Ordering number : ENN7736

Monolithic Linear IC

LA8511

Telephone Speech Network IC

Overview

The LA8511 is a telephone system IC that includes both a speech network circuit and a BTL power amplifier.

Applications

– Cordless telephones, telephone answering machines, and multifunction telephones

Functions

- Speech network
  2-wire to 4-wire conversion circuit, impedance matching circuit, line driver, transmitter amplifier, BTL receiver amplifier, transceiver gain (pad) control, DTMF input, key tone input, handset selection switch, muting switch, and extension call power supply switching circuit.
- BTL power amplifier and power amplifier circuit current cutoff function

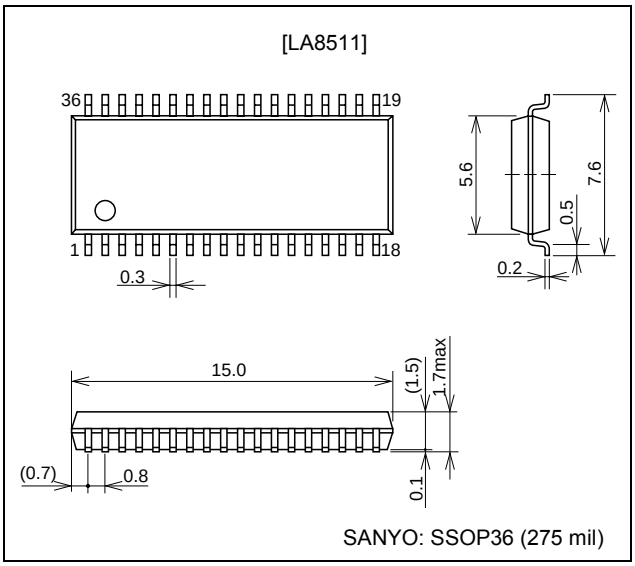
Features

- Includes power supply switching circuits for the transmitter/receiver amplifiers and other circuits, and thus allows extension-to-extension calls using handsets without drawing current from the telephone line.
- The receiver amplifier supports both ceramic and dynamic receivers.
  – Ceramic receiver ⇒ BTL configuration
  – Dynamic receiver ⇒ single configuration
- Built-in low-voltage drive ($V_{CC} \geq 2.7$ V or higher) BTL power amplifier (load: 8 to 16Ω)
  – Maximum output power 1: 200 mW (V_{CC} = 3.3 V, RL = 8Ω)
  – Maximum output power 2: 250 mW (V_{CC} = 5.0 V, RL = 16Ω)

Package Dimensions

units: mm

3247A-SSOP36



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_L$max		15	V
	V_{CC}max		7	V
Line current	$I_L$max		130	mA
Allowable power dissipation	Pdmax	Ta ≤ 70°C ∗	800	mW
Operating temperature	Topr		–20 to +70	°C
Storage temperature	Tstg		–40 to +150	°C

∗: Mounted on a glass epoxy board: 114.3 mm × 76.1 mm × 1.6 mm

SANYO Electric Co.,Ltd. Semiconductor Company
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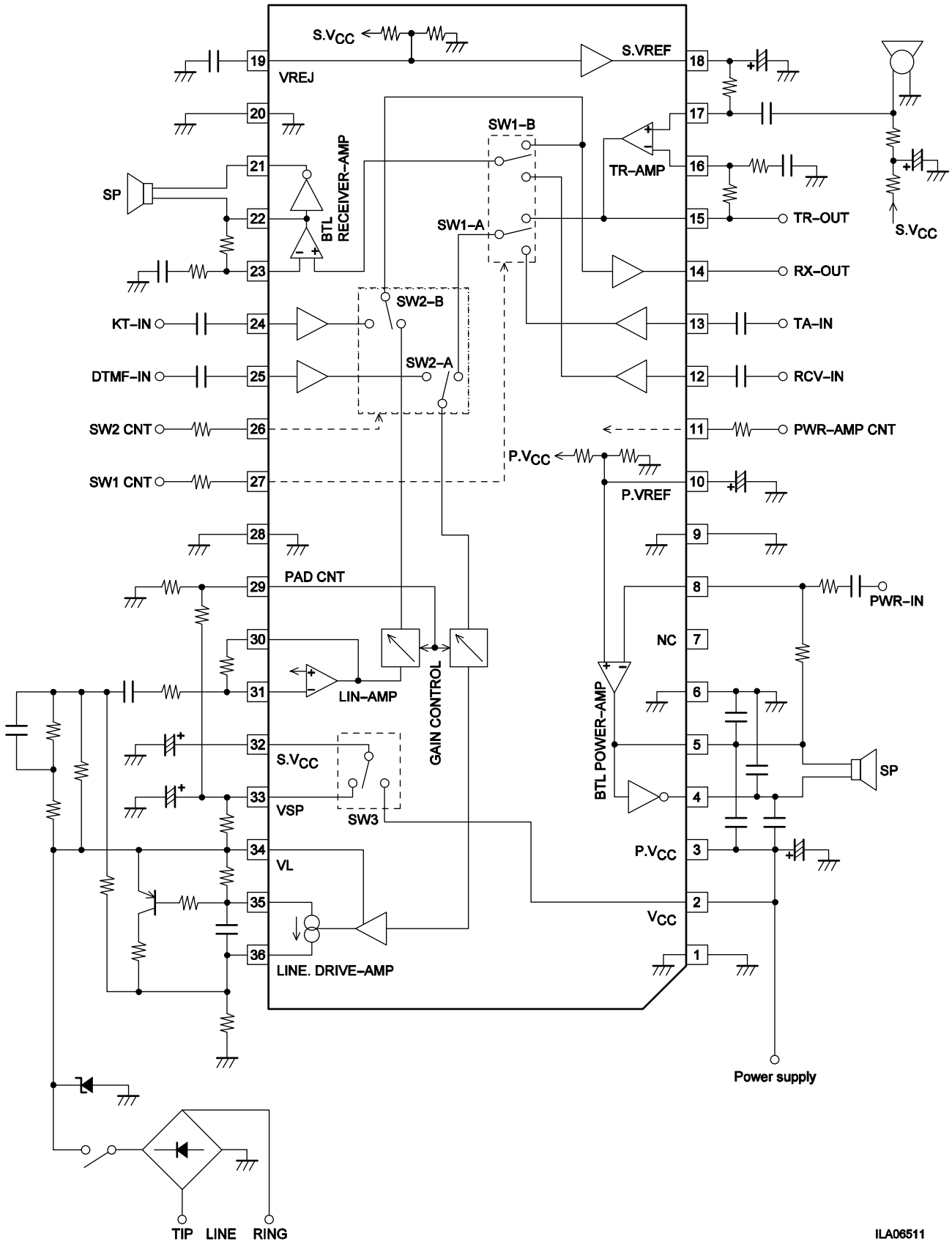
Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC} (2/3 pin)		3.3	V
Allowable operating supply voltage range	V_{CC} (2/3 pin)		2.7 to 5.5	V

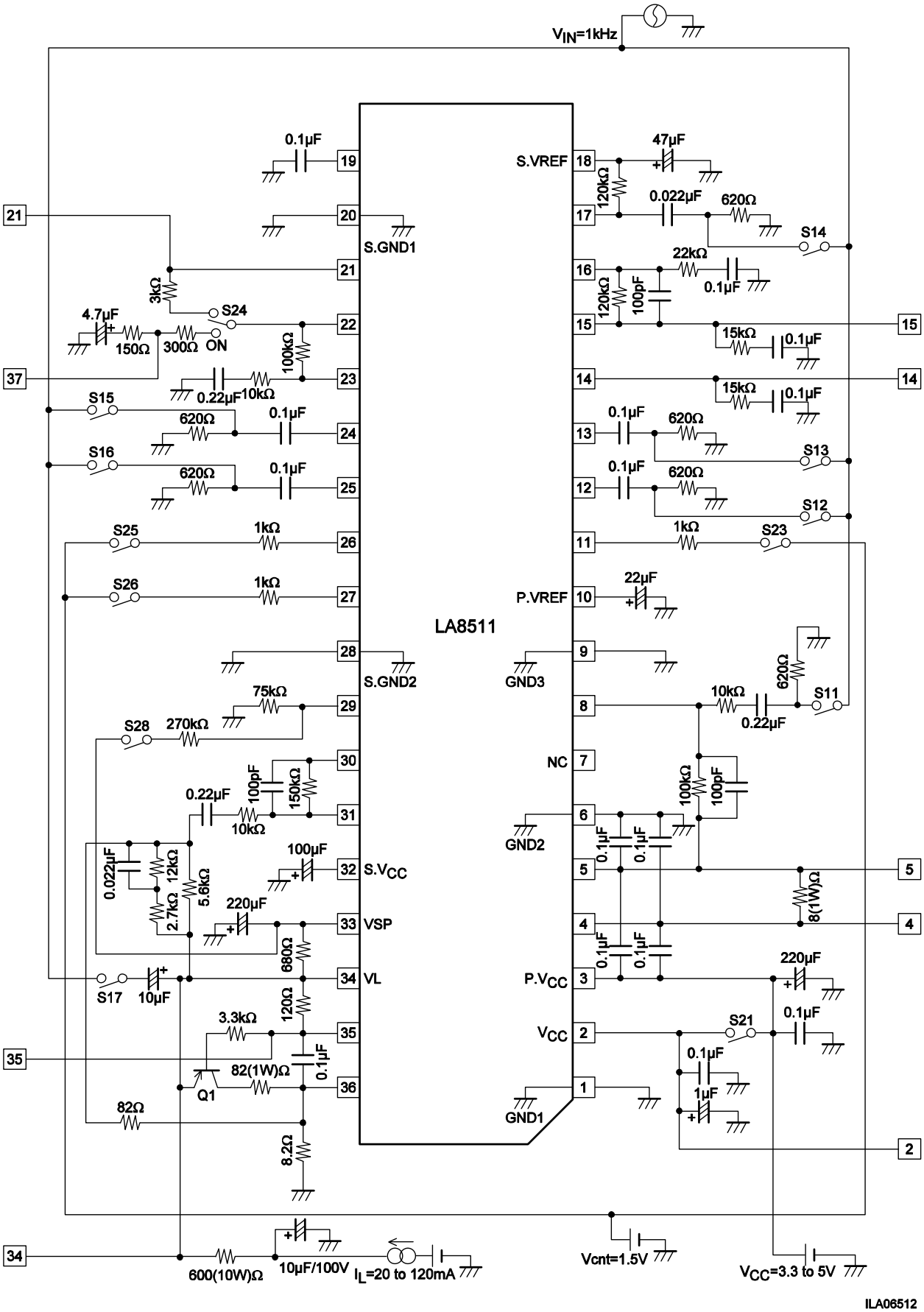
Electrical Characteristics at Ta = 25°C, V_{CC} = 3.3 V, fin = 1 kHz

