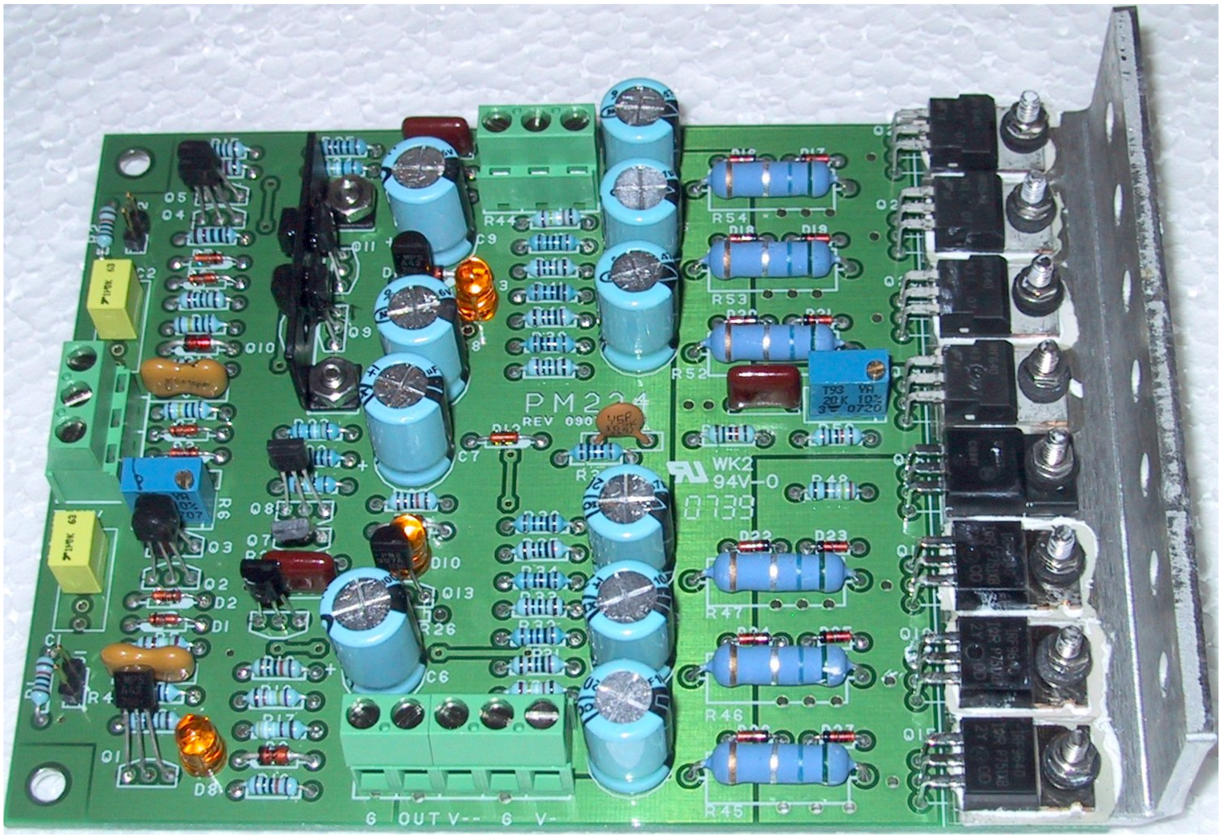
Marchand Electronics Inc.

PO Box 18099, Rochester, NY 14618
Tel:(585) 423 0462 Fax:(585) 423 9375
info@marchandelec.com   www.marchandelec.com

PM224 Installation Instructions



General

The PM224 is a power amplifier module capable of driving an 8 Ohm or 4 Ohm load. It has a differential input, but can also be used with a single ended input. The amplifier needs an external dual voltage DC power supply and must be bolted onto a heatsink.

