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
- Two Ringer Inputs Selectable
- 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 ESD Protection

Monolithic Integrated Feature Phone Circuit EMI Improved

U4090B-P

4743-CORD-01/10

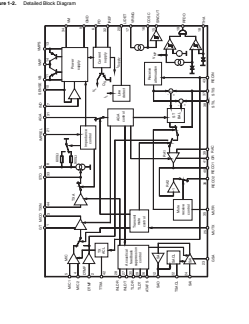
1. Description

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 equalizer 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.

Figure 1-1. Block Diagram

Figure 1-2. Detailed Block Diagram



2. Pin Configuration

Figure 2-1. Pinning SSO44

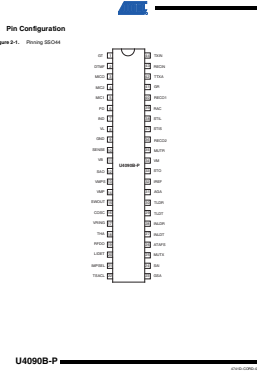


Table 3-1. Pin Description

Pin	Symbol	Function
1	GT	A resistor from this pin to GND sets the amplification of the microphone and DTMF signals; the input capacitance of the microphone amplifier is reduced
2	DTMF	Input for DTMF signals; also used for the answering machine and hands-free input
3	MIC0	Output of microphone preamplifier
4	MIC2	Non-inverting input of microphone amplifier
5	MIC1	Inverting input of microphone amplifier
6	PD	Active high input for reducing the current consumption of the circuit; simultaneously V_o 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 capacitor 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 shunt resistor (Sense) connected between this pin to V_L sets the slope of the DC characteristic and also the DC loop length equalization characteristics and the line current at which the loudspeaker amplifier is switched on
11	VS	Unregulated supply voltage for peripheral circuits (voice switch); limited typically 7V
12	SAO	Output of loudspeaker amplifier
13	VMPO	Unregulated supply voltage for microcontroller; limited to 4.3V
14	VMP	Regulated supply voltage of 3.0V for peripheral circuits (especially microprocessor); minimum output current 3 mA (charge) 2 mA (speech mode)
15	SWO	Output for driving external switching transistor
16	CCBC	20 kHz oscillator for ringing power converter
17	VRING	Input for ringing signal connecting to internal Zener diode
18	TRA	Threshold adjustment for ringing frequency detector
19	RFDO	Output of ringing frequency detector
20	LOST	Line detect output to see when the line current is more than 10 mA
21	INPSEL	Control input for selection of line programmer 1. GND 2. 100Ω 3. Mode of second transmit stage (TEA); also used for indication of speech supply (answering machine); last chosen impedance is stored
22	TSACL	Time constant of anti-clipping of speaker amplifier
23	ISBA	Current input for setting the gain of the speaker amplifier, adjustment characteristic is logarithmic, or RISBA = 2 MΩ, the speaker amplifier is switched off
24	SA 1	Speaker amplifier input 1 (loudspeaker, hands-free origin 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 sidetone signal (DTMF signal) 3. Input DTMF used for answering machine and hands-free use; receive branch not affected
26	AFWS	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	RLOT	Input of transmit level detector
28	RLDR	Input of receiver level detector
29	TLOT	Time constant of transmit level detector

Table 3-1. Pin Description (Continued)

Pin	Symbol	Function
30	TLDR	Time constant of receive level detector
31	AGA	Automatic gain adjustment with first current, a resistor connected from this pin to GND sets the starting point, maximum gain charge: 8 dB
32	IREF	Internal reference current generation; IREF = 4.2 kΩ / IREF = 20 µA
33	STO	Balance reduction output Output resistance approximate: 300Ω Maximum load impedance: 10 kΩ
34	VM	Reference node for microphone-earphone and loudspeaker amplifier, supply for electret microphone (IM = 500 mA)
35	MUTR	Three-state mute input 1. Mute receiver 2. Mute forward speak 3. Mute for RECIN signal Condition of earpiece mute is stored
36	RECOS	Inverting output of receiving amplifier
37	STS	Input for sidetone network (short loop) or for answering machine
38	STIL	Input for sidetone network (long loop)
39	RAC	Input of receiving amplifier for AC coupling in hardware path
40	RECO1	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 used for gain control (GC)
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: When applied electromagnetic interference (EMI) are located at following pins: MIC1, MIC2, RECIN, TXIN, STS, STIL and RAC.

