audio~metrics

power amplifier

PW-100

RADIO SYSTEMS INC
DESIGN & MANUFACTURING

RIDLEY CREEK PLAZA, 5131 WEST CHESTER PIKE, EDGEMONT, PENNSYLVANIA 19028 (215) 356-4700

INTRODUCTION

The "Audio-Metrics" PW100-A is a 50 watt, stereo power amplifier designed specifically for broadcast use. A rack mount cabinet, balanced inputs and specialized indicators and controls make the amplifier ideal for studio monitor applications.

Many "broadcast" monitor amplifiers fall short in the area of audio fidelity. Like all other units in the "Audio-Metrics" line, the PW100-A power amplifier has been designed with primary concern for sonic performance. In fact, the PW100-A may be the only broadcast amplifier which can rival high end equipment designed for the demanding consumer, "audiophile" market.

Circuitry includes the use of discreet components in the input stages and multiple output devices in conjunction with a large heat sink. Conservative component rating and true, state of the art design, combine to insure total accurate sound reproduction and dependable performance.

As broadcasters' concern for audio quality and the fidelity of home equipment increases, accurate sound monitoring is critical. The PW100-A will help broadcasters insure that their air signal is of the highest possible quality.

This manual continues on to describe hook-up techniques and operational instructions and also devotes space to a discussion of the specifications that audibly affect the sonic performance of the unit.

WARRANTY

Radio Systems warrants for one year from date of purchase, parts and labor on any unit returned to us for repair. Please ship the unit prepaid with a note detailing the malfunction and reason for return. Repair and return of the unit will be made promptly. Within the warranty period, there is no charge for this service on units that show no sign of misuse or unauthorized alterations.

CONNECTIONS

The diagrams on the opposite page illustrate hook-up options for balanced and unbalanced inputs in the mono and stereo operational modes. These diagrams, especially as they pertain to the variable aspect of ground terminations, are for reference purposes and some modification may be required for your particular situation.

Experimentation may be necessary to find connection schemes that avoid ground loops. Generally, ground wires should not be "double terminated". That is, ground should be floated on one side of the input cabling connection. The proper choice of chassis ground or circuit ground, both available on the rear of the PW100-A, may also affect and reduce any input hum, cross-talk or RFI pickup. Normally, these two ground points should be connected together.

Circuitry is such that a positive voltage applied to the + input terminal produces a positive voltage on the + (red) speaker terminal. It is important that the unused input terminals in unbalanced connections be connected to the ground terminals on the amplifier.

CABLING

Two conductor, shielded wire should be used for balanced input connections. Single conductor shielded cable is acceptable for unbalanced connections.

Because the PW100-A output impedance is only a few milliohms, it is essential that heavy gauge speaker wire be used. This helps maintain the amplifier's high damping factor by reducing connecting wire interaction. We suggest 16 gauge wire for short runs and as large as 10 gauge wire for runs 50 feet and longer. The use of heavy gauge wire will have a major effect on perceivable bass reproduction, especially on large cone speakers.

