NEWTON STEREO VALVE PREAMPLIFIER

PART 2

Power Supply Unit

KIT AVAILABLE (LT75S) Price £44.99 84

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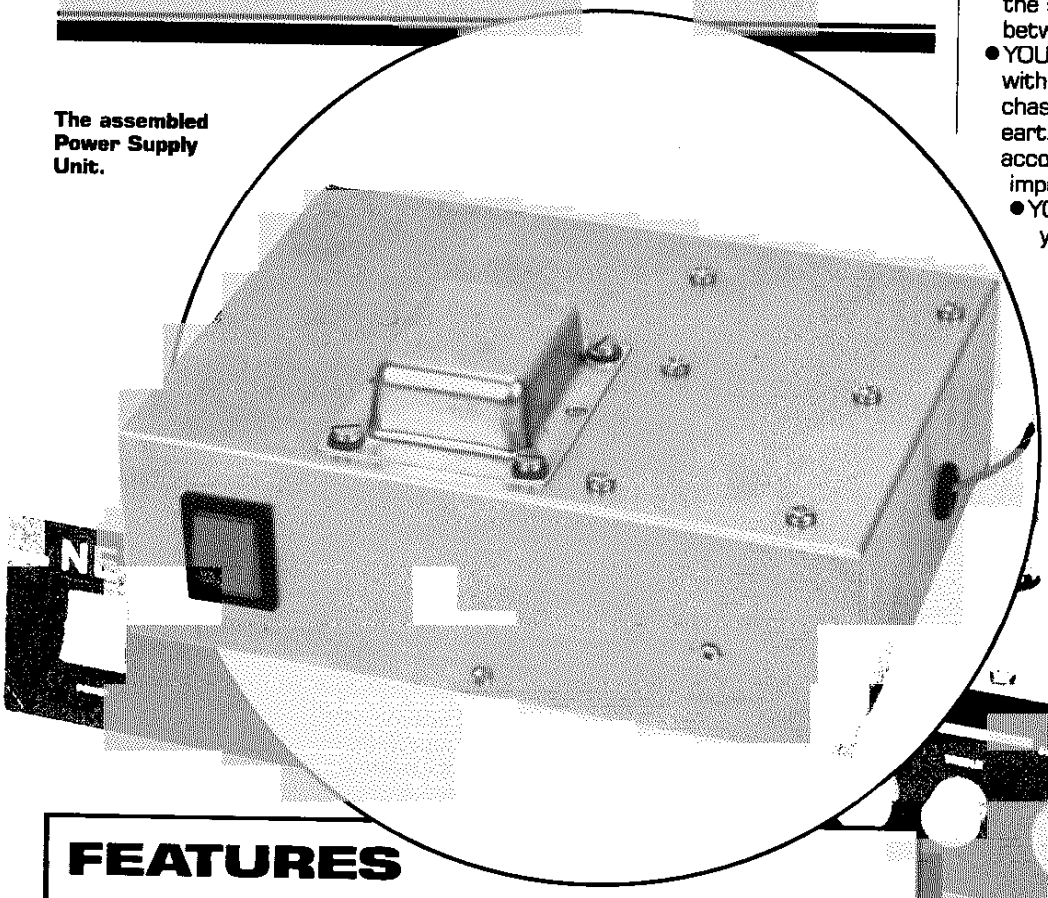
Text by Mike Holmes

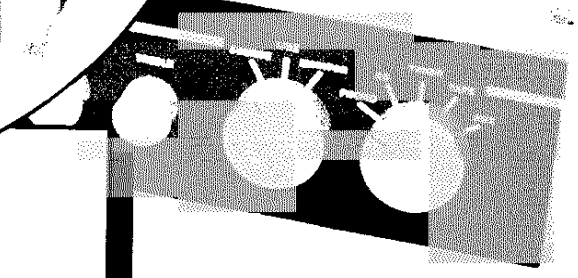
Earlier in this issue Part One described the RIAA Phono Module of the 'Newton' all-valve preamplifier. This part describes the Power Supply Unit.

To reiterate, a word of warning before you start.

- YOU MUST only use parts from the kit, and build it strictly according to the instructions.
- YOU MUST install the amplifier module PCBs in a fully enclosed and earthed chassis. The Phono Module Kit includes a 4 × 8 × 2·5 inch chassis, into which both this and the Tone Control PCB can be fitted if desired. Such a chassis must be physically joined to the PSU so that the supply cabling can pass directly between them.
- YOU MUST take particular care with wiring up the HT power supply, chassis earth and common signal earth connections. Follow the accompanying wiring diagrams implicitly.
- YOU MUST NOT attempt to make your own PCBs – you can try 'hardwiring' in the good old fashioned way with tag boards and the like, IF YOU HAVE THE RELEVANT EXPERIENCE, otherwise always use the ready-made PCB that includes a solder resist layer as an aid to insulation and user safety.



The assembled Power Supply Unit.



FEATURES

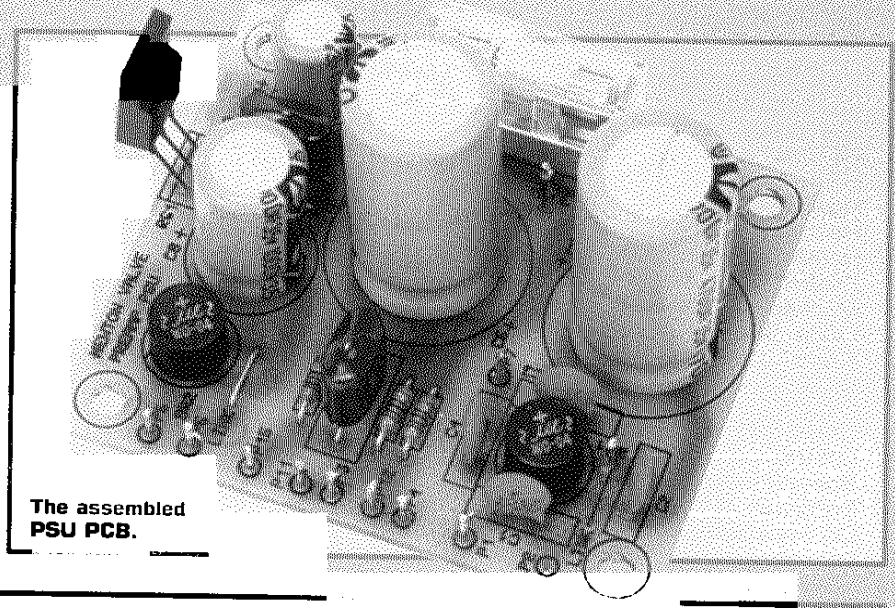
* Simple PCB construction
* π – filtered HT line
* AC and DC heater supplies
* UK and US mains compatible

