

Application Note: Assembling Low-Current, Low Noise DHT Coleman Regulator.

Version: v4.2, 2012-9-5: Add 6P21S

Please Read this Note together with Andht01 [PDF Manual]

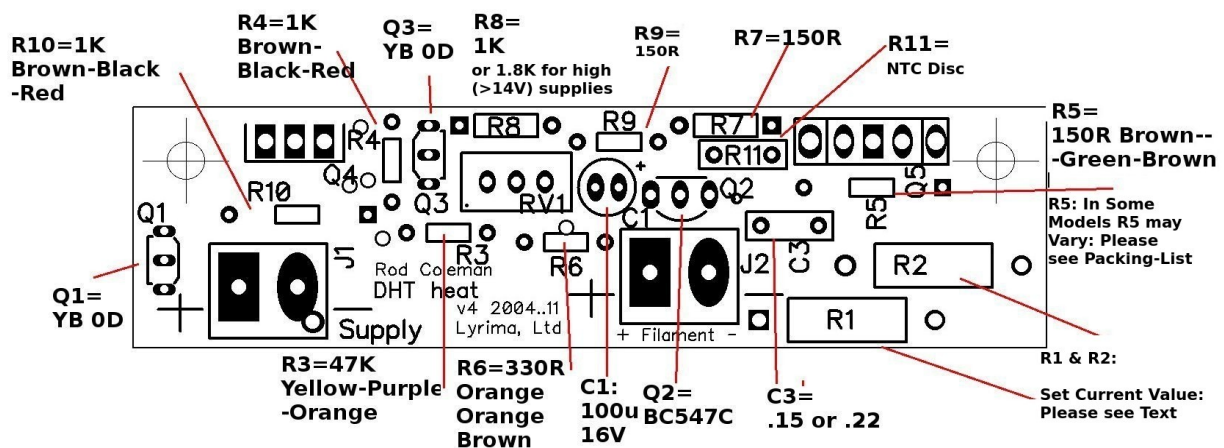
1. Parts you will need (NOT supplied in the kit):

Test Resistors (Cheap Cement wirewound type). To make up (e.g.): 20R [250mA filaments] or 6.8R [500mA Aa/Ba filaments] with at least 5W total power handling, but preferably more, eg 6.8R 10W WELWYN W23 from Farnell: Part Nr. 9505547 and Mouser 756-W22-6R8JI for W22 7W - will be alternatives if you don't have something in your parts box. 1R and lower value resistors are also needed to build the raw dc supply [see the dc supply paragraphs], so be sure to have plenty of these in hand.

Mounting screws. Transistor and PCB mounting holes are suited to M3 screws.

Components for a raw dc supply: 7.5V 15VA[500mA Ba, Aa] or 9V 15VA [250mA #71A, 01A etc] transformer (split-bobbin EI type), 2x 10000uF capacitors, 2x 1N5822 Schottky diodes, and 0.47R & 1R WW resistors [see dc supply example at the end of the document]. Additional 1000uF 16v [Panasonic FC] if your wiring between the raw dc supply and the regulator is more than 150mm [6"].

2. PCB components: All the components mounted on the PCB come in the kit: Check the diagram and see that all parts are ready to stuff the board:

