

SIEMENS

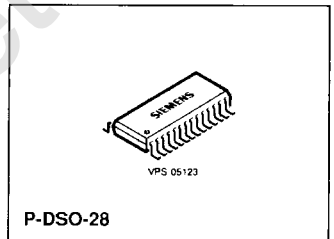
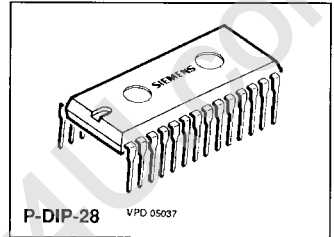
2.1 Enhanced Speech Circuit (ESC)

PSB 4506; A
PSB 4506-T; A-T

Bipolar IC

Features

- Active line impedance generation for minimal signal loss in transmitting mode (real or complex impedance generation)
- Only one complex network is necessary to make a flat frequency response on a resistive load (for example 600 Ω) although the internal output impedance is complex
- 3 supply outputs for external circuits:
 - V_{REF} – 1.26 V reference voltage
 - V_{CC1} – regulated and adjustable supply (2.5 V to 3.5 V)
 - V_{CC2} – Power supply able to supply high current to peripheral circuitry with a limiting at 5 V (4506) or 6.5 V (4506A)
- Anticlippping control avoids line signal distortion in transmit direction
- Indication of the line status (line loop interruption; pulse dialing)
- Very low noise in transmit and receive direction
- Adjustable DC threshold voltage for the line voltage drop
- Adjustable differential DC resistance
- DTMF interface with adjustable confidence – tone gain
- MUTE input for DTMF dialing
- Special microphone MUTE input
- Wide setting range for microphone and earpiece amplifier gains
- Automatic gain control (AGC) adaptable to line attenuation or fixed current dependent gain
- Exact compensation of the line attenuation by AGC
- Two selectable AGC gain ranges (3/6 dB)
- Control input for hands-free or loudspeaking operation in combination with the PSB 45030 and current AGC enabled
- Positive line current sink input to reduce the power dissipation in the IC



Type	Version	Ordering Code	Package
PSB 4506	V 1.2	Q67000-A6017	P-DIP-28
PSB 4506A	V 1.2	Q67000-A6019	P-DIP-28
PSB 4506-T	V 1.2	Q67000-A6012	P-DSO-28 (SMD)
PSB 4506A-T	V 1.2	Q67000-A6031	P-DSO-28 (SMD)

The Enhanced Speech Circuits (ESC) PSB 4506, 4506A perform all speech and interface functions required in fully electronic telephone sets. The ICs are designed for comfort telephone sets and allow the supply of several external circuits such as hands-free control circuits or μ P controllers without a high value inductor. A special anticlipping control circuit prevents line distortion in the transmit direction.

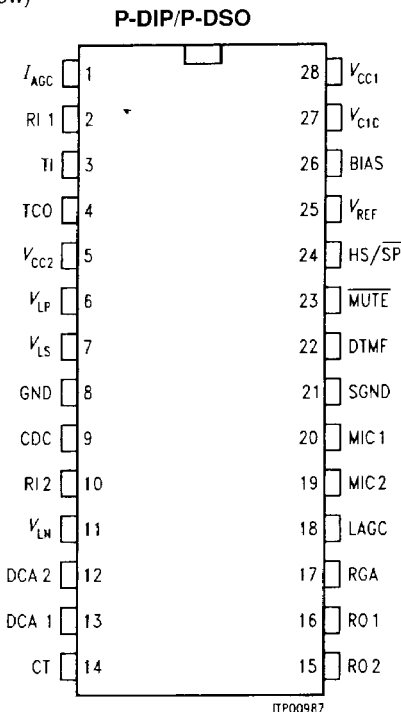
The PSB 4506A has a higher limiting at V_{CC2} , also refer to **figure 1**.

Figure 1

	PSB 4506	PSB 4506A
V_{CC2} (voltage limiting)	5 V	6.5 V

Pin Configuration

(top view)



Pin Definitions and Functions

Pin No.	Symbol	Function
1	I_{AGC}	Startpoint of AGC
2	RI1	Receiver input
3	TI	Transmitter input
4	TCO	Transmitter preamplifier output
5	V_{CC2}	Non-regulated power supply
6	V_{LP}	Positive line terminal
7	V_{LS}	Positive line current sink
8	GND	Ground
9	CDC	Voltage regulator decoupling
10	RI 2	Receiver-offset comparator capacity
11	V_{LN}	Negative line terminal
12	DC A2	DC R_{DIFF} adjustment
13	DC A1	DC threshold voltage adjustment
14	CT	Anticlippping control & microphone MUTE
15	RO 2	Receiver output 2
16	RO1	Receiver output 1
17	RGA	Receiver gain adjustment
18	L_{AGC}	AGC level (3/6 dB) adjustment
19	MIC 2	Microphone input 2
20	MIC1	Microphone input 1
21	SGND	Signal ground
22	DTMF	DTMF signal input
23	MUTE	DTMF MUTE input
24	HS/ \overline{SP}	Control input handset/speaker
25	V_{REF}	Reference voltage output
26	BIAS	BIAS current adjustment input
27	V_{C1C}	Control input for V_{CC1}
28	V_{CC1}	Regulated supply output

Figure 2
Block Diagram (real impedance)

