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
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 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.

Figure 1-1. Block Diagram

- MC with EEPROM/DTMF
- Audio amplifier
- Speech circuit
- Voice switch
- Tone ringer
- Loud-hearing
- Tone ringing
Figure 1-2. Detailed Block Diagram

GT MICO TXIN
STO VL IMPSEL AGA IND SENSE
GND
PD
LIDET
RFDO
THA
RECIN
STISSTILRACGRRECO2 RECO1MUTRMUTXGSA
MIC1
MIC2
DTMF
TTXA
INLDR
TLDR
ATAFS
SAO
TSACL
SAI

Acoustical feedback suppression
Transmit mute control
SACL
Mute receive control
Impedance control
Power supply
Current supply
ISupply
Line detect
AGA control
Receive attenuation
+ - + -
VMP
ST
BAL
TXA
INLDT
TLDT
900 Ω
1 2 6 4 12 5
7 8 3 16 15 10 3
22 24 25 26 29 30 27 28 19 14 13
21 600 Ω
VB VMP VMPS
VM
IREF
VRING
COSC
SWOUT
IL QS
VL
Figure 2-1. Pinning SSO44
<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>T</td>
<td>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 GT.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>DTMF Input for DTMF signals, also used for the answering machine and hands-free input</td>
</tr>
<tr>
<td>3</td>
<td>MICO</td>
<td>Output of microphone preamplifier</td>
</tr>
<tr>
<td>4</td>
<td>MIC2</td>
<td>Non-inverting input of microphone amplifier</td>
</tr>
<tr>
<td>5</td>
<td>MIC1</td>
<td>Inverting input of microphone amplifier</td>
</tr>
<tr>
<td>6P</td>
<td></td>
<td>Active high input for reducing the current consumption of the circuit, simultaneously VL is shorted by an internal switch</td>
</tr>
<tr>
<td>7I</td>
<td>N</td>
<td>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</td>
</tr>
<tr>
<td>8</td>
<td>VL</td>
<td>Line voltage</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Reference point for DC- and AC-output signals</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>SENSE A small resistor (fixed) connected from this pin to VL 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</td>
</tr>
<tr>
<td>11</td>
<td>VB</td>
<td>Unregulated supply voltage for peripheral circuits (voice switch), limited to typically 7V</td>
</tr>
<tr>
<td>12</td>
<td>SAO</td>
<td>Output of loudspeaker amplifier</td>
</tr>
<tr>
<td>13</td>
<td>VMPS</td>
<td>Unregulated supply voltage for microcontroller, limited to 6.3V</td>
</tr>
<tr>
<td>14</td>
<td>VMP</td>
<td>Regulated supply voltage of 3.3V for peripheral circuits (especially microprocessors), minimum output current: 2 mA (ringing) 4 mA (speech mode)</td>
</tr>
<tr>
<td>15</td>
<td>SWOUT</td>
<td>Output for driving external switching transistor</td>
</tr>
<tr>
<td>16</td>
<td>COSC</td>
<td>40-kHz oscillator for ringing power converter</td>
</tr>
<tr>
<td>17</td>
<td>VRING</td>
<td>Input for ringing signal protected by internal Zener diode</td>
</tr>
<tr>
<td>18</td>
<td>THA</td>
<td>Threshold adjustment for ringing frequency detector</td>
</tr>
<tr>
<td>19</td>
<td>RFDO</td>
<td>Output of ringing frequency detector</td>
</tr>
<tr>
<td>20</td>
<td>LIDET</td>
<td>Line detect; output is low when the line current is more than 15 mA</td>
</tr>
<tr>
<td>21</td>
<td>IMPSEL</td>
<td>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</td>
</tr>
<tr>
<td>22</td>
<td>TSACL</td>
<td>Time constant of anti-clipping of speaker amplifier</td>
</tr>
<tr>
<td>23</td>
<td>GSA</td>
<td>Current input for setting the gain of the speaker amplifier, adjustment characteristic is logarithmical, or RGSA &gt; 2 MΩ, the speaker amplifier is switched off</td>
</tr>
<tr>
<td>24</td>
<td>SA</td>
<td>Speaker amplifier input (for loudspeaker, tone ringer and hands-free use)</td>
</tr>
<tr>
<td>25</td>
<td>MUTX</td>
<td>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</td>
</tr>
<tr>
<td>26</td>
<td>ATAFS</td>
<td>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</td>
</tr>
<tr>
<td>27</td>
<td>INLDT</td>
<td>Input of transmit level detector</td>
</tr>
<tr>
<td>28</td>
<td>INLDR</td>
<td>Input of receive level detector</td>
</tr>
<tr>
<td>29</td>
<td>TLDT</td>
<td>Time constant of transmit level detector</td>
</tr>
</tbody>
</table>
Note: Filters against electromagnetic interference (EMI) are located at following pins: MIC1, MIC2, RECIN, TXIN, STIS, STIL and RAC.