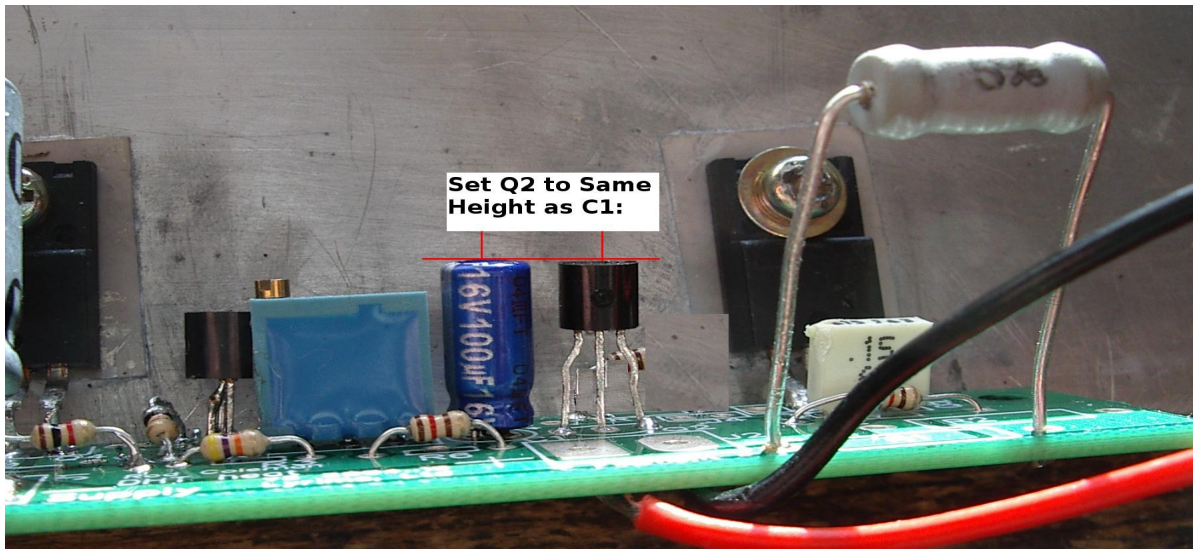


All the low-current models are stuffed the same, except for the R1 position, and R5 for the 4P1L.

R1 is 1.5 ohm for Svetlana **4P1L** (500 to 700mA range), **Russian 6P21S** and TFK **RE604** (580mA filament) and similar; **R1 is 1.8R** for 500mA filaments (Aa, Ba etc). **3.9 ohms** for PT625, #71A, 01A, 112A (250mA) **R1= 16R/0.5W** for the RCA #30, early Philips A409, TM2. (60mA). *Other types will specify R1 & R2 in the packing-list, found in the kit of components.*

3. Lead Formation.

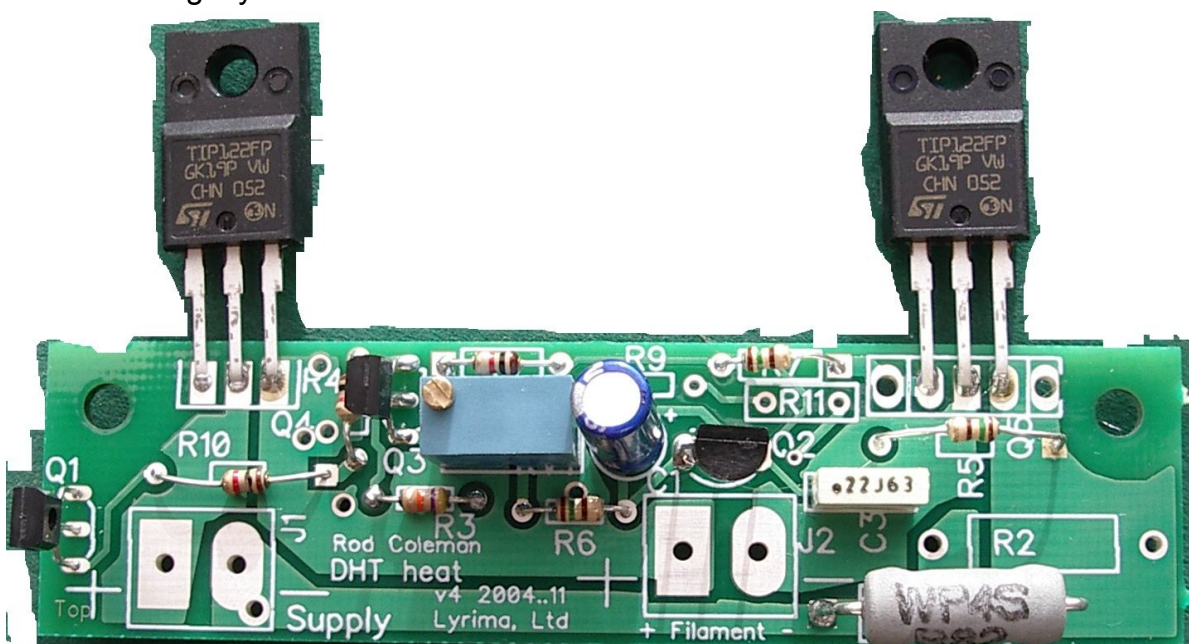
3.1 Q2: Mount Q2 so that the top is level with C1:



3.2 Resistor R1 and R2. These resistors sense the current. They are 2W types, but are only stressed at 25 .. 35% of this, to prevent them running very hot. Still **they will reach 150 degrees Centigrade or more**, so be careful not to touch them when running the heater. Mount the resistors so that the body **is 7mm or more from the PCB**, or the board may be burned.

3.3 RV1 trimmer. Mount this so that the adjustment screw is at the top-left [i.e.: nearest R4]. Some parts versions require lead forming of the centre-lead to achieve this.

3.4 Power transistors Q4 and Q5. You must decide how to mount the regulator in relation to the heatsink and chassis before forming these leads. You can mount them under the PCB [if you want a horizontal mounted regulator] or with formed leads and TO-220 body at right angles, if you want (say) the PCB on the amplifier base, and the back panel as a heatsink. See picture for this transistor mounting style.