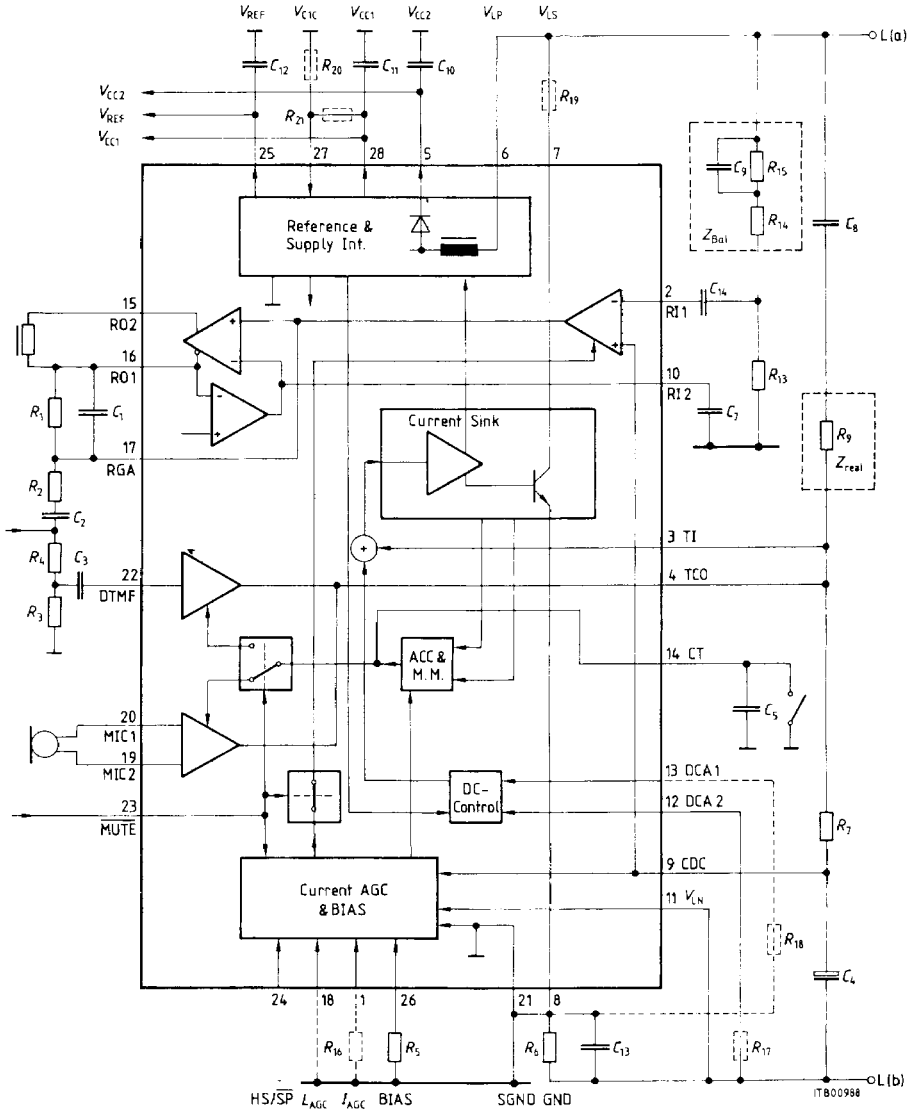
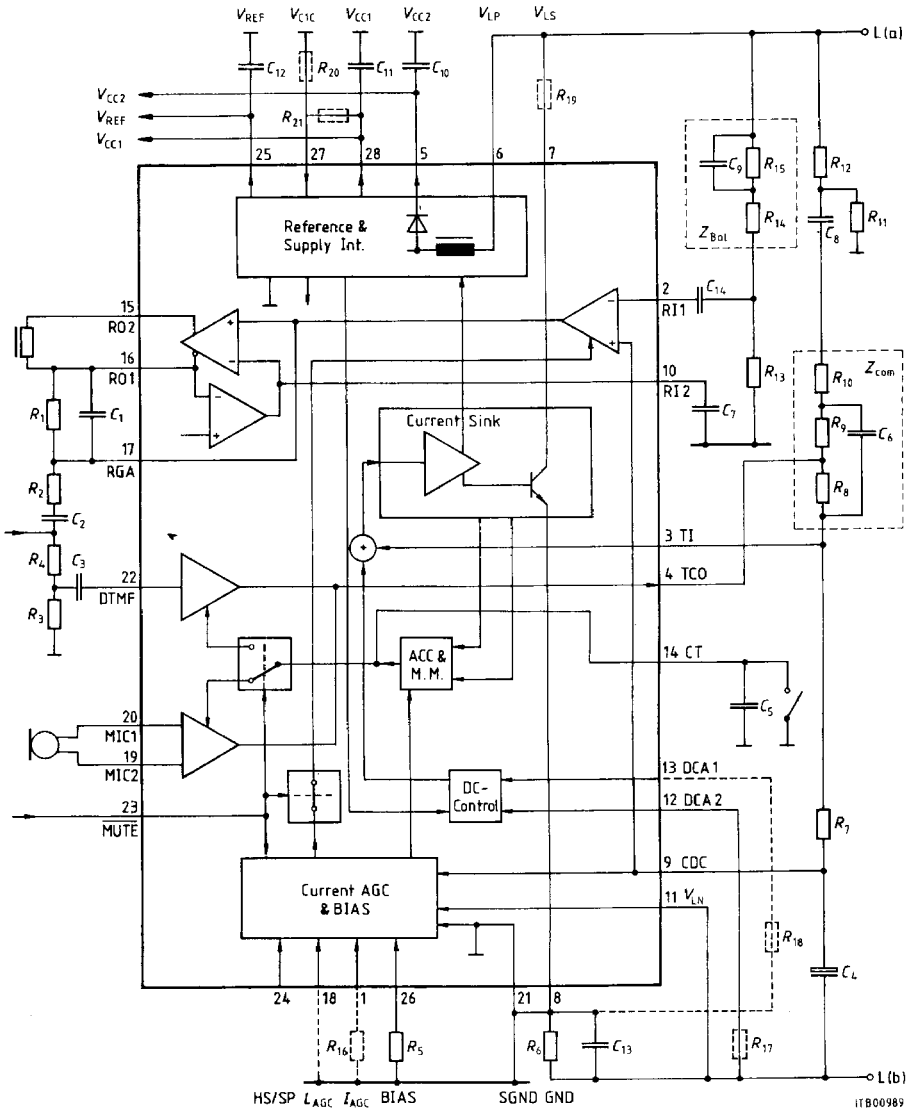


Figure 3
Block Diagram (complex impedance)



1TB00989

Functional Description of the Block Diagrams of the ESC

The ESC consists of the following functional blocks:

- the reference & supply interface with a start-up circuit
- the current AGC & bias block
- the DC control block
- the current sink
- several amplifiers for speech signals in transmit and receive direction
- the anticlipping control circuit

The reference & supply interface is feeding the circuit itself and represents a powerful supply point for external circuits, such as dialers (PSB 8510-x) and hands-free add-on circuits (PSB 45030). It also controls, in dependence of the line status, a quick charging of the storage capacitors after the circuit will be switched on.

The bias control unit senses the voltage drops at the resistor R_6 and the capacitor C_4 . With this information and in respect of the conditions of the DC control block the current sink adjusts the voltage drop over the circuit V_{LINE} .

With the DC control block (pin DCA1 and DCA2; R_{17} , R_{18}) it is possible to vary the DC characteristics.

The resistor R_5 between the pin BIAS (26) and the pin GND (8) adjusts an internal reference current which enables the bias control block to adjust the operating points of the transmit and receive amplifiers. The current dependent AGC senses the current on the telephone line and varies, if enabled, the amplification of the receive and microphone preamplifier.

The current sink also amplifies the transmit signals coming from the microphone or DTMF preamplifier and modulates the line.

The anticlipping control circuit senses a clipping of the current sink in transmit direction and reduces the amplification of the microphone preamplifier at once. This means a reduced distortion level in transmit direction.

List of External Components for the ESC

Component	Note	Typ. Value
R_1	Receiving amplifier gain adjustment	33 k Ω
R	Confidence tone adjustment	1.5 M Ω
R_3	DTMF input level adjustment	4.7 k Ω
R_4	DTMF input level adjustment	100 k Ω
R_5	Reference current adjustment	120 k Ω
R_6	Slope/sensing resistor	10 Ω
R_7	Active circuit impedance generation + transmitting amplifier adjustment	10 k Ω for Z_{comp}
	Active circuit impedance generation + transmitting amplifier adjustment	5.37 k Ω for Z_{real}
R_8	Active circuit impedance generation + transmitting amplifier adjustment	61 k Ω for Z_{comp}
R_9	Active circuit impedance generation + transmitting amplifier adjustment	21 k Ω for Z_{comp}
	Active circuit impedance generation + transmitting amplifier adjustment	317 k Ω for Z_{real}
R_{10}	Active circuit impedance generation + transmitting amplifier adjustment	12 k Ω for Z_{comp}
R_{11}	Active circuit impedance generation + transmitting amplifier adjustment	10 k Ω for Z_{comp}
R_{12}	Active circuit impedance generation + transmitting amplifier adjustment	92 k Ω for Z_{com}
R_{13}	Sidetone suppression	1 k Ω
R_{14}	Sidetone suppression (balancing network)	22 k Ω
R_{15}	Sidetone suppression (balancing network)	82 k Ω
R_{16}	AGC (startpoint adjustment)	0.74 k Ω /mA
R_{17}	DC characteristics (R_{DIF} adjustment)	
R_{18}	DC characteristics (U_0 adjustment)	
R_{19}	Reduction of the power dissipation in the IC	
R_{20}	Adjustment of V_{CC1}	
R_{21}	Adjustment of V_{CC1}	

List of External Components for the ESC (continued)

Component	Note	Typ. Value
C ₁	Stabilization of the receiving amplifier	120 pF
C ₂	Confidence tone (decoupling capacitor)	100 nF
C ₃	DTMF input (decoupling capacitor)	100 nF
C ₄	DC characteristics (sensing capacitor)	3.3 μF
C ₅	Anticlippping capacitor	470 nF
C ₆	Active circuit impedance generation	1.15 nF
C ₇	Rec. ampl. (offset compensation capacitor)	2.2 μF
C ₈	Active circuit impedance generation	220 nF
C ₉	Sidetone suppression (balancing network)	1.12 nF
C ₁₀	Power supply (smoothing capacitor)	470 μF
C ₁₁	Power supply (smoothing capacitor)	10 μF
C ₁₂	Power supply (smoothing capacitor)	100 nF
C ₁₃	Stabilization capacitor	2.2 μF
C ₁₄	Rec. ampl. input (decoupling capacitor for the sidetone suppression)	100 nF

Circuit Description

V_{LP} (6), V_{LS} (7), DCA1 (13), DCA 2 (12), CDC (9):

DC Characteristics and Corresponding Control Pins

The IC is usually supplied from the telephone line. The pin V_{LP} is the input for the supply interface and for the circuit's own supply. V_{LP} has to be connected directly to the positive line of the telephone system.

The pin V_{LS} is the positive input of the current sink. It has to be connected to the positive telephone line. With an optional resistor (R_{19}) between the positive telephone line and V_{LS} it is possible to decrease the power dissipation in the IC.

