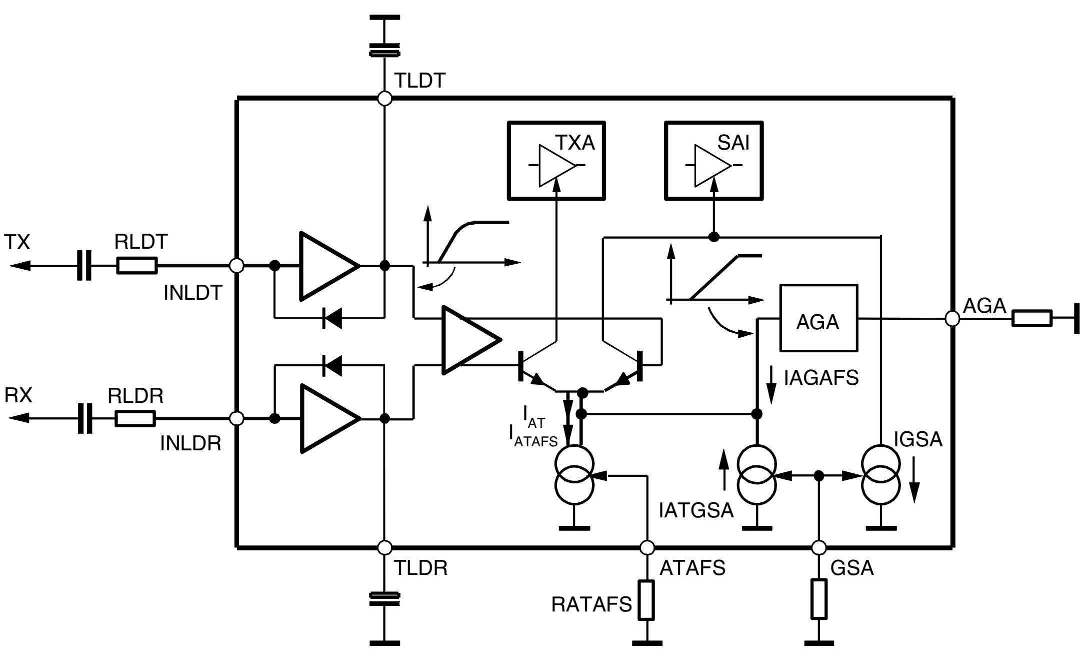


Figure 9. Acoustic Feedback Suppression by Alternative Control of Transmit and Speaker Amplifier Gain



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 IAT 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

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

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

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 RATAFS, 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
$GSA \le GSA0 = 36\ dB - ATAFS_m$.

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

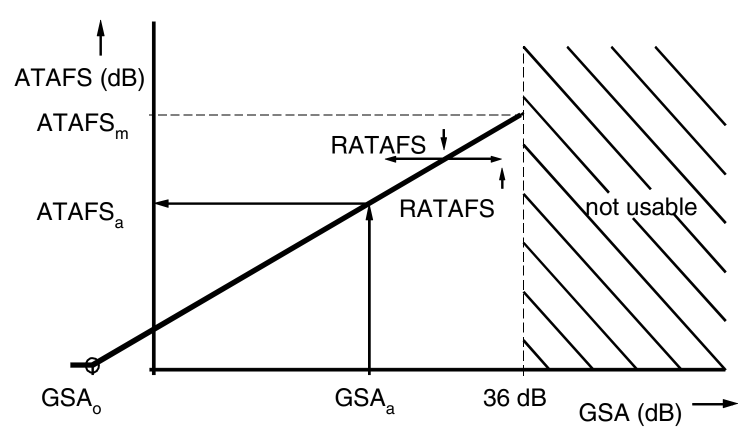
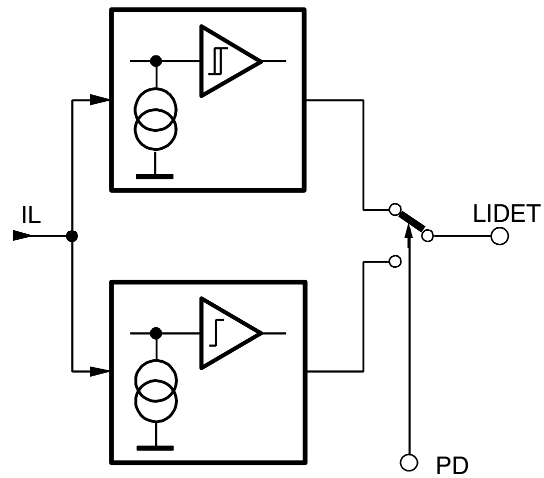


Figure 11. Line Detection with Two Comparators for Speech Mode and Pulse Dialing

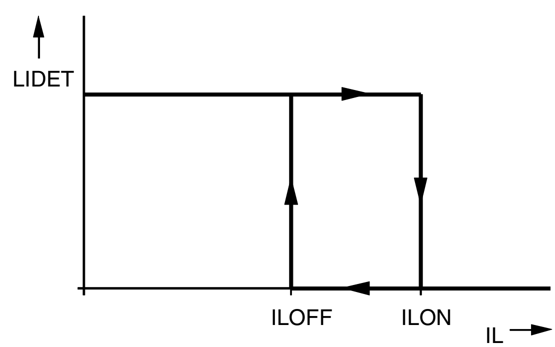


Line Detection (LIDET)

The line current supervision is active under all operating conditions of the U4090B-P. In speech mode (PD = 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 ILON/ILOFF 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 QS (see Figure 6). As long as IL is above typically 1.6 mA, output LIDET is low. This comparator does not use hysteresis.

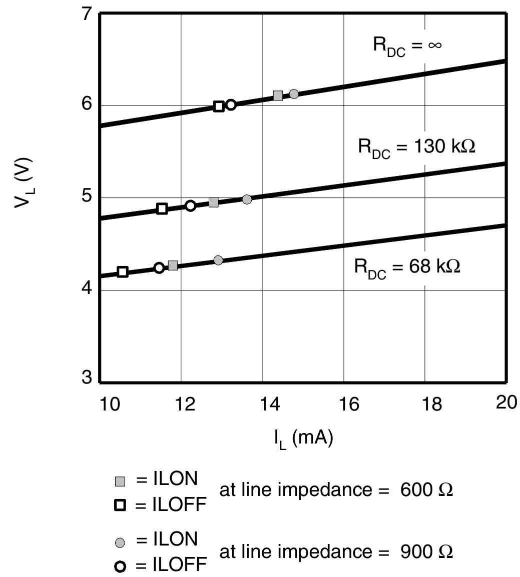
Figure 12. Line Detection in Speech Mode with Hysteresis



Ringing Power Converter (RPC)

The RPC transforms the input power at VRING (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 VRING is fixed at 5 kΩ and the efficiency of the step-down converter is approximate 65%.

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



Ringing 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 µA and 24 µA. 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	°C
Ambient temperature	T_{amb}	-25 to +75	°C
Storage temperature	T_{stg}	-55 to +150	°C
Total power dissipation, T_{amb} = 60°C	P_{tot}	0.9	W

Thermal Resistance

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

Electrical Characteristics

f = 1 kHz, 0 dBm = 775 mV_{rms}, I_M = 0.3 mA, I_{MP} = 2 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 560 kΩ, Z_{ear} = 68 nF + 100 Ω, Z_M = 68 nF, pin 31 open, V_{IMPSEL} = GND, V_{MUTX} = GND, V_{MUTR} = GND, unless otherwise specified

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

Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV_{rms}, I_M = 0.3 mA, I_{MP} = 2 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 560 kΩ, Z_{ear} = 68 nF + 100 Ω, Z_M = 68 nF, pin 31 open, V_{IMPSEL} = GND, V_{MUTX} = GND, V_{MUTR} = GND, unless otherwise specified

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

Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV_{rms}, I_M = 0.3 mA, I_{MP} = 2 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 560 kΩ, Z_{ear} = 68 nF + 100 Ω, Z_M = 68 nF, pin 31 open, V_{IMPSEL} = GND, V_{MUTX} = GND, V_{MUTR} = GND, unless otherwise specified

