LIGHTHOUSE ELECTRIC 60-100 WATT POWER AMPLIFIER

CIRCUIT DESCRIPTION
This amplifier circuit is a stable, proven design, implementing a quasi-complementary output stage topology. Over the years it was steady improved. This version features short-circuit protection and a Baxandall diode (D7) for improved linearity. The input of the amplifier consists of a differential voltage amplifier (Q1, Q2) with a constant current source (Q3). The BIAS transistor (Q5) is mounted on a common heat sink with the output transistors for effective temperature tracking. Short circuit and overload protection is implemented by limiting the driver and output transistors current.

Specifications:

Frequency Response: 5Hz - 60kHz (-3dB)
Low Distortion THD 0.1% (1kHz at 60 Watt)
Signal to Noise Ratio S/N 90dB (shorted input)
Input Sensitivity: 775mV
Input Impedance: 20 kOhm
Output Impedance: 4-15 Ohms

Parts List

Resistors:

R1, R10: 1k	R2: 47k
R3: 4.7k	R4: 5.6k
R5, R9: 680R	R6, R27: not used
R7: 22k	R8, R14: 2.2k
R11: 2.7k	R12: 150k
R13, R17: 330R	R16: 510R
R19, R20: 1.2k	R18, R21: 180R
R22, R23, R28: 100R	R24, R25: 0R33/5W
R26: 15R/0.5W	TR1: 1k trim-pot.

NOTE: All resistors are 0.25W 5%, unless indicated otherwise.

Capacitors:

C1: 1uF/100V Film *Note1	C2: 220uF/50V Electrolytic rad.
C3, C11: 22pF/50V cer.	C4, C5: 100uF/50V Electrolytic rad.
C6: 100pF/50V cer.	C7: 220pF/50V cer.
C8: 0.1uF/100V Film rad.	C9, C10: 0.1uF/100V Mono. ceramic.

*Note1: Alternatively C1 can be a non-polarized electrolytic capacitor made from two 2.2uF caps, soldered in series. Connect same polarity leads. See Fig. 1 below.

Semiconductors:

Q1, Q2, Q3, Q7: BC556 PNP Transistor	Q4: BC639 or C2383 NPN
Q5, Q6: BC546 NPN Transistor	Q8: TIP31C NPN Transistor
Q9: TIP32C PNP Transistor	Q10, Q11: 2N3773 or TIP35C
D1: 1N5242B Zener Diode	D2, D3, D4, D5: 1N4148 Diode
D6: 1N5402 or CR25 Diode	D7: FR152 or UF4002 Diode