A capacitor C_4 between CDC and V_{LN} decouples the DC voltage drop (detected on R_6) from the AC signals on the line. The capacitor C_{13} is necessary to ensure stability for the feedback loop of the negative line pin.

DCA1 and DCA2 are the control pins for the adjustment of the DC characteristics. **Figure 4** shows the DC characteristics of the ESC with the variable parameters U_0 and R_{DIFF} .

For full performance of the circuit the following requirement has to be fulfilled:

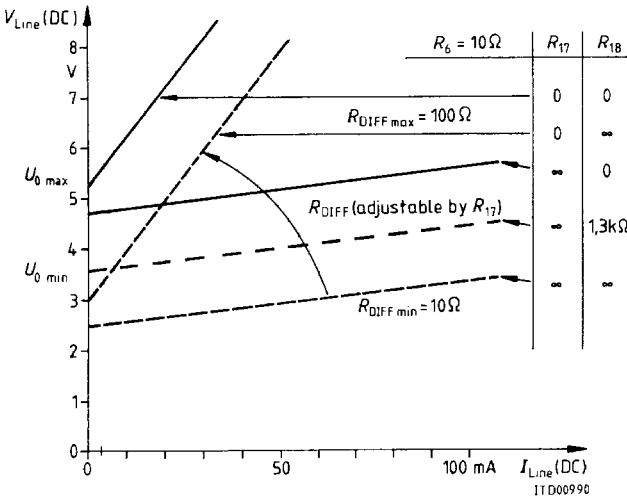
$$V_{Line} > V_{CC1} + 1.1V + I_{Line} \times R_{DIFF}$$

V_{CC1} can be adjusted between 2.5 V and 3.5 V.

The virtual startpoint ($I_{Line} = 0$ mA) is $U_0 \min = V_{CC1} + 1.1$ V. U_0 can be adjusted with equation (2).

Figure 4 shows an example for an adjustment of V_{CC1} at 2.5 V (curve starting at $U_0 \min$). In the area below the curve starting at $U_0 \min$ (see **figure 4**) the performance of the IC is reduced.

Figure 4
DC Characteristics



With DCA1 it is possible to adjust the DC threshold voltage U_0 which is normally 3 V (DCA1 open and DCA 2 connected to V_{LN}). By means of an optional resistor R_{18} between DCA1 and GND the DC threshold voltage U_0 can be adjusted up to 5 V.

DCA 2 is the control pin for the DC R_{DIFF} adjustment. R_{DIFF} is 100 Ω in standard case (connection of DCA 2 to V_{LN}) and is adjustable by a resistor R_{17} between DCA 2 and V_{LN} .

With the equations (1) and (2) it is possible to adjust the DC- R_{DIFF} (1) and the DC threshold voltage U_0 (2) with max. two external resistors R_{17} and R_{18} . It is necessary to adjust R_{DIFF} (1) first because R_{17} influences the value of U_0 (see equation (2)).

$$R_{DIFF} = R_6 \left(\frac{R_{11}}{R_{14} + R_{17}} + 1 \right) \quad (1)$$

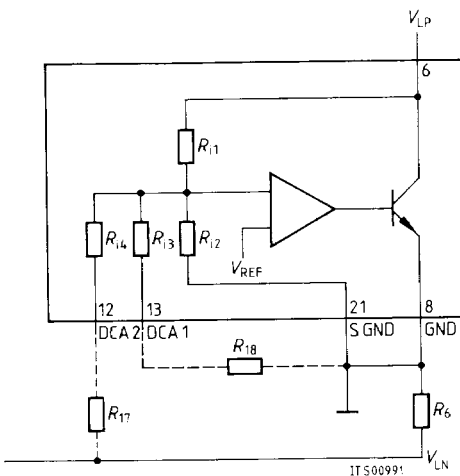
$$U_0 = V_{REF} \left[R_{11} \left(\frac{1}{R_{14} + R_{17}} + \frac{1}{R_{13} + R_{18}} + \frac{1}{R_{12}} \right) + 1 \right] \quad (2)$$

$R_{11,2,3,4}$ are internal resistors. The typical values ($\pm 20\%$) are $R_{11} = 42.3 \text{ k}\Omega$; $R_{12} = R_{13} = 1.1 \text{ k}\Omega$; $R_{14} = 4.7 \text{ k}\Omega$; $V_{REF} = 64 \text{ mV}$.

For standard characteristics (3 V/100 Ω) the external programming resistors can be omitted. There has to be only a connection between DCA2 and V_{LN} .

Figure 5 shows the equivalent circuit for the current sink (DC characteristics) with the above (equation (1) + (2)) mentioned resistors $R_{11,2,3,4}$; R_{17} and R_{18} .

Figure 5
Simplified Equivalent Circuit of the Current Sink to Adjust the DC Characteristics



V_{CC1} (28), V_{C1C} (27), V_{CC2} (5), V_{REF} (25): Supply Interface for External Circuitry

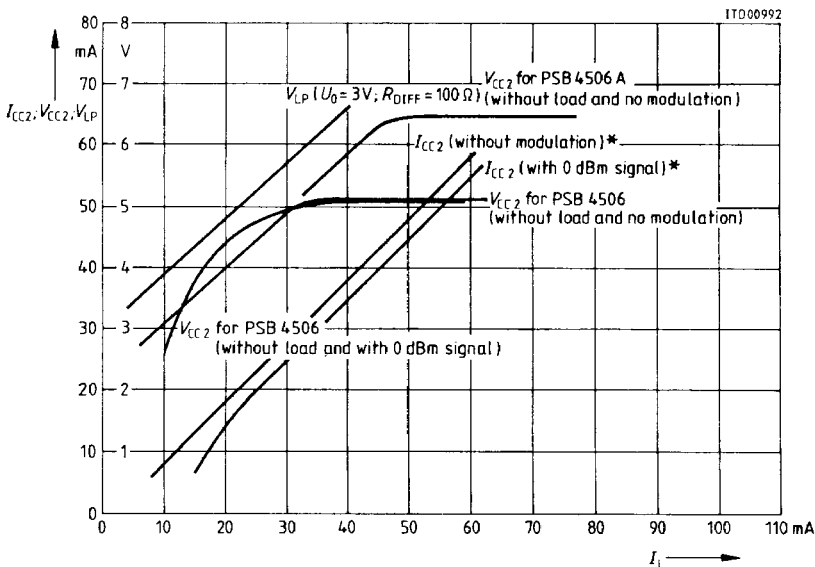
The supply interface consists of three outputs and one control input:

- V_{CC2} : power supply output with an internal voltage limiter at about 5 V (PSB 4506) or 6.5 V (4506A).
Load variation at V_{CC2} does not affect the DC line characteristics until V_{REF} is maintained. Figure 6 shows the supply performance of V_{CC2} .
- V_{CC1} : 3 V regulated voltage. This can be adjusted between 2.5 V and 3.5 V and is derived from V_{CC2} . V_{CC1} is maintained as long as V_{CC2} is greater than $V_{CC1} + 0.5$ V. The maximal source current is $I_{max} = 5$ mA.
- V_{C1C} : with a resistor R_{20} between V_{C1C} and GND the voltage at pin V_{CC1} can be adjusted between 3 V and 3.5 V.
With a resistor R_{21} between V_{C1C} and V_{CC1} the voltage at pin V_{CC1} can be adjusted between 2.5 V and 3 V.
- V_{REF} : constant voltage reference of 1.26 V with a maximum output current of $I_{max} = \pm 150 \mu A$, derived from V_{CC2} . If V_{CC2} falls below 2.7 V V_{REF} (1.26 V) is not longer maintained. If DTMF MUTE is not enabled and V_{LP} falls below 1.2 V, V_{REF} is switched off -this can be used for the line loop indication.

Figure 6

Voltage V_{CC2} and Current I_{CC2} Characteristics of the Power Supply Output V_{CC2} in Dependence of the Line Feed Current I_L for PSB 4506.

*) The maximum permissible load of I_{CC2} is determined by $V_{CC2} = 2.7$ V.