Input

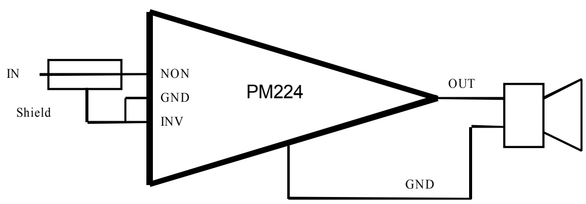
The input is differential. There is a 3-position terminal block on the circuit board, labeled INV-GND-NON. These are the inverting input, the ground terminal and the Non Inverting inputs. These should be hooked to the signal source. For single ended input, choose GND and either INV or NON INV. The unused terminal MUST be grounded to the GND terminal.
The inputs are AC or DC coupled. For DC coupling, install two shorting blocks on the two 2-pin header near the input. For AC coupling remove the shorting blocks.

Output

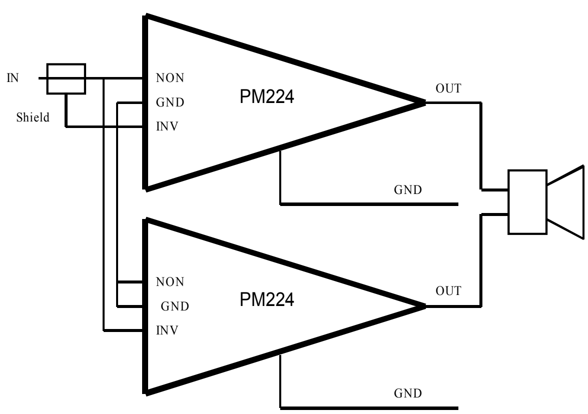
Connect the load to the two terminals labeled OUT-GND on the 5-position terminal block. The PM224 is designed for loads of 4 Ohm or 8 Ohm. Maximum output power depends on the value of the load and the power supply voltage. With a 8 Ohm load and a power supply voltage of +/- 65 Volt, an output power of 200W RMS can be achieved. In a 4 Ohm load the max power will be 200 Watt using a 45 Volt power supply.

Power Supply

A regulated or unregulated dual power supply of nominally +/- 50 Volt should be connected to the terminals V- and GND of the 5-position terminal block and terminals V++ and GND of the 3-position terminal block. Use stranded insulated hookup wire of 20 gauge or thicker. The terminals marked V++ and V-- should be connected to the same supplies as V+ and V-. In other words, connect both V+ and V++ to the positive supply and both V- and V-- to the negative supply. The minimum supply voltage is +/- 25V, and the maximum value is +/- 80 V. A higher value than 80V may damage the amplifier. The current capability of the power supply depends on the load and the voltage. For a 40 volt supply and an 8Ohm load, a rating of 2.5 Amp on each side is recommended.
Alternatively, the terminals V++ and V-- can be connected to a separate power supply with a voltage approx. 10 volt more than the main power supply. The current drain on these terminals is about 40 mA. each. Using a separate power supply for this driver section of the amp will improve efficiency of the amp by allowing an output voltage swing closer to the supply rails. The max voltage on V++ and V-- is 90 VDC.



Single Channel Hookup



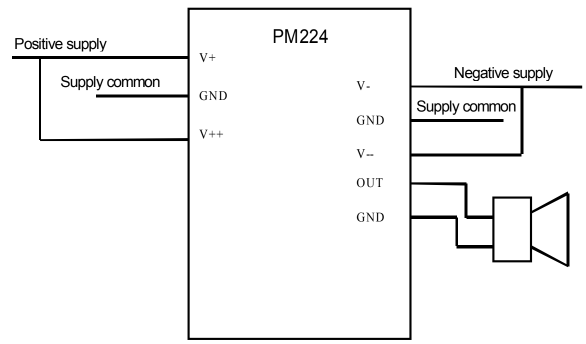
Bridged Hookup using 2 Amplifiers

Heat sink

The PM224 should be bolted onto a heat sink of sufficient size to keep the amplifier cool. Use of a thermal cutout mounted on the heatsink is recommended. Use a Normally Closed thermal switch of 5A and 70^{0}C rating. Install this switch in the AC line going to the power transformer.

Bias current

The PM224 operates in class AB. The bias current can be set with potentiometer R51. A bias current of ~ 45mA, when cold, is normal. The bias current can be observed with an Amp-Meter in the power supply, or by measuring the voltage across R51. See the section "Bias Current Adjustment". The voltage across R45 will be 15 mV for a bias current of 45 mA. The bias current will increase or decrease slightly when the amplifier warms up. This is normal.



