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

Block Diagram / Application Circuit

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

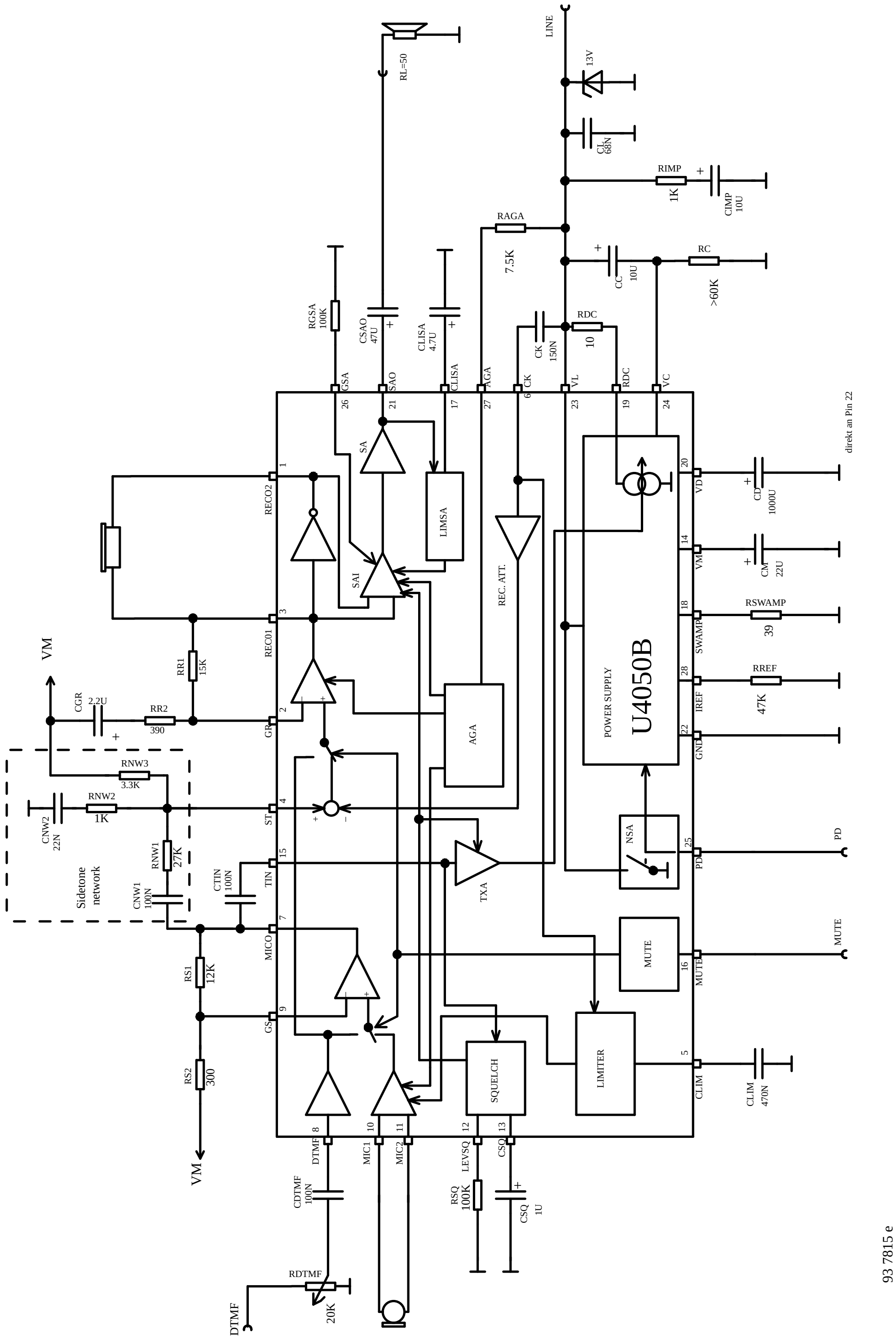


Figure 1 Typical application diagram

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 T_{amb} = 60°C SO 28	P_{tot}	750	mW

Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient SO 28	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 f = 300 to 3400 Hz	ΔG_S			± 0.5	dB
Gain change with current	Pin AGA open I_L = 15 to 100 mA	ΔG_S			± 0.5	dB
Gain deviation	T_{amb} = –10 to +60°C I_L = 15 mA	ΔG_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 V_L = 775 mVrms	d_s			2	%
Maximum output voltage	I_L > 19 mA d < 5 % V_{mic} = 10 m	V_{1max}	1.8	3	4.2	dBm

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Noise at line psophometrically weighted	I_L > 15 mA G_S = 48 dB	n_o		–80	–72	dBmp
Anticlipping attack time	V_{mic} = 20 mV C = 470 nF			0.5		ms
Release time	each 3dB overdrive			9		ms
Gain at low operating current	I_L = 10 mA, I_D = 1 mA RC = 68 kΩ 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 I_D = 1 mA, RC = 68 kΩ V_{mic} = 10 mV	ds			6	%
Line loss compensation	I_L = 100 mA R_{AGA} = 7.5 kΩ	ΔG_{SI}	–5	–6	–7	dB
Mute suppression	$I_L \geq$ 15 mA 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 differential	G_R	–8		+8	dB
Receiving amplification	I_L = 15 mA differential	G_R	–1	–0.5	0	dB
Amplification of DTMF signal from DTMF IN to RECO 1/2	$I_F \geq$ 15 mA Mute active	G_{RM}	–15	–12	–9	dB
Frequency response	I_L > 15 mA, C_L = 4.7 nF f = 300 to 3400 Hz	ΔG_{RF}			± 0.5	dB
Gain change with current	I_L = 15 to 100 mA	ΔG_R			± 0.5	dB
Gain deviation	T_{amb} = –10 to + 60 °C I_L = 15 mA	ΔG_R			± 0.5	dB
Ear protection differential	$I_L \geq$ 15 mA 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 R_{AGA} = 7.5 kΩ	ΔG_{RI}	–5.0	–6.0	–7.0	dB
Output voltage Push pull Single ended	I_L = 15 mA, d ≤ 2 % Z_H = 68 nF Z_H = 450 Ω Z_H = 150 Ω		 0.775 0.6 0.3			V_{rms}
Receiving noise psophometrically weighted	Z_H = 68 nF G_R = 0 dB I_L > 15 mA	n_i		–83	–78.5	dBmp
Gain at low operating current	I_L = 10 mA I_D = 1 mA I_M = 0 mA V_{gen} = 560 mV RC = 68 kΩ	G_R	–1.5		+ 0.5	dB
Distortion at low operating current	I_L = 10 mA, I_D = 1 mA V_{gen} = 560 mV RC = 68 kΩ	dr			5	%