Bias (26): Adjustment of Microphone, DTMF and Receive Preamplicifier Transconductances

An internal reference current for the adjustment of the basic transconductances of the microphone-preamplicifier (typ. 1 mA/V), DTMF-preamplicifier (typ. 0.35 mA/V if LAGC = high and 0.3 mA/V if LAGC = low) and receive-preamplicifier (typ. 1 mA/V) is adjusted by a resistor R_5 (typ. 120 k Ω) between the pins BIAS and GND.

The transconductance of the microphone- and receive-preamplicifiers (typ. 1 mA/V) will be influenced by the line current, if the current AGC is enabled.

MIC 1 (20), MIC 2 (19), TCO (4): Microphone Preamplicifier Inputs and Output

The ESC has symmetrical microphone inputs MIC1 and MIC 2. The input impedance is 2×30 k Ω . The microphone preamplicifier is realized as an OTA and has one current output TCO.

The transconductance of the preamplicifier is influenced by the current AGC (see AGC) and is typically 1 mA/V if AGC is disabled ($R_{16} = \infty$, LAGC = high; HS/SP = high).

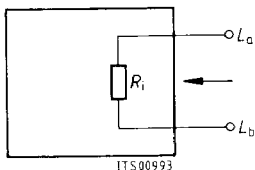
Either dynamic, piezoelectric or electret microphones with integrated FET source follower can be used.

V_{LP} (6), TI (3), TCO (4): Active Generation of the Impedance in Transmitting Direction (Real or Complex) and Transmitting Gain Adjustment

1) Active generation of a real circuit impedance R_i

Figure 7a

Real Circuit Impedance



With help of the following equation (3) it is possible to adjust the real circuit impedance R_i .

$$R_i = R_6 \left(\frac{R_9}{R_7} + 1 \right) \quad (3)$$

With equation (4) the resistor R_9 can be dimensioned.

$$R_9 = R_7 \left(\frac{R_i}{R_6} - 1 \right) \quad (4)$$

The capacitor C_8 has to fit with the following equation (5).

$$C_8 \geq \frac{1}{2\pi f_u \times R_9} \quad (5)$$

f_u = lower limiting frequency

With equation (6) the transmitting gain $A_{\text{trans real}}$ for a real circuit impedance can be adjusted.

$$A_{\text{trans real}} = \frac{R_9}{\left(\frac{R_i}{R_L} + 1\right)} \times S \quad (6)$$

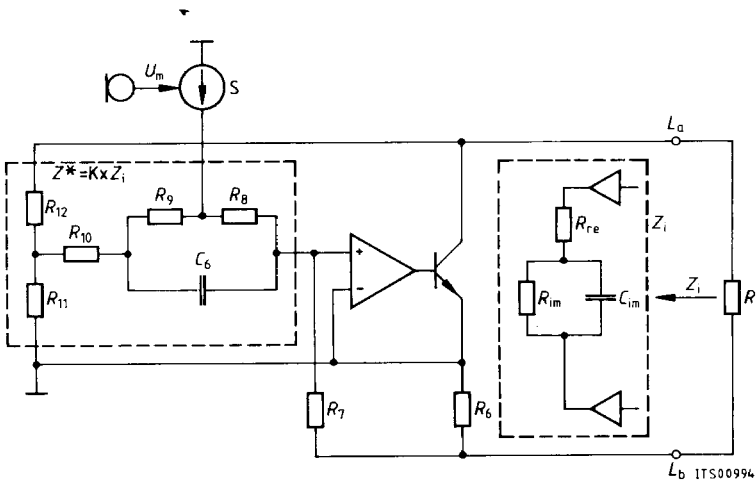
S = transconductance of the microphone (S_{mic}) or DTMF (S_{DTMF}) preamplifier

R_L = resistive load (exchange supply)

2) Active generation of a complex circuit impedance Z_i (with flat frequency response on a resistive load R_L).

Figure 7b

Equivalent Circuit for the Complex Circuit Impedance Determination



With help of the following equation (7) it is possible to adjust the complex circuit impedance Z_i .

$$Z_i = \frac{R_6}{R_7} [Z_{\text{comp}} \left(\frac{R_{12}}{R_{11}} + 1\right) + R_{12}] \text{ where } Z_{\text{comp}} = R_{10} + (R_9 + R_8) // C_6 \quad (7)$$

With equation (8) to (13) the network Z_{comp} can be dimensioned.

If we determine the impedance "Mirrorfactor" K (see figure 7b):

$$\frac{Z^*_{\text{chn}}(C_6, R_8, R_9, R_{10}, R_{11}, R_{12})}{Z_i} = K \quad (8)$$

then the components will be determined with:

$$R_7 = \frac{R_L + R_{RE}}{R_{RE} - R_6} \times \frac{R_6}{R_L} \times \frac{A}{S} \quad (9)$$

$$R_{10} + R_{11} // R_{12} = K \times (R_{RE} - R_6) \quad (10.1)$$

... one value R_{10} or $R_{11} // R_{12}$ and the ratio R_{12} / R_{11} can be freely chosen!; then:

$$R_{11} = \left(\frac{R_{11}}{R_{12}} + 1 \right) \times R_{11} // R_{12} \quad (10.2)$$

$$R_{12} = \left(\frac{R_{12}}{R_{11}} + 1 \right) \times R_{11} // R_{12} \quad (10.3)$$

$$R_8 = K \times R_{IM} \times \frac{R_L + R_6}{R_L + R_{RE}} \quad (11)$$

$$R_9 = K \times R_{IM} \times \frac{R_{RE} - R_6}{R_L + R_{RE}} \quad (12)$$

$$C_6 = \frac{C_{IM}}{K} \quad (13)$$

With equation (14) the transmitting gain $A_{\text{trans complex}}$ for a complex circuit impedance can be adjusted.

$$A_{\text{trans complex}} = \frac{\frac{R_L}{R_L + R_6}}{R_{10} \times \left(\frac{R_{12}}{R_{11}} + 1 \right) + R_{12}} + \frac{R_6}{R_7} \times S \quad (14)$$

S = transconductance of the microphone (S_{mic}) or DTMF (S_{DTMF}) preamplifier

R_L = resistive load (exchange supply)

CT (14): Anticlippping Control (ACC) & Special Microphone MUTE

In poor feeding conditions, e.g.

- very low line current and long line cable or
- two or more telephone sets in parallel operation and a long line cable
- and high microphone level

the anticlippping control prevents the transmitted signal from being distorted when the signal is reaching the maximum linear range of the output stage.

If any distortion (clipping) is sensed by the peak detector (threshold level), the gain of the microphone amplifier is reduced at once within a very short time constant to a nondistorting gain level – the ESC remains in a state of reduced gain. Without any loss, the output dynamic range is then equivalent to the input dynamic range.

How long the circuit remains in this reduced transmitting condition, is dependent on the overdrive condition. For a capacitor of $C_5 = 470$ nF the release time is approximately 6 ms for each 3 dB overdrive, respectively for each 3 dB gain reduction.

This release time is proportional to the value of C_5 at pin 14 (CT), because it is recharged by an internal current source.

The pin CT is also in use for the **special microphone MUTE**. If the pin is connected to GND the microphone preamplifier is disabled. The receiving direction remains in the active state.

MUTE (23), DTMF (22): DTMF-Interface, Adjustable Confidence Tone Gain

A low level at the MUTE pin enables the DTMF input and inhibits the microphone and receiving amplifier inputs. With high level the opposite occurs.

Switching the MUTE input causes negligible clicking in the earpiece and line.

When the DTMF input (pin 22) is enabled, dialing signals can be transmitted on the telephone line. In case of pulse dialing (interrupt of line feed) V_{REF} will be not switched off (See also: supply interface/ V_{REF}). The transconductance of the DTMF preamplifier from pin DTMF to pin TCO is typical 9 dB lower (0.35 mA/V) than the transconductance of the microphone preamplifier if LAGC = high. The DTMF gain is 9 dB lower than the microphone gain. If an AGC-level of 3 dB is selected (LAGC = low), the gain difference is only 7.5 dB (see figure 8).

The adjustment of the DTMF signal level coming from a DTMF dialer circuit to the DTMF signal level on the line is possible with the voltage divider R_3 , R_4 . C_3 is used as decoupling capacitor.

The dialing signals can be faintly heard in the earpiece (confidence tone) by using an external network C_2 and R_2 which connects the DTMF input with the RGA pin (17) (input of the earpiece power amplifier). The confidence tone gain can be adjusted with R_2 . (See equation 15).

$$A_{\text{conf.}} = \frac{V_{RO2}}{V_{\text{DTMF}}} = \frac{R_1}{R_2} \quad (15)$$

V_{DTMF} = output signal of a dialer circuit.

