Ordering number : EN4276

Monolithic Linear IC

No. 4276

LA8517M

Audio Signal Processing Circuit for Cordless Telephone Base Set Applications

Overview

The LA8517M, an audio signal processing IC for cordless telephone answering machine applications, incorporates speech network, audio signal processing and cross-point switching functions into a single chip.

Applications

Speech Network

- 2 to 4 wire conversion
- Impedance matching
- Line driver
- DTMF interfacing
- Transmitting amplifier
- Key tone interfacing
- Receiving amplifier

Audio Signal Processing

- Recorder preamplifier (with ALC)
- Playback equalizer amplifier
- Recorder amplifier
- Voice detection circuit (VOX)
- Power amplifier (P_O = 200 mW, R_L = 8Ω, V_{CC} = 5 V)

Cross-point Switching

- 8 X 8 equivalent cross-point switching
- CPU interfacing (serial control)

Features

Speech Network

- Supports direct interfacing using low impedance telephone receiver.
- Using dialer IC mute signaling, supports output to circuit following changeover of telephone receiver and dial signal (DTMF).
- Transmit gain and receive gain are controlled automatically in response to loop current.
- Supports forced attenuation of transmit gain and receive gain from gain control pin.
- Equipped with dial confirmation tone (key tone) input pin (mute signal control).
- Variety of handsets supported using externally connected components for varying transmit gain and receive gain.
- Outstanding for branch performance with low operating current.

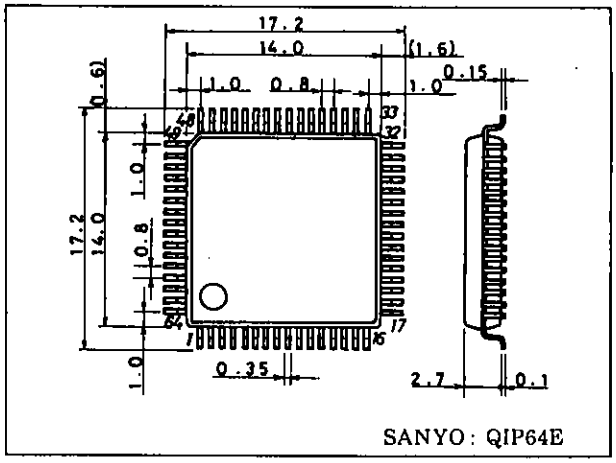
Audio Signal Processing

- Supports single mechanism system.
- All necessary answering machine functions built-in; microcontroller control permits unique system construction.
- Built-in power amplifier.
- Permits independent settings for recording amplifier gain and recording bias current using external resistors.

Package Dimensions

unit : mm

3159-QIP64E



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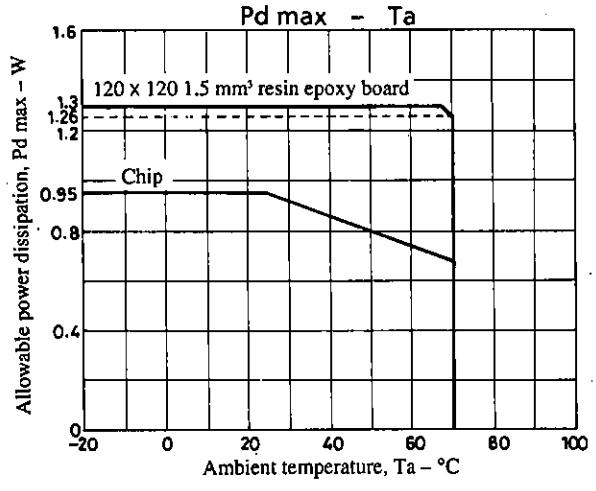
			min	typ	max	unit
<PB AMP>						
Voltage gain	VG_E	–60dBV input between pins 23 – 25	47	49	51	dB
Total harmonic distortion	THD	–60dBV input between pins 23 – 25		0.3	1.0	%
Equivalent input noise voltage	V_{NI}	23pin shorts (in terms of AC), 20Hz to 20kHz		1.0	5	μVrms
<OGM AMP>						
Voltage gain	VG_G	–20dBV input between pins 29 – 30	8	10	12	dB
Total harmonic distortion	THD	–20dBV input between pins 29 – 30		0.1	1.0	%
<REC AMP>						
Voltage gain	VG_R	Pin 21 Z_{AC} = 9kΩ between pins 27 – 22	–6	–4	–2	dB
Output bias voltage (pin 22 voltage)	V_B	Pin 21 Z_{DC} = 15kΩ, 6.8 kΩ pin 22 load,	0.8	1.0	1.2	V
Total harmonic distortion	THD	–30 dBV input pin 9 , pin 22 fixed		0.5	1.0	%
<MIC AMP>						
Voltage gain	VG_M	–40dBV input between pins 34 – 36	28	30	32	dB
Total harmonic distortion	THD	–40dBV input between pins 34 – 36		0.1	1.0	%
Equivalent input noise voltage	V_{NI}	34 pin shorts (in terms of AC), 20Hz to 20kHz		1.5	5	μVrms
<POWER AMP : R_L = 8Ω>						
Voltage gain	VG_P	–30dBV input between pins 45 – 42	28	30	32	dB
Output power	P_O	THD = 10%	200	250		mW
Total harmonic distortion	THD	–30dBV input between pins 45 – 42		0.5	1.5	%
Input resistance	Ri			60		kΩ
Ripple rejection	SVRR	Rg = 0, fr = 100Hz, Vr = –20dBV	50	60		dB
Output noise voltage	V_{NO}	45 pin shorts (in terms of AC), 20Hz to 20kHz		0.04	0.1	mVrms
<VOX>						
Sensitivity 1	V_{OXL}	–24dBV input			0.3	V
Sensitivity 2	V_{OXH}	–28dBV input	4.5			V
<V_{REF}>						
Output voltage	V_{REF}		2.1	2.3	2.5	V
<CONTROL>						
Clock frequency	F_{CK}				500	kHz
Input signal "H" level	V_H		3			V
Input signal "L" level	V_L				1.5	V

Allowable power dissipation vs. ambient temperature



Specifications

Maximum Ratings at Ta = 25°C

				unit
Maximum supply voltage	V_L max	Speech network	15	V
	V_{CC} max	Excluding speech network	10	V
Loop current	I_L max		130	mA
Allowable power dissipation	Pd max		950	mW
Operating temperature	Topr		–20 to +70	°C
Storage temperature	Tstg		–40 to +150	°C

Operating Conditions at Ta = 25°C

				unit
Recommended supply voltage	V_{CC}	Excluding speech network	5	V
Supply voltage operating range	V_{CC} op	Excluding speech network	4.5 to 7.5	V

Operating Characteristics at Ta = 25°C, f = 1kHz

[Speech network]

			min	typ	max	unit
Line voltage	V_L	I_L = 20mA	3.3	3.8	4.3	V
		I_L = 50mA	5.5	6.3	7.1	V
		I_L = 120mA	10.2	12.2	14.2	V
Internal supply voltage	V_{CC}	I_L = 20mA	1.9	2.1	2.3	V
		I_L = 50mA	3.3	3.6	3.9	V
		I_L = 120mA	6.8	7.1	7.4	V
Transmitting gain	G_T	I_L = 20mA, V_{IN} = –55dBV	34	36	38	dB
		I_L = 120mA, V_{IN} = –55dBV	32	34	36	dB
Receiving gain	G_R	I_L = 20mA, V_{IN} = –20dBV	–5	–3	–1	dB
		I_L = 120mA, V_{IN} = –20dBV	–9.5	–7.5	–5.5	dB
DTMF gain	G_{MF}	I_L = 20mA, V_{IN} = –30dBV	19.5	21.5	23.5	dB
		I_L = 120mA, V_{IN} = –30dBV	17	19	21	dB
KTI gain	G_{KT}	I_L = 20mA, V_{IN} = –40dBV	12	14	16	dB
		I_L = 120mA, V_{IN} = –40dBV	14	16	18	dB
Transmitting dynamic range	DR_T	I_L = 20mA, THD = 4%	2.5			V_{P-P}
		I_L = 120mA, THD = 4%	4.5			V_{P-P}
Receiving dynamic range	DR_R	I_L = 20mA, THD = 10%	0.3			V_{P-P}
		I_L = 120mA, THD = 10%	0.5			V_{P-P}
DTMF input impedance	Z_{MF}			20		kΩ
KTI input impedance	Z_{KT}			24		kΩ
Mute input "H" level voltage	V_{IH}	I_L = 20mA to 120mA	V_{CC}/2		V_{CC}	V
Mute input "L" level voltage	V_{IL}	I_L = 20mA to 120mA	0		0.2	V
Transmitting PADC attenuation	$\triangle G_T$	I_L = 30mA, 24kΩ ground		3		dB
Receiving PADC attenuation	$\triangle G_R$	I_L = 30mA, 24kΩ ground		6		dB
Internal reference voltage	V_{REF}	I_L = 20mA		0.65		V
		I_L = 50mA		1.13		V
		I_L = 120mA		2.25		V

[Audio signal processing]

Quiescent current	I_{CCO}		10	21	30	mA
<PRE AMP>						
Voltage gain	VG_C	–48dBV input between pins 8 – 27	37	39	41	dB
Total harmonic distortion	THD	–30dBV input between pins 8 – 27		0.25	1.0	%
ALC saturation output level	V_{OS}	–30dBV input between pins 8 – 27	430	530	630	mVrms
ALC range	ALCW	After ALC is on and until THD becomes 1%	35	40		dB
Equivalent input noise voltage	V_{NI}	Number 8 pin shorts (in terms of AC), 20 Hz – 20 kHz		2.0	5	μVrms