3. DC Line Interface and Supply-voltage Generation

The DC line interface consists of an electrolytic inductance and a dual-port output stage which charges the capacitors at V_{CC1} and V_{CC2}. The value of the equivalent inductance is given by:

$$L = R_{LINE1} \cdot C_{CC1} \cdot (R_{i1} + R_{o1})(R_{i2} + R_{o2})$$

In order to improve the supply during worst-case operating conditions, two PNP current sources I_{CC1} and I_{CC2} – hand-on extra amount of current to the supply voltages when the MPWs in parallel are unable to conduct current.

A flowchart for the control of the current sources (Figure 3-3) shows how a priority for supply VMPS is achieved.

Figure 3-1. DC Line Interface with Electronic Inductance and Generation of a Regulated and an Unregulated Supply

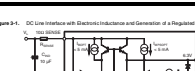
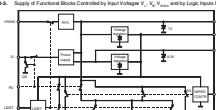


Figure 3-2. Supply Capacitors CMPS and CB Are Charged with Priority on CMPS

Figure 3-3. Supply of Functional Blocks Controlled by Input Voltage V_s, V_{ip}, V_{micro} and by Logic Inputs PD and IMPSEL


VTRIG
MIC
Voltage Detector
Voltage Detector
Power Loss
Voltage Detector
VL
VLOW
VS
RL
Impedance Control
IMPSEL
LEDT
LED
VFOC
MIC Amplifier
Tone Ringer
Tone Ringer
Voltage Detector
MIC Amplifier
MIC Amplifier
MIC Amplifier

There are four major supply states:

1. Speech condition: In speech condition the system is supplied by the line current. If the LEDET block detects a line voltage above the fixed threshold (1.9 V), the internal signal V_{LON} is activated, thus switching off RFD and RFC and switching on all other blocks of the chip. At line voltages below 1.9V, the switches remain in their quiescent state as shown in Figure 3-4 on page 10.
   OFFSACOMP disables the group listening feature (SAI, SA, SACL, AFS) below line currents of approximately 10 mA.
2. Power down (pulse dialing): When the chip is in power-down mode (PD = high), e.g., during pulse-dialing, the internal switch DS shorts the line and all amplifiers are switched off. In this condition, LEDET, voltage regulators and IMPSD CONTR are the only active blocks.
3. Ringing: During ringing, the supply for the system is fed into V_{ll} via the ringing power converter (RPC). The only functional amplifiers are in the speaker amplifier section (SAI, SA, SACL).
4. External supply: In an answering machine, the chip is powered by an external supply via pin V_{ll}. This application allows the possibility to activate all amplifiers (except the transmit line interface TXA). Selecting MIPSEL = high impedance activates all switches at the SS line.

3.2 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 suppress ion circuit, which uses a modified voice switch topology. Figure 3-4 on page 10 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 U4090B-P, is illustrated in Figure 3-6 on page 11. TXA and SAI represent the two attenuators, the logarithmic envelope detectors are shown in a simplified way (operational amplifiers with two diodes).

Figure 3-4. Basic Voice Switch System

Figure 3-5. Integration of the Acoustic Feedback Suppression Circuit into the Speech Circuit Environment

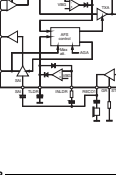
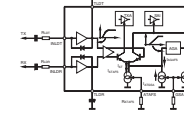


Figure 3-4. Acoustic Feedback Suppression by Alternative Control of Transmit and Speaker Amplifier Gain



A detailed diagram of the AFS (acoustic feedback suppression) is given in Figure 3-4. Receive and transmit signals are first processed by logarithmic rectifiers in order to produce the envelopes of the speech at TLOT and RLOT. After amplification, a decision is made by the differential peak which direction should be transmitted.

