BIPOLAR ANALOG INTEGRATED CIRCUIT
μPC1313HA

T-77-21

LOW NOISE DUAL PREAMPLIFIER
SILICON BIPOLAR MONOLITHIC INTEGRATED CIRCUIT

DESCRIPTION

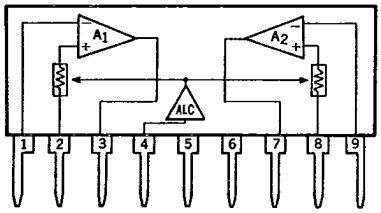
The μPC1313HA is a silicon monolithic integrated circuit and a low noise dual preamplifier with ALC (Automatic Level Control) circuit designed for record and play-back amplifier of stereo portable cassette tape-recorder. Its major features are low noise, low distortion, high gain, large dynamic range and wide supply range.

Outline is a 9-lead single in-line plastic package, for small mounting space on P.C. Board.

FEATURES

- Very low seated height : 5.72 mm MAX.
- High open loop gain : A_{VO} = 90 dB TYP. (f = 1 kHz)
- Low noise : V_{nin} = 1.3 μV TYP. (R_G = 2.2 kΩ NAB)
- Low distortion : THD = 0.05 % TYP. (V_O = 0.3 V)
- Large dynamic range : V_{OM} = 1.8 V TYP. (THD = 1 %)

BLOCK DIAGRAM



CONNECTION DIAGRAM

PIN No.	ELECTRICAL CONNECTION
1	Negative feed back 1
2	Input 1
3	Output 1
4	ALC Input
5	Ground
6	Power Supply
7	Output 2
8	Input 2
9	Negative feed back 2

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ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

Supply Voltage	V_{CC}	15	V
Package Dissipation	P_D	300*	mW
Operating Temperature	T_{opt}	−20 to +75	°C
Storage Temperature	T_{stg}	−40 to +125	°C

* T_a = 75 °C

RECOMMENDED OPERATING CONDITIONS (T_a = 25 °C)

Supply Voltage Range	V_{CC}	4 to 15	V	(PLAY)
	V_{CC}	7.5 to 15	V	(REC. at Application Circuit 1)
	V_{CC}	6.5 to 15	V	(REC. at Application Circuit 2)
	V_{CC}	5.0 to 15	V	(REC. at Application Circuit 3)
Voltage Gain	A_V	46 MIN.	dB	(NAB)
	A_V	40 MIN.	dB	(FLAT)

ELECTRICAL CHARACTERISTICS (T_a = 25 °C, V_{CC} = 9 V, f = 1 kHz, R_L = 10 kΩ NAB)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT	TEST CONDITIONS
Quiescent Current	I_{CC}	2.5	4	6	mA	(1)	V_{in} = 0
Open Loop Voltage Gain	A_{VO}	80	90		dB	(1)	V_O = 0.3 V
Voltage Gain	A_V		46		dB	(2)	V_O = 0.3 V
Maximum Output Voltage	V_{OM}	1.2	1.8		V	(2)	THD = 1 %
Total Harmonic Distortion	THD		0.05	0.3	%	(2)	V_O = 0.3 V with 400 pF and 30 kHz 4 pF
Input Impedance	R_i	25	45		kΩ	(2)	
Equivalent Input Noise Voltage	V_{nin}		1.3	4	μV	(3)	R_G = 2.2 kΩ
Cross Talk	CT	−50	−65		dB	(4)	V_O = 1 V, (The other channel V_{in} = 0, R_G = 2.2 kΩ)
ALC Balance	ΔV_{ALC}		0	2.5	dB	(6)	V_{in} = −50 dBV
ALC THD	THD_{ALC}		0.2	1	%	(5)	V_{in} = −50 dBV
ALC	ALC	40	46		dB	(5)	from V_{in} = −70 dBV to become THD = 10 %

TEST CIRCUITS

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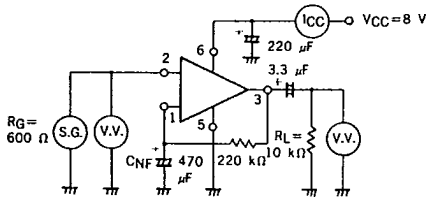
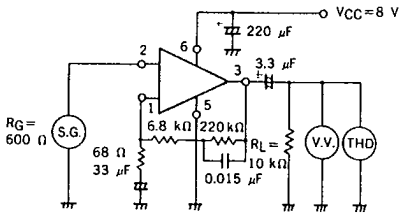
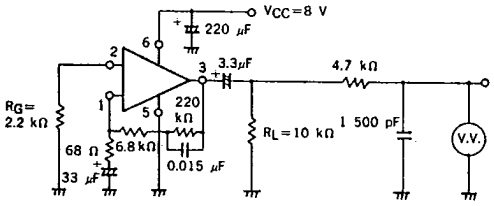
(1) I_{CC}, A_{VO} test circuit



(2) A_V, V_{OM}, THD, Z_{in} test circuit (for CH1)

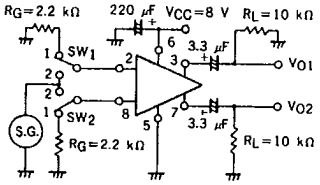


(3) V_{nin} test circuit (for CH1)



AV f=1 kHz

(4) Cross talk, Channel balance test circuit



NOTE 1: External components of the IC are the same as the test circuit (2).

2: Cross talk procedure
Switch position SW.1 → 2, SW.2 → 1, 20 log V_{O2}/V_{O1}
Switch position SW.1 → 1, SW.2 → 2, 20 log V_{O1}/V_{O2}

3: Channel balance
Switch position SW.1 → 2, SW.2 → 2, 20 log V_{O1}/V_{O2}

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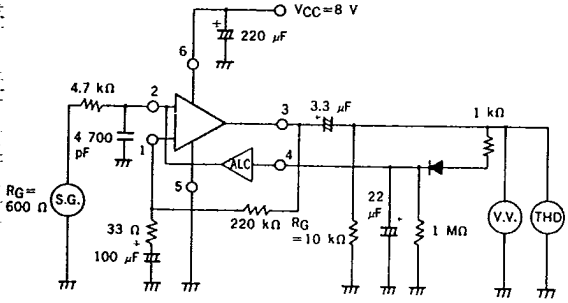
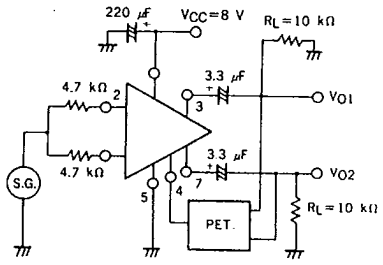
(5) THD_{ALC}, ALC test circuit (for CH1)