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 V_{gen} = 10 mV	G_{SA}	27.5	29	30.5	dB
Output power	Load resistance R_L = 50 Ω d < 5 % V_{gen} = 300 mVrms I_L > 15 mA I_L = 20 mA	PSA PSA	5	20		mW
Output noise	I_L > 15 mA (Input G_{SA} open)	nsa			200	µV
Gain devitation	I_L = 15 mA T_{amb} = –10 to + 60°C	ΔG_{SA}			± 1	dB
Gain change with current	I_L = 15 to 100 mA R_{AGA} = 7.5 kΩ	ΔG_{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 V_L = 0 dBm Pin G_{SA} open	V_{SAO}			–50	dBm
Gain change with frequency	I_L = 15 mA f = 300 to 3400 Hz	ΔG_{SA}			± 1	dB
Attack time	20 dB overdrive	t_r		1		ms
Release time		t_f		300		ms
Distortion	I_L = 15 mA 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 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 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 V_I = 0 dBm	d			2	%
Gain deviation with current	I_L = 15 to 100 mA R_{AGA} = 7.5 kΩ	ΔG_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 I_D = 2 mA RC = 68 kΩ	V_D	2.9			V
	I_L = 15 mA I_D = 2 mA RC = 130 kΩ	V_D	3.1			V
	I_L = 100 mA I_D = 0 mA T_{amb} = –10 to + 60°C	V_D			6.1	V
Supply voltage for an electret microphone	I_M = 0.3 mA $I_L \geq$ 15 mA RC = 130 kΩ	V_M	1.45		3.3	V
Squelch	**see figure 6**					
Attenuation of transmit gain	$I_L \geq$ 15 mA	ΔG_S	8	10	12	dB
Attenuation of speaker amplifier	$I_L \geq$ 15 mA R_{GSA} = 18 to 560 kΩ	ΔG_{SA}	7.5	10	12.5	dB
Switching level of squelch	$I_L \geq$ 15 mA RSQ = 100 kΩ	V_{mico}	6.5		10	mV
Squelch disable	$I_L \geq$ 15 mA	RSQ	0.5	1	2	MΩ
MUTE input	**see figure 7**					
MUTE input current	MUTE active I_L > 15 mA $V_{MUTE} = V_D$	I_{MUTE}		20	30	µA
MUTE input voltage	Mute inactive I_L > 15 mA	V_{MUTE}			0,3	V
	Mute active I_L > 15 mA	V_{MUTE}	1.5		0,3	V
PD input	**see figure 7**					
PD input current	PD active I_L > 15 mA $V_{PD} = V_D$	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 PD = active I_L= 15 mA	I_{DPD}		–40	–100	µA
Voltage drop at V_L	I_L = 15 mA PD = active	V_L		1.5		V
	I_L=100 mA PD = active	V_L		1.7		V

