# NEWTON STEREO VALVE PREAMPLIFIER

## PART:1

# RIAA Phono Module

**Design by Mike Holmes and John Mosely**
**Text by Mike Holmes**

It was only logical that the 'Millennium 4-20' 20W power amplifier should eventually be followed by an audio preamplifier to partner it. It should be noted, however, that the 'Newton' need not be restricted to serving the 'Millennium' alone, and it is easily capable of filling in as the front end for other power amplifiers, valve types or otherwise.

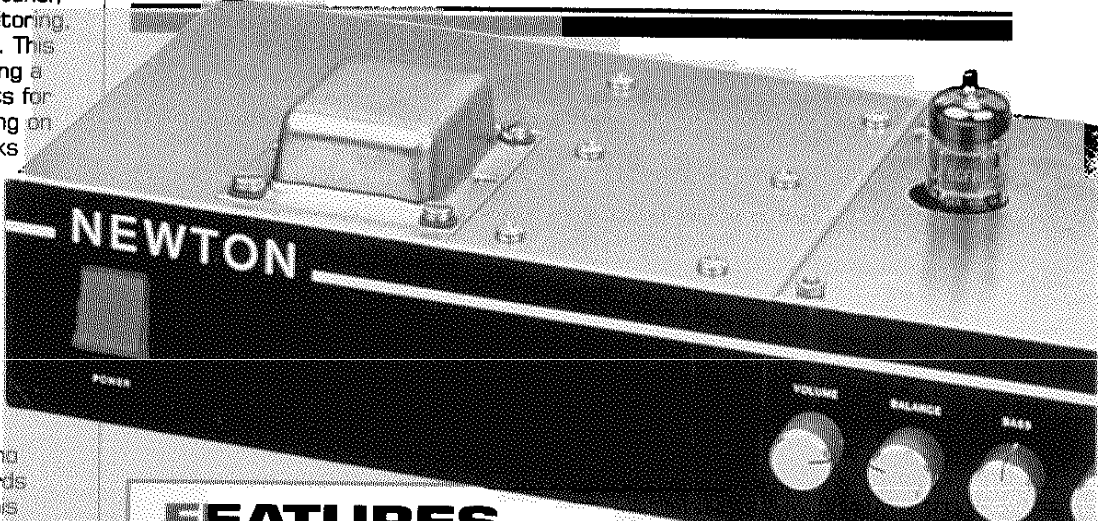
In addition, it is often necessary for a stereo preamplifier to cater for many other items of equipment to be connected to it, and simultaneously be able to provide line level outputs to tape recorders and receive other signal sources, such as from a tuner, CD, etc., even for off-tape monitoring, via multi-way selector switches. This versatility can extend to providing a number of auxiliary mains outlets for the other equipment, thus saving on the number of multiple plugblocks required.

How many of these facilities you feel you need is entirely up to you, the constructor, hence, of the three modules in total, only the power supply unit is described in any great detail as to its construction, to ensure that it is safe to use according to mains power and earthing regulations.

Proponents of 'minimalism' who will just want to play their records through valves won't want all this paraphernalia (even less so the tone control module, or so I am assured). If, however, you are the sort whose idea of a decent preamplifier unit is a glorified switch-box – for the best of all reasons of course, that is, that you have lots of other sound sources to plug into it – there still has to be some sort of electronics at the heart of it.

## System Overview

The Phono Module, along with the Tone Control Module, provides the basic electronics. It is difficult (and, in my opinion, not right) for us to dictate precisely how you should build a 'good' stereo preamplifier. Only you will know what is 'good' for you. Only you know how many and what sort of switches you want, what style of knobs, etc., and the size and shape of the thing. Therefore we have tried, as far as




## FEATURES

* ✱ Simple PCB construction
* ✱ Compact stereo module
* ✱ Versatile connection options
* ✱ Onboard low-impedance line driver
* ✱ Passive RIAA equalisation
* ✱ High output
* ✱ Wide dynamic range

**KIT AVAILABLE (LT76H) PRICE £34.99A1**

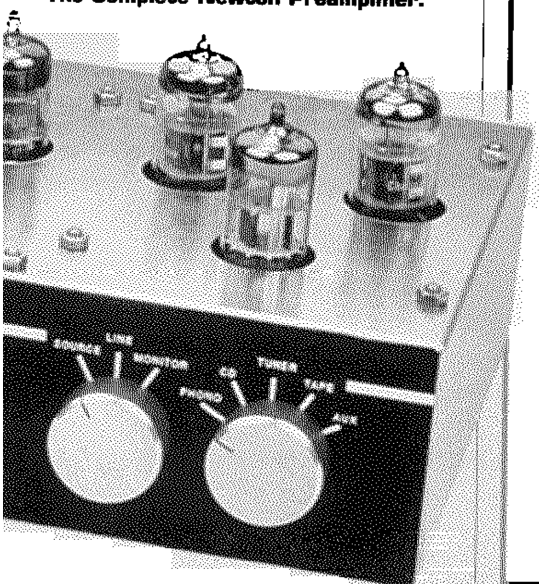
**4 PROJECT RATING**

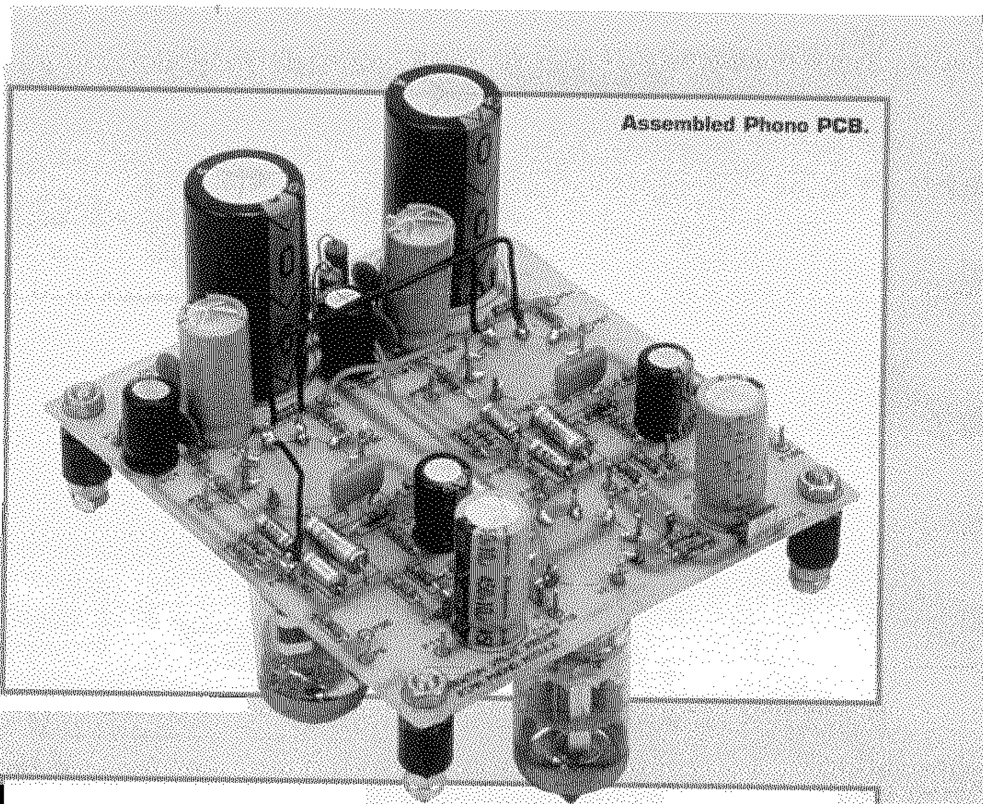
possible, to make the modules as universal as is practicable; in fact you can look on them as virtual 'Data File' type modules, where the choice and number of external connections are entirely at the whim of the user. (Having said that, however, some suggestions will be illustrated in Part 3.)