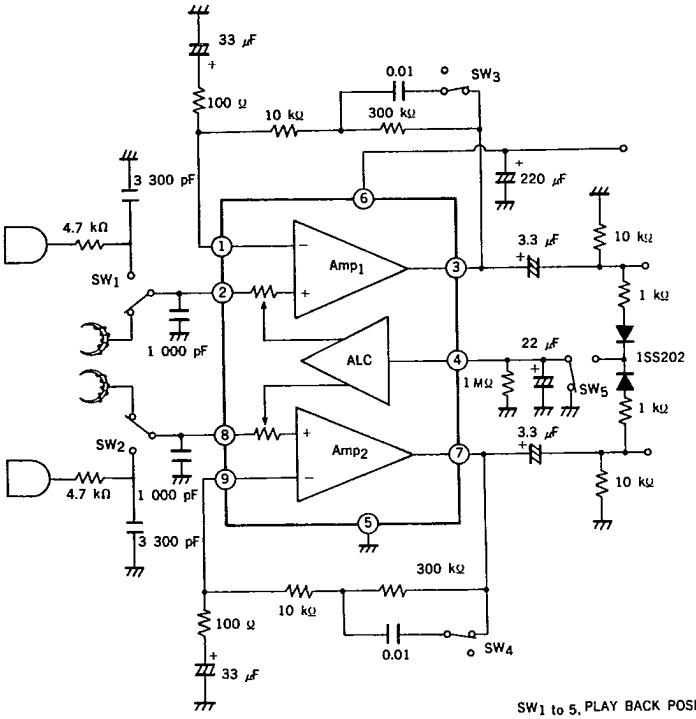
(6) ALC balance test circuit



NOTE 1: External components of the IC are the same as test circuit (5).

2: ALC balance: 20 log V_{O1}/V_{O2}

APPLICATION CIRCUIT 1 (V_{CC} = 7.5 to 15 V)



SW1 to 5. PLAY BACK POSITION

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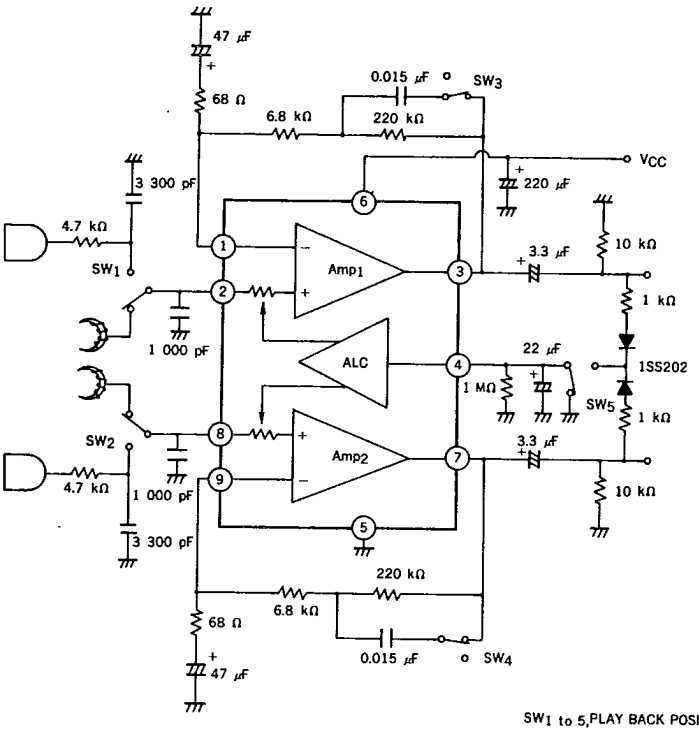
APPLICATION CIRCUIT 2 (V_{CC} = 6.5 to 15 V)



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SW_1 to 5, PLAY BACK POSITION

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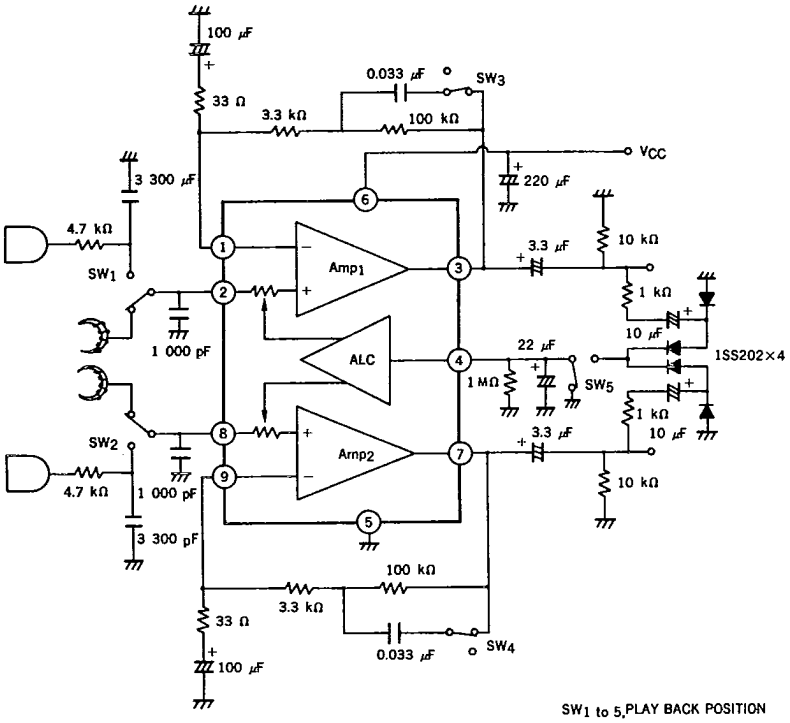
APPLICATION CIRCUIT 3 (5.0 V to 15 V)



SW1 to 5 PLAY BACK POSITION

TYPICAL PCB

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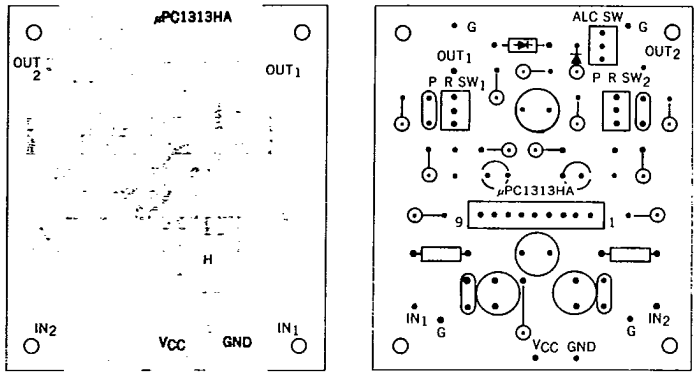

(COPPER SIDE)

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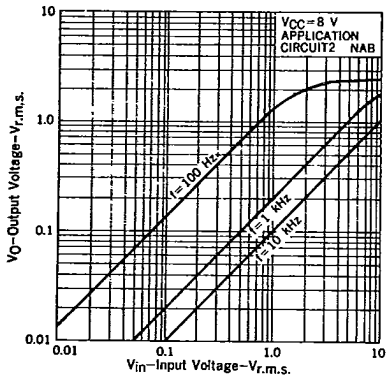
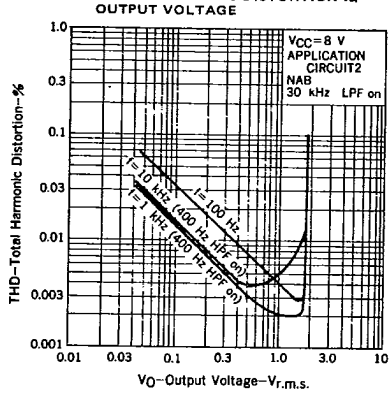
TYPICAL CHARACTERISTICS (T_a = 25 °C)