3. 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 VMP S and VB . The value of the equivalent inductance is given by:

$$ L = R_{SEN} \times C_{IND} \times \left( \frac{R_{DC} \times R_{30}}{R_{DC} + R_{30}} \right) $$

In order to improve the supply during worst-case operating conditions, two PNP current sources - IBOPT and IOMP SP T - 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 3-2) shows how a priority for supply VM PS is achieved.

1. Normal operation
2. Mute for ear piece
3. Mute for RECIN signal

Condition of earpiece mute is stored.

36 RECO2 Inverting output of receiving amplifier
37 STIS 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 feedback path
40 RECO1 Output of receiving amplifier
41 GRA 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.

Table 2-1. Pin Description (Continued)
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

- $V_L = 10\Omega$
- $\text{SENSE}$
- $R_{\text{SENSE}} < 5\text{ mA}$
- $30\text{ k}\Omega$
- $6.3V$
- $3.3V$
- $470\text{ µF}$
- $3.3V$ / $2\text{ mA}$
- $7.0V$
- $=\text{IND}$
- $C_{\text{IND}}$
- $I_{\text{BOOST}}$
- $R_{30}$
- $V_{\text{OFFS}}$
- $R_{\text{DC}}$
- $I_{\text{MPS OPT}}$
- $V_{\text{MPS}}$
- $V_{\text{MP}}$
- $V_B$
- $47\text{ µF}$
- $220\text{ µF}$
- $10\text{ µF}$
- $V_{\text{SENSE}} - V_B > 200\text{ mV}$
- $V_{\text{SENSE}} - V_{\text{MPS}} > 200\text{ mV}$
- $V_B < 6.3V$
- Charge CB ($I_{\text{BOOST}}$)
- Charge CMPS ($I_{\text{MPS OPT}}$)
- $V_{\text{MPS}} < 6.3V$
- $I_{\text{BOOST}} = 0$
- Reduce $I_{\text{BOOST}}$ ($I_{\text{MPS OPT}} = 0$)

$Y$

$N$

$Y$

$N$

$Y$

$N$
The U 4090B-P contains two identical series regulators which provide a supply voltage VMP of 3.3V suitable for a microprocessor. In speech mode, both regulators are active because VMP and VB are charged simultaneously by the DC-line interface. Output current is 4 mA. The capacitor at VMP 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, VB is charged by the on-chip ringing power converter. In this mode only one regulator is used to supply VMP with a maximum of 2 mA.

3.1 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 3-3.
There are four major supply states:

1. **Speech condition**: 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 1.9V, 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 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. **Ringing**: During ringing, the supply for the system is fed into VB 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 VB. 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.

### 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 suppression 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 curve.

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
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 3-6. Receive and transmit signals are first processed by logarithmic rectifiers in order to produce the envelopes of the speech at TLDT and RLDT. After amplification, a decision is made by the differential pair which direction should be transmitted.

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

$$I_{AT} = I_{ATFS} - I_{ATGSA} - I_{AGAFS} \Delta$$

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

Figure 3-7 on page 12 illustrates the principle relationship between speaker amplifier gain ($G_{SA}$) and attenuation of AFS ($A_{AFS}$). Both parameters can be adjusted independently, but the internal coupling between them has to be considered. The maximum usable value of $G_{SA}$ is 36 dB.

The shape of the characteristic is moved in the $x$-direction by adjusting resistor $R_{ATFS}$, thus changing $A_{AFS}$. The actual value of attenuation ($A_{AFS}$), however, can be determined by reading the value which belongs to the actual gain $G_{SA}$. 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 $G_{SA} \leq G_{SAG0} = 36 \text{ dB} - A_{AFSm}$.

$I_{ATSA}$ 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

AGA TLDT RLDT INLDT RLDR

SAITXA IGSA IATGSA IAGAFS AGA GSA ATAFS RATAFS TLDR TX RX IAT IATAFS
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 \( I_{LO}=I_{OFF} \) 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 3-3 on page 8). As long as \( I_L \) is above typically 1.6 mA, output LIDET is low. This comparator does not use 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 $V_B$ (low voltage/high current) which is capable of driving the low-ohmic loudspeaker. Input impedance at $VRING$ is fixed at $5\,\Omega$ and the efficiency of the step-down converter is approximate 65%.

