RS Data Library

Audio preamplifiers LM381, HA12017 and 6270

Stock numbers 306-825, 304-576, 302-132

Two high quality audio preamplifier i.c.s. suitable for magnetic cartridge amplification using RIAA equalisation, or microphone amplification using a "flat" characteristic. Also a microphone preamplifier incorporating a Voice Operated Gain Adjusting Device (V.O.G.A.D.).

LM381

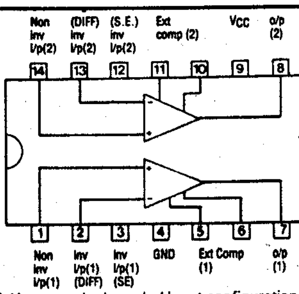
A dual preamplifier specially designed to meet the requirements of amplifying low level signals in low noise applications. Each amplifier contains an internal power supply decoupler-regulator, providing 120dB supply rejection and 60dB channel separation. Other features include high gain, large output voltage swing and a wide power bandwidth. Operation is from a single supply in the range 9 to 40V and the device is internally compensated and short-circuit protected.

Maximum ratings

Supply voltage	40V
Dissipation	715mW
Operating temperature range	0 to 70°C
Input voltage for linear swing	300mV rms

Typical electrical characteristics

Voltage gain open loop single ended	320,000 (110dB)
Voltage gain open loop single differential	160,000 (104dB)
Total supply current ($R_L = \infty$)	10mA
Input resistance	100kΩ
Open loop output resistance	150Ω
Voltage swing	$V_{CC} - 2V$
Full power bandwidth	75kHz
Channel separation	60dB
Harmonic distortion at 60dB gain	0.1% at 1kHz



Either differential input or single ended input configurations may be selected.

NOTES

A ready made pc board RS stock number 434-396 is available to accommodate the LM 381 and associated components (including the tone and volume controls) for a stereo pre-amplifier giving RIAA flat characteristics.

Applications

Figure 1 **Magnetic cartridge amplifier to the RIAA characteristic**

An amplifier to RIAA characteristics for use with dynamic cartridges with a standard load of 50kΩ. When a crystal or ceramic cartridge is used the LM380 "single ended amplifier" circuit may be connected directly. Gain $\triangleq \frac{30{,}000}{Re\Omega}$

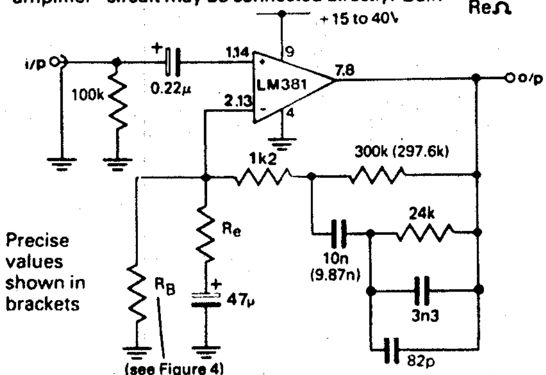
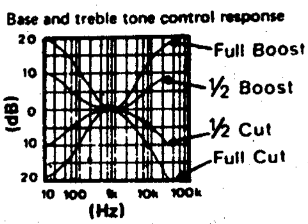
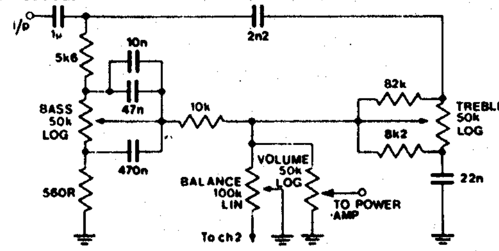


Figure 2 **Tone control stage**

Some audio applications require bass and treble tone controls. Normally two preamplifiers are required to compensate for the insertion loss of the controls. However, due to the excellent gain and large output of the LM381, only a single preamplifier is needed.





The i/p of the tone control stage can be put in series with any preamplifier circuit.