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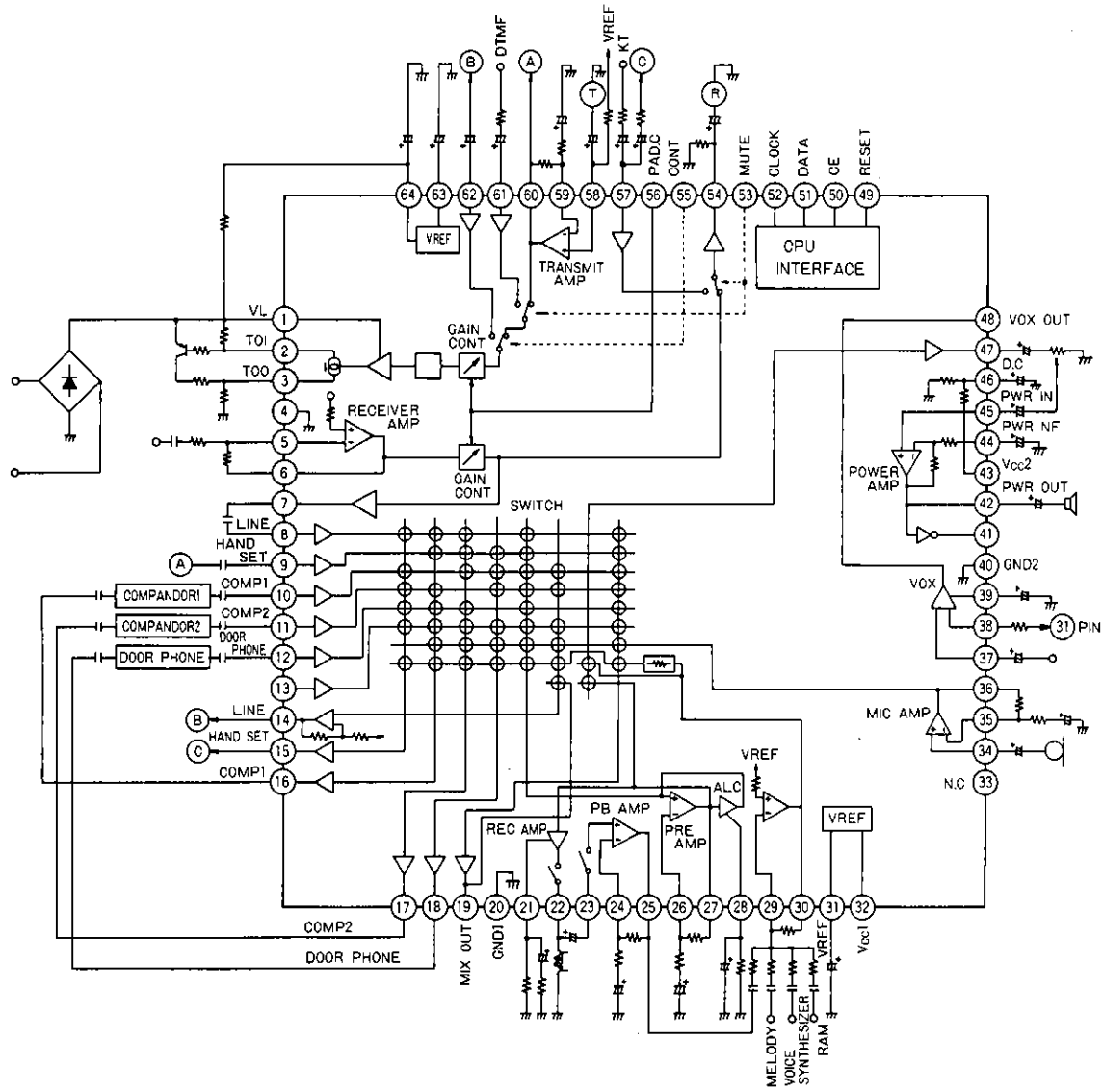
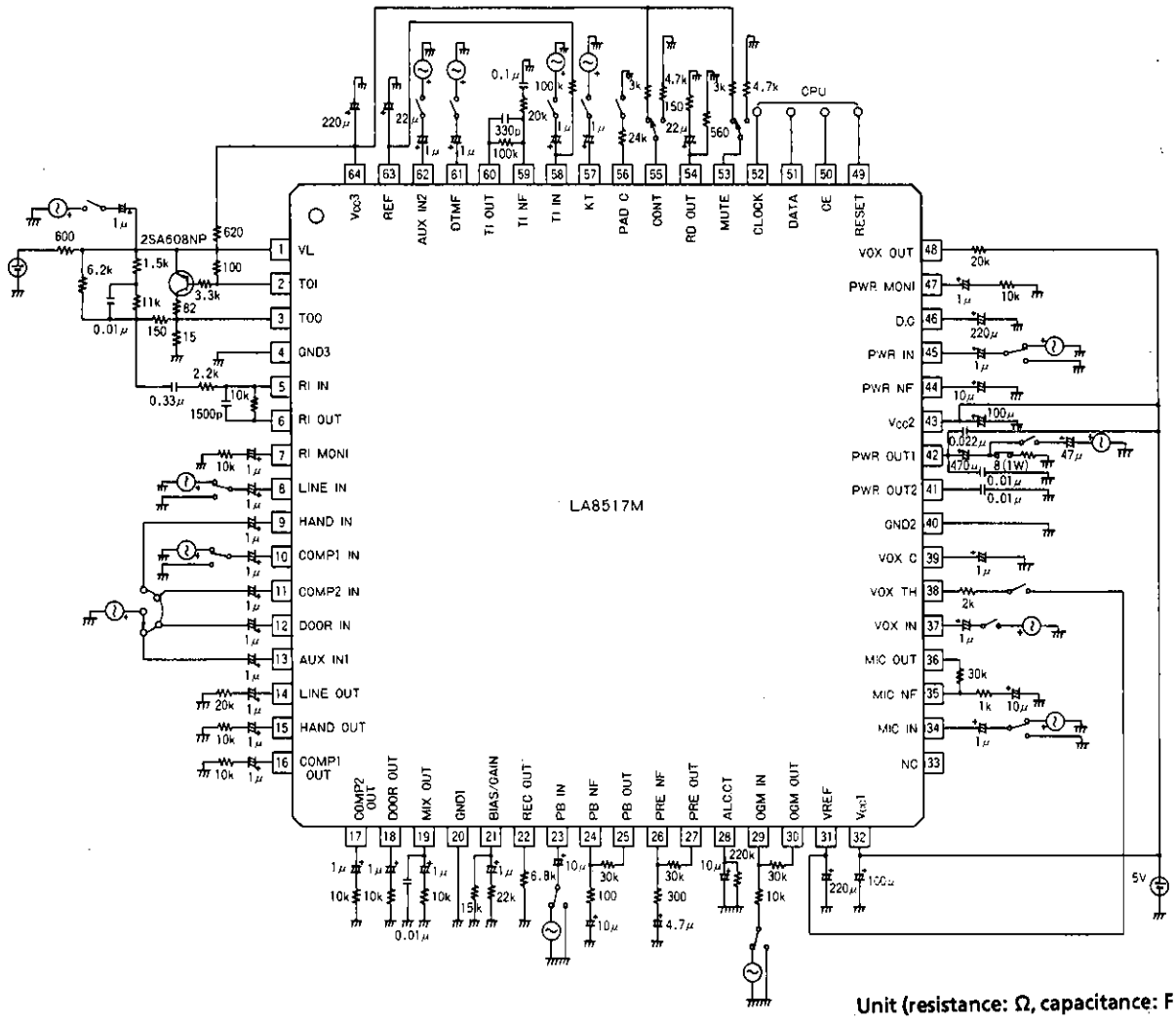
Equivalent Circuit Block Diagram and Peripheral Circuits



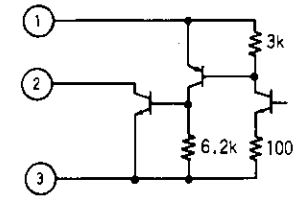
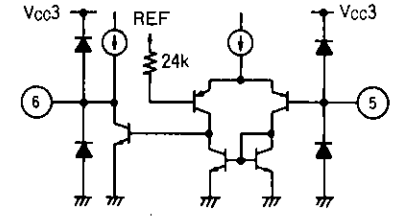
1. V_L	17. COMP2 OUT	33. NC	49. RESET
2. TOI	18. DOOR OUT	34. MIC IN	50. CE
3. TOO	19. MIX OUT	35. MIC NF	51. DATA
4. GND3	20. GND1	36. MIC OUT	52. CLOCK
5. RI IN	21. BIAS/GAIN	37. VOX IN	53. MUTE
6. RI OUT	22. REC OUT	38. VOX TH	54. RD OUT
7. RI MONI	23. PB IN	39. VOX C	55. CONT
8. LINE IN	24. PB NF	40. GND2	56. PAD C
9. HAND IN	25. PB OUT	41. PWR OUT2	57. KT
10. COMP1 IN	26. PRE NF	42. PWR OUT1	58. TI IN
11. COMP2 IN	27. PRE OUT	43. V_{CC2}	59. TI NF
12. DOOR IN	28. ALC CT	44. PWR NF	60. TI OUT
13. AUX IN1	29. OGM IN	45. PWR IN	61. DTMF
14. LINE OUT	30. OGM OUT	46. D.C	62. AUX IN2
15. HAND OUT	31. V_{REF}	47. PWR MONI	63. REF
16. COMP1 OUT	32. V_{CC1}	48. VOX OUT	64. V_{CC3}

Test Circuit



Description of Pin Functions

Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
1	V_L		Input pin for Loop current and Line voltage.
2	TOI		Inlet pin for transmitting output current.
3	TOO		Transmitting output current output pin
4	GND3		Speech network system ground (GND) pin.
5	RI IN		Receiving input amplifier negative (–) input pin. Permits adjustments of gain and frequency performance using externally connected components.
6	RI OUT		Receiving input amplifier output pin.

