# Speech Circuit with Line-Powered Loudspeaker Amplifier

## Description

The electronic speech circuit U4050B is a linear integrated circuit for use in telephone sets. It replaces the hybrid transformer, side tone 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 loudspeaker amplifier allows loudhearing operation.

## Features

- Integrated amplifier for loudhearing operation
- Anticlipping for loudspeaker amplifier
- Supply voltages for all functional blocks of a subscriber set
- Adjustable dc characteristics
- Adjustable sending and receiving amplification
- Automatic line loss compensation
- Symmetrical output of earpiece amplifier
- Built in ear protection
- Symmetrical input of microphone amplifier
- Adjustable side tone suppression independent of sending and receiving amplification
- DTMF and MUTE inputs
- Anticlipping in transmit direction
- Squelch
- Integrated transistor for short circuiting the line voltage
- Power down
- Operation possible at line currents above 10 mA

## Benefits

- Independent adjustment of transmit gain, receive gain and side tone suppression
- Low number of external components



Preliminary Information

## Block Diagram / Application Circuit

With a squelch function, acoustical feedback during loudhearing can be reduced significantly. The generated supply voltage is suitable for a wide range of peripheral circuits.

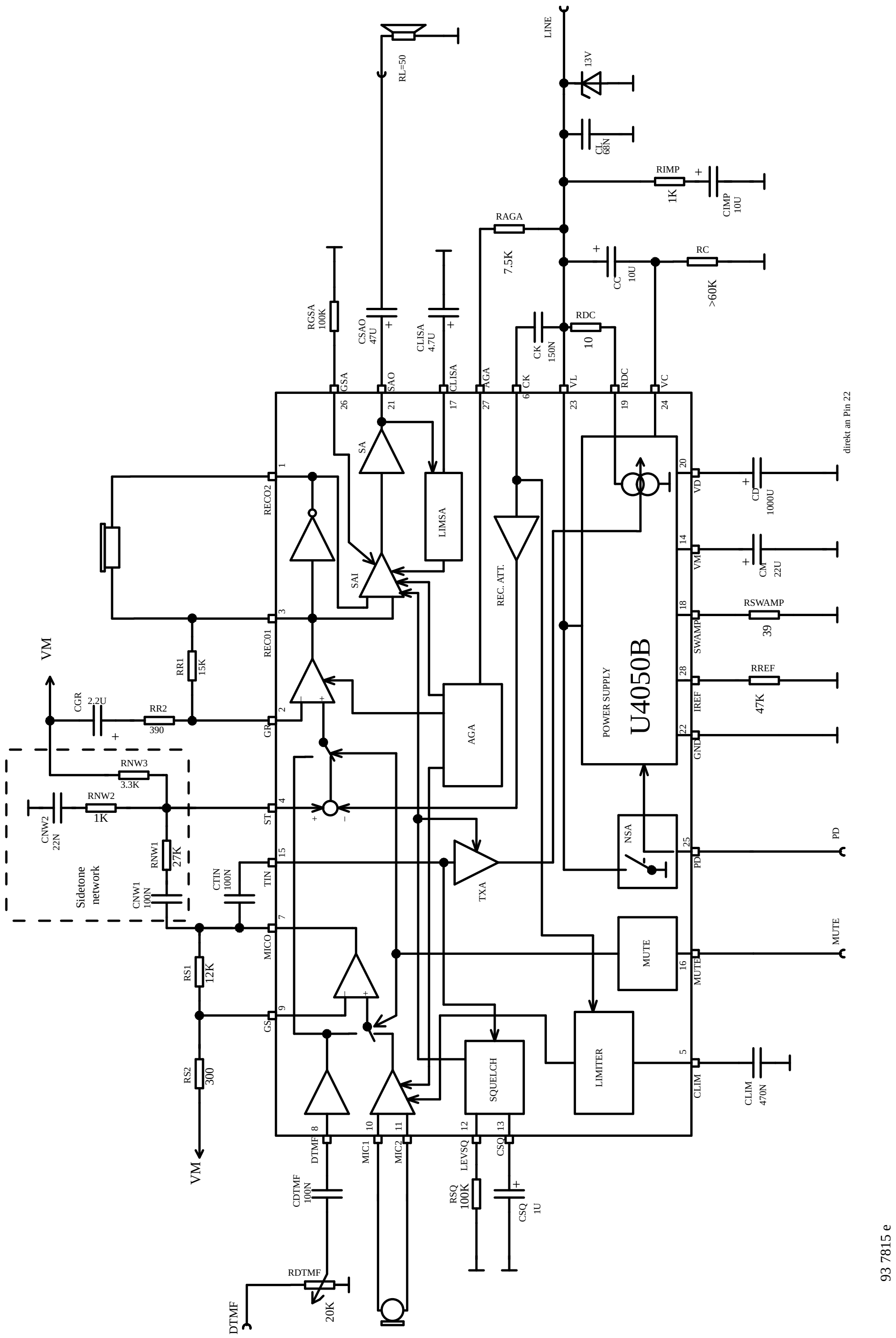



Figure 1. Typical application diagram

## Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1, 3 | $R_{ECO}$ 2, $R_{ECO}$ 1 | Symmetrical outputs of receiving amplifier |
| 1, 3 | $R_{ECO}$ 2, $R_{ECO}$ 1 | Symmetrical outputs of receiving amplifier |
| 2 | $G_R$ | A resistor connected from this pin to $V_M$ (ac coupled) sets the receiving amplification at the circuit |
| 4 | ST | Input of side tone amplifier |
| 5 | CLIM | Time constant of anticlipping in transmit patch |
| 6 | CK | Input of receiving path |
| 7 | MICO | Output of microphone preamplifier |
| 8 | DTMF | Input for DTMF signals (ac coupled). In Mute condition a small portion of the signal at this pin is monitored to the receiver output. |
| 9 | $G_S$ | A resistor from this pin to $V_M$ sets the amplification of microphone and DTMF signals. |
| 10 | MIC $_1$ | Inverting input of microphone amplifier |
| 11 | MIC $_2$ | Non-inverting input of microphone amplifier |
| 12 | LEVSQ | Input for setting the switching level of the squelch circuit |
| 13 | $C_{SQ}$ | Time constant of the squelch function |
| 14 | $V_M$ | Reference node for microphone, earphone and loudspeaker amplifier. Supply for electret microphone set to $V_D$/2. |
| 15 | TIN | Input of intermediate transmit stage |
| 16 | MUTE | Active high input to switch the circuit into DTMF condition. |
| 17 | CLISA | Time constant of anticlipping of speaker amplifier. |

| Pin | Symbol | Function |
|---|---|---|
| 18 | SWAMP | A resistor connected from this pin to ground converts the excess line current into heat in order to prevent the IC from thermal destruction at high line currents |
| 19 | $R_{DC}$ | A small resistor connected from this pin to $V_L$ sets the slope of the characteristic and also affects the line length equalization characteristics and the line current at which the loudspeaker amplifier is switched on. |
| 20 | $V_D$ | Unregulated supply voltage for peripheral circuits (dialers, microprocessors, etc.). Output current capability and output voltage increase with line current. |
| 21 | $S_{AO}$ | Output of loudspeaker amplifier. |
| 22 | GND | Reference point for dc and ac output signals |
| 23 | $V_L$ | Line voltage |
| 24 | $V_C$ | 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 line voltage. |
| 25 | PD | Active high input for reducing the current consumption of the circuit. Simultaneously $V_L$ is shorted by an internal switch. |
| 26 | $G_{SA}$ | Current input for setting the gain of the speaker amplifier |
| 27 | AGA | Automatic gain adjustment with line current. A resistor connected from this pin to $V_L$ sets the starting point. Maximum gain change is 6 dB. |
| 28 | IREF | Internal reference current generation |