Power supply hookup

PM224 Parts List

Resistors

R1	100K	1% ,1/4W, Metal Film
R2	100K	1%, 1/4W, Metal Film
R3	2.00K	1%, 1/4W, Metal Film
R4	1.00M	1%, 1/4W, Metal Film
R5	24.9K	1%, 1/4W, Metal Film
R6	100 Ohm	Trimmer Potentiometer
R7		not used
R8		not used
R9	1.00M	1%, 1/4W, Metal Film
R10	24.9K	1%, 1/4W, Metal Film
R11	1.00M	1%, 1/4W, Metal Film
R12	2.00K	1%, 1/4W, Metal Film
R13	10.0K	1%, 1/4W, Metal Film
R14	10.0K	1%, 1/4W, Metal Film
R15	2.00K	1%, 1/4W, Metal Film
R16	100K	1%, 1/4W, Metal Film
R17	49.9K	1%, 1/4W, Metal Film
R18	249K	1%, 1/4W, Metal Film
R19	100K	1%, 1/4W, Metal Film
R20	249 Ohm	1%, 1/4W, Metal Film
R21	249 Ohm	1%, 1/4W, Metal Film
R22	100 Ohm	1%, 1/4W, Metal Film
R23	249 Ohm	1%, 1/4W, Metal Film
R24	249 Ohm	1%, 1/4W, Metal Film
R25	100 Ohm	1%, 1/4W, Metal Film
R26		not used
R27	100K	1%, 1/4W, Metal Film
R28		not used
R29	100K	1%, 1/4W, Metal Film
R30	249K	1%, 1/4W, Metal Film
R31	2.00K	1%, 1/4W, Metal Film
R32	100 Ohm	1%, 1/4W, Metal Film
R33	2.00K	1%, 1/4W, Metal Film
R34	100 Ohm	1%, 1/4W, Metal Film
R35	2.00K	1%, 1/4W, Metal Film
R36	100 Ohm	1%, 1/4W, Metal Film
R37	100 Ohm	1%, 1/4W, Metal Film
R38	2.00K	1%, 1/4W, Metal Film
R39	100 Ohm	1%, 1/4W, Metal Film
R40	2.00K	1%, 1/4W, Metal Film
R41	100 Ohm	1%, 1/4W, Metal Film
R42	2.00K	1%, 1/4W, Metal Film
R43	100 Ohm	1%, 1/4W, Metal Film
R44	249K	1%, 1/4W, Metal Film
R45	0.68 Ohm	3W Power
R46	0.68 Ohm	3W Power
R47	0.68 Ohm	3W Power
R48	3.48K	1%, 1/4W, Metal Film
R49	100K	1%, 1/4W, Metal Film
R50	100K	1%, 1/4W, Metal Film
R51	20 KOhm	Trimmer Potentiometer
R52	0.68 Ohm	3W Power
R53	0.68 Ohm	3W Power
R54	0.68 Ohm	3W Power

Capacitors

C1	1uF	Stacked Film
C2	1uF	Stacked Film
C3	5pF	Silver Mica
C4	5pF	Silver Mica
C5	0.22uF,100V	Stacked Film
C6	1000uf, 16v	Aluminum Electrolytic
C7	1000uf, 16v	Aluminum Electrolytic
C8	1000uf, 16v	Aluminum Electrolytic
C9	1000uf, 16v	Aluminum Electrolytic
C10	0.22uF,100V	Stacked Film
C11	47uF, 100V	Aluminum Electrolytic
C12	47uF, 100V	Aluminum Electrolytic
C13	47uF, 100V	Aluminum Electrolytic
C14	1000pF	Ceramic NPO
C15	47uF, 100V	Aluminum Electrolytic
C16	47uF, 100V	Aluminum Electrolytic
C17	47uF, 100V	Aluminum Electrolytic
C18	0.22uF,100V	Stacked Film
C19*	0.22uF,100V	Stacked Film
C20**	1000pF,100V	ceramic