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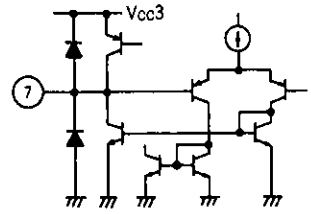
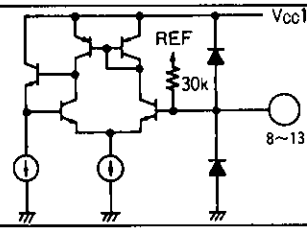
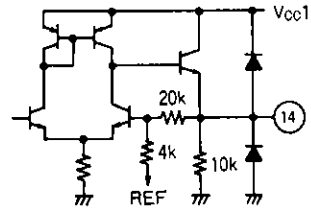
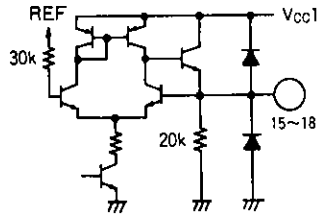
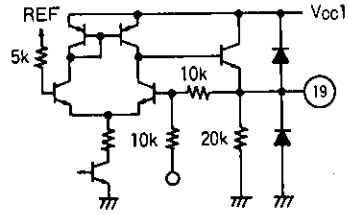
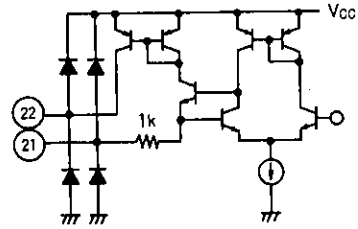
Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
7	RI MONI		Receiving input monitor amplifier output pin.
8	LINE IN		Line input pin.
9	HAND IN		Handset input pin.
10	COMP1 IN		Compandor 1 input pin.
11	COMP2 IN		Compandor 2 input pin.
12	DOOR IN		Door phone input pin.
13	AUX IN1		Auxiliary input pin.
14	LINE OUT		Line output pin.
15	HAND OUT		Handset output pin.
16	COMP1 OUT		Compandor 1 output pin.
17	COMP2 OUT		Compandor 2 output pin.
18	DOOR OUT		Door phone output pin.
19	MIX OUT		Mixing output pin.
20	GND1		Signal processing ground (GND) pin.
21	BIAS/GAIN		Bias pin. Supports control of recording amplifier gain and recording bias using external resistor.
22	REC OUT		Recording amplifier output pin.

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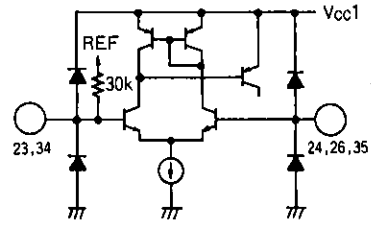
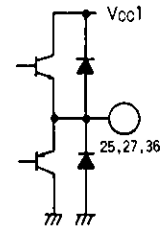
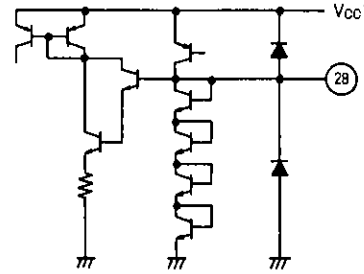
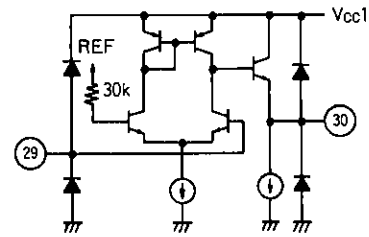
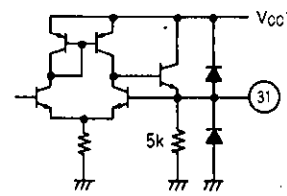
Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
23	PB IN		PB amplifier positive (+) input pin.
24	PB NF		PB amplifier negative (–) input pin.
26	PRE NF		Preamplifier negative (–) input pin.
34	MIC IN		Microphone amplifier positive (+) input pin.
35	MIC NF		Microphone amplifier negative (–) input pin.
25	PB OUT		PB amplifier output pin.
27	PRE OUT		Preamplifier output pin.
36	MIC OUT		Microphone amplifier output pin.
28	ALC. CT		ALC time constant connection pin.
29	OGM IN		Outgoing message (OGM) signal negative (–) input pin.
30	OGM OUT		Outgoing message (OGM) signal output pin.
31	V_{REF}		Internal reference voltage output pin.
32	$V_{CC}1$		Signal processing power supply pin.
33	N. C		No connection (NC).

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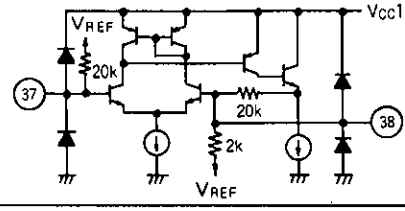
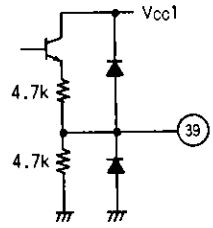
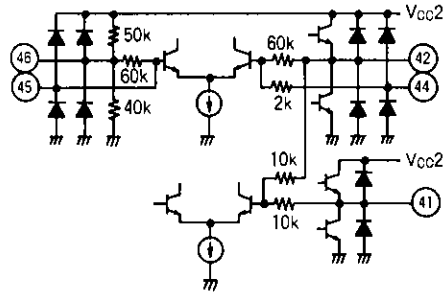
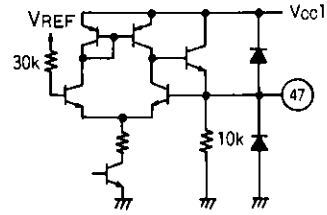
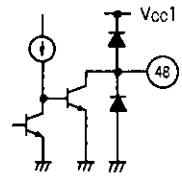
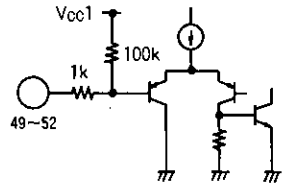
Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
37	VOX IN		Voice detection (VOX) positive (+) input pin.
38	VOX TH		Voice detection (VOX) sensitivity adjustment pin. Adjusts VOX sensitivity using connection to V_{REF} (pin 31) with resistor located between.
39	VOX. C		Voice detection (VOX) output pin.
40	GND2		Power system ground (GND) pin.
41	PWR OUT2		Power amplifier 2 output pin (inverted).
42	PWR OUT1		Power amplifier 1 output pin (non-inverted).
44	PWR NF		Power amplifier negative (–) input pin.
45	PWR IN		Power amplifier positive (+) input pin.
46	D. C		Power amplifier reference voltage output pin (approximately 4/9 X $V_{CC}2$.
43	$V_{CC}2$		Power system power supply pin.
47	PWR MONI		Power amplifier output pin.
48	VOX		Voice detection (VOX) output pin, open-collector (O/C).
49	RESET		Reset pin. Resets with "L".
50	CE		Chip enable input pin.
51	DATA		Data input pin.
52	CLOCK		Clock input pin.

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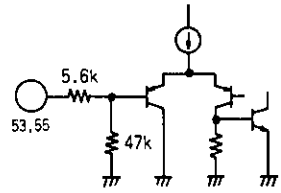
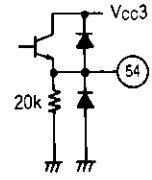
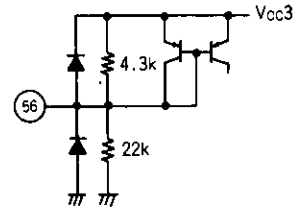
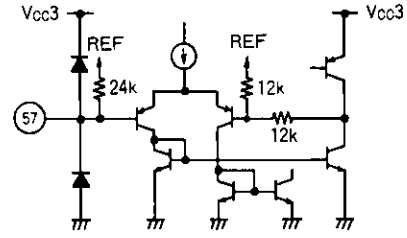
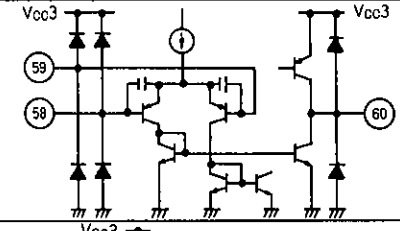
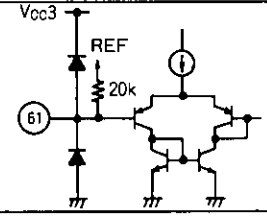
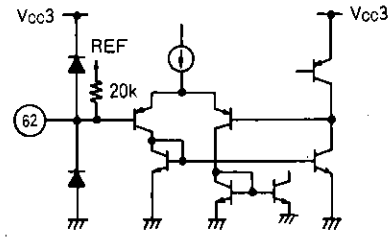
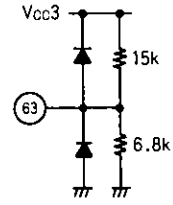
Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
53	MUTE		Mute pin. Changes receiving signal, KT signal of receiving system and transmitting signal as well as DTMF signal of transmitting system. "H": Call settings "L": DTMF transmitting, KT receiving output
55	CONT		Control pin. When set to "L", signal input from AUX IN2 (pin 62) becomes transmitting output.
54	RD OUT		Receiving output pin. Connected to low impedance telephone receiver (approximately 150Ω) through capacitor.
56	PADC		PAD control pin. The valve of the resistor between this pin and either the $V_{CC}3$ (pin 64) or GND3 (pin 4) determines the shape of the Loop - current vs. gain control (auto PAD) characteristics.
57	KT		Key tone input. The input signal switches to receiving output when the MUTE pin (pin 53) is set to "L" for low.
58	TI IN		Transmitting input amplifier positive (+) input pin.
59	TI NF		Transmitting input amplifier negative (–) input pin.
60	TI OUT		Transmitting input amplifier output pin.
61	DTMF		DTMF input pin. The input signal becomes transmitting output when the MUTE pin (pin 53) is set to "L" for low.