Figure 3 **Audio mixer**

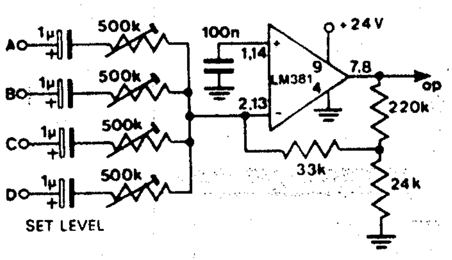


Figure 4 **Biasing**

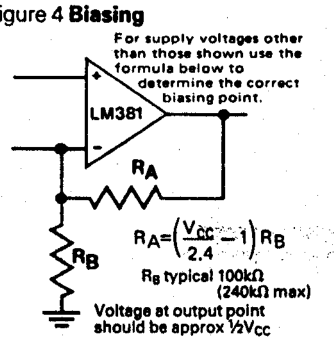


Figure 5 **Biasing – split supply**

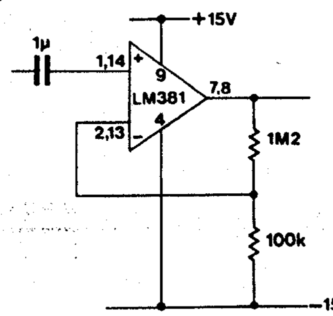
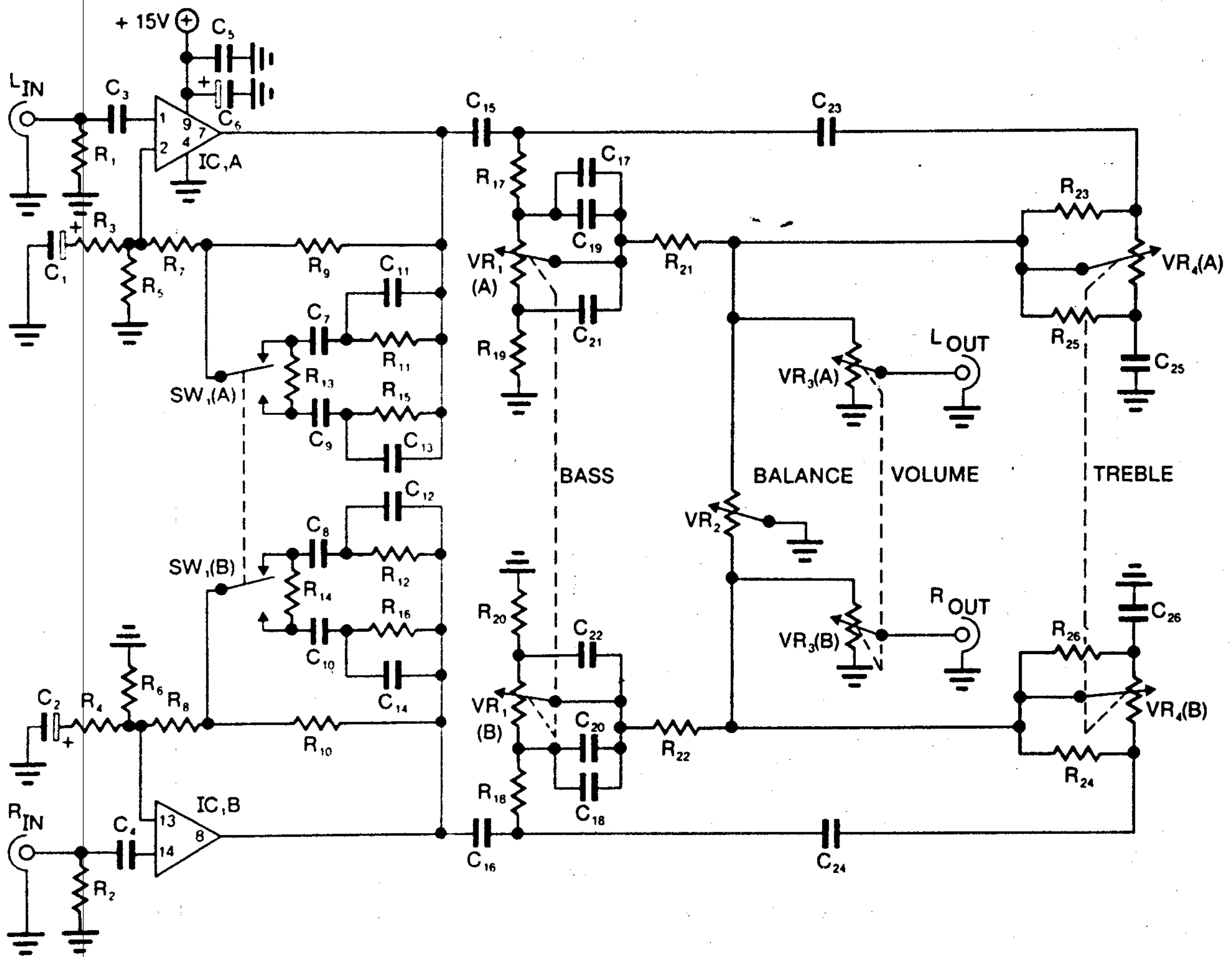