A word of warning before you start, though. In this case, the active electronic elements are valves, and as with all valves this involves the use of lethally high supply voltages. Consequently, as you design your ideal preamplifier as a complete system, that will do all you want it to, incorporate the following guidelines:

- YOU MUST only use the recommended power supply unit and build it absolutely 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.

**The Complete Newton Preamplifier.**





**Assembled Phono PCB.**

## Specification of the complete system

**Phono stage**

| | |
|---|---|
| Input impedance: | 51kΩ + 330pF* |
| Line output impedance: | 1kΩ |
| Overall gain, phono to line: | 48dB @ 1kHz |
| Line output level: | 1 to 2V peak (2·5mV @ 1kHz for 5cm/s) |
| Signal to noise ratio: | 40 to 60dB (depending on cartridge) |
| RIAA equalisation network type: | Passive optimised |

* Select values to match the requirements of the cartridge used.

**Tone control stage**

| | |
|---|---|
| Line input impedance: | 1MΩ |
| Main output (to power amp) impedance: | <10kΩ |
| Overall gain: | 6dB flat |
| Frequency response: | 20Hz to 20kHz ±0·5dB, −2dB @ 100kHz |
| Output noise: | <200μV peak max. |
| Signal to noise ratio: | 60dB for 100mV input level |
| Line input signal level: | 0dB typical |
| Maximum permissible input level before onset of clipping: | 6V Pk-to-Pk |
| Bass boost and cut: | +16dB and −12dB @ 20Hz max. |
| Treble boost and cut: | +18dB and −19dB @ 20kHz max. |
| Balance offset boost: | +3dB max. |
| Tone control network type: | Passive Baxandall |
| Power supply: | 230 to 240V @ 50Hz or 115 to 120V @ 60Hz |
| Power consumption: | 30W approx. |

- 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 EXPERIENCE OF THIS, otherwise always use the ready-made PCB that includes a solder resist layer as an aid to insulation and user safety.

Outside these constraints, what type of signal connectors you use and precisely what you connect to the signal inputs and outputs and how you wire them up is up to you – although it would be prudent to use good quality screened cable for all inputs.

The three basic modules consist of a complete Power Supply Unit, the self-contained RIAA equalised Phono Preamplifier PCB, and similarly a Tone Control PCB, the latter is described in Part 3. Each is available as a separate kit, where the PSU and the Phono Module each includes a suitable aluminium chassis. Figure 1 is a block diagram of the complete system using the three modules. The interconnections and switching arrangements shown here only serve to show what is possible. You may not, for example, want the line functions, but prefer more inputs from the selector, or you could do without the Tone Control Module.

## RIAA Phono Preamplifier Module

During the latter decade of the valve era, while many power amplifier circuit designs were circulating amongst the DIY fraternity, there were comparatively few front-end preamplifier circuits. It seems, however, that a popular choice for home constructors was the so-called Mullard 'two-valve' and 'three-valve' designs. When we eventually examined

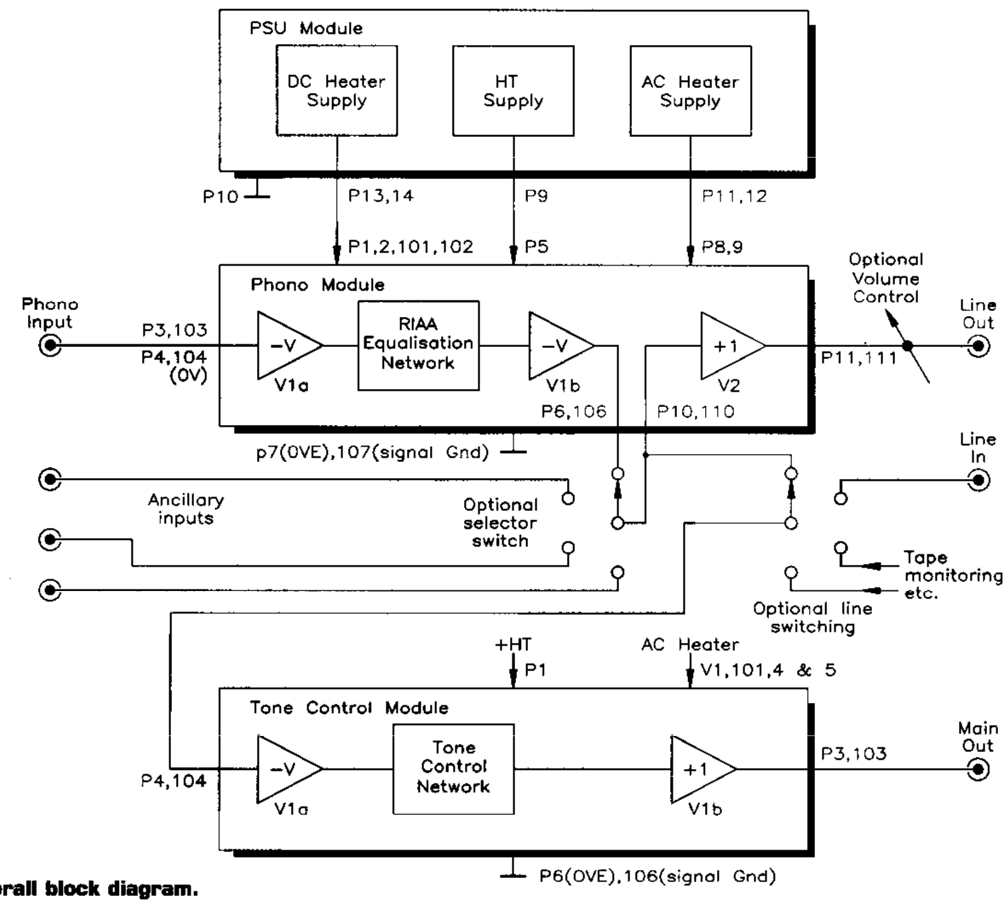



**Figure 1. Overall block diagram.**

the Mullard 'two-valve' in detail, it has to be said that we were singularly unimpressed with it. It was, I suspect, derived from a commercial design and as such is heavily compromised to cut production costs to a minimum. Consequently it has daft elements to it, such as the tape outlet that is merely tapped off an anode load, providing a low level signal intended for sending down a screened lead, but effectively in series with a 100kΩ resistor?