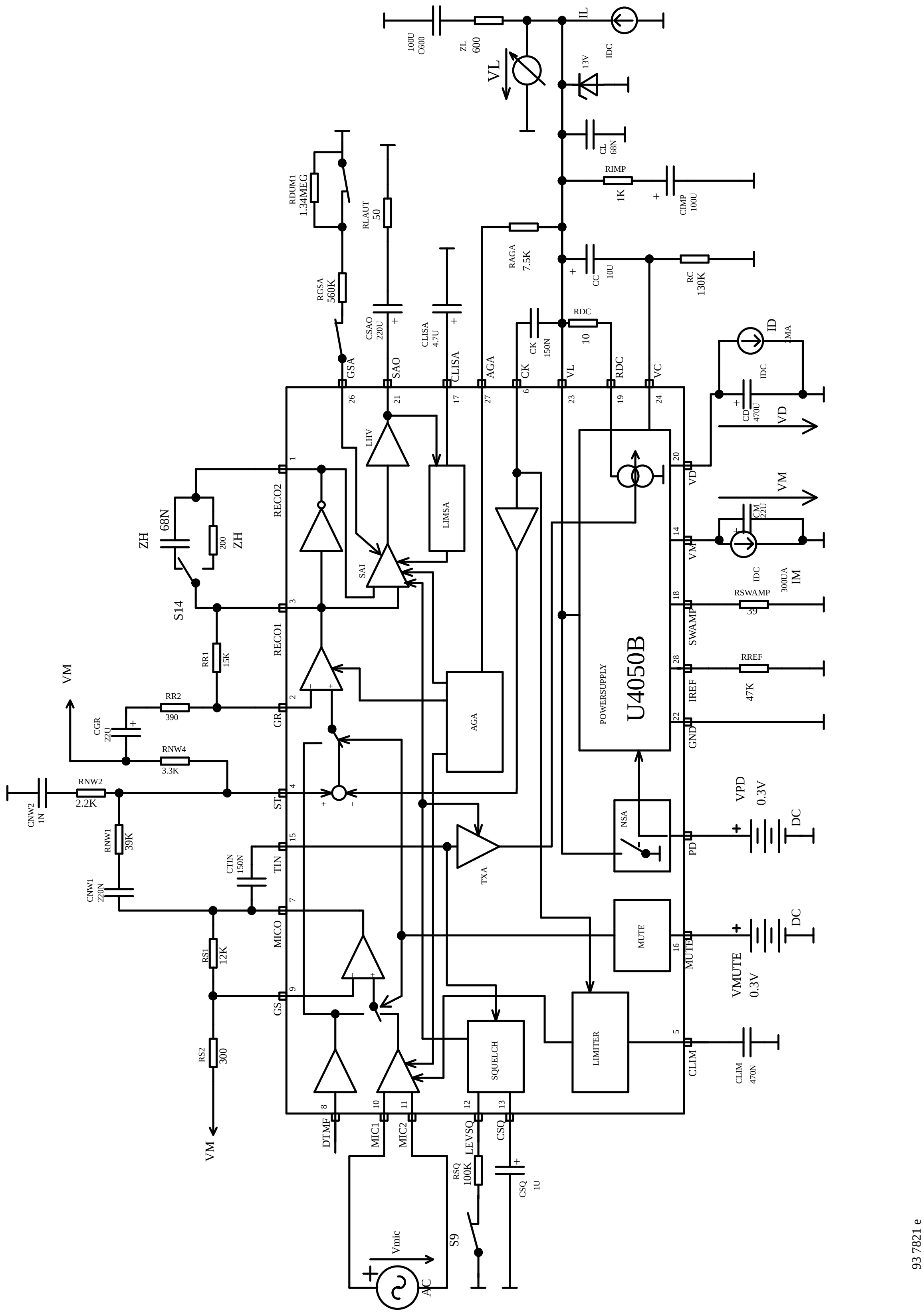


Figure 1 Supply voltage dc characteristics

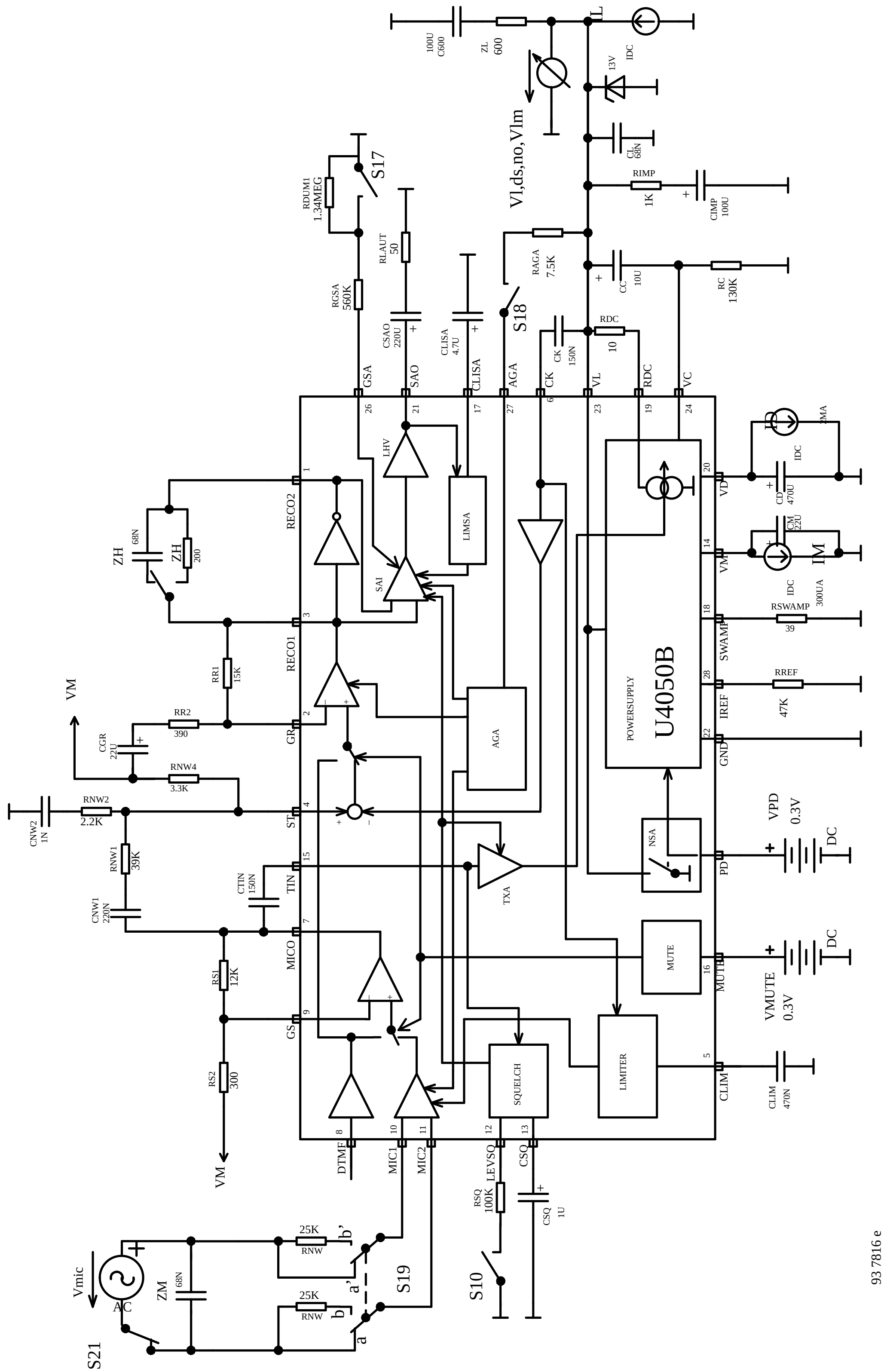