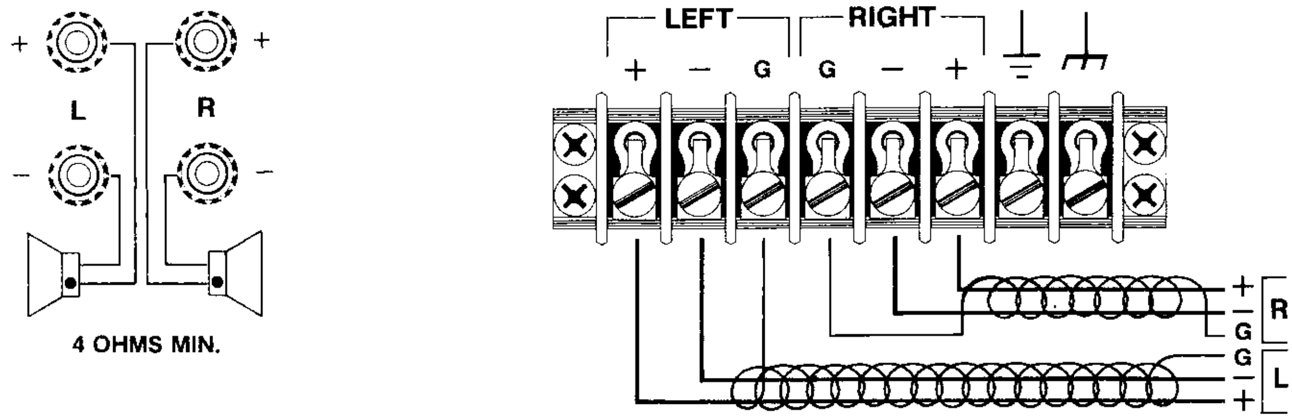
MOUNTING

The PW100-A is designed for standard 19" rack cabinets. Caution should be taken to insure that the heat sink is kept clear to allow sufficient air-flow for cooling. Keep plastic away from the heat sink to avoid melting.

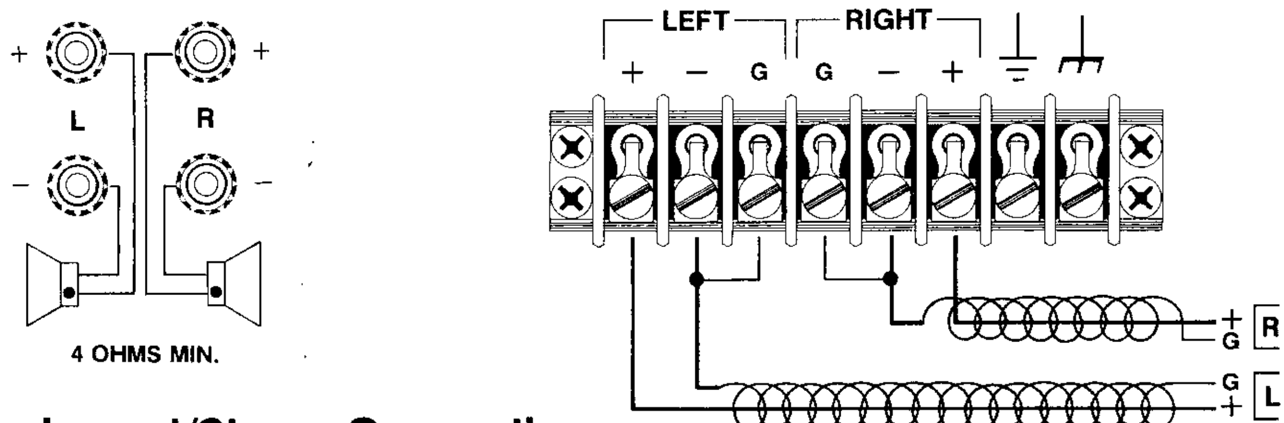
OPERATION

Front panel controls of the PW100-A are straight-forward. The volume control is typically set at maximum unless input levels cannot be attenuated before connection to the power amplifier. The recessed balance control can be set to compensate for off-center monitoring positions.

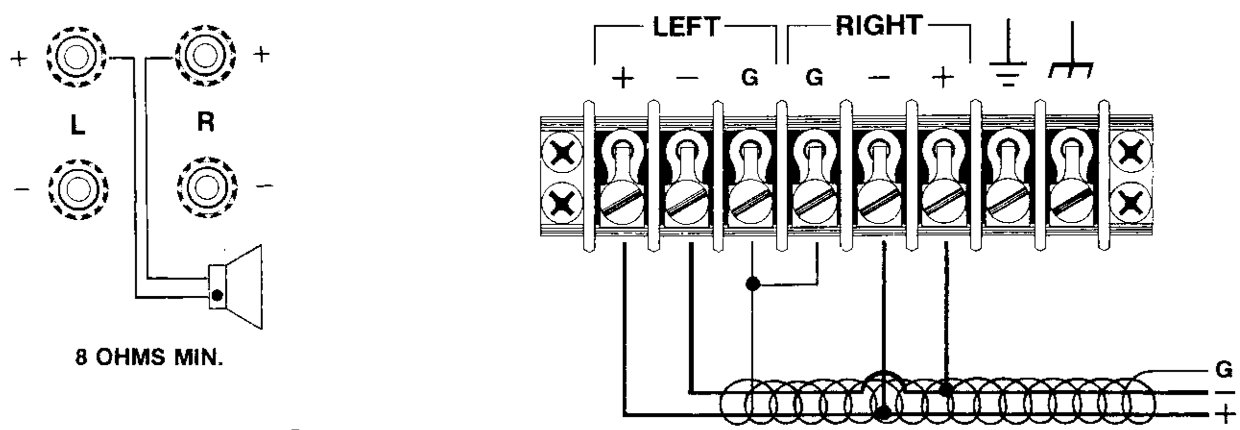
The PW100-A is equipped with peak level indicators to show both positive and negative clipping on both channels. These lamps can be especially useful when off-air monitoring a station using asymmetric modulation techniques. Additionally, some recorded music, especially percussion instruments, exhibit high asymmetry. Occasional flashes are not unusual with music with a high dynamic range. However, the amplifier should not be operated with frequent high clipping levels apparent.