4 PROJECT RATING

The Power Supply Unit

In Figure 1 of Part One, it can be seen that, derived from the mains input, the PSU module produces three different outputs. These are the main HT supply common to all valve circuits, a conventional 6·3V AC heater supply, which will be used by the phono module's line driver and the tone control module, and a special 12·6V regulated DC heater supply specifically for the phono preamplifier valves only. (See also Tables 1, 2 and 3.)

Figure 1 shows the complete PSU circuit diagram. Many of the components are contained on the single PCB, except a couple that are 'hardwired' to T1 (TS1 & C11), and the choke L1.



The assembled PSU PCB.

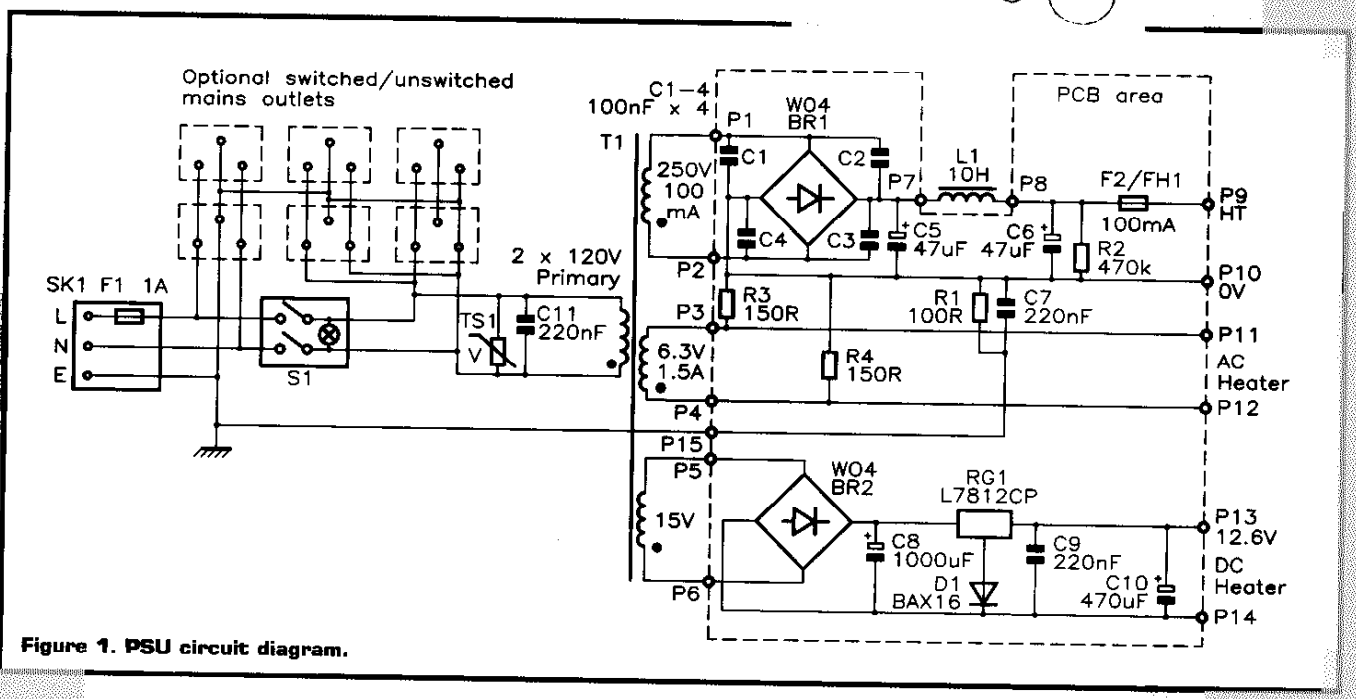


Figure 1. PSU circuit diagram.

Mains transformer T1 has a 'dual-standard' primary voltage capability, depending on how its two primary windings are configured. Hence the PSU can be built for the UK/European mains standard of 220 to 240V AC (nominally 230V AC) 50Hz, or for the USA/North American mains standard of 110 to 120V AC (nominally 115V AC) 60Hz. Mains power enters the PSU chassis via SK1, a fused and filtered Euro-style mains inlet socket, and is switched by double-pole neon switch S1. Optional Euro-facility mains outlets may be added, connected on one side or the other of S1 depending on whether unswitched or switched outlets to ancillary equipment are required. With the choke in place there may be space on the rear panel of the chassis for up to four such sockets, however, DO NOT attempt to install these if you have had no experience of fitting them or you are at all unsure of your proficiency at mains wiring! If you do use them then also use the protective insulating 'boots' (see optional Parts List).

At T1 primary there is also included a voltage transient or 'spike' suppressor, TS1, and a 220nF polypropylene capacitor C11. These, together with the filtered mains inlet, may seem like 'overkill' but having experienced excessively noisy mains I feel they are not out of place. (The prototype even has a second filter block following the inlet filter.)