Figure 2   Transmit amplifier

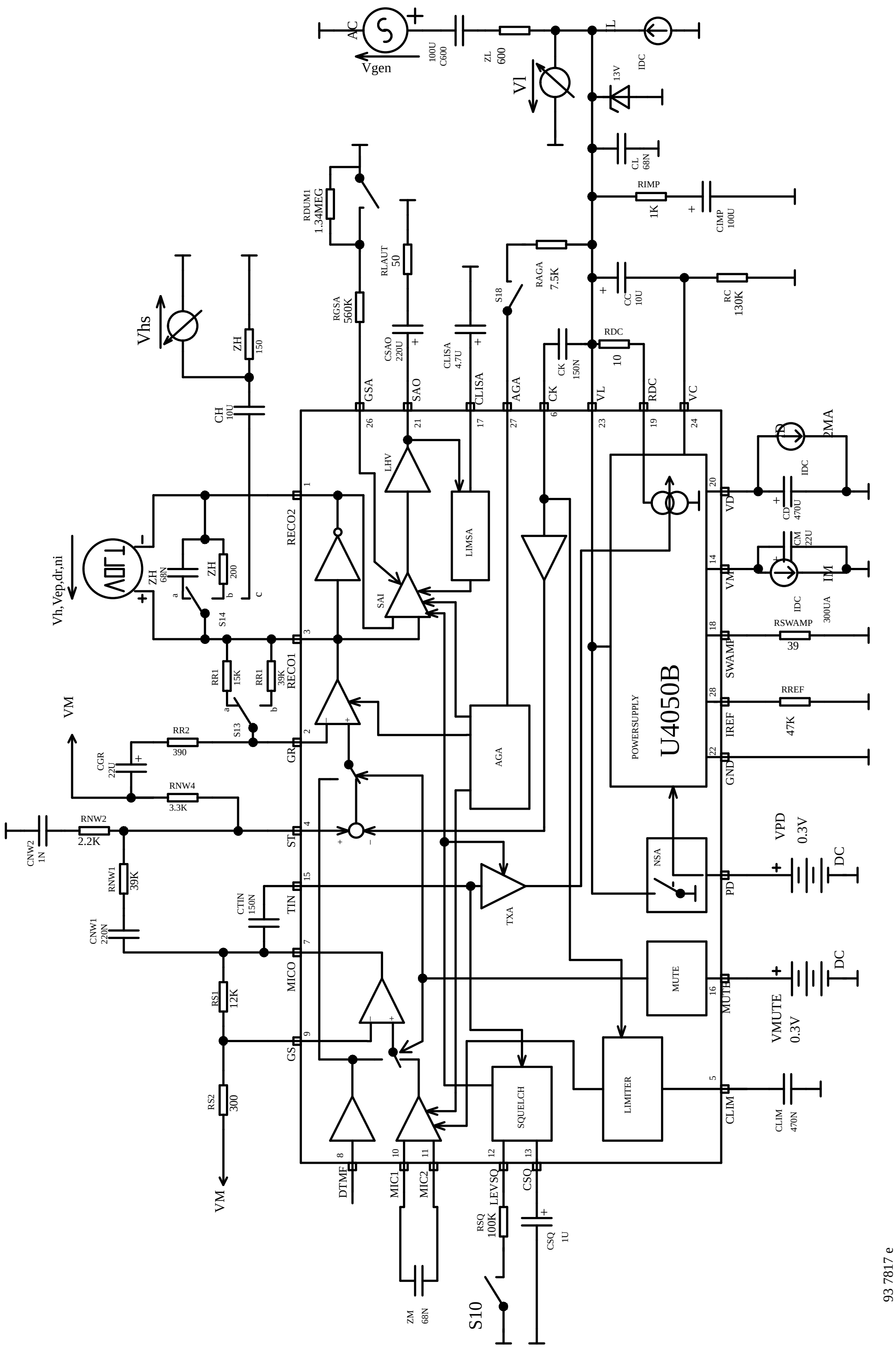


Figure 3 Receiving amplifier