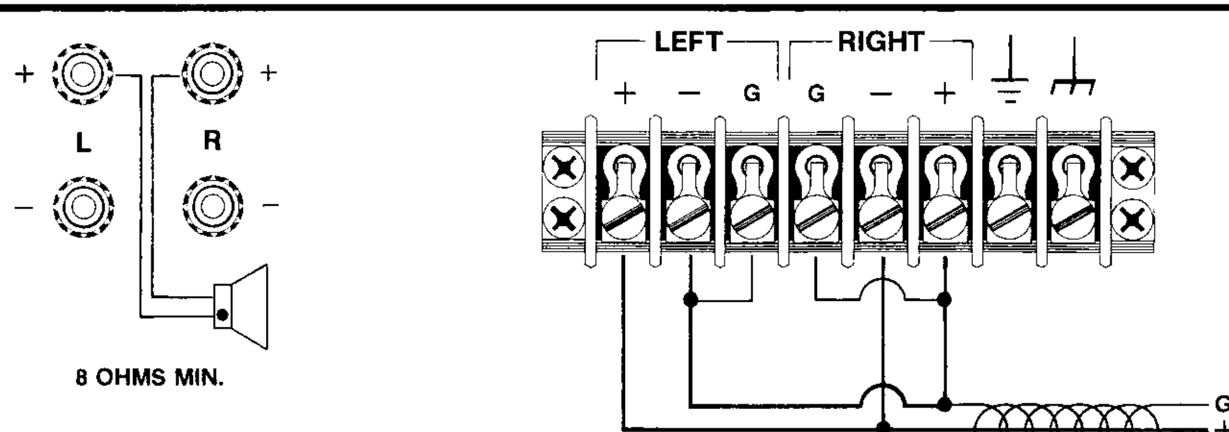
Balanced/Stereo Connections



Unbalanced/Stereo Connections



Balanced/Mono Connections



Unbalanced/Mono Connections

CIRCUIT DESCRIPTION

The power supply is a conventional full wave dual supply. The power transformer T1, diode bridge DB, and capacitors C1 and C2 provide ± 40 volts. The primary of T1 is double fused. One fuse is on the rear panel and the other is internal for added protection in the event that too large a fuse is accidentally used in the external socket. Thermal cutout switch TC, which is mounted on the heat sink, is also connected in the primary of T1. In the event of heat sink overheating, TC will open and shut down the amp until the unit cools.

The input stage utilizes high speed op amp, A1, as a differential amplifier to provide a high Z active balanced input. This stage drives the input of the main amp, attenuated through the volume control.