**RI1 (2), RI2 (10), RO2 (15), RO1 (16), RGA (17):
Receiving Amplifier Inputs and Outputs, Amplifier Adjustment**

The receiving amplifier (an OTA) is designed as a differential amplifier with two inputs. The own receiving signal from the line is sensed internally (CDC pin) via C_4 from V_{LN} . RI1 is the AC signal input from the line via the Z_{bal} network.

The pin RI2 is for the offset compensation of the output amplifier and is connected via a capacitor C_7 to SGND. The receiving preamplifier has a transconductance of typ. 1 mA/V with AGC disabled ($R_{16} = \infty$, LAGC = high; HS/SP = high). The above mentioned transconductance is influenced by AGC.

The following output amplifier is a current/voltage converter. Its gain is given by equation (16).

$$A_E = (R_1 // R_2) \times S_R \times \frac{1}{\frac{1}{A_O} + \frac{R_2}{R_1 + R_2}} \quad (16)$$

Receiving Gain Adjustment for Differential Input Signal and Asymmetrical Output with DTMF Confidence Tone Coupling.

S_R = transconductance of the receiving preamplifier
 $A_O = 5000$

RO1 and RO2 are the two complementary outputs. Both outputs may be operated in symmetrical or asymmetrical mode, depending on the sensitivity and type of the earpiece. Amplification from RI1 to RO1 is adjustable in a wide range with R_1 . This is sufficient for magnetic or dynamic earpieces of low impedance. These earpieces are suitable for asymmetrical operation. Using both outputs enables differential drive, and amplification is increased by 6 dB. Differential drive should be chosen if the earpiece impedance exceeds 450 Ω (high-impedance dynamic, magnetic or piezoelectric earpieces).

Between RO1 and RGA a resistor R_1 and a capacitor C_1 in parallel are connected; C_1 is necessary for stability of the receiving amplifier.

Sidetone Suppression

For good sidetone suppression it is possible to adjust the Z_{bal} network with the following equation (17).

$$\frac{Z_{\text{bal}}}{Z_{\text{LINE}}} = \frac{R_{13}}{R_6} \quad (17)$$

Standard values for R_{13} and R_6 are: $R_{13} = 1 \text{ k}\Omega$; $R_6 = 10 \text{ }\Omega$

Equation (18) is the result:

$$Z_{\text{bal}} = 100 \cdot Z_{\text{LINE}} \quad (18)$$

Equation (19) describes the attenuation of the antisidetone bridge in receiving direction A_{rec} .

$$A_{\text{rec}} = \frac{\Delta V_{\text{RI}}}{\Delta V_{\text{ab}}} = \frac{R_6}{R_i} + \frac{R_{13}}{R_{13} + Z_{\text{bal}}} \left(1 - \frac{R_6}{R_i} \right) \quad (19)$$

ΔV_{RI} = differential signal at pin RI1 (2)

ΔV_{ab} = differential signal on line ($L_a - L_b$)

LAGC (18), IAGC (1), HS/ $\overline{\text{SP}}$ (24):

Line Current Dependent AGC Control Input and Corresponding Pins

Connecting a resistor R_{16} between IAGC and GND enables automatic line loss compensation (current dependent AGC). The automatic gain control varies microphone and receive gain according to the DC line current. A control range of 6 dB corresponds to a line length of 5 km for a twisted copper pair cable of 0.5 mm diameter, a DC resistance of 176 Ω /km and an average attenuation of 1.2 dB/km.

The AGC control range can be switched from 6 dB to 3 dB by connecting pin 18 (LAGC) to GND. For 6 dB control range this pin should be left open. Switching affects not the slope of the attenuation dependent on the line current; it has only an influence on the endpoint (lower current value) of the AGC control range. At pin IAGC it is possible to adjust the start point (threshold current) of the AGC control range. The resistor R_{16} adjusts I_{start} . See equation (20).

$$R_{16} = R_6 \frac{I_{\text{start}}}{13.5 \text{ mA}} \quad (20)$$

From equation (20) it is possible to get the AGC start point adjustment for $R_6 = 10 \text{ }\Omega$:

$$R_{16} [\text{k}\Omega] = 0.74 \cdot I_{\text{start}} [\text{mA}]$$

With open circuit on pin IAGC the start point is $I_{start} = \infty$ (AGC disabled). In this case microphone and receive amplifiers are operated at maximum gain.

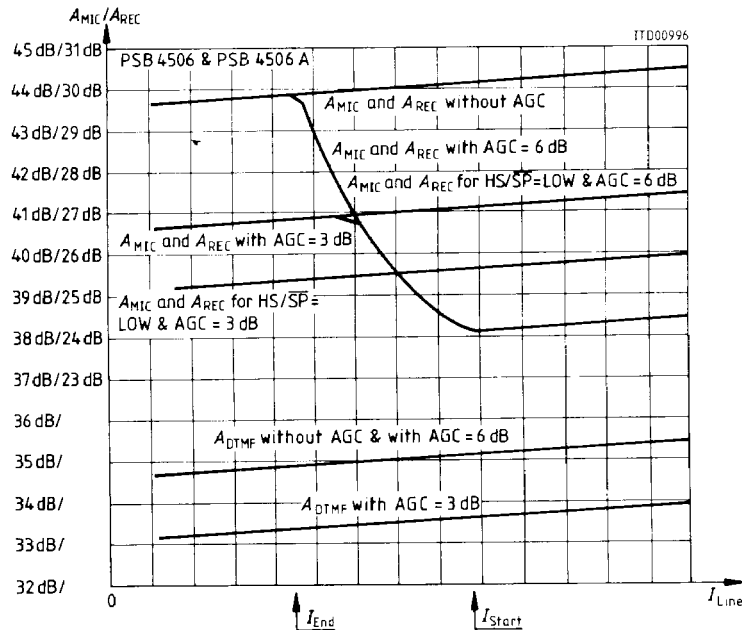
The ratio between I_{start} and I_{end} is fixed – it is approximately 2 at 6 dB AGC range and 1.4 at 3 dB AGC range, because the slope of the AGC control range is constant.

The pin HS/SP (24) is used in loudhearing or hands-free operation. If this pin is connected to GND (= low) the microphone and receiving gain will cut back and fixed to the middle of the control range – the microphone and receiving amplifiers have a constant gain (3 dB lower at a 6 dB control range and 1.5 dB lower at a 3 dB control range) – (see figure 8).

If AGC is not required, the AGC inputs should not be connected.

Figure 8

The Gain of the Microphone- (Receive-) and DTMF-Path as a Function of the Line Current in Dependence from the AGC- and HS/SP-Application Conditions



Electrical Characteristics

Absolute Maximum Ratings

(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values	Unit
Continuous positive line voltage (pins 5, 6)	V_{LP}, V_{LS}	12	V
Repetitive positive peak voltage on line (pins 5, 6) – during line interruption or AC modulation	V_{LP}, V_{LS}	15	V
Repetitive positive peak voltage on V_{LP}, V_{LS} (pins 5, 6) $t_{\text{puls}}/t_{\text{pause}} = \text{max. } 1 \text{ ms}/5 \text{ s}$	V_{LP}, V_{LS}	24	V
Continuous negative line voltage (pin 11)	V_{LN}	- 2	V
Repetitive negative peak voltage (pin 11)	$V_{LN \text{ peak}}$	- 3	V
Line current ($R_s = 10 \Omega$)	I_L	140	mA
Maximal positive voltage peak on pins with clamping diodes to V_{CC2} (pin # 1,2,3,4,8,9,10,14, 15,16,17,18,19,20,22,25,26,27,28)	$V_{I+ \text{ peak}}$	$V_{CC2} + 0.7$	V
Maximal positive voltage on logical input pins (pin # 23,24)	V_I	7	V
Maximal negative voltage peak on pins with clamping diodes to SGND (pin # 1,2,3,4,5,6,7,8,9, 10,14,15,16,17,18,19,20,22,23,24,25,26,27,28)	$V_{I- \text{ peak}}$	$V_{SGND} - 0.7$	V
Maximal negative voltage (pin # 11,12,13)	V_I	- 3	V
Operating temperature	T_A	- 20 to 70	°C
System (chip-)temperature	T_i	125	°C
Thermal resistance to ambient	R_{thA}	55	K/W
Total power dissipation	P_{tot}	850	mW
Storage temperature	T_{stg}	- 40 to 125	°C