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Output power	Load resistance R_L = 50 Ω, d < 5% V_{SAI} = 20 mV I_L = 15 mA I_L = 20 mA	 P_{SA} P_{SA}	 3	 7 20		mW
Output noise (Input SAI open) psophometrically weighted	I_L > 15 mA	n_{SA}			200	μV_{psoph}
Gain deviation	I_L = 15 mA, T_{amb} = -10 to +60°C	ΔG_{SA}			±1	dB
Mute suppression	I_L = 15 mA V_L = 0 dBm V_{SAI} = 4 mV Pin 23 open	V_{SAO}			-60	dBm
Gain change with current	I_L = 15 to 100 mA	ΔG_{SA}			±1	dB
Resistor for turning off speaker amplifier	I_L = 15 to 100 mA	RG_{SA}	0.8	1.3	2	MΩ
Gain change with frequency	I_L = 15 mA, f = 300 to 3400 Hz	ΔG_{SA}			±0.5	dB
Attack time of anti-clipping	20 dB over drive	tr		5		ms
Release time of anti-clipping		tf		80		ms
DTMF Amplifier Test Conditions: IMP = 2 mA, IM = 0.3 mA, V_{MUTX} = VMP						
Adjustment range of DTMF gain	I_L = 15 mA mute active	G_D	40		50	dB
DTMF amplification	I_L = 15 mA V_{DTMF} = 8 mV Mute active: MUTX = V_{MP}	G_D	40.7	41.7	42.7	dB
Gain deviation	I_L = 15 mA, T_{amb} = -10 to +60°C	G_D			±0.5	dB
Input resistance	R_{GT} = 27 kΩ R_{GT} = 15 kΩ	R_i	60 26	180 70	300 130	kΩ
Distortion of DTMF signal	I_L ≥ 15 mA V_L = 0 dBm	d_D			2	%
Gain deviation with current	I_L = 15 to 100 mA	ΔG_D			±0.5	dB
AFS Acoustic Feedback Suppression						
Adjustment range of attenuation	I_L ≥ 15 mA		0		50	dB
Attenuation of transmit gain	I_L ≥ 15 mA I_{INLDT} = 0 µA R_{ATAFS} = 30 kΩ I_{INLDR} = 10 µA	ΔG_T		45		dB
Attenuation of speaker amplifier	I_L ≥ 15 mA I_{INLDP} = 0 µA R_{ATAFS} = 30 kΩ I_{INLDR} = 10 µA	ΔG_{SA}		50		dB
AFS disable	I_L ≥ 15 mA	V_{ATAFS}	1.5			V
Supply Voltages, V_{MIC} = 25 mV, T_{amb} = -10 to +60°C						
V_{MP}	I_L = 14 mA RDC = 68 kΩ I_{MP} = 2 mA	V_{MP}	3.1	3.3	3.5	V

Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV_{rms}, I_M = 0.3 mA, I_{MP} = 2 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 560 kΩ, Z_{ear} = 68 nF + 100 Ω, Z_M = 68 nF, pin 31 open, V_{IMPSEL} = GND, V_{MUTX} = GND, V_{MUTR} = GND, unless otherwise specified

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

Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV_{rms}, I_M = 0.3 mA, I_{MP} = 2 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 560 kΩ, Z_{ear} = 68 nF + 100 Ω, Z_M = 68 nF, pin 31 open, V_{IMPSEL} = GND, V_{MUTX} = GND, V_{MUTR} = GND, unless otherwise specified

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Input voltage	Input high	V_{MUTX}	V_{MP} - 0.3 V			V
	Input low	V_{MUTX}			0.3	V
Line Detection						
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 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 Ω TXA = on ES = off	Speech
0 to Z	Line impedance = 600 Ω TXA = off ES = on	Transmit-mute
1 to Z	Line impedance = 900 Ω TXA = off ES = on	Transmit-mute
1	Line impedance = 900 Ω TXA = on ES = off	Speech

Table 2. Selection of Earpiece Mute and Answering Machine Mode

Logic Level	MUTR	MODE
0	RA2 = on RECATT = on STIS + STIL = on	Speech
0 to Z	RA2 = on RECATT = off STIS = on, STIL = off	For answering machine
1 to Z	RA2 = off RECATT = off STIS = on, STIL = off AGA off for STIS	For answering machine
1	RA2 = off RECATT = on STIS + STIL = on	Speech + earpeace mute

Table 3. Selection of Transmit Mute

Logic Level	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

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

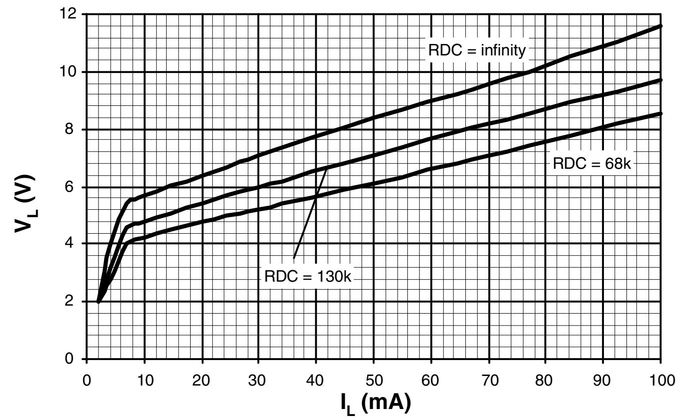


Figure 15. Typical Adjustment Range of Transmit Gain

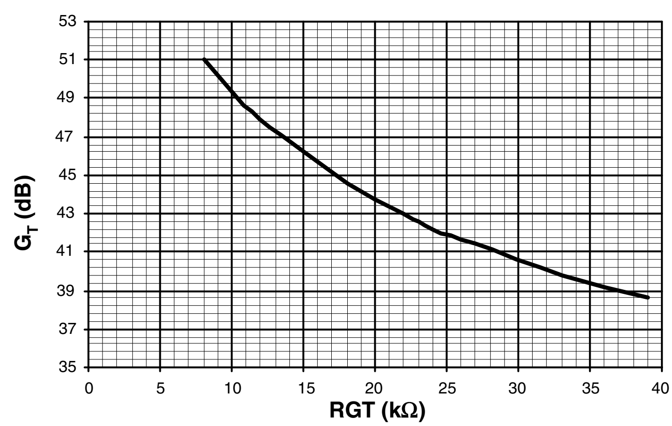


Figure 16. Typical Adjustment Range of Receive Gain (Differential Output)