Really, though, the only phono equalised designs truly worth bothering with are dedicated ones, be they solid state or valve. So the search was on for an RIAA equalised preamp design and it turned up in the form of an RCA circuit. It also incorporated the passive RIAA equalisation network, which we wanted to compare with the now universal integral NFB type found in solid state designs. The Phono Module's specification is listed in Table 1.

| | |
|---|---|
| Test conditions | |
| Input signal level: | 2·5mV peak, 1kHz |
| Input source impedance: | 600Ω via 1·5m screened lead |
| HT supply: | 300V + 100mV ripple @ 100Hz |
| Input impedance: | 51kΩ + 330pF* |
| Buffered output impedance (using V2): | <1kΩ |
| Overall gain: | 48dB @ 1kHz |
| Output levels, with simulated magnetic cartridge input | |
| #1: moving coil, = 2·5mV @ 1kHz | 630mV |
| Signal to noise ratio: | >39dB |
| #2: moving magnet, = 5·5mV @ 1kHz | 1·5V |
| Signal to noise ratio: | >43dB |
| Real conditions (example = Tenorel TMC10 moving coil cartridge, O/P = 2·5mV @ 1kHz for 5cm/s) | |
| Output level in use: | 2V peak |
| Signal to noise ratio: | >52dB (nearer 60dB) |
| V1a & b triode stage gain: | 34dB each |
| Equalisation network type: | Passive RIAA standard |
| Power requirements: | |
| HT supply: | 300 to 350V DC |
| HT current consumption: | 15mA incl. buffer |
| Heater supply #1: | 12·6V DC @ 300mA** |
| Heater supply #2: | 6·3V AC @ 300mA |

* Select values to match the requirements of the cartridge used.
** DC heater must be regulated and one side connected to signal I/P 0V near V1.

**Table 1. RIAA Phono Module Specification.**

## Circuit Description

It can be seen in Figure 1 that the phono module also includes a unity gain line driver or buffer. This is necessary even if the phono module is intended to be used on its own, to provide sufficient output driving capability for interconnecting screened output leads with possibly a fairly low terminating impedance at the other end. Other elements can be interposed between the phono preamp proper and the line driver, such as a source selector switch, and if desired a volume or level control can be added across the driver's output.

Figure 2 shows one complete channel only of both the phono preamplifier and the line driver; all that is shown here is contained on the PCB. The other channel is identical, and they share only the few supply filtering components. The PCB is approximately 4sq.in. square yet carries all three valve envelopes and