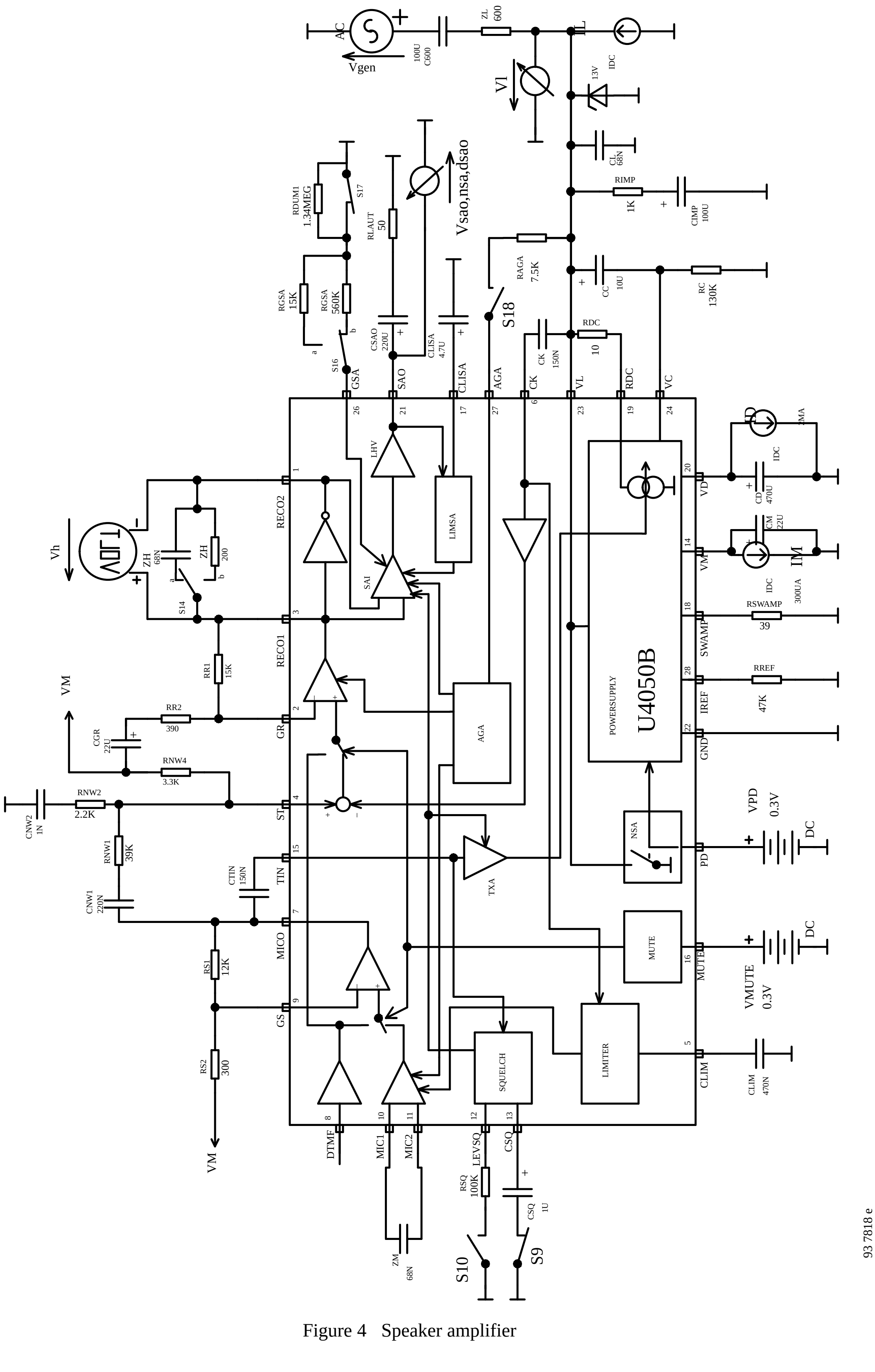


Figure 4 Speaker amplifier

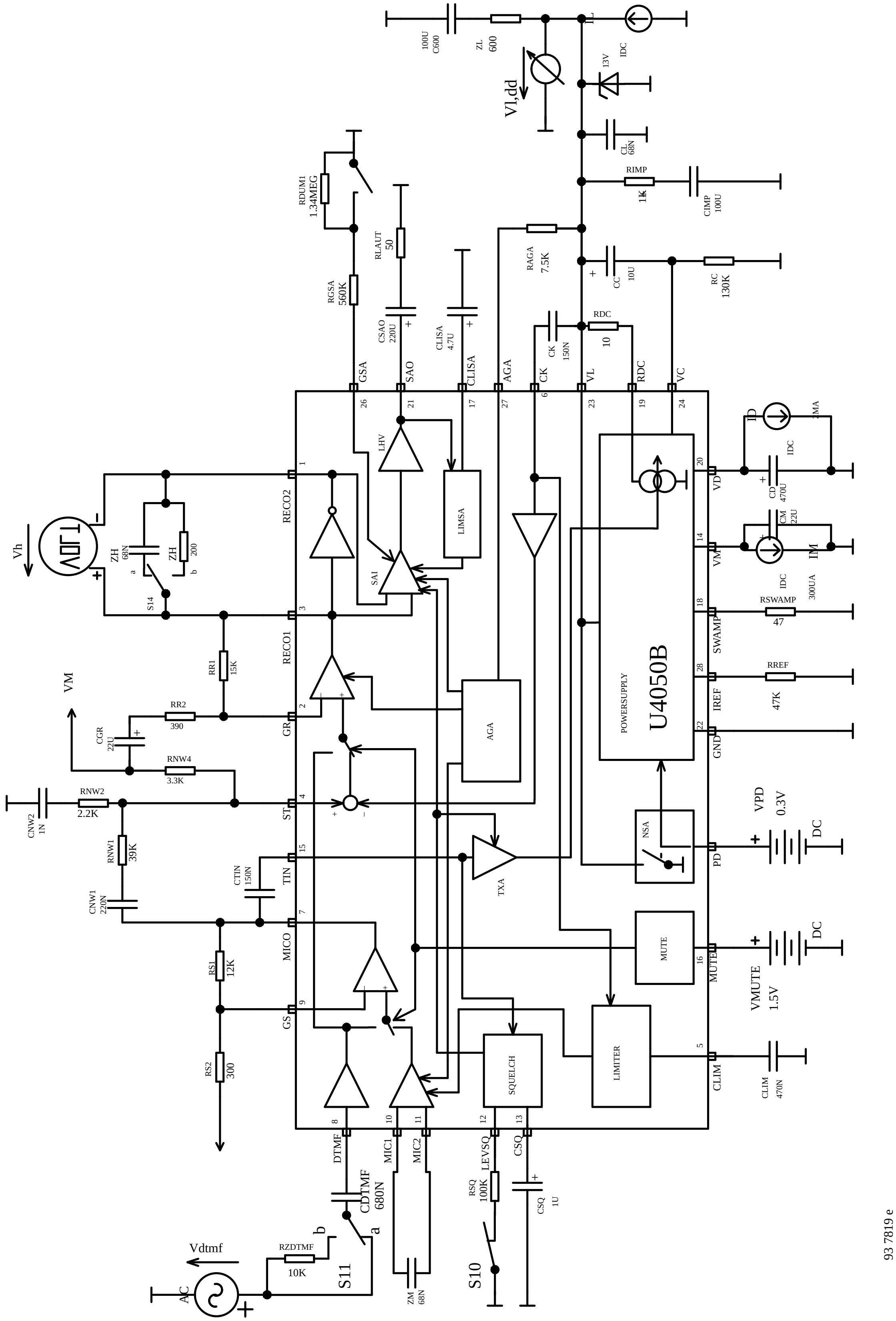