On the secondary side, the 250V AC winding feeds a bridge rectifier block BR1, which includes noise suppression capacitors C1 to C4, developing unregulated DC HT on the main reservoir C5. All these components are on the PCB, but a break is made at this point to include the choke, L1, the output side of which goes to C6; together these two form an integrator or LC low-pass filter to minimise the 100Hz ripple voltage.

Return of the LF Choke

For non-critical audio usage (that is, it is not a test instrument, for example) HT 'stabilisers' are not strictly necessary, and if there is sufficient supply decoupling then any level fluctuations manifest themselves as very slowly changing transitions at the output, at a subsonic level below the AF range. If signal coupling capacitors are just small enough in value then not even much of this will be seen at the output.

Hence, it is only really necessary to reduce the ripple, which can be quite a nuisance, but at the same time not lose any more HT level than we can help, it being rather hard to come by as it is, given the unavoidable losses in the transformer.

In the valve heyday, a typical supply electrolytic was the 'double-plate' type, effectively two capacitors in one can sharing a common negative side, and between the anodes a choke was connected. The arrangement was very common and employed LF chokes in large numbers. In Figure 1, the HT supply from C5 is carried to C6 via the choke L1; the choke is chassis mounted and connected in circuit by wire to PCB pins P7 and P8. If the 100Hz ripple (a rounded, ramp shaped waveform) on C5 is 10 to 12V peak (typical), then it is reduced to the order of approximately 70mV – at least <100mV – after passing

Transformer core material:	Low-field grain-oriented steel
Primary windings:	2 × 115V (dual UK/US standard)
Secondary windings:	3
HT voltage:	350V max.*
HT current:	100mA max.*
Heater #1 voltage:	6·3V
Heater #1 current:	1·5A max.
Heater #2 voltage:	15V
Heater #2 current:	1·5A max.
Mechanical fittings:	4-bolt top cover and frame
Fixing centres:	64·5 × 52mm (4 off)
Overall dimensions:	80 × 66 × 70mm high

*Not available simultaneously.

Choke core material:	Electrical steel
Lamination distribution:	Insulated 'E' and 'I' groups
Specific inductance:	7 to 10H nominal @ 50mA DC
Maximum DC (wire rating):	100mA
DC resistance:	150Ω approx.
DC voltage drop:	7·5V @ 50mA
Mechanical fitting:	2-hole 'clamp' type
Fixing centres:	67 to 75mm (M4 or 4BA)
Overall dimensions excluding lugs:	60 × 52 × 49mm high

Table 1. Specification of PSU transformer and choke.

Input voltage:	230 to 240V AC @ 50Hz, or 115 to 120V @ 60Hz
Primary side protection:	500mA (UK) or 1A (US) 'quick-blow' fuse, inline filter and noise suppression
HT output voltage:	<300 to 350V max. (dependent on load)
HT output current:	up to 50mA nominal, 100mA max.
HT ripple:	<100mV peak @ 50mA
HT reservoir discharge method:	Leakage resistor
Reservoir discharge time:	1 minute approx.
HT protection:	100mA 'quick-blow' fuse
AC heater supply:	6·3V @ 1·5A max.
DC heater supply:	12·6V @ 500mA max.

Table 2. Specification of Power Supply Module.

PSU Module Pin No.	Function
P1	250V AC in #1
P2	250V AC in #2
P3	6·3V AC in #1
P4	6·3V AC in #2
P5	15V AC in #1
P6	15V AC in #2
P7	HT stage 1 out to L1
P8	L1 in to HT stage 2
P9	+350V DC HT output
P10	HT 0V and AC heater common 0VE
P11	6·3V AC heater #1
P12	6·3V AC heater #2
P13	+12·6V DC heater output
P14	DC heater 0V (–)
P15	Chassis earth

Table 3. PSU Module PCB pin designations.

through L1 to C6. This is a reduction factor of 100 times (40dB) minimum, yet, with a 50mA drain from C6, the total voltage drop across L1 is only 7·5V DC.

Now much less noisy, the HT at C6 is available from pin P9 via protective fuse F2, housed in a covered, PCB mounting fuseholder FH1. R2 is a safety resistor ensuring that the HT line is discharged in the absence of a load or if F2 goes open circuit. The HT supply common earth is at P10, and this point is connected to chassis or mains earth at P15 via R1 and C7. R1 is a 'hum-loop block' if other audio equipment connected to the 'Newton' shares a mains earth with a signal earth via the mains lead and the screens of audio leads, the loop being completed at the PSU module. R1 is of sufficiently low value to blow F2 should a short circuit occur in the HT supply connections.

The 6·3V AC heater supply is available at pins P11 and P12. A winding centre-tap is emulated by resistors R3 & R4, tying it to 0V (P10). The heater supply thus forms two opposing, equal and opposite waveforms of 3·15V each balanced either side of 0V. When the heater supply wires are formed into twisted pairs, the opposing electric fields cancel, and these techniques reduce hum injection into sensitive areas to a minimum.

Even this may not be quite enough for the very sensitive phono preamplifier stages, so a better approach is adopted, exploiting a modern regulator IC. The valve heaters can be operated in series, so a smoothed and regulated 12·6V DC supply is provided by BR2, C8, RG1, C9 & C10, from a 15V AC winding of T1. Designed for 12V, the output of RG1 is raised to 12·6V by inserting diode D1 in its common (0V) connection. This supply is self-contained and electrically isolated from the others, meant to behave, as far as is possible, like a noise-free battery connected to the phono module only. More details about this will emerge later on.

WARNING! Before proceeding with any kind of work on this circuit, take heed – high voltages **CAN KILL!** NEVER touch any high-voltage part of the circuit with either fingers or uninsulated tools unless the power is OFF! While power is on, you should only touch any part of a circuit with an insulated test probe when required. Every time you switch off, adopt the following industrial safety procedure, known by the acronym 'SIDE', which spells out the following steps:

SWITCH OFF – Switch off the main PSU front panel rocker switch, and switch off at the mains outlet wall socket.
ISOLATE – Pull the mains lead out of the mains inlet socket at the back of the PSU.
DISCHARGE – Discharge the main line HT reservoir capacitor to zero volts (**NOT** with a screwdriver!).
EARTH – Earth the main line HT to chassis 0V with a leakage resistor to prevent any electrolytics recovering a charge from their own dielectric absorption.