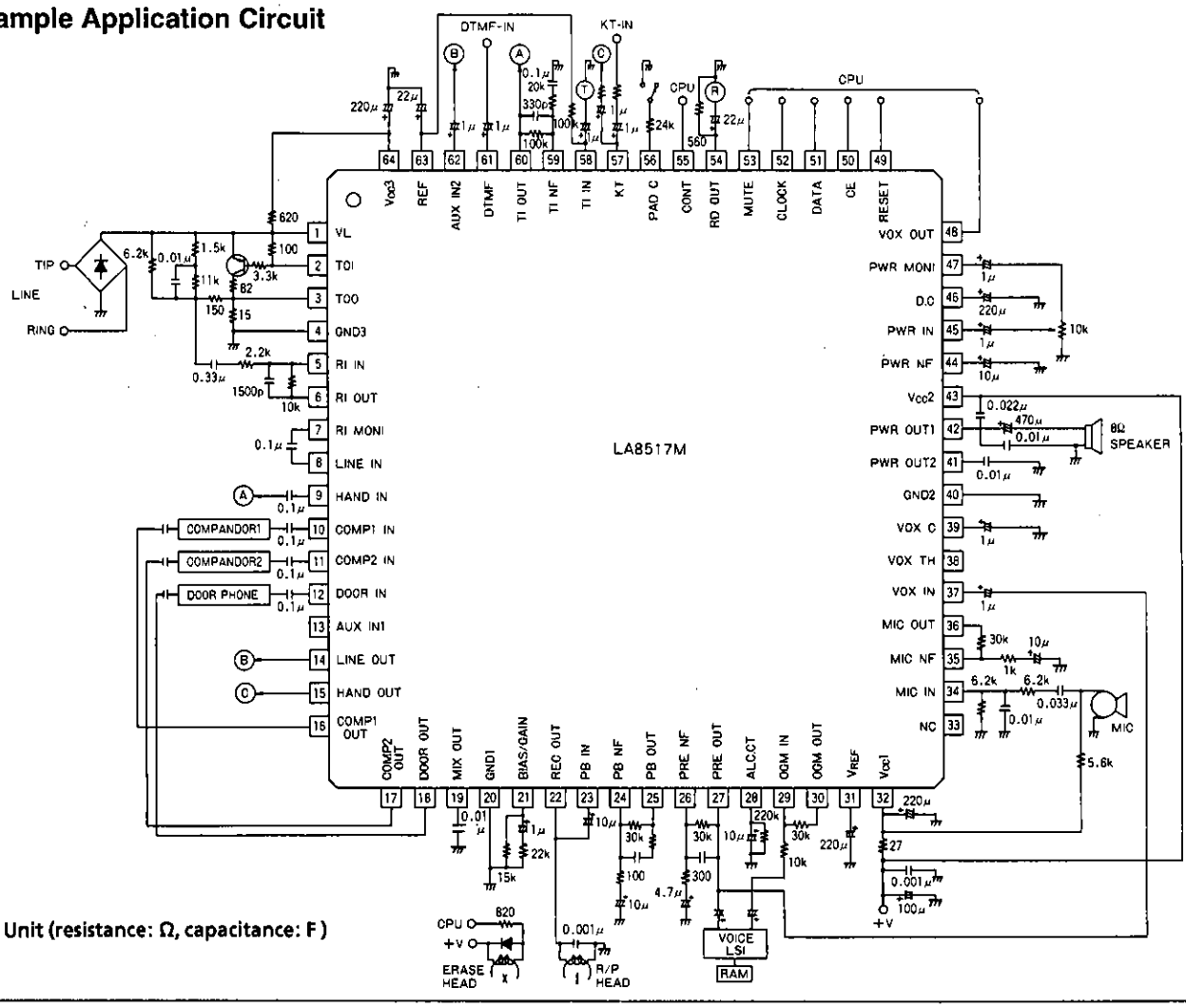
Continued on next page.

Continued from preceding page.

Unit (resistance: Ω)

Pin Number	Pin Name	Internal Equivalent Circuit	Pin Description
62	AUX IN2		Auxiliary input pin. The input signal switches to transmitting output when the CONT pin (pin 55) is set to "L" for low.
63	REF		Internal reference voltage output pin. Should not be used as an external power supply source.
64	$V_{CC}3$		Internal power supply pin. Internal circuit power supply voltage. Should not be used as an external power supply source other than for MUTE pin and CONT pin "H" (high) level voltage.

Sample Application Circuit

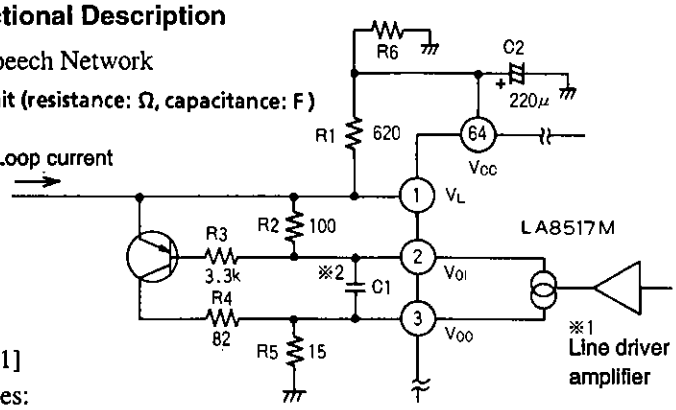


Unit (resistance: Ω, capacitance: F)

Functional Description

1) Speech Network

Unit (resistance: Ω, capacitance: F)



[Fig. 1]

Since the LA8517 is equipped with a built-in power amplifier, a surface mount transistor for the allowable demand should be attached as shown in figure 1 so that loop current is consumed outside the IC. Loop current flowing to the transistor can be controlled by varying the R3 base resistor. R4 and R5 allowable electrical power setting reflects the maximum current requirements of the expected loop current.

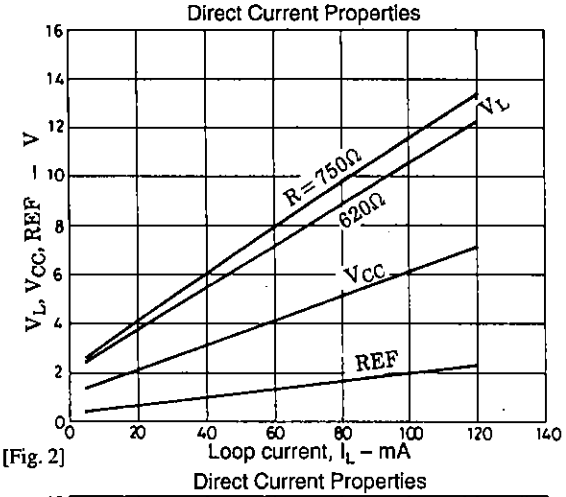
Notes:

*1. The line driver amplifier absorbs transmitting signal delivery and direct current.

*2. In cases of oscillation caused by load conditions existing between V_L and GND, a 0.1 μF rated capacitor should be installed.

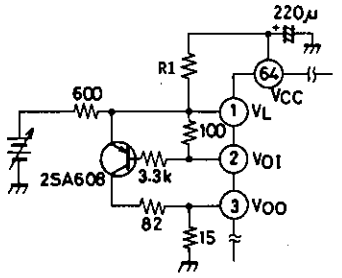
• Modifying Direct Current Resistance

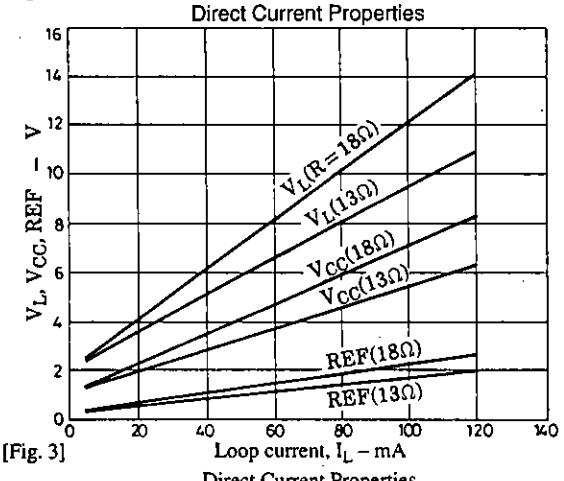
Unit (resistance: Ω, capacitance: F)



[Fig. 2]

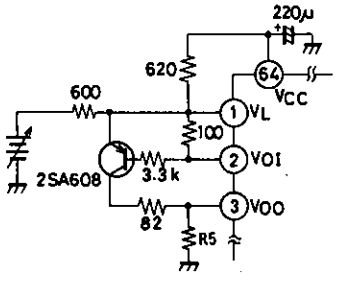
① By varying R1 (620Ω), direct current resistance can be modified as shown in figure 2. Under such circumstances, the alternating current impedance is also changed.