Figure 5 DTMF amplifier

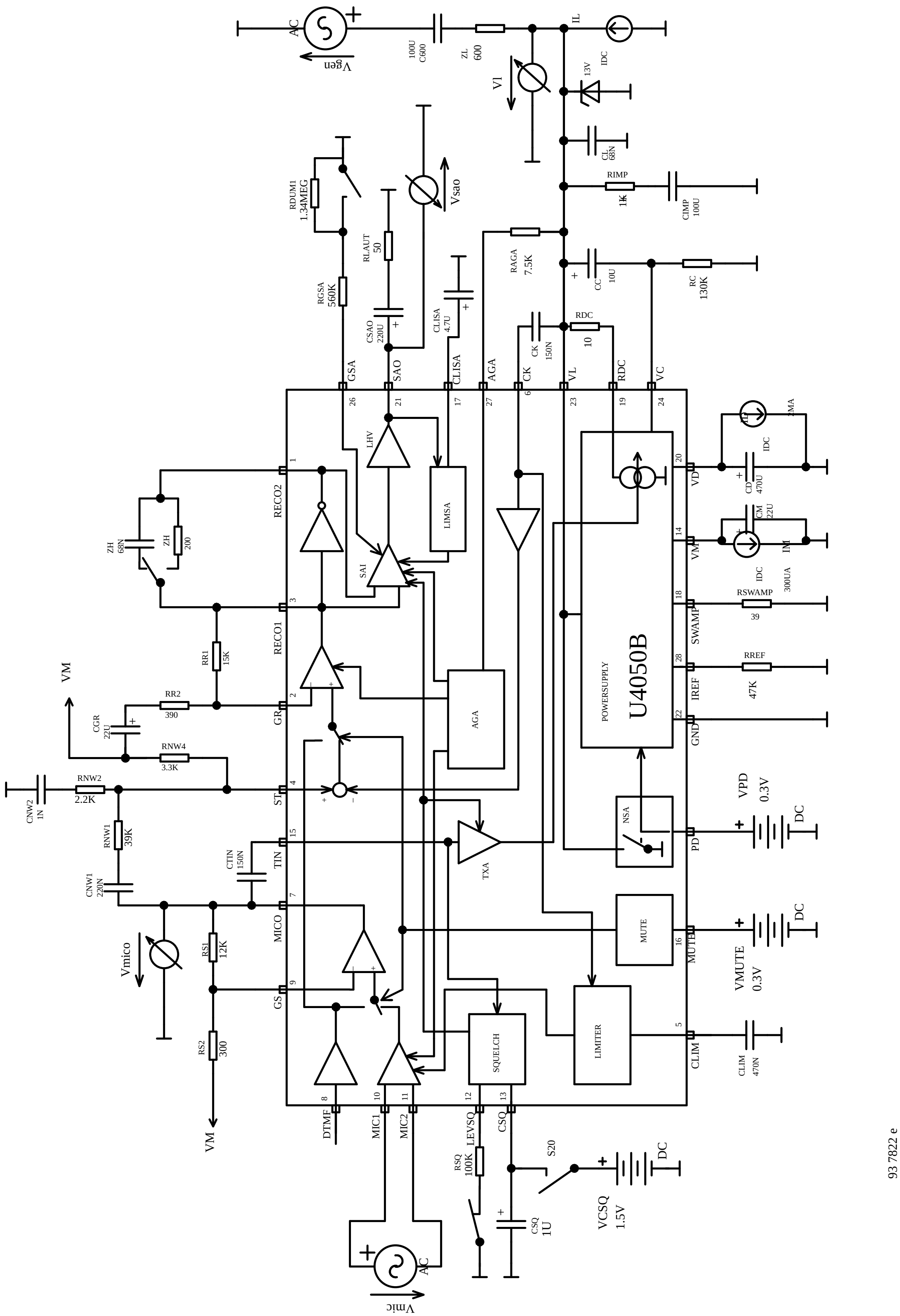


Figure 6 Squelch

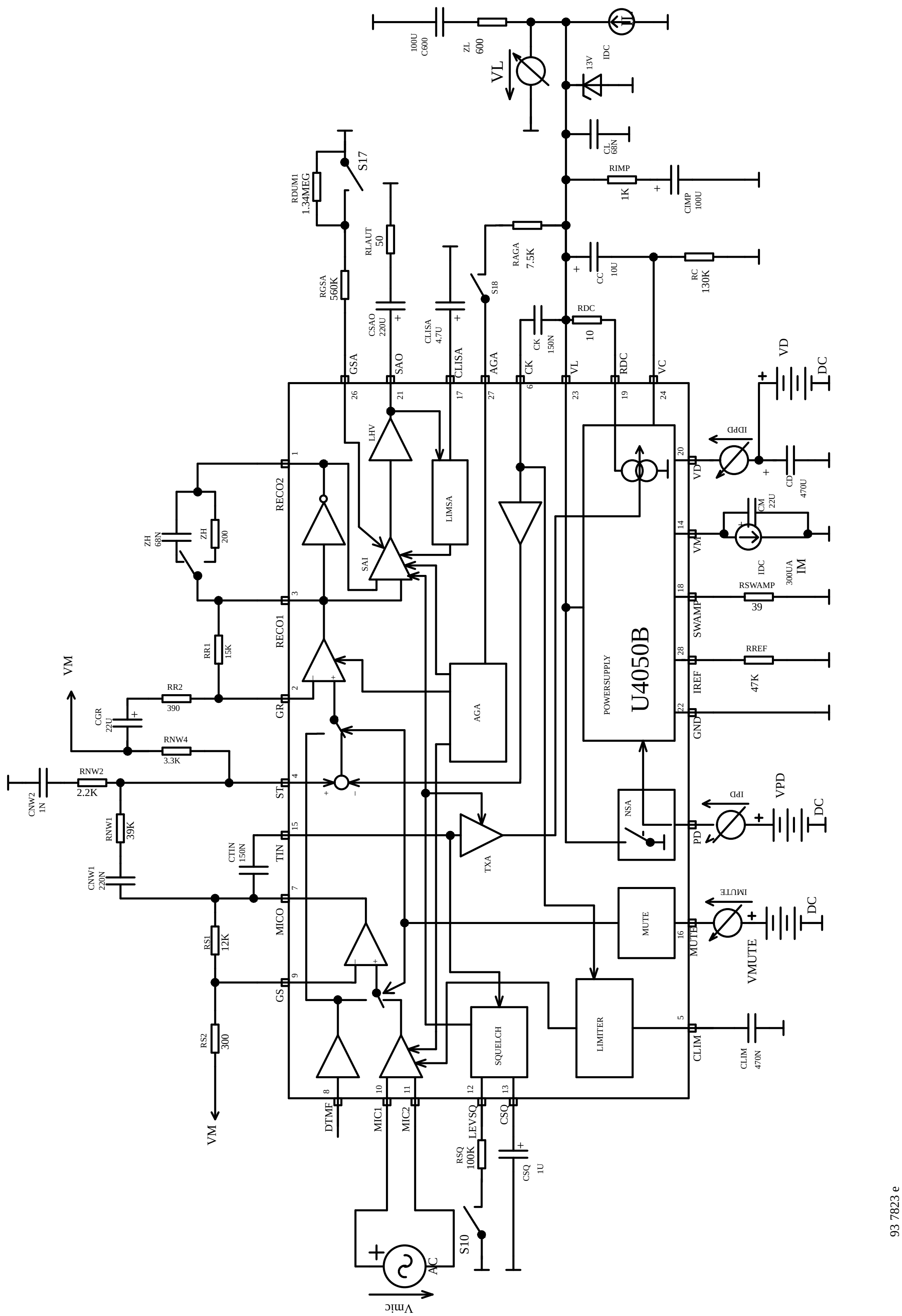