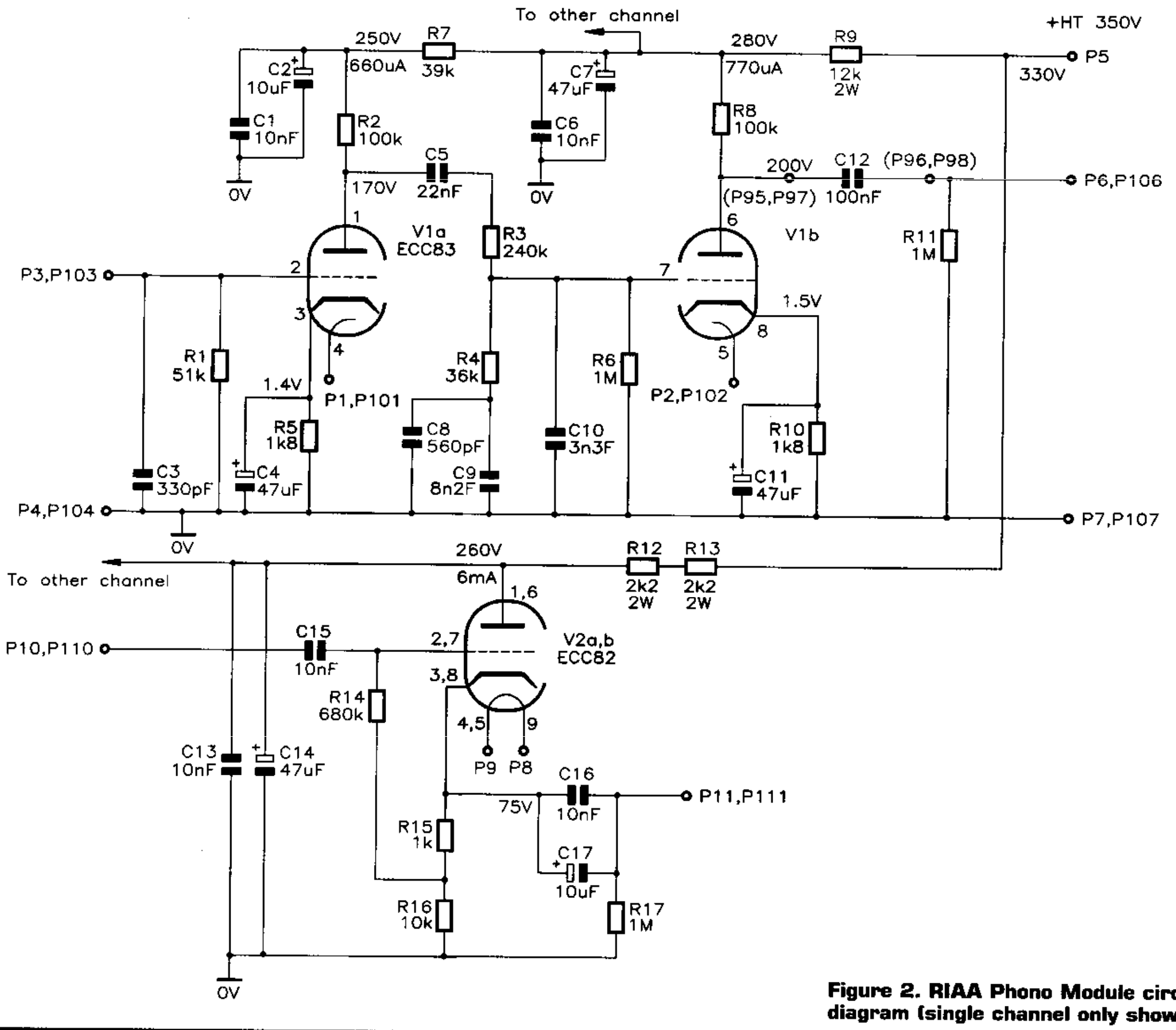



**Figure 2. RIAA Phono Module circuit diagram (single channel only shown).**

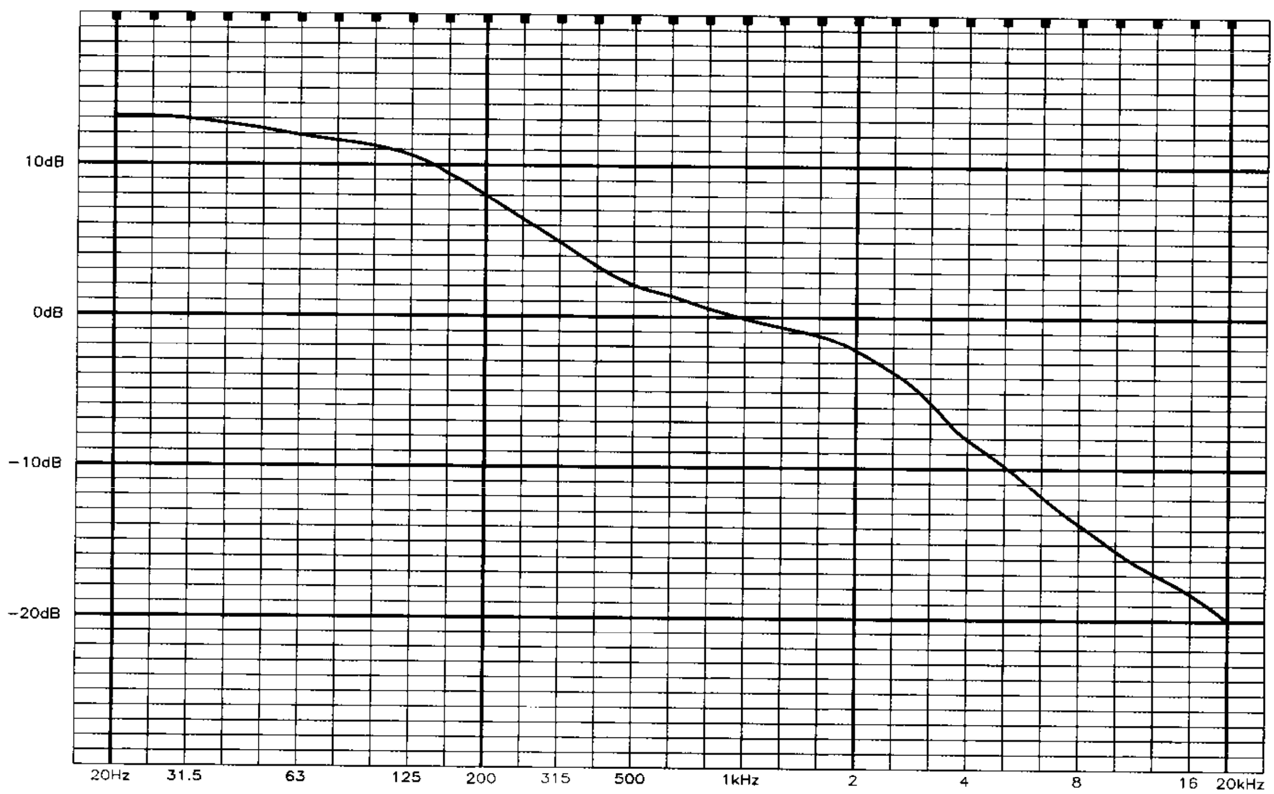



**Figure 3. Phono Module RIAA response graph.**

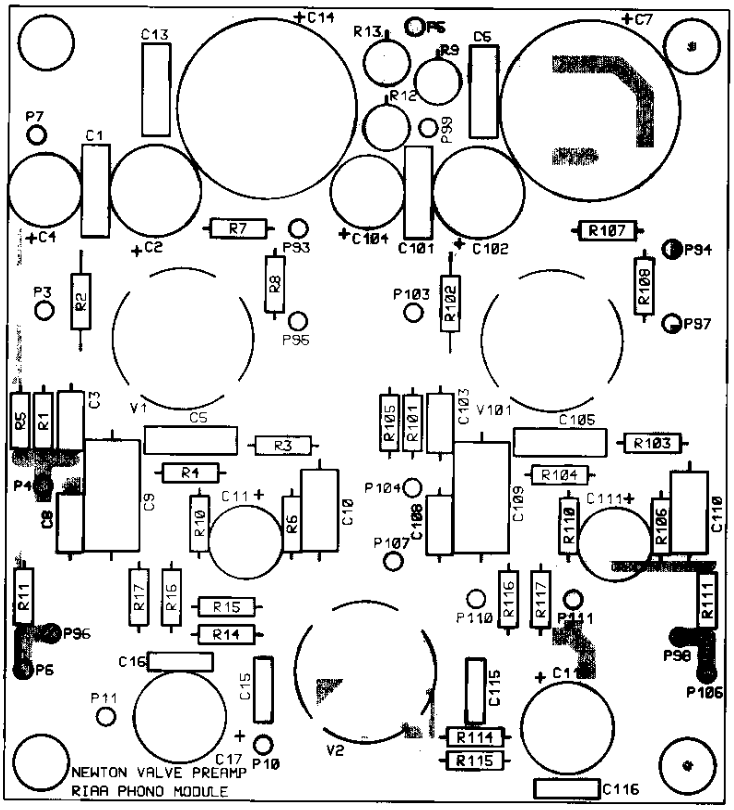



**Figure 4. Phono Module PCB Legend.**

**RIAA Phono Module**

| **Pin No.** | **Function** | **Channel** |
|---|---|---|
| (P1) | V1 pin 4, DC heater (–), link to P4 | Left |
| (P2) | V1 pin 5, DC heater (+) | Left |
| P3 | Phono signal input | Left |
| P4 | Phono input screen 0V | Left |
| P5 | +HT supply | Common |
| P6 | RIAA phono output | Left |
| P7 | supply 0VE from earth bus (PSU) | Common |
| (P8) | V2 pin 9 AC heater #1 | Common |
| (P9) | V2 pins 4,5 AC heater #2 | Common |
| P10 | Line buffer signal input | Left |
| P11 | Line buffer output | Left |
| (P101) | V1 pin 4, DC heater (–) | Right |
| (P102) | V1 pin 5, DC heater (+) | Right |
| P103 | Phono signal input | Right |
| P104 | Phono input screen 0V | Right |
| P106 | RIAA phono output | Right |
| P107 | signal 0V for phono outputs & buffer | Common |
| P110 | Line buffer signal input | Right |
| P111 | Line buffer output | Right |
| P93 | HT source for V1 stage via Link 1 | Left |
| P94 | V1 stage HT via Link 1 | Left |
| P95 | V1 pin 6 to C12 | Left |
| P96 | C12 to R11 and P6 (phono out) | Left |
| P97 | V101 pin 6 to C112 | Right |
| P98 | C112 to R111 and P106 (phono out) | Right |
| P99 | HT source for V2 stages via Link 2 | Common |

**Table 2. Phono Module PCB pin designations**

all the components directly associated with them. Each phono preamp circuit uses a complete ECC83 double triode valve, while the stereo line drivers share one common ECC82 double triode valve.

The following circuit description should help you understand better how the various stages of the module function, and aid any fault-finding or testing that you may need or want to carry out. The phono preamp comprises two identical triode amplifier stages in cascade. The RCA circuit naturally employed American valves. Here Mullard ECC83 small signal valves are used, and each stage is built with Mullard's recommended standard circuit configuration and component values. This ensures that the best possible performance is obtained from the valve and each stage has a signal gain of 34dB (voltage gain of 50 times).

The HT supply for the whole module connects to pin P5 on the PCB, while the common 0VE connects to P7. Supply decoupling for the stereo phono amplifier is provided by R9 and C7, with C6 helping to remove any high-frequency elements. This common point serves both stages V1b and V101b. Further supply decoupling is provided from here to the input stages, V1a and V101a, each of which has its own group R7, C2 and C1, and R107, C102 and C101, respectively.