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Speech Network Block] : PAD-CNT Switch ON						
Line voltage (20 mA)	VL1	IL = 20 mA	3.26	3.8	4.24	V
Line voltage (50 mA)	VL2	IL = 50 mA	5	5.75	6.6	V
Line voltage (120 mA)	VL3	IL = 120 mA	8.9	10.7	12.4	V
Transmit gain (20 mA)	GTR1	IL = 20 mA, V_{IN} = −45 dBV	42.8	44.8	46.8	dB
Transmit gain (120 mA)	GTR2	IL = 120 mA, V_{IN} = −45 dBV	41.1	43.1	45.1	dB
TA gain (20 mA)	GTA1	IL = 20 mA, V_{IN} = −30 dBV	26.5	28.5	30.5	dB
TA gain (120 mA)	GTA2	IL = 120 mA, V_{IN} = −30 dBV	24.6	26.6	28.6	dB
DTMF gain (20 mA)	GDT1	IL = 20 mA, V_{IN} = −30 dBV	26.8	28.8	30.8	dB
DTMF gain (120 mA)	GDT2	IL = 120 mA, V_{IN} = −30 dBV	25	27	29	dB
Transmit dynamic range (20 mA)	DRTR1	IL = 20 mA, THD = 4%	2.5	6.5	–	Vp-p
Transmit dynamic range (120 mA)	DRTR2	IL = 120 mA, THD = 4%	4.5	14	–	Vp-p
Transmit noise level	VNTR	IL = 20 mA, Rg = 620 Ω, 20 to 20 kHz	–	0.45	1.1	mVrms
Receiver gain (20 mA, ceramic)	GRVB1	IL = 20 mA, V_{IN} = −20 dBV, Output: pin 21	8.6	10.6	12.6	dB
Receiver gain (120 mA, ceramic)	GRVB2	IL = 120 mA, V_{IN} = −20 dBV, Output: pin 21	3.4	5.4	7.4	dB
Receiver gain (20 mA, dynamic)	GRV1	IL = 20 mA, V_{IN} = −20 dBV	−1.2	+0.8	+2.8	dB
Receiver gain (120 mA, dynamic)	GRV2	IL = 120 mA, V_{IN} = −20 dBV	−6	−4	−2	dB
RX gain (20 mA)	GRX1	RL = 15 kΩ, IL = 20 mA, V_{IN} = −20 dBV	−11.5	−9.5	−7.5	dB
RX gain (120 mA)	GRX2	RL = 15 kΩ, IL = 120 mA, V_{IN} = −20 dBV	−17.2	−15.2	−13.2	dB
RCV gain (20 mA)	GRCV1	IL = 20 mA, V_{IN} = −30 dBV, Output: pin 21	18.1	20.1	22.1	dB
RCV gain (120 mA)	GRCV2	IL = 120 mA, V_{IN} = −30 dBV, Output: pin 21	18.7	20.7	22.7	dB
KT gain (20 mA)	GKT1	IL = 20 mA, V_{IN} = −30 dBV, Output: pin 21	18.1	20.1	22.1	dB
KT gain (120 mA)	GKT2	IL = 120 mA, V_{IN} = −30 dBV, Output: pin 21	18.7	20.7	22.7	dB
Receiver noise level	VNRV	IL = 20 mA, 20 to 20 kHz, Output: pin 21	–	0.8	2	mVrms
Receiver BTL dynamic range (20 mA)	DRRB1	RL = 3 kΩ, IL = 20 mA, THD = 10%	2	4	–	Vp-p
Receiver BTL dynamic range (120 mA)	DRRB2	RL = 3 kΩ, IL = 120 mA, THD = 10%	5	11	–	Vp-p
Receiver dynamic range (20 mA)	DRRS1	RL = 150 Ω, IL = 20 mA, THD = 10%	0.3	0.65	–	Vp-p
Receiver dynamic range (120 mA)	DRRS2	RL = 150 Ω, IL=120 mA, THD = 10%	0.5	1.9	–	Vp-p
Transmit PADC attenuation	PADT	IL = 120 mA, PADC– off/on difference	2.1	3.1	4.1	dB
Receiver PADC attenuation	PADR	IL = 120 mA, PADC– off/on difference	4.8	5.8	6.8	dB
SW1/SW2 control high-level voltage	VHC1	IL = 20 mA to 120 mA, (pins 26 and 27)	1.5	–	–	V
SW1/SW2 control low-level voltage	VLC1	IL = 20 mA to 120 mA, (pins 26 and 27)	0	–	0.4	V
SW3 control high-level voltage	VHC2	IL = 20 mA to 120 mA, (pin 33)	1.5	–	–	V
SW3 control low-level voltage	VLC2	IL = 20 mA to 120 mA, (pin 33)	0	–	0.5	V
Internal supply voltage (20 mA)	$SV_{CC}1$	IL = 20 mA, (pin 32)	–	2.2	–	V
Internal supply voltage (120 mA)	$SV_{CC}2$	IL = 120 mA, (pin 32)	–	6.1	–	V
Internal reference voltage (20 mA)	SVREF1	IL = 20 mA, (pin 18)	–	0.95	–	V
Internal reference voltage (120 mA)	SVREF2	IL = 120 mA, (pin 18)	–	2.7	–	V
[BTL Power Amplifier Block]						
Quiescent current 1	$I_{CC}1$	When IL is off, no signal, (pins 2 and 3)	–	11.3	18	mA
Quiescent current 2	$I_{CC}2$	When IL is on, no signal, (pins 2 and 3)	–	8.7	14	mA
Standby current drain	ISTBY	Pin 11 = high, no signal, (pin 3)	–	85	150	μA
Standby control high-level voltage	VHC3	(pin 11)	1.5	–	–	V
Standby control low-level voltage	VLC3	(pin 11)	0	–	0.4	V
BTL voltage gain	GBPWR	RL = 8 Ω, V_{IN} = −30 dBV	23.4	25.4	27.4	dB
BTL maximum output power 1	POMX1	RL = 8 Ω, THD = 10%	200	275	–	mW
BTL maximum output power 2	POMX2	RL = 16 Ω, THD = 10%, V_{CC} = 5 V	250	540	–	mW
Total harmonic distortion	THDP	RL = 8 Ω, V_{IN} = −30 dBV	–	0.8	1.5	%
Ripple rejection ratio	SVRR	Rg = 620 Ω, fr = 100 Hz, Vr = −20 dBV	40	50	–	dB
Output noise voltage	VNPWR	Rg = 620 Ω, 20 to 20 kHz	–	15	50	μVrms