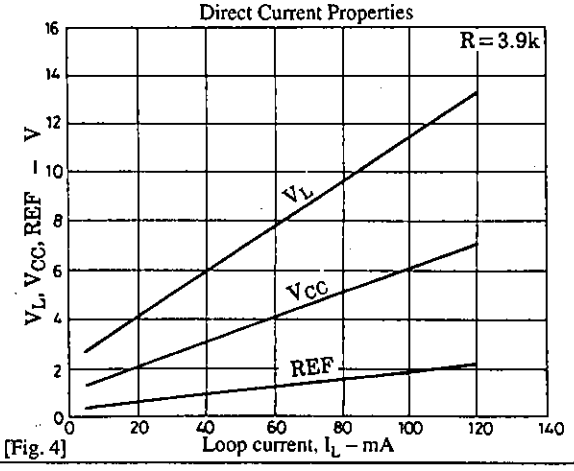




[Fig. 3]

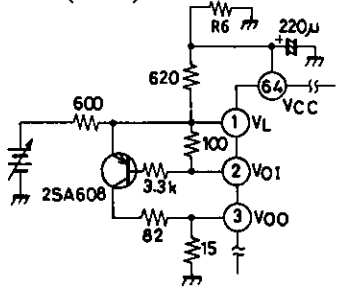
② By varying R5 (15Ω), direct current resistance can be modified as shown in figure 3. Under such circumstances, BN (balancing network) conditions and transmitting gain are also changed.



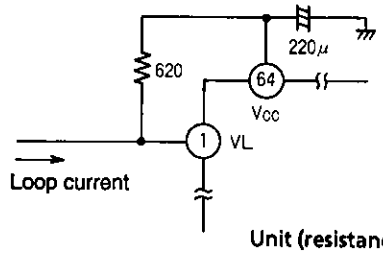


[Fig. 4]

③ Direct current resistance can also be altered, as shown in figure 4, by establishing a connection from the V_{CC} pin (pin 64) through an R6 to the ground (GND).



• Setting Alternating Current Impedance

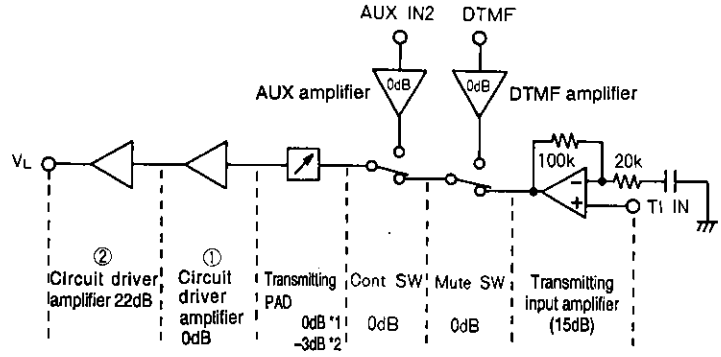


Alternating current impedance is fundamentally decided according to 620Ω 220μF. In practice, because current loads, other than those of the speech network, enter from the line, alternating current impedance is synthetically adjusted to match the impedance of the speech network.

Unit (resistance: Ω, capacitance: F)

Gain Allocation

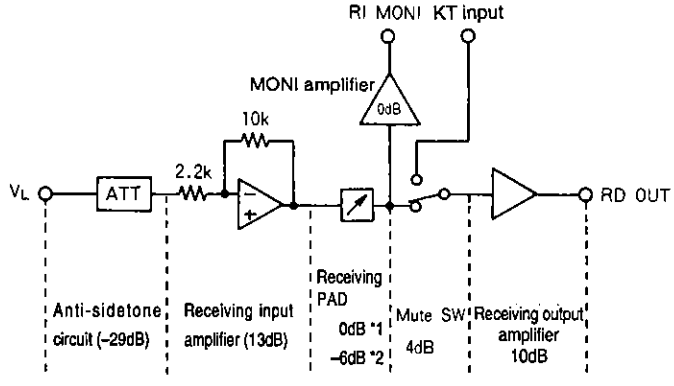
① Transmitting Gain Allocation



*1, I_L = 20mA. *2, I_L = 120mA.
*Loop 600Ω at termination

Unit (resistance: Ω)

② Receiving Gain Allocation



* MONI amplifier gain differs depending on the load (approximately -2 dB at R_L = 10kΩ).
* Gain numeric values are summary values.
* Values represented within parenthesis may be modified using externally attached components.

Unit (resistance: Ω)

- Gain Control Circuit (PADC pin)

① PADC pin open (auto PAD)

Loop current capacity which supports transmitting and receiving gain is automatically adjusted. When transmitting is approximately –3dB and when receiving is approximately –6dB, attenuation follows the increase of loop current.

② PADC pin connected to ground (GND) using resistor

Gain attenuation begins using a loop current capacity which is lesser than when the PADC pin is open.

③ PADC pin connected to V_{CC} using resistor

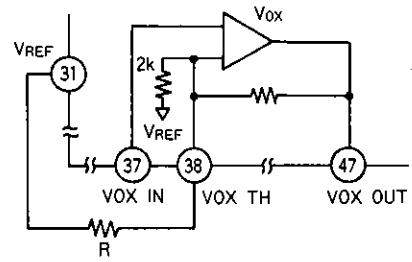
Gain attenuation begins using a loop current capacity which is greater than when the PADC pin is open.

- Receiving Amplifier

Uses a dynamic receiver.

2) Signal Processing

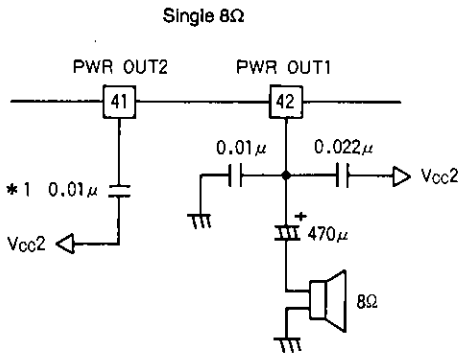
- ALC
  ALC operates with input ranging between approximately –45dBV to –5dBV. ALC saturation power level is approximately 500 mVrms.
- V/I Conversion
  V/I conversion is made to draw the recording current for DC bias. The conversion gain and bias current can be controlled using an external resistor connected to pin 21. DC equalling pin 21 DC output is output from pin 22.
- VOX
  Detects the presence or absence of a call. When the VOX input pin (pin 37) signal is –24dB or greater, the VOX output pin (pin 47) switches to "L" for low. Detection level adjustments may be performed by installing an R resistor between VOX TH (pin 38) and V_{REF} (pin 31) as shown in the following figure.

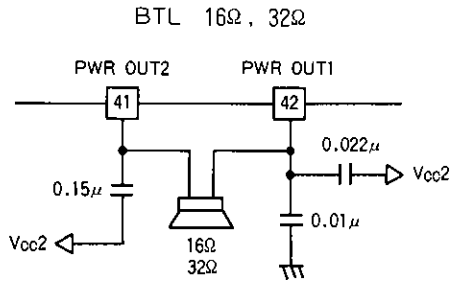


Unit (resistance: Ω)

3) Power Amplifier

- Oscillation prevention Capacitor





Unit (resistance: Ω, capacitance: F)

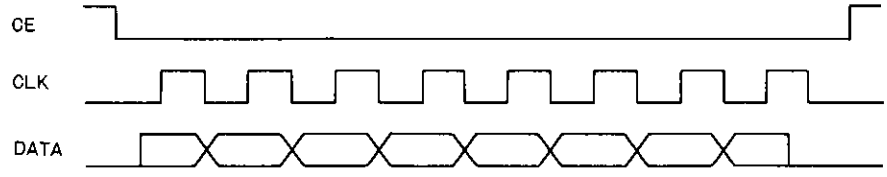
Note: A Mylar capacitor is recommended as a damping capacitor. (A ceramic capacitor may be use in * 1.)

- Mute
  Under mute conditions, power amplifier output impedance switches to high impedance.

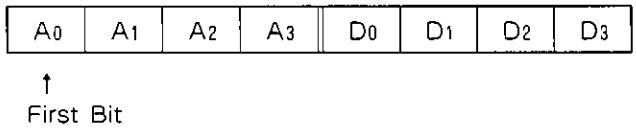
4) Cross-point

- Mixing
  Mixing is possible with MIX OUT only (pin 19).
- Line Output Amplifier
  Line output amplifier gain becomes approximately 16dB. When set to –6dB using serial control, line output amplifier gain is established at approximately 10dB.

Serial Control Input Data Format



Serial Data Contents



$A_3 = 0$ ⇒ Displays control data for cross-point switching. At such a time, A_2 through A_0 indicate cross-point switching output addresses.
$A_3 = 1, A_2 = 0$ ⇒ Indicates mixing output control data.
$A_3 = 1, A_2 = 1$ ⇒ Indicates audio signal processing control data.
Table 1 indicates contents.