4. Assembled PCB picture. See above. The finished board should look like this. Check the resistor colour codes here, if in doubt about values. Double check the

orientation/polarisation of C1, RV1, Q1,Q2,Q3, and the offset position of C3:

5. Testing the Regulator.

When you have stuffed the board according to the diagram, test it carefully before connecting to a DHT filament.

5.1 Inspection. Use a lens to check that no solder shorts are present, especially around fine-pitch parts like C1, Q1, Q3.

5.2 Meter Test.

Set a DMM to resistance [20K range]. Try the Supply input [red to +]: should only give momentary or high impedance reading. Try Filament Terminals [both directions], should also read HIGH IMPEDANCE.

5.3 Raw dc [Open] Test

Check your raw dc supply gives the OPEN CIRCUIT voltage predicted by PSUDii [see the Application Note on power supply design].

5.4 Dummy load Test

Mount the Regulator on a Heatsink. Pass transistors will be destroyed if the regulator is used - even for less than 1 second - without a heatsink. Mount Q4 & Q5 directly to the heatsink, using some heatsink compound. Connect the Test Resistors [dummy load] to the Filament Terminals, with an Ammeter in series. Monitor supply voltage and filament voltage. Power ON, and check that current is in the range 0.1 to 0.7A. If too high, immediately power OFF, and look for short circuits, or wrong components values. If OK, use a trimmer screwdriver to check the adjustment range is at least 50 to 70mA (60mA version); 210 to 280mA (250mA version); 280 to 350mA (4P1L version); 440 to 580mA (500mA version). The range will be correct provided there is a dc supply attached 4.0V to 6.6V **more than the filament voltage**. When this is OK, set the trimmer to **minimum current** and switch OFF.

5.5 Connect DHT

Now wire the DHT filament (see *CONNECTING* section of the General Application Note: AN_DHT_01.PDF).

5.5.1. Turn the trimmer RV1 fully anticlockwise. It's a 25-turn trimmer, for precision adjustment.

5.5.2. Switch ON filament supply WITHOUT B+ (HT supply) and adjust current until the rated voltage appears across the filament (5V for 01A/71A; 3.5V for Ba, 3.8V for Aa, 3.25V for 4P1L etc.).

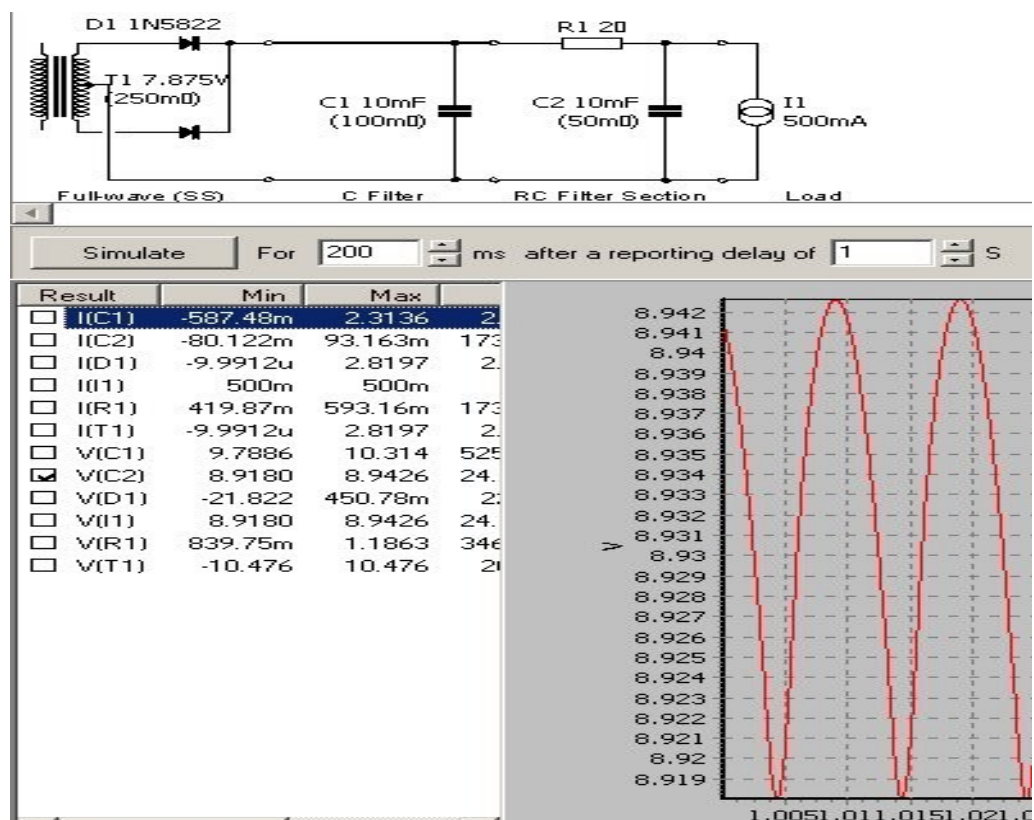
5.5.3. Keep monitoring filament current, and apply B+. The current will increase a little! Adjust again, and keep monitoring until the amplifier is warmed up.

