# Marchand Electronics Inc.

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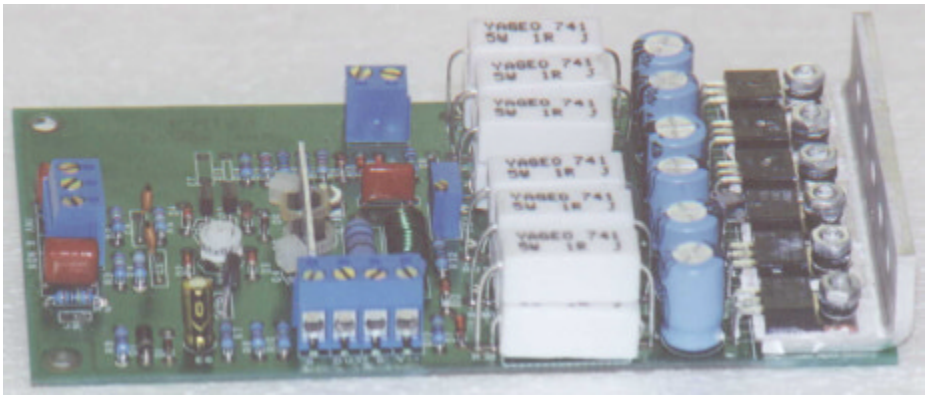
## PM124 Installation Instructions



### General

The PM124 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

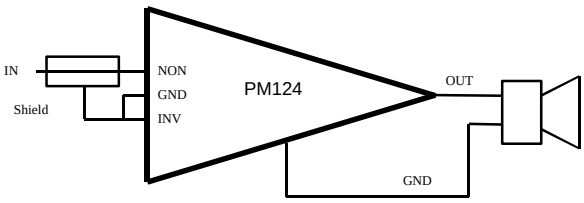
The input is differential. There is a 3-position terminal block on the circuit board, labeled INV-GND-NON. These are the inverting input, the ground terminal and the Non Inverting inputs. These should be hooked to the signal source. For single ended input, choose GND and either INV or NON INV. The unused terminal MUST be grounded to the GND terminal.
The inputs are AC or DC coupled. For DC coupling, install two shorting blocks on the 4-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 4-position terminal block. The PM124 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

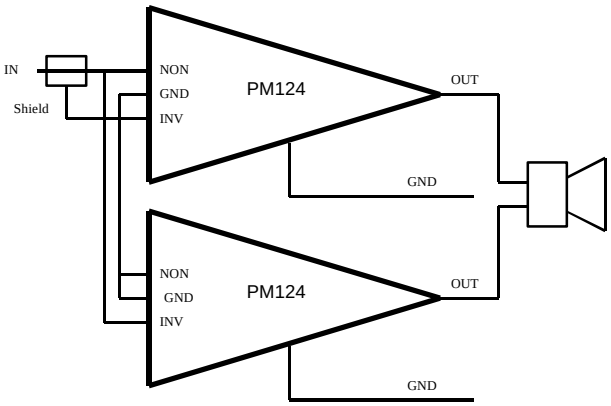
A regulated or unregulated dual power supply of nominally +/- 50 Volt should be connected to the terminals V-- GND of the 4-position terminal block and terminals V++ GND of the 3-position terminal block. Use stranded insulated hookup wire of 22 gauge or thicker. The minimum supply voltage is +/- 25V, and the maximum value is +/- 75 V. A higher value than 75V 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.



Single Channel Hookup

**Figure 1**

See <u>important</u> note about revisions of this board on the last page.