## Absolute Maximum Ratings

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Line current | $I_L$ | 140 | mA |
| Line voltage | $V_L$ | 15 | V |
| Junction temperature | $T_j$ | 150 | °C |
| Ambient temperature | $T_{amb}$ | –25 to +75 | °C |
| Storage temperature | $T_{stg}$ | –55 to +150 | °C |
| Total power dissipation<br>$T_{amb}$ = 60°C<br>SO28 | $P_{tot}$ | 750 | mW |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Junction ambient<br>SO28 | $R_{thJA}$ | 120 | K/W |

## Electrical Characteristics

Test conditions unless otherwise specified: f = 1 kHz, 0 dBm = 775 Vrms, $I_M$ = 0.3 mA, $I_D$ = 2 mA, RC = 130 kΩ, $T_{amb}$ = 25°C, $R_{GSA}$ = 560 kΩ, $Z_H$ = $Z_M$ = 68 nF, Pin AGA open

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | **see figure 1** | | | | | |
| DC voltage drop over circuit | $I_L$ = 2 mA | $V_L$ | | 1.9 | | V |
| | $I_L$ = 15 mA | $V_L$ | 4.8 | 5.2 | 5.6 | V |
| | $I_L$ = 19 mA | $V_L$ | | 5.4 | | V |
| | $I_L$ = 30 mA | $V_L$ | | 6.0 | | V |
| | $I_L$ = 100 mA | $V_L$ | | 9.5 | | V |
| **Transmission amplifier** | **see figure 2 and 8** | | | | | |
| Adjustment range of transmit gain | $I_L$ = 15 mA | $G_S$ | 40 | 48 | 56 | dB |
| Transmitting amplification | $I_L$ = 15 mA | $G_S$ | 47.75 | 48.25 | 48.75 | dB |
| Frequency response | $I_L$ ≥ 15 A, $C_L$ = 4.7 nF<br>f = 300 to 3400 Hz | $\Delta G_S$ | | | ± 0.5 | dB |
| Gain change with current | Pin AGA open<br>$I_L$ = 15 to 100 mA | $\Delta G_S$ | | | ± 0.5 | dB |
| Gain deviation | $T_{amb}$ = –10 to +60°C<br>$I_L$ = 15 mA | $\Delta G_S$ | | | ± 0.5 | dB |
| CMRR of microphone amplifier | | CMRR | 60 | 80 | | dB |
| Input resistance of MIC amplifier | | $R_i$ | 45 | 60 | 80 | kΩ |
| Distortion at line | $I_L$ > 15 mA<br>$V_L$ = 775 mVrms | $d_s$ | | | 2 | % |
| Maximum output voltage | $I_L$ > 19 mA d < 5 %<br>$V_{mic}$ = 10 m | $V_{1max}$ | 1.8 | 3 | 4.2 | dBm |
| Noise at line psophometrically weighted | $I_L$ > 15 mA<br>$G_S$ = 48 dB | $n_o$ | | –80 | –72 | dBmp |

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Anticlipping attack time | $V_{mic}$ = 20 mV<br>C = 470 nF | | | 0.5 | | ms |
| Release time | each 3 dB overdrive | | | 9 | | ms |
| Gain at low operating current | $I_L$ = 10 mA, $I_D$ = 1 mA<br>RC = 68 kΩ<br>$V_{mic}$ = 1 mV $I_M$ = 0 mA | $G_S$ | 47 | | 50 | dB |
| Distortion at low operating current | $I_L$ = 10 mA, $I_M$ = 0 mA<br>$I_D$ = 1 mA, RC = 68 kΩ<br>$V_{mic}$ = 10 mV | ds | | | 6 | % |
| Line loss compensation | $I_L$ = 100 mA<br>$R_{AGA}$ = 7.5 kΩ | $\Delta G_{SI}$ | –5 | –6 | –7 | dB |
| Mute suppression | $I_L \geq$ 15 mA<br>$V_{mute}$ = 1.5 V | $G_{SM}$ | 60 | | | dB |
| **Receiving amplifier** | **see figure 3 and 5** | | | | | |
| Adjustment range of receiving gain | $I_L \geq$ 15 mA<br>differential | $G_R$ | –8 | | +8 | dB |
| Receiving amplification | $I_L$ = 15 mA<br>differential | $G_R$ | –1 | –0.5 | 0 | dB |
| Amplification of DTMF signal from DTMF IN to RECO 1/2 | $I_F \geq$ 15 mA<br><br>Mute active | $G_{RM}$ | –15 | –12 | –9 | dB |
| Frequency response | $I_L$ > 15 mA, $C_L$ = 4.7 nF<br>f = 300 to 3400 Hz | $\Delta G_{RF}$ | | | ± 0.5 | dB |
| Gain change with current | $I_L$ = 15 to 100 mA | $\Delta G_R$ | | | ± 0.5 | dB |
| Gain deviation | $T_{amb}$ = –10 to + 60 °C<br>$I_L$ = 15 mA | $\Delta G_R$ | | | ± 0.5 | dB |
| Ear protection differential | $I_L \geq$ 15 mA<br>$V_{gen}$ = 11 $V_{rms}$ | $V_{ep}$ | | | 2.2 | $V_{rms}$ |
| Output resistance | each output against GND | $R_o$ | | | 10 | Ω |
| Line loss compensation | $I_L$ = 100 mA<br>$R_{AGA}$ = 7.5 kΩ | $\Delta G_{RI}$ | –5.0 | –6.0 | –7.0 | dB |
| Output voltage<br>Push pull<br><br>Single ended | $I_L$ = 15 mA, d ≤ 2 %<br>$Z_H$ = 68 nF<br>$Z_H$ = 450 Ω<br>$Z_H$ = 150 Ω | | <br>0.775<br>0.6<br>0.3 | | | $V_{rms}$ |
| Receiving noise psophometrically weighted | $Z_H$ = 68 nF<br>$G_R$ = 0 dB<br>$I_L$ > 15 mA | $n_i$ | | –83 | –78.5 | dBmp |
| Gain at low operating current | $I_L$ = 10 mA<br>$I_D$ = 1 mA<br>$I_M$ = 0 mA<br>$V_{gen}$ = 560 mV<br>RC = 68 kΩ | $G_R$ | –1.5 | | + 0.5 | dB |
| Distortion at low operating current | $I_L$ = 10 mA, $I_D$ = 1 mA<br>$V_{gen}$ = 560 mV<br>RC = 68 kΩ | dr | | | 5 | % |