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 $VRING$ is transformed into a current via $R_{THA}$. The thresholds are $8\,\mu A$ and $24\,\mu A$. $RFDO$ and $VRING$ are in phase. A second comparator with hysteresis is used to enable the output $RFDO$ as long as the supply voltage for the microprocessor $V_{MP}$ is above 2.0V.
4. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line current</td>
<td>I_L</td>
<td>140</td>
<td>mA</td>
</tr>
<tr>
<td>DC line voltage</td>
<td>V_L</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>Maximum input current, pin 17</td>
<td>I_RING</td>
<td>15</td>
<td>mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
<td>125</td>
<td>°C</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>T_amb</td>
<td>–25 to +75</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_stg</td>
<td>–55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Total power dissipation, Tamb = 60°C</td>
<td>P_tot</td>
<td>0.9</td>
<td>W</td>
</tr>
</tbody>
</table>

5. Thermal Resistance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction ambient</td>
<td>SSO44</td>
<td>70</td>
<td>K/W</td>
</tr>
</tbody>
</table>

6. Electrical Characteristics

f = 1 kHz, 0 dBm = 775 mVrms, IM = 0.3 mA, IMP = 2 mA, RDC = 130 kΩ, Tam b = 25°C, RGSA = 560 kΩ, Zear = 68 nF + 100 Ω, ZM = 68 nF, pin 31 open, VIMPSEL = GND, VMUTX = GND, VMUTR = GND, unless otherwise specified.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC voltage drop over circuit</td>
<td>IL = 2 mA</td>
<td>VL</td>
<td>4.6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>IL = 14 mA</td>
<td></td>
<td></td>
<td></td>
<td>8.8</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>IL = 60 mA</td>
<td></td>
<td>2.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>IL = 100 mA</td>
<td></td>
<td>5.0</td>
<td></td>
<td>7.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.4</td>
<td></td>
<td>10.0</td>
<td>V</td>
</tr>
</tbody>
</table>

Transmission Amplifier, IL = 14 mA, VMIC = 2 mV, RGT = 27 kΩ, Unless Otherwise Specified

- Range of transmit gain | G_T | 40 45 50 dB
- Transmitting amplification | RGT | 47 39.8 48 49 41.8 dB
- Frequency response | f ≥ 14 mA | 300 to 3400 Hz | ΔGT ±0.5 dB
- Gain change with current | Pin 31 open | IL = 14 to 100 mA | ΔGT ±0.5 dB
- Gain deviation | T am b = –10 to +60 °C | ΔGT ±0.5 dB
- CMRR of microphone amplifier | CMRR | 60 80 dB
- Input resistance of MIC amplifier | RGT | 45 50 75 110 kΩ
- Distortion at line | IL > 14 mA | VL = 700 mVrms | dt 2%
- Maximum output voltage | IL > 19 mA, d < 5% | VMIC = 25 mV, CTXA = 1 µF | VMICOmax 1.8 3 4.2 dBm IMPSEL = open | RGT = 12 kΩ | VMICOmax –5.2 dBm
Noise at line psophometrically weighted

IL > 14 mA
GT = 48 dB
–80 –72 dBmp

Anti-clipping attack time

CTXA = 1 µF
each 3 dB overdrive
0.5
9 ms

Gain at low operating current

IL = 10 mA
IMP = 1 mA
RDC = 68 kΩ
VMIC  = 1 mV
IM = 300 µA
GT 40 42.5 dB

Distortion at low operating current

IL = 10 mA
IM = 300 µA
IMP = 1 mA
RDC = 68 kΩ
VMIC  = 10 mV
dt 5%

Line loss compensation

IL = 100 mA
RAGA = 20 kΩ
Δ
GTI –6.4 –5.8 –5.2 dB

Mute suppression

a) MIC muted
(microphone preamplifier)
b) TXA muted (second stage)
IL ≥ 14 mA
MUTX = open
GTM 60 80 dB
IMPSEL = open
G TTX 60 dB

Receiving Amplifier, IL = 14 mA, RGR  = 62 kΩ

Adjustment range of receiving gain

IL ≥ 14 mA, single ended
differential
MUTR = GND
GR
–8
–2
+2
+8 dB

Receiving amplification

RGR = 62 kΩ
differential
RGR = 22 kΩ
differential
GR
–1.75 –1
0 7.5
–0.25 dB

Amplification of DTMF signal from
DTMF IN to RECO 1, 2

IL ≥ 14 mA
VMUTX  = VMP
GRM 71 0 1 3 dB

Frequency response

IL > 14 mA, f = 300 to 3400 Hz
Δ
GRF ±0.5 dB

Gain change with current

IL = 14 to 100 mA
Δ
GR ±0.5 dB

Gain deviation

Tam b = –10 to +60°C
Δ
GR ±0.5 dB

Ear-protection differential

IL ≥ 14 mA, VGEN  = 11 Vrms
EP 2.2 V rms

MUTE suppression

a) RECATT
b) RA2
c) DTMF operation
IL ≥ 14 mA
MUTR = open
VMUTR = VMP
VMUTX  = VMP
Δ
GR 60 dB