Bridged Hookup using 2 Amplifiers

**Figure 2**

### Heat sink

The PM124 should be bolted onto a heat sink of sufficient size to keep the amplifier cool. (see Figure 6) 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 PM124 operates in class AB. The bias current can be set with potentiometer R34. A bias current of ~ 100 mA, when cold, is normal. The bias current can be observed with an Amp-Meter in the power supply, or by measuring the voltage across R31. See the section "Bias Current Adjustment". The voltage between the two testpoints will be 16 mV for a bias current of 100 mA. The bias current will increase or decrease slightly when the amplifier is warm. This is normal

## PM124 Parts List

| ID | Value | Description |
|---|---|---|

### Resistors

| | | |
|---|---|---|
| R1 | 1.00M | 1% ,1/4W, Metal Film |
| R2 | 1.00M | 1%, 1/4W, Metal Film |
| R3 | 24.9K | 1%, 1/4W, Metal Film |
| R4 | 499K | 1%, 1/4W, Metal Film |
| R5 | 24.9K | 1%, 1/4W, Metal Film |
| R6 | 499K | 1%, 1/4W, Metal Film |
| R7 | 1.50K | 1%, 1/4W, Metal Film |
| R8 | 154Ohm | 1%, 1/4W, Metal Film |
| R9 | 100K | 1%, 1/4W, Metal Film |
| R10 | 154Ohm | 1%, 1/4W, Metal Film |
| R11 | 1.00M | 1%, 1/4W, Metal Film |
| R12 | 1.00M | 1%, 1/4W, Metal Film |
| R13 | ------- | not used |
| R14 | 1.00M | 1%, 1/4W, Metal Film |
| R15 | 4.22K | 1%, 1/4W, Metal Film |
| R16 | 154Ohm | 1%, 1/4W, Metal Film |
| R17 | 4.22K | 1%, 1/4W, Metal Film |
| R24 | 5.6 Ohm | 2W |
| R25 | 5.6 Ohm | 2W |
| R18 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R19 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R20 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R21 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R22 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R23 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| R26a | 1.0 Ohm | 5W Wirewound |
| R26b | 1.0 Ohm | 5W Wirewound |
| R27a | 1.0 Ohm | 5W Wirewound |
| R27b | 1.0 Ohm | 5W Wirewound |
| R28a | 1.0 Ohm | 5W Wirewound |
| R28b | 1.0 Ohm | 5W Wirewound |
| R29a | 1.0 Ohm | 5W Wirewound |
| R29b | 1.0 Ohm | 5W Wirewound |
| R30a | 1.0 Ohm | 5W Wirewound |
| R30b | 1.0 Ohm | 5W Wirewound |
| R31a | 1.0 Ohm | 5W Wirewound |
| R31b | 1.0 Ohm | 5W Wirewound |
| R32 | 1.50K | 1% ,1/4W, Metal Film |
| R33 | 100 Ohm | Trimmer Potentiometer |
| R34 | 10 KOhm | Trimmer Potentiometer |
| R35 | 154Ohm | 1% ,1/4W, Metal Film |

### Capacitors

| | | |
|---|---|---|
| C1 | 1uF | Stacked Film |
| C2 | 1uF | Stacked Film |
| C3 | 1pF | Ceramic NPO |
| C4 | 1pF | Ceramic NPO |
| C5 | ------- | not used |
| C6 | 10uf, 50v | Aluminum Electrolytic |
| C7 | ------- | not used |
| C8 | .22uF, 100V | Stacked Film |
| C9 | 47uF, 100V | Aluminum Electrolytic |
| C10 | 47uF, 100V | Aluminum Electrolytic |
| C11 | 47uF, 100V | Aluminum Electrolytic |
| C12 | 47uF, 100V | Aluminum Electrolytic |
| C13 | 47uF, 100V | Aluminum Electrolytic |
| C14 | 47uF, 100V | Aluminum Electrolytic |
| C15 | .22uF, 100V | Stacked Film |