Preliminary Information

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Speaker amplifier** | **see figure 4** | | | | | |
| Minimum line current for operation | No ac signal | $I_{Lmin}$ | 10.5 | | 15 | mA |
| Gain from $V_L$ to SAO | $I_L \geq 15$ mA<br>$V_{gen} = 10$ mV | $G_{SA}$ | 27.5 | 29 | 30.5 | dB |
| Output power | Load resistance<br>$R_L = 50\ \Omega$<br>d < 5 %<br>$V_{gen} = 300$ mVrms<br>$I_L > 15$ mA<br>$I_L = 20$ mA | <br><br><br><br>PSA<br>PSA | <br><br><br><br>5 | <br><br><br><br><br>20 | | <br><br><br><br>mW |
| Output noise | $I_L > 15$ mA<br>(Input $G_{SA}$ open) | nsa | | | 200 | µV |
| Gain devitation | $I_L = 15$ mA<br>$T_{amb} = -10$ to + 60°C | $\Delta G_{SA}$ | | | ± 1 | dB |
| Gain change with current | $I_L = 15$ to 100 mA<br>$R_{AGA} = 7.5$ kΩ | $\Delta G_{SA}$ | | | ± 1.5 | dB |
| Resistor for turning off speaker amplifier | $I_L = 15$ to 100 mA | $R_{GSA}$ | 0.8 | 1.3 | 2 | MΩ |
| Maximum off-state Output voltage | $I_L = 15$ mA<br>$V_L = 0$ dBm<br>Pin $G_{SA}$ open | $V_{SAO}$ | | | –50 | dBm |
| Gain change with frequency | $I_L = 15$ mA<br>f = 300 to 3400 Hz | $\Delta G_{SA}$ | | | ± 1 | dB |
| Attack time | 20 dB overdrive | $t_r$ | | 1 | | ms |
| Release time | | $t_f$ | | 300 | | ms |
| Distortion | $I_L = 15$ mA<br>$V_{gen} = 300$ mV | $d_{SAO}$ | | | 5 | % |
| **DTMF - amplifier** | **see figure 5** | | | | | |
| Test conditions: $I_D = 2$ mA, $I_M = 0.3$ mA, $R_{AGA} = 7.5$ kΩ, mute active | | | | | | |
| Adjustment range of DTMF gain | $I_L = 15$ mA<br>Load = 600 Ω | $G_D$ | 18 | 26 | 34 | dB |
| DTMF amplification | $I_L = 15$ mA | $G_D$ | 24.5 | 26 | 27 | dB |
| Gain deviation | $I_L = 15$ mA<br>$T_{amb} = -10$ to 60°C | $G_D$ | | | ± 0.5 | dB |
| Input resistance | | $R_i$ | 20 | 25 | 30 | kΩ |
| Distortion of DTMF signal | $I_L \geq 15$ mA<br>$V_I = 0$ dBm | d | | | 2 | % |
| Gain deviation with current | $I_L = 15$ to 100 mA<br>$R_{AGA} = 7.5$ kΩ | $\Delta G_D$ | | | ± 0.5 | dB |

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Supply voltage** | **see figure 1** | | | | | |
| Test conditions: $V_{MIC}$ = 10 mV; $T_{amb}$ = –10 to 60°C | | | | | | |
| Output voltage | $I_L$ = 15 mA<br>$I_D$ = 2 mA<br>RC = 68 kΩ | $V_D$ | 2.9 | | | V |
| | $I_L$ = 15 mA<br>$I_D$ = 2 mA<br>RC = 130 kΩ | $V_D$ | 3.1 | | | V |
| | $I_L$ = 100 mA<br>$I_D$ = 0 mA<br>$T_{amb}$ = –10 to + 60°C | $V_D$ | | | 6.1 | V |
| Supply voltage for an electret microphone | $I_M$ = 0.3 mA<br>$I_L$ ≥ 15 mA<br>RC = 130 kΩ | $V_M$ | 1.45 | | 3.3 | V |
| **Squelch** | **see figure 6** | | | | | |
| Attenuation of transmit gain | $I_L$ ≥ 15 mA | $\Delta G_S$ | 8 | 10 | 12 | dB |
| Attenuation of speaker amplifier | $I_L$ ≥ 15 mA<br>$R_{GSA}$ = 18 to 560 kΩ | $\Delta G_{SA}$ | 7.5 | 10 | 12.5 | dB |
| Switching level of squelch | $I_L$ ≥ 15 mA<br>RSQ = 100 kΩ | $V_{mico}$ | 6.5 | | 10 | mV |
| Squelch disable | $I_L$ ≥ 15 mA | RSQ | 0.5 | 1 | 2 | MΩ |
| **MUTE input** | **see figure 7** | | | | | |
| MUTE input current | MUTE active<br>$I_L$ > 15 mA<br>$V_{MUTE} = V_D$ | $I_{MUTE}$ | | 20 | 30 | µA |
| MUTE input voltage | Mute inactive<br>$I_L$ > 15 mA | $V_{MUTE}$ | | | 0,3 | V |
| | Mute active<br>$I_L$ > 15 mA | $V_{MUTE}$ | 1.5 | | 0,3 | V |
| **PD input** | **see figure 7** | | | | | |
| PD input current | PD active<br>$I_L$ > 15 mA<br>$V_{PD} = V_D$ | $I_{PD}$ | | 20 | 50 | µA |
| Input voltage | PD = active | $V_{PD}$ | 2 | | | V |
| | PD = inactive | $V_{PD}$ | | | 0.3 | V |
| Current consumption | $V_D = V_{PD}$ = 4.5 V<br>PD = active<br>$I_L$= 15 mA | $I_{DPD}$ | | –40 | –100 | µA |
| Voltage drop at $V_L$ | $I_L$ = 15 mA<br>PD = active | $V_L$ | | 1.5 | | V |
| | $I_L$=100 mA<br>PD = active | $V_L$ | | 1.7 | | V |