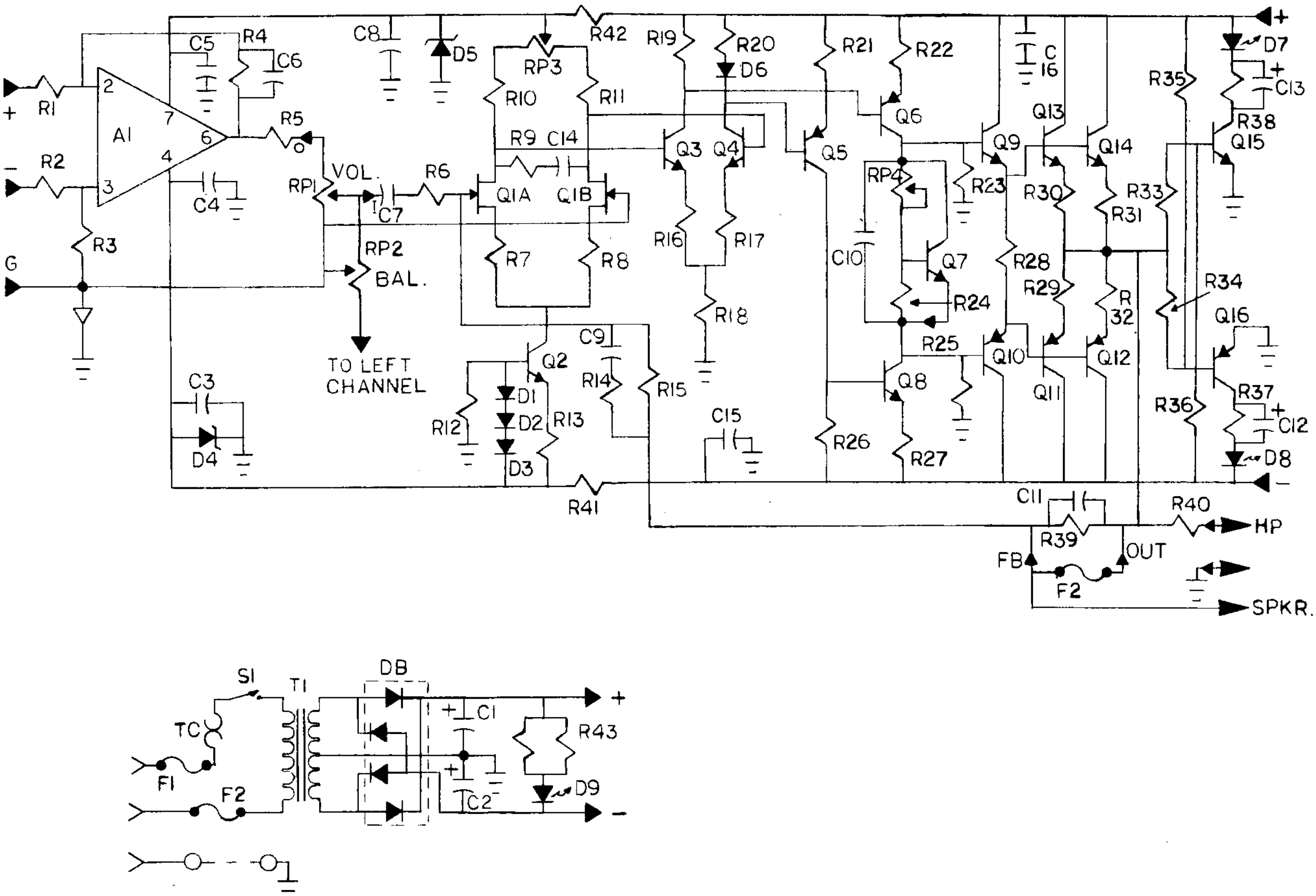
The first stage of the main amp is a dual J-fet, Q1. The gate of Q1B is tied to signal ground and the signal is fed to Q1A forming an internal inverting amplifier. The DC for Q1 is set by zener diodes D4 and D5. This assures bias stability with fluctuating power supply voltages. Current source stage Q2 sets operating currents for the entire amplifier. It also provides a high common mode resistance for Q1. To keep the slew rate high, all compensation is done at Q1 via R9 and C14. RP3 adjusts the DC offset at the output terminals.

Stage 2, comprised of Q3 and Q4, is also a differential stage. This maintains the balanced DC operation of stage 1 and provides additional voltage gain. The Q4 half of stage 2 is loaded by current mirror, Q5. Using a current mirror allows the driving of the output stages in a push-pull mode through Q8 and Q6.

Q7 is utilized as a VBE multiplier. RP4 adjusts idling current in the output stages to prevent crossover distortion. To prevent thermal runaway, Q7 is mounted on the heatsink. As the heatsink gets hot, the collector to emitter voltage of Q7 decreases, keeping the idling current below the turn on level of the output transistors.