5.5.4. The current will decrease by 2 ..8% when fully warmed up, so run it a little LOW (say, 2 to 5% less than nominal) when warmed up. After that, you should not need to adjust again, right across the lifetime of the DHT.

5.5.5. But if you install a different DHT, remember to adjust the current again.

6. Power Supply Examples: Ba: 500mA DHT

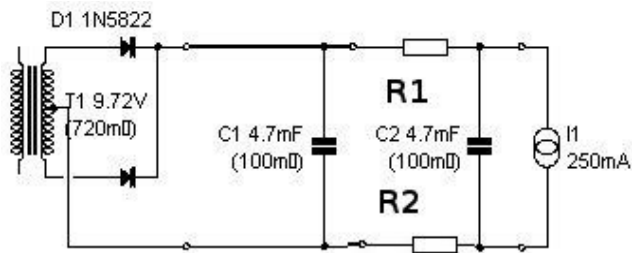
- 6.1 Raw dc voltage of **7.5V minimum, 9V nominal, 12V maximum** is the recommended level. Below 7.5V, the current range is lower, and the sound quality **will be seriously harmed**.
- 6.2 Please study the General Application Note to see the refinements of good power supply design. The example below gives example design for some low-current DHTs.
- 6.3 The screenshot shows an example power supply. Use a 7.5V 15VA transformer minimum, (one for each tube, **DO NOT share L & R channels**).
- 6.4 Rectifier [full-wave, or bridge] made with 1N5822 [Farnell 1612319; Mouser 863-1N5822G] or MBR1045 [Farnell 1702813; Mouser 844-MBR1045PBF] diodes. C1 and C2 capacitors are Nichicon LG, Panasonic TSUP or TSHA or TSHB or Samwha HC series 10000uF/16V “snap-in” types. I believe that the action of the Regulator means that “Audio Quality” capacitors are not needed. The Samwha HC 10000uF/16v handles 3A ripple, and was used during the design proving (available cheaply in UK/Europe www.rapidonline.com). Snap-ins usually have good ratings for ripple current – **it is essential to have a ripple-current rating of 1A or more, for this design**.
- 6.5 If your local mains has problems with HF noise, or you have radio stations nearby, add a choke e.g.: a 1mH EPCOS – B82721K2202N001 or similar, rated at 2A (it sees 2A peaks, so use a larger Choke if you prefer to derate). Farnell order code 1644802.
- 6.6 The series resistance is about 80mR for these chokes, so add two 1R 7W Wirewound resistors to set the nominal raw dc at 9.0V to 9.5V (at the correct filament current, warmed up, line voltage normal). Have some 1R and 0.47R resistors at hand, to fine-tune the raw dc voltage by inserting them at the R1/R2 position [see R1 and R2 in the general Application Note for designing the raw dc Supply.



6.7 Design example for the 01A, 71A 112A: 5.0V 250mA Filament.

This regulator can adjust from about 215mA to 330mA.

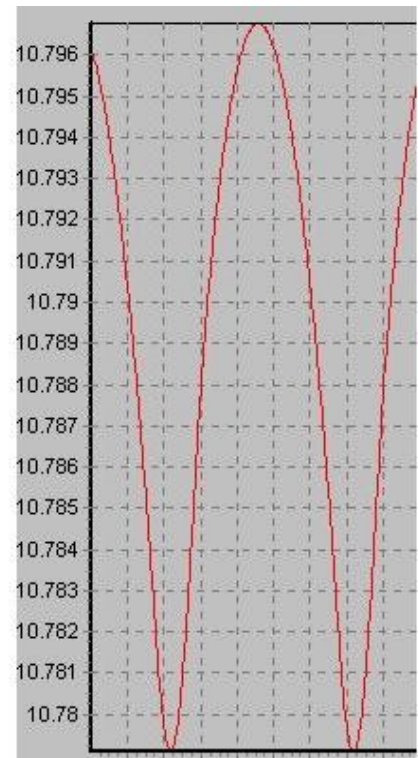
For the 01A, 112A, 71A (etc) recommended raw dc level is 9.0V minimum, 11.0V nominal, 14V maximum. The 250mA/5V filament supply is built just like the Ba (above), except: Trafo is 9V 15VA (or higher rating). R1 & R2 in the picture are 3.3R 5W resistors. The next screenshot shows a 250mA supply built with a transformer with 9V 27VA secondary, eg Hammond 266K18.



