

PeeCeeBee Construction and Set-up

Bill of Materials

Parts listed are for one channel only.

Semiconductors:

1x P Channel L-MOSFET, TO-3 or TO-247 (2SJ50, BUZ, ALF, 2SJ162 or similar)
1x N Channel L-MOSFET, TO-3 or TO-247 (2SK135, BUZ, ALF, 2SK1058 or similar)
1x PNP VAS Transistor, TO-126 (BD140-16, KSA1381E, KSA1220A or similar)
1x NPN VAS Transistor, TO-126 (BD139-16, KSC3503E, KSC2690A or similar)
1x PNP IPS Transistor, TO-92 (KSA992F or similar)
1x NPN IPS Transistor, TO-92 (KSC1845F or similar)
4x 1 Ampere General Purpose Diode / Rectifier (1N4007 or similar)
2x General Purpose Small Signal Diode (1N4148, 1N914B or similar)

Capacitors:

The capacitors should generally be voltage rated at least slightly greater than an individual power supply rail, so for most places 50V is fine unless lower is noted.

2x 22pF-47pF, 100V+, 5mm LS, NP0/C0G Ceramic or Silver Mica, VAS Compensation
1x 100pF, 5mm LS, NP0/C0G Ceramic or Silver Mica, Input RF/HF Filter
4x 1uF, 50V, 5mm W x 10mm L, 5mm LS, Film or X7R Ceramic, Power Supply Bypass
1x 10uF, 10mm W x 28mm L, 22.5mm LS, Film, Input Coupling
1x 10uF, 5mm W x 10mmL or 7.5mm Ø, 5mm LS, X7R Ceramic or Aluminum, Bias
2x 1000uF, 50V, 12mm Ø, 5mm LS, Aluminum Electrolytic, Power Supply Filtering
2x 2200uF, 6.3V, 12mm Ø, 5mm LS, Aluminum Electrolytic, Feedback Network

Resistors:

All resistors can be either Metal Film or Carbon Film, 1/4W, and may be either 5% or 1% tolerance except for the feedback network (noted by*) where best match within reason is desired. Values for OFF1 or OFF2 are determined experimentally during set-up, as is BIAS should a reduction in output stage quiescent current be required or desired.

5x 10Ω
4x 100Ω (only two need to be matched)*
2x 470Ω
1x 1kΩ
2x 2.2kΩ *
1x 10kΩ
2x 18kΩ (for +/- 35-40V rails, see Table 1 for recommendations for other supply ranges)
1x 100kΩ
1x OFF1 or OFF2, value TBD during set-up but typically between 100KΩ and 1MΩ
1x BIAS, value TBD during set-up if even required at all, typically less than 470Ω

Construction:

Normal construction practices will serve for building the PeeCeeBee. I recommend soldering the fast-on spade connectors first since they require extra heat and are easier to position when the board is blank. Then stuff the board with the resistors. Remember to choose the 'current injectors', R5 and R10, based on supply voltage. See Table 1 for suggestions but do bear in mind you may need to adjust these to suit your actual build. Leave the OFF1, OFF2 and BIAS resistors unpopulated for the time being. Next install the diodes paying attention to polarity. Follow this with the installation of the physically small capacitors.

Current Injector Resistor Values Based On Supply Voltages

Supply Voltage Ranges	Recommended Values
+/-20V to +/-25V	10k Ω to 12k Ω
+/-25V to +/-30V	12k Ω to 15k Ω
+/-30V to +/-35V	15k Ω to 18k Ω
+/-35V to +/-40V	18k Ω to 20k Ω

Table 1

I suggest ensuring you have small heat sinks attached to the VAS transistors as they may have to dissipate about 0.5W and would get quite hot without. Bend the VAS transistor leads and solder into place, be mindful of orientation and placing the correct polarity in each location.

For the IPS transistors I suggest using a little brightly colored nail polish or paint on the top of the PNP part to distinguish it from its complement since these will be glued or bound together face to face. A little instant glue can be used to thermally bond the input stage transistors, or use some thermal paste and heat shrink tubing. Bend the leads and solder in the pair of input transistors, pay attention to the orientation of the devices to ensure the correct polarity is placed where it belongs.

At this point you can mount the bigger electrolytic capacitors to the board, once again minding the polarity and device location. The supplied diagram shows a filled in segment to denote the negative (-) terminal of the capacitors.

Use the drill template to prepare the heat sink adapter. Line up the edge of the template with the edge of the adapter, along the length of the adapter you would like the board positioned. Centre punch accurately on the cross hairs and drill out using a 1/8" drill bit. Please do chamfer and de-burr your metal work to ensure no electrical shorts occur due to mechanical chaff being left behind. You may elect to use small brass or copper washers under the nuts on the board side for reinforcement.