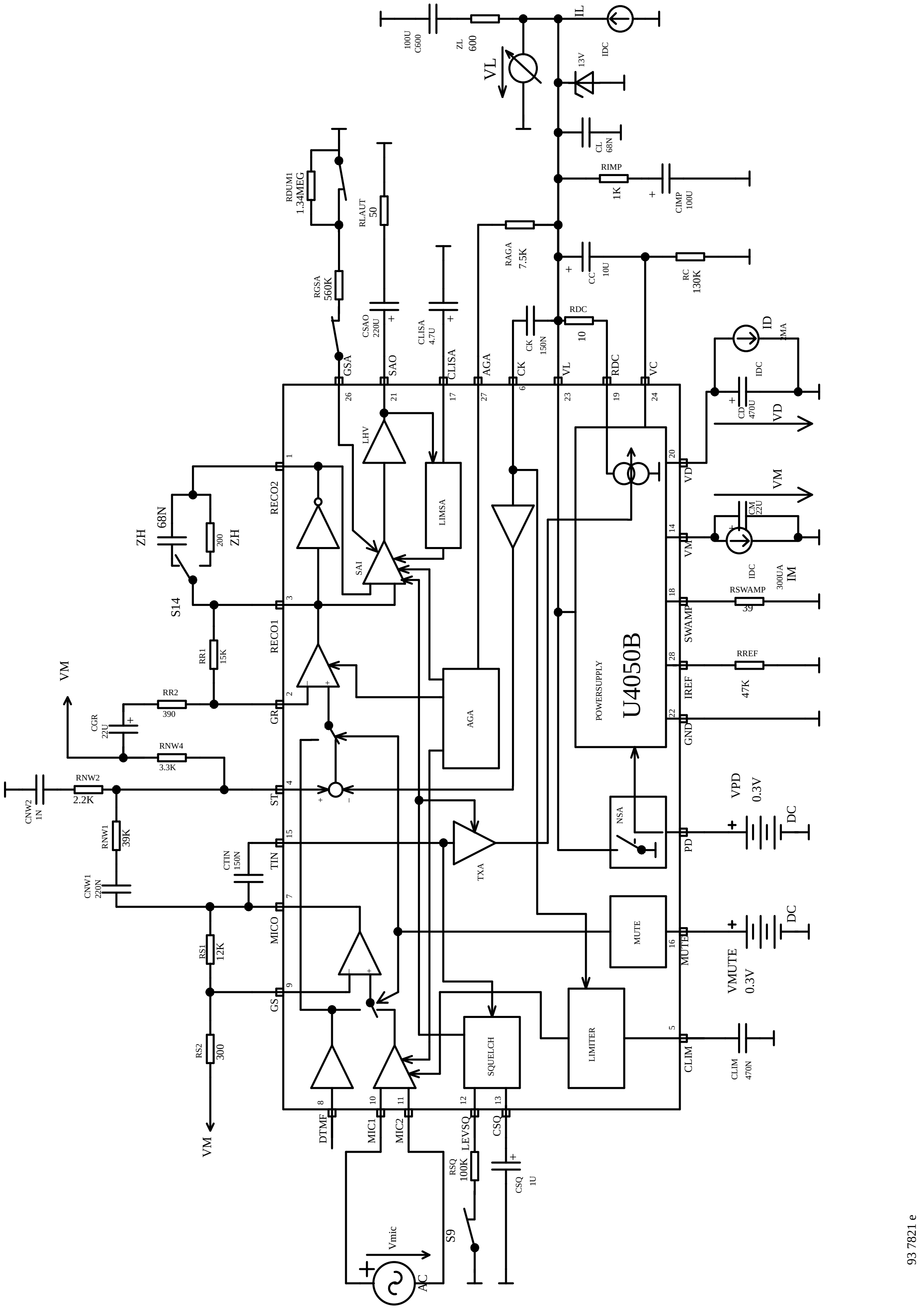



Figure 2. Supply voltage dc characteristics



Preliminary Information

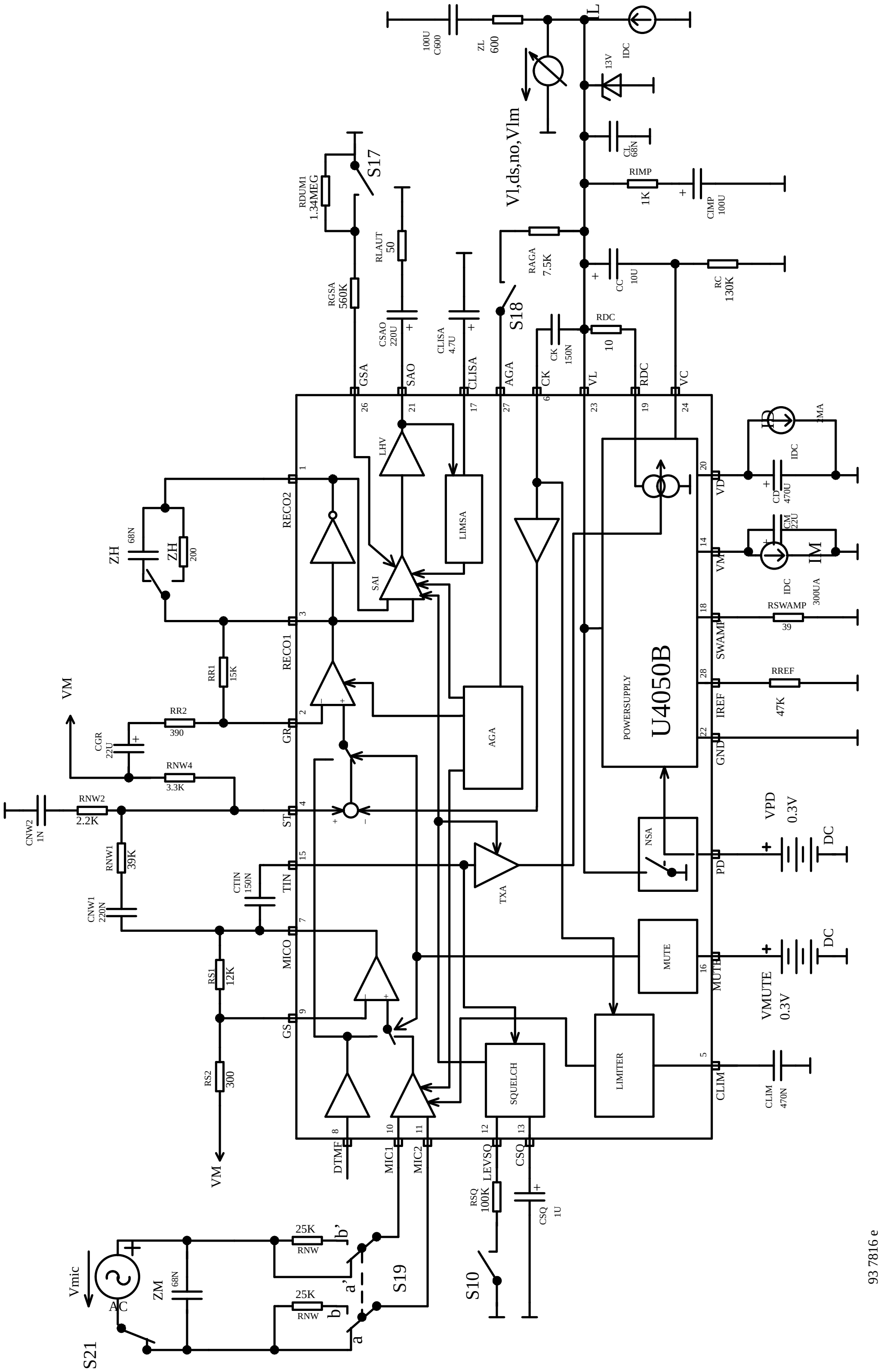