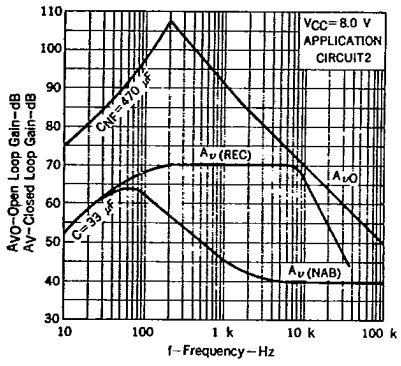
OUTPUT VOLTAGE vs. INPUT VOLTAGE



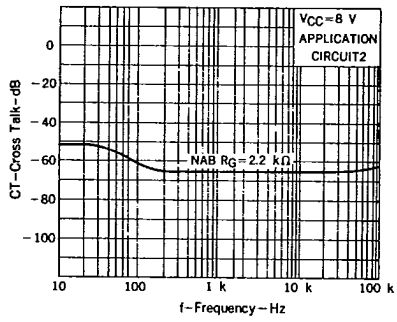
TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE



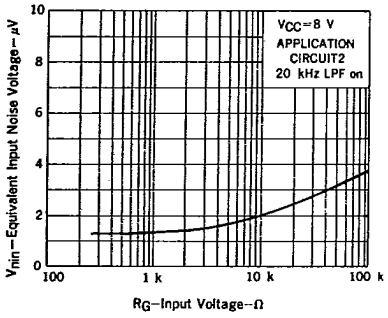
OPEN AND CLOSED LOOP GAIN vs. FREQUENCY



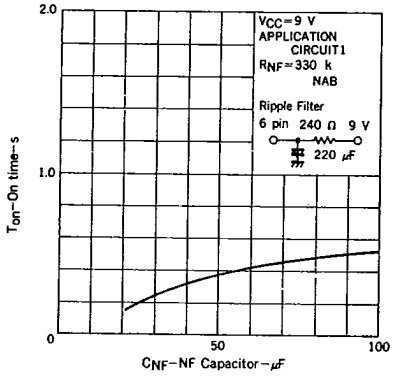
CROSS TALK vs. FREQUENCY



EQUIVARENT INPUT VOLTAGE vs. INPUT RESISTANCE



ON TIME vs. NF CAPACITOR



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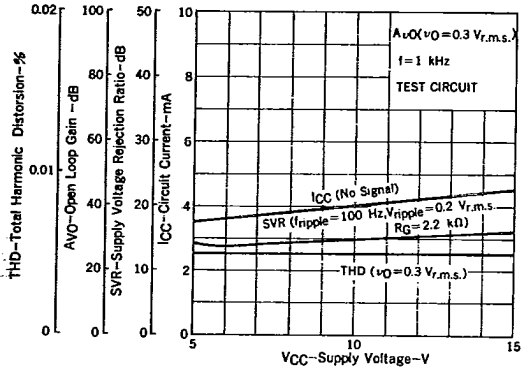
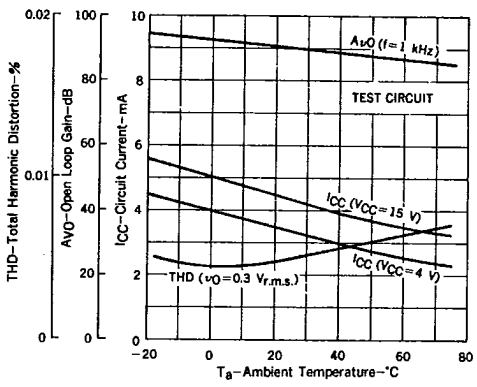
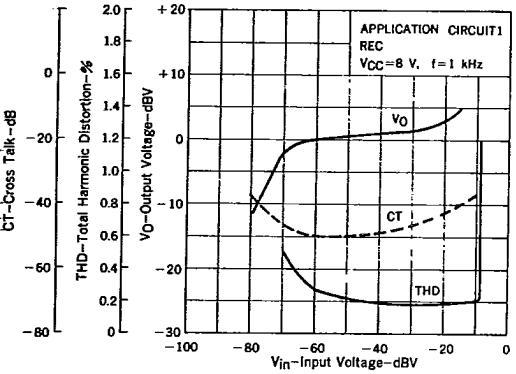
TOTAL HARMONIC DISTORTION, OPEN LOOP GAIN, SUPPLY VOLTAGE REJECTION RATIO, CIRCUIT CURRENT vs. SUPPLY VOLTAGE



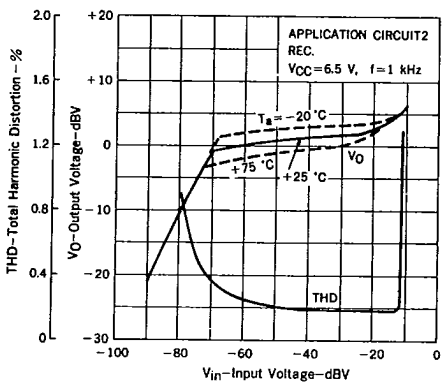
TOTAL HARMONIC DISTORTION, OPEN LOOP GAIN, CIRCUIT CURRENT vs. AMBIENT TEMPERATURE



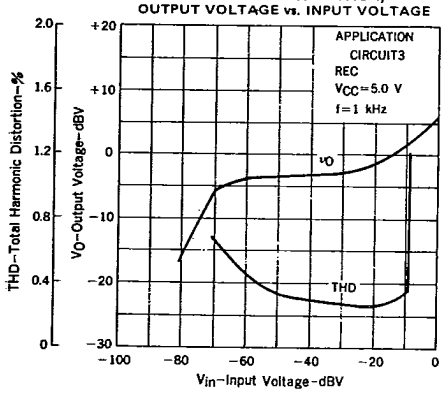
CROSS TALK, TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



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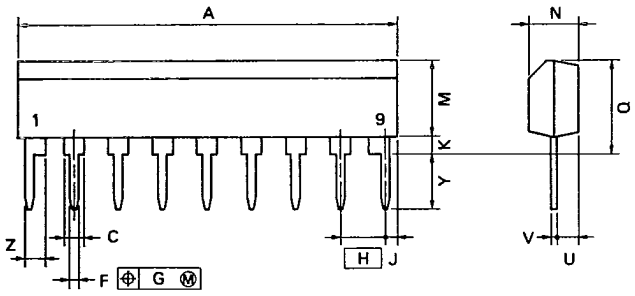
9 PIN PLASTIC SLIM SIP



P9HA-254B

ITEM	MILLIMETERS	INCHES
A	22.86 MAX.	0.9 MAX.
C	1.1 MIN.	0.043 MIN.
F	$0.5^{+0.1}_{-0.05}$	$0.02^{+0.004}_{-0.003}$
G	0.25	0.01
H	2.54	0.1
J	1.27 MAX.	0.05 MAX.
K	0.51 MIN.	0.02 MIN.
M	5.08 MAX.	0.2 MAX.
N	$2.8^{+0.2}_{-0.1}$	$0.11^{+0.008}_{-0.005}$
Q	5.75 MAX.	0.227 MAX.
U	1.5 MAX.	0.059 MAX.
V	$0.25^{+0.10}_{-0.05}$	$0.01^{+0.004}_{-0.003}$
Y	$3.2^{+0.5}_{-0.3}$	$0.126^{+0.020}_{-0.012}$
Z	1.1 MIN.	0.043 MIN.