### Diodes

| | | |
|---|---|---|
| D1 | 1N5232 | 5.6 Volt Zener Diode |

| | | |
|---|---|---|
| D2 | 1N4148 | Signal Diode |
| D3 | 1N4148 | Signal Diode |
| D4 | 1N4148 | Signal Diode |
| D5 | 1N4148 | Signal Diode |
| D6 | 1N5232B | 5.6 Volt Zener Diode |
| D7 | 1N5232B | 5.6 Volt Zener Diode |
| D8 | 1N5232B | 5.6 Volt Zener Diode |
| D9 | 1N4148 | Signal Diode |
| D10 | 1N4148 | Signal Diode |
| D11 | HER102 | High Efficiency Diode |
| D12 | 1N4148 | Signal Diode |
| D13 | 1N4148 | Signal Diode |

* UFR102 may be substituted for HER102

## Transistors

| | | |
|---|---|---|
| Q1* | ZVNL120A | N-Channel SS MOSFET |
| Q2* | ZVNL120A | N-Channel SS MOSFET |
| Q3 | ZVNL120A | N-Channel SS MOSFET |
| Q4 | ZVNL120A | N-Channel SS MOSFET |
| Q5 | ZVNL120A | N-Channel SS MOSFET |
| Q6 | ZVP2120A | P-Channel SS MOSFET |
| Q7 | ZVP2120A | P-Channel SS MOSFET |
| Q8 | ZVNL120A | N-Channel SS MOSFET |
| Q9 | IRF640 | N-Channel Power MOSFET |
| Q10 | IRF640 | N-Channel Power MOSFET |
| Q11 | IRF640 | N-Channel Power MOSFET |
| Q12 | IRF9640 | P-Channel Power MOSFET |
| Q13 | IRF9640 | P-Channel Power MOSFET |
| Q14 | IRF9640 | P-Channel Power MOSFET |

*NOTE Q1,Q2 come as a matched pair

The PM124 kits contains the following parts:

| **Qu.** | **Value** | **Description** |
|---|---|---|

## Resistors

| | | |
|---|---|---|
| 6 | 49.9 Ohm | 1%, 1/4W, Metal Film |
| 4 | 154 Ohm | 1%, 1/4W, Metal Film |
| 2 | 1.50K | 1%, 1/4W, Metal Film |
| 2 | 4.22K | 1%, 1/4W, Metal Film |
| 2 | 24.9K | 1%, 1/4W, Metal Film |
| 1 | 100K | 1%, 1/4W, Metal Film |
| 2 | 499K | 1%, 1/4W, Metal Film |
| 5 | 1.00M | 1% ,1/4W, Metal Film |
| 1 | 100 Ohm | Trimmer Potentiometer |
| 1 | 10 KOhm | Multiturn Trimmer Potentiometer |
| 12 | 1.0 Ohm | 5W Wirewound |
| 2 | 5.6 Ohm | 2W Power Resistor |

## Capacitors

| | | |
|---|---|---|
| 2 | 1uF | Stacked Film |
| 2 | 1pF | NPO Ceramic |
| 2 | .22uF, 100V | Stacked Film |
| 1 | 10uf, 50v | Aluminum Electrolytic |
| 6 | 47uF, 100V | Aluminum Electrolytic |

## Diodes

| | | |
|---|---|---|
| 8 | 1N4148 | Signal Diode |
| 4 | 1N5232B | 5.6 Volt Zener Diode |
| 1 | HER102 | High Efficiency Diode |

## Transistors

| | | |
|---|---|---|
| 1pair | ZVNL120A | N-Channel SS MOSFET |
| 4 | ZVNL120A | N-Channel SS MOSFET |
| 2 | ZVP2120A | P-Channel SS MOSFET |
| 3 | IRF640 | N-Channel Power MOSFET |
| 3 | IRF9640 | P-Channel Power MOSFET |

## Mechanical

| Quantity | Description |
|---|---|
| 1’ | 20 gauge magnet wire |
| 1 | 2 Pos. Terminal block |
| 1 | 3 Pos. Terminal block |
| 1 | 4 Pos. Terminal block |
| 6 | TO220 Insulator |
| 6 | TO220 plastic washer |
| 6 | #4 fiber washer |
| 8 | 4/40x1/2” Machine Screw |
| 8 | 4/40 Nut |
| 6 | #4 split lockwasher |
| 1 | Heat Sink Bracket |
| 1 | TO92 heatsink |
| 2 | 3” cable tie |
| 1 | Bag Heat Sink Compound |
| 1 | Tube Silicone Glue |
| 1 | PM124 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. **NOTE**: do **NOT** install transistor Q8 till last and follow the special installation instructions below. Do **NOT** install R25 before reading the section on inductor below.