Trafo:
9V 10VA

C1=C2=
4700uF 16V
1A or more
Ripple Current
Handling

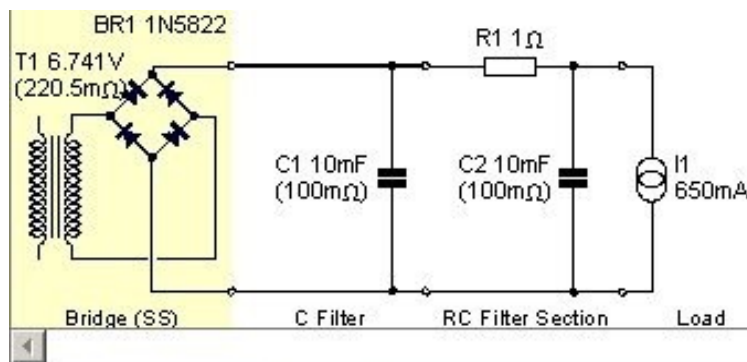
R1=R2=
3.3R WW
Flameproof
2W or more



6.8 4P1L: Svetlana directly Heated Pentode.

This versatile, low cost Russian Pentode can be heated with the filament sections in series (4,2V 325mA +/- 25mA) but it is better to connected the sections in parallel, and heat to 2.1V 650mA (+/-50mA). This way the offset of the grid voltage by the filament voltage will be lower. Experimenters at DIYaudio have reported that this pentode (triode wired) sounds better with reduced filament current, and the special 4P1L Filament Regulator is designed to be able to control from 500mA to 700mA, to allow experimentation for this purpose.

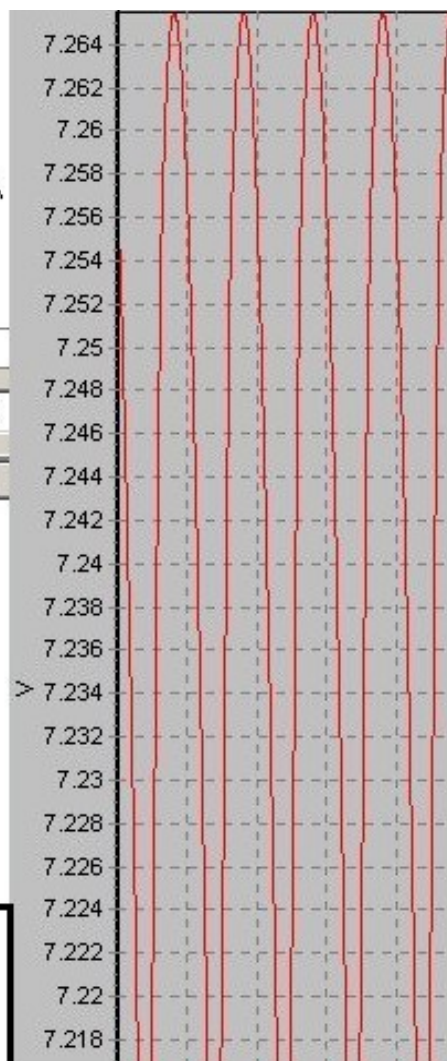
Choose 6.3V secondary transformer, 2A rms rating: eg **Hammond 266L6**