The output stage, Q9 to Q14, is a full complementary darlington stage. Resistors R29 through R32 balance the load to the output transistors to prevent current hogging.

Overall feedback is taken from the output side of speaker fuse F2. This preserves the damping factor and also provides for short circuit protection. Because four high dissipation transistors are used along with adequate heat sinking, instantaneous current limiting circuitry is not needed. F2 provides adequate protection of both speakers and amplifier. For peak level indication, Q15 and Q16 are biased to turn on just before the output reaches the DC supply level. D7 and D8 will therefore light slightly before the onset of clipping.



+
R1
−
R2
G
R3
A1
2
3
7
4
6
C5
R4
C6
R5
C4
C3
D4
RP1
VOL.
C7
R6
RP2
BAL.
TO LEFT
CHANNEL
C8
D5
RP3
R42
R10
R11
R9
C14
Q1A
Q1B
R7
R8
Q2
C9
R14
R15
R12
D1
D2
D3
R13
R41
R19
R20
D6
Q3
Q4
R16
R17
R18
C15
Q5
R21
R22
Q6
RP4
C10
Q7
R24
R25
Q8
R26
R27
Q9
R23
Q10
C
16
Q13
Q14
R30
R31
R28
R29
R
32
Q11
Q12
R35
R33
R34
R36
D7
C13
R38
Q15
Q16
R37
C12
D8
C11
R39
R40
HP
FB
OUT
F2
SPKR.
S1
T1
TC
F1
F2
DB
C1
C2
R43
D9
+
−