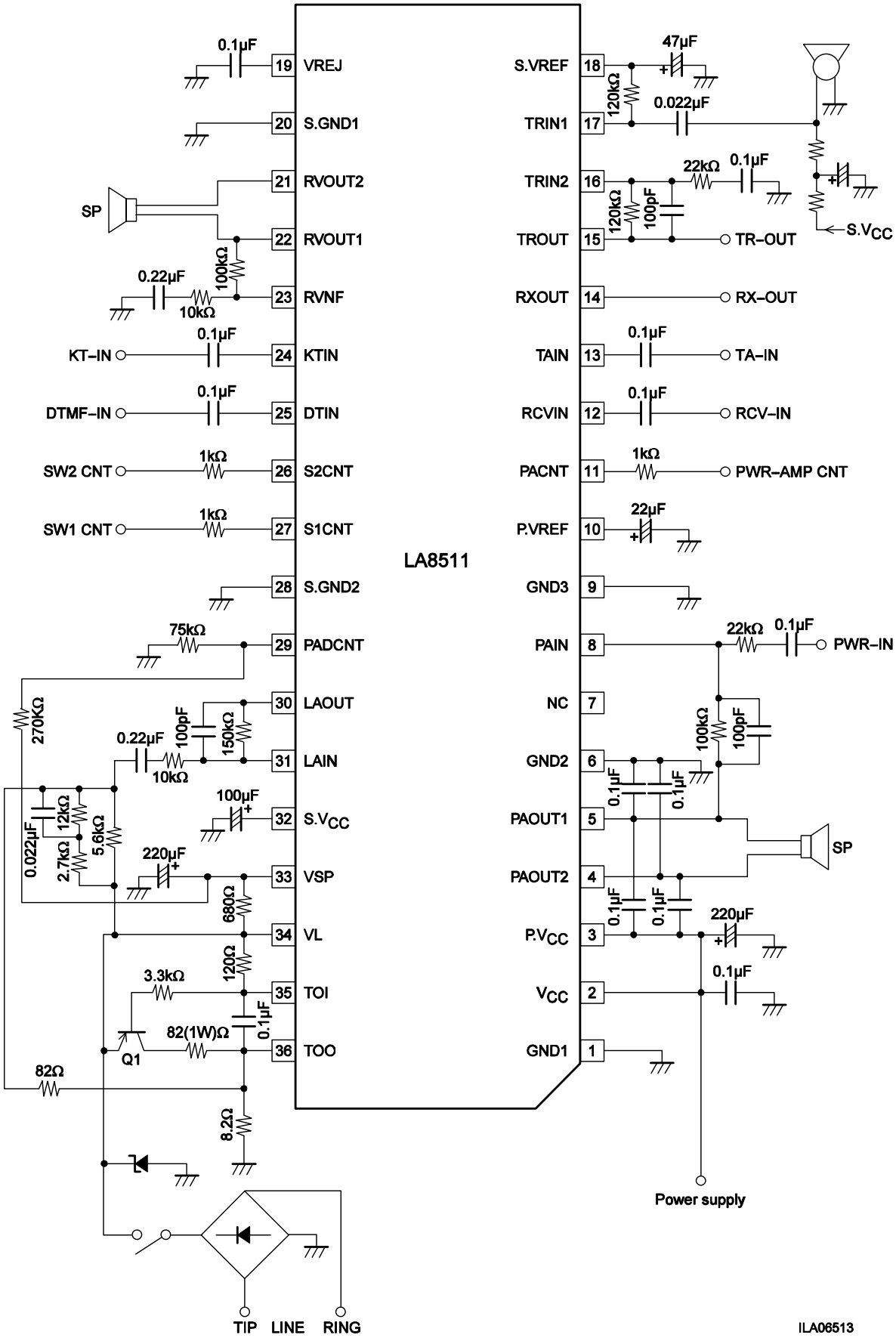
Block Diagram



Test Circuit



Sample Application Circuit



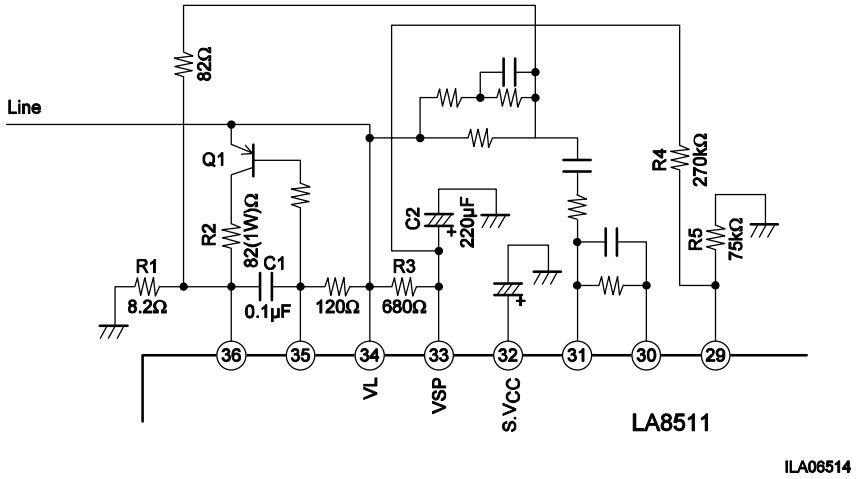
LA8511 Usage Notes

1. External Drive Transistor

Due to allowable power dissipation considerations, the heat dissipating transistor Q1 is connected as shown in figure 1 to dissipate the line current outside the IC. The allowable power dissipation of the resistors R1 and R2 must be determined based on the expected maximum value of the line current. (Component values are provided as examples for reference purposes only.)

Note that capacitor C1 (about 0.1 μF) must be added if oscillation occurs due to the nature of the load between VL and ground.

Figure 1



2. DC Resistance Conversion

The DC resistance can be changed by changing the value of resistor R1 shown in figure 1.

However, note that the transmit gain and balancing network conditions will also change.

3. AC Impedance Determination

The AC impedance is basically determined by R3 (680 Ω) and C2 (220 μF) shown in figure 1.

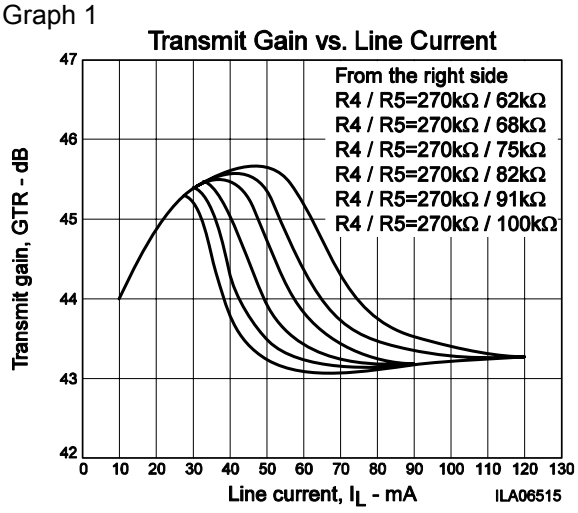
If there are any other AC loads in addition to the speech network connected to the line, the total AC impedance must be set to match the speech network impedance.

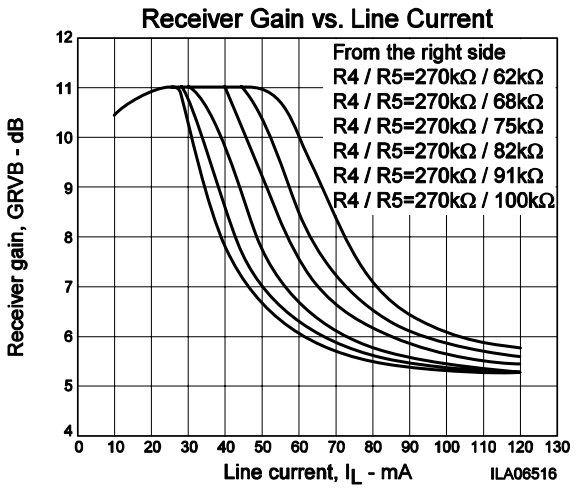
Note that if a variable resistor is used for R3, it will also change the DC resistance.

4. Pad Control

Pin 29 is the transmission/receiver gain control pin, and is connected to the comparator input block. The threshold voltage is about 0.65 V. To change the pad control start point, change the division ratio for the divider resistors R4 and R5 shown in figure 1. (See graph 1.)

Graph 1

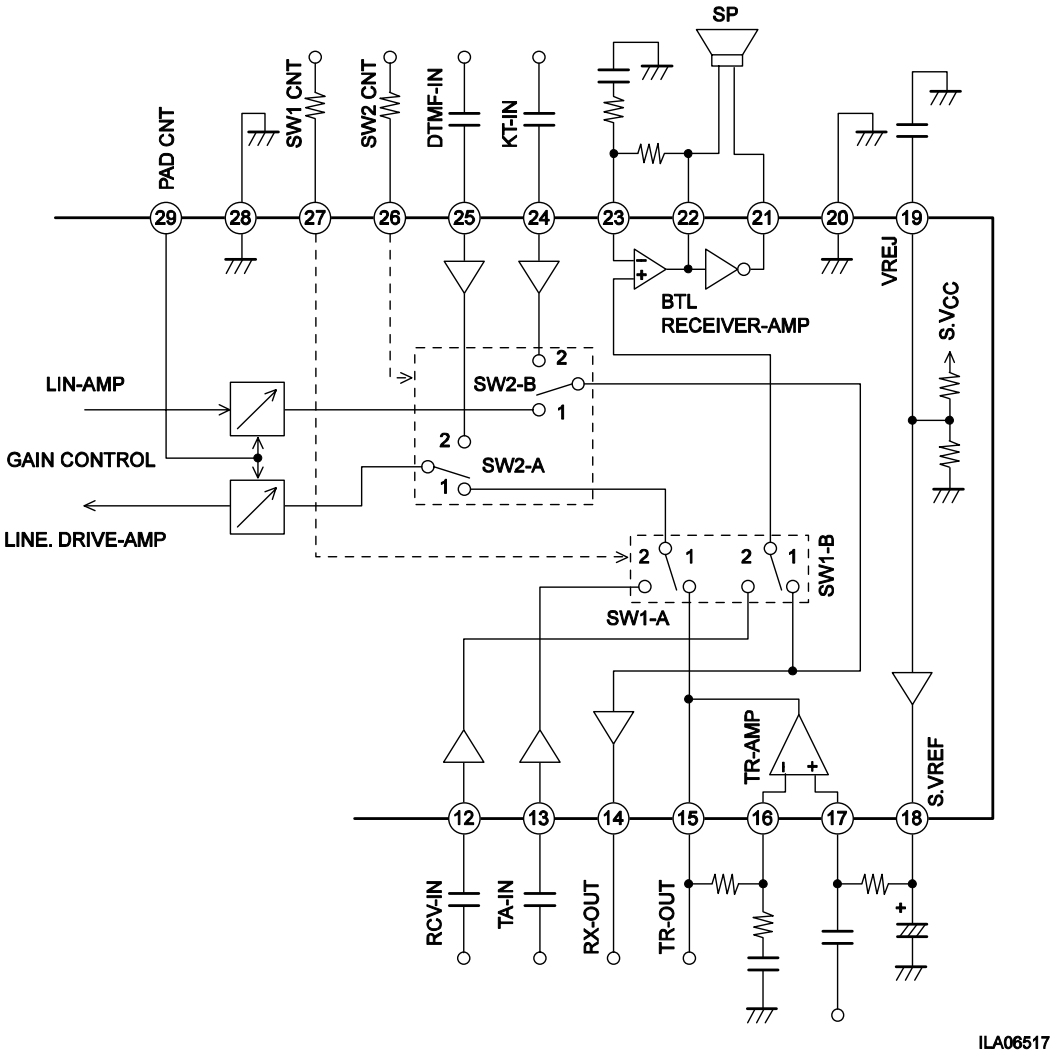




5. Internal Analog Switch Operation

Switches SW1-A and SW1-B (A and B are linked) are controlled from pin 27, and switches SW2-A and SW2-B (A and B are linked) are controlled from pin 26.