* C19 across R48 on solder side

** C20 across D6 on solder side

Diodes

D1...4	1N4148	Signal Diode
D5	1N4735	6.2 Volt Zener Diode
D6	1N4148	Signal Diode
D7	1N4148	Signal Diode
D8		LED
D9	1N4735	6.2 Volt Zener Diode
D10		LED
D11	1N4735	6.2 Volt Zener Diode
D12	1N4148	Signal Diode
D13		LED
D14	1N4735	6.2 Volt Zener Diode
D15	1N4148	Signal Diode
D16..28	1N5240	10 Volt Zener Diode

Transistors

Q1	MPSA42	NPN small signal
Q2*	ZVNL120A	N-Channel SS MOSFET
Q3*	ZVNL120A	N-Channel SS MOSFET
Q4*	ZVP2120A	P-Channel SS MOSFET
Q5*	ZVP2120A	P-Channel SS MOSFET
Q6	MPSA42	NPN small signal
Q7*	ZVNL120A	N-Channel SS MOSFET
Q8*	ZVNL120A	N-Channel SS MOSFET
Q9*	ZVNL120A	N-Channel SS MOSFET
Q10*	ZVNL120A	N-Channel SS MOSFET
Q11*	ZVP2120A	P-Channel SS MOSFET
Q12*	ZVP2120A	P-Channel SS MOSFET
Q13	2N2907	PNP small signal
Q14	MPSA42	NPN small signal
Q15*	IRF9640	P-Channel Power MOSFET

Q16*	IRF9640	P-Channel Power MOSFET
Q17*	IRF9640	P-Channel Power MOSFET
Q18	MJF47	NPN power
Q19*	IRF640	N-Channel Power MOSFET
Q20*	IRF640	N-Channel Power MOSFET
Q21*	IRF640	N-Channel Power MOSFET
Q22*	IRF640	N-Channel Power MOSFET

*NOTE ZVNL120A come as a matched set of 7
*NOTE ZVP2120 come as a matched set of 4
*NOTE Q15…Q17 come as a matched set of 3
*NOTE Q19…Q22 come as a matched set of 4

The PM224 kits contains the following parts:

Qu.	**Value**	**Description**

Resistors

9	100 Ohm	1%, 1/4W, Metal Film
4	249 Ohm	1%, 1/4W, Metal Film
9	2.00K	1%, 1/4W, Metal Film
2	10.0K	1%, 1/4W, Metal Film
1	3.48K	1%, 1/4W, Metal Film
2	24.9K	1%, 1/4W, Metal Film
1	49.9K	1%, 1/4W, Metal Film
8	100K	1%, 1/4W, Metal Film
3	249K	1%, 1/4W, Metal Film
3	1.00M	1% ,1/4W, Metal Film
1	100 Ohm	Trimmer Potentiometer
1	20 KOhm	Trimmer Potentiometer
6	0.68 Ohm	3W Power

Capacitors

2	5pF	Silver Mica
2	1000pF	ceramic disk
4	.22uF, 100V	Stacked Film
2	1uF	Stacked Film
6	47uF, 100V	Aluminum Electrolytic
4	1000uf, 16v	Aluminum Electrolytic

Diodes

8	1N4148	Signal Diode
12	1N5240	10 Volt Zener Diode
4	1N4735	6.2 Volt Zener Diode
3		LED

Transistors

6	ZVNL120A	N-Channel SS MOSFET
4	ZVP2120A	P-Channel SS MOSFET
1	2N2907	PNP small signal
3	MPSA42	NPN small signal
4	IRF640	N-Channel Power MOSFET
3	IRF9640	P-Channel Power MOSFET
1	MJF47	NPN power

Mechanical

Quantity	Description
3	3 Pos. Terminal block
2	2 Pos. Terminal block
8	#4 flat washer
8	4/40x3/4” Machine Screw
2	4/40x3/8” Machine Screw
10	4/40 Nut
16	#4 split lockwasher
8	#4 fiber washer
8	nylon shoulderwasher
8	Mica TO220 insulator
1	Heat Sink Bracket
1	TO92 heatsink
2	3” cable tie
1	Bag Heat Sink Compound
1	PM224 circuit board
2	2 pin header
2	shorting block

Assembly Instructions

Most parts are installed in the usual way. Insert the part at the location on the circuit board as indicated by the silk screen identification and solder on the solder side of the board. Start with installing smaller parts and install large parts last. This makes installation easiest. The circuit board has plated through holes, so parts need only be soldered on the solder side of the board.