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

| | |
|---|---|
| 49.9 Ohm | Yellow-White-White-Gold--Brown |
| 150 Ohm | Brown- Green -Black-Black--Brown |
| 1.50 K | Brown-Green-Black-Brown--Brown |
| 4.22 K | Yellow-Red-Red-Brown--Brown |
| 24.9 K | Red-Yellow-White-Red--Brown |
| 100 K | Brown-Black-Black-Orange--Brown |
| 499 K | Yellow-White-White -Orange-Brown |
| 1.00 M | Brown-Black-Black-Yellow--Brown |

When placing resistors it is recommended to check each value with a DMM. The six power resistors R26 .. R31 are installed in pairs. Each location holds two resistors, mounted one on top of the other. When installing the power resistors leave a gap of about 0.1" between the body of the resistor and the circuit board and between the two resistors of each pair. This will improve the cooling of the resistors. The small resistors can be installed flush with the circuit board.
The multiturn trimmer resistor R34 should be installed as shown in Figure 3.

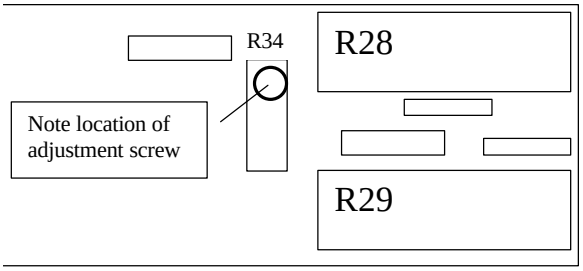



**Figure 3** Orientation of R34. This is important.

**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.

**Inductor**: The inductor L1 is made up with 10 turns of 20 gauge magnet wire on resistor R25. Install as usual. Carefully wind the wire tightly around the 2W power resistors. Strip the ends of the magnet wire and solder to the resistor leads.

**Diodes**: Diodes D1 ... D13 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.

**Transistors**: Transistors Q1,2,3,4,6,7 and 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 Q1 and Q2 come as a matched pair in a separate bag. Make sure to use these in the locations Q1 and Q2. Install the transistors according to the marking on the circuit board. Make **sure** there is no mistake here.
Transistors Q4,5,6,7 are mounted on a small heatsink. Install the heatsink onto the circuit board using a 4/40 screw and nut as shown in Figure 4. 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 silicone glue and a cable tie. The cable tie goes through the holes on each side and around both transistors, securing them firmly to the heatsink.

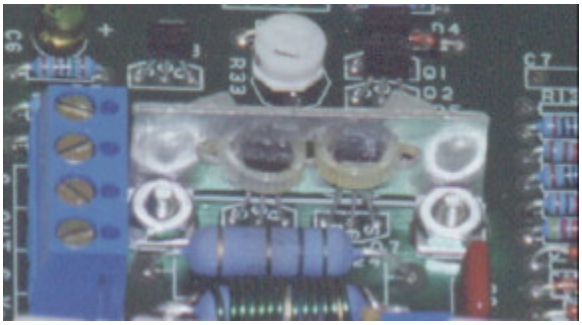


Figure 4

Power transistors Q9 through Q14 are installed onto the heat-sink bracket. Use the insulating wafers between the transistors and the heat-sink bracket.

Apply a thin uniform layer of the white silicone compound on both sides of the insulating wafers before installing. Install the transistors with the 4/40 screws, plastic washer, fiber washer, split lockwasher and nut. See Figure 5. Orient the screws so that the head of the screw is on the solder side and the nut is on the component side. The black plastic shoulder washer fits between the transistor tab and the nut. It serves to isolate the transistor from the mounting screw. Solder the three transistor pins only after all the mounting screws have been tightened.