In the design of the PSU 'discharging' and 'earthing' is automatically taken care of by R2 in the PSU circuit. Please note that it may take the resistor up to one minute to completely discharge the unloaded HT to 0V. To make doubly sure, you **MUST** test the main line HT with a multimeter set to high DC volts before touching any part of any circuit. This shall hereon be referred to as 'the SIDE procedure'. **DON'T CUT CORNERS!**

PSU Construction

More detailed instructions are provided in the leaflet (XV10L), the PCB is assembled with reference to Figure 2, the PCB legend Figure 2 and the Parts List.

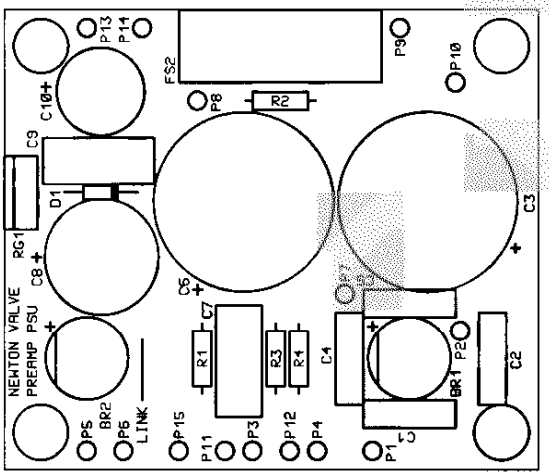
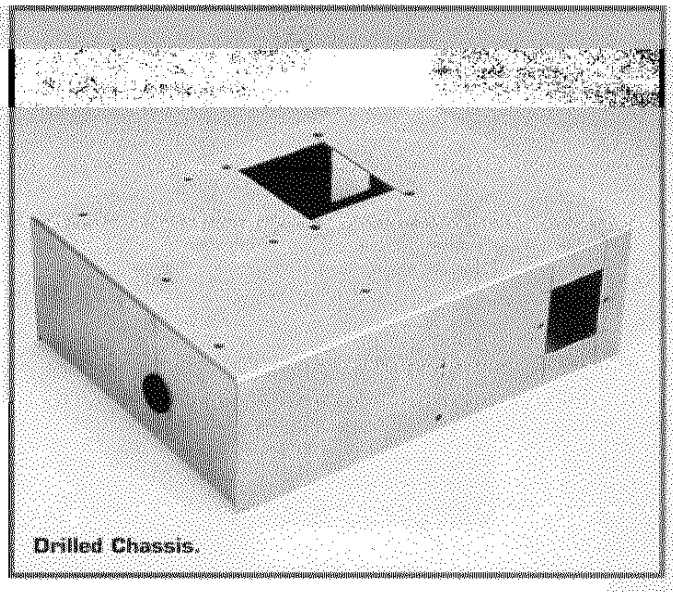


Figure 2. PSU PCB legend.



Drilled Chassis.

Regulator IC RG1 is a type having a plastic mounting tab instead of a metal one. This will make assembly into the chassis much easier as there is no need for a mica insulating kit. While the metal tab would be at earth potential if it were used, and not need an insulating kit anyway, for the reasons discussed earlier the DC heater supply must remain electrically isolated from the chassis. This is mentioned in case you were thinking of substituting RG1 with a different device.

Double-check the PCB for the quality of solder joints and correct orientation of components. Once the PCB is installed in the chassis it will be quite awkward to remove again to correct errors! The PCB includes a solder resist on the track side. After removing flux with a PCB cleaner, track side solder joints should be covered with a conformal coating to help the solder resist prevent creepage, or tracking, between points of high potential difference. Some areas are at the full HT line potential.