Figure 6 **Circuit diagram of preamplifier using RS printed circuit board 434-396**



List of components

Resistors

R_1 R_2 R_{11} R_{12}	47k	148-893
R_3 R_4	120R	148-281
R_5 R_6	100k	148-972
R_7 R_8	1k2	148-528
R_9 R_{10}	510k	149-155
R_{13} R_{14}	10M	158-159
R_{15} R_{16}	750R	148-477
R_{17} R_{18}	5k6	148-679
R_{19} R_{20}	560R	148-449
R_{21} R_{22}	10k	148-736
R_{23} R_{24}	82k	148-950
R_{25} R_{26}	8k2	148-714

All 0.25W Metal Film except R_{13} R_{14} Hi-Stab Carbon Film.

Capacitors

C_1 C_2	47μ	16V P.C.B. Electrolytic	104-461
C_3 C_4	100n	63V Polyester	114-840
C_5	100n	30V Disc Ceramic	124-178
C_6	470μ	16V P.C.B. Electrolytic	104-499
C_7 C_8	6n8	160V Polystyrene	113-386
C_9 C_{10}	2μ2	100V Polyester	114-446
C_{11} C_{12}	1n5	160V Polystyrene	113-336
C_{13} C_{14}	33p	160V Polystyrene	113-235
C_{15} C_{16}	1μ	Min. Dipped Polyester	115-152
C_{17} C_{18}	10n	Min. Dipped Polyester	115-051
C_{19} C_{20}	47n	Min. Dipped Polyester	115-089
C_{21} C_{22}	470n	Min. Dipped Polyester	115-130
C_{23} C_{24}	2n2	Miniature Polyester	112-721
C_{25} C_{26}	22n	Min. Dipped Polyester	115-067

Miscellaneous

VR_1 VR_3 VR_4	50k Log	162-451
VR_2	100k Lin	161-818
IC_1	LM 381	306-825
SW_1	D.P.D.T.	327-658
IC socket	14-pin	402-305
P.C.B.		434-396

Determination of gain, bandwidth, attack and decay times

The mid band gain of the second stage, which is run in parallel feedback configuration, is determined by the ratio of the 10k internal feedback resistor and the 680R resistor in series with the output of the first stage. This gain may be reduced by wiring an external feedback resistor, R_{ext}, between pins 7 and 8. The gain will then be given by the expression:

$$G = \frac{R_{ext} \times 10{,}000}{(R_{ext} + 10{,}000) \times 680} \qquad (R_{ext} \text{ in ohms})$$

The minimum permissible value for R_{ext} is 680R. The threshold point, i.e. the input level at which A.G.C. action commences, is approximately 1mV for $R_{ext} = \infty$ and approximately 8mV for $R_{ext} = 1k$.

The low frequency −3dB point is determined by the series combination of the internal 680R resistor and C_1. The high frequency −3dB point is determined by the parallel combination of the internal 10k gain-setting resistor, any external resistor R_{ext}, and C_2. Using the typical values $C_1 = 1\mu$, $C_2 = 4n7$, and $R_{ext} = \infty$, the −3dB points will occur at 234Hz and 3386Hz.