DC Line Characteristics

(without AC signals; $V_{LP} = V_{LS}$);
(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

DCA1 = open; DCA2 = V_{LN} ($V_{LO} = 3\text{ V}$; $R_{DIFF} = 100\ \Omega$) (fig. 10a + fig. 9)

Positive line voltage V_{LP} (pins 6 or 7 or 8) at $I_L = 10\text{ mA}$; $I_{CC2} = 0$ to -5 mA $I_L = 20\text{ mA}$; $I_{CC2} = 0$ to -15 mA $I_L = 40\text{ mA}$; $I_{CC2} = 0$ to -35 mA $I_L = 60\text{ mA}$; $I_{CC2} = 0$ to -55 mA	V_{LP}	3.5	3.9	4.3	V
		4.3	4.8	5.3	V
			6.6		V
		7.6	8.4	9.2	V
Negative line voltage V_{LN} (pins 11 to 8) at $I_L = 20\text{ mA}$; $I_{CC2} = 0$ to -15 mA $I_L = 40\text{ mA}$; $I_{CC2} = 0$ to -35 mA	$-V_{LN}$		0.2		V
			0.4		V
Differential DC line resistance ($V_{LP+} + I_{V_{LN}}$) _{40 mA} - ($V_{LP-} + I_{V_{LN}}$) _{20 mA}	R_{DIFF}	90	100	110	Ω
Variation with temperature	$\Delta V/\Delta T$		t.b.n.		V/°C

DCA1 = GND; DCA2 = open ($V_{LO} = 4.9\text{ V}$; $R_{DIFF} = 10\ \Omega$) (fig. 10 a + fig. 9)

Positive line voltage V_{LP} (pins 6 or 7 to 8) at $I_L = 20\text{ mA}$; $I_{CC} = 0$ to -15 mA $I_L = 40\text{ mA}$; $I_{CC2} = 0$ to -35 mA $I_L = 80\text{ mA}$; $I_{CC2} = 0$ to -75 mA $I_L = 120\text{ mA}$; $I_{CC2} = 0$ to -110 mA	V_{LP}	4.5	4.9	5.3	V
			4.9		V
			4.9		V
			5.0		V
Negative line voltage V_{LN} (pins 11 to 8) at $I_L = 40\text{ mA}$; $I_{CC2} = 0$ to -15 mA $I_L = 80\text{ mA}$; $I_{CC2} = 0$ to -35 mA	$-V_{LN}$		0.4		V
			0.8		V
Differential DC line resistance ($V_{LP+} + I_{V_{LN}}$) _{80 mA} - ($V_{LP-} + I_{V_{LN}}$) _{40 mA}	R_{DIFF}	9.0	10	110	Ω

DCA1 = GND; DCA2 = V_{LN} ($V_{LO} = 5.5\text{ V}$; $R_{DIFF} = 100\ \Omega$) (fig.10 a + fig. 9)

Positive line voltage V_{LP} (pins 6 or 7 to 8) at $I_L = 20\text{ mA}$; $I_{CC2} = 0$ to -15 mA	V_{LP}	6.5	7.1	7.7	V
Differential DC line resistance	R_{DIFF}	90	100	110	Ω

DCA1 = 1.1 k Ω ; DCA2 = $R_{17} = 4.7\text{ k}\Omega$ ($V_{LO} = 4.05\text{ V}$; $R_{DIFF} = 55\ \Omega$) (fig. 10 a + fig. 9)

Positive line voltage V_{LP} (pins 6 or 7 to 8) at $I_L = 20\text{ mA}$; $I_{CC2} = 0$ to -15 mA	V_{LP}		4.9		V
Differential DC line resistance	R_{DIFF}	50	55	61	Ω

DC Line Characteristics

(without AC signals; $V_{LP} = V_{LS}$);
(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

Power Supply Unit ($R_6 = 10 \Omega$; DCA1 = open; DCA2 = V_{LN}) ($V_{LO} = 3 \text{ V}$; $R_{DIFF} = 100 \Omega$)
(fig. 10 b + fig. 9)

V_{CC2} (pins 5 to pin 8) ($I_L = 10 \text{ mA}$ to 80 mA ; $I_{CC1} = I_{CC2} = 0$)							
	PSB 4506 PSB 4506 A	V_{CC2} V_{CC2}	$V_{LP} - 1$ $V_{LP} - 1$		5.5 6.9	V V	
$I_L = 20 \text{ mA}$: $V_{CC2} = (V_{LAC} = 0 \text{ V}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = 0 \text{ V}; V_{CC2} = 3.5 \text{ V})$ $V_{CC2} = (V_{LAC} = + 4 \text{ dBm}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = + 4 \text{ dBm}; V_{CC2} = 3.5 \text{ V})$			4.0 17 4.9 7.5		V mA V mA		
	PSB 4506 $I_L = 40 \text{ mA}$: $V_{CC2} = (V_{LAC} = 0 \text{ V}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = 0 \text{ V}; V_{CC2} = 3.5 \text{ V})$ $V_{CC2} = (V_{LAC} = + 4 \text{ dBm}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = + 4 \text{ dBm}; V_{CC2} = 3.5 \text{ V})$		4.5 35	5.1 37 5.1 36		V mA V mA	
		PSB 4506A $I_L = 60 \text{ mA}$: $V_{CC2} = (V_{LAC} = 0 \text{ V}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = 0 \text{ V}; V_{CC2} = 3.5 \text{ V})$ $V_{CC2} = (V_{LAC} = + 4 \text{ dBm}; I_{CC1} = I_{CC2} = 0)$ $I_{CC2} = (V_{LAC} = + 4 \text{ dBm}; V_{CC2} = 3.5 \text{ V})$		5.7 53	6.5 55 6.4 53		V mA V mA
			V_{CC1} (pin 28 to pin 8) ($V_{CC2} = V_{CC1} + 0.5 \text{ V}$; $I_{CC1} = 0$ to 5 mA) $V_{C1C} = V_{CC1}$ (pin 27 to pin 28) $V_{C1C} = \text{open}$ $V_{C1C} = \text{GND}$	V_{CC1}	2.3 2.8 3.3	2.45 3.0 3.55	2.60 3.15 3.75
						-5 -6	-10 -15
						5	mA

DC Line Characteristics

(without AC signals; $V_{LP} = V_{LS}$);
(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

Power Supply Unit ($R_6 = 10 \Omega$; DCA1 = open; DCA2 = V_{LN}) ($V_{LO} = 3 \text{ V}$; $R_{DIFF} = 100 \Omega$)
(fig. 10 b + fig. 9)

V_{REF} (pin 25 to pin 8)	V_{REF}	1.23	1.26	1.29	V
ΔV_{REF} ($\Delta I_{REF} = 150 \mu\text{A}$ from pin 25)				- 1.2	mA
ΔV_{REF} ($\Delta I_{REF} = 150 \mu\text{A}$ into pin 25)				1.5	mV
$I_{REF \text{ max}}$ ($\Delta V_{REF} \leq 2.5 \text{ mV}$)				200	μA

At Line Interrupt

V_{REF} (pin 25 to pin 8) at MUTE = LOW The above mentioned values are true.					
V_{REF} (pin 25 to pin 28) at MUTE = HIGH without RL on the line ($V_{CC2} \geq 2.7 \text{ V}$; $I_{REF} = + 10 \mu\text{A}$) $V_{LP} < 1.1 \text{ V}$ negative slope delay time ($C_{12} = 100 \text{ nF}$; $V_{REF} = 0.8 \text{ V}$) $V_{LP} \geq 1.3 \text{ V}$ positive slope delay time ($C_{12} = 100 \text{ nF}$; $V_{REF} = 1.2 \text{ V}$)	$V_{REF \text{ nsl}}$ t_{dnl} $V_{REF \text{ psi}}$ t_{dpl}	1.2	0.5 1.26	0.8 2 1	V ms V ms

AC Characteristics (fig. 10 c + fig. 9)