**Header**: Install the two 2-pin next to R1 and R2. The two jumper blocks are installed onto the

header. Remove these for AC coupling. Leave for DC coupling.

**Terminal Blocks**: Install the 2-pin 3-pin and 4-pin terminal blocks at the edge of the circuit board. The 4-pin terminal block is made by joining two 2-pin terminal blocks together.

**Q8 (do this last !!)**: This transistor senses the temperature of the output transistors. It is glued to transistor Q12. Insert transistor Q8 in the designated holes near transistor Q12. Leave the leads long, do **not** cut them at this point. Bend the leads of Q8 90 degrees so that the body of Q8 rests onto the leads of the power transistor Q12. Holding the transistor in place solder the leads of Q8. Now apply a generous amount of silicone glue between the two transistors.

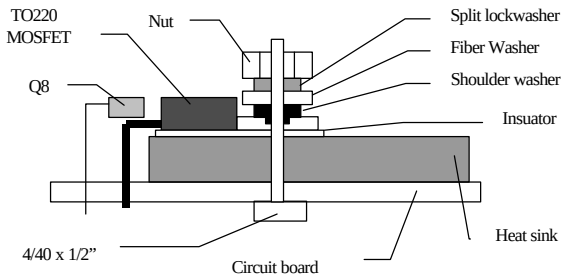



**Figure 5** Mounting of power transistors.

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 R34. First turn the potentiometer fully counterclockwise. This will set the bias current to zero. Hook the PM124 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 PM124 onto a large heatsink during testing.
Connect a DVM or suitable voltmeter between the leads of power resistor R31. 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 R34 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.

| | 4 Ohm Load | | 8 Ohm Load | |
|---|---|---|---|---|
| Max. output power | Bias current | R37 reading | Bias current | R37 reading |
| 25W | 1.8A | 300mV | 1.2A | 200mV |
| 50W | 2.4A | 400mV | 1.8A | 300mV |
| 100W | 3.6A | 600mV | 2.5A | 400mV |

Table 1 Bias settings for class A

A large heatsink is reqired to keep the amplifier cool with these bias currents. The standard heatsink shown in Figure 6 is usually not sufficient. 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.

### Offset adjustment.

The offset voltage of the amplifier must be adjusted by setting the potentiometer R33. With no signal applied to the inputs, adjust R33 for minimum DC voltage at the outputs. A residual output voltage of a few mV is normal.

The assembly and adjustment of PM124 is now complete.

### Gain adjustment.

The gain of the amplifier can be changed by replacing the two resistors R3 and R5. 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=499/R3, R3 in Kohm. See Table 1. Use nearest available values.

| R3 = R5 | Gain | |
|---|---|---|
| 10K | 50 | 34 dB |
| 15K | 33 | 30 dB |
| 25K | 20 | 26 dB |
| 50K | 10 | 20 dB |
| 100K | 5 | 14 dB |