Normally the 6270 device is required to respond quickly by holding the output level almost constant as the input is increased. This "attack time", i.e. the time taken for the output to return to within 10% of the original level following a 20dB increase in the input level, will be approximately 20ms with the circuit in figure 11. It is determined by the value of C_T and can be calculated approximately by the formula:

$$\text{Attack time} \simeq 0.4\text{ms}/\mu\text{F}$$

The decay time is determined by the discharge rate of the capacitor, this being dependent on the values of R_T and C_T. For $R_T = 1M$ and $C_T = 47\mu$ the decay time is approximately 20dB/second. Other values of R_T may be used to vary the decay time for specific applications.

Figure 10(a) **Voltage gain (single ended input) – typical**

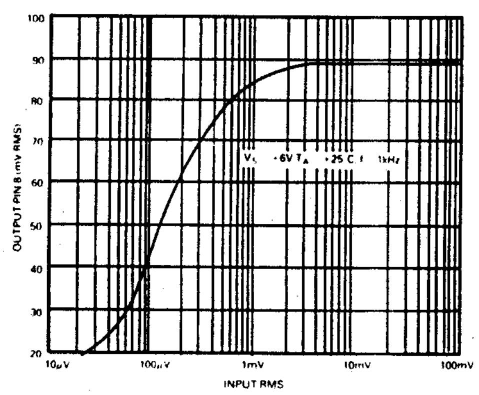
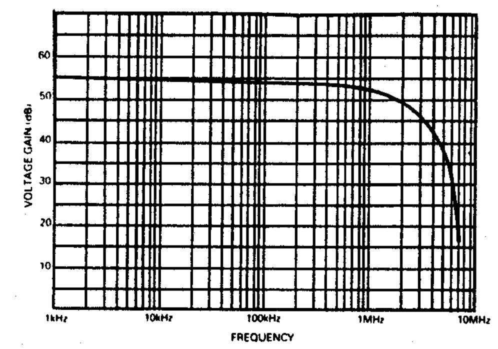


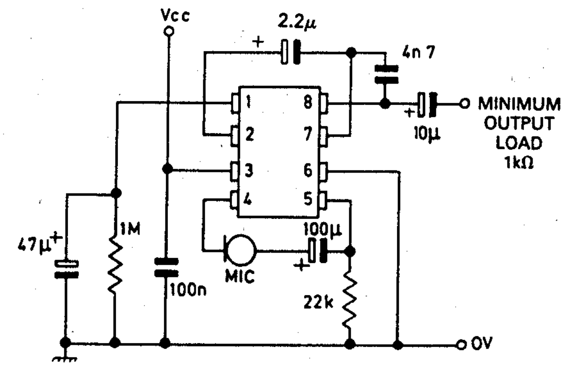
Figure 10(b) **Open loop frequency response (typical)**



Typical application

Figure 11 shows a typical application with the 6270 used as preamplifier for a 300Ω microphone. The bandwidth is approximately from 230Hz to 3,400Hz (−3dB). The input should normally be a.c. coupled, but if for any reason the coupling capacitor is omitted, the d.c. resistance between pins 4 and 5 should be less than 10 ohms. The 22k resistor

Figure 11

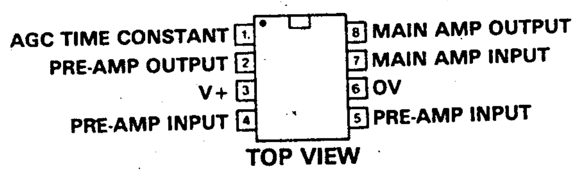


between pin 5 and ground is necessary to ensure that the offsets in the device at the onset of A.G.C. are of such polarity as to inhibit oscillation. If it is required to use the device with an unbalanced source, then the input may be A.C. coupled to pin 4 or pin 5, the unused input remaining floating. Any tendency to pick up noise when used in this mode may be inhibited by decoupling the unused input to ground by a 1000p capacitor. **The inputs must not be D.C. grounded.**

Bandwidth, gain, attack and decay times may be altered in accordance with the information given above to suit the differing requirements of specific applications.