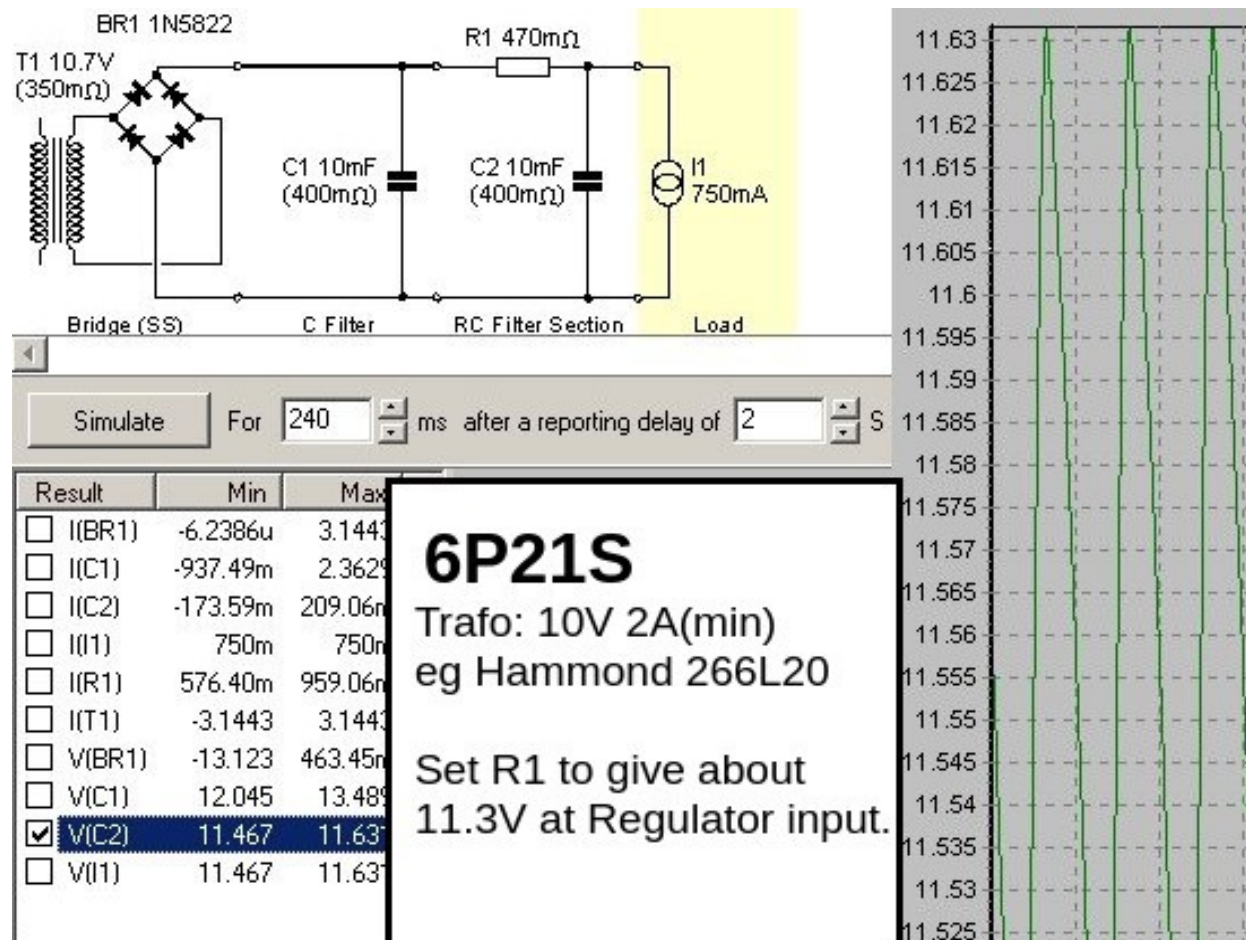
Simulate For 240 ms after a reporting delay of 2

Result	Min	Max	Diff	Mean	RMS
<input type="checkbox"/> I(BR1)	-3.9944u	3.3090	3.3090	325.00m	931.67m
<input type="checkbox"/> I(C1)	-830.36m	2.6329	3.4633	3.0268p	1.1283
<input type="checkbox"/> I(C2)	-164.99m	211.18m	376.18m	1.2752p	117.77m
<input type="checkbox"/> I(I1)	650m	650m	0	650.00m	649.99m
<input type="checkbox"/> I(R1)	485.00m	861.18m	376.18m	650.00m	660.58m
<input type="checkbox"/> I(T1)	-3.3090	3.3090	6.6181	15.407f	1.3175
<input type="checkbox"/> V(BR1)	-8.2425	469.68m	8.7122	-5.0698	6.1402
<input type="checkbox"/> V(C1)	7.7628	8.3856	622.84m	8.0215	8.0235
<input checked="" type="checkbox"/> V(C2)	7.2027	7.2654	62.703m	7.2415	7.2415
<input type="checkbox"/> V(I1)	7.2027	7.2654	62.703m	7.2415	7.2415
<input type="checkbox"/> V(R1)	485.00m	861.18m	376.18m	650.00m	660.58m

4П1Л (4P1L) Svetlana
2,1V @ 500 to 675mA
Trafo: Hammond 266L6
(6.3V 2A rms)
Rectifier: 1N5821
Caps: 10000uF 16V