Output voltage

d ≤ 2% differential
IL = 14 mA, Zaer = 68 nF + 100 Ω
0.775 V rms

Maximum output current

d ≤ 2% Zaer = 100 Ω
4 mA (peak)

Receiving noise psophometrically weighted

Zaer = 68 nF + 100 Ω
IL ≥ 14 mA
ni –80 –77 dBmp

Output resistance

Each output against GND
R o 10 Ω

Line loss compensation

R AGA = 20 kΩ, IL = 100 mA
Δ
GRI –7.0 –6.0 –5.0 dB

6. Electrical Characteristics (Continued)
f = 1 kHz, 0 dBm = 775 mVrms, IM = 0.3 mA, IMP  = 2 mA, RDC = 130 kΩ, Tam b = 25°C, RGSA = 560 kΩ, Zaer = 68 nF + 100 Ω, ZM  = 68 nF , pin 31 open, VIMPSEL  = GND, VMUTX  = GND, VMUTR  = GND, unless otherwise specified.

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<th>Parameters</th>
<th>Test Conditions</th>
<th>Symbol</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Gain at low operating current

IL = 10 mA  
IMP = 1 mA  
IM = 300 µA  
VGEN = 560 mV  
RDC = 68 kΩ

AC impedance VIMPSE L = GND

VIMPSE L = VMP

Z_{imp} = 570, 840, 600, 900, 640, 960 Ω

Distortion at low operating current

IL = 10 mA  
IMP = 1 mA  
VGEN = 560 mV  
RDC = 68 kΩ

dR = 5 %

Speaker Amplifier

Minimum line current for operation No AC signal I_{Lmin} = 15 mA

Input resistance P_{in} = 24, 14, 22 kΩ

Gain from SAI to SAO

V_{SAI} = 3 mV  
IL = 15 mA  
R_{GS_A} = 560 kΩ  
R_{GS_A} = 20 kΩ

G_{SA} = 35.5, 36.5, –3, 37.5 dB

Output power

Load resistance R_{L} = 50 Ω, d < 5%

V_{SAI} = 20 mV  
IL = 15 mA  
IL = 20 mA

P_{SA} = 37, 20 mW

Output noise (Input SAI open)

psophometrically weighted I_{L} > 15 mA

n_{SA} = 200 µV

Gain deviation I_{L} = 15 mA, T_{amb} = –10 to +60 °C

ΔG_{SA} = ±1 dB

Mute suppression

IL = 15 mA  
VL = 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

R_{GA} = 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 t_{r} = 5 ms

Release time of anti-clipping t_{f} = 80 ms

DTMF Amplifier Test Conditions: IMP = 2 mA, IM = 0.3 mA, VMU TX = VMP

Adjustment range of DTMF gain I_{L} = 15 mA mute active G_{D} = 40, 50 dB

DTMF amplification

IL = 15 mA  
V_{DTMF} = 8 mV  
Mute active: MUTX = VMP

G_{D} = 40.7, 41.7, 42.7 dB

Gain deviation I_{L} = 15 mA, T_{amb} = –10 to +60°C

ΔG_{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

VL = 0 dBm  
d_{D} = 2%

Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 mVrms, IM = 0.3 mA, IMP = 2 mA, R_{DC} = 130 kΩ, T_{amb} = 25°C, R_{GA} = 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.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Gain deviation with current $I_L = 15$ to $100$ mA

$\Delta GD = 0.5$ dB

AFS Acoustic Feedback Suppression

Adjustment range of attenuation $I_L$:

$\geq 15$ mA

25 dB

Attenuation of transmit gain

$I_L \geq 15$ mA

$I_{IN LD}$:

- $T = 0$ $\mu$A
- $R_{AT FS} = 30$ $\Omega$
- $R_{AT P} = 10$ $\mu$A

$\Delta GT = 45$ dB

Attenuation of speaker amplifier

$I_L \geq 15$ mA

$I_{IN LD}$:

- $P = 0$ $\mu$A
- $R_{AT FS} = 30$ $\Omega$
- $R_{AT P} = 10$ $\mu$A

$\Delta GSA = 50$ dB

AFS disable $I_L$

$\geq 15$ mA

$V_{AT AF S} = 1.5$ V

Supply Voltages, $V_{MIC} = 25$ mV, $T_{amb} = –10$ to $+60$°C

$V_{MP}$:

- $I_L = 14$ mA
- $R_{DC} = 68$ $k\Omega$
- $I_{MP} = 2$ $mA$
- $V_{MP} = 3.1$ to $3.3$ V
- $I_{MP} = 2$ $mA$
- $V_{MP} = 6.7$ V

$V_{IL} \geq 14$ mA

$I_M = 700$ $\mu$A

$R_{DC} = 130$ $k\Omega$

$V_{M} = 1.3$ to $3.3$ V

$V_B$:

- $I_L = 20$ $mA$
- $V_B = 77.6$ V

Ringing Power Converter

$I_{RING} = 1$ $mA$, $I_M = 0$ $mA$

$V_{RING} = 20.6$ V

$P_{SA} = 20$ mW

Threshold of ring frequency detector $RFDO$: low to high

$V_{HYST} = V_{RING ON} – V_{RING OFF}$

$V_{RING ON} = 17.5$ V

$V_{HYST} = 11.0$ V

Input impedance $V_{RING} = 30$ V

$R_{RING} = 456$ $k\Omega$

Input impedance in speech mode

- $f = 300$ Hz to $3400$ Hz
- $I_L > 15$ mA
- $V_{RING} = 20$ V + $1.5$ Vrms

$R_{RING SP} = 150$ $k\Omega$

Logic level of frequency detector

$V_{RING} = 0$ V

$V_B = 4$ V

$V_{RING} = 25$ V

$V_{RFDO}$

$V_{MP}$

Ring detector enable

$V_{RING} = 25$ V, $RFDO$ high

$V_{MP ON} = 1.8$ to $2.0$ to $2.2$ V

Zener diode voltage

$V_{RING max} = 30.8$ to $33.3$ V

MUTR input

- $VMUTR = GND$, $I_L > 14$ mA
- $VMUTR = V_{MP}$, $I_L > 14$ mA

$IMUTE = -20$ to $+10$ to $-30$ $\mu$A

MUTR input voltage

- Mute low; $I_L > 14$ mA $V_{MUTE} = 0.3$ V
- Mute high; $I_L > 14$ mA $V_{MUTE} = V_{MP} – 0.3$ V

6. Electrical Characteristics (Continued)

$f = 1$ kHz, $0$ dBm = 775 mVrms, $I_M = 0.3$ $mA$, $I_{MP} = 2$ $mA$, $R_{DC} = 130$ $k\Omega$, $T_{amb} = 25$°C, $R_{GSA} = 560$ $k\Omega$, $Z_{ear} = 68$ $nF + 100$ $\Omega$, $Z_M = 68$ $nF$, pin 31 open, $V_{IMPSEL} = GND$, $VMUTX = GND$, $VMUTR = GND$, unless otherwise specified.
184741D–CORD–01/10

U4090B-P

PD Input

PD input current PD active, $I_{PD} > 14 \text{ mA}$

$V_{PD} = V_{MP}$

$V_{PD} = 9 \mu A$

Input voltage PD = active

$V_{PD}$

$V_{PD} = 0.3 \text{ V}$

Voltage drop at $V_L$

$IL = 14 \text{ mA}$, PD = active

$V_L = 1.5 \text{ V}$

$IL = 100 \text{ mA}$, PD = active

$V_L = 1.9 \text{ V}$

Input Characteristics of IMPSEL

Input current $I_{IMPSEL}$

$\geq 14 \text{ mA}$

$V_{IMPSEL} = V_{MP}$

$V_{IMPSEL} = GND$

$I_{IMPSEL} = 18 \text{ } - 18 \mu A$

Input voltage Input high $V_{IMPSEL}$

$V_{MP} - 0.3 \text{ V}$

Input low $V_{IMPSEL}$

$0.3 \text{ V}$

MUTX Input

Input current $V_{MUTX}$

$= V_{MP}$

$V_{MUTX}$

$= GND$

$I_{MUTX} = 20 \text{ } - 20 \text{ } - 30 \mu A$

Input voltage Input high $V_{MUTX}$

$V_{MP} - 0.3 \text{ V}$

Input low $V_{MUTX}$

$0.3 \text{ V}$

Line Detection

Line current for LIDET active PD = inactive

$IL_{ON} = 12.6 \text{ mA}$

Line current for LIDET inactive PD = inactive

$IL_{OFF} = 11.0 \text{ mA}$

Current threshold during power down $VB = 5 \text{ V}$, PD = active

$IL_{ONPD} = 0.8 \text{ } - 1.6 \text{ } - 2.4 \text{ mA}$

6. Electrical Characteristics (Continued)

$f = 1 \text{ kHz}$, $0 \text{ dBm} = 775 \text{ mV}_{\text{rms}}$, $IM = 0.3 \text{ mA}$, $IMP = 2 \text{ mA}$, $R_{DC} = 130 \text{ k}\Omega$