Resistors: The 1% metal film resistors are identified with colored bands in the usual way. The 1% Metal film resistors have the following markings:

100 Ohm	Brown- Black -Black-Black--Brown
249 Ohm	Red-Yellow-White -Black--Brown
3.92 K	Orange-Wihite-Red-Brown--Brown
2.00 K	Red -Black-Black-Brown--Brown
10.0 K	Brown-Black-Black- Red --Brown
11.0 K	Brown-Brown-Black- Red --Brown
49.9 K	Yellow-White -White-Red--Brown
100 K	Brown-Black-Black-Orange--Brown
249 K	Red-Yellow -White -Orange-Brown
1.00 M	Brown-Black-Black-Yellow--Brown

When placing resistors it is recommended to check each value with a DMM. When installing the power resistors R45,R46,R47, R52,R53,R54 leave a gap of about 0.1” between the body of the resistor and the circuit board. This will improve the cooling of the resistors. The small resistors can be installed flush with the circuit board.
The multiturn trimmer resistors should be installed so that the screw is at the location indicated by the white square..

Capacitors: The Electrolytic capacitors are all radial type. Be **sure** to observe polarity markings when installing. The stacked film capacitors are brown and have marking 224 for .22 uF and 105 for the 1 uF part.

Diodes: Diodes are installed in the usual way. Make sure to observe polarity: the band indicated on the circuit board must coincide with the band on the device. The band indicates the cathode.

Transistors: Transistors Q1…14 are the small black parts with the three leads. Note that the black part has a big flat side and a round side. Note that Q2 and Q3 come as a matched pair in a separate bag. Make sure to use these in the locations Q2 and Q3. Install the transistors according to the marking on the circuit board.
Transistors Q9,10,11,12 are mounted on a small heatsink. Install the heatsink onto the circuit board using two 4/40 screws and nuts as shown in Figure 2. Mount the transistors so that the body of the each is between two of the three holes in the heatsink. After soldering the transistors attach them to the heatsink with some heatsink compound and a cable tie. The cable tie goes through the holes on each side and around both transistors, securing them firmly to the heatsink.
Power transistors Q15 through Q22 are installed onto the heat-sink bracket.

Apply a thin uniform layer of the white silicone compound on both side of each mica insulator. Place the mica insulator on the bottom of the transistor. Install the transistors with the 4/40 screws, two split lockwashers, flat washer, nylon shoulder washer, fiber washer and nut. See Figure 1. Orient the screws so that the head of the screw is on the solder side and the nut is on the component side. Solder the three transistor pins only after all the mounting screws have been tightened.

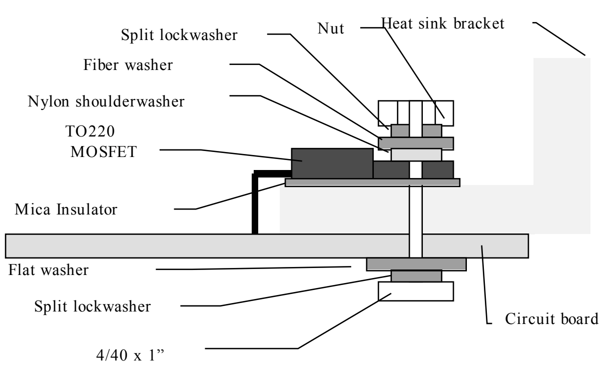


Figure 1 Mounting of metal tab TO220 power transistors.