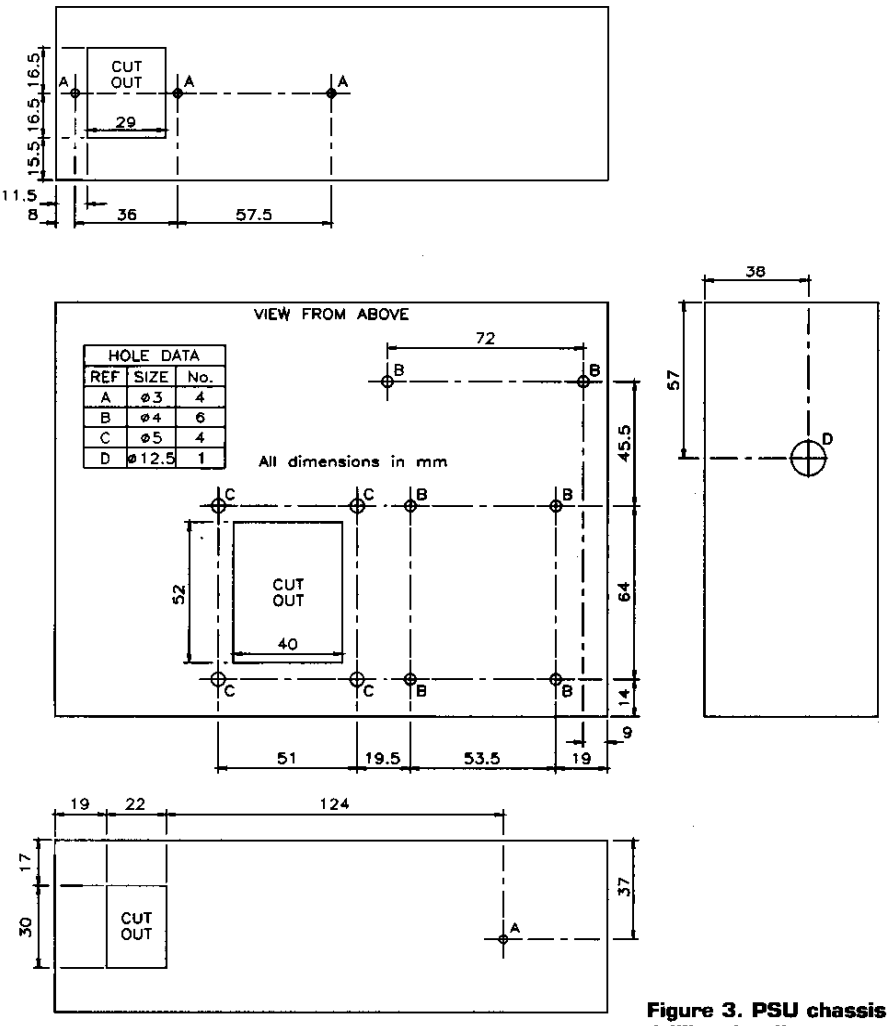


Figure 3. PSU chassis drilling details.

Preparing the Chassis

Cutting and drilling details are given in Figure 3. All holes are made in the main body of the 8 × 6 in. aluminium chassis; the removable lid will become the bottom, not the top!

Assembling the Chassis

With all holes prepared, begin by mounting T1 with reference to Figure 4. To comply with Class 1 requirements for mains powered equipment, we must ensure that the top cover of T1 is satisfactorily earthed to the chassis metalwork on fitting. It is not sufficient to rely on a metal-to-metal contact. One bolt should have its fibre washer replaced with an M5 shakeproof washer. Also place the rectangular steel frame over the lower side of the former, carefully manoeuvring it over the solder tags, until it seats onto the core.

Supporting the chassis on its side with T1 *in situ* (don't let it move!), place three of the fibre washers, plain washers, shakeproof washers and nuts (supplied in a plastic bag with the transformer) only onto those bolts also having fibre washers at the top, and tighten lightly. For the bolt having the shakeproof washer at the top, replace its fibre and plain washers, then add the M5 solder-tag washer beneath the shakeproof washer and nut. This should be one of the two bolts near the centre of the chassis. Eventually an earth strap will connect this to the chassis; by having shakeproof washers at the top and bottom, this bolt will ensure that the top cover is electrically earthed.

This done, install the mains rocker switch by pressing it into its rectangular cut-out (all terminals orientated towards what will be the

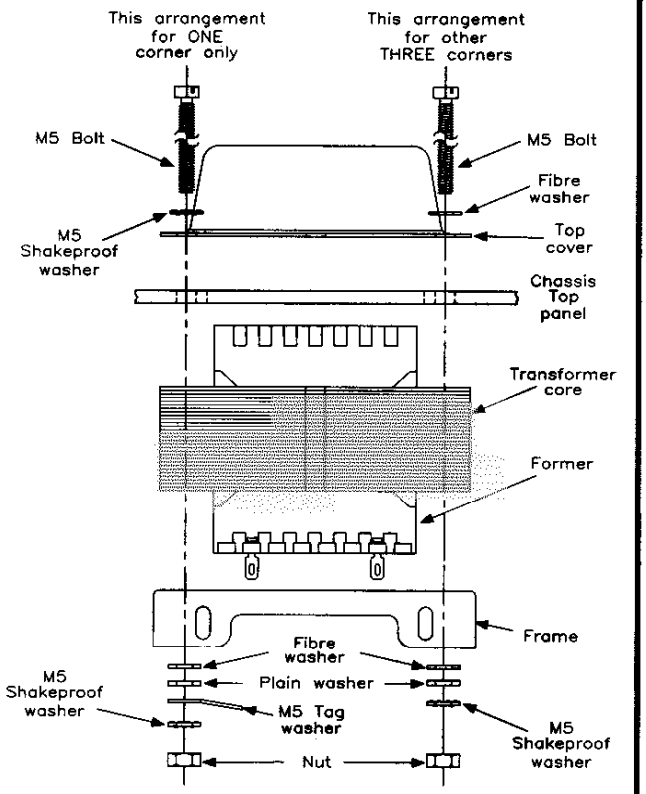
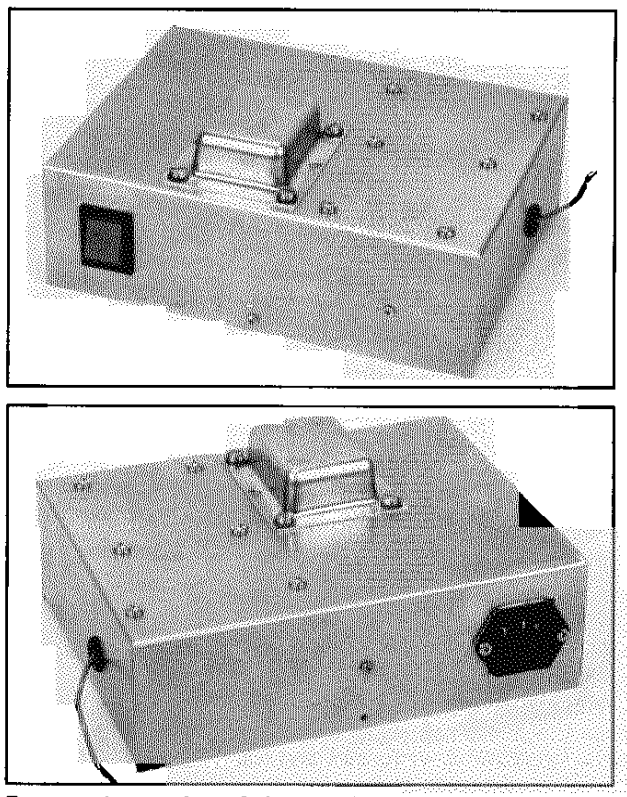


Figure 4. Mounting the mains transformer.