The attenuation of the controlled amplifiers TXA and SA is determined by the emitter current (AT which consists of three parts:

I_{TXAS} sets maximum attenuation

I_{TXAAS} decreases the attenuation when speaker amplifier gain is reduced

I_{TXAATS} decreases the attenuation according to the loop gain reduction caused by the AGA function

$I_{T} = I_{TXAS} - I_{TXAAS} - I_{TXAATS}$

$\Delta G = I_{T}/5 \approx 0.67\ dB/\mu A$

Figure 3-7 on page 12 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 $ATAFS_0$. The actual value of attenuation ($ATAFS_0$) however, can be determined by reading the value which belongs to the actual gain GSA_0. 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

$GSA < GSA0 > 36\ dB - ATAFS_0$

Figure 3-7. Reducing Speaker Amplifier Gain Results in an Equal Reduction of AFS Attenuation

Figure 3-8. Line Detection with Two Comparators for Speech Mode and Pulse Dialing

3.3 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 3-9 on page 13. 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 CS (see Figure 3-2 on page 8). As long as IL is above typically 1.6 mA, output LIDET is low. This comparator does not use hysteresis.

Figure 3-9. Line Detection in Speech Mode with Hysteresis

3.4 Ringing Power Converter (RPC)

The RPC transforms the input power at VRING (high voltage/low current) into an equivalent output power at V_{S_1} (low voltage/high current) which is capable of driving the low-ohmic loudspeaker. Input impedance at VRING is fixed at 5 kΩand the efficiency of the step-down converter is approximate 65%.

Figure 3-10. Comparator Thresholds Depending on DC Mask and Line Impedance

3.5 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_{RFD} is transformed into a current via RTHA. The thresholds are 8 µA and 24µA. RFDO and V_{RFD} are in phase. A second comparator with hysteresis is used to enable the output RFDO as long as the supply voltage for the microprocessor VMF is above 2.0V.

4. Absolute Maximum Ratings

Absolute maximum ratings of the device "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_{LINE}	140	mA
DC line voltage	V_{LINE}	12	V
Maximum input current, pin 17	I_{17max}	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

5. Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient SSOI24	R_{thja}	70	K/W

6. Electrical Characteristics

I_L = 7.8mA, R_{DBR} = 715 mW, f_{osc} = 0.3 kHz, R_{VCC} = 130 kΩ, T_{amb} = 25°C, R_{VGAR} = 940 kΩ,
A_{vd} = 68 pF = 1000, A_{vd} = 68 nF pin 20 open, C_{MRCA} = GND, $V_{mic\ in}$ = GND, $V_{mic\ in}$ = 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 = 16 mA I_L = 80 mA	V_L	4.6 - -	5.4 6.0 8.8	5.9 6.5 10.0	V
Transmission Amplifier, I_L = 14 mA, f_{osc} = 3.9 kHz, R_{DBR} = 27 kΩ, Unless Otherwise Specified						
Range of transmit gain		G_x	40	43	50	dB
Transmitting amplifier	R_{gi} = 12 kΩ R_{gi} = 27 kΩ	G_x	47 38.8	49 41.8	52 44.8	dB
Frequency response	f_{osc} = 3.9 kHz f = 300 to 3400 Hz	ΔG_x			±0.5	dB
Gain change with current	Pin 23 open I_L = 14 to 100 mA	ΔG_x			±0.5	dB
Gain deviation	T_{amb} = -10 to +60°C	ΔG_x			±0.8	dB
CMRR of microphone amplifier		CMRR	60	80		dB
Input resistance of MIC amplifier	R_{gi} = 12 kΩ R_{gi} = 27 kΩ	R_i	49 19	79 39	110 59	kΩ
Distortion at line	$V_{mic\ in}$ = 10 mV $V_{mic\ in}$ = 50 mV	d_L			2 -	%
Maximum output voltage	f = 150 Hz, C_L = 51% $V_{mic\ in}$ = 50 mV CTXA = 1 µF	V_{Lmax}	1.8	3	4.2	dBm
	Transmit, open R_{gi} = 12 kΩ	V_{Xmax}		-4.2		dBm

6. Electrical Characteristics (Continued)

f_c = 1 kHz, 0 dBm = 775 mV_{eff}, T_{amb} = 0 ...+ 3.0 mA, I_{ref} = 2 mA, RDC = 130 kΩ, T_{amb} = 25 °C, RGSA = 980 kΩ, R_{ext} = 98 kΩ, C_{ext} = 1000 R_{ext}, C_{ext} = 68 nF, pin 27 open, $V_{pin\,10}$ = GND, $V_{pin\,14}$ = GND, $V_{pin\,15}$ = GND, unless otherwise specified.