NOTE
Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

μPC1313HA

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The μPC1313HA is a dual preamplifier in a new 9-pin slim SIP (Single In-line Package), with ALC (Automatic Level Control) circuit, and designed as two channels recording or playback amplifier for a portable cassette tape recorder.

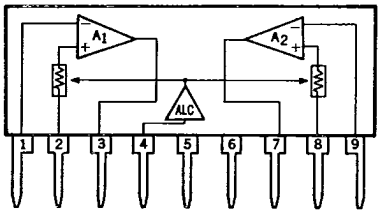
The μPC1313HA has high voltage gain, low noise, low distortion, high output voltage and stable characteristics in wide supply voltage range.

High resistance as a value of feedback resistor can be used so that excellent playback characteristics can be performed with smaller capacitance.

1. FEATURES

- Very low seated height : 5.72 mm MAX.
- High open loop gain : A_{VO} = 90 dB TYP. (f = 1 kHz)
- Low noise : V_{nin} = 1.3 μV TYP. (R_G = 2.2 kΩ NAB)
- Low distortion : THD = 0.05 % TYP. (V_O = 0.3 V)
- Large dynamic range : V_{OM} = 1.8 V TYP. (THD = 1 %)

2. BLOCK DIAGRAM



3. CONNECTION DIAGRAM

PIN No.	ELECTRICAL CONNECTION
1	Negative feedback 1
2	Input 1
3	Output 1
4	ALC Input
5	Ground
6	V_{CC}
7	Output 2
8	Input 2
9	Negative feedback 2

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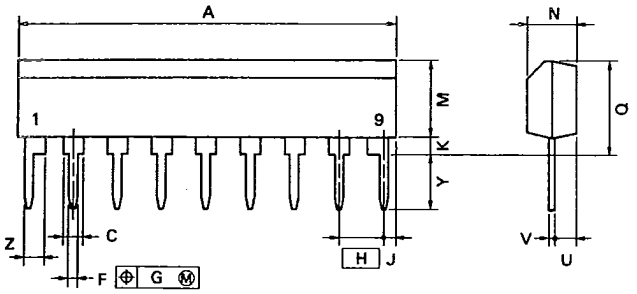
4. PACKAGE DIMENSIONS

9 PIN PLASTIC SLIM SIP



P9HA-254B

ITEM	MILLIMETERS	INCHES
A	22.86 MAX.	0.9 MAX.
C	1.1 MIN.	0.043 MIN.
F	$0.5^{+0.1}_{-0.2}$	$0.02^{+0.004}_{-0.008}$
G	0.25	0.01
H	2.54	0.1
J	1.27 MAX.	0.05 MAX.
K	0.51 MIN.	0.02 MIN.
M	5.08 MAX.	0.2 MAX.
N	$2.8^{+0.2}_{-0.1}$	$0.11^{+0.008}_{-0.004}$
Q	5.75 MAX.	0.227 MAX.
U	1.5 MAX.	0.059 MAX.
V	$0.25^{+0.10}_{-0.05}$	$0.01^{+0.004}_{-0.002}$
Y	$3.2^{+0.5}_{-0.1}$	$0.126^{+0.002}_{-0.004}$
Z	1.1 MIN.	0.043 MIN.

NOTE
Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

5. EQIVALENT CIRCUIT

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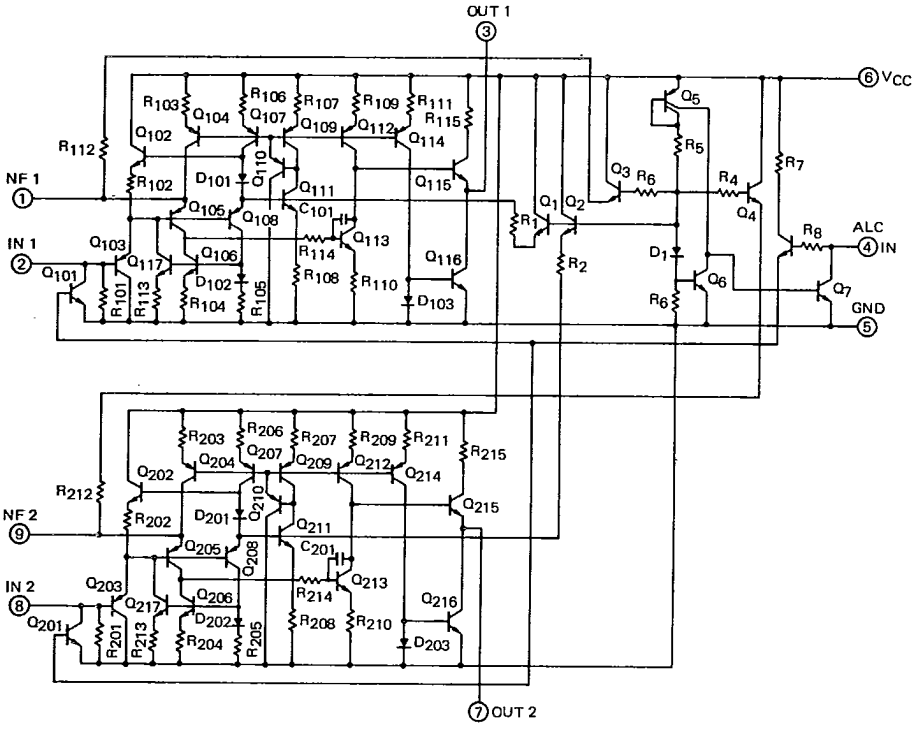

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6. CHARACTERISTICS

6.1 ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

Supply Voltage	V_{CC}	15	V
Package Dissipation	P_D	300*	mW
Operating Temperature	T_{opt}	−20 to +75	°C
Storage Temperature	T_{stg}	−40 to +125	°C

* T_a = 75 °C

6.2 RECOMMENDED OPERATING CONDITIONS (T_a = 25 °C)

Supply Voltage Range	V_{CC}	4 to 15	V	(PLAY)
	V_{CC}	7.5 to 15	V	(REC. at Application Circuit 1)
	V_{CC}	6.5 to 15	V	(REC. at Application Circuit 2)
	V_{CC}	5.0 to 15	V	(REC. at Application Circuit 3)
Voltage Gain	A_V	46 MIN.	dB	(NAB)
	A_V	40 MIN.	dB	(FLAT)