Figure 2



SW1-A/B Operation

Pin 27 state	Usage	SW1-A	SW1-B
Low/open	Used for the handset microphone and speaker	1	1
High	Used for paths other than the handset	2	2

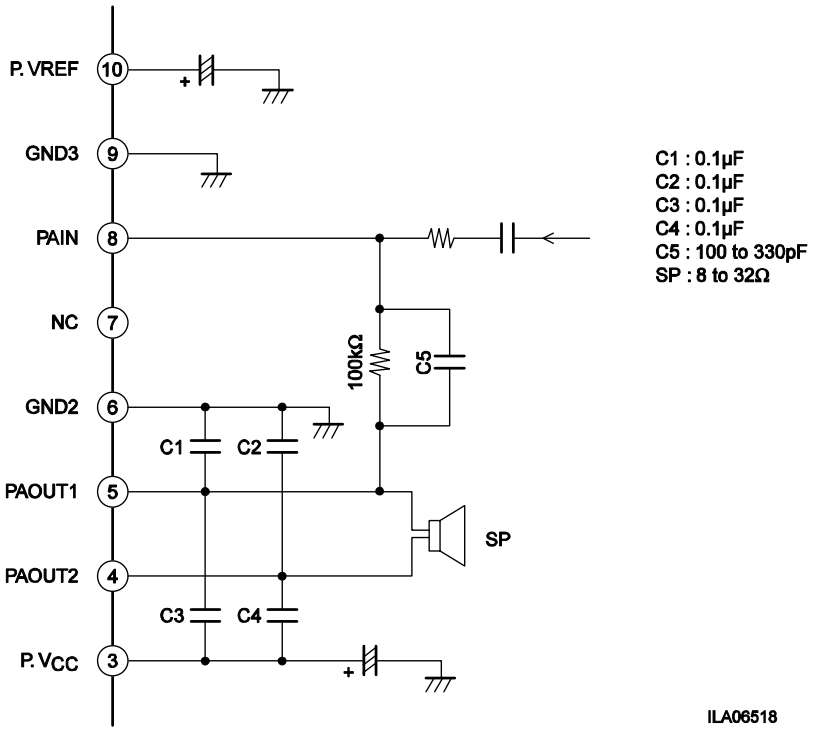
SW2-A/B Operation

Pin 26 state	Usage	SW2-A	SW2-B
Low/open	Used for audio system signal bypass	1	1
High	Used for audio system muting (DTMF/KT input)	2	2

6. Power Amplifier Phase Compensation Capacitors (Component values are provided for reference purposes.)

Of the external components, the capacitors C1, C2, C3, and C4 are the power amplifier phase compensation capacitors. If these components are positioned away from their corresponding pins in the PWB layout, the phase compensation effect may be reduced due to impedance considerations, and high band oscillation may occur. Therefore we recommend that these four capacitors, especially C1 and C2, be located as close as possible to the IC pin in the PWB layout. However, if the relationship with the layout results in conditions conducive to oscillation, we can also recommend phase compensation methods that use resistors (roughly 1 to 2.2 Ω) inserted in series with these capacitors.

The capacitor C5 is connected in parallel with the feedback resistor to reduce high band noise. However, this capacitor can cause phase delay in the feedback path, and certain values may cause high band parasitic oscillation. Therefore, the time constant of the feedback resistor and C5 must be kept under 33 μs (sample values for reference: 100 kΩ, 330 pF).



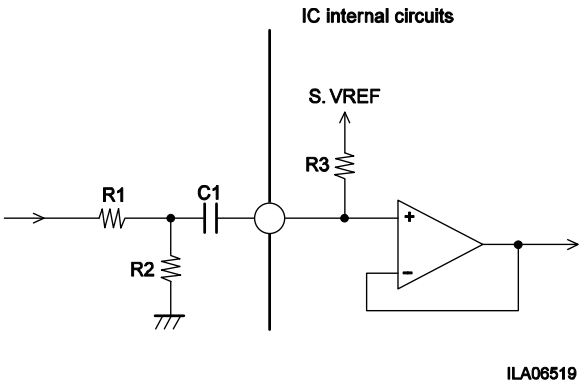
7. Input Block (pins 12, 13, 24, and 25) Signal Attenuation

To attenuate the signal at the input block, insert a series resistor in the signal path. The ratio of that resistor to the internal resistor R3 determines the attenuation ratio.

However, note that the variations in the value of the internal semiconductor resistor are larger than those of commonly used carbon resistors, and that these variations can result in variations in the amount of attenuation provided by this circuit. To minimize these variations, we recommend using two resistors as shown in figure 3, which minimizes the effect of the variations in the internal resistor R3.

Application designs must take into account the fact that the internal resistor has sample-to-sample variations of 20%.

Figure 3



8. Control Input Pins (Pins 11, 26, and 27)

The LA8511 provides both built-in pull-down resistors and built-in input current limiting resistors. Furthermore, since the high side protection diodes have been eliminated, it is possible to directly connect the microcontroller to the LA8511 even if the power supply voltages differ.
However, we recommend inserting series resistors (about 1 to 2.2 kΩ) since direct connection with the microcontroller output ports can influence the substrate and lead to degradation of the signal-to-noise ratio.

9. Speech Network System Internal Power Supply Pin (Pin 32)

Pin 32 (S. V_{CC}) supplies power through the power supply switch SW3. When pin 33 (VSP) is over 1.5 V, power is supplied from pin 32, and when pin 33 is under 0.5 V, power is supplied from pin 2 (V_{CC}).

10. ESD Protection Diodes

Pins without protection diodes:	Pins 1, 6, 9, 20, 28.
Pins with only low side protection diodes:	Pins 2, 3, 11, 26. 27, 32, 33, 34, 35, 36
Pins with both low and high side protection diodes:	All other pins

11. Shorting Between Pins

The IC may be damaged or destroyed if power is applied when any pins are shorted together. After mounting this IC on a circuit board, always verify that there is no solder or other material shorting adjacent pins together before applying power.