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Reference line psophometrically weighted	$V_{pin\,10}$ = GND G_x = 48 dB	n_{ref}		−80	−72	dBmp
Anti-clipping attack/rise release time	CTIA = 1 µF switch 3 dB overdrive	t_a t_r		3 75		ms
Start-up low operating current	I_{ref} = 0 mA $V_{pin\,10}$ = 1 V RDC = 130 kΩ $V_{pin\,14}$ = 1.6 V $V_{pin\,15}$ = 300 µA	G_x	40		62.5	dB
Distortion at low operating current	I_{ref} = 0 mA $V_{pin\,10}$ = 300 µA $V_{pin\,14}$ = 1 V RDC = 80 kΩ $V_{pin\,15}$ = 1 V $V_{pin\,27}$ = 1 V	d_t			5	%
Line-cross compensation	$V_{pin\,10}$ = 0 mA $R_{pin\,10}$ = 20 kΩ	ΔG_x	−6.4	−5.6	−3.2	dB
Mute suppression (a) MIC muted (microphone preamplifier) (b) TXA muted (second stage)	$V_{pin\,10}$ = 0 mA MUTE = open MPI/SS = open	G_{mu} G_{mu}	80 60	80 66		dB
Receiving Amplifier, I_x = 16 mA, R_{ext} = 98 kΩ	**Min./ Unless Otherwise Specified, $V_{pin\,10}$ = 300 mV**					
Adjustment range of receiving gain	$V_{pin\,10}$ = 0 mA, single ended $V_{pin\,10}$ = 0 mA, RL = 2 kΩ	G_x	−8		+2 +8	dB
Receiving amplification	$V_{pin\,10}$ = 62 kΩ differential $V_{pin\,10}$ = 0 mA, single ended	G_x	−1.75	−1 −7	−0.25	dB
Amplification of DTMF signal from DTMF IN to REC O1, 2	$V_{pin\,10}$ = 0 mA f_c = 1 kHz f = 300 to 3400 Hz	G_{dtmf}	7	10	13	dB
Frequency response	$V_{pin\,10}$ = 0 mA f = 300 to 3400 Hz	G_{fdtmf}			±0.5	dB
Zero-change with current	$V_{pin\,10}$ = 300 mA	ΔG_x			±0.5	dB
Zero-deviation	T_{amb} = −10 to +60 °C	ΔG_x			±0.5	dB
Sat-protection differential	f = 16 kHz, $V_{pin\,10}$ = 11 V_{eff}	ΔP			2.2	V
MIC1B, suppression (a) INACIT (b) RECIT (c) DTMF operation	f = 16 mA MUTA = open MUTA = open $V_{pin\,10}$ = 0 mA	ΔG_x	60			dB
Output voltage d. c.(0% differential	f = 16 mA, R_{ext} = 68 kΩ + 100Ω			0.775		V_{eff}
Maximum output current d. c.	$V_{pin\,10}$ = 0 mA			4		V_{eff} (peak)
Receiving noise psophometrically weighted	f = 68 nF + 100Ω I_x 16 mA	n		−80	−77	dBmp
Output resistance	Short-circuit against GND	R_o			10	Ω
Line-cross compensation	$V_{pin\,10}$ = 20 kΩ, L = 100 mA	ΔG_x	−7.0	−6.0	−5.0	dB

6. Electrical Characteristics (Continued)

f_c = 1 kHz, 0 dBm = 775 mV$_{eff}$, V_S = 3.0 mA, V_{CC} = 2.4 mA, RDC = 130 kΩ, T_{amb} = 25°C, RGSA = 940 kΩ, R_{GSD} = 88 kΩ, R_{GSD} = 1 MΩ, R_{GSD} = 88 kΩ, pin 27 pin 28 open, V_{CC} = 2.4 V, V_{SS} = GND, V_{CC} = GND, unless otherwise specified.