6.9 Russian 6P21S: Directly Heated Tetrode.



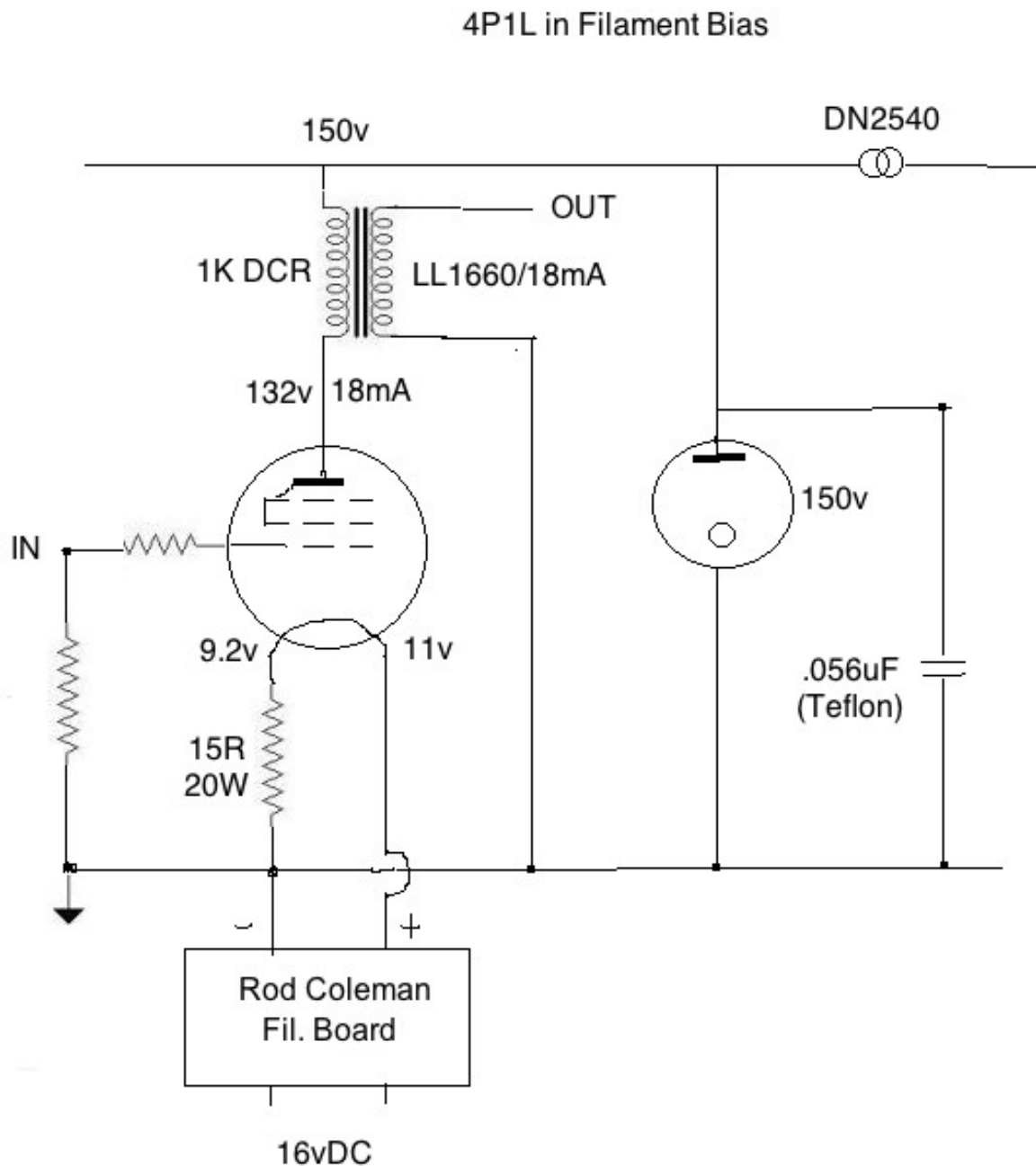
Filament Rating: 6.3V 750mA. Use transformer 10V 2A or more, eg Hammond 266L20. 1N5822 Bridge [Farnell 1612319; Mouser 863-1N5822G] 10000uF or 15000uF 16V snap-in capacitors. Raw dc Input Range: 11V to 12.5V, best.

7. Filament Bias

This bias method allows cathode-biasing of the DHT with a low value of cathode resistor – low enough that a cathode bypass capacitor is not required. Since the cathode-bias capacitor usually needs to be electrolytic (which strongly degrades the sound) – filament bias can be used to advantage, especially where the filament current is moderately low. All the filament current passes through the bias resistor (a high-power, high quality wirewound is required – minimum standard is multiple parallel Welwyn W24 14W vitreous enamelled type).