Construction

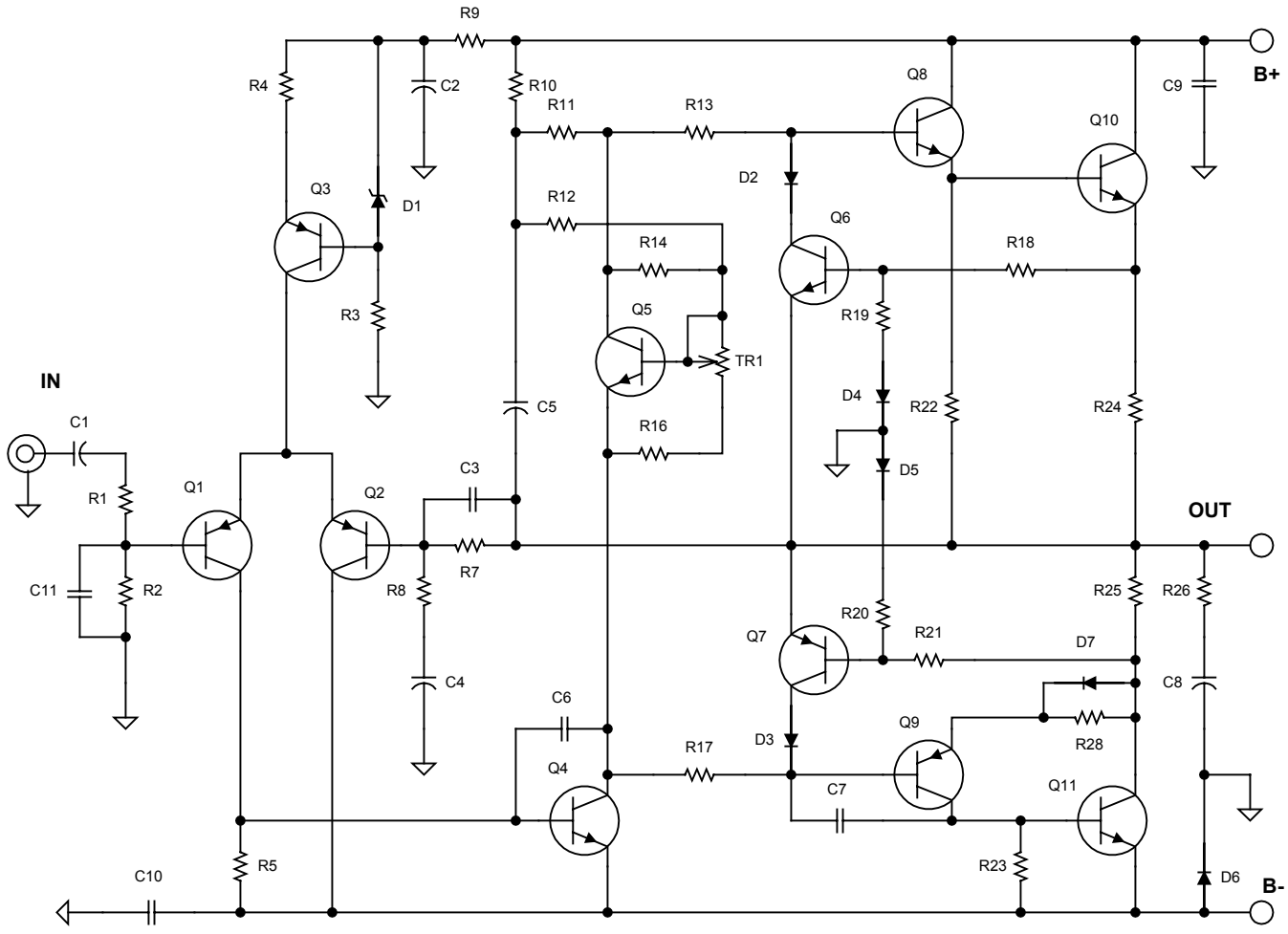
Start PCB assembly with the smallest parts like the jumper wires, resistors and diodes. There are three small jumpers to install on the PCB. Do not install more than 4-6 resistors at a time, as it will be difficult to solder them. Cut off the ends and install the next batch. Since the PCB was manufactured, the specifications for Q4, Q8 and Q9 changed. Use Fig.3 as placement guide. To install Q4, bent the center lead (collector) forward as shown in Fig.3 Use caution when soldering diodes or other solid state components as not to overheat them. Next install the plastic capacitors, then the electrolytic capacitors. Make sure the polarity of the electrolytic capacitors is correct. Finally install the rest of the components. Q5 transistor will be later mounted on a heat-sink, together with the output transistors. However, do not install it on the heat-sink yet. Use the supplied three lead flat cable to make the connection between the PCB and Q5 as shown in Fig.2 Observe correct transistor connections. Insulate the joints with silicone sealant. Temporary solder in a jumper into the input terminals. Carefully inspect the assembled PCB for any errors. Supplied solder contains organic flux, which can be cleaned with water. To give a nice shiny look brush the solder side under hot water stream. Finally rinse off both PCB sides under hot water. Shake off excess water and set aside to dry. To speed-up drying time, use a hair dryer.

Set-Up and Initial Testing:

After the board is completely dry, make a visual inspection. Look for missed solder joints, possible solder shorts, wrong polarity of diodes, electrolytic capacitors etc. The output transistors Q10, Q11 must not be connected to the PCB yet.
Next, a power supply, with minimum +/- 15 Volts and 1 Amp current will be needed. If is not available, then the designated amplifier-supply must be build first. Connect the plus and minus supply leads, in series with a 1 Amp AGC (quick blow) fuse, to 'B+' and 'B-' on the PCB respectively. Connect the zero (GND) lead to 'GND' on the PCB.