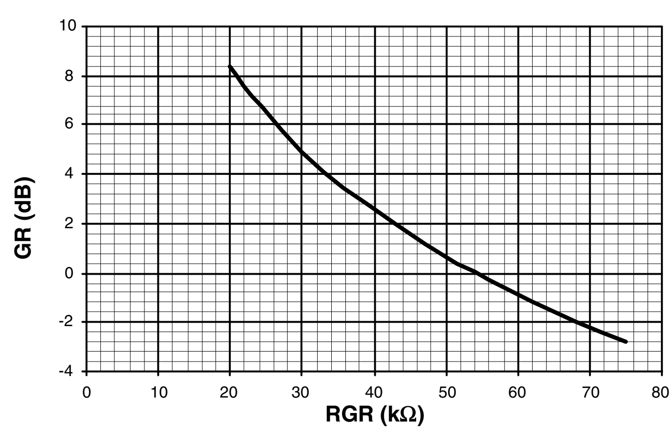


Figure 17. Typical AGA Characteristic

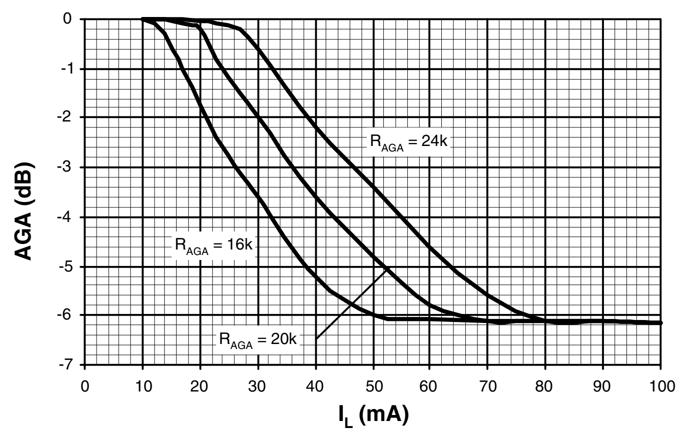
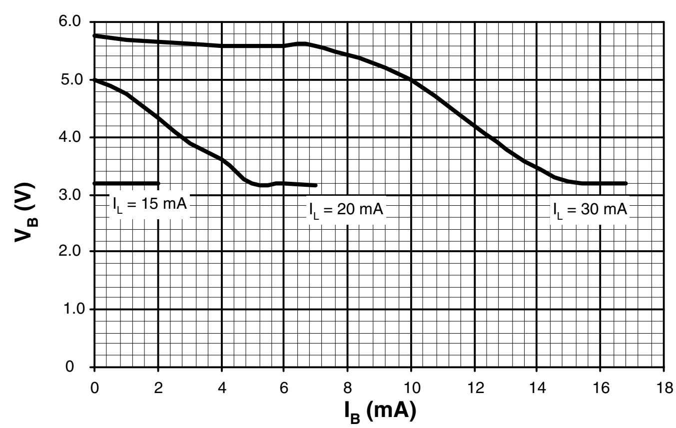
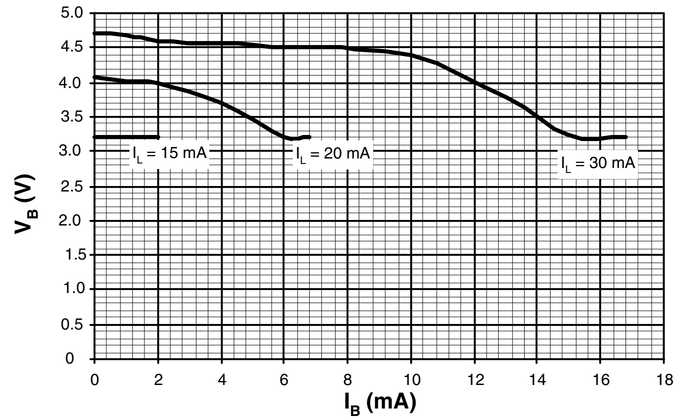


Figure 18. Typical Load Characteristic of V_B for a Maximum (RDC = Infinity) DC-characteristic and 3-mW Loudspeaker Output



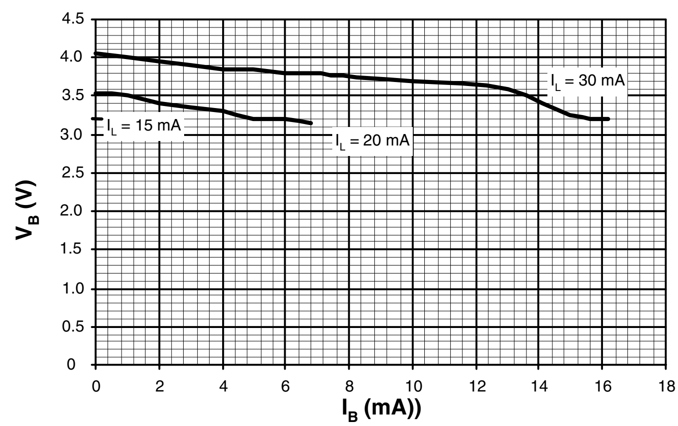
RDC = Infinity; VI = 200 mV/1 kHz; PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560k

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



RDC = 130 k; VI = 200 mV/ 1 kHz; PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560k

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



RDC = 68 k, VI = 200 mV, PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560k

Figure 21. Basic Test Circuit

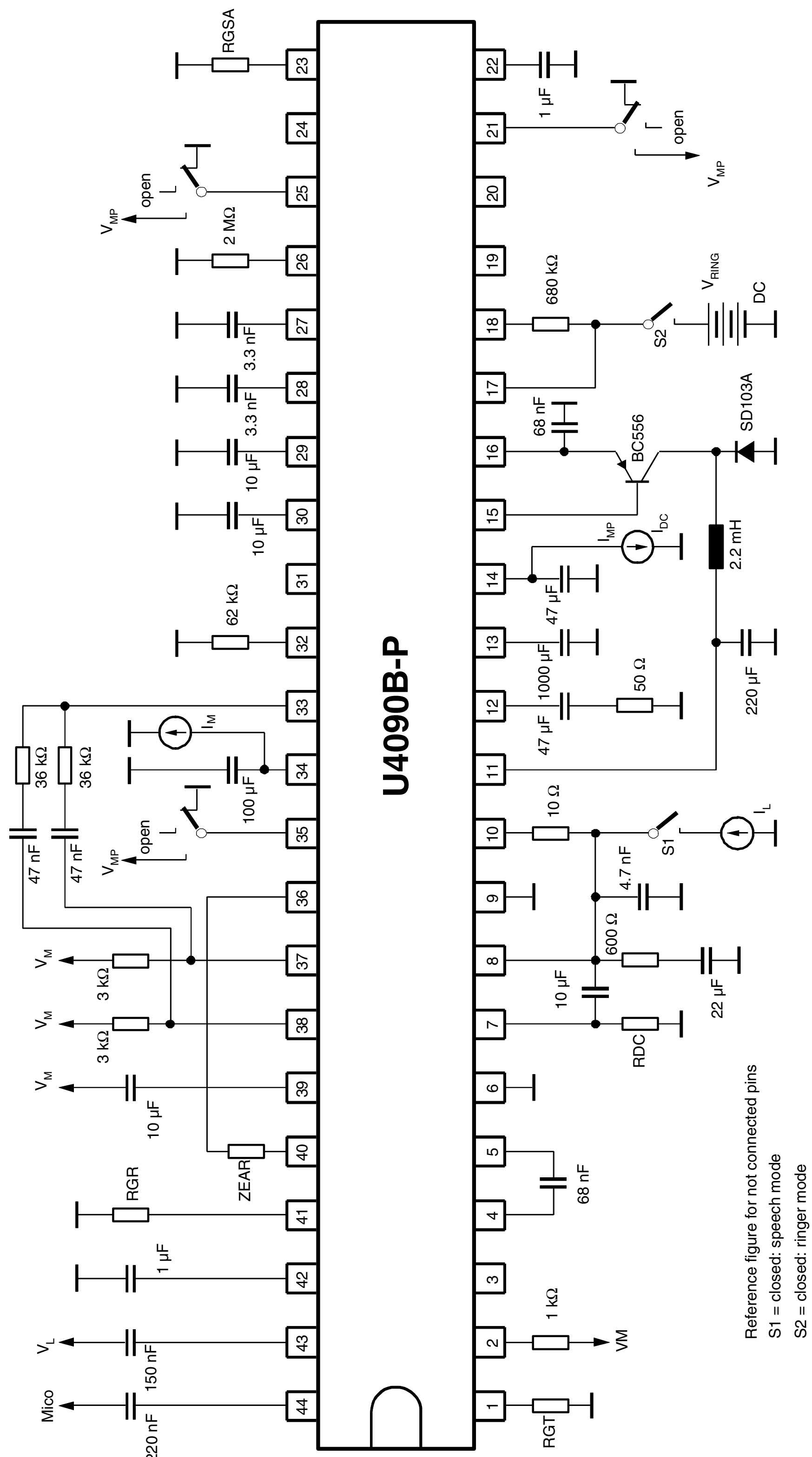
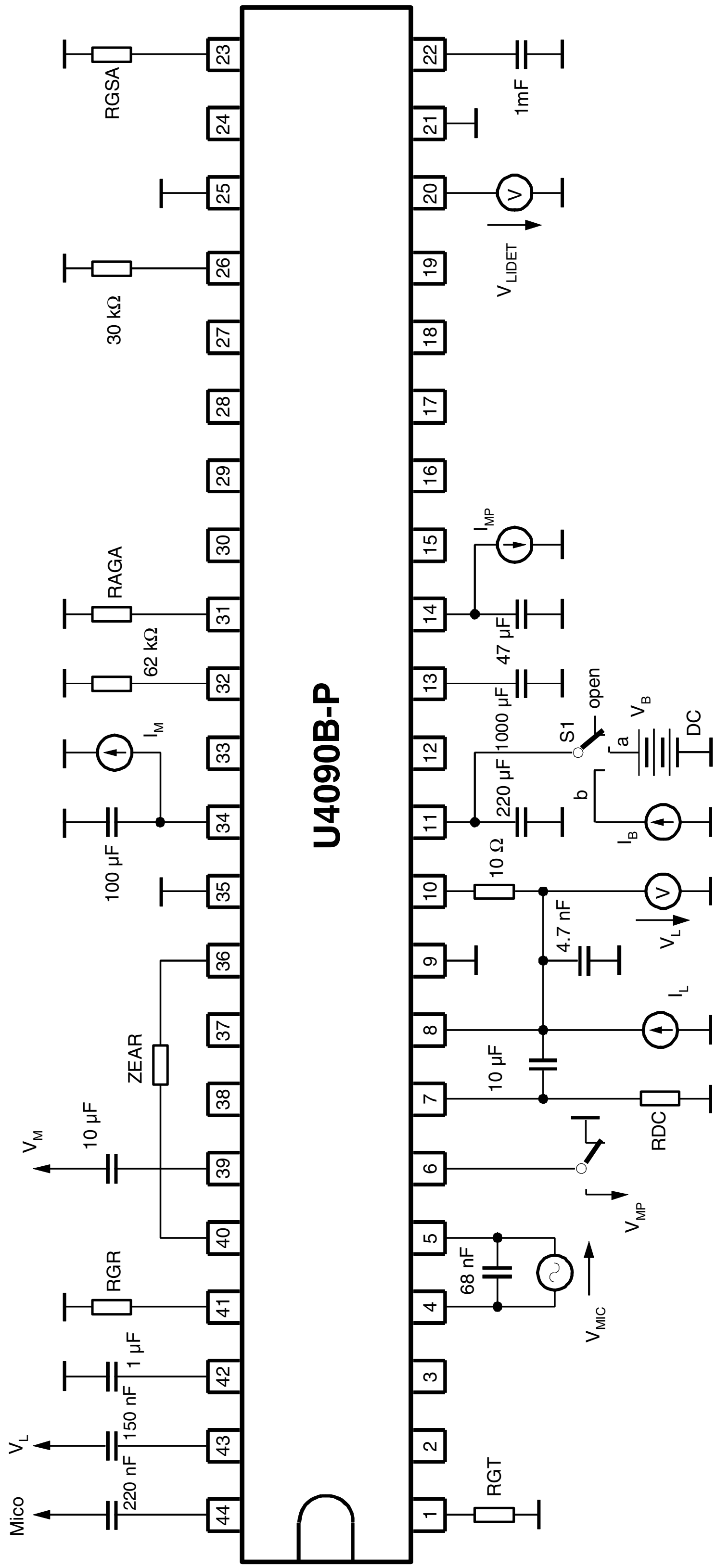