Figure 7   MUTE and PD Test

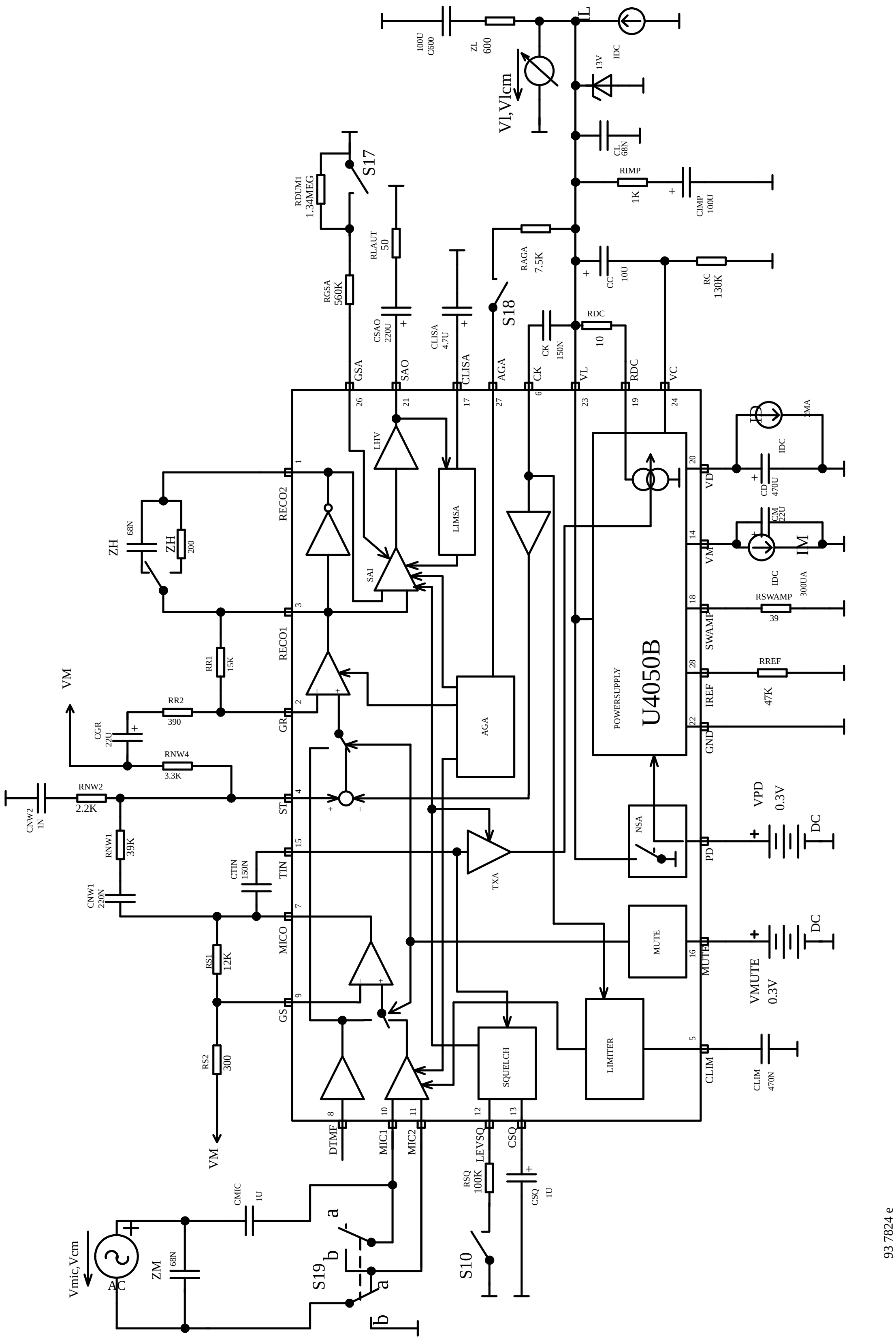
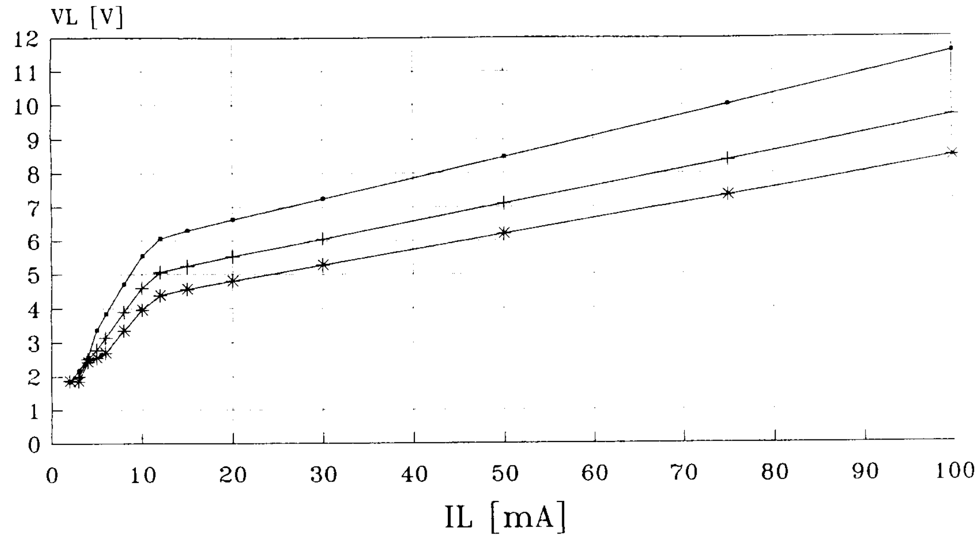