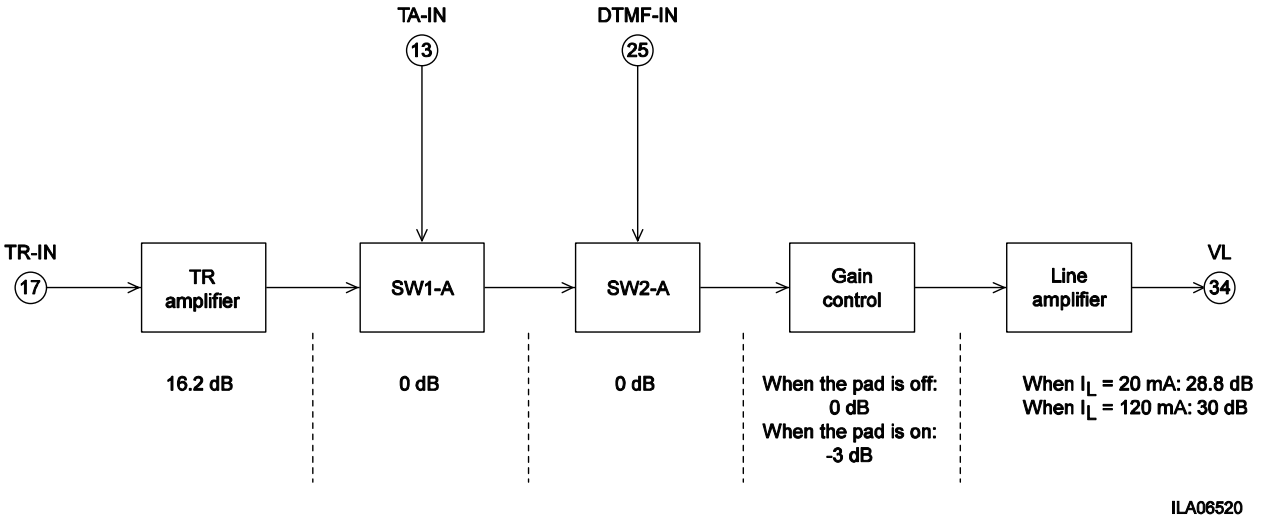
12. Load Shorting

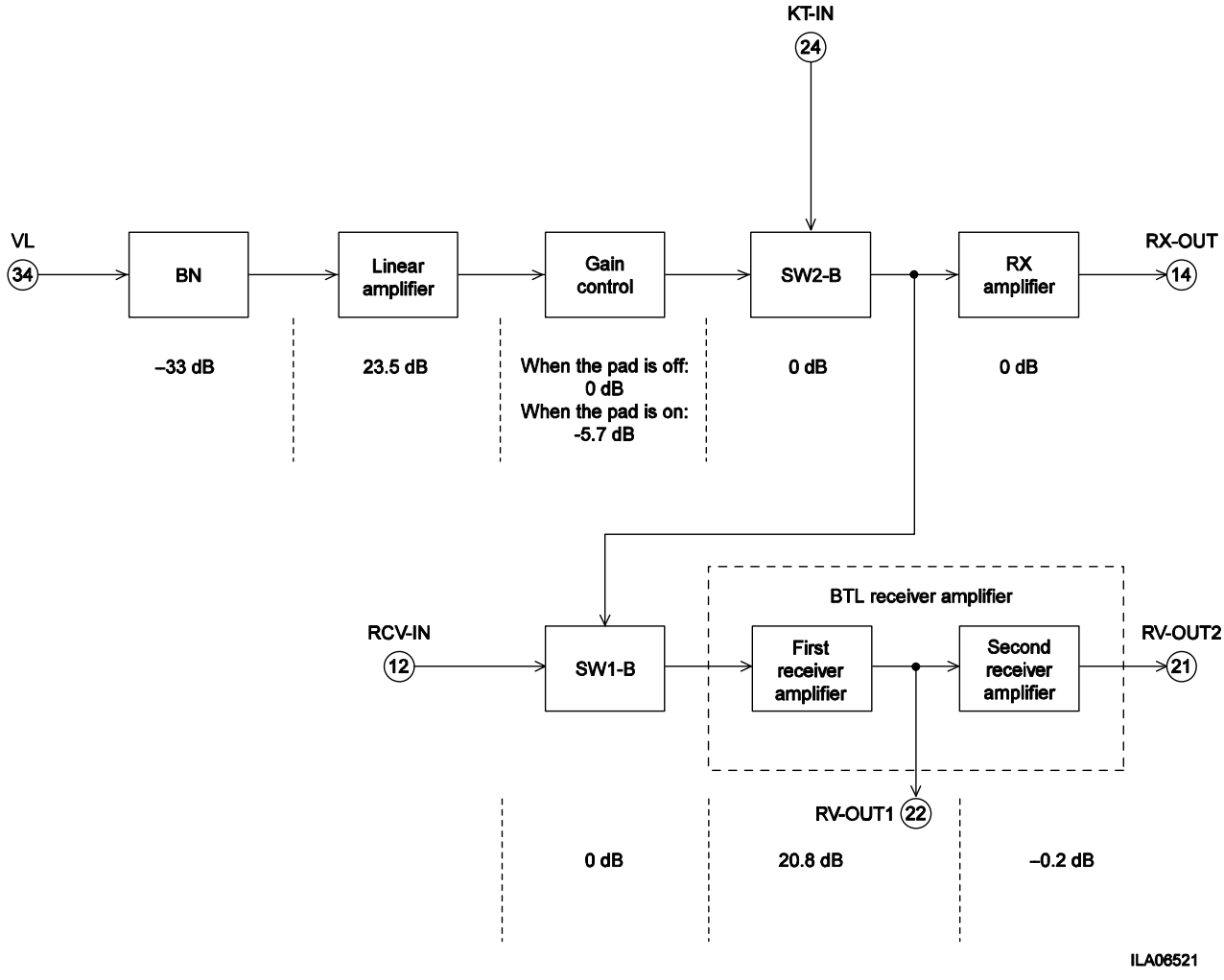
The IC may be damaged or destroyed if operated with the load shorted for extended periods of time. Never operate this IC in the load shorted state.

13. Maximum Ratings

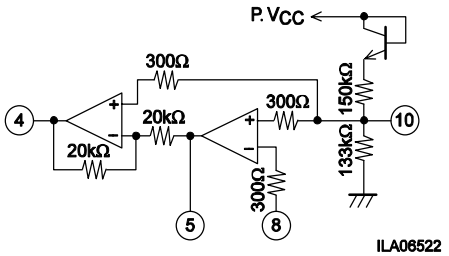
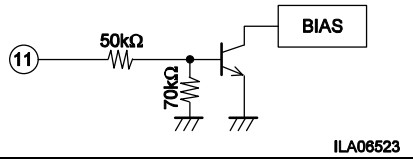
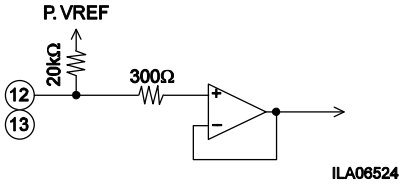
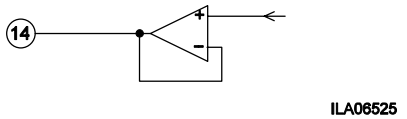
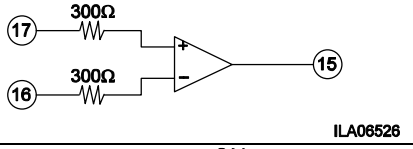
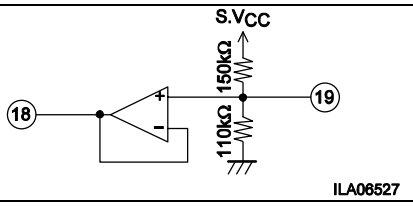
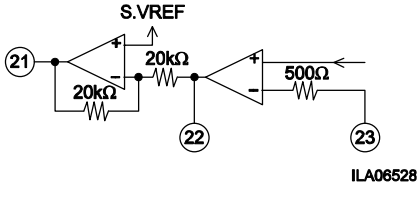
If this IC is operated near the maximum ratings, the maximum ratings may be exceeded by even slight variations in operating conditions, and that could lead to destruction of the IC. Therefore, adequate margins for fluctuations in the supply voltage must be provided, and the IC must be used in ranges such that the maximum ratings are never exceeded.

Speech Network Block Level Diagrams





Pin Functions (When V_{CC} = 3.3 V, IL = 20 mA)

Pin No.	Pin Name	Pin Voltage (V)	Remarks	Equivalent Circuit
1	GND1	–	First ground pin	
2	V_{CC}	Voltage applied	Switch SW3 power supply	
3	$P.V_{CC}$	Voltage applied	BTL power amplifier power supply	
6	GND2	–	Second ground pin	
7	NC	–	Unused	
9	GND3	–	Third ground pin	
4	PAOUT2	1.25	BTL power amplifier output 2	
5	PAOUT1	1.25	BTL power amplifier output 1	
8	PAIN	1.25	BTL power amplifier minus input	
10	P.VREF	1.25	BTL power amplifier reference voltage	
11	PACNT	0	BTL power amplifier circuit current control	
12	RCVIN	–	Switch SW1-B input 2	
13	TAIN	0.95	Switch SW1-A input 2	
14	RXOUT	0.95	Switch SW2-B output	
15	TROUT	0.95	Handset microphone amplifier output	
16	TRIN2	0.95	Handset microphone amplifier minus input	
17	TRIN1	0.95	Handset microphone amplifier plus input	
18	S.VREF	0.95	Speech network reference voltage	
19	VREJ	0.95	Ripple suppression	
20	S.GND1	–	Speech network first ground	
21	RVOUT2	0.95	BTL receiver amplifier output 2	
22	RVOUT1	0.95	BTL receiver amplifier output 1	
23	RVNF	0.95	BTL receiver amplifier gain setting	