$T_{amb} = 25^\circ \text{C}$, $RGSA = 560 \text{ k}\Omega$

$Z_{ear} = 68 \text{ nF} + 100 \Omega$

$Z_{M} = 68 \text{ nF}$, pin 31 open, $V_{IMPSEL} = GND$, $V_{MUTX} = GND$, $V_{MUTR} = GND$, unless otherwise specified.
### Table 7-1. Selection of TX Mute and Line Impedance

<table>
<thead>
<tr>
<th>Logic Level</th>
<th>IMPSEL MODE</th>
<th>TXA</th>
<th>ES</th>
<th>Line Impedance</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>on</td>
<td>off</td>
<td>600 Ω</td>
<td>TXA = on, ES = off, Speech</td>
</tr>
<tr>
<td>0</td>
<td>0 to Z</td>
<td>off</td>
<td>on</td>
<td>600 Ω</td>
<td>TXA = off, ES = on, Transmit-mute</td>
</tr>
<tr>
<td>1</td>
<td>1 to Z</td>
<td>off</td>
<td>on</td>
<td>900 Ω</td>
<td>TXA = off, ES = on, Transmit-mute</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>on</td>
<td>off</td>
<td>900 Ω</td>
<td>TXA = on, ES = off, Speech</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Logic Level</th>
<th>MUTR MODE</th>
<th>RA2</th>
<th>RECATT</th>
<th>STIS</th>
<th>STIL</th>
<th>AGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>on</td>
<td>on</td>
<td>on</td>
<td>off</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>to Z</td>
<td>off</td>
<td>off</td>
<td>on</td>
<td>off</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>off</td>
<td>off</td>
<td>on</td>
<td>off</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>AGA = off</td>
<td>on</td>
<td></td>
<td>Speech + earpiece mute</td>
</tr>
</tbody>
</table>

### Table 7-3. Selection of Transmit Mute

<table>
<thead>
<tr>
<th>Logic Level</th>
<th>MUTX MODE</th>
<th>MIC 1/2</th>
<th>AFS</th>
<th>AGA</th>
<th>TXACL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>transmit enabled</td>
<td>receive enabled</td>
<td>AFS = on</td>
<td>AGA = on</td>
</tr>
<tr>
<td>0</td>
<td>Z</td>
<td>DTMF transmit enabled</td>
<td>DTMF to receive enable</td>
<td>AFS = on</td>
<td>AGA = on</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>DTMF transmit enabled</td>
<td>DTMF to receive enable</td>
<td>AFS = off</td>
<td>AGA = off</td>
</tr>
</tbody>
</table>

For answering machine
8. 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 8-1. Typical DC Characteristic

Figure 8-2. Typical Adjustment Range of Transmit Gain

Table 7-4. Specification of Logic Levels

<table>
<thead>
<tr>
<th>Logic Level</th>
<th>0 = (0.3V)</th>
<th>Z = (&gt; (1V) &lt; (VMP – 1V) or (open input))</th>
<th>1 = (&gt; (VMP – 0.3V))</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL (mA)</td>
<td>0 2 4 6 8 10 12</td>
<td>RDC = 68k</td>
<td>RDC = 130k</td>
</tr>
<tr>
<td>VL (V)</td>
<td>0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 0 1 0 0</td>
<td>35 37 39 41 43 45 47 49 51</td>
<td>0 5 10 15 20 25 30 35 40</td>
</tr>
</tbody>
</table>
Figure 8-3. Typical Adjustment Range of Receive Gain (Differential Output)

Figure 8-4. Typical AGA Characteristic

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

-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10

RGR (kΩ)

GR (dB)

-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10

IL (mA)

AGA (dB)

RAGA = 24kΩ
RAGA = 20kΩ
RAGA = 16kΩ

0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10

IB (mA)

VB (V)

IL = 30 mA
IL = 20 mA
IL = 15 mA

RDC = Infinity; VI = 200 mV/1 kHz; PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560kΩ
Figure 8-6. Typical Load Characteristic of VB for a Medium DC-characteristic (RDC = 130 kΩ) and 3-mW Loudspeaker Output

Figure 8-7. Typical Load Characteristic of VB for a Minimum DC-characteristic (RDC = 68 kΩ) and 3-mW Loudspeaker Output

IL = 30 mA
IL = 20 mA
IL = 15 mA
RDC = 130 k; VI = 200 mV/1 kHz; PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560k

IL = 20 mA
IL = 15 mA
RDC = 68 k, VI = 200 mV, PSAO = 3 mW; IMP = 2 mA; IM = 300 µA; RGSA = 560k
Figure 8-8. Basic Test Circuit