6270

An integrated circuit combining the functions of audio amplifier and Voice Operated Gain Adjusting Device (V.O.G.A.D.), designed to accept signals from a low output microphone and to provide an essentially constant output signal of 90mV for a 60dB range of input. The dynamic range, attack and decay times are controlled by external components. Typical applications include audio A.G.C. systems, transmitter overmodulation protection, tape recorders, etc.



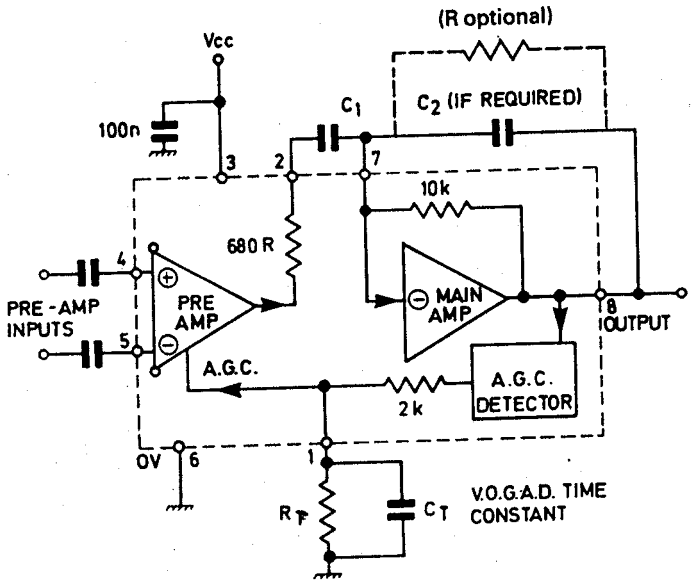
Absolute Maximum Ratings

Supply voltage V_{CC} ———— +12V
Storage temperature range T_{stg} ———— −55 to +125°C

Electrical characteristics

Parameter	Symbol	Test Conditions	min.	typ.	max.	units
Supply voltage	V_{CC}		4.5	6	10	V
Supply current	I_Q		—	5	10	mA
Input impedance	$Z_{IN(S)}$	Single ended, pin 4 or pin 5	—	150	—	Ω
Differential input impedance	$Z_{IN(D)}$	Input between pins 4 & 5	—	300	—	Ω
Voltage gain	G_V	72μV rms input pin 4	40	52	—	dB
Output level	V_{OUT}	4mV rms input pin 4	55	90	140	mV rms
Total harmonic distortion	T.H.D.	90mV input pin 4	—	2	5	%
Operating temperature range	T_{AMB}		−30		+85	°C

Figure 9



Circuit description

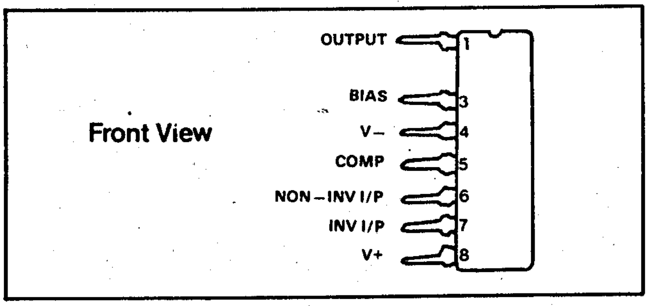
The principal elements of the device are shown in figure 9. The differential input preamplifier is A.G.C. controlled. The output from this stage is a.c. coupled via a capacitor to the second stage which is gain programmable by a single resistor to enable the overall sensitivity to be set. Adding a capacitor in parallel with this resistor permits the H.F. response to be tailored, if required. The output from the second stage provides the main audio output from the device, and also drives the A.G.C. detector. The detected output, which is input level dependent, is applied to the time constant circuit and the A.G.C. controlled first stage. The second stage is run in inverting mode.

HA12017

A low noise, very low distortion pre-amplifier i.c. designed for high quality magnetic cartridge amplification using RIAA equalisation.