**Table 2 Gain vs. R3**

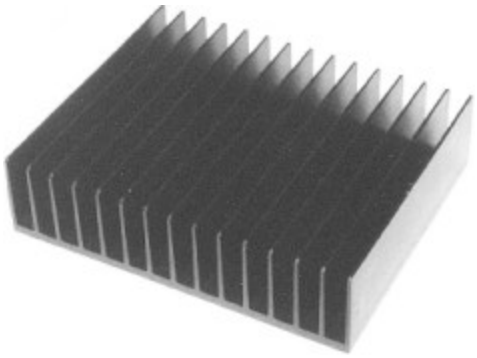
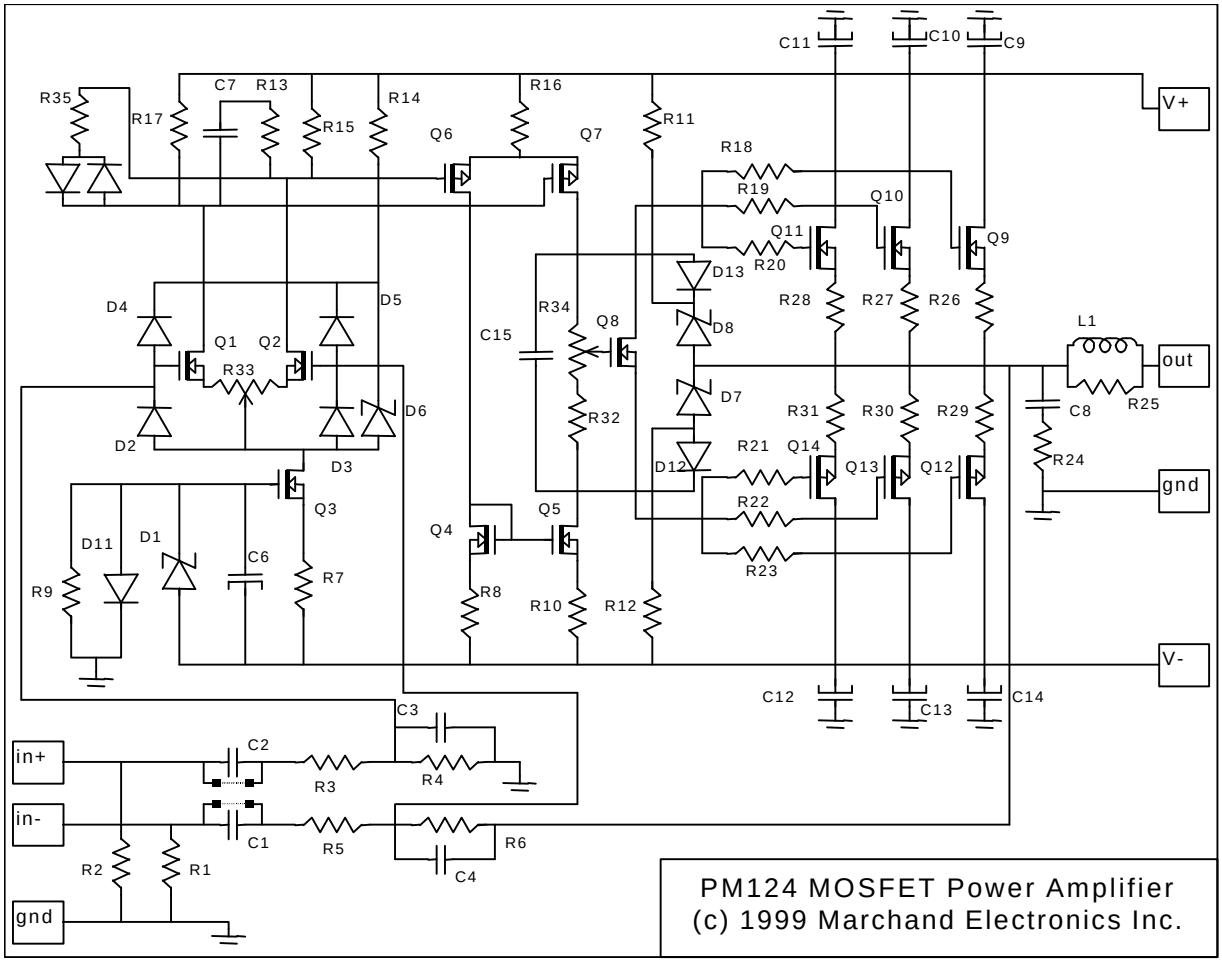


**Figure 6** PM124HS. Typical heatsink for PM124. Dimensions are 5”x6.1”x1.6”; 0.8$^{o}$C/W.




## Important Note:

On circuit board PM124-REV1 Diodes D7, D12 and D13 are shown REVERSED.

All other revisions (notably REV 1099 and later) are labeled correctly.