HT is routed independently via R12 and R13 to decoupling capacitors C13 and C14, where it is shared by the two line drivers. It should be noted that this measure of supply decoupling is not only to remove any noise on the supply line from the PSU, but also to minimise crosstalk between the various stages and promote stable operation.

In addition a 6·3V AC heater supply is required for V2 (across valve pins 4+5 and 9), and 12·6V DC in parallel across V1 pins 4 and 5 and V101 pins 4 and 5. These are the six basic supply connections and come directly from the PSU module.

The signal from the magnetic pickup cartridge arrives at the phono input P3, 103 (and the earth return P4, 104), and is terminated by R1 and C3. It should be pointed out that the values of these two components as provided in the kit are arbitrary, based on those commonly quoted for cartridges of this type. To ensure a complete match to the specific cartridge that you intend to use you should install the values quoted in the cartridge's specifications. Due to the very high signal sensitivity in this area, using switches and extra components to change the impedance matching for different cartridges is not a good idea.

The 'raw' signal is then subjected to a flat gain of 34dB in the first stage of V1a, which directly sources the passive RIAA equalisation network. The actual network itself has been optimised for best results along similar lines to that first published in 1985 in *Wireless World* and since updated. (RCA's version is much simpler in comparison.) The frequency response contour of this network is illustrated in Figure 3. The network operates as a controlled low-pass filter comprising, in Figure 2, R3 in series with R4, C8, C9 and C10. These capacitors are high tolerance polystyrene types. The network is AC coupled to V1a anode by C5, a polyester type capacitor chosen for its 400V working range; one has to remember that until the valve warms up, the voltage level at its anode is actually the full unloaded HT level of 350V! Given the high impedance of the network, the apparently small value of 22nF is perfectly satisfactory.

The output of the network, at the junction of R3, R4 and C10, is taken directly to the signal grid of V1b. Resistor R6 provides the 'grid leak'

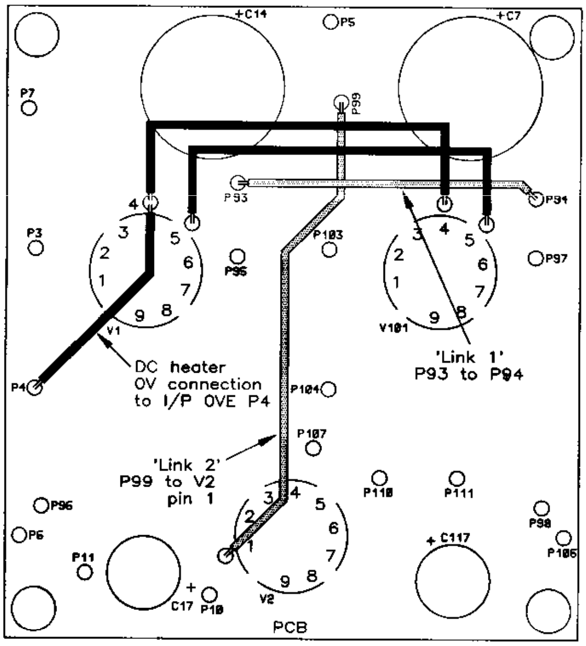



**Figure 5. Phono Module onboard HT and heater wiring.**

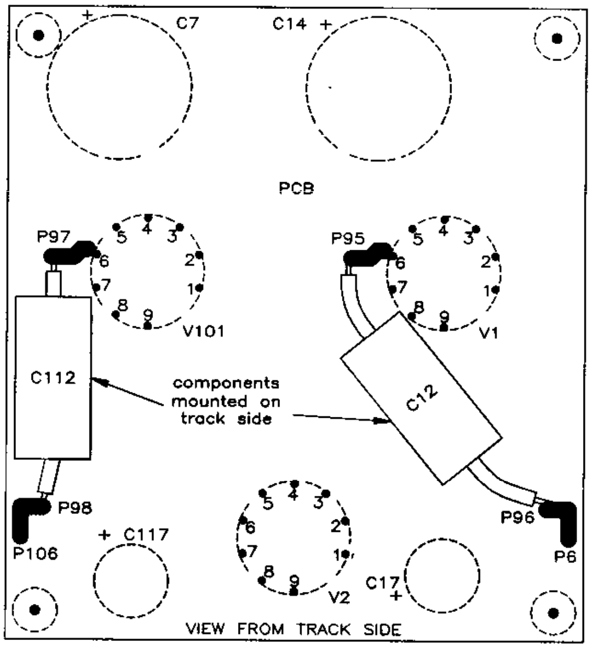



**Figure 6. Mounting C12 & C112 to the track side of the Phono PCB.**

or DC bias for the second triode and is at 0V potential. A value of 1MΩ ensures minimum loading of the network, yet provides a satisfactory grid bias for the valve.

At this point signal strength is quite reduced, a majority of the gain provided by V1a is lost in the network. A further 34dB of flat gain provided by V1b boosts this signal up to a much more satisfactory level for output. Overall, however, the amplifier is very efficient, producing approximately 2V – high enough to rival the output of the average CD player – from a signal supplied by a fairly low sensitivity moving coil cartridge. When one is accustomed to expecting 100 to 200mV from the solid state equivalents, this high level of output is quite extraordinary – try getting that from just two transistors!

The output is AC coupled from V1b anode with a 100nF polypropylene capacitor, having a very high insulation resistance and working voltage range, C12. Again this component has to handle maximum HT level until after warm-up. Its value allows the output to be loaded down to approximately 100kΩ with no loss in bass response. Resistor R11 ensures that the output side of C12 is referenced to 0V DC at all times. This is so that, if 'Phono' is chosen with a selector switch where previously it was not, the amplifier does not deliver a hefty pulse down the line to the rest of the system as C12 charges up!

## The Line Driver

Each half of V2 forms the active element of the line driver or buffer. An ECC82 double triode is used here which has a higher current capability than the ECC83, and is better suited to this role. The identical stages follow the unity gain, non-inverting cathode follower configuration, with cathode bias properly derived from a series resistor chain, R15 and 16. The bulk of the voltage drop, which allows a sizeable signal voltage swing, is across R16 and is derived from a healthy anode current of 7mA. This leaves R15 to develop the actual cathode bias of 7V, with the lower end communicated to the signal grid via the grid leak resistor R14.

The input impedance of the stage is not determined by the value of R14 alone. The action of the cathode following the signal grid results in an impedance multiplying effect for R14, so that instead of being 680kΩ the actual input impedance is neare to 10MΩ. The small value of the polycarbonate capacitor, C15, which AC couples the input, is more than ample for this and the line driver would be extremely useful for buffering signal sources having a very high output impedance.

This line driver is very simple yet very capable, having a flat frequency response to at least 100kHz and is able to drive loads down to 1kΩ before signal quality is seriously degraded. This allows a fair degree of 'fan-out' for sourcing more than one item of external equipment whilst coping with the core to screen capacitance of cables; it is certainly able to drive 1·5m or more of consumer quality screened lead with no discernible losses.