Figure 3. Transmit amplifier

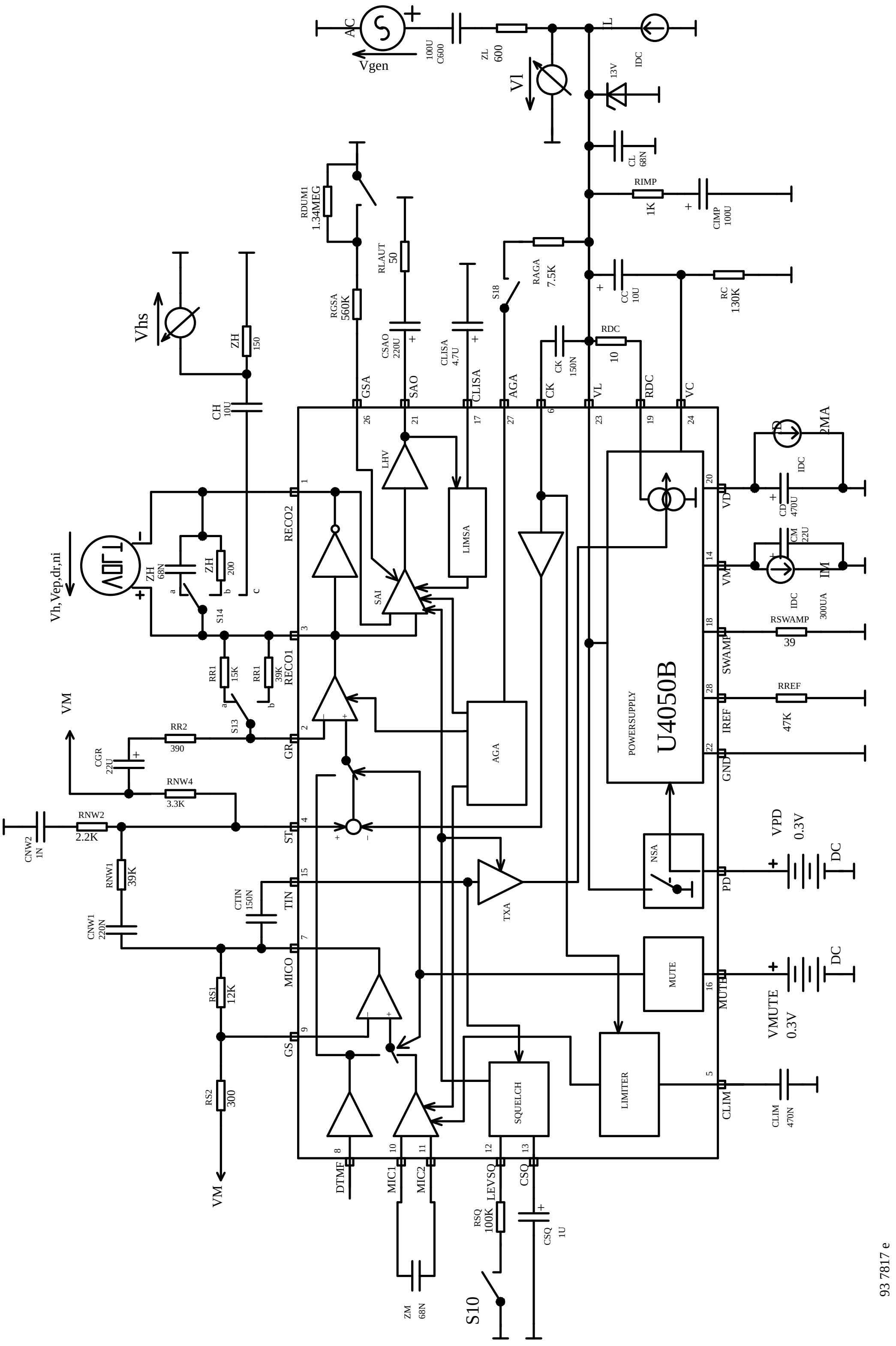



Figure 4. Receiving amplifier

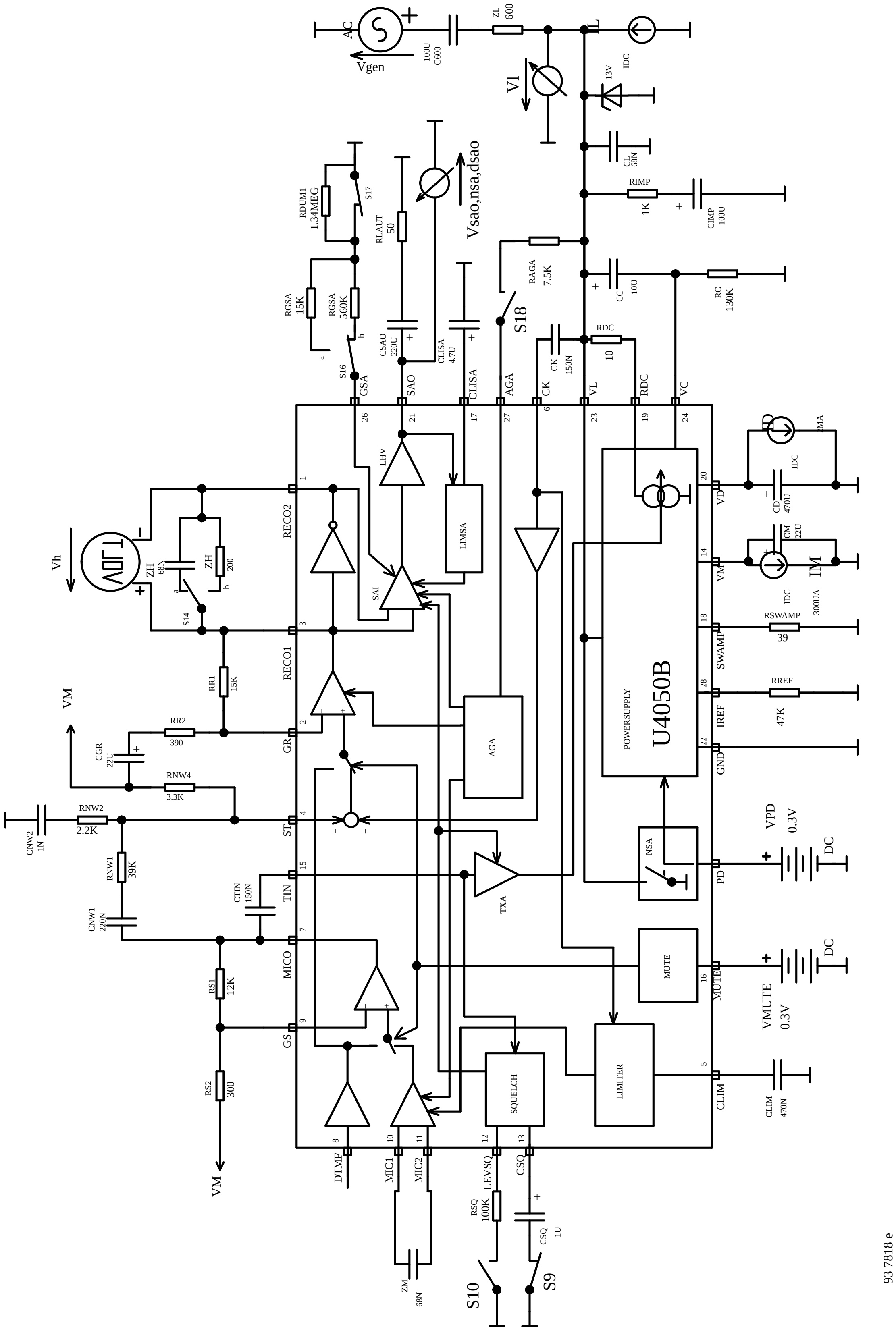