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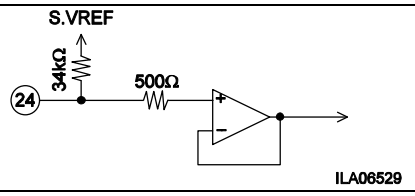
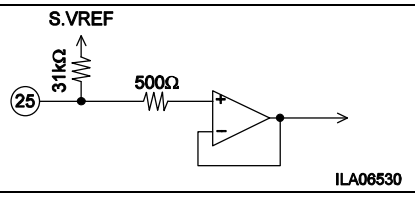
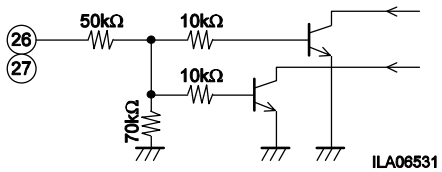
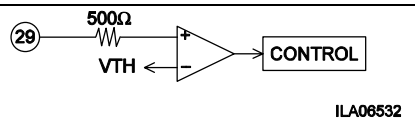
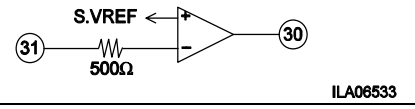
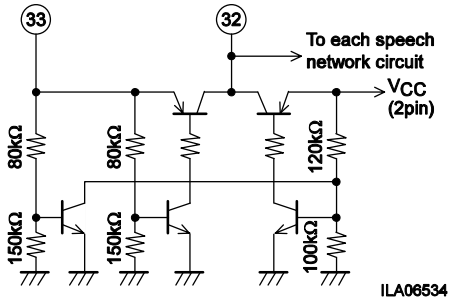
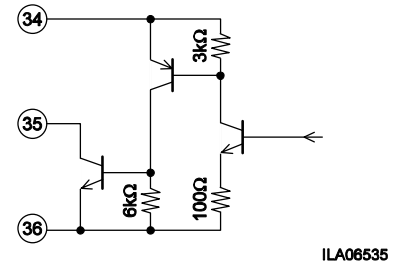
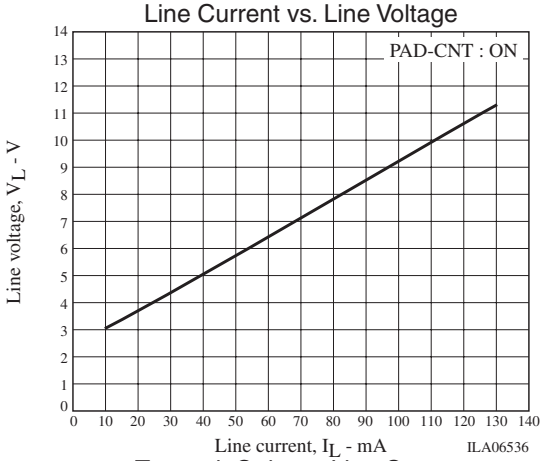
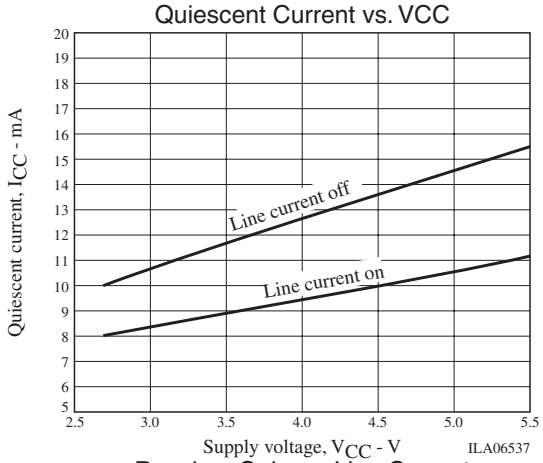
Pin No.	Pin Name	Pin Voltage (V)	Remarks	Equivalent Circuit
24	KTIN	0.95	Switch SW2-B input 2	
25	DTIN	0.95	Switch SW2-A input 2	
26	S2CNT	0	Switch SW2 control	
27	S1CNT	0	Switch SW1 control	
28	S.GND2	–	Speech network second ground	
29	PADCNT	0.5	Pad curve control	
30	LAOUT	0.95	Line input amplifier output	
31	LAIN	0.95	Line input amplifier minus input	
32	S. V_{CC}	2.2	Speech network system internal power supply (SW3 output)	
33	VSP	2.35	Speech network system power supply	
34	VL	3.8	Line current input (line voltage)	
35	TOI	2.9	Transmit output current sink	
36	TOO	0.15	Transmit output current source	