6.3 ELECTRICAL CHARACTERISTICS (T_a = 25 °C, V_{CC} = 9 V, f = 1 kHz, R_L = 10 kΩ NAB)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT	TEST CONDITIONS
Quiescent Current	I_{CC}	2.5	4	6	mA	(1)	V_{in} = 0
Open Loop Voltage Gain	A_{VO}	80	90		dB	(1)	V_O = 0.3 V
Voltage Gain	A_V		46		dB	(2)	V_O = 0.3 V
Maximum Output Voltage	V_{OM}	1.2	1.8		V	(2)	THD = 1 %
Total Harmonic Distortion	THD		0.05	0.3	%	(2)	V_O = 0.3 V with 400 Hz HPF and 30 kHz LPF
Imput Impedance	R_i	25	45		kΩ	(2)	
Equivalent Input Noise Voltage	V_{nin}		1.3	4	μV	(3)	R_G = 2.2 kΩ
Cross Talk	CT	−50	−65		dB	(4)	V_O = 1 V, (The other channel V_{in} = 0, R_G = 2.2 kΩ)
ALC Balance	ΔV_{ALC}		0	2.5	dB	(6)	V_{in} = −50 dBV
ALC THD	THD_{ALC}		0.2	1	%	(5)	V_{in} = −50 dBV
ALC	ALC	40	46		dB	(5)	from V_{in} = −70 dBV to become THD = 10 %

6.4 TEST CIRCUITS

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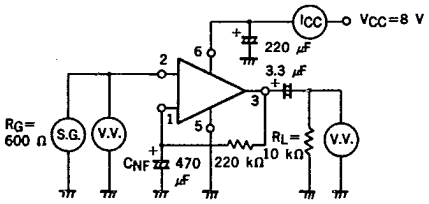
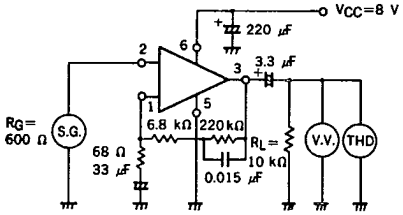
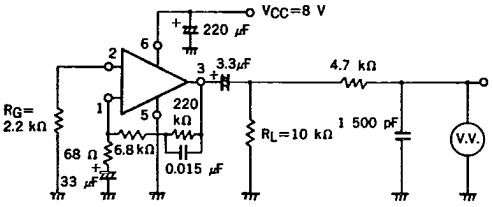
(1) I_{CC}, A_{VO} test circuit



(2) A_V, V_{OM}, THD, Z_{in} test circuit (for CH1)

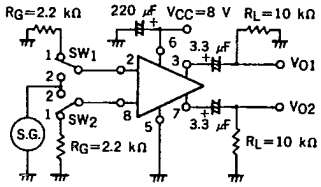


(3) V_{nin} test circuit (for CH1)



AV f=1 kHz

(4) Cross talk, Channel balance test circuit



NOTE 1: External components of the IC are the same as the test circuit (2).

2: Cross talk procedure
Switch position SW.1 → 2, SW.2 → 1, 20 log V_{o2}/V_{o1}
Switch position SW.1 → 1, SW.2 → 2, 20 log V_{o1}/V_{o2}

3: Channel balance
Switch position SW.1 → 2, SW.2 → 2, 20 log V_{o1}/V_{o2}

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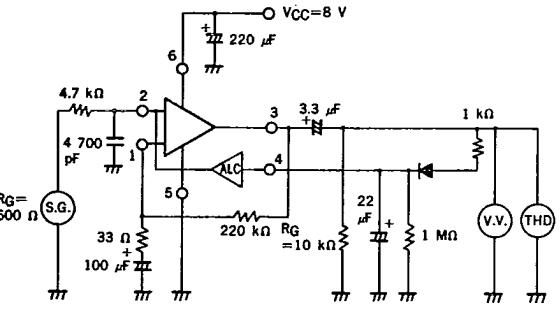
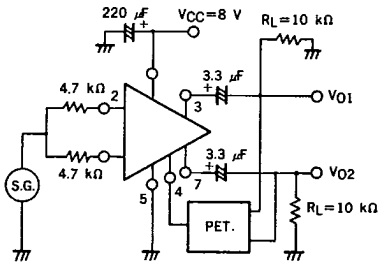
(5) THD_{ALC}, ALC test circuit (for CH1)



(6) ALC balance test circuit



NOTE 1: External components of the IC are the same as test circuit (5).

2: ALC balance: 20 log V_{o1}/V_{o2}

7. EXTERNAL PARTS AND CHARACTERISTICS

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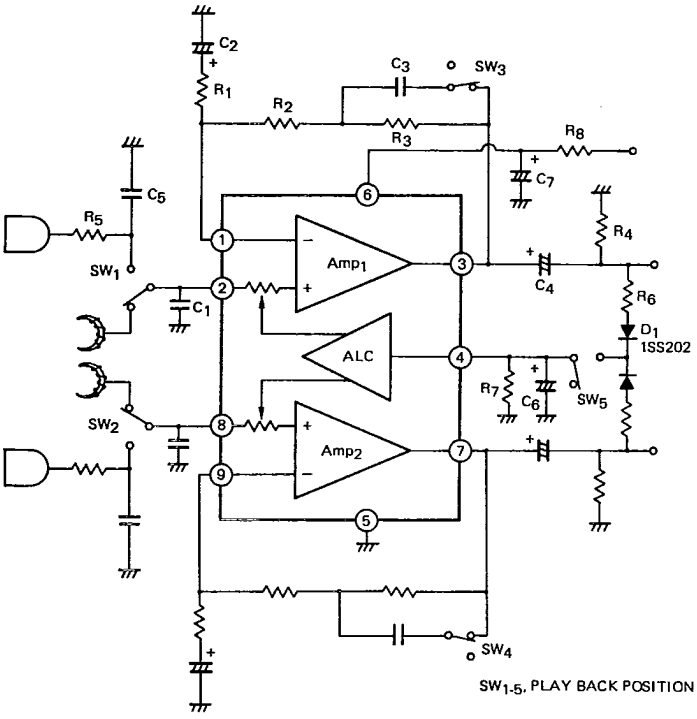

Fig. 1 Typical Application Circuit

Table 1. External Parts and Characteristics

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Parts No.	Purpose	Influence	
		Smaller than TYP.	Larger than TYP.
C_1	Resonance	Sellect according to head coil	
C_2	Coupling	Bad low Frequency responce	
R_1	A_v adjustment	Not available at $A_v < 40$ dB	
R_2 R_3 C_3	Output DC voltage adjustment NAB characteristic adjustment	Low V_{OM} Out of NAB characteristic	Low V_{OM} Out of NAB characteristic
C_4	Coupling	Bad low frequency response	
R_4	Load	Low V_{OM}	
R_5	ALC range adjustment	Narrow ALC range	Increase noise
C_5	Phase compensation	Oscillation	Bad high frequency response
R_6	ALC attack time adjustment	Short attack time	Long attack time
C_6	ALC attack time and recovery time adjustment	Short attack and recovery time	Long attack and recovery time
R_7	ALC recovery time adjustment	Short recovery time	Long recovery time

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8. GUIDES FOR USAGE

8.1 OUTPUT DC VOLTAGE ADJUSTMENT

Output DC voltage (V_{ODC}) is adjusted by the voltage drop in $R_2 + R_3$, and is kept constantly against the change of supply voltage. Output maximum voltage (V_{OM}) is determined by output DC voltage.