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Sidetone	V_{ms} = 0 V V_{sp} = 1 V Gain at low operating current	G_{st}	–2	–1	0	dB
AC impedance	V_{ms} = 0 V V_{sp} = 1 V V_{sp} = 0 mA	Z_{ms} Z_{sp}	570 840	600 900	630 960	Ω kΩ
Distortion at low operating current	V_{ms} = 0 V V_{sp} = 1 V RDC = 88 kΩ	dR			5	%
Speaker Amplifier						
Minimum line current for operation	No AC signal	I_{LOW}			15	mA
Input resistance	Pin 24	R_{in}	14		22	kΩ
Gain from SAI to SAO	V_{SAI} = 0 V V = 0 dBm RGSA = 940 kΩ RGSD = 88 kΩ	G_{SA}	36.5	36.5 37.5	37.5	dB
Output power	Load resistance R_L = 8Ω d = 3% V_{CC} = 3.0 V V_{CC} = 2.4 V	P_o P_{po}	3 2			mW
Output noise (input SAI open)	V_{CC} = 3.0 V	n_{ao}			200	µV$_{eff,noise}$
Supply-voltage rejection	V_{CC} = 3.0 V, V_{ripple} = 100 Hz ±60 mV	S_{vo}			–41	dB
Mute suppression	V_{CC} = 3.0 V V = 0 dBm V = 0 mV Pin 20 open	V_{mute}			–60	dBm
Gain change with current	V_{CC} = 3.0 V to 1.00 mA	dG_{vo}			+1	dB
Resistor for turning off speaker amplifier	V_{CC} = 3.0 V	RG_{off}	0.8	1.0	2	MΩ
Gain change with frequency	V = 0 dA, f = 300 to 3400 Hz	dG_{vo}			±0.5	dB
Attack time of anti-clipping	20 dB over drive	tr		4		ms
Release time of anti-clipping		tf		60		ms
DTMF Amplifier Test Conditions: BW = 2 kHz, R_L = 5.2 mA, $V_{CC,DTMF}$ = VMP						
Adjustment range of DTMF gain	V = 0 mA (sum active	G_d	–60		50	dB
DTMF amplification	V = 0 dBm Mute active: MUTX = V_{CC}	G_d	–60.7	–61.7	–62.7	dB
Gain deviation	V = 0 dA, T_{amb} = –10 to +60°C	G_d			±0.5	dB
Input resistance	R_d = 27 kΩ R_d = 15 kΩ	R_i	60 28	100 130	200 150	kΩ
Distortion of DTMF signal	V = 0 dA V = 0 dBm	d_d			2	%

6. Electrical Characteristics (Continued)

f_c = 1 kHz, 0 dBm = 775 mV$_{eff}$, T_j = 0 ...3 A, I_q = 2 mA, RDC = 180 kΩ T_{amb} = 25 °C, RSGA = 910 kΩ, V_{CC} = 16 dBμV = 1 V$_{eff}$, R_L = 8Ω ±5% 20 ...20 000 Hz, V_{CC} = 9 V, V_{SGA} = GND, V_{SGA} = GND, unless otherwise specified.