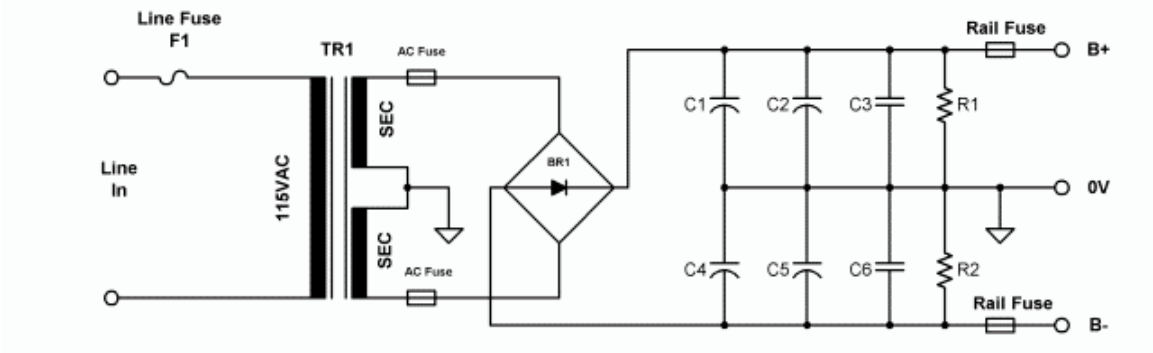
Switch your multi-meter to 50 or 100 VDC. Connect the COM lead to 'GND'. The trim-pot 'TR1' must be set fully clockwise (when delivered, it is already set to this position).
NOTE: TR1 trim pot does not have end positions in order to avoid damage.
Make sure the board is somewhat secured, so it won't move when tested. Now turn the power on and measure B+ and B- supply voltages, directly on the board. If one or both voltages are missing, turn off power immediately. There is a wiring error present and one or both fuses are blown. Otherwise measure the output voltage at the 'OUT' point (where R24 and R25 join). There will be some voltage between + 5V and -5V present. Now turn the trim pot slowly counter-clockwise. After a few turns, the voltage at 'OUT' should change towards zero. As soon as zero volts are reached, stop turning. The board is now pre-set.
At this point, the final assembly can be made. Remove the shorting jumper from the input. Install the power-transistors on a heat sink, large enough to dissipate the rated output power. Make the connections with 18GA or larger wire. To prevent any feedback or oscillations, do not make the wires longer than necessary
Install Q5 transistor on the same heat sink, between the two power-transistors. Use the supplied small clamp, and silicon paste to make a good heat transfer.
Final Calibration:
This final calibration is to be made after all amplifier components are installed in a cabinet and the project is nearly finished. Again, make a visual inspection. Make sure all power supply connections are correct, the fuse is still 1A AGC. Check the power-transistor connections. Short the input terminals. Connect your multimeter to the B+ fuse-holder terminals, positive (red) probe on the power-supply side. Switch the meter to 10 Amps DC. Turn on the power. Now, remove the fuse from the fuse holder. The multimeter should indicate less than 1A (if any) current flow, otherwise turn off power immediately. Look for wiring errors. If the test was successful, switch you meter to 0.5 or 1 Amp DC. Adjust BIAS current with the TR1 trim-pot to 0.1A (100mA). Turn CCW to increase, opposite to decrease. After 5 minutes re-adjust. Let it warm-up for 30 minutes and re-adjust again.
This finalizes the calibration procedure. Turn off the power and replace the fuses with correct values. The amp is ready for operation. Speakers are connected between amplifier "OUT" and power supply GND (0V). Do not connect to PCB ground.

Amplifier schematic:



Power Supply (not supplied):

Power supply is strait forward, as seen here. The output power depends on the rail DC supply voltages.
+/- 27 Volts will deliver 60 Watts RMS and +/- 34 Volts 100 Watts. C1, C2, C4 and C5 are the filter capacitors and C3 and C6 are noise by-pass capacitors. R1 and R2 are bleeding resistors.



Power Supply Parts List:

Up to 60 Watts:
Transformer AC Secondary Voltage 2 x 22VAC 2A
Rectifier Bridge BR1 200V 4A
C1, C2, C4, C5 = 3300uF/35V, alternatively C1, C4 (omit C2, C5) = 6800uF/35V
R1, R2 = 3.3k/0.5W
C3, C6 = 0.1uF/100V
Line Fuse =1A MDL Rail Fuses =3 A MDL

Up to 100 Watts:
Transformer AC Secondary Voltage 2 x 28VAC 2.5A
Rectifier Bridge BR1 200V 5A
C1, C2, C4, C5 =4700uF/50V, alternatively C1, C4 (omit C2, C5) =8200uF/50V
R1, R2 = 4.7k/0.5W
C3, C6 = 0.1uF/100V
Line Fuse = 1.5A MDL Rail Fuses = 4 A MDL

NOTE: Bridge rectifier and capacitor specifications are minimum ratings. These components may be substituted with higher ratings.

Fig. 1
C1 is a non-polarized electrolytic capacitor made from two 2.2uF caps, soldered in series.
Connect same polarity leads.

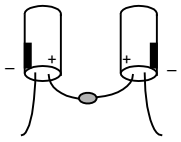


Fig.2
Shown Q4 with forward bent leg and Q5 with soldered 3-lead cable.