Front and rear view of the completed Newton Preamplifier PSU.

top of the chassis) then the fused Euro mains inlet socket at the rear (fuse tray towards what will be the bottom of the chassis). Secure in place with two M3 × 10mm bolts, shakeproof washers and nuts.

Mount the four M4 × 14mm threaded spacers to the inside of the chassis if not already in place, using the two M4 × 10mm screws through the top panel.

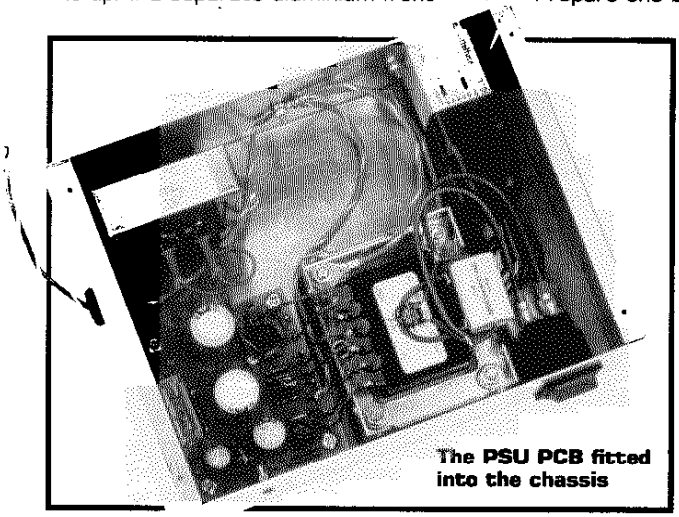
Mount the choke to the rear corner of the top panel using M4 × 10mm bolts, shakeproof washers and nuts as in Figure 5. The finished PCB can be installed onto its four mounting pillars. In so doing, carefully bend out the leads of RG1 so that it is flat against the inside of the front panel. Its fixing hole should be lined up with the M3 clearance hole drilled in the front panel; if this is not possible file out or re-drill the chassis hole until they do line up. If a separate aluminium front panel is fitted, this should be drilled at this position accurately. RG1 is retained with a countersunk M3 screw, shakeproof washer and nut; the separately fitted front panel should have a countersunk hole such that the screw head is flush with the surface. Thereafter it can be hidden with filler and paint or a stick-on front panel label. DO NOT over-tighten! The PCB is secured with four M4 × 6mm bolts to the pillars.

Mains Wiring

Complete the mains side wiring with reference to Figure 9a. Prepare a 23cm length of green/yellow power connection wire with a 1/4in. push-on connector crimped on one stripped end (no insulating sleeve required), and push the connector onto the 1/4in. earth terminal of SK1.

Prepare one blue and one brown 15cm length of power wire with insulated 1/4in. push-on connectors at each end, and include the insulating boot for SK1. Prepare a further blue and brown pair, 12cm long, with insulated connectors at one end of each only.

Referring to Figure 9a, connect the Live and Neutral terminals of the Euro mains inlet socket SK1 with the lower (as you see them from the bottom of the chassis) Live and Neutral terminals of the rocker switch SW1 (not the central pair), using the brown and blue 15cm leads. Also push the green/yellow earth lead from the earth terminal of SK1 through the boot, and cover all connections of SK1 with the boot. The boot should be stretched over the rear end of the metal body of SK1, and may need persuading with a thin-bladed screwdriver or similar, and perhaps a little lubricant. (It may be a good idea to press the boot onto SK1



The PSU PCB fitted into the chassis

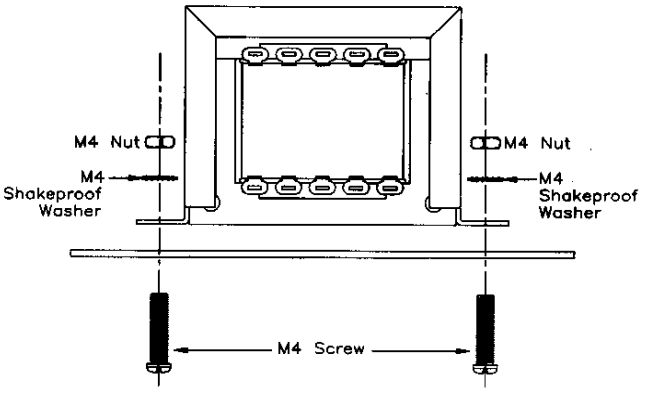


Figure 5. Mounting the choke on the chassis.

as soon as you receive the kit to 'train' it into the right shape before final assembly.) Likewise connect the brown and blue 12cm leads to the central terminals of SW1.

Transformer Primary Connections

The primaries of T1 are wired according to the country of use, that is for UK/European or USA/North American operation:

- For UK/European use, join the centre two primary tags on T1 with a single short length of power wire, as shown in Figure 6a.
- For USA/North American use, connect the primaries in parallel using two short lengths of power wire as in Figure 6b.

Simultaneously hardwire the yellow 220nF polypropylene capacitor C11, with the transient suppressor TS1, across the outer pair of primary tags, locating them as shown in Figure 9a (or Figure 9b). Both should have their leads sleeved with insulation stripped from power connection wire:

- For use in the UK/Europe, TS1 should be the 250V type.
  For use in the USA/North America, TS1 should be the 130V type.

Strip and solder the loose ends of the 12cm leads from SW1 to the same outer mains primary solder tags of T1; trim lengths to suit.

Earth Wiring

Solder an M3 solder-tag washer to the loose end of the green/yellow wire from SK1. Prepare 18 and 6cm lengths of green/yellow power wire with M3 solder-tag washers at one end only. Prepare a 20cm length of green/yellow power wire with M3 solder-tag washers at both ends.