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Open-circuit-voltage-gain	f_c = 100 ...10 kHz	dG_{vo}			≤0.5	dB
AFS Acoustic Feedback Suppression						
Adjustment range of attenuation	f_c = 70 mA			0	90	dB
Attenuation of transmit gain	f_c = 0 µA V_{pin1} = 0 V R_{pin1} = 20 kΩ R_{pin2} = 10 µA	dG_v		45		dB
Attenuation of speaker amplifier	f_c = 0 µA V_{pin1} = 0 V R_{pin1} = 20 kΩ R_{pin2} = 10 µA	dG_{vo}		50		dB
AFS disable	f_c = 70 mA	V_{pin2}	1.5			V
Supply Voltages, V_{pin} = 20 mV, T_{amb} = 10 to +40 °C						
V_{ref}	f_c = 0 mA RDC = 180 kΩ I_q = 2 mA	V_{ref}	3.1	3.3	3.5	V
V_{AFS}	f_c = 350 mA RDC = ∞Ω I_{pin} = 0 mA	V_{AFS}			6.7	V
V_q	f_c = 0 mA I_q = 700 µA I_{pin} = 0 mA	V_q	1.3		3.3	V
V_s	f_c = 0 mA I_q = 2 mA I_{pin} = 0 mA	V_s		7	7.6	V
Ringing Power Converter, ISIP = 1 mA, M = 0						
Maximum output power	V_{pin} = 20 mV	P_{ro}	50			mW
Threshold of ring frequency detector	V_{pin} = 20 mV V_{pin} = V_{pin1} ON − V_{pin1} OFF	V_{thrdon} V_{thrdhy}		17.5 11.5		V
Input impedance	V_{pin} = 20 mV	R_{pin1}	4	6	8	kΩ
Input impedance in speech mode	V_{pin} = 200 mV to 3600 mV, f_c = 10 ...4000 Hz, V_{pin2} = V_{pin1}	R_{pin1}		150		kΩ
Logic level of frequency detector	V_{pin} = 0 V V_s = 9 V V_{pin1} = 200 V	V_{ldrdon}		V_s −1 V		V
Ring detector enable	V_{pin1} = 200 V, RFDO high	V_{ldrdon}	1.8	2.0	2.2	V
Zener diode voltage	V_{pin1} = 20 mA	V_{zdrdon}	30.8		33.3	V
MUTE input						
MUTE input current	V_{pin} = GND f_c = 0 mA V_{pin2} = V_{pin1}	I_{mute}		−20 +10	−30 −	µA
MUTE input voltage	Mute low, I_q = 14 mA	V_{mute}		GND		V
	Mute high, I_q = 14 mA	V_{mute}		V_{REF} − 0.2V		V

6. Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mV$_{eff}$, I_{ch} = 0.3 mA, I_{ch} = 2 mA, RDC = 130 kΩ, T_{amb} = 25 °C, RGSA = 910 kΩ, R_{ref} = 68 dF = 1680, R_p = 68 nF pin 27 open, $V_{pin(12)}$ = GND, $V_{pin(14)}$ = GND, $V_{pin(16)}$ = GND, unless otherwise specified.

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
PC input						
PC input current	PD active, I_{ch} = 14 mA V_{PC} = V_{ref}	I_{PC}		9		µA
Input voltage	PD = active PD = inactive	V_{PC} V_{PC}	2		0.3 V_{ref}	V
Voltage drop at V_{PC}	I_{ch} = 16 mA, PD = active I_{ch} = 100 mA, PD = active	V_{C}		1.0 1.4		V
Input Characteristics at IM-P34L						
Input current	I_{ch} = 0 mA $V_{pin(2)}$ = V_{ref} $V_{pin(2)}$ = GND	$I_{pin(2)}$ $I_{pin(2)}$		0 −15		µA µA
Input voltage	Input high Input low	$V_{pin(2)}$ $V_{pin(2)}$	V_{ref} − 0.2V		 0.3	V V
IM-TX input						
Input current	$V_{pin(1)}$ = V_{ref} $V_{pin(1)}$ = GND	$I_{pin(1)}$ $I_{pin(1)}$		−20 −30	30 −20	µA µA
Input voltage	Input high Input low	$V_{pin(1)}$ $V_{pin(1)}$	V_{ref} − 0.2V		 0.3	V V
Line Detection						
Line current for LCET active	PD = inactive	I_{LCR}		12.0		mA
Line current for LCET inactive	PD = inactive	I_{LCF}		11.0		mA
Current threshold duringpower down	R_{ch} = 82 PD = active	I_{LCRPD}	0.8	1.6	2.4	mA

7. U4090B-P Control

Table 7-1. Selection of TX Mute and Line Impedance

Logic Level	DIPTBL	MODE
0	Line impedance = 600Ω TXA = on BSS = off	Speech
0 to Z	Line impedance = 600Ω TXA = off BSS = on	Transmit-mute
1 to Z	Line impedance = 600Ω TXA = off BSS = on	Transmit-mute
1	Line impedance = 600Ω TXA = on BSS = off	Speech