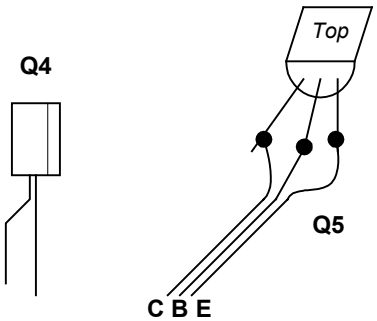
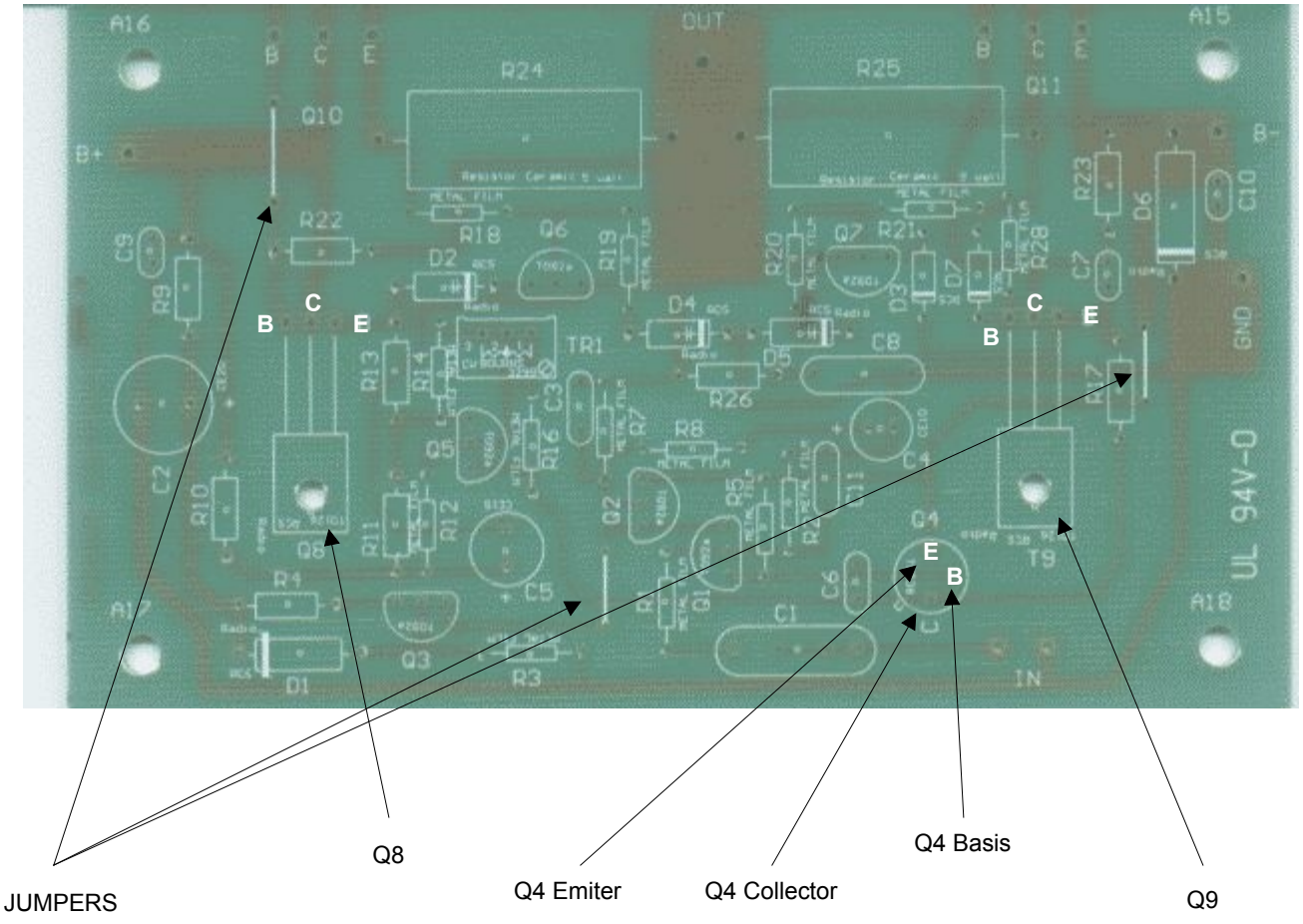
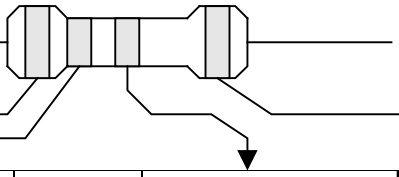


Fig.3

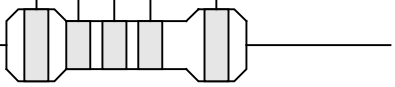
Transistor Types and Placement Guide



4 BAND RESISTOR COLOR CODE



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	0	1 Ohm	
BROWN	1	1	1	10 Ohm	1% (F)
RED	2	2	2	100 Ohm	2% (G)
ORANGE	3	3	3	1K Ohm	
YELLOW	4	4	4	10K Ohm	
GREEN	5	5	5	100K Ohm	0.5% (D)
BLUE	6	6	6	1M Ohm	0.25% (C)
VIOLET	7	7	7	10M Ohm	0.10% (B)
GREY	8	8	8		0.05% (B)
WHITE	9	9	9		
GOLD				0.1	5% (J)
SILVER				0.01	10% (K)



5 BAND RESISTOR COLOR CODE