A_3	A_2	A_1	A_0	Contents	
0	0	0	0	Output address 0	HANDSET
0	0	0	1	Output address 1	COMP 1
0	0	1	0	Output address 2	COMP 2
0	0	1	1	Output address 3	DOOR PHONE
0	1	0	0	Output address 4	PRE AMP
0	1	0	1	Output address 5	LINE
0	1	1	0	Output address 6	POWER
1	0	0	0	Ouput address 7A	MIXING OUT
1	0	0	1	Output address 7B	MIXING OUT
1	1	*	*	CONTROL DATA	

* : don't cae

[Table 1]

D_3 to D_0: Input addresses for cross-point switching control data are shown in table 2. Table 3 shows address assignments for mixing output control data. On/off settings for all controls are indicated in table 4 for audio signal processing control data.

D_3	D_2	D_1	D_0	Contents	
0	0	0	0	ALL OFF	
0	0	0	1	Input address 1	LINE
0	0	1	0	Input address 2	HANDSET
0	0	1	1	Input address 3	COMP 1
0	1	0	0	Input address 4	COMP 2
0	1	0	1	Input address 5	DOOR PHONE
0	1	1	0	Input address 6	AUX
0	1	1	1	Input address 7	MIC
1	0	0	0	Input address 8	OGM
*	0	0	1	Input address 9	PRE (Used only with output address 6)
*	0	1	0	Input address 10	MIX (Used only with output address 5)

* : don't care

[Table 2]

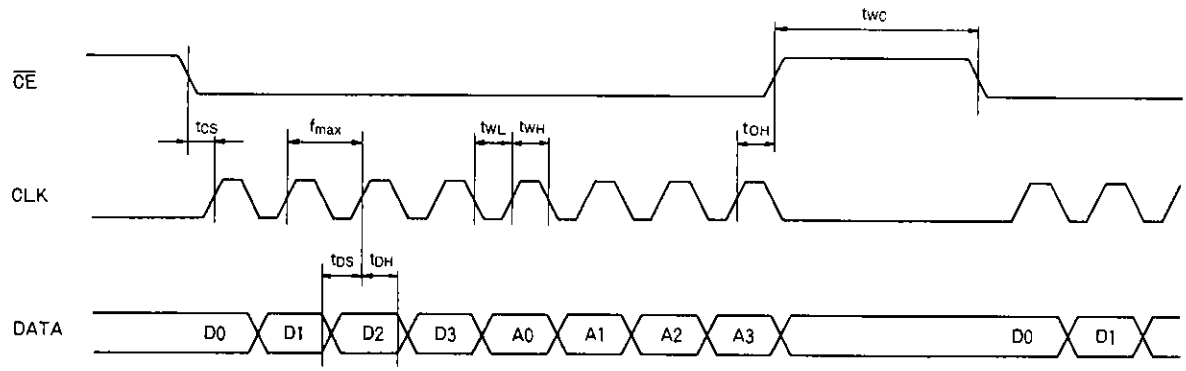
Item	Contents	
	Output Address 7-A	Output Address 7-B
D_0	Input address 1 LINE	Input address 5 DOOR PHONE
D_1	Input address 2 HANDSET	Input address 6 AUX
D_2	Input address 3 COMP 1	Input address 7 MIC
D_3	Input address 4 COMP 2	Input address 8 OGM

[Table 3]

Item	Contents		
A_1	LINE –6dB	1: On	0: Off
D_0	ALC	1: On	0: Off
D_1	PB	1: On	0: Off
D_2	REC	1: On	0: Off
D_3	POWER AMP MUTE	1: Mute	0: Release

[Table 4]

Input Address Port Timing



- fmax (Maximum clock frequency) 500kHz
- t_{WL} (Clock pulse width "L") 250ns or more
- t_{WH} (Clock pulse width "H") 250ns or more
- t_{CS} (Chip enable setup time) 200ns or more
- t_{CH} (Chip enable hold time) 400ns or more
- t_{DS} (Data setup time) 250ns or more
- t_{DH} (Data hold time) 250ns or more
- t_{WC} (Chip enable pulse width) 400ns or more

Proper Care for IC Applications

1) PCB
During PCB manufacturing, the ground (GND) line of pin 20 becomes thicker and shorter. When common impedance is applied, problems may occur due to distorted coefficients.

2) If the IC is used in the vicinity of the maximum rating, even a slight variation in conditions may cause the maximum rating to be exceeded, thereby leading to a breakdown. Allow an ample margin of variation in such areas as supply voltage and use the IC in a range where the maximum rating will not be exceeded.

3) Shorting Between Pins
If the power supply is applied when the space between pins is shorted, a breakdown or deterioration may occur. When installing the IC on the board or applying the supply voltage, make sure that the space between pins is not shorted with solder or by other means.

4) Load Shorting
If the IC is used with the load shorted for a long time, a breakdown or deterioration may occur. Be sure not to short the load.

Serial Control Mode

The following table indicate basic modes.

Mode	Serial Data								Notes
	A_0	A_1	A_2	A_3	D_0	D_1	D_2	D_3	
ICM REC	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	0	1	1	0	1	0	0	*	Input is set to PRE while output sets to PWR.
	*	*	1	1	1	0	1	0	ALC and REC are on.
2 WAY REC	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	*	*	1	1	1	0	1	0	ALC and REC are on.
DECT REC	0	0	1	0	1	1	1	0	Input is set to MIC while output sets to PRE.
	*	*	1	1	1	0	1	0	ALC and REC are on.
2 WAY BEEP	0	1	1	0	0	0	0	1	Input is set to OGM while output sets to PWR.
	0	0	1	0	0	0	0	1	Input is set to OGM while output sets to PRE.
	1	0	1	0	0	0	0	1	Input is set to OGM while output sets to LINE.
	*	*	1	1	1	0	1	0	ALC and REC are on.
	*	1	1	1	0	0	0	0	LINE Amp –6dB
ICM OUT	0	1	1	0	0	0	0	1	Input is set to OGM while output sets to PWR.
	1	0	1	0	0	0	0	1	Input is set to OGM while output sets to LINE.
	*	*	1	1	0	1	0	0	PB ON
ICM PLAY	0	1	1	0	0	0	0	1	Input is set to OGM while ouput sets to PWR.
	*	*	1	1	0	1	0	0	PB ON
OGM REC	0	0	1	0	1	1	1	0	Input is sets to MIC while output sets to PRE.
	*	*	1	1	1	0	0	0	ALC ON
OGM CHANGE	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	0	1	1	0	1	0	0	*	Input is set to PRE while output sets to PWR.
	*	*	1	1	1	0	0	0	ALC ON
OGM OUT	0	1	1	0	0	0	0	1	Input is set to OGM while output sets to PWR.
	1	0	1	0	0	0	0	1	Input is set to OGM while output sets to LINE.
OGM PLAY	0	1	1	0	0	0	0	1	Input is set to OGM while output sets to PWR.
ROOM MONI	1	0	1	0	1	1	1	0	Input is set to MIC while output sets to LINE.
ROOM OUT	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	0	1	1	0	1	0	0	*	Input is set to PRE while output sets to PWR.
VOICE SELE	1	0	1	0	0	0	0	1	Input is set to OGM while output sets to LINE.
	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	0	1	1	0	1	0	0	*	Input is set to PRE while output sets to PWR.
Dialogue REC	1	0	1	0	0	0	0	1	Input is set to OGM while output sets to LINE.
	0	0	1	0	1	0	0	0	Input is set to LINE while output sets to PRE.
	*	*	1	1	1	0	1	0	ALC and REC are on
Extension calling (main phone ← → extension phone)	1	0	0	0	0	1	0	0	Input is set to HAND while output sets to COMP1.
	0	0	0	0	1	1	0	0	Input is set to COMP1 while output sets to HAND.
Extension phone → external line (used for accessing an external line)	1	0	1	0	1	1	0	0	Input is set to COMP1 while output sets to LINE.
	1	0	0	0	1	0	0	0	Input is set to LINE while output set to COMP1.

"1" = High, "0" = Low

* : don't care

Mode Description

1) ICM REC (Incoming Message Rec.)
   - Incoming message recording.
   - Recording of dictation from distant location (remote-controlled at separate location).

2) 2-way REC
   - Recording of both conversations while talking over the telephone.
   - Incoming message recording.

3) DICT REC
   - Dictation recording using microphone (records family messages or other messages with limited contents).

4) 2-way BEEP
   - Outputs alarm sound to speaker and if recording incoming message (ICM), simultaneously activates line output to also inform caller.
   - Informs caller of recording activity.
   - Line output sets to 6dB for line output of other modes.

5) ICM OUT
   - Incoming message playback.
   - Listening to the incoming message using telephone from distant location.
   - Incoming message transfer.
   - Recorded dictation playback.

6) ICM PLAY
   - Incoming message playback.
   - Recorded dictation playback.

7) OGM REC (Outgoing Message Rec.)
   - Outgoing message recording.

8) OGM CHANGE
   - Changing outgoing message from distant location using remote control operations.

9) OGM OUT
   - Outgoing message playback.
   - Outgoing message transmitting (with remote control operations, etc.).

10) OGM PLAY
    - Outgoing message playback and confirmation.

11) ROOM MONI
    - Listening to microphone input using remote control operations from distant location.