Reference figure for not connected pins

S1 = closed: speech mode
S2 = closed: ringer mode
Figure 8-9. Test Circuit for DC Characteristics and Line Detection

- **Mico**
- **IM**
- **V**: 220 nF, 150 nF
- **RGR**: 100 µF, RAGA: 30 kΩ
- **RGT**: 68 nF
- **RDC**: 4.7 nF
- **10 VB**: S1
- **b** open
- **1000 µF**: 1 mF
- **V**: RGSA
- **Line detection**: S1a, VB (external supply): S1b
- **Open pins should be connected as shown in Figure 8-14**

- **ZEAR**: 62 kΩ
- **10 µF**: VM
- **VL**: 1 µF, VMIC, VMP: 10 µF
- **IL**: VL
- **IB**: 220 µF, 47 µF
- **IMP**
Figure 8-10.

Test Circuit for Transmission Amplifier

Input resistance: Ri = 50 kΩ (S2 = closed)

Transmitting amplification GT = 20 \times \log\left(\frac{V_{L}}{V_{mic}}\right)

Line loss compensation: ΔGTI = GT (at IL = 100 mA) - GT (at IL = 14 mA), S3 = closed

Gain change with current: ΔGTI = GT (at IL = 100 mA) - GT (at IL = 14 mA)

Common mode rejection ratio: CMRR = 20 \log\left(\frac{V_{CM}}{V_{L}}\right)

Mute suppression: GTM = 20 \times \log\left(\frac{V_{L} (at MUTX = low)}{V_{L} (at MUTX = open)}\right)

GTTX = 20 \times \log\left(\frac{V_{L} (at IMPSEL = low)}{V_{L} (at IMPSEL = open)}\right)

Open pins should be connected as shown in Figure 8-14.
Figure 8-11. Test Circuit for Receiving Amplifier

- \( Mico \)
- \( V \)
- \( 220 \text{ nF} \)
- \( 150 \text{ nF} \)
- \( RGR \)
- \( 100 \text{ µF} \)
- \( 62 \text{ k} \)
- \( RAGA \)
- \( 68 \text{ nF} \)
- \( RGT \)
- \( 1 \text{ µF} \)
- \( \text{open} \)
- \( \text{open} \)
- \( 220 \text{ nF} \)
- \( V \)
- \( S2 \)
- \( 4.7 \text{ nF} \)
- \( V \text{ MP} \)
- \( \text{AC} \)
- \( \text{Line loss compensation: } \Delta GRI = GR (\text{at } IL = 100 \text{ mA}) - GR (\text{at } IL = 14 \text{ mA}), S3 = \text{closed} \)
- \( \text{Receive amplification: } GR = 20 \times \log (\text{VZEAR}/\text{VLR}) \text{ dB} (S1 = b, S2 = \text{open}) \)
- \( \text{DTMF-control signal: } GRM = 20 \times \log (\text{VZEAR}/\text{VDTMF}) \text{ dB} (S1 = a, S2 = \text{closed}) \)
- \( \text{AC-impedance: } (\text{VLR}/(\text{VGEN} - \text{VLR})) \times ZL \)
- \( \text{Mute suppression:} \)
  - a) RECATT: \( \Delta GR = 20 \times \log (\text{VLR}/\text{VZEAR}) \text{ dB} + GR, \text{ MUTR} = \text{open} \)
  - b) RA2: \( \Delta GR = 20 \times \log (\text{VLR}/\text{VZEAR}) \text{ dB} + GR, \text{ MUTR} = \text{VMP} \)
  - c) DTMF operation: \( \Delta GR = 20 \times \log (\text{VLR}/\text{VZEAR}) \text{ dB} + GR, \text{ MUTX} = \text{VMP} \)
- \( \text{Open pins should be connected as shown in Figure 8-14} \)
Figure 8-12.
Test Circuit for Speaker Amplifier

U4090B-P

Mico

V MIC

220 nF

150 nF

RGR

RGSA

68 nF

RDC

30 k

Ω

RGT

S4

V AFS

20

k

Ω

V

220 nF

V

S1

10 µF

ZEAR

V

SAI

S4 = closed

VZA

SAO = open

nSA

Input impedance: \( \frac{V_{ZIN}}{V_{SAO} - V_{ZIN}} \times R_{IN} \)

Gain from SAI to SAO: \( 20 \times \log \left( \frac{V_{SAO}}{V_{SAI}} \right) \) dB

Output power: \( P_{SA} = V_{SAO}^2 \)