Connect all four wires to the common earthing point on the rear panel using an M3 × 10mm bolt and nut. Two shakeproof washers should be situated on either side of the stack of four solder tags, that is at the chassis surface and beneath the nut. The 'free' earthing strap is to connect the PSU and the preamplifier chassis together electrically via the interconnecting grommet when they are joined, and is attached to each via dedicated fixings, using M3 × 10mm bolts, shakeproof washers and nuts at each tag washer.

Finally install the fuse F1 into the fuseholder tray of SK1 (the tray is released by squeezing the clips at either side), the value of which is according to the country of use:

- For UK/European use, fit the F500mA ceramic fuse.
- For USA/North American use, fit the F1A ceramic fuse.

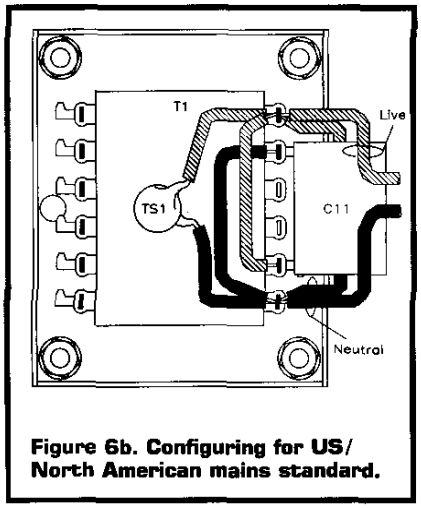
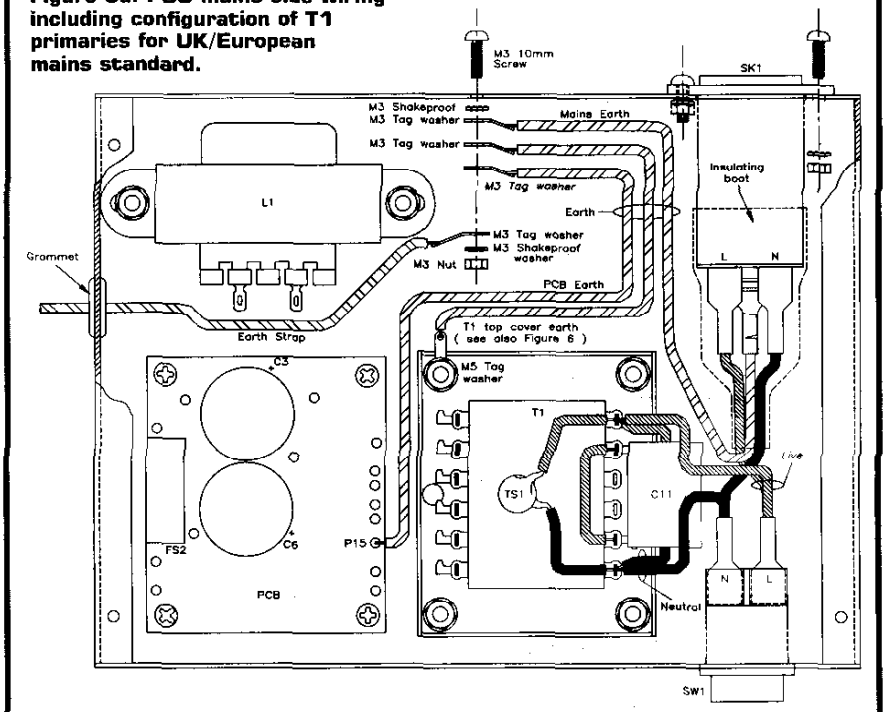


Figure 6b. Configuring for US/ North American mains standard.

Figure 6a. PSU mains side wiring including configuration of T1 primaries for UK/European mains standard.



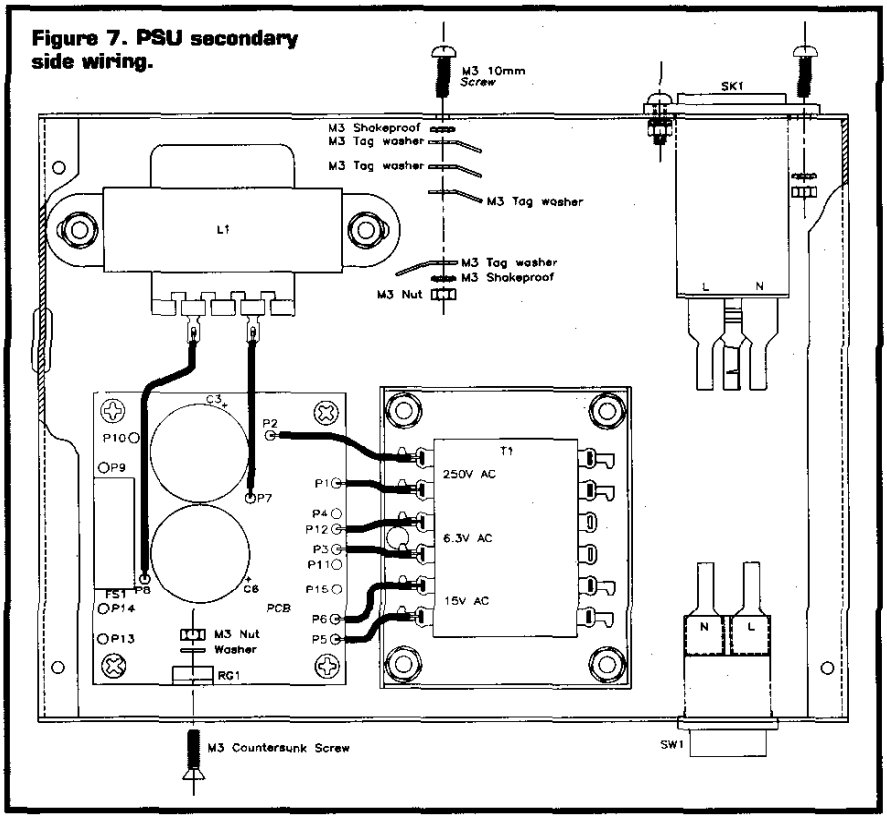
Secondary Side Wiring

Referring to Figure 7, connect six lengths of brown, stranded hook-up wire to the secondary tags of T1 (approximately 4cm long). Cover each tag with a 1/2in. length of red, heat-resistant sleeving. Connect to the PCB as follows: the 15V pair to P5 & P6; 6·3V pair to P3 & P4; 250V pair to P1 & P2.