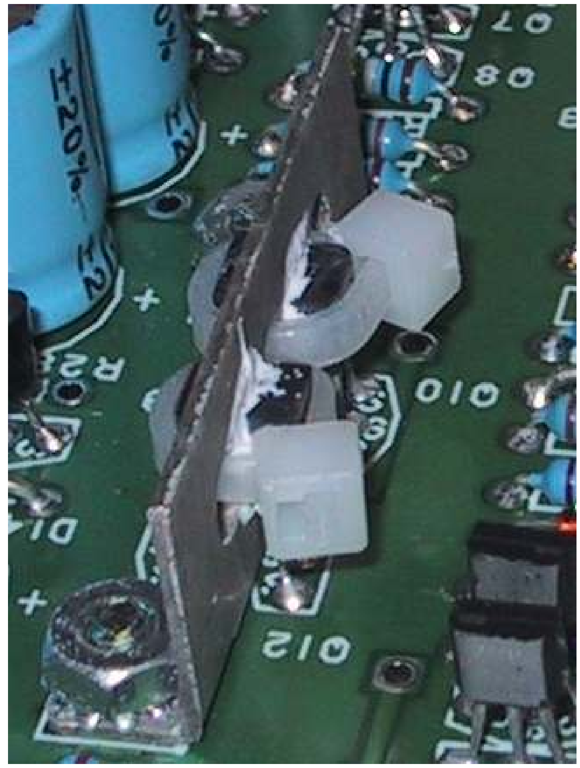


Figure 2

Header: Install the two 2-pin headers next to R1 and R2. The two jumper blocks are installed onto the header. Remove these for AC coupling. Leave for DC coupling. (Audio is usually AC coupled)

Terminal Blocks: Install the two 3-pin and 5-pin terminal blocks at the edge of the circuit board. The 5-pin terminal block is made by joining a 2-pin and a 3-pin terminal block together.

Assembly is now complete. Take a few minutes to check all components and orientations. Also make sure there are no solder bridges.

Bias current adjustment (Class AB) .

The bias current of the amplifier must be adjusted by setting the potentiometer R51. First turn the potentiometer fully counterclockwise. This will set the bias current to zero. Hook the PM224 to a bipolar power supply. The supply voltage should be between +/- 30V and +/- 60 V. For doing this step it is best to use a 30V supply. This lower voltage will reduce chance of damage to the parts if there is an error in the installation of the parts. It is best to mount the PM224 onto a large heatsink during testing.

Connect a DVM or suitable voltmeter between the leads of power resistor R45. If the DMM indicates a voltage of more than a few mV turn the power off **immediately** and check all parts placements. A very safe way to do this step is to use a variac to increase the power supply voltage slowly from zero to about 30V, while observing the DMM. Now slowly adjust R51 clockwise until a reading of 15 mV is shown on the DMM. Precise adjustment is difficult. But a value between 10 mV and 20 mV is acceptable. Note that the unit will start heating up a little. The adjustment should be made when cold. When the amplifier is hot, the bias current will change a little. This is normal.

Bias current adjustment (Class A) .

For operation in class A the bias current should be set to a higher value. Proceed as outlined above for the class AB bias and confirm that the amplifier is working properly. After this adjust the bias current to the class A operating point according to Table 1.

A larger heatsink is required to keep the amplifier cool with these bias currents. The standard heatsink shown in Figure is usually not sufficient when running in class A. An alternative solution is to run in partial class A mode. Adjusting the operating levels to about half those shown in Table 1 will result in class A operation for low level signals, up to about ¼ of the power shown. At higher power levels the amp will then operate in class AB.

	4 Ohm Load		
Max. output power	Bias current	R45 reading	Power Supply
25W	1.8A	600mV	+/- 20V
50W	2.4A	800mV	+/- 25V
100W	3.6A	1.2 V	+/- 35V
	8 Ohm Load		
25W	1.2A	400mV	+/- 25V
50W	1.8A	600mV	+/- 35V
100W	2.5A	800mV	+/- 45V

Table 1 Bias settings for class A

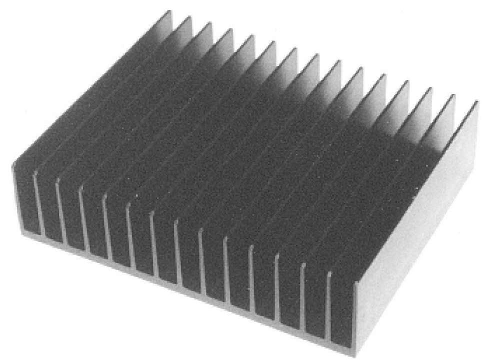


Figure 6 PM224HS. Typical heatsink for PM224. Dimensions are 5”x6.1”x1.6”; 0.8°C/W.