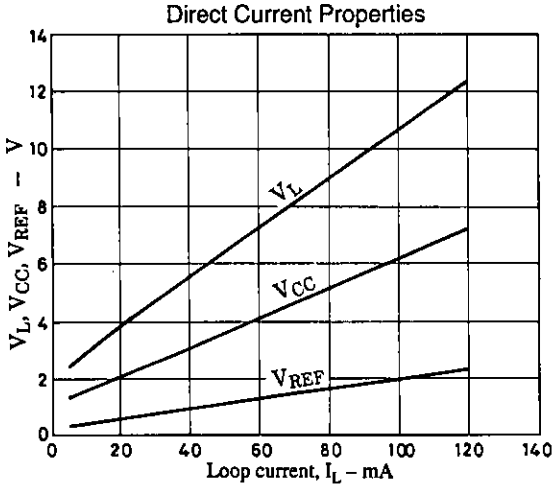
12) ROOM OUT
    - Generating speaker output such as messages using remote control operations from distant location.

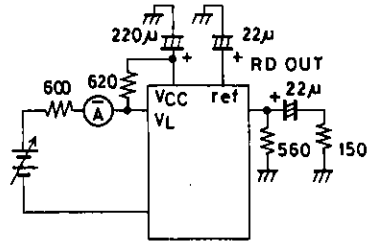
13) VOICE SELE
    - Confirming speaker output of other person's voice along with outgoing message transmission.

14) Dialog REC
    - Recording incoming message while transmitting outgoing message.

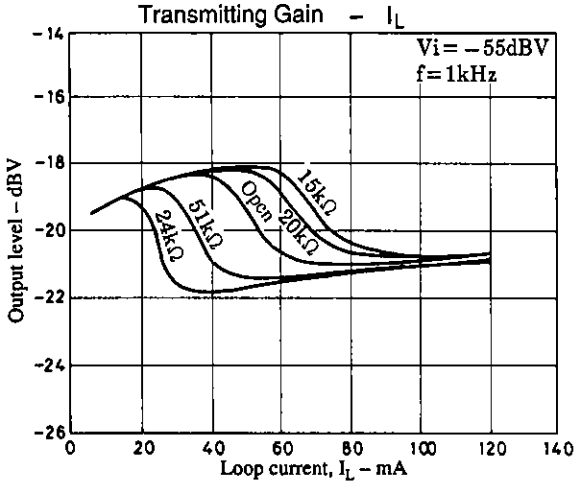
Unit (resistance: Ω, capacitance: F)

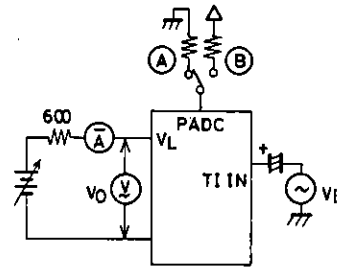
Direct Current Properties



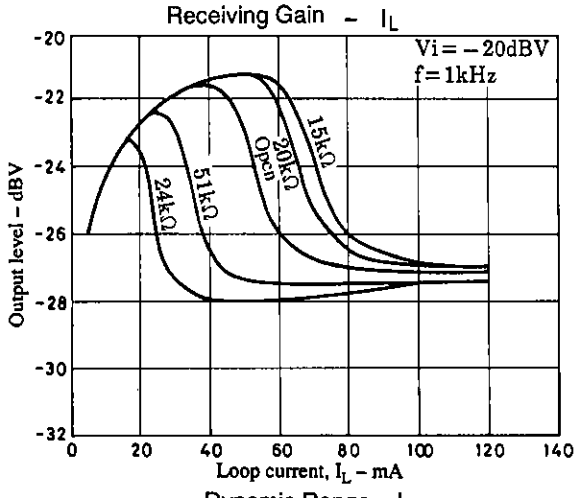


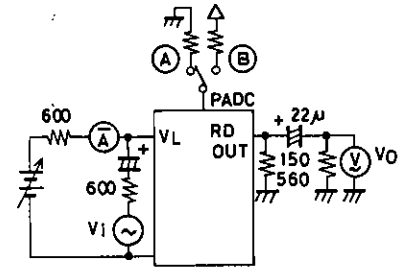
Transmitting Gain – I_L



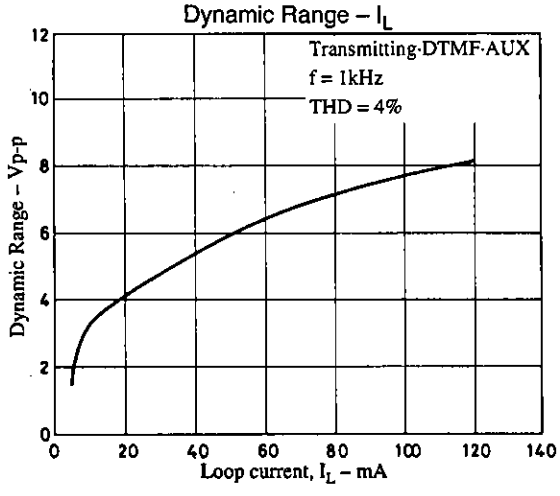


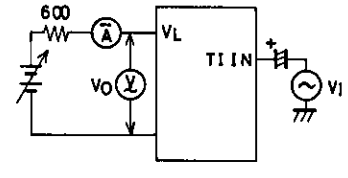
Receiving Gain – I_L





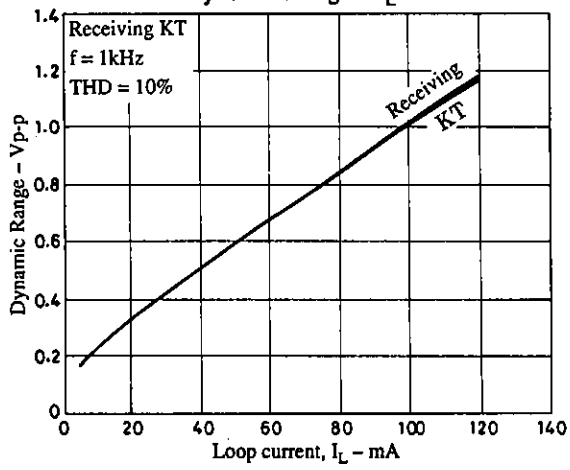
Dynamic Range – I_L

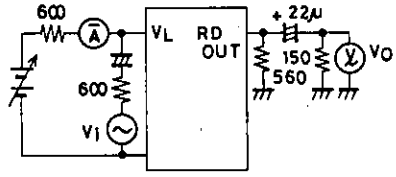




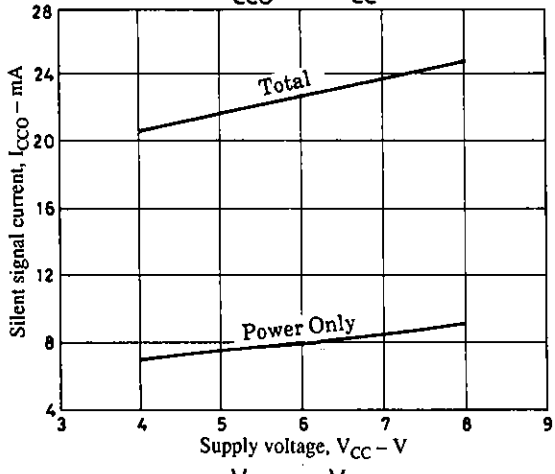
Unit (resistance: Ω, capacitance: F)