Figure 5. Speaker amplifier

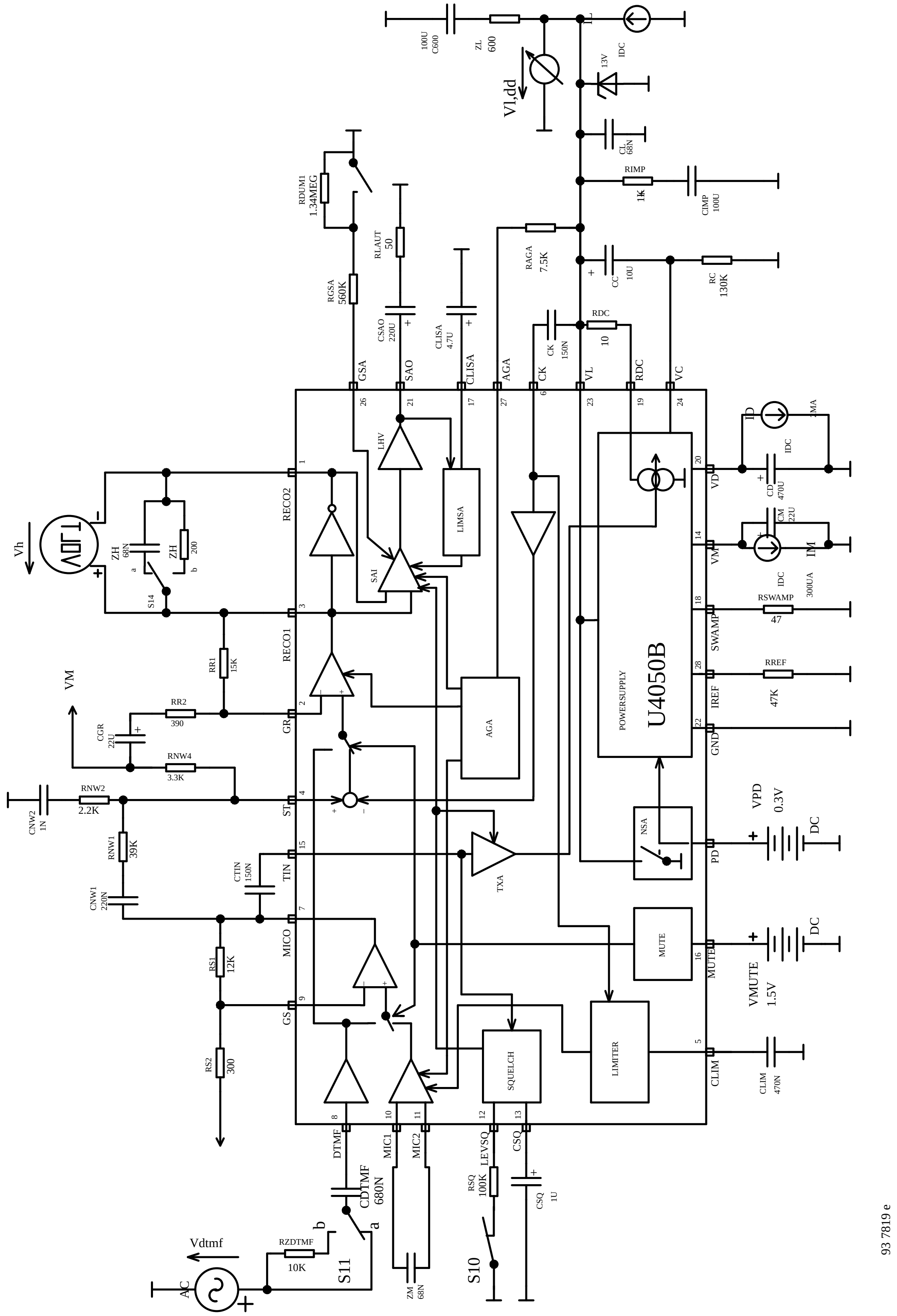



Figure 6. DTMF amplifier

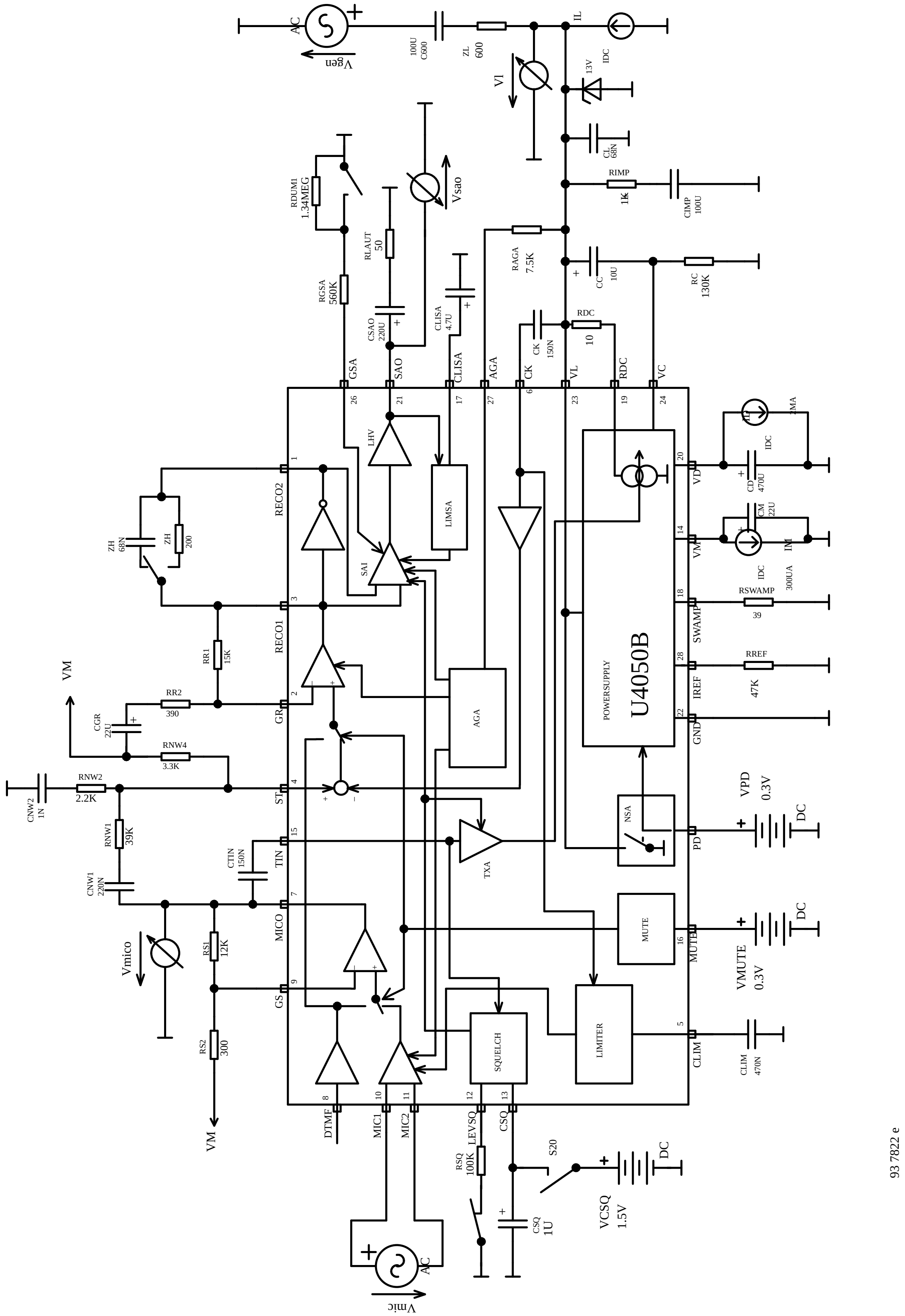



Figure 7. Squelch