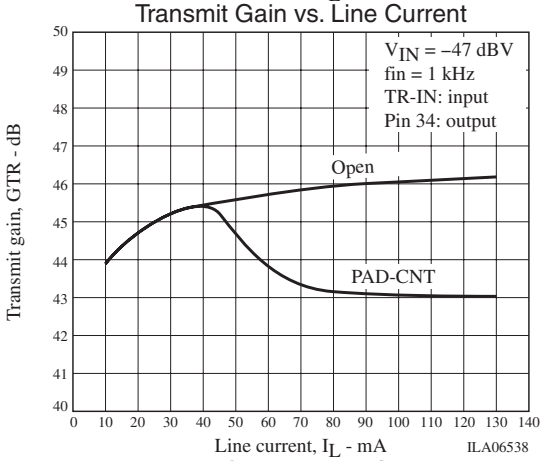
Line Current vs. Line Voltage



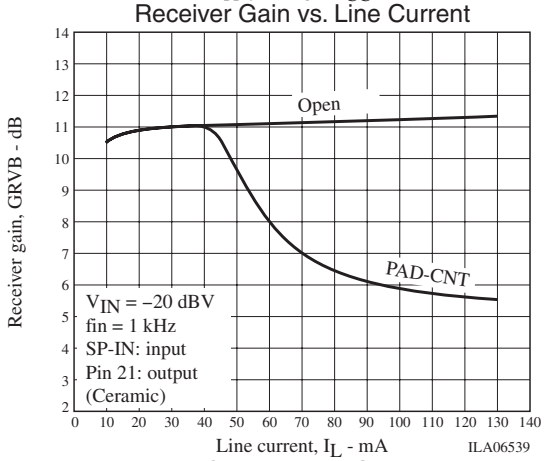
Quiescent Current vs. VCC



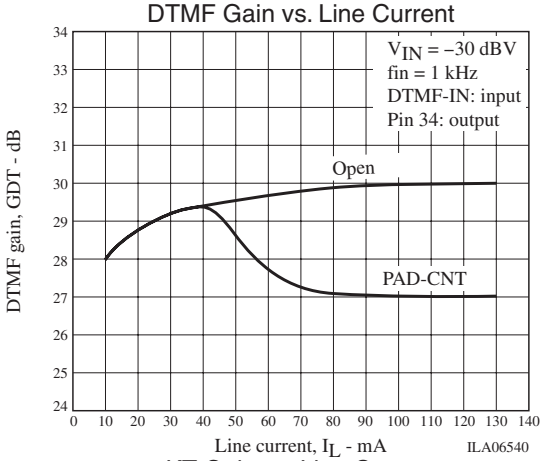
Transmit Gain vs. Line Current



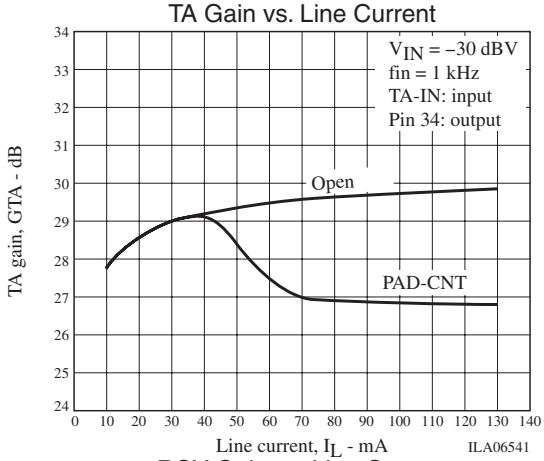
Receiver Gain vs. Line Current



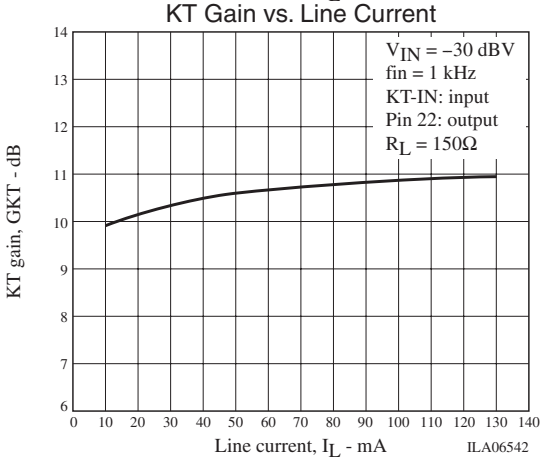
DTMF Gain vs. Line Current



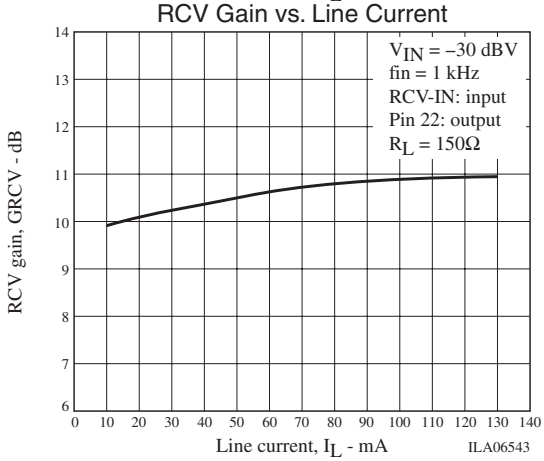
TA Gain vs. Line Current



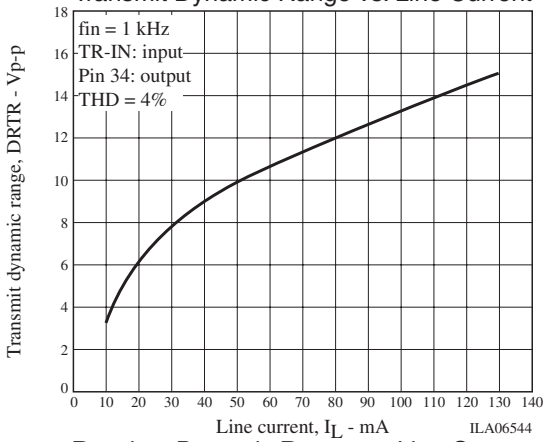
KT Gain vs. Line Current



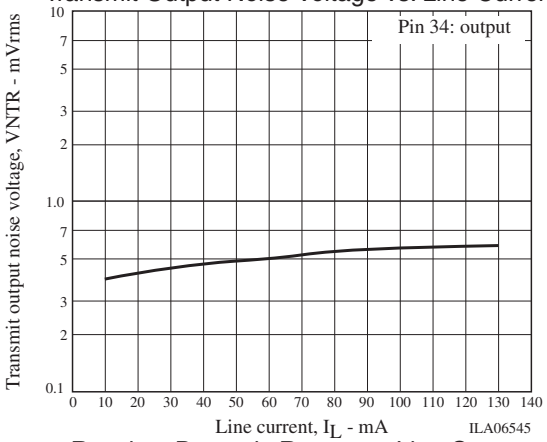
RCV Gain vs. Line Current



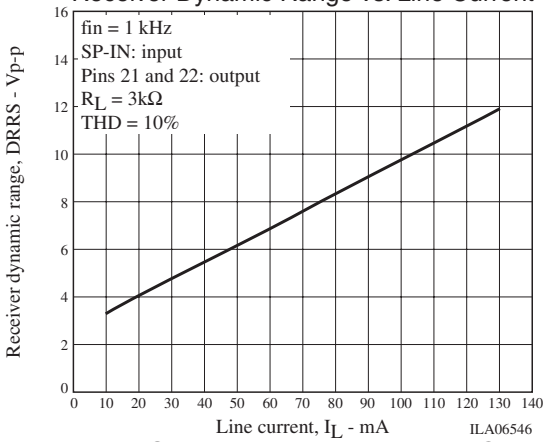
Transmit Dynamic Range vs. Line Current



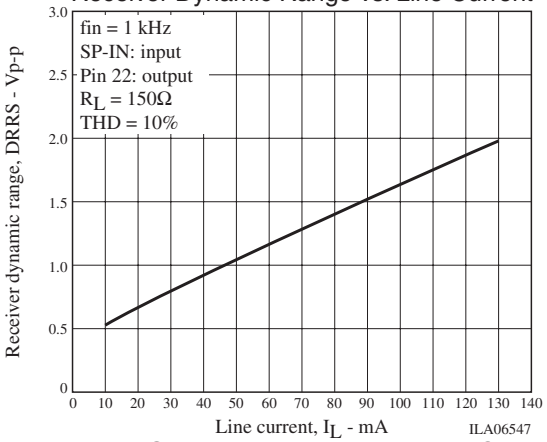
Transmit Output Noise Voltage vs. Line Current



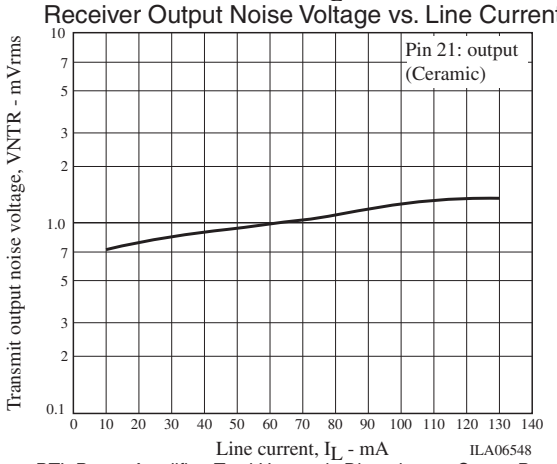
Receiver Dynamic Range vs. Line Current



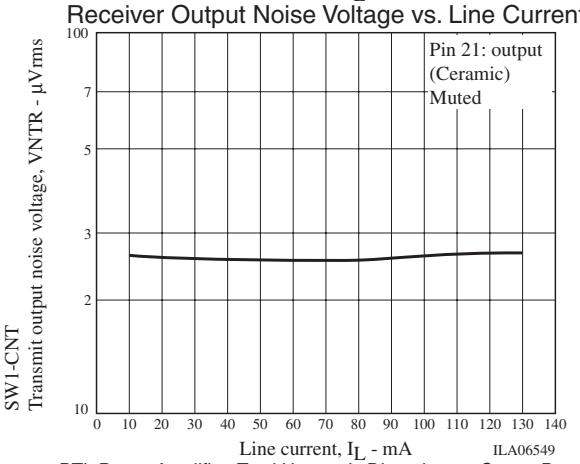
Receiver Dynamic Range vs. Line Current



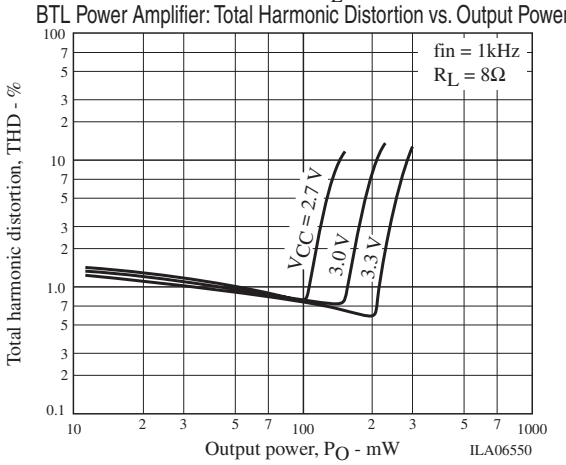
Receiver Output Noise Voltage vs. Line Current



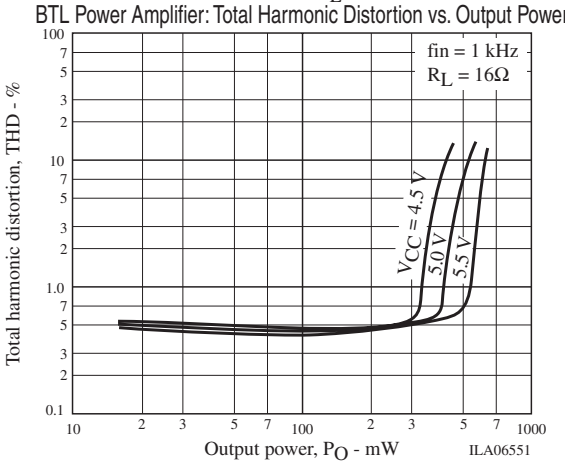
Receiver Output Noise Voltage vs. Line Current



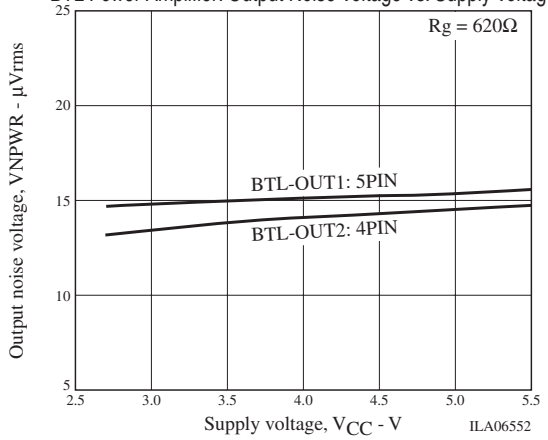
BTL Power Amplifier: Total Harmonic Distortion vs. Output Power



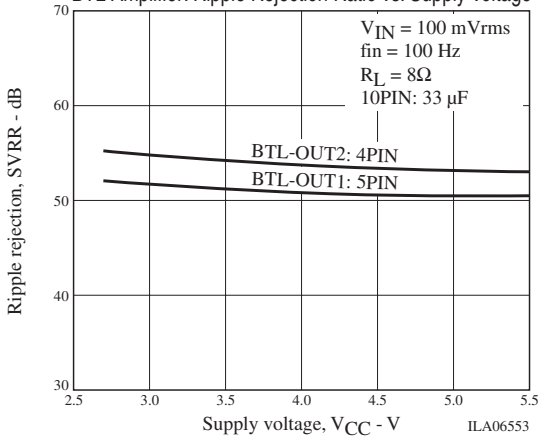
BTL Power Amplifier: Total Harmonic Distortion vs. Output Power



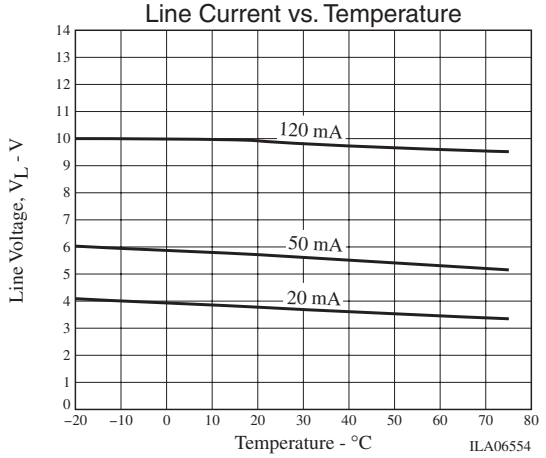
BTL Power Amplifier: Output Noise Voltage vs. Supply Voltage



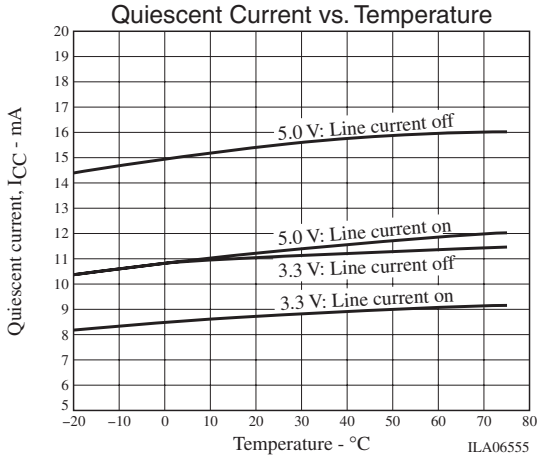
BTL Amplifier: Ripple Rejection Ratio vs. Supply Voltage