AC coupling at the output is via C17, a high-voltage electrolytic. Generally electrolytics of this type are not a good choice for an audio signal path, but a high value is necessary to ensure good bass response into a (comparatively) low impedance load. However, HF performance is assured by C16. Alternatively you might replace these with an equivalent value made up from audio grade polypropylene types, but these are very large and will have to be connected off the board with the space to accommodate them.

R17 serves the same function as R11. One concern here was the

HT+ = 330V
Junction of R9, C7 = 280V
Junction of R7, C2 and R107, C102 = 250V

| V1 Pin No. | Volts | V101 Pin No. | Volts | V2 Pin No. | Volts | |
|---|---|---|---|---|---|---|
| 1 | 170 | 1 | 170 | 1 | 260 | anode |
| 2 | 0 | 2 | 0 | 2 | 68* | signal grid |
| 3 | 1·4 | 3 | 1·4 | 3 | 75 | cathode |
| 6 | 200 | 6 | 200 | 6 | 260 | anode² |
| 7 | 0 | 7 | 0 | 7 | 68* | signal grid² |
| 8 | 1·5 | 8 | 1·5 | 8 | 75 | cathode² |

* = measure at junction of R15/16, R115/116, NOT at valve grid pin.

**Table 3. RIAA Phono Module Voltage Test Points.**

danger of inflicting any solid state circuits that are connected to the output of the buffer to high-voltage pulses on switching on or off. In practice though the transition is very slow, both at warm-up and switch-off, and peak deviations are rarely more than 2 or 3V.

**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 'earthing'and'discharging' 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!**

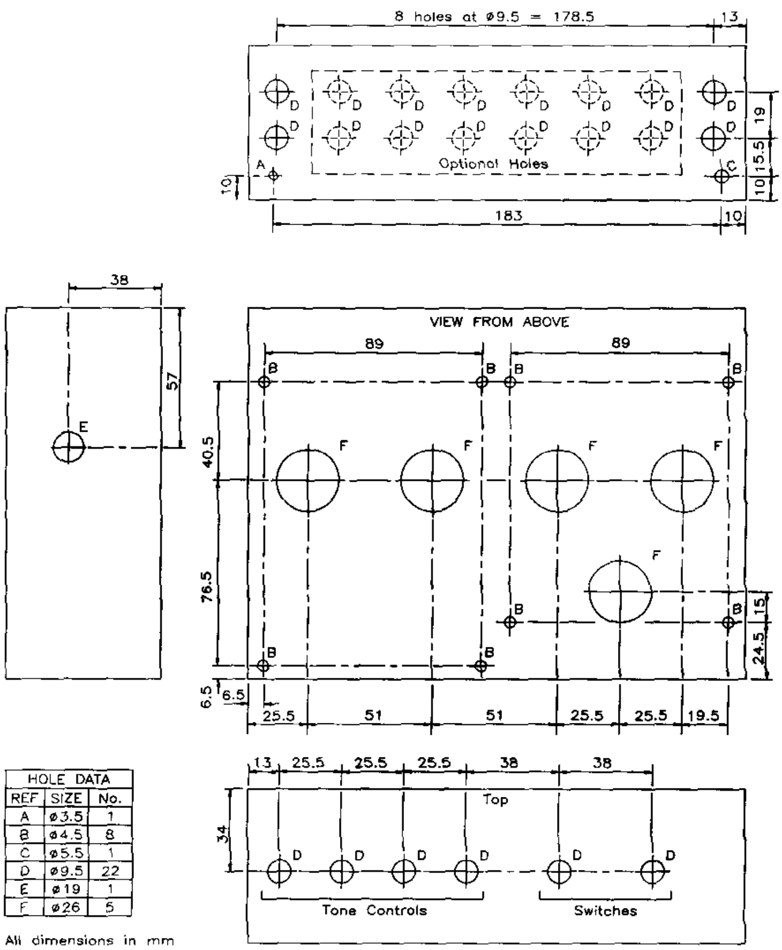
## Phono Module Construction

Refer to Figure 4 for the PCB legend. The PCB is a single-sided glass fibre type, and is strong enough to carry all the components including the valves in their holders. Note that it includes a solder resist layer on the track side, which will also help to minimise current 'creepage' across the surface between points of high potential difference when in use, for this reason the PCB track has not been shown.

Once the PCB has been assembled and tested, and is known to operate correctly and be ready for use, you are advised to apply conformal coating to the finished solder joints to augment this protection.

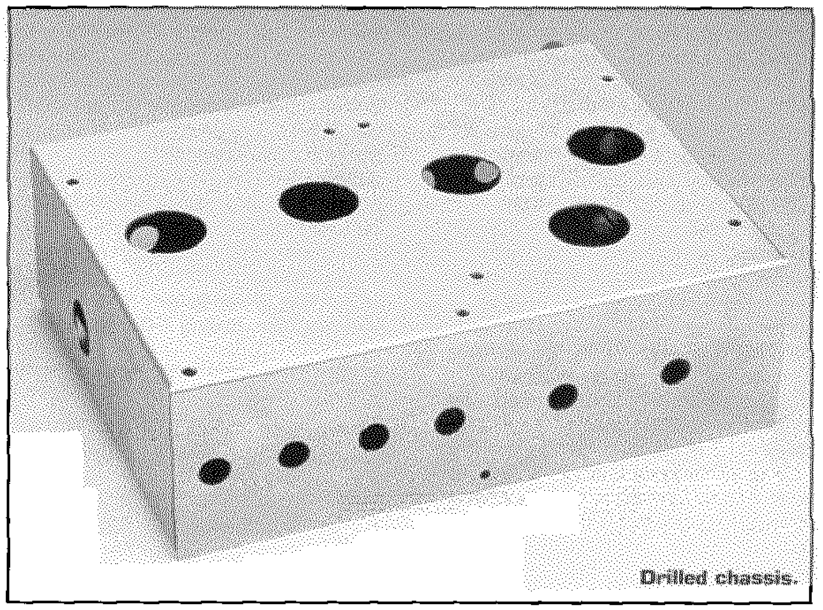
More detailed instructions are given in the leaflet (XV11M), but basically construction begins by inserting and soldering the 40 PCB pins at P3 to P7, P103 to P107, P10, P11, P110, P111, also at the three valve holder positions. In each case, insert and solder nine pins from the track side into the outer of the two concentric rings of holes for each valve holder; that with the smaller holes. Next, carefully insert the B9A valve holder into the board from the track side, into the inner ring (larger holes) until it is fully seated flat on the PCB. Each pin of the valve holder is then bound to its corresponding PCB pin with a turn of bared bell wire and soldered to it (c) don't be sparing with the solder).

Some 'spare' holes will be left over, P93 to P99. These do not have PCB pins. (Table 2 lists the functions of the various pins and links.)