Figure 8 Transmit amplifier (CMRR)

Typical Curves

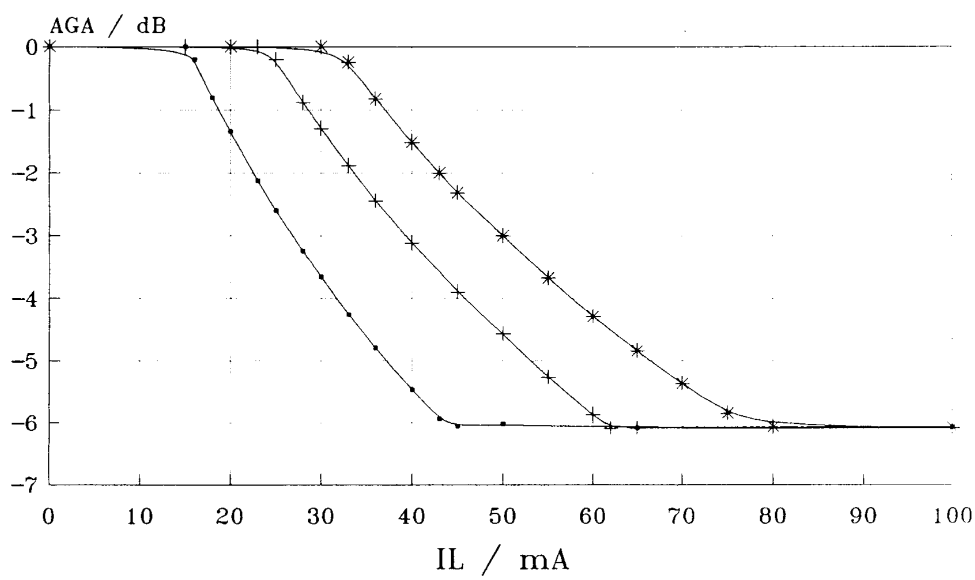


94 7832 e

max. curve RC = 130 k RC = 68 k (min. curve)

Cond.: ID = 0 mA

Figure 9 DC characteristics



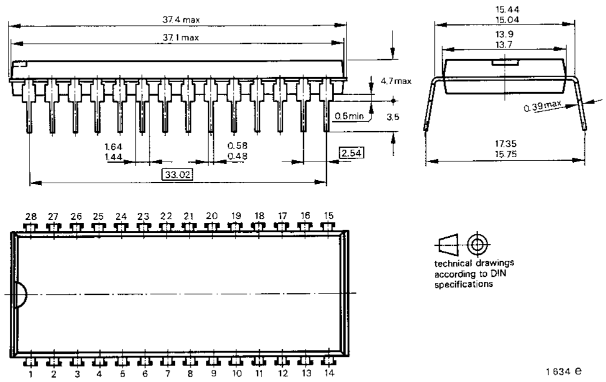
94 7833 e

RAGA=5.6k RAGA=7.5k RAGA=9.1k

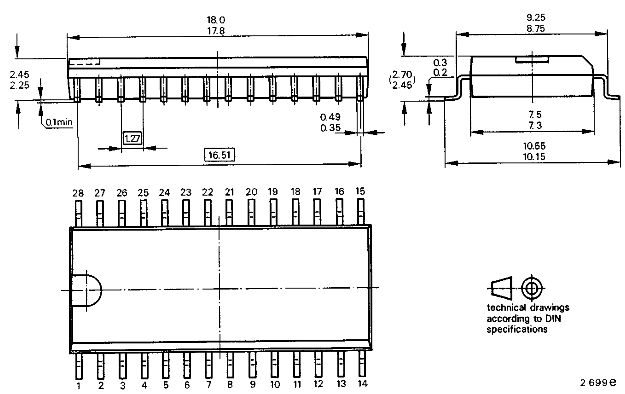
Figure 10 AGA characteristics

Dimensions in mm

Package: DIP 28



Package: SO 28



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.

TEMIC TELEFUNKEN microelectronic GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany
Telephone: 49 (0)7131 67 2831, Fax number: 49 (0)7131 67 2423