The relation among supply voltage (V_{CC}), output DC voltage and output maximum voltage is shown in the Figure 2.

$V_{ODC} = (R_2 + R_3) \times I_{NF}$

$I_{NF} = 3.5$ to 10×10^{-6} (A) (NF Terminal Sink Current)

$V_{NF} = 1.25$ TYP. (V) (NF Terminal DC Voltage)

When $(V_{+sat} - V_{ODC}) < (V_{ODC} - V_{-sat})$

V_{OM} is $(V_{+sat} - V_{ODC}) / \sqrt{2}$

When $(V_{+sat} - V_{ODC}) > (V_{ODC} - V_{-sat})$

V_{OM} is $(V_{ODC} - V_{-sat}) / \sqrt{2}$

V_{+sat} : Upper Saturation Voltage $\fallingdotseq V_{CC} - 1$ V

V_{-sat} : Lower Saturation Voltage $\fallingdotseq 0.2$ V

The relation between V_{ODC} and $R_2 + R_3$ is shown Figure 4. Figure 5 shows thermal characteristic of V_{ODC}.

It is necessary to adjust the value of $R_2 + R_3$ according to ambient temperature range, minimum supply voltage, and V_{OM} required.

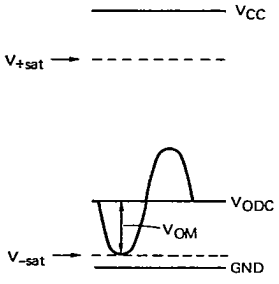

Fig. 2 The Relation among V_{CC}, V_{ODC} and V_{OM}

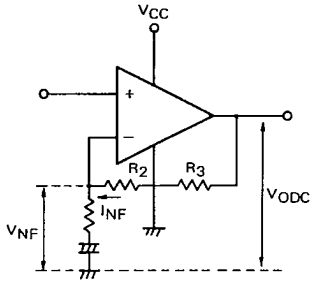

Fig. 3 The Relation among V_{ODC}, V_{NF} and I_{NF}

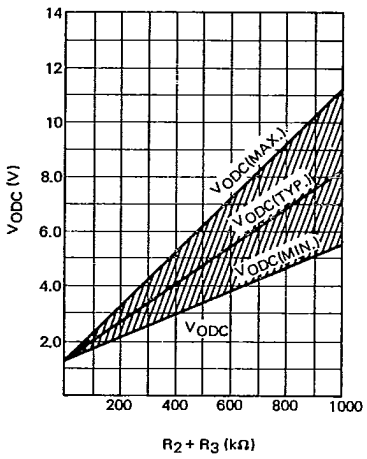

Fig. 4 $R_2 + R_3$ vs. V_{ODC}

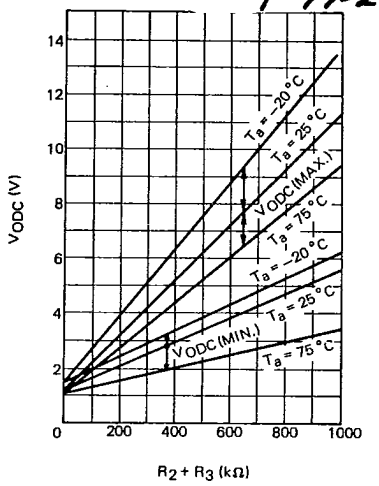

Fig. 5 Thermal Characteristic of V_{ODC}

8.2 PLAYBACK CHARACTERISTICS

Table 2 shows time constant specified by NAB.

Table 2. Time Constant

	9.5 cm/s	4.75 cm/s
C_3 (R_2 + R3)	3 180 μs	1 590 μs
$C_3 \cdot R_2$	90 μs	120 μs

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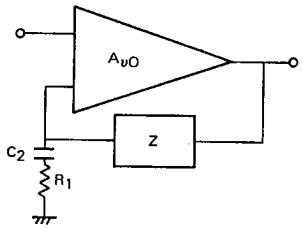
The voltage gain of playback mode is adjusted by C_3, R_2, R_3 and R_1. The value of $R_2 + R_3$ is already determined in chapter 7.1.

In a negative feedback circuit shown in the right, its voltage gain is approximately

$$A_v = Z/R_1$$

μPC1313HA's voltage gain can be adjusted in the above equation. And μPC1313HA can't be used less than 40 dB in high frequency due to a oscillation. So adjust its voltage gain at 1 kHz more than 46 dB.



Low frequency roll off (f_L) is influenced by the coupling capacitor (C_2).

$$f_L = (2\pi C_2 R_1)^{-1}$$

Also C_2 and $R_2 + R_3$ influence rising time when power supply switch is turn on. (Refer to Table 1).

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8.3 RECORDING CHARACTERISTICS

By removing C_2 in the circuit shown in Fig. 1. μPC1313HA operates as a flat amplifier. In this case its voltage gain is

$$A_{v(REC)} = (R_2 + R_3) / R_1$$

Sellect the value of R_1 to adjust its voltage gain.

ALC circuit devides the input signal to the amplifier stage with external resistor R_5 and conductance of ALC output circuit. The control signal of ALC circuit is obtained by rectifying output signal of amplifier stage. As the ALC control voltage the rectified voltage is required in the range of about 0.9 V to 1.4 V. (Refer to Fig. 6)

When μPC1313HA is used in a low supply voltage μPC1313HA can't provide enough output signal to control ALC circuit. In this case use the voltage doubling rectifier shown in application circuit 3. The attack-time is adjusted by C_6 and R_6 and the recovery-time is adjusted by C_6 and R_7//Ri(4). (Ri(4): Input Impedance of 4 pin).

Also C_5 is required to keep the stability against oscillation. 3 300 pF as its value is recommended.

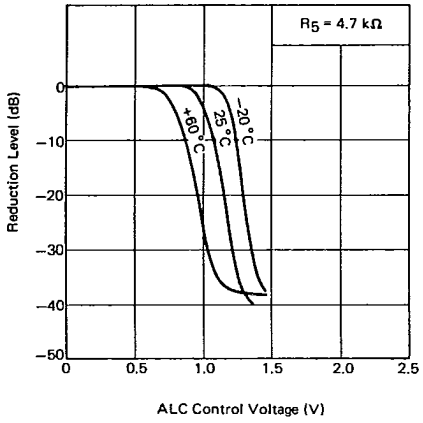

Fig. 6 Reduction Level vs. ALC Control Voltage

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8.4 RIPPLE FILTER

In case that there is a high level ripple in a power supply, use a ripple filter circuit like which is shown in Fig. 7.