Recommended operating conditions

Power supply voltage V_{CC}	±24V
Minimum power supply voltage	±6V
Operating temperature range	−30 to +75°C



Absolute maximum ratings

Supply voltage V_{CC}	±26.5V
Power dissipation (T_A 25°C) P_T	500mW
Storage temperature range T_{stg}	−55 to +125°C

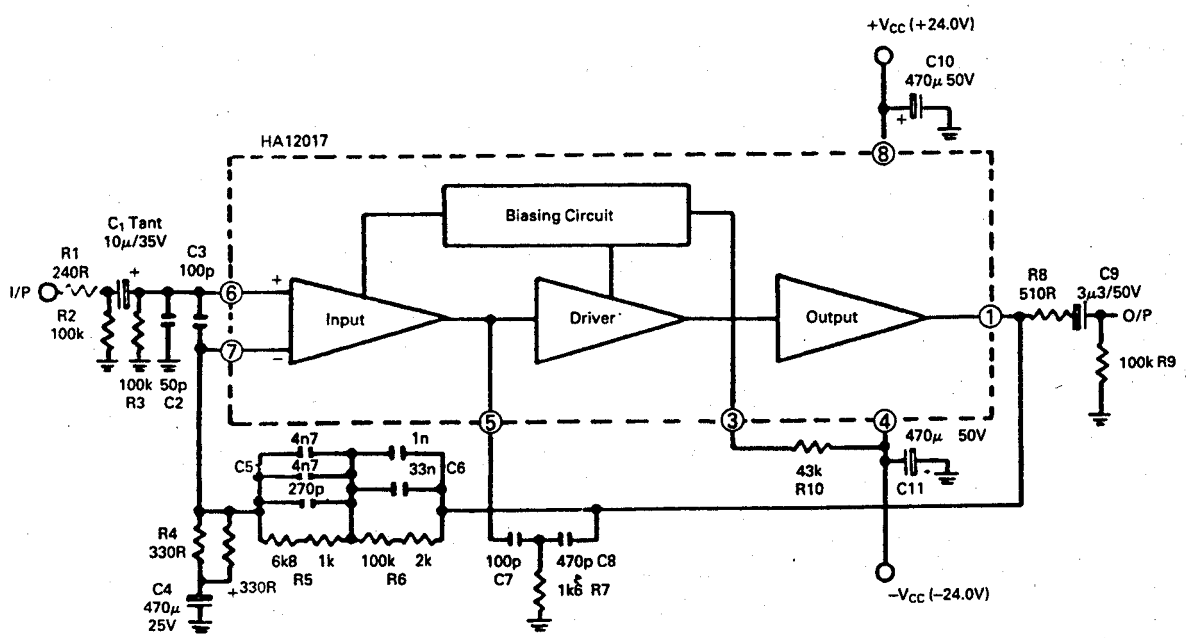
Electrical characteristics

(V_{CC} = ±24V, T_A = 25°C)

Parameter	Symbol	Test Conditions	min.	typ.	max.	unit
Quiescent Current	Io	no input signal		4.0	6.0	mA
Open Loop Voltage Gain	$G_{V(OL)}$	f = 1kHz	95	105	—	dB
Total Harmonic Distortion	THD	f = 1kHz, V_{out} = 10V	—	0.002	0.01	%
Output Voltage	V_{out}	f = 1kHz,THD = 0.1%	13.5	14.7	—	V
Overload Margin	—	f = 1kHz, THD = 0.1% G_v = 35.9dB		235		mV
Supply Ripple Rejection	SVR+	f = 100Hz Rg = 43Ω		56		dB
	SVR−	f = 100Hz Rg = 43Ω		45		dB
Output Noise Voltage 1	V_{n1}	R_k = 43Ω, IHF-A Network	—	11.5	15.6	µV
Output Noise Voltage 2	V_{n2}	R_k = 3.3kΩ, BW −20Hz to 20kHz	—	53	90	µV

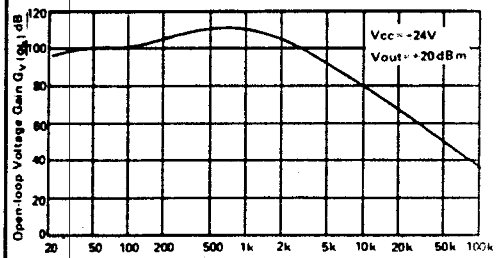
NOTES: 1. All the parameters except $G_{V(OL)}$ are tested with RIAA curve and G_V = 35.9dB. (Av = 62).
2. R_k = Source impedance to pin 6.