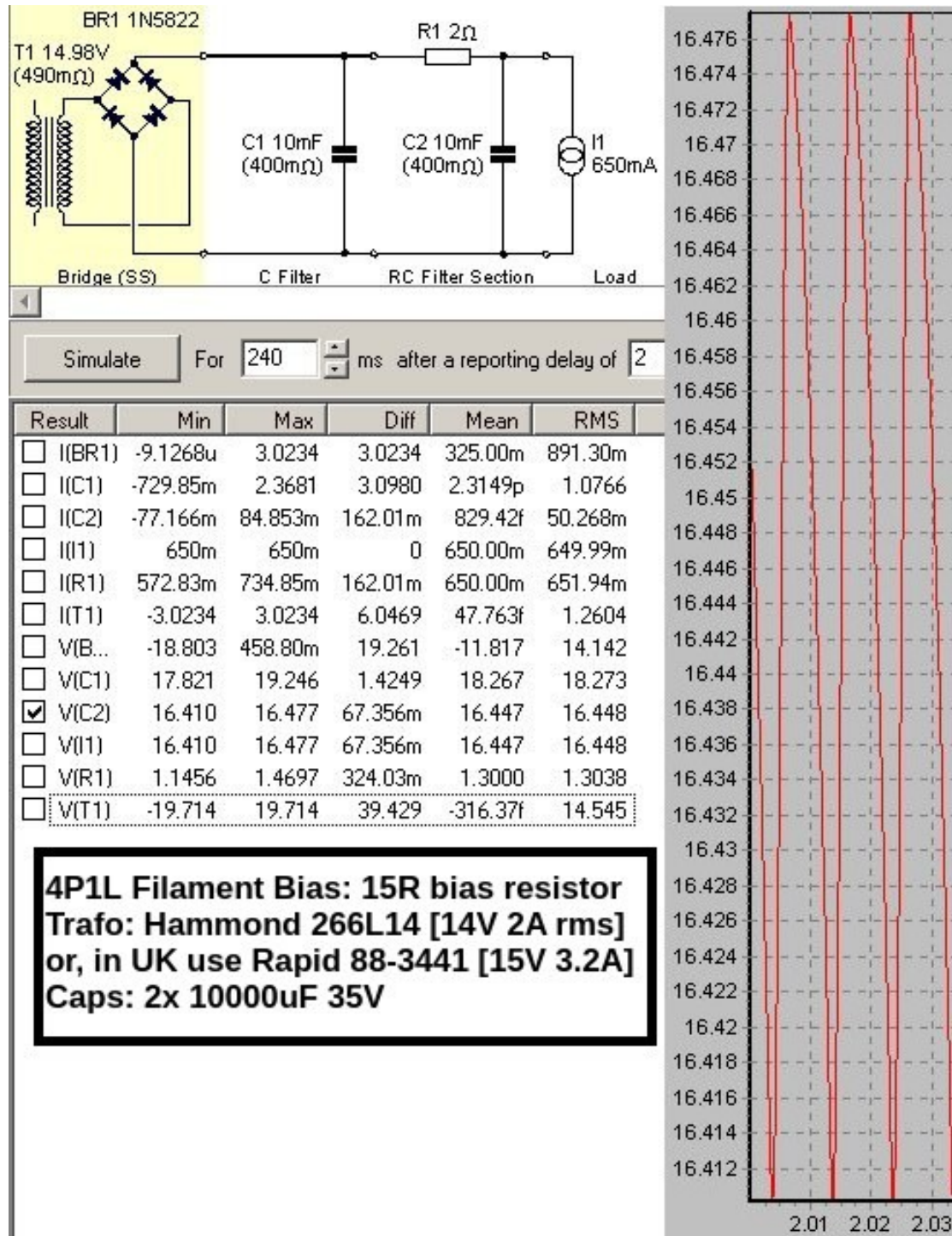
7.1 Example filament bias Design

The picture shows Andy Evans' design for 4P1L in filament bias:



Cathode resistor must be high quality wire wound
4P1L starved filaments, 1.8v

The Filament Supply requires a higher supply voltage to cope with the increased output voltage – In this case, 16V is required (Range 15,5V to 18V). the transformer must be uprated to a higher voltage and power capability for filament bias. To achieve 16Vdc, here is an example supply using the Hammond 266L14 (14V 2A), or the Rapid electronics 88-3441 (15V 50VA). The dc output can be adjusted to 16-16,5V by using different values of R1 (as shown in the diagram.. When 266L14 is used: 2x 1R 5W will suffice; for Rapid 88-3441, please use 2x 2.2R 7W – ordinary cheap ceramic-body power resistors:



7.2 Changes to the Regulator for Filament Bias Use:

The higher voltage at the supply means two changes to the regulator's build:

7.2.1. C1: changes to 47uF/35V

7.2.2. R8: becomes 3.3K for supply voltage of 12 to 18V, 10K for 19V to 27V