Figure 22. Test Circuit for DC Characteristics and Line Detection



Line detection: S1a
VB (external supply): S1b
Open pins should be connected as shown in Figure 27

Figure 23. Test Circuit for Transmission Amplifier

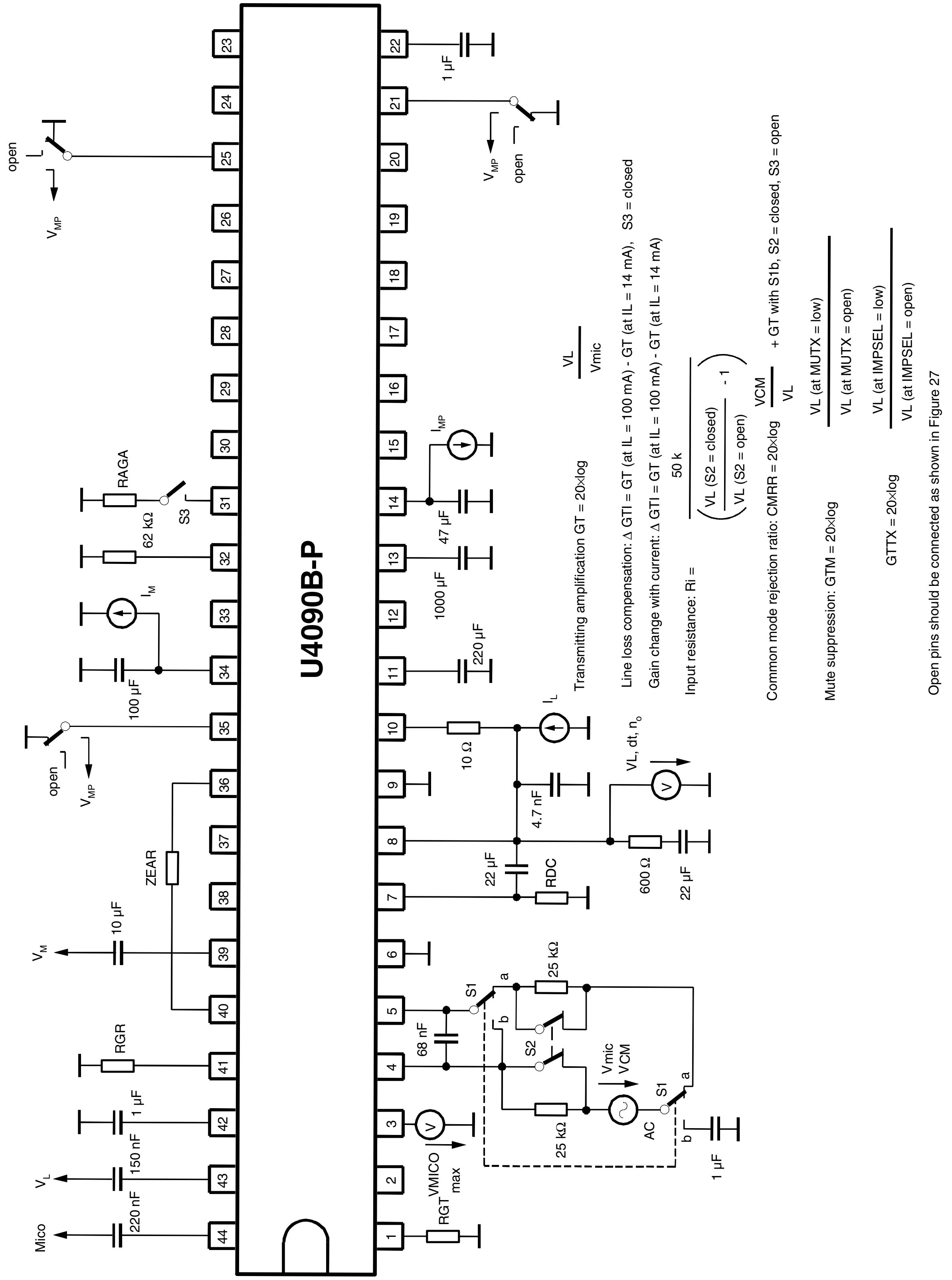


Figure 24. Test Circuit for Receiving Amplifier

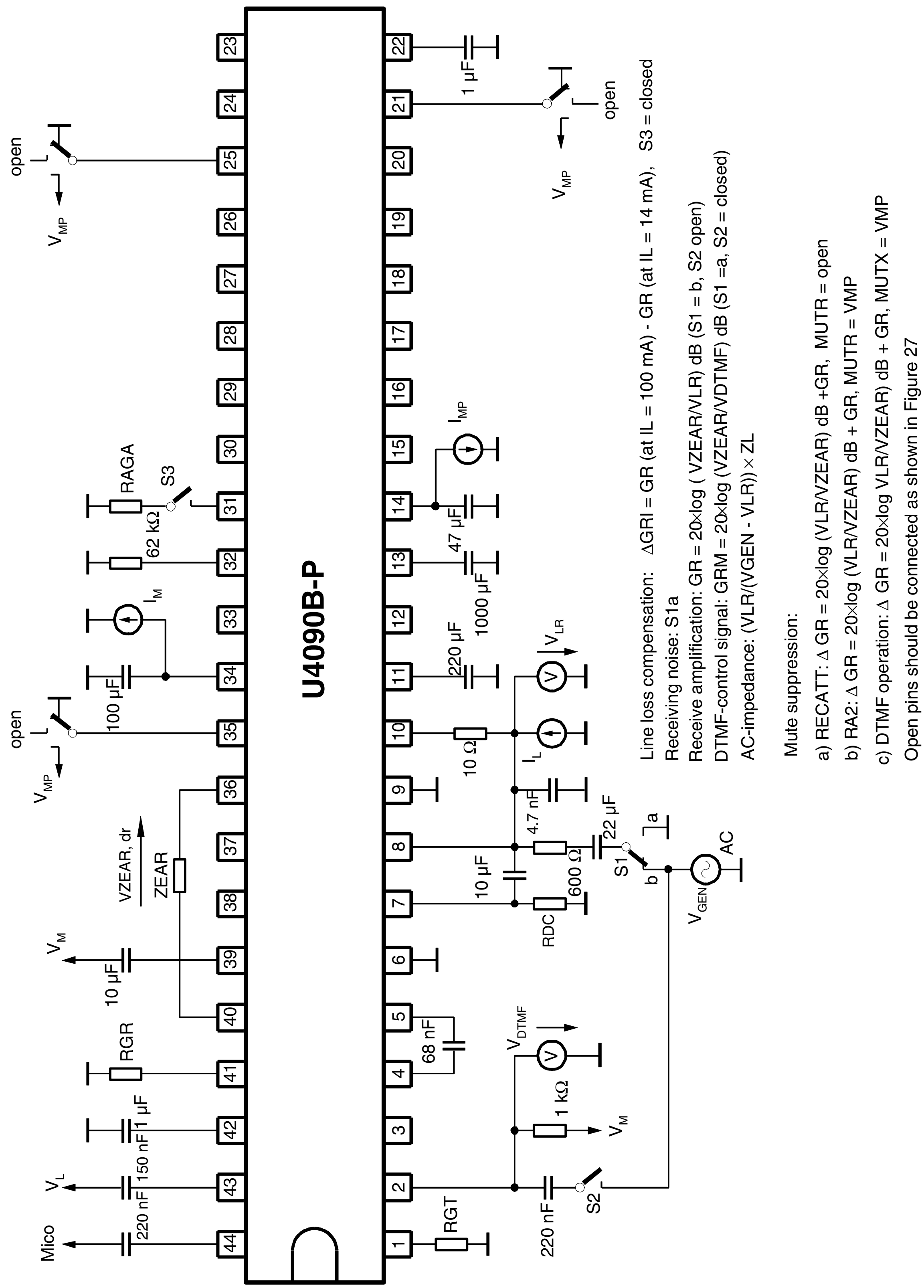


Figure 25. Test Circuit for Speaker Amplifier