Table 7-2. Selection of Earpiece Mute and Answering Machine Mode

Logic Level	MUTR	MODE
0	RAX = off REC-ATT = off STSS = STL = on	Speech
0 to Z	RAX = on REC-ATT = off STSS = on, STL = off	For answering machine
1 to Z	RAX = off REC-ATT = on STSS = on, STL = off TXACL = on	For answering machine
1	RAX = off REC-ATT = on STSS = STL = on	Speech + earpeace mute

Table 7-3. Selection of Transmit Mute

Logic Level	SMUTX	MODE
0	MIC 1/2 transmit enabled receive enable AFS = on ASA = on TXACL = on	Speech
Z	DTMF transmit enabled receive-enable AFS = on ASA = on TXACL = on	For answering machine
1	DTMF transmit enabled DTMF to receive enable AFS = off ASA = off TXACL = off	DTMF dialling

Table 7-4. Specification of Logic Levels

Logic Level
V_{IL} = (0.3V)
V_{IH} = (VMP – 1V) or (open input)
V_{OH} = (VMP – 0.3V)

8. Explanation of Abbreviations

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

Figure 8-1. Typical DC Characteristic

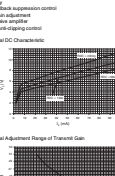


Figure 8-2. Typical Adjustment Range of Transmit Gain

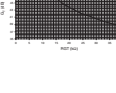
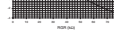


Figure 8-3. Typical Adjustment Range of Receive Gain (Differential Output)

Figure 8-4. Typical AGA Characteristic

Figure 8-5. Typical Load Characteristic of V_L for a Maximum (RDC = Infinity) DC-characteristic and 3-mW Loudspeaker Output



RDC = Infinity; V_I = 200 mV1 kHz; RSIDC = 3 mW;
RIP = 2 mA; M = 300 µA; RGSB = 5kΩ

Figure 8-6. Typical Load Characteristic of V_L for a Medium DC-characteristic (RDC = 120 kΩ and 3-mW Loudspeaker Output