Attenuation of transmit gain: S1 = closed

Open pins should be connected as shown in Figure 8-14

IINL

DIINL

10 µF

62 k

Ω

1 µF

V M

1 µF

V LE

IMP

47 µF

220 µF

22 µF

50

Ω

600

Ω

10

Ω

IL

10 µF

V L

IMP
Figure 8-13. Test Circuit for DTMF Amplifier

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mica V L</td>
<td>220 nF</td>
</tr>
<tr>
<td>R GR</td>
<td>100 µF</td>
</tr>
<tr>
<td>R GT</td>
<td>68 nF</td>
</tr>
<tr>
<td>R DC</td>
<td>1 µF</td>
</tr>
<tr>
<td>Z EAR</td>
<td>10 µF</td>
</tr>
<tr>
<td>V M</td>
<td>10 µF</td>
</tr>
<tr>
<td>V GEN3</td>
<td>1000 µF</td>
</tr>
<tr>
<td>V S3</td>
<td>4.7 nF</td>
</tr>
</tbody>
</table>

DTMF-amplifier: 20log (VL/VDTMF) dB
Input resistance: (VL50K/(VL - VL50k)) x 50 kΩ
Open pins should be connected as shown in Figure 8-14
VL: S3 = closed
VL 50 kΩ: S3 = open

220 µF 1000 µF 47 µF

IMP
Figure 8-14. Test Circuit for Ringing Power Converter

4) Input impedance in speech mode (IL > 15 mA):

1) Max. output power:

3) Input impedance:

2) Threshold of ringing frequency detector: detecting VRFDO, when driving VRING from 2V to 22V (VRINGON) and back again (VRINGOFF) (S2 = closed)

5) Ring detector enable: detecting VRFDO, when driving VMP from 0.7V to 3.3V (VMPON) and back again (VMPOFF) (S5, S3 = closed)

Open pins should be connected as shown in Figure 8-14.
Open pins should be connected as shown in Figure 8-14.
Figure 8-16. Application Circuit for Loud-hearing to ST

- Microphone
- DTMF Generator
- Microcontroller
- Earphone

Components:
- U4090B-P
- Tip
- Ring
- Hook switch
- Earpeace

Resistors:
- R1, R2, R3, R4, R5
- R6, R7
- R8, R9, R10, R11, R12
- R13, R14, R15
- R16, R17, R18
- R19

Capacitors:
- C1, C2, C3, C4
- C5, C6, C7
- C8
- C9
- C10
- C11
- C12, C13
- C14, C15
- C16
- C17
- C18
- C19
- C20, C21
- C22

Inductors:
- L1

Other Components:
- STN 2 (Option)
- ST
Figure 8-17. Application for Hands-free Operation to ST

- Microphone
- DTMF
- RECO
- LOGTX
- Loudspeaker
- Earpiece
- HF-Mic
- Tip
- Ring
- BC177
- STN 2 (Option)
- VM
- Microcontroller
- U4090B-P
- Tip
- Ring
- VM
- C1
- R1
- R11
- C5
- R5
- R6
- C6
- R4
- C7
- R9
- R10
- C8
- R3
- C9
- R2
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Name</th>
<th>Value</th>
<th>Name</th>
<th>Value</th>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>100 nF</td>
<td>C16</td>
<td>47 µF</td>
<td>R3</td>
<td>&gt; 68 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R18</td>
<td>30 kΩ</td>
<td>C17</td>
<td>10 µF</td>
<td>R4</td>
<td>10 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>4.7 nF</td>
<td>C18</td>
<td>10 µF</td>
<td>R5</td>
<td>1.5 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R19</td>
<td>6.8 kΩ</td>
<td>C19</td>
<td>68 nF</td>
<td>R6</td>
<td>62 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>10 µF</td>
<td>C20</td>
<td>68 nF</td>
<td>R7</td>
<td>680 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R20</td>
<td>6.8 kΩ</td>
<td>C21</td>
<td>1 µF</td>
<td>R8</td>
<td>22 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>220 µF</td>
<td>C22</td>
<td>100 nF</td>
<td>R9</td>
<td>330 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R21</td>
<td>15 kΩ</td>
<td>C23</td>
<td>6.8 nF</td>
<td>R10</td>
<td>3 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>47 µF</td>
<td>C24</td>
<td>10 nF</td>
<td>R11</td>
<td>62 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R22</td>
<td>330 kΩ</td>
<td>C25</td>
<td>100 nF</td>
<td>R12</td>
<td>30 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>470 µF</td>
<td>C26</td>
<td>470 nF</td>
<td>R13</td>
<td>62 kΩ</td>
<td></td>
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10. Package Information

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9. Ordering Information

Technical drawings according to DIN specifications

Package SSO44

Dimensions in mm

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