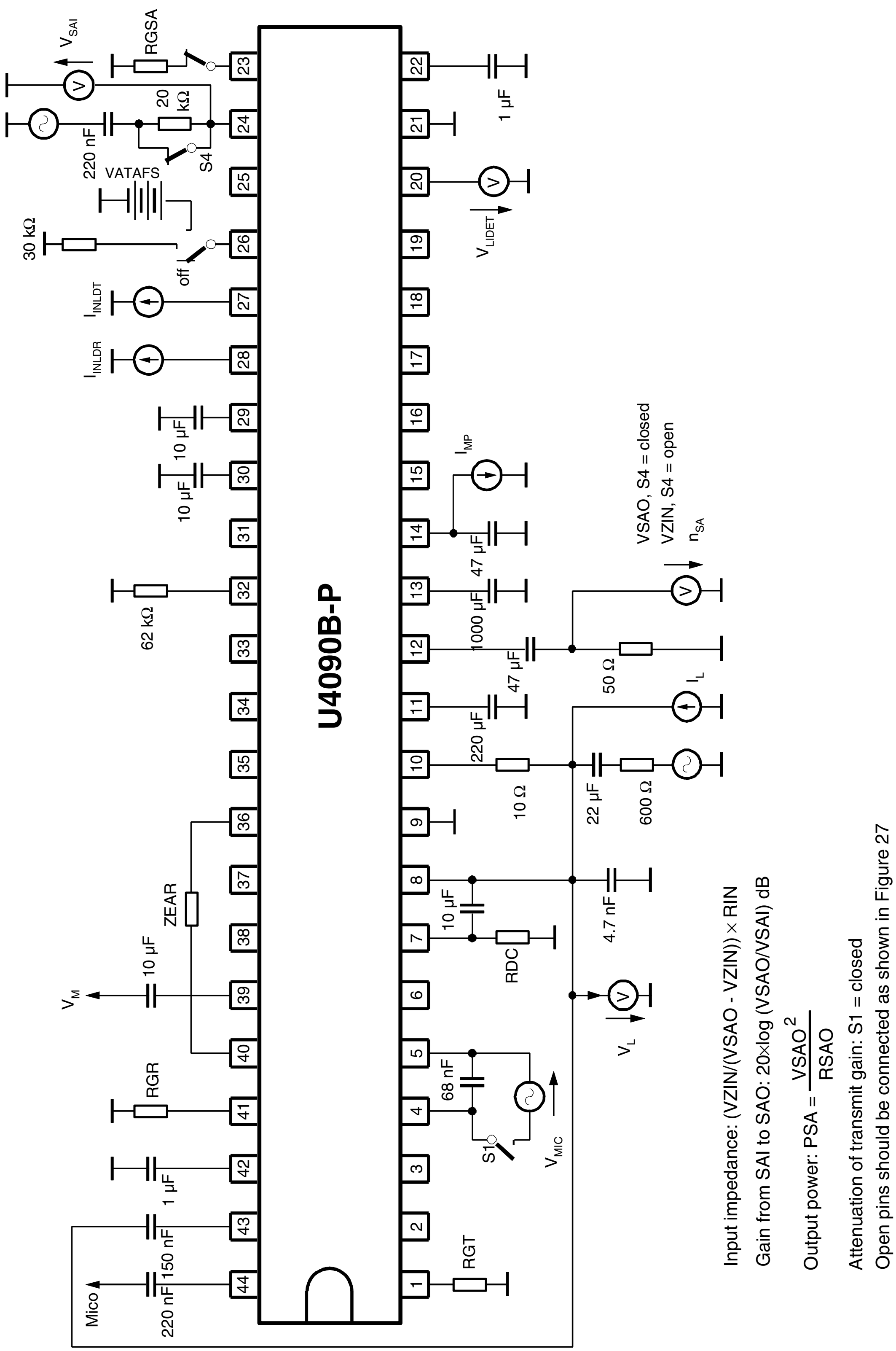


Figure 26. Test Circuit for DTMF Amplifier

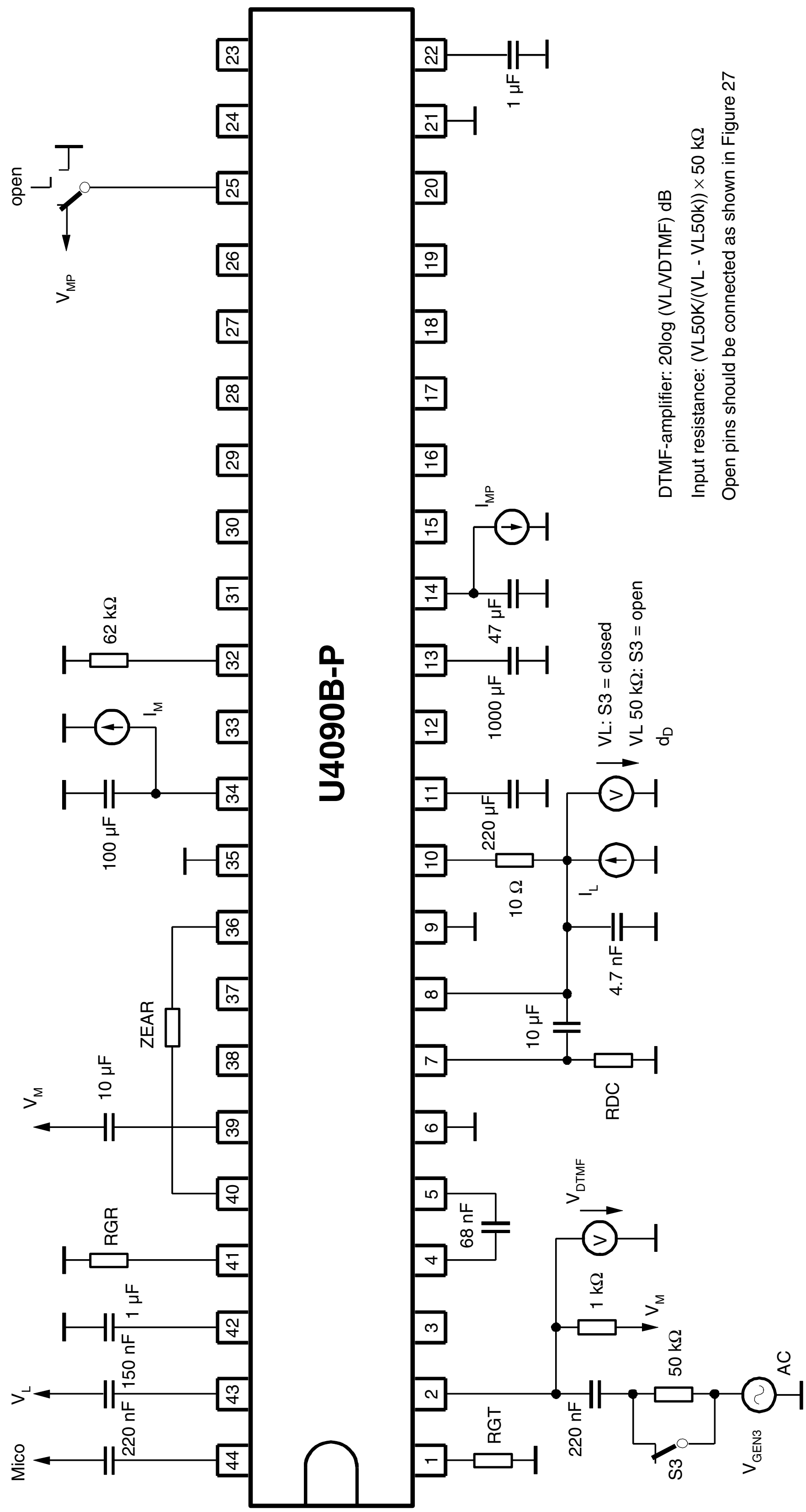


Figure 27. Test Circuit for Ringing Power Converter

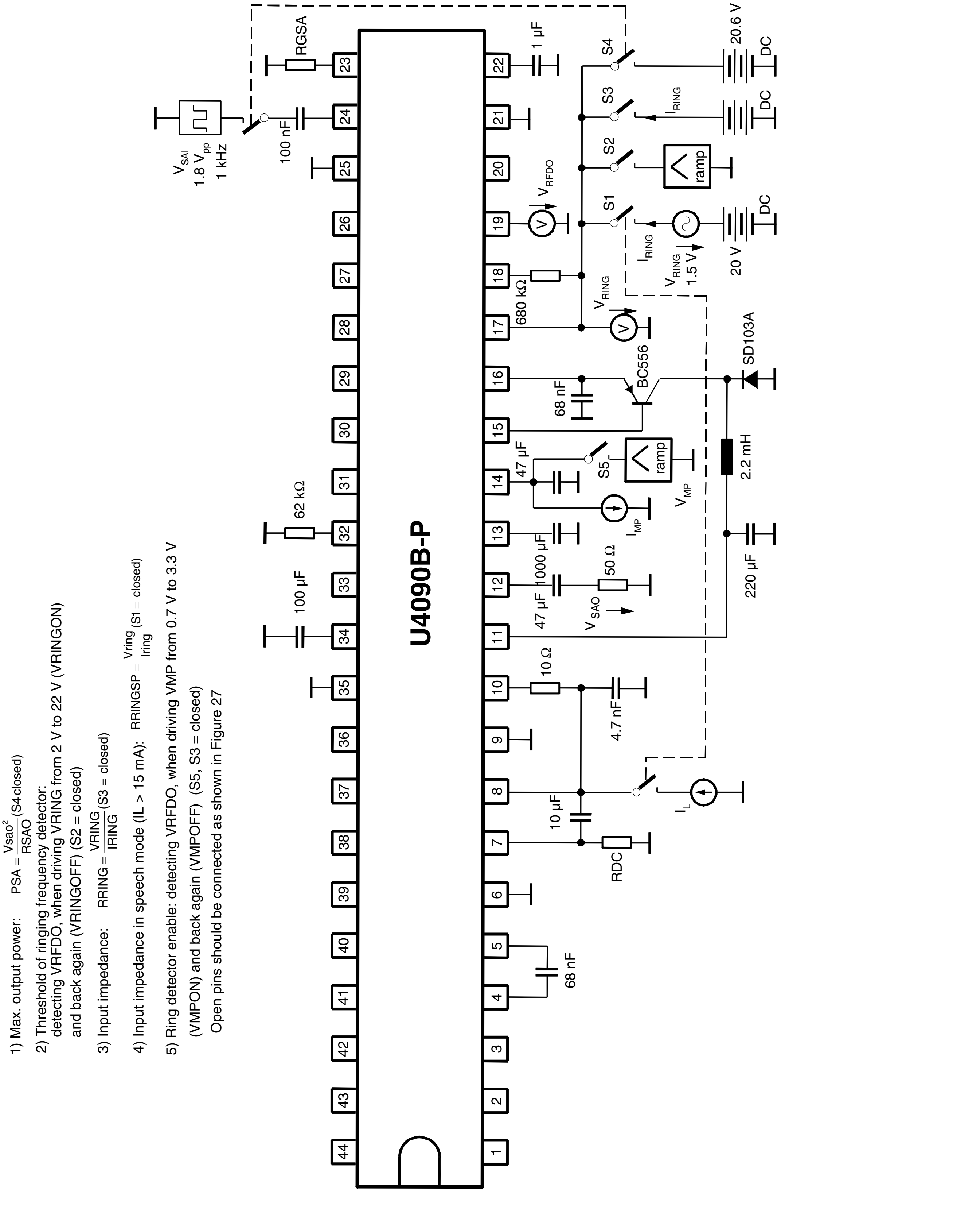


Figure 28. Test Circuit for Input Characteristics of I/O Ports

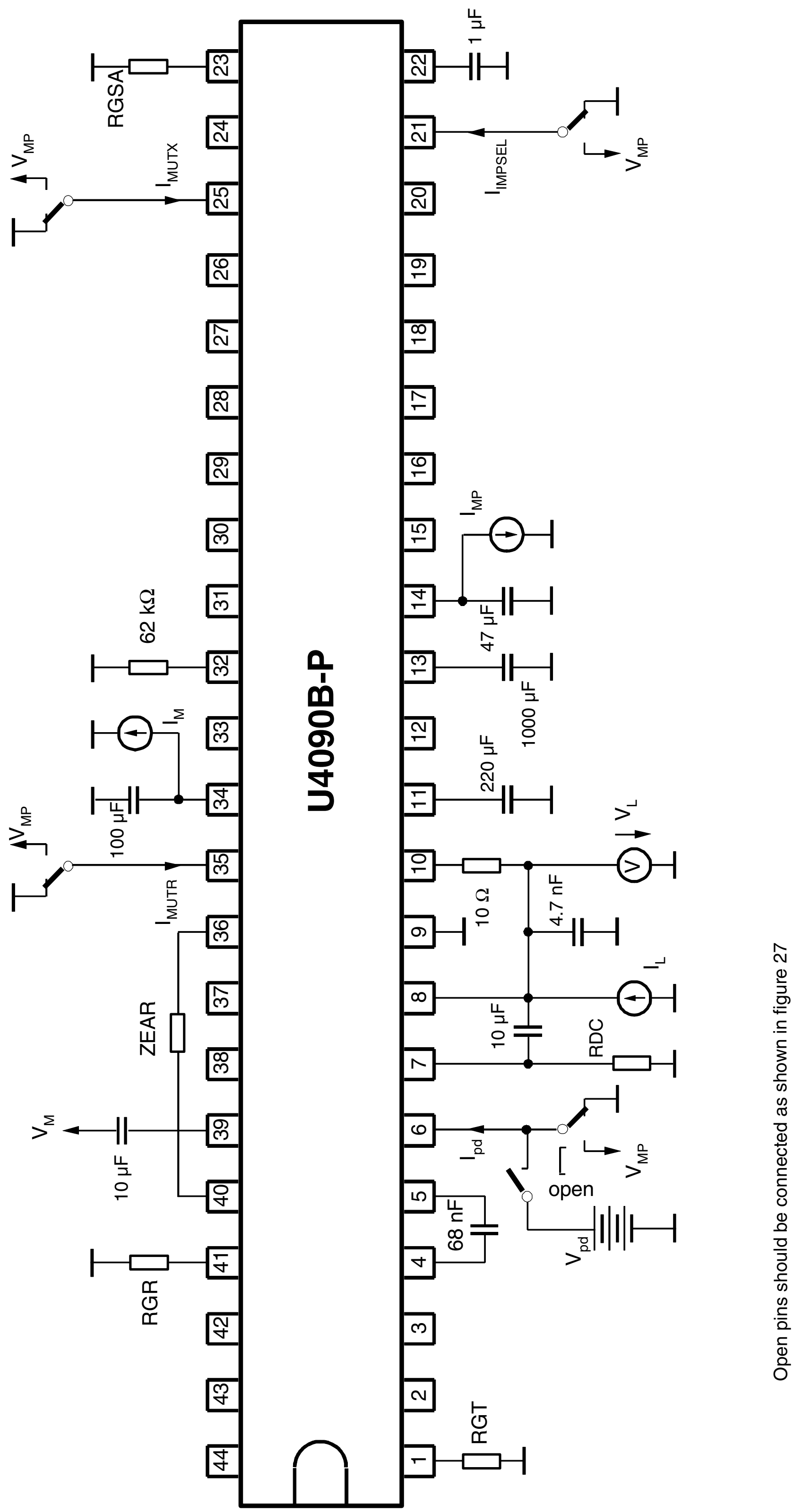


Figure 29. Application Circuit for Loud-hearing

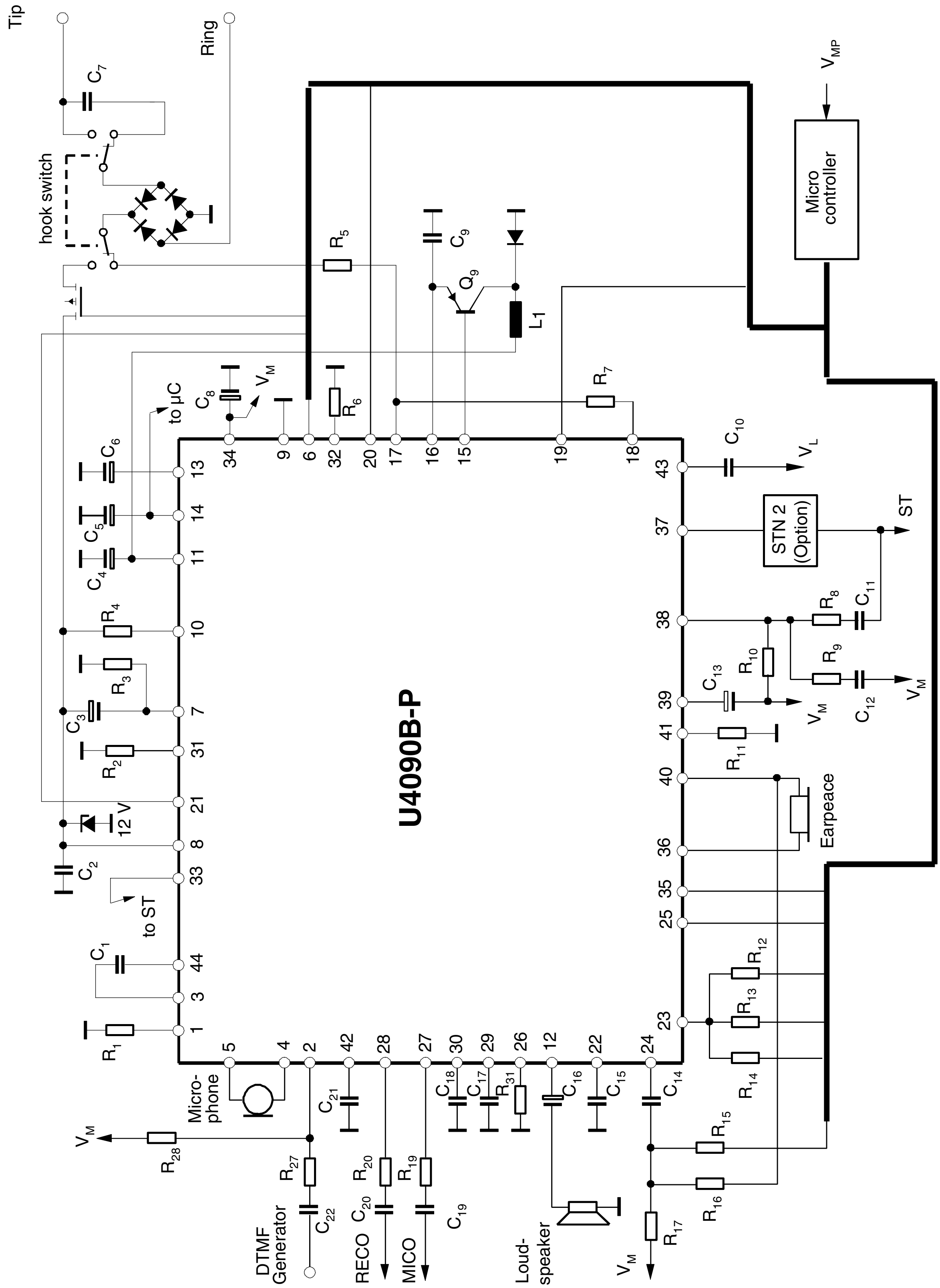