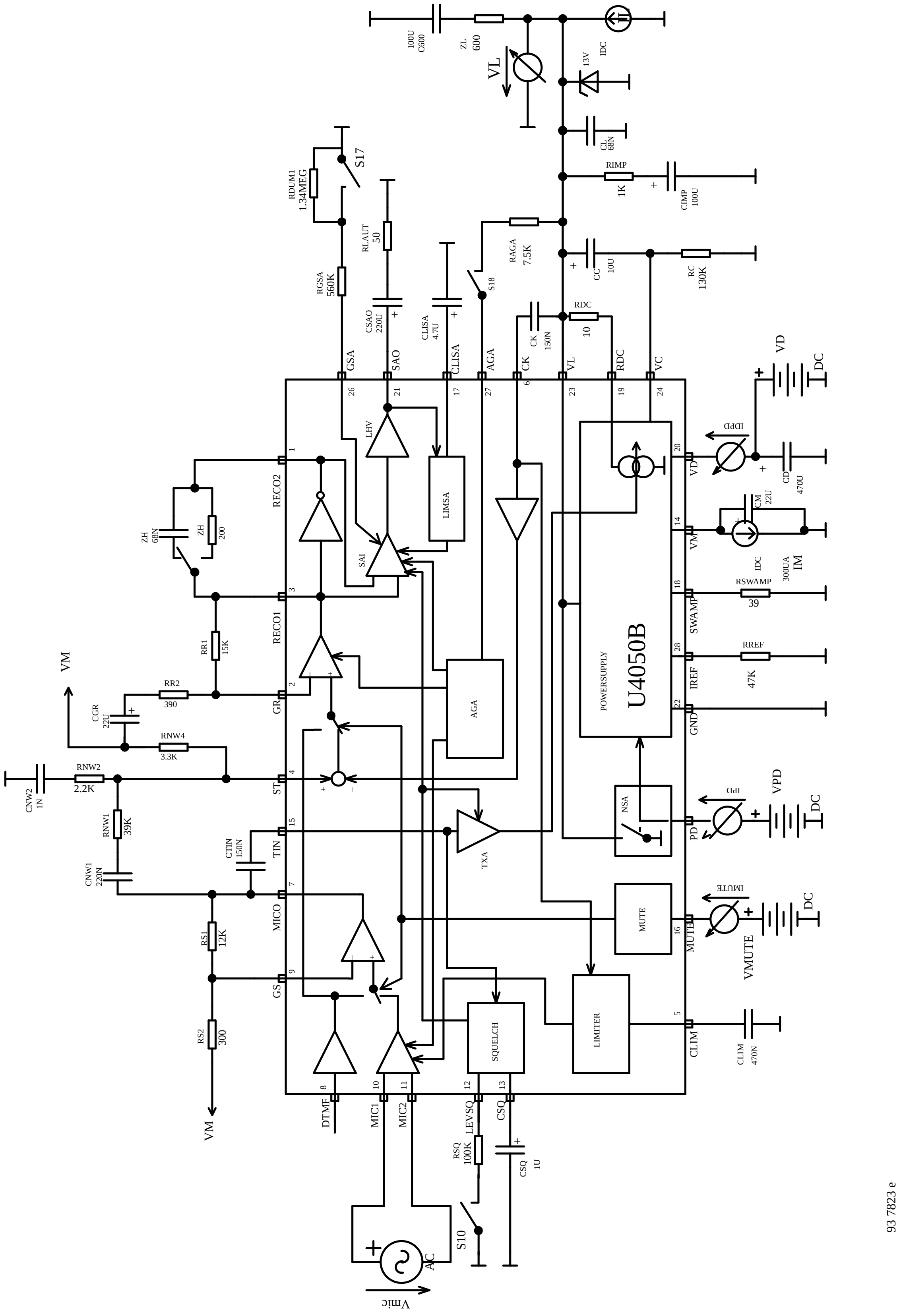



Figure 8. MUTE and PD Test

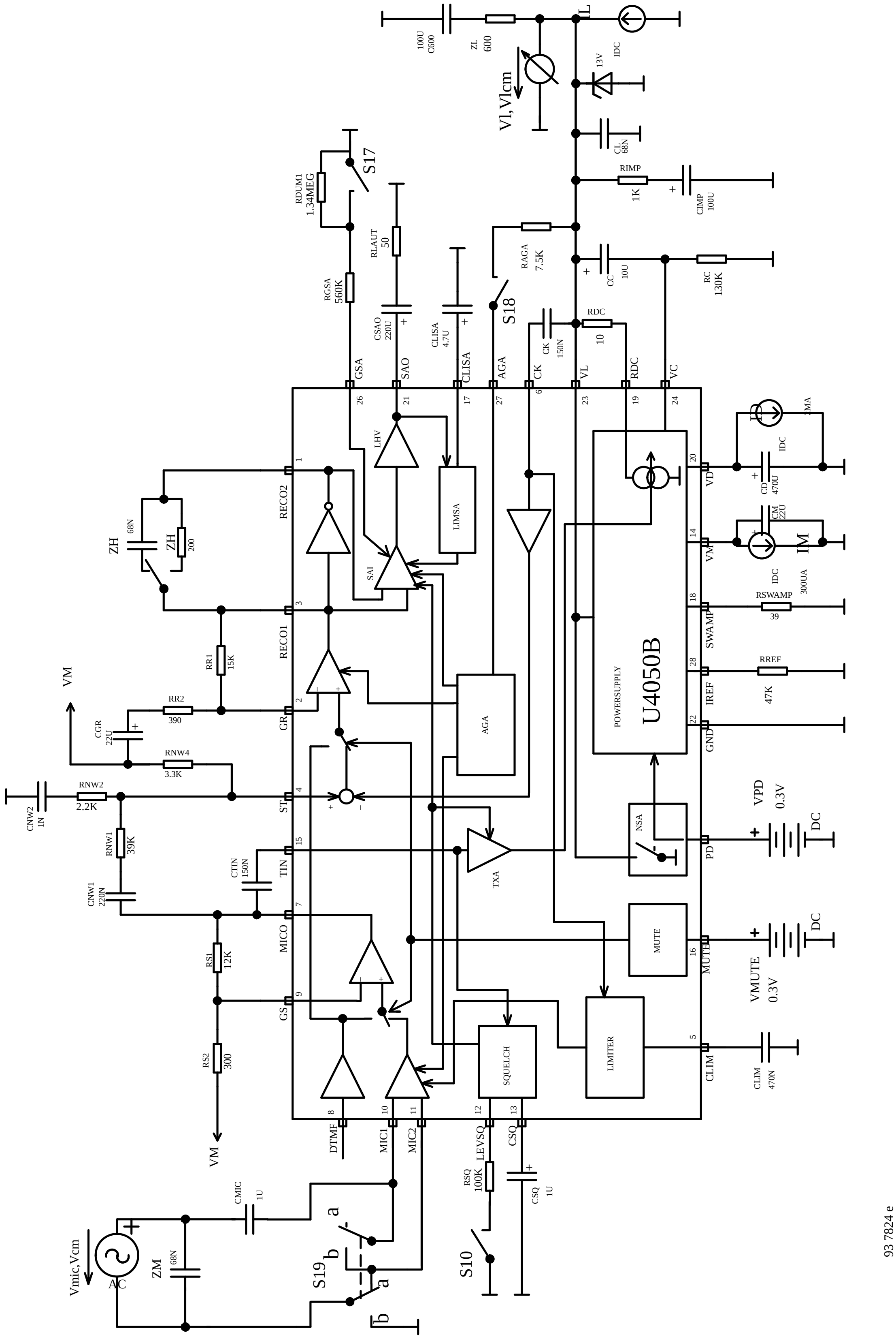
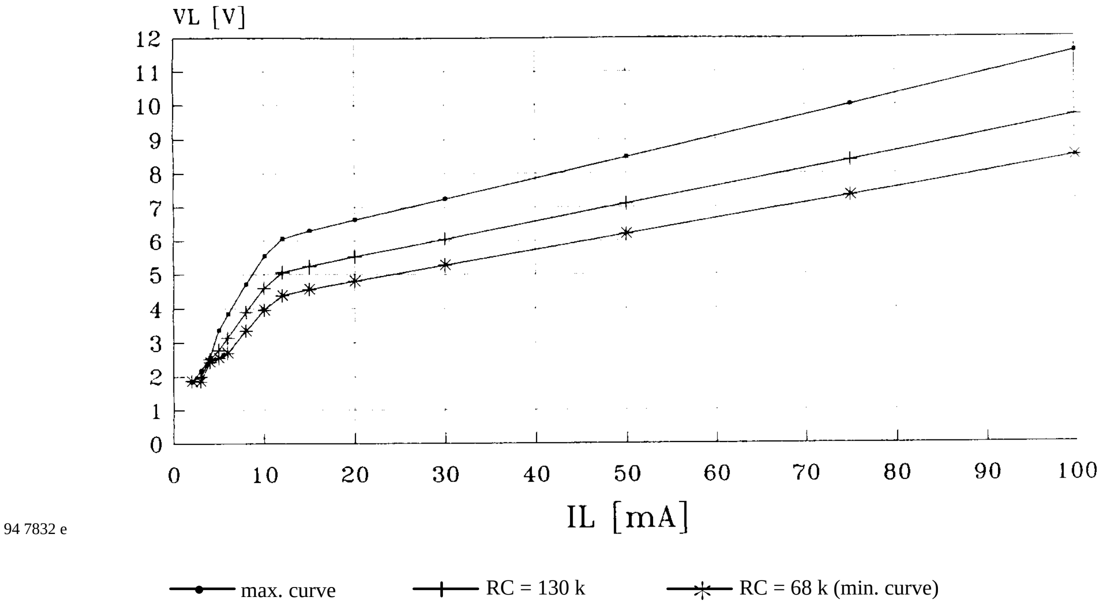