Figure 7 **RIAA pre-amplifier**

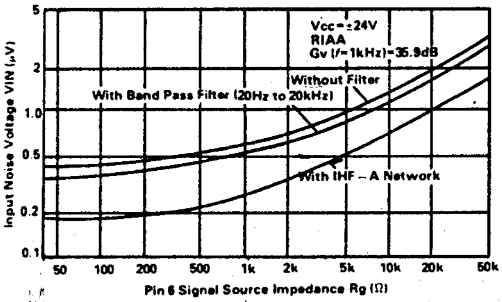


The RIAA pre-amplifier circuit is designed to accurately follow the RIAA playback curve, consequently some of the components in the feedback circuit consist of combinations of standard value capacitors and resistors in order to achieve an accurate response (e.g. 4n7 + 4n7 +270p). For less demanding applications standard preferred value components may be substituted in place of these networks. Input impedance of the amplifier circuit is approximately 50kΩ in order to match the load impedance requirements of the popular dynamic cartridges.

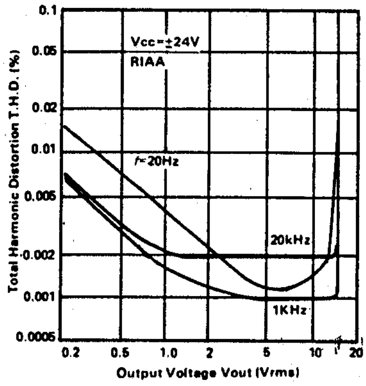
Figure 8
Open loop voltage gain V frequency



Input noise voltage V source impedance



THD V output voltage



RIAA Pre-amplifier external component functions

Component	Recommended Value	Function
R1	240Ω	Protects the i.c. from abnormal input voltage. Prevents parasitic oscillation caused by signal-source impedance. Decreases high-frequency disturbance.
R2	100kΩ	Passes the electric charge of C1. Decides Rin (input resistance) Rin – R1 + (R2/R3)
R3	100kΩ	Supplies DC bias to pin-6 (input pin). Decides input resistance.
R4	165Ω	Decides voltage gain as feedback resistance.
R5 R6	7.8kΩ 102kΩ	Decides RIAA characteristics, in pairs with C5 and C6.
R7	1.6kΩ	In a pair with C8, decides the frequency at which Gv (OL) characteristic changes from –12dB/oct to –6dB/oct.
R8	510Ω	Prevents parasitic oscillation caused by capacitive load.
R9	100kΩ	Keeps the voltage of output terminals at DC standard level. Prevents shock noise caused by function-switching.
R10	43kΩ	Decides basic bias current R10 – (+V_{CC} – (–V_{CC}) –5) kΩ
C1	10uF	Input coupling.
C2	50pF	In combination with C3, increases stability of large-amplitude operation in high frequency range.
C3	100pF	In strong field, prevents detection of TV, FM and AM signals.
C4	470uF	Supplies full DC-feedback. Decides roll off frequency (f_L) in low frequency range. F_L = 3Hz (Typical application) $F_L = \frac{1}{2\pi C4.R4}$
C5 C6	9670pF 34000pF	Decides RIAA characteristics in pairs with R5 and R6.
C7	100pF	Supplies phase-compensation.
C8	470pF	In a pair with R7, decides the frequency at which Gv (OL) characteristic changes from –12dB/oct to –6dB/oct.
C9	3.3uF	Output-coupling.
C10 C11	470uF 470uF	Removes ripple on V_{CC} line.