Figure 30. Application for Hands-free Operation

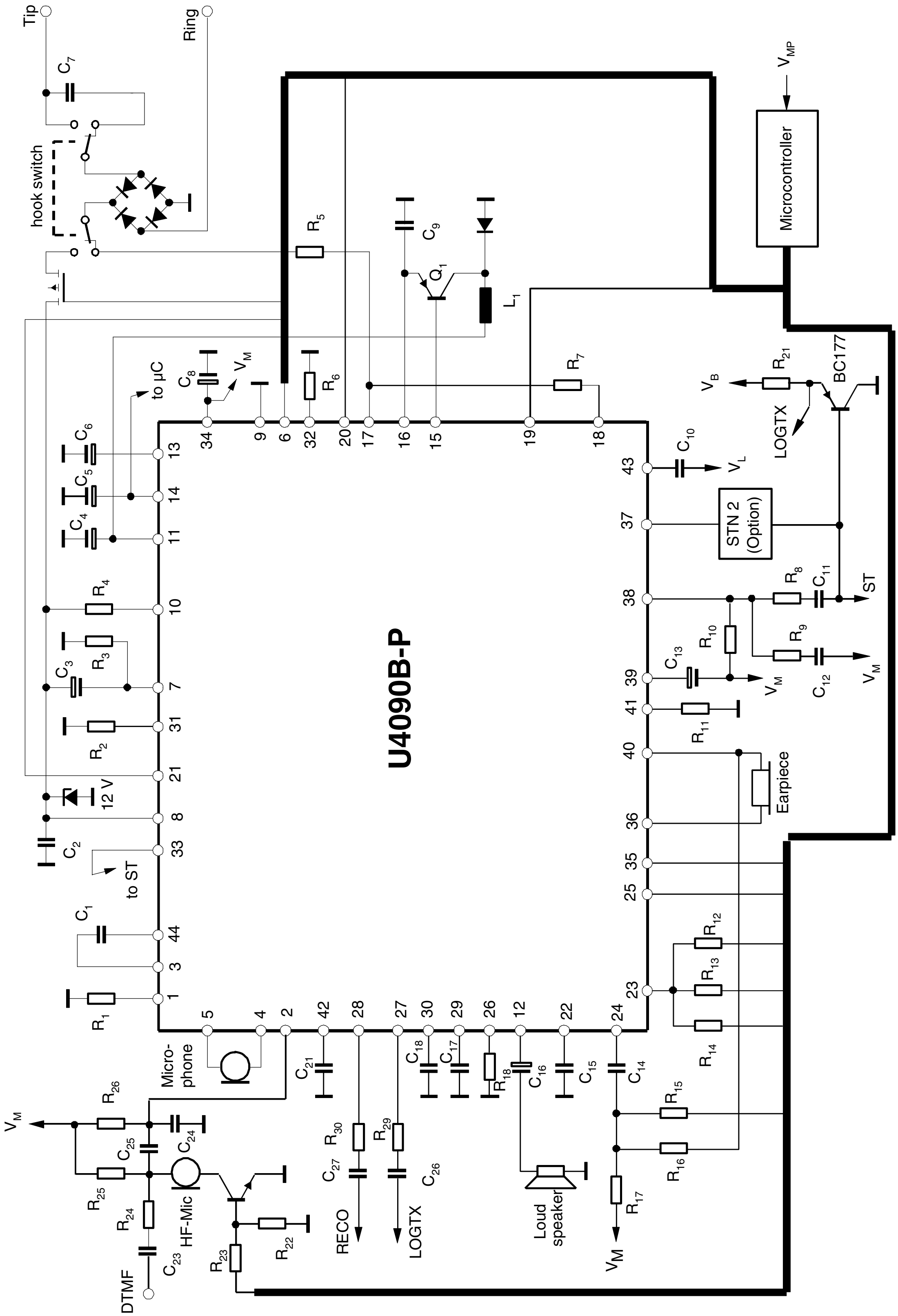


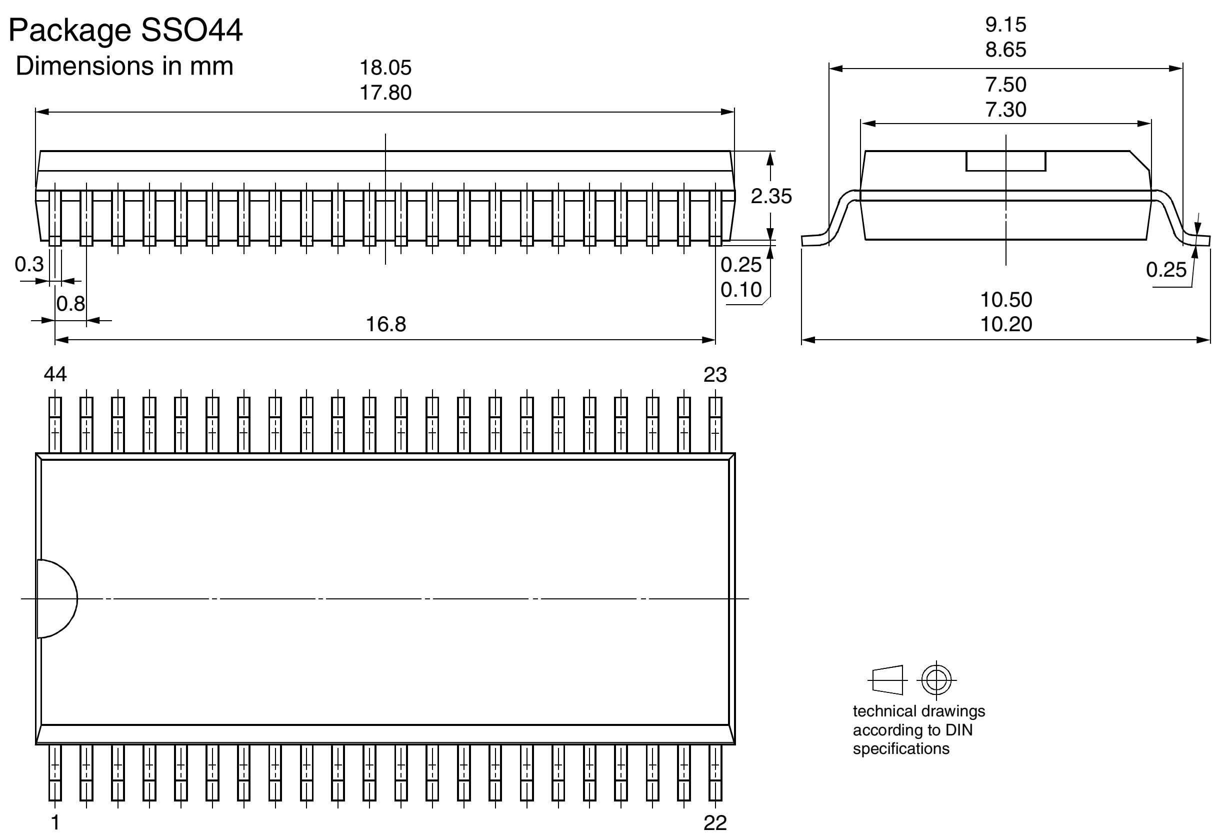
Table 5. Typical Values of External Components (Figure 29 and Figure 30)

Name	Value	Name	Value	Name	Value	Name	Value
C_1	100 nF	C_{16}	47 µF	R_3	> 68 kΩ	R_{18}	30 kΩ
C_2	4.7 nF	C_{17}	10 µF	R_4	10 kΩ	R_{19}	6.8 kΩ
C_3	10 µF	C_{18}	10 µF	R_5	1.5 kΩ	R_{20}	6.8 kΩ