(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

Transmit Direction

($R_5 = 120 \text{ k}\Omega$; $R_6 = 10 \text{ }\Omega$; $R_7 = 5,37 \text{ k}\Omega$; $R_9 = 317 \text{ k}\Omega$; $DCA2 = V_{LN}$; $DCA1 = \text{open}$;
 $R_L = 600 \text{ }\Omega$)

MICROPHONE MUTE (pin 23) = HIGH					
Microphone input impedance differential between pin 19 and 20 single ended (pin 19 or 20 to V_{REF})	$R_{i \text{ DIFF}}$ $R_{i \text{ single}}$	48 24	60 30	72 36	$\text{k}\Omega$
Microphone voltage amplification (pin 20 to V_L) – CT (pin 14) open (only C_5) without AGC ($I_{AGC} = \text{open}$; $I_{LAGC} = \text{open}$; $HS/\overline{SP} = \text{open}$) $I_L = 20 \text{ mA}$; $V_{LAC} \leq +4 \text{ dBm}$ variation with $I_L = 15 \text{ mA}$ to 80 mA variation with frequency (300 Hz to 3.4 kHz)	$A_{MIC(0)}$	43	44	45 1 0.5	dB dB dB
with AGC: $\Delta A = +6 \text{ dB}$ ($I_{LAGC} = \text{open}$; $R_{16} = 33 \text{ k}\Omega$) $I_L \geq 50 \text{ mA}$; $V_{LAC} \leq +4 \text{ dBm}$; $HS/\overline{SP} = \text{HIGH}$ $I_L \geq 20 \text{ mA}$; $V_{LAC} \leq +4 \text{ dBm}$; $HS/\overline{SP} = \text{HIGH}$ $I_L \geq 15 \text{ mA}$ to 80 mA ; $HS/\overline{SP} = \text{LOW}$	$A_{MIC(6)}$	37 43	38 44 41	39 45	dB dB dB
with AGC: $\Delta A = +3 \text{ dB}$ ($I_{LAGC} = \text{LOW}$; $R_{16} = 33 \text{ k}\Omega$) $I_L \geq 50 \text{ mA}$; $V_{LAC} \leq +4 \text{ dBm}$; $HS/\overline{SP} = \text{HIGH}$ $I_L \geq 30 \text{ mA}$; $V_{LAC} \leq +4 \text{ dBm}$; $HS/\overline{SP} = \text{HIGH}$ $I_L \geq 15 \text{ mA}$ to 80 mA ; $HS/\overline{SP} = \text{LOW}$	$A_{MIC(3)}$	37 40	38 41 39.5	39 42	dB dB dB
Microphone MUTE (CT pin 14) = LOW Reduction of microphone voltage amplification	$A_{MIC \text{ red}}$	70			dB
DTMF MUTE (pin 23) = LOW Reduction of microphone voltage amplification	$A_{MIC \text{ red}}$	70			dB
DTMF input impedance		24	30	36	$\text{k}\Omega$

AC Characteristics (fig. 10 c + fig. 9)

(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	
Transmit Direction (continued)					
(R ₅ = 120 kΩ; R ₆ = 10 Ω; R ₇ = 5,37 kΩ; R ₉ = 317 kΩ; DCA2 = V _{LN} ; DCA1 = open; R _L = 600 Ω)					
DTMF voltage amplification (pin 22 to Line) PSB 4506/4506A – has a fixed gain which is dependent from the adjusted AGC level: without AGC (IAGC = open; LAGC = open; HS/SP = open) for ΔA = + 6 dB (LAGC = open; R ₁₆ = 33 kΩ) ΔA = + 3 dB (LAGC = LOW; R ₁₆ = 33 kΩ)	A _{DTMF}		35		dB
			35		dB
			33.5		dB
Anticlippping function (I _L = 20 mA) Threshold level; d _{tot} ≤ 2 % distortion at 10 dB overdrive on microphone inputs at 15 dB overdrive on microphone inputs Attack time for ACC; C ₅ = Release time for each 3 dB overdrive; C ₅ =	V _{LAC (rms)}		t.b.n.		V
				t.b.n.	%
	f _{att}		t.b.n.	t.b.n.	%
	f _{rel}		t.b.n.	t.b.n.	ms
Noise output voltage on Line in transmitting direction (psophometrical weighted – CCITT) I _L = 20 mA; R _L = 600 Ω; ΔA = 44 dB; 8 kΩ/22 nF between MIC inputs (pins 19 and 20)	V _{no}		- 75	- 72	dBmp

AC Characteristics (fig. 10 d + fig. 9)
(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

Receiving Direction

($R_5 = 120 \text{ k}\Omega$; $R_6 = 10 \text{ }\Omega$; $R_1 = 33 \text{ k}\Omega$; $R_2 = 33 \text{ k}\Omega$)

MUTE (pin 23) = HIGH Input impedance (pin 2; RI1)	$R_{i \text{ single}}$	24	30		$\text{k}\Omega$
Voltage amplification single ended (pin 2 to pin 15 or 16) capacitive coupled $R_{\text{Load}} \geq 100 \text{ }\Omega$ on RO1 or RO2					
without AGC (IAGC = open; LAGC = open; HS/ $\overline{\text{SP}}$ = open) $I_L = 20 \text{ mA}$; $V_{\text{RO1}} \leq 250 \text{ mV}_{\text{rms}}$ variation with $I_L = 10 \text{ mA}$ to 80 mA variation with frequency (300 Hz to 3.4 kHz)	$A_{R \text{ single}}$	29	30	31 1 0.5	dB dB dB
with AGC: $\Delta A = +6 \text{ dB}$ (LAGC = open; $R_{16} = 33 \text{ k}\Omega$) $I_L \geq 50 \text{ mA}$; $V_{\text{RO1}} \leq 250 \text{ mV}_{\text{rms}}$; HS = HIGH $I_L \leq 20 \text{ mA}$; $V_{\text{RO1}} \leq 250 \text{ mV}_{\text{rms}}$; HS = HIGH $I_L = 10 \text{ mA}$ to 80 mA ; HS/ $\overline{\text{SP}}$ = LOW		23 29	24 30 27	25 31	dB dB dB
with AGC: $\Delta A = +3 \text{ dB}$ (LAGC = open; $R_{16} = 33 \text{ k}\Omega$) $I_L \geq 50 \text{ mA}$; $V_{\text{RO1}} \leq 250 \text{ mV}_{\text{rms}}$; HS = HIGH $I_L \leq 20 \text{ mA}$; $V_{\text{RO1}} \leq 250 \text{ mV}_{\text{rms}}$; HS = HIGH $I_L = 10 \text{ mA}$ to 80 mA ; HS/ $\overline{\text{SP}}$ = LOW		23 26	24 27 25.5	25 28	dB dB dB
Voltage amplification differential (pin 2 to pin 15, 16) for $R_{\text{Load}} \geq 150 \text{ }\Omega$; $V_{\text{RO1/2}} \leq 500 \text{ mV}_{\text{rms}}$	$A_{R \text{ DIFF}}$			$A_{R \text{ single}}+6$	dB
MUTE (pin 23) = LOW Reduction of voltage amplification from RI1 to RO1 or RO2	ΔA	65			dB
Amplification for external driving (confidence tone) into pin 17 (RGA) through $R_2 = 33 \text{ k}\Omega$ single ended differential drive	$A_{\text{DTMFsingle}}$ A_{DTMFDIFF}	-0.5 5.5	0 6	0.5 6.5	dB dB
Noise output voltage on RO1/ RO2 in receiving direction between pin 15 and (psophometrical weighted – CCITT) differential $R_{\text{Load}} \leq 1 \text{ k}\Omega$	V_{no}		80	120	μV

AC Characteristics (fig. 10 c + fig. 9)

(all parameters are measured to GND or SGND)

Parameter	Symbol	Limit Values			Unit
		min.	typ.	max.	