PARTS LIST

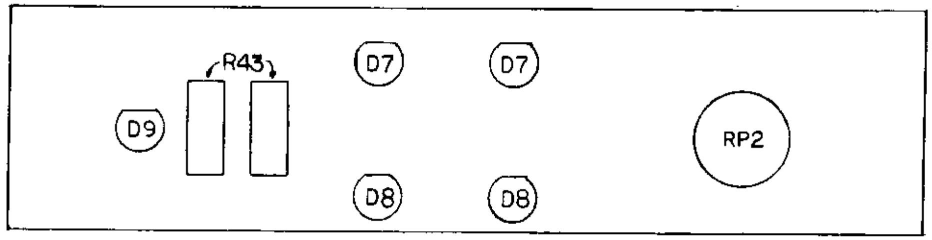
PARTS LIST

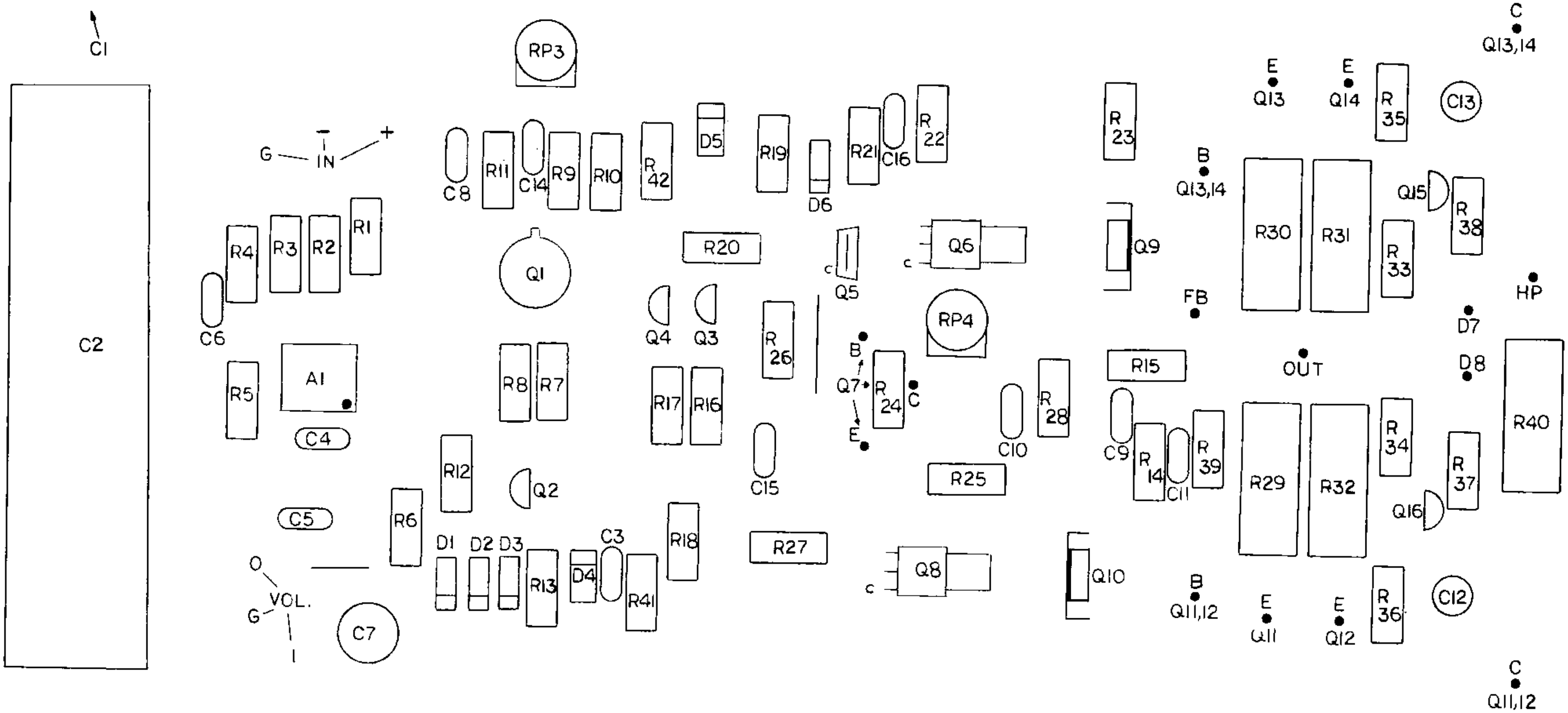
R1	10K
R2	10K
R3	10K
R4	10K
R5	100
R6	2K
R7	100
R8	100
R9	100
R10	10K
R11	10K
R12	10K
R13	1300
R14	100
R15	56K
R16	100
R17	100
R18	5.6K
R19	1500
R20	1500
R21	1500
R22	100
R23	20K
R24	22K
R25	20K
R26	1500
R27	100
R28	330
R29	.2 2W
R30	.2 2W
R31	.2 2W
R32	.2 2W
R33	15K
R34	15K
R35	22K
R36	22K
R37	2.2K
R38	2.2K
R39	1000
R40	470 2W
R41	3000
R42	3000
R43	10K X 2

RP1	10K (vol)
RP2	10K (bal)
RP3	100 (offset)
RP4	10K (bias)
C1	4700 50V
C2	4700 50V
C3	.1
C4	.1
C5	.1
C6	56pf
C7	100
C8	.1
C9	10pf
C10	.1
C11	.1
C12	10 50V
C13	10 50V
C14	300pf
C15	.1
C16	.1
D1	IN4148
D2	IN4148
D3	IN4148
D4	IN4746
D5	IN4746
D6	IN4148
D7	LED (red)
D8	LED (red)
D9	LED (grn)
DB	PK20F

A1	LM351N
Q1	2N3955A
Q2	2N3904
Q3	NB113EH
Q4	NB113EH
Q5	MPSU57
Q6	MPSU57
Q7	2N6037
Q8	MPSU07
Q9	2SC2528
Q10	2SA1078
Q11	2SA1076
Q12	2SA1076
Q13	2SC2526
Q14	2SC2526
Q15	NB113EH
Q16	NB123EH
F1	2A slo blo
F2	4A
F3	4A
T1	F280U

Note: All resistor values are in ohms and are ½ watt, unless otherwise indicated.
All capacitor values in microfarads unless otherwise indicated.