When installing the output transistors the mounting screws will carry the output signal to the board, so do not use insulators under the screw head or nut but DO insulate the screw where it passes through the adapter. Also insulate the two leads from the heat sink adapter. Remember to use either a sil-pad, kapton or mica insulator and thermal compound where required for each output transistor. Once the output transistors are physically mounted and electrical isolation from the heat sink adapter is verified you can then solder the two leads to the board. Ensure you have not over tightened the mounting screws prior to soldering the leads and do not tighten or loosen the screws after soldering the leads.

The compensation capacitors, COMP1 and COMP2, are considered optional dependent on the VAS transistors chosen. I would suggest using them, starting with 22pF, to ensure that there is no oscillations present. In the unlikely event of oscillation these can be increased in value as required, up to perhaps 100pF if needed. If the amplifier proves to be stable, one can also choose to try it without them but I doubt there is much sonic benefit to removing them.

Initial Power-up

Once the physical construction is complete and verified we can move on to applying power and making adjustments if needed. It is good practice to use a current limited supply for initial power up. This may even just be an incandescent light bulb in series with the power supply mains connection. You may also elect to bring up the unit under test through a variac though this isn't strictly necessary.

Since there are no source resistors in this design for us to use to measure quiescent current I suggest putting 10Ω resistors in line with both polarities of the power supply. We can then measure the quiescent current by monitoring the voltage across these resistors and they will also provide some additional current limiting in case of a fault.

Short the input connections and leave the output unloaded for initial testing. Apply power and bring the supply voltage up to normal operating level, observing for any signs of a fault. A bulb limited supply may get the bulb to glow but it shouldn't light up brightly.

Once the supply voltage is at its nominal value, check for DC offset and measure the voltages across the 10Ω resistors in-line with the power supply rails. The DC offset could be relatively high, say up to 200mV, without there being any fault. This is dependent on component tolerances. We will trim away any DC offset present.

The voltage across the 10Ω current sensing resistors should be around 1.6V, give or take, if the quiescent currents are correct at about a total of 160mA. This value isn't super critical so long as it isn't way too high or low. If there are no actual faults present then shut down the power supply and remove the 10Ω current sense resistors and bulb limiting. Recheck for normal power up using 1A fuses on a regular power supply. If all is well, we move on to the adjustment phase.

Adjustment

There are two basic adjustments to make, assuming they are even required at all. The first will be DC offset trimming and then bias adjustment.

Offset Adjustment:

Prepare a $1\text{M}\Omega$ linear potentiometer with a set of leads so that the resistance can be varied at those leads between 0Ω and $1\text{M}\Omega$, and set it to the full $1\text{M}\Omega$ value. Take a DC offset measurement on the amplifier and then power it down.

Install the potentiometer in one of the amplifier offset resistor locations and power it back up. Re-check the DC offset value and turn the potentiometer part way to see if the offset improves or worsens. If the offset worsens then power the amplifier down and move the potentiometer to the other offset resistor location.

Once turning the potentiometer gets offset moving towards 0mV , continue until you find the lowest reasonable value of offset without bringing the potentiometer to 0Ω . At this point power down the amplifier and without changing the potentiometer wiper position remove it from the circuit. Measure the resistance on the leads of the potentiometer and select the closest standard value of resistor and install it in the same offset resistor location that the potentiometer occupied to make the adjustment.

Power the amplifier back up and verify the DC offset is at an acceptable level, we should be able to achieve a DC offset of $<25\text{mV}$ without being too fussy about our offset resistor value. If you want greater precision you can 'build' a value closer to the exact value required with a combination of resistors, but in practice this won't be required.

Bias Adjustment:

If the measurement of bias across the 10Ω resistors used during initial power-up suggested that the bias current should be reduced, or if you would simply like to reduce it to suit your own preference, then you will be installing a resistor into the bias resistor location on the board.

As with the offset adjustment, similarly prepare a 500Ω potentiometer with leads and install across the bias resistor terminals. Install an ammeter into the positive power supply line. Power the amplifier up and adjust the potentiometer until a total bias of about 160mA is read, or lower if you so choose. Power the unit off and remove the potentiometer, carefully as to not disturb the wiper position. Measure the resistance and install the closest (or next lower) standard value into the bias resistor location. Recheck the offset though it shouldn't need to be re-adjusted.

Final Verification:

Apply a test signal and test load, monitor behavior on an oscilloscope. If all looks normal, then proceed to a full functional test with a real speaker and music. Enjoy!