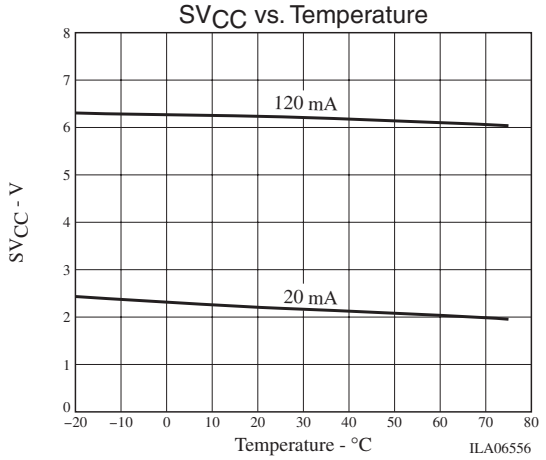
Line Current vs. Temperature



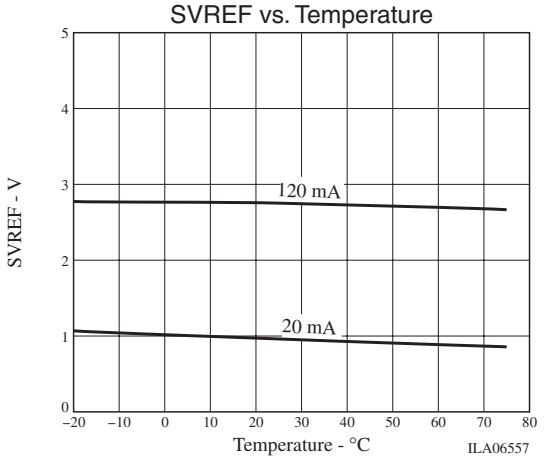
Quiescent Current vs. Temperature



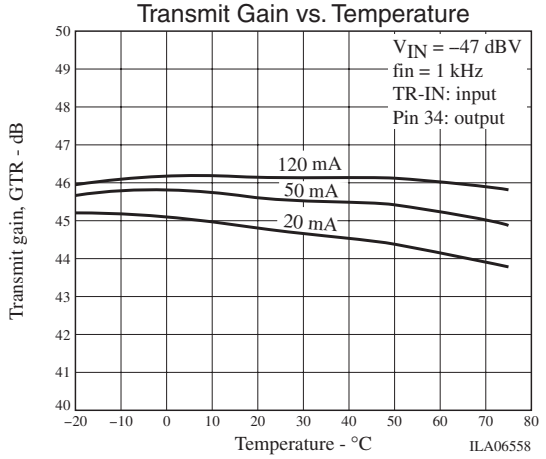
SVCC vs. Temperature



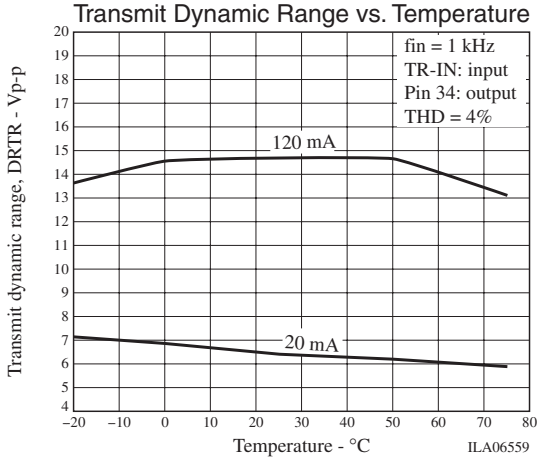
SVREF vs. Temperature



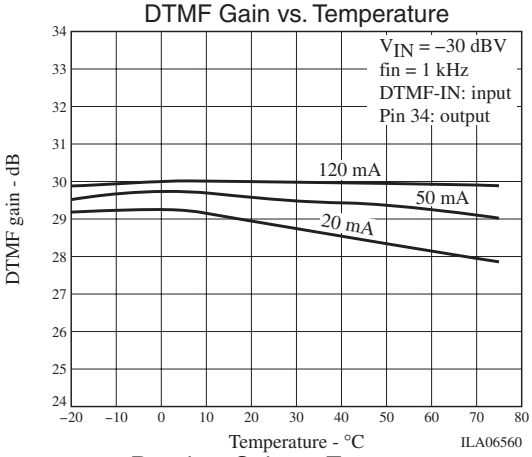
Transmit Gain vs. Temperature



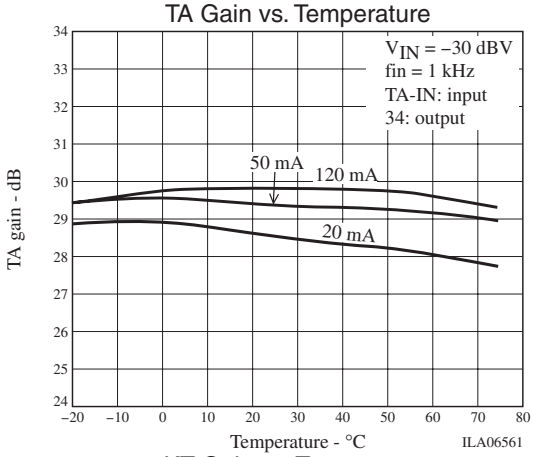
Transmit Dynamic Range vs. Temperature



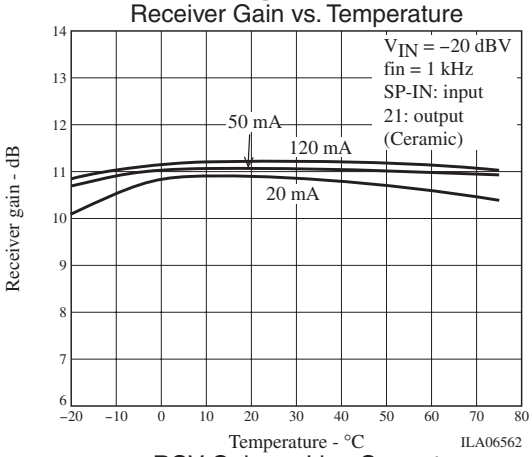
DTMF Gain vs. Temperature



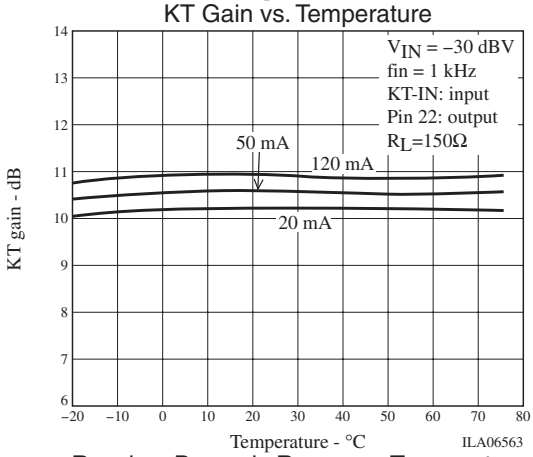
TA Gain vs. Temperature



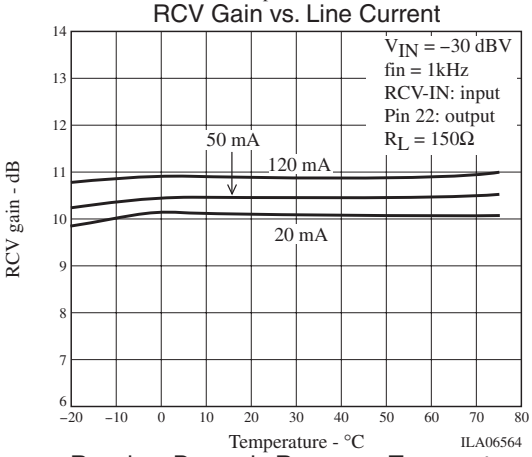
Receiver Gain vs. Temperature



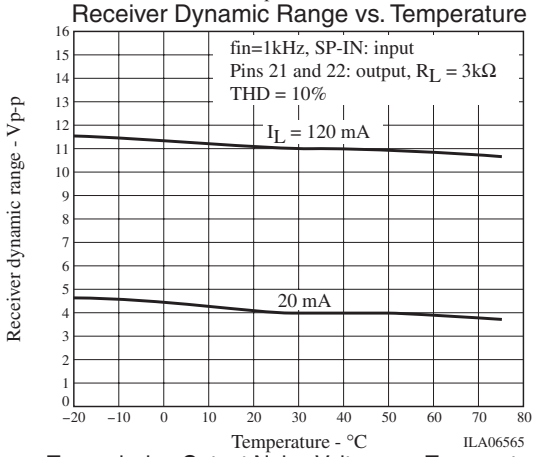
KT Gain vs. Temperature



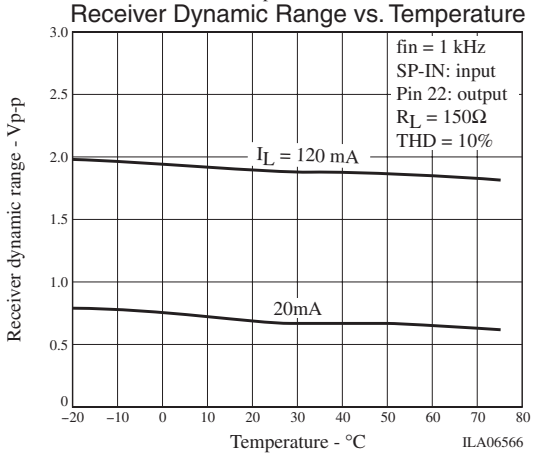
RCV Gain vs. Line Current



Receiver Dynamic Range vs. Temperature



Receiver Dynamic Range vs. Temperature



Transmission Output Noise Voltage vs. Temperature