Figure 9. Transmit amplifier (CMRR)

## Typical Curves




Cond.: ID = 0 mA

Figure 10. DC characteristics

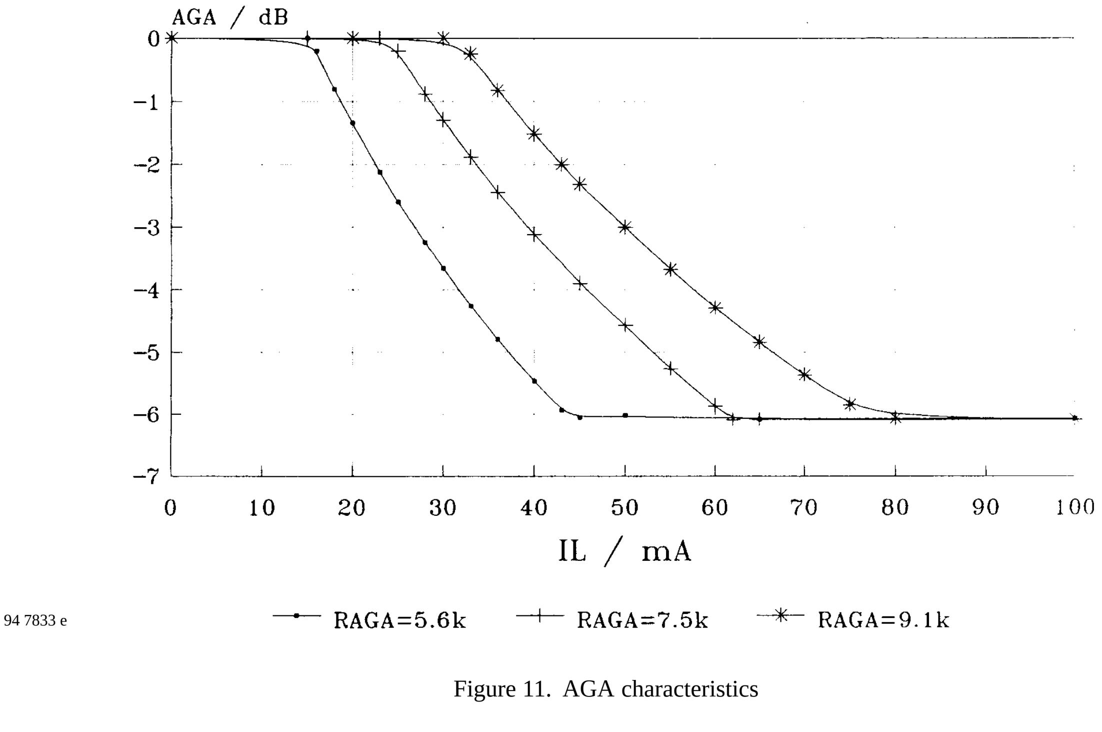
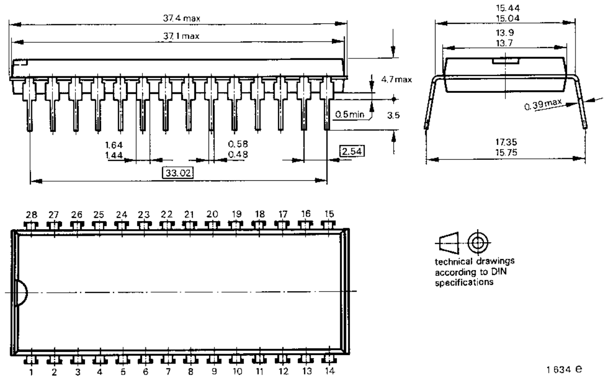


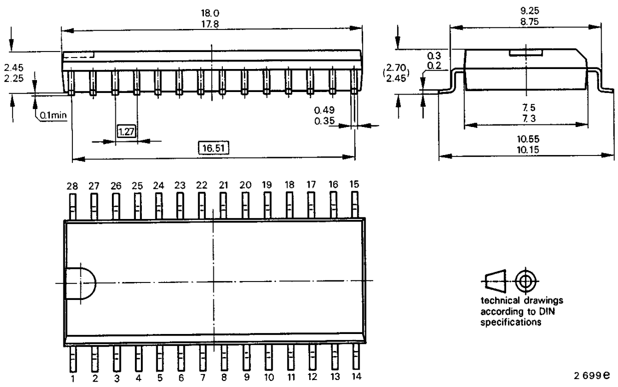

Figure 11. AGA characteristics

## Dimensions in mm

Package: DIP28




Package: SO28



## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC TELEFUNKEN microelectronic GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

**TEMIC TELEFUNKEN microelectronic GmbH** semiconductor division has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

**TEMIC** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.



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