R43
D7
D7
D9
D8
D8
RP2


C1
C2
G
IN
+
R4
R3
R2
R1
C6
A1
R5
C4
C5
O
VOL.
G
I
C7
RP3
C8
R11
C14
R9
R10
Q1
R8
R7
R12
Q2
R6
D1
D2
D3
R13
D4
C3
R41
R42
D5
R19
R20
Q4
Q3
R17
R16
R18
C15
R26
R27
D6
R21
C16
R22
Q5
Q6
RP4
Q7
B
C
E
R24
R25
C10
R28
Q8
R23
Q9
R15
C9
R14
C11
R39
Q10
B
Q13,14
FB
B
Q11,12
E
Q13
E
Q14
R30
R31
R29
R32
OUT
E
Q11
E
Q12
R35
R33
R34
R36
C13
C12
Q15
Q16
R38
R37
D7
D8
HP
R40
C
Q13,14
C
Q11,12

SPECIFICATIONS

Output power	—	50 watts minimum sine wave continuous output per channel into 8 ohms from 20 Hz to 20 kHz. THD at any power level from 250 milliwatts to 50 watts is no more than .04%.
	—	65 watts minimum sine wave continuous output per channel into 4 ohms from 20 Hz to 20 kHz. THD at any power level from 250 milliwatts to 65 watts is no more than .05%.
	—	130 watts mono sine wave continuous output into 8 ohms from 20 Hz to 20 kHz. THD at any power level from 250 milliwatts to 130 watts is no more than .05%.
THD @1 kHz	—	@ 50 watts 8 ohms .01% @ 65 watts 4 ohms .01% @130 watts mono 8 ohms .01%
Intermodulation distortion	—	250 milliwatts to rated power max. .05%
Frequency response	—	±.1 dB 20-20 kHz ±3 dB 5 Hz-100 kHz
Hum and noise	—	Greater than 100dB below 50 watts
Input sensitivity	—	1 volt for max. output
Voltage gain	—	28 dB
Input impedance	—	20K ohms balanced common mode rej. 60 dB min.
Damping factor	—	400 to 1 reference 8 ohms 20 Hz-20 kHz
Load rating	—	3 ohms or greater-resistive or reactive
Slew rate	—	50V/μsec.
Power bandwidth	—	5 Hz-40 kHz
Dynamic head room	—	2 dB
Clipping power	—	60 watts 8 ohms per channel 75 watts 4 ohms per channel
DC offset	—	15 mv. max.
Protection	—	AC fusing Speaker fuse in feedback loop Heatsink thermal cutout

ON DISTORTION—The significance of specifications

Any operation on a signal which alters it in an unwanted fashion is distortion. There are many types of distortions in an audio system, some of which are not ever labeled as such. For example, poor frequency response is a type of distortion.

Obviously, some types of distortion are worse than others. Lately, studies have been made to discover what types of distortion are the worst and at which levels they are noticeable. Probably, harmonic distortion is the least offensive of the big three: harmonic, intermodulation and transient. This is obvious for at least two reasons. One is that harmonics are high in frequency and the ear, being a low pass filter, tends to remove them. Experimentation with a function generator and a set of good headphones will prove that it is hard, if not impossible, to hear the difference between a 10 kHz sine and square wave. You would have to be part beagle to hear the 30 kHz third harmonic, let alone the 50 kHz fifth harmonic, etc., etc., etc. The other factor is that since all musical instruments and voices have copious amounts of harmonics, harmonic distortion would have to be severe, perhaps as high as 3%, to change the "voice" of an instrument.

On the other hand, intermodulation distortion does something quite different; it creates signals. If a device was handling a signal that had only 2 instruments, the sum and difference of the fundamental and all harmonics (known as the beat frequencies) of just two notes can generate dozens of extraneous signals. These beat frequencies would have no musical relationship to either of the original notes. This is audibly perceivable as bad sound.

Transient distortion occurs during fast signal transitions. If an amp depends exclusively on error correction (feedback or feedforward) for linearity, a given stage might overload during a fast transient. In this case, the error correction might not be there in time to fix it. This gives music a very unpleasant, harsh, grating sound.

The overall design concept of the PW100-A was to make an amplifier with good open loop characteristics—in this case, THD of .5%, and use feedback for improvement. High frequency devices used throughout keep phase shifts to a minimum, allowing for the use of very little compensation. This leads to high slew rates, 0 TIM distortion and immunity from capacitive load problems. In short, what goes in—comes out, with no additions, subtractions or multiplications.