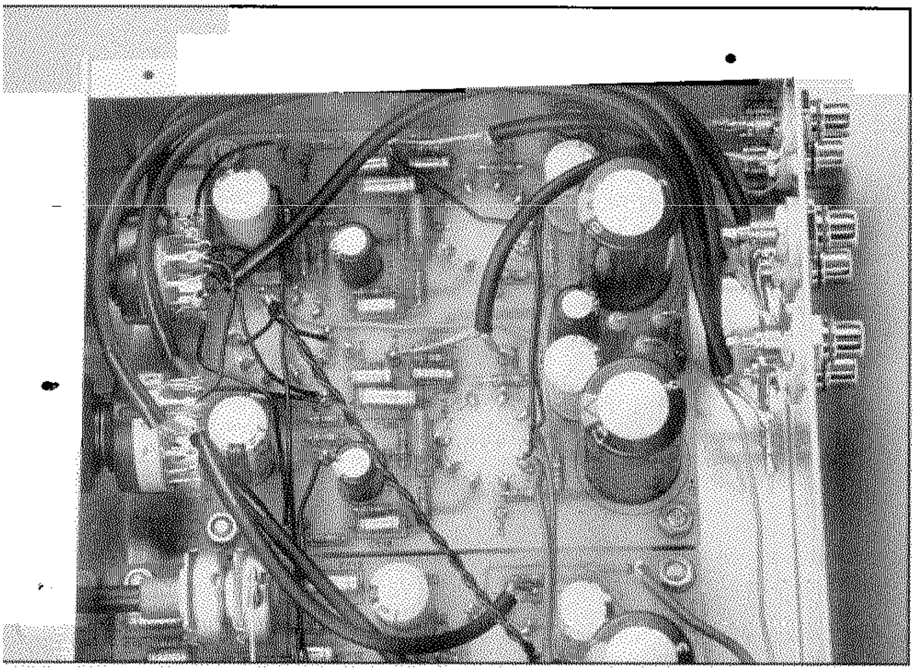



| HOLE DATA | | |
|---|---|---|
| REF | SIZE | No. |
| A | ø3.5 | 1 |
| B | ø4.5 | 8 |
| C | ø5.5 | 1 |
| D | ø9.5 | 22 |
| E | ø19 | 1 |
| F | ø26 | 5 |

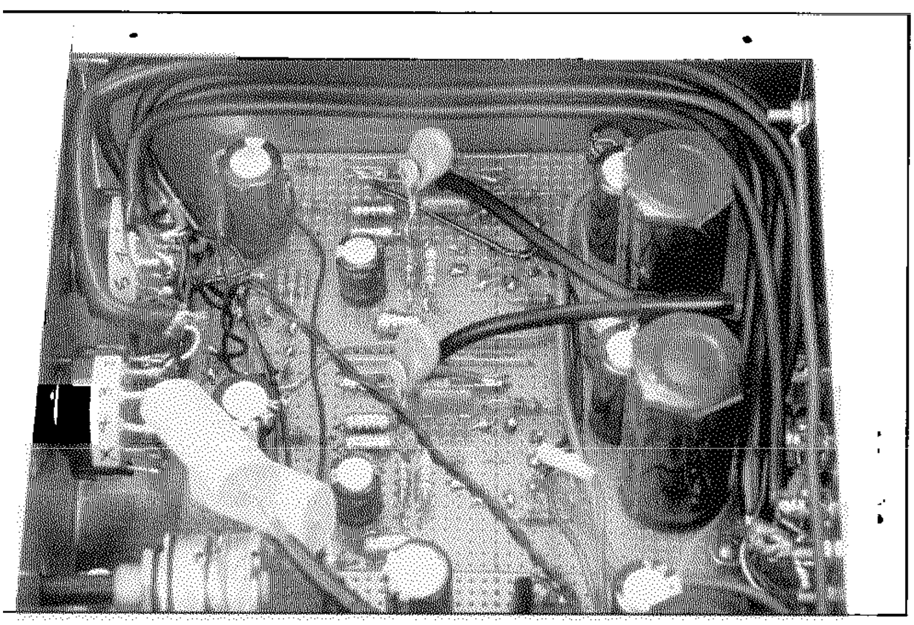
**Figure 7. Phono Module chassis drilling details.**



Drilled chassis.



**The Phono PCB fitted into the chassis.**



**The prototype Phono module fitted into the chassis.**

Components are installed by fitting the smallest first, working up to the largest. The 2W metal film resistors R9, R12 and R13 all stand on end to conserve space on the PCB and to aid cooling in use. For each, bend one lead to lay flat against the body of the resistor, and insert the component vertically orientating it to the PCB legend.

Using orange bell wire, link P99 (near R12) to V2 pin 1 near C15, as in Figure 5. Pin numbering for all the valves is clockwise as viewed from the component side of the board, and always with pin 9 at the bottom. The rings of PCB pins make all valve connections accessible, and the bell wire can be wrapped and soldered around that for V1 pin 1. This is 'Link 2' in Table 3.

Also link holes P93 and P94 with orange bell wire (Figure 15). With lengths of black bell wire, join V1 pin 4 to V101 pin 4, and V1 pin 5 to V101 pin 5, using the PCB pins, see Figure 7. It is not necessary to twist the wires together as in normal AC heater wiring practice (but there's no harm if you do).

Due to their physical size, it was more convenient, if a little unconventional, for the yellow polypropylene capacitors C12 and C112 to be mounted on the track side, as illustrated in Figure 6. The method of mounting the PCB allows plenty of room. Cover exposed lengths of lead with sleeving stripped from power connection wire or mains cable. C12 connects between P95 and P96, while C112 is between P97 and P98, ON THE TRACK SIDE. The leads are pushed through the holes and bent over and cropped as usual, but soldered on the track side where they enter each hole.

Finally prepare the four rubber couplings these will be used as mounting pillars for the PCB. Remove the spring washers from each and replace the nuts and tighten carefully, to avoid splitting the rubber. The final distance will be approximately 17mm. Using the extra M4 nuts provided in the kit, attach each coupling to the PCB mounting holes on the track side. In use the PCB hangs upside down in the chassis, while the three valves will protrude through holes in the chassis top panel. Temporarily set aside the assembled PCB while you prepare the chassis.

## Preparing the Amplifier Chassis

Drilling and cutting details for the chassis for the amplifier section is shown in Figure 7. The removable lid is the bottom of the box. The 3/8in. holes in the rear panel are for gold plated phono sockets (JZ05F (black) and JZ06G (red)), which come with insulating shoulder washers, since the 0V side of the sockets must be isolated from the chassis. Alternatively, you might use an 8-way phono socket on a paxolin panel (with 4 × M3 fixing holes), for which a rectangular cut-out is required. It can also include an earthing terminal post for a record deck, see optional parts list.

The left-hand side panel has a 3/4in. diameter hole whose position corresponds with the grommet on the PSU chassis, allowing the two chassis to be joined end to end.

The top panel has 1in. diameter holes, preferably made with a round sheet-metal punch, to clear the valve envelopes when the PCBs are in place. The Phono PCB must be on the right-hand side (three valve holes) furthest away from the PSU. If the Tone Control Module is not used then the two left-hand valve clearance holes and associated M4 clearance mounting holes are not required.