Connect the choke tags to P7 & P8 with brown hook-up wire, with heat-

Continued on page 71.

Figure 7. PSU secondary side wiring.



NEWTON STEREO VALVE PREAMPLIFIER PSU – *Continued from page 69.*

resistant sleeving over the choke solder tags. With this the PSU is complete.

Testing The PSU

With the chassis still upside down and the bottom cover off, plug a Euro mains lead into SK1, switch on at the mains socket and switch on the front panel rocker SW1. The red neon lamp should light and the transformer may be heard to hum slightly.

Set a multimeter to its highest (i.e., 500 to 1000V) AC voltage range, and with insulated probes check for 250V AC (approximately) at T1 secondary output pins P1, P2 on the PCB. Remove probes. Switch to 10V AC range or equivalent, and check heater supply output across pins P11 & P12, it should be 6·3V between both pins, and 3·15V between either and the common earth '0VE' P10 on the PCB.

Switch to a high DC volts range (500 to 1000V), and test the main line HT output against '0VE' (black probe to P10, red probe to P9). It should be approximately 350V DC. (In use the HT level is reduced, due to internal winding resistance in the T1 HT secondary, to approximately 300V.) Remove probes.

Switch off at the front panel. Stand by with the multimeter probes and recheck the HT level. It should be falling; this proves that the safety discharge resistor R2 is working. If you need to sort out a problem, carry out the complete SIDE procedure BEFORE TOUCHING ANYTHING! It will take nearly a minute for the HT to completely discharge, in the absence of any other load.

If all is well after the above tests, switch off at the mains socket and remove the mains lead. Apply both the Mains Warning and High Voltage Warning labels to the bottom cover, and temporarily fit it to the chassis with four of the self-tapping screws.

NEWTON VALVE PREAMP PSU PARTS LIST

RESISTORS All 0·6W 1% Metal Film			
R1	100Ω	1	(M100R)
R2	470k	1	(M470K)
R3,4	150Ω	2	(M150R)
CAPACITORS			
C1,2,3,4	High Voltage Disc Ceramic 10nF 500V	4	(BX15R)
C5,6	Radial Electrolytic 47µF 50V	2	(JL18U)
C7,9	Mylar Film 220nF	2	(WW83E)
C8	Radial Electrolytic 1000µF 35V	1	(FF18U)
C10	Radial Electrolytic 470µF 35V	1	(FF16S)
C11	Polypropylene 220nF 1000V (Class X/Y)	1	(FA22Y)
SEMICONDUCTORS			
D1	BAX16	1	(QB29G)
RG1	L7812CP	1	(QR16S)
BR1,2	W04	2	(QL40T)
MISCELLANEOUS			
TS1	Transient Suppressor 250V AC	1	(HW13P)
TS1	Transient Suppressor 130V AC	1	(CP75S)
L1	10H 100mA Choke	1	(ST28F)
T1	115V/230V to 350V/15V/6·3V Transformer	1	(ST29G)
FS1	F500mA 20mm Ceramic Fuse	1 Pkt	(DA05F)
FS1	F1A 20mm Ceramic Fuse	1 Pkt	(DA06G)
FS2	F100mA 20mm Glass Fuse	1	(WR00A)
	PCB Fuseholder and Cover	1	(KU29G)
S1	Dual Red Neon Rocker Switch	1	(YR70M)
SK1	Fused Inlet/Filter	1	(KR99H)
	Cover For Fused Inlet/Filter	1	(JK67X)
	Aluminium Chassis AC86	1	(XB68Y)
	¼in. Push-on Receptacle	1 Pkt	(HF10L)
	¼in. Push-on Receptacle Covers	1 Pkt	(FE65V)
	9·5mm Grommet	1 Pkt	(JX63T)
	Mains Warning Label	1	(WH48C)
	HV Warning Label	1	(DM55K)
	6A Green/Yellow Wire	1m	(XR38R)
	6A Brown Wire	1m	(XR34M)
	6A Blue Wire	1m	(XR33L)
	1·4A Brown Wire (10m)	1 Pk	(BL02C)
	Red Heat-Resistant Sleeving	1m	(BL70M)
	Single Ended 1mm PCB Pin	1 Pkt	(FL24B)
	M3 x 10mm Steel Bolt	1 Pkt	(JY22Y)
	M3 x 10mm Countersunk Bolt	1 Pkt	(LR57M)
	M3 Steel Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M4 Steel Nut	1 Pkt	(JD60Q)
	M4 x 10mm Steel Bolt	1 Pkt	(JY14Q)
	M4 x 6mm Steel Bolt	1 Pkt	(JY13P)
	M4 x 14mm Threaded Spacer	1 Pkt	(FG39N)
	M5 Solder Tag	1 Pkt	(LR62S)
	M3 Solder Tag	1 Pkt	(LR64U)
	M4 Shakeproof Washer	1 Pkt	(BF43W)
	PCB	1	(GH98G)
	Instruction Leaflet	1	(XV10L)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	Euro Outlet	As Req.	(HL42V)
	Insulating Cover for Euro Outlet	As Req.	(JK68A)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as kits, which offers a saving over buying the parts separately.

Order As LT75S (Newton PSU Kit)
Price £44.99B4

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1995 Maplin Catalogue.

Newton PSU PCB **Order As GH98G Price £2.49**
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