Figure 8-6. Basic Test Circuit

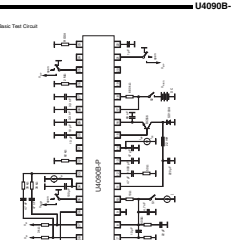


Figure 8-5. *Test Circuit for DC Characteristics and Line Detection*

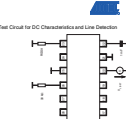

U4090B-P
LA
LB
VS
GND
VCC
VCC
VCC

Figure 8-10. Test Circuit for Transmission Amplifier

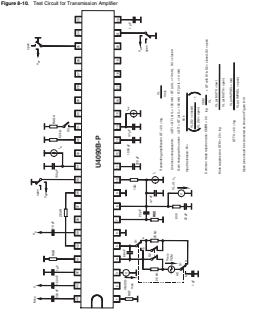


Figure 8-11. Test Circuit for Receiving Amplifier

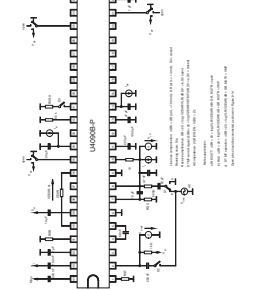


Figure 8-12. Test Circuit for Speaker Amplifier

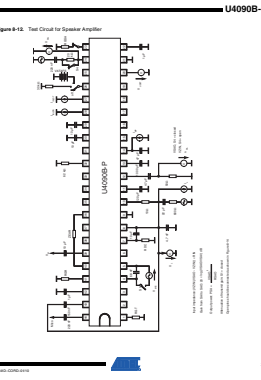

U4090B-P
VS
VCC
VCC
VCC

Figure 8-13. *Test Circuit for DTMF Amplifier*

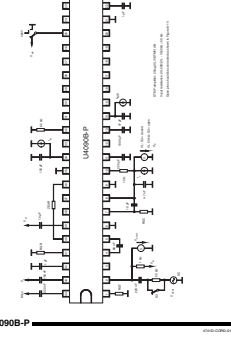


Figure 8-14. Test Circuit for Ringing Power Converter

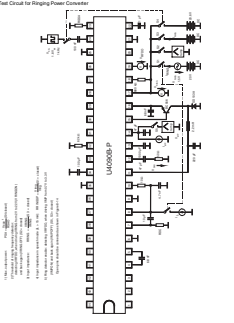

U4090B-P
VBAT
VCC
VCC
VCC

Figure 8-15. *Test Circuit for Input Characteristics of I/O Ports*

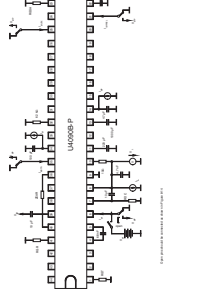


Figure 8-16. Application Circuit for Loud-hearing

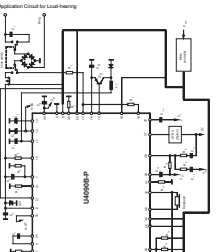

U4090B-P
Loud-hearing
Loudspeaker
Battery
Mic
Mic Bias
Mic Amp
Mic Amp
Mic Amp

Figure 8-17. Application for Hands-free Operation

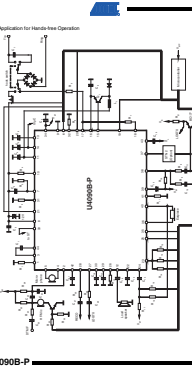

U4090B-P
Battery
Voltage
Regulator
Battery
Voltage
Regulator
Hook
Switch
Ringer
Relay
Ringer
Relay
Ringer
Relay

Table 8-1. Typical Values of External Components (Figure 8-16 on page 31 and Figure 8-17 on page 32)

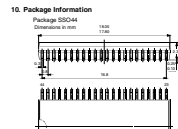
Name	Value	Name	Value	Name	Value	Name	Value
C_1	100 nF	C_{11}	47 pF	R_1	≈ 68 kΩ	R_{18}	20 kΩ
C_2	6.7 µF	C_{12}	10 pF	R_2	1 kΩ	R_{19}	6.8 kΩ
C_3	10 µF	C_{13}	10 pF	R_3	1.8 kΩ	R_{20}	6.8 kΩ
C_4	220 µF	C_{14}	68 nF	R_4	82 kΩ	R_{21}	15 kΩ
C_5	47 µF	C_{15}	68 nF	R_5	680 kΩ	R_{22}	330 kΩ
C_6	470 nF	C_{16}	1 µF	R_6	22 kΩ	R_{23}	220 kΩ
C_7	820 nF	C_{17}	100 nF	R_7	330 kΩ	R_{24}	68 kΩ
C_8	100 pF	C_{18}	6.8 nF	R_{8a}	3 kΩ	R_{25}	2 kΩ
C_9	100 nF	C_{19}	10 nF	R_{8b}	82 kΩ	R_{26}	3.3 kΩ
C_{10}	100 nF	C_{20}	100 nF	R_{10}	39 kΩ	R_{27}	56 kΩ
C_{11}	86 nF	C_{21}	470 nF	R_{11}	82 kΩ	R_{28}	2 kΩ
C_{12}	33 nF	C_{22}	33 nF	R_{12}	120 kΩ	R_{29}	1 kΩ
C_{13}	10 µF	L_1	2.2 mH	R_{13}	47 kΩ	R_{30}	12 kΩ
C_{14}	100 nF	R_1	27 kΩ	R_{14}	1 kΩ	R_{31}	86 kΩ
C_{15}	1 µF	R_2	39 kΩ	R_{15}	1.2 kΩ		

9. Ordering Information

Extended Type Number	Package	Remarks
U4090B-PFNGSY	SSO44	Taped and reeled, Pb-free
Sample-FC	Die	Chip on foil

10. Package Information

Package SSO44
Dimensions in mm



11. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
4741D-CORD-07/10	• Section 9 "Ordering Information" on page 34 changed

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