Control Inputs (fig. 9)

MUTE input (pin 23)					
Input voltage HIGH	V_{IH}	1.5		7	V
Input voltage LOW	V_{IL}			0.45	V
Input current ($V_{MUTE} = V_{IL}$)				-10	μ A
Reduction of voltage amplification (MUTE = HIGH) from DTMF input (pin 22) to Line		70			dB
(MUTE = LOW) from MIC input (pin 19, 20) to Line from RI1 input (pin 2) to RO1 or RO2 (pin 16 or 15)		70 65			dB dB
Microphone MUTE input CT (pin 14) (MUTE = HIGH)					
Input voltage HIGH	V_{IH}		open		
Input voltage LOW	V_{IL}			1	V
Reduction of voltage amplification (CT = LOW) from MIC input (pin 19, 20) to Line		70			dB
LAGC input (pin 18)					
Input voltage HIGH	V_{IH}	2.0		7	V
Input voltage LOW	V_{IL}			0.45	V
Input current ($V_{LAGC} = V_{IL}$)			-3	-10	μ V
HS/\overline{SP} input (pin 24)					
Input voltage HIGH	V_{IH}	2.0		7	V
Input voltage LOW	V_{IL}			0.45	V
Input current ($V_{HS} = V_{IL}$)			-3	-10	μ A

Figure 9
Basic Test Circuit

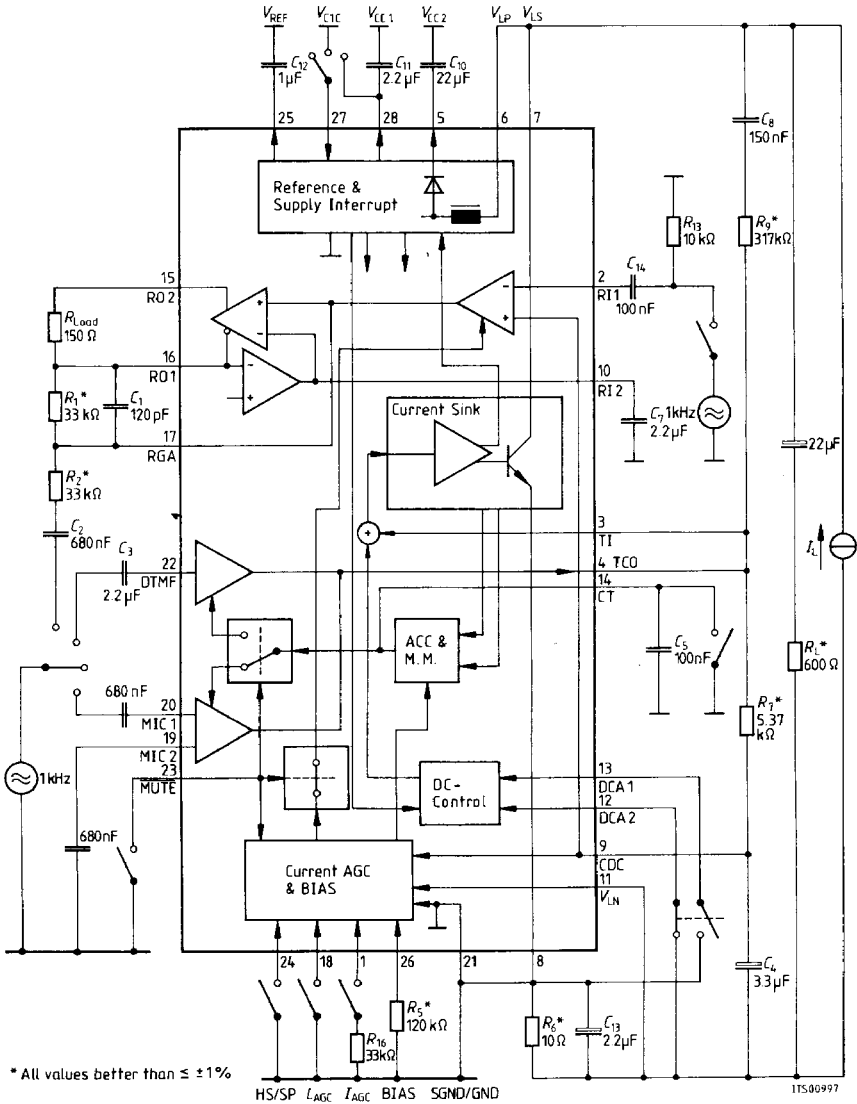


Figure 10 a
Test Circuit for DC-Line Characteristics

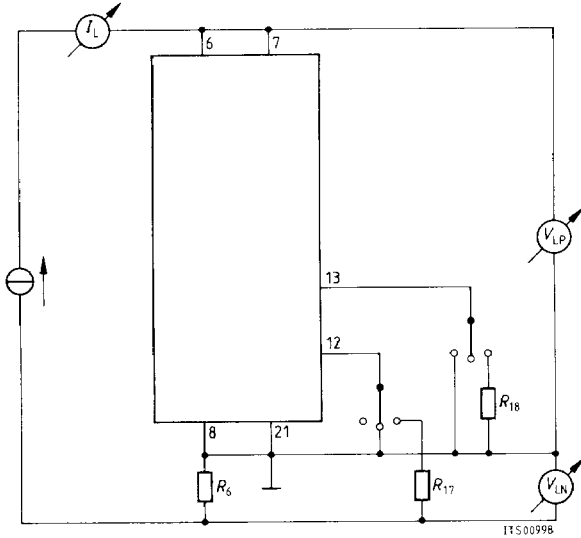


Figure 10 b
Test Circuit for Power Supply Unit

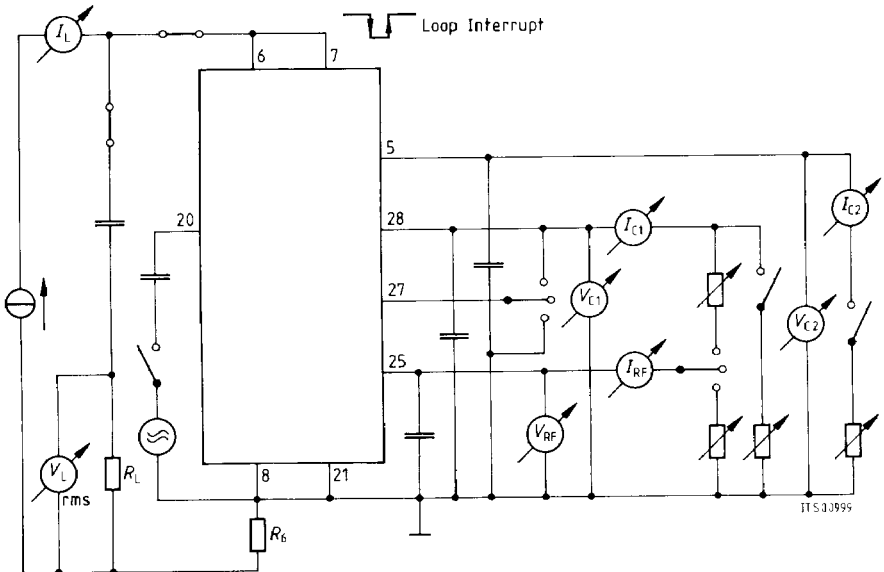


Figure 10 c
Test Circuit for AC-Characteristics in Transmit Direction

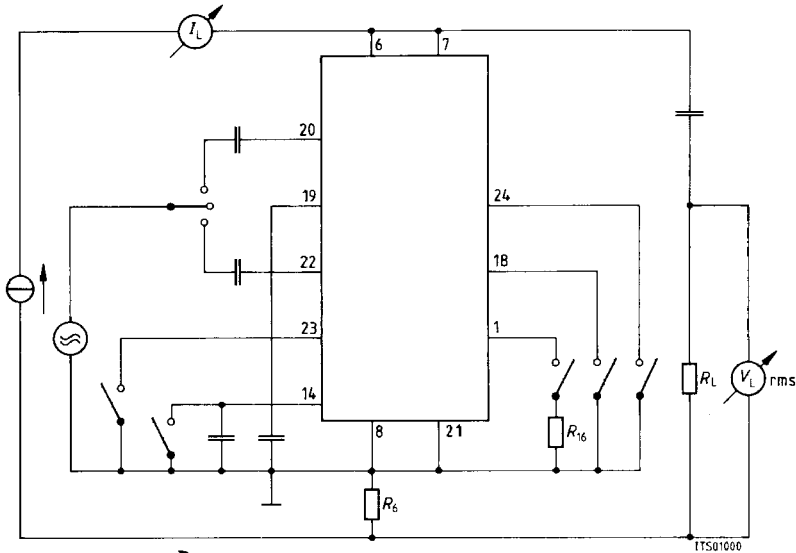


Figure 10 d
Test Circuit for AC-Characteristics in Receive Direction