Offset adjustment.

The offset voltage of the amplifier must be adjusted by setting the potentiometer R6. With no signal applied to the inputs, adjust R6 for minimum DC voltage at the outputs. A residual output voltage of a few mV is normal.

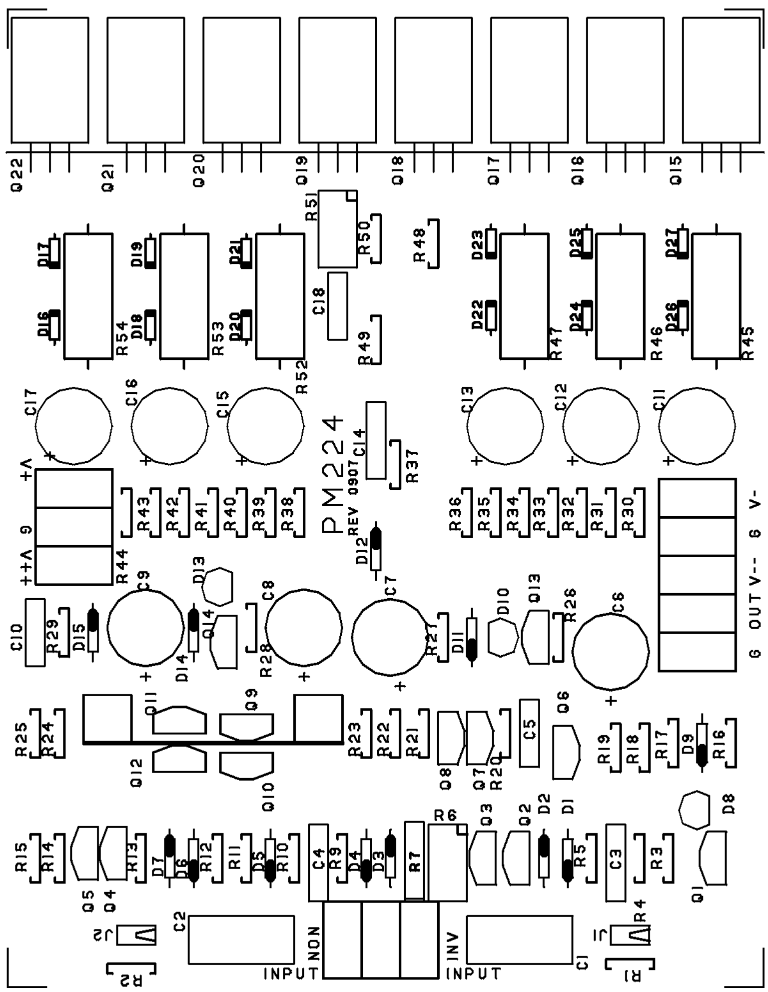
<u>The assembly and adjustment of PM224 is now complete.</u>