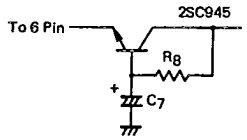
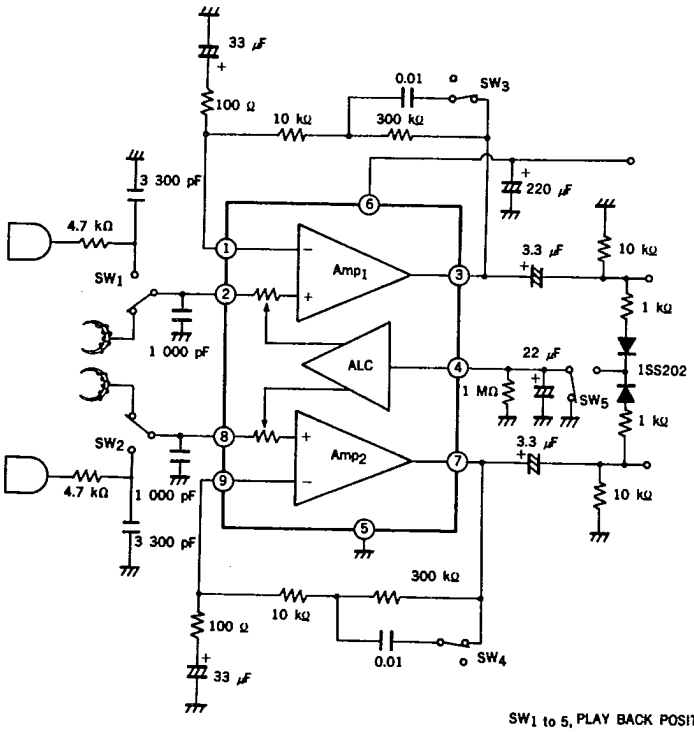


Fig. 7 Ripple Filter

9. EXAMPLE OF APPLICATION

9.1 APPLICATION CIRCUIT 1 (V_{CC} = 7.5 to 15 V)



SW_1 to 5, PLAY BACK POSITION

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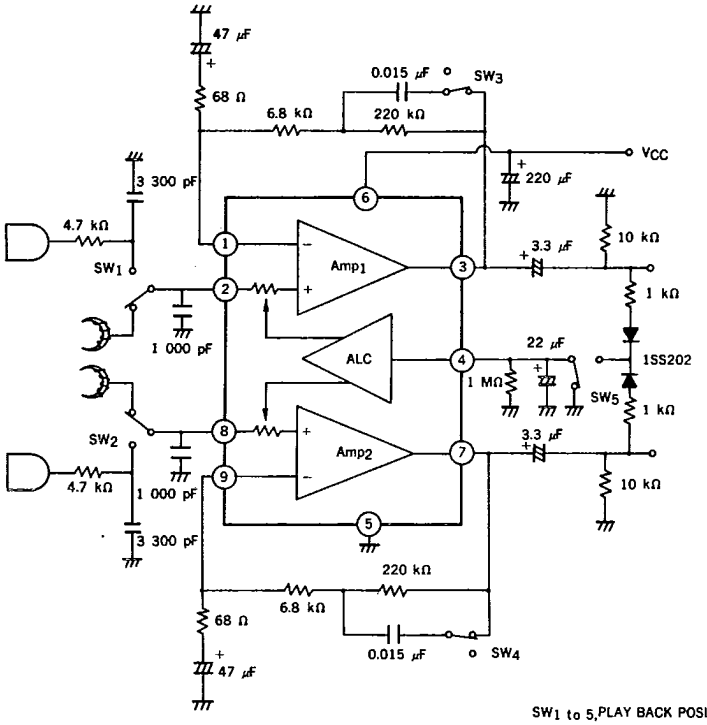
APPLICATION CIRCUIT 2 (V_{CC} = 6.5 to 15 V)



SW1 to 5,PLAY BACK POSITION

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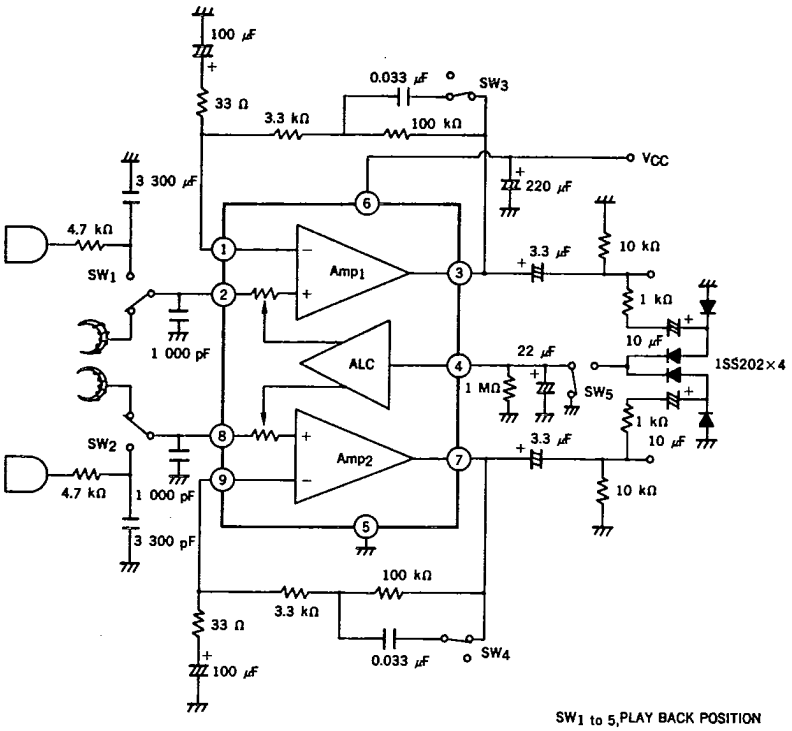
APPLICATION CIRCUIT 3 (5.0 V to 15 V)



SW1 to 5, PLAY BACK POSITION

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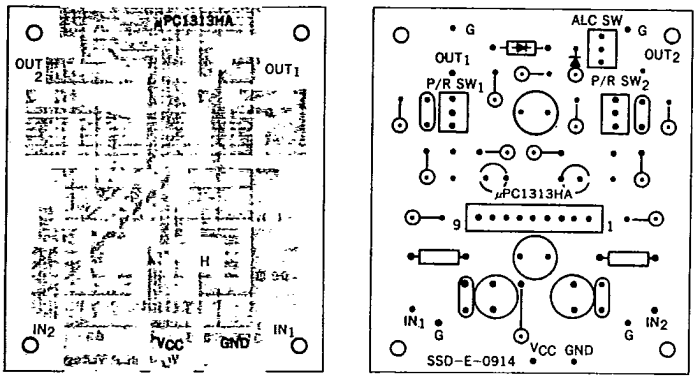
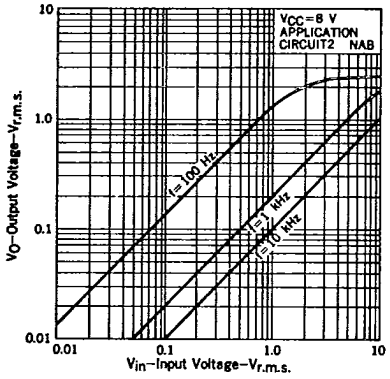
9.2 TYPICAL PCB