C_4	220 µF	C_{19}	68 nF	R_6	62 kΩ	R_{21}	15 kΩ
C_5	47 µF	C_{20}	68 nF	R_7	680 kΩ	R_{22}	330 kΩ
C_6	470 µF	C_{21}	1 µF	R_8	22 kΩ	R_{23}	220 kΩ
C_7	820 nF	C_{22}	100 nF	R_9	330 kΩ	R_{24}	68 kΩ
C_8	100 µF	C_{23}	6.8 nF	R_{10}	3 kΩ	R_{25}	2 kΩ
C_9	100 nF	C_{24}	10 nF	R_{11}	62 kΩ	R_{26}	3.3 kΩ
C_{10}	150 nF	C_{25}	100 nF	R_{12}	30 kΩ	R_{27}	18 kΩ
C_{11}	86 nF	C_{26}	470 nF	R_{13}	62 kΩ	R_{28}	2 kΩ
C_{12}	33 nF	C_{27}	33 nF	R_{14}	120 kΩ	R_{29}	1 kΩ
C_{13}	10 µF	L_1	2.2 mH	R_{15}	47 kΩ	R_{30}	12 kΩ
C_{14}	100 nF	R_1	27 kΩ	R_{16}	1 kΩ	R_{31}	56 kΩ
C_{15}	1 µF	R_2	20 kΩ	R_{17}	1.2 kΩ		

Ordering Information

Extended Type Number	Package	Remarks
U4090B-PFN	SSO44	–
U4090B-PFNG3	SSO44	Taped and reeled
T4090B-PC	Die	Chip on foil

Package Information



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