Dynamic Range – I_L

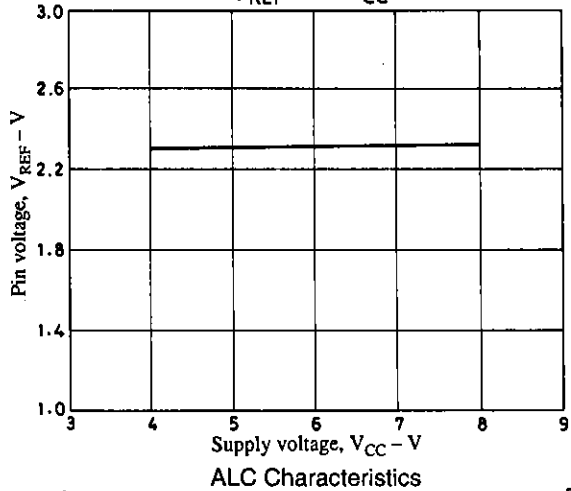




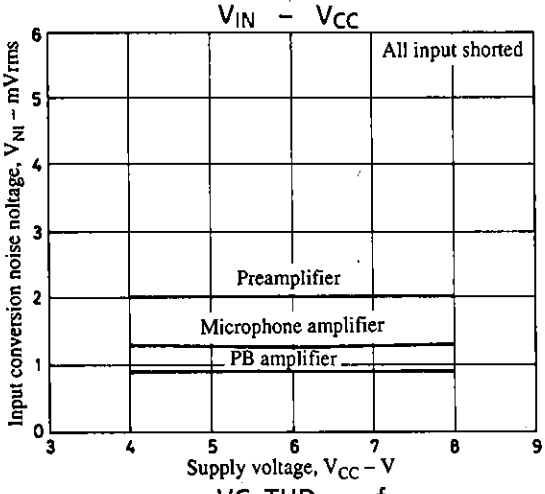
I_{CCO} – V_{CC}



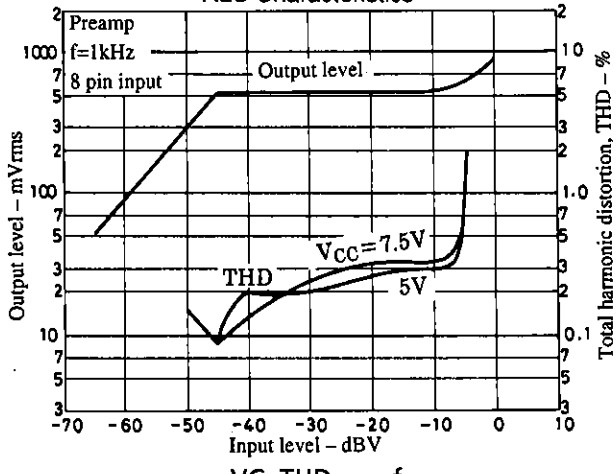
V_{REF} – V_{CC}



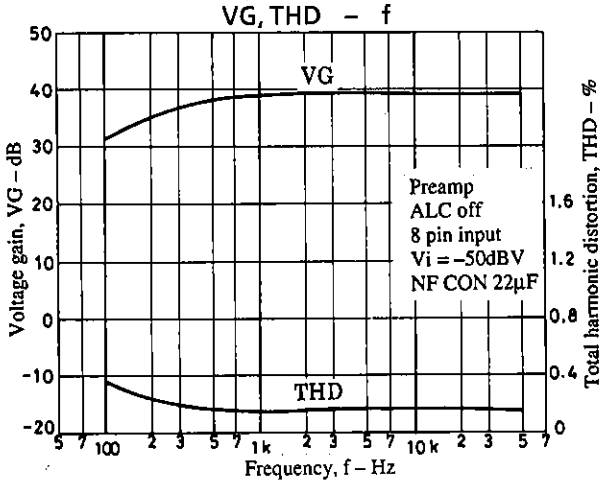
V_{IN} – V_{CC}



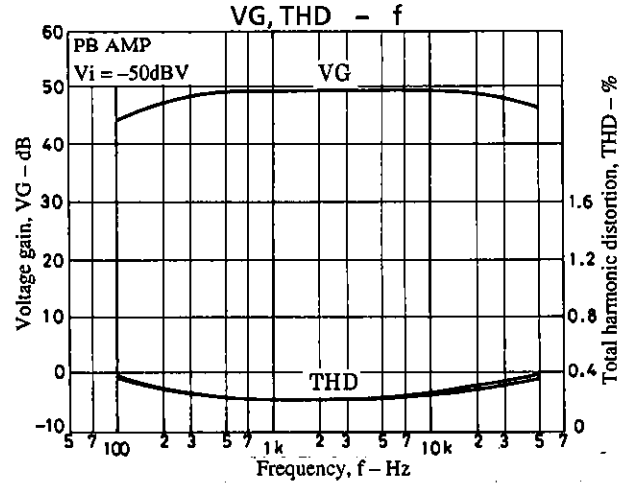
ALC Characteristics



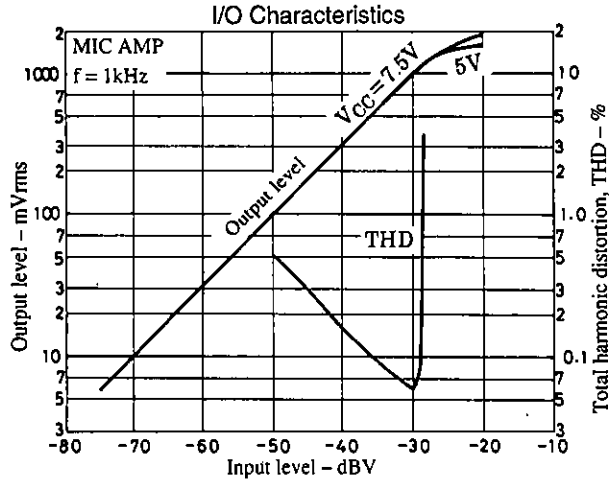
VG, THD – f



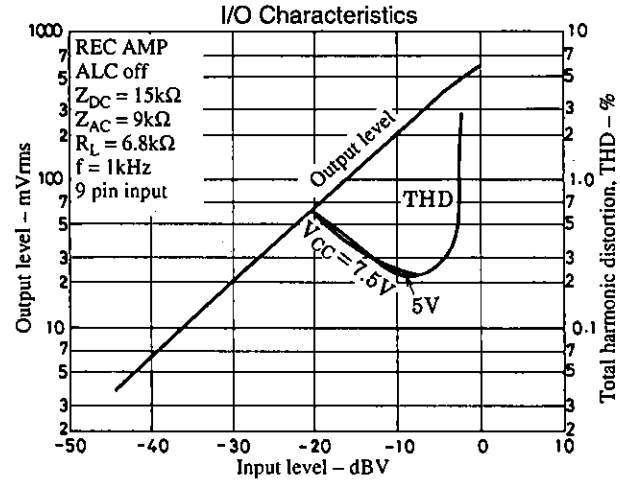
VG, THD – f



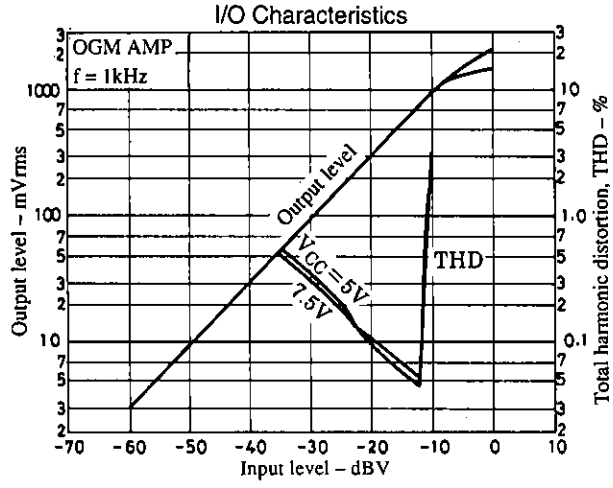
I/O Characteristics



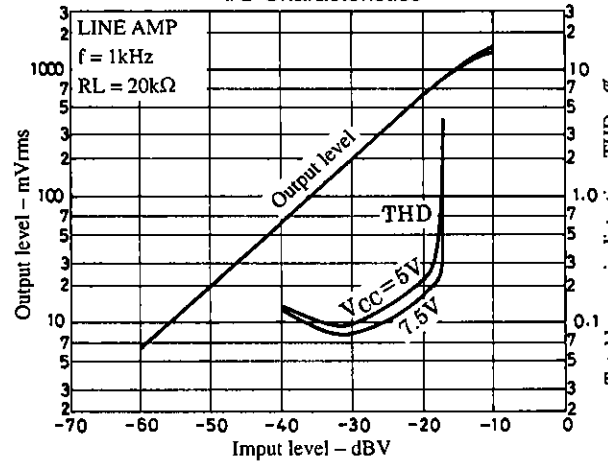
I/O Characteristics



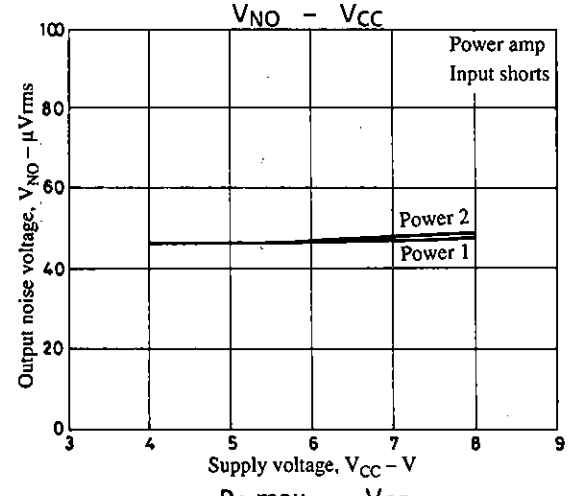
I/O Characteristics



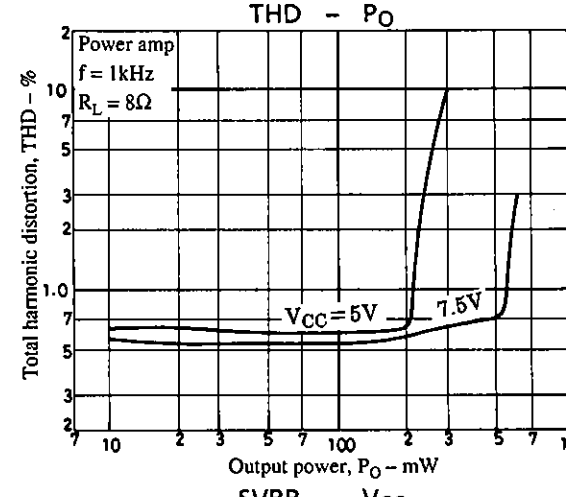
I/O Characteristics



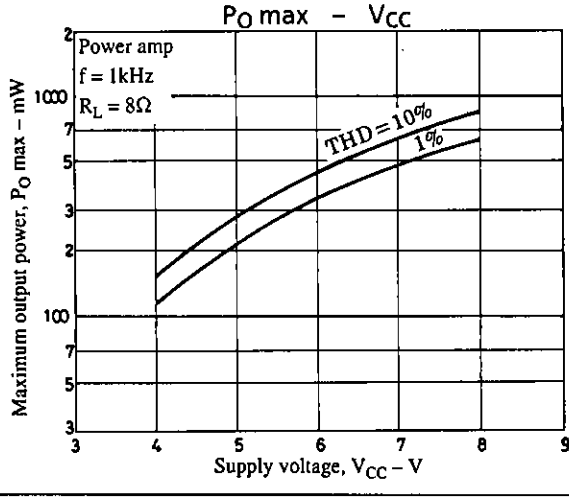
V_{NO} – V_{CC}



THD – P_O



P_O max – V_{CC}



SVRR – V_{CC}