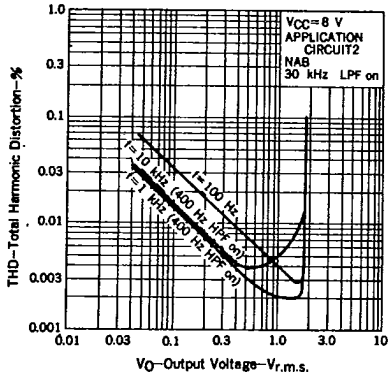
(COPPER SIDE)

9.4 TYPICAL CHARACTERISTICS (T_a = 25°C)

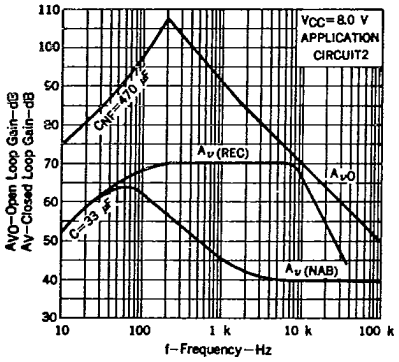
OUTPUT VOLTAGE vs. INPUT VOLTAGE



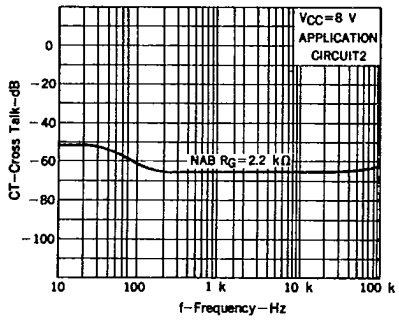
TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE



OPEN AND CLOSED LOOP GAIN vs. FREQUENCY



CROSS TALK vs. FREQUENCY



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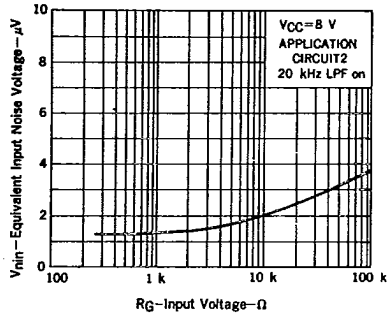
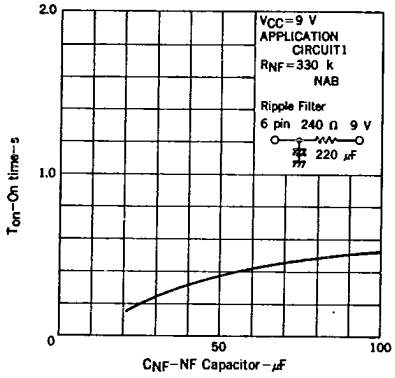
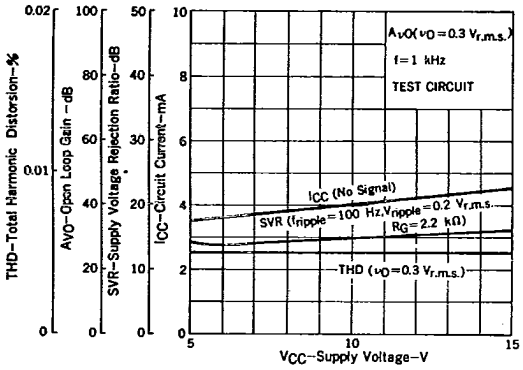
EQUIVALENT INPUT VOLTAGE vs. INPUT RESISTANCE



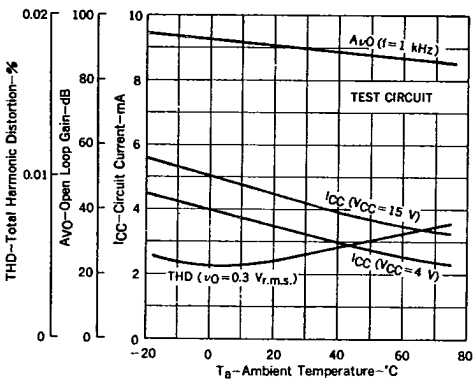
ON TIME vs. NF CAPACITOR



TOTAL HARMONIC DISTORTION, OPEN LOOP GAIN, SUPPLY VOLTAGE REJECTION RATIO, CIRCUIT CURRENT vs. SUPPLY VOLTAGE



TOTAL HARMONIC DISTORTION, OPEN LOOP GAIN, CIRCUIT CURRENT vs. AMBIENT TEMPERATURE



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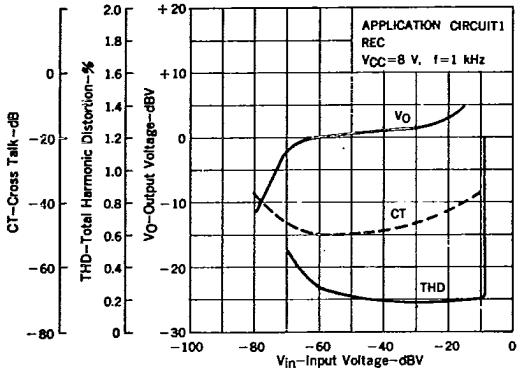
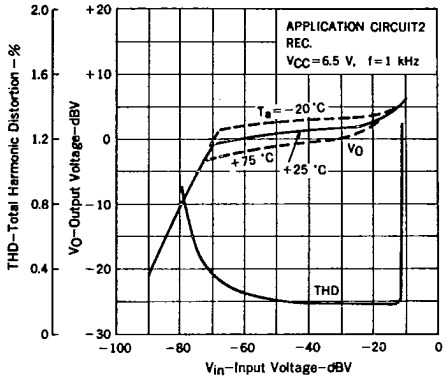
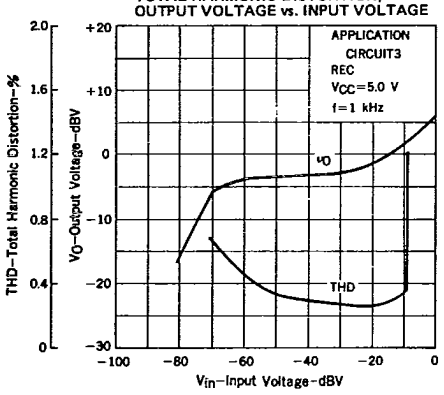
CROSS TALK, TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



TOTAL HARMONIC DISTORTION, OUTPUT VOLTAGE vs. INPUT VOLTAGE



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