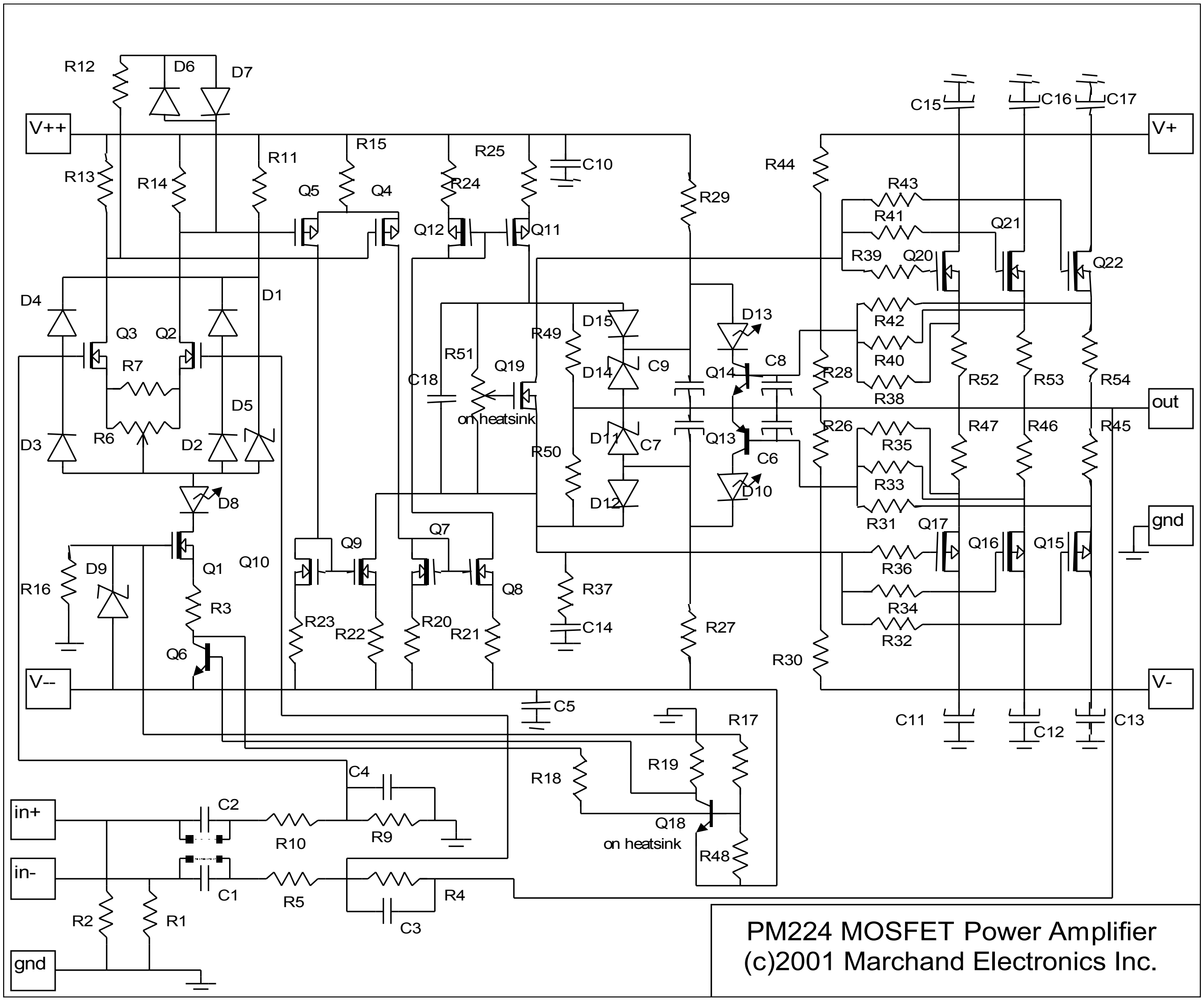
Gain adjustment.

The gain of the amplifier can be changed by replacing the two resistors R5 and R10. These two resistors should be of equal value. It is best to use 1% 1/4W metal film resistors, but other types, like 5% carbon, can also be used. The gain is given by A=1000/R3, R3 in Kohm. Use nearest available values.

R10 = R5	Gain	
10K	100	40 dB
15K	66	36 dB
25K	40	32 dB
50K	20	26 dB
100K	10	20 dB

Table 2 Gain vs. R3


PM224
REV 0907
NON
INPUT
INV
INPUT
G OUT V-- G V-
V++ G V+


V++
V+
V--
V-
in+
in-
gnd
out
R1
R2
R3
R4
R5
R6
R7
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
R47
R48
R49
R50
R51
R52
R53
R54
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
Q19
Q20
Q21
Q22
on heatsink
on heatsink
PM224 MOSFET Power Amplifier
(c)2001 Marchand Electronics Inc.