## Combining the Chassis

When the PSU and amplifier chassis are joined end to end, the complete assembly becomes 16in. wide which is a typical width for most stereo items. The rear join should be made with a rectangle of aluminium plate 2½in. high × 1in. wide with a hole at each corner for fixing, using M4 hardware or pop rivets. Ideally the front should have a covering front panel cut from 16 swg aluminium sheet (see optional parts list). All frontal holes will be duplicated in this panel. It can be any height you like (the prototype is 4½in. high to fill a gap between two shelves). The separate front panel is rigidly attached to both chassis by M3 hardware in each corner of the front panels of both chassis. The panel can be painted, and countersunk screws allow a stick-on design to be attached, completely hiding the fixings (and the fixing screw for RG1, see the PSU Module). Figure 8 shows the front and rear panel legends available as an optional item.

## Installing the Phono Module PCB

The four flexible rubber couplings that are used as mounting pillars for the PCB should, as already described, be fitted onto the PCB first. Experience has indicated that it is much easier to insert the threaded ends of the pillars through the chassis when the PCB is fitted, rather than the PCB over the pillars. (This is especially true of the Tone Control PCB, which is larger.) Because the mountings are flexible, it is a simple matter to 'hook' the studs through the chassis panel with a thin-bladed screwdriver. Secure all four studs with the four M4 nuts and DO NOT over-tighten, or there is a risk of damage to the rubber. You will find that any rotary switches will have to be fitted after the PCB is in place, as space is rather tight.

If you are also going to mount the Tone Control PCB later, be aware that rotary switches AND the Phono PCB will have to be removed again to make room for manoeuvring the Tone Control PCB into position (mainly because of the four control spindles). It is not too difficult to disconnect and reattach the PCB pin connections, and all wiring can remain connected to the rotary switches while they are removed.

## Power Supply Wiring to the Phono Module

Figure 9a shows the basic essential wiring between the Phono PCB and PSU. While signal connections are flexible, these connections are not and these instructions must be adhered to.

Firstly establish what is called an 'earth bus', which shall connect ALL the signal earth tags of however many phono sockets are fitted together, EXCEPT the actual phono input pair (from the record deck). This bus becomes a common supply and signal earth, and should be isolated from chassis and mains earth, which is a separate system. Use stripped bell wire or tinned copper wire. It will be noticed that there is an approximate 1in. gap between the rear edge of the PCB and the rear panel for wiring and socket connections along the back of the chassis.

Next fasten the earth strap (green/yellow wire) from the PSU to the amplifier chassis with its M3 solder tag, using an M3 × 10mm bolt, nut and TWO shakeproof washers (see Figure 10a).

Connect a length of green power connection wire from P10 on the PSU PCB and the nearest end of the earth bus (all routes through the grommet). Also connect green power wire from the other end of the earth bus and P7 on the Phono PCB. The heavy gauge of this cable is quite important, it provides the minimum resistance for all signal and supply earth returns, ensuring good performance. Don't be sparing with the solder.

Connect P5 on the Phono PCB with P9 on the PSU PCB (+HT supply) using orange bell wire. Connect the PCB pins of V101 pins 4 & 5 to P14 & P13 on the PSU PCB using stranded brown hook-up wire. V101 pin 4 (referenced to 0V by a link on the board) must connect to P14 (DC heater supply –V).

Finally, connect V2 pin 4 or 5 (they are linked by a track) and V2 pin 9 to P11 & P12 on the PSU PCB using a tightly twisted pair of black bell wires. The pair should rise vertically to a level of 1in. above the PCB surface before going directly to the grommet, avoiding the areas of V1, V101 and associated components.

These are the six vital connections to the Phono PCB and they do not deviate. See also Table 2 for overall PCB pin designations.

Turn the chassis over and plug in the valves – V1 & V101 = ECC83, V2 = ECC82. The Phono Module should now be operational and ready for initial testing.

## Testing the Phono Module

Turn the chassis upside down and support it to keep the three valves clear of the work surface. Connect the Euro mains lead and switch on. In a short time you should be able to establish that all three valves are glowing. If not, perform the complete SIDE procedure and examine the heater supply wiring for errors. **WARNING!** Never heat valve holder pins with a soldering iron while a valve is still plugged in; remove it first. (Heating a valve pin too quickly risks cracking the glass envelope.)

If all valves are glowing, then the basic DC voltages around the circuit can be checked with reference to Table 3 (test points). Due to the vagaries of the HT supply, these levels are approximate, but measured values should not deviate greatly, a drastic difference will show an obvious fault. As opposed to semiconductors, it is most unlikely that a valve is damaged by a serious fault, at least in the short term, since they are, electrically speaking, extremely tough. If, however, you have a short circuit somehow across a DC blocking capacitor, such as C5 or C105, then other capacitors may be damaged, such as the polystyrene types which are not high voltage rated.

If the DC tests are good you may go on to AC testing if you have the equipment, such as an AF signal generator and oscilloscope. This will show whether the two identical circuits perform the same, if not, one of them has a fault. Dry joints in the equalisation network can produce some weird effects.

If a fault is found carry out the complete S.I.D.E. procedure before rectifying it. At this stage the PCB may be removed without completely disconnecting it, AFTER the valves have been removed!

## Signal Wiring

Figure 9b attempts to illustrate some signal wiring options for the Phono Module, particularly if used alone. The extra phono sockets and selector

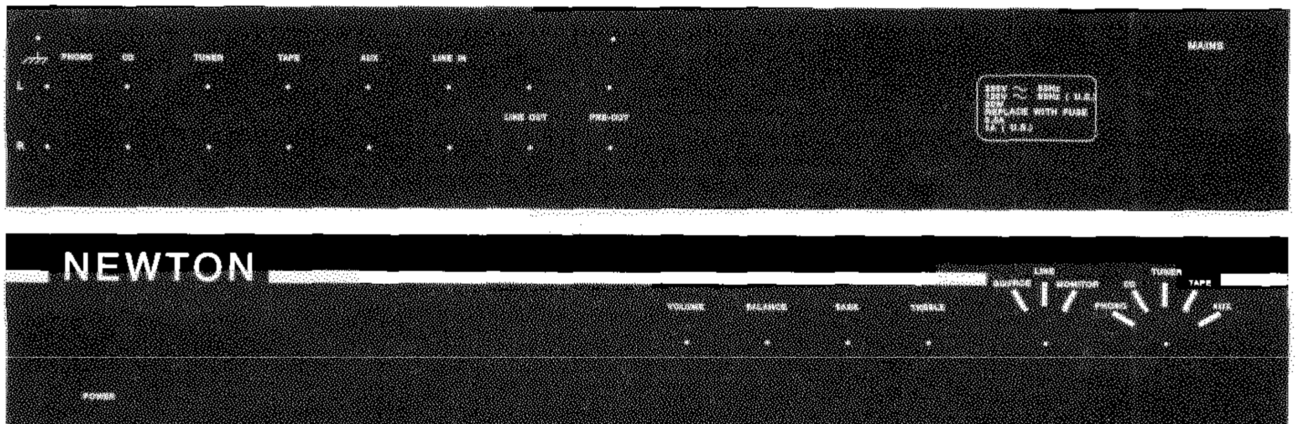



**Figure 8. Newton Preamplifier Phone Module front/rear panel label. Scale: $^7/_{16}$in. = 1in.**

**Figure 9a. Basic general earth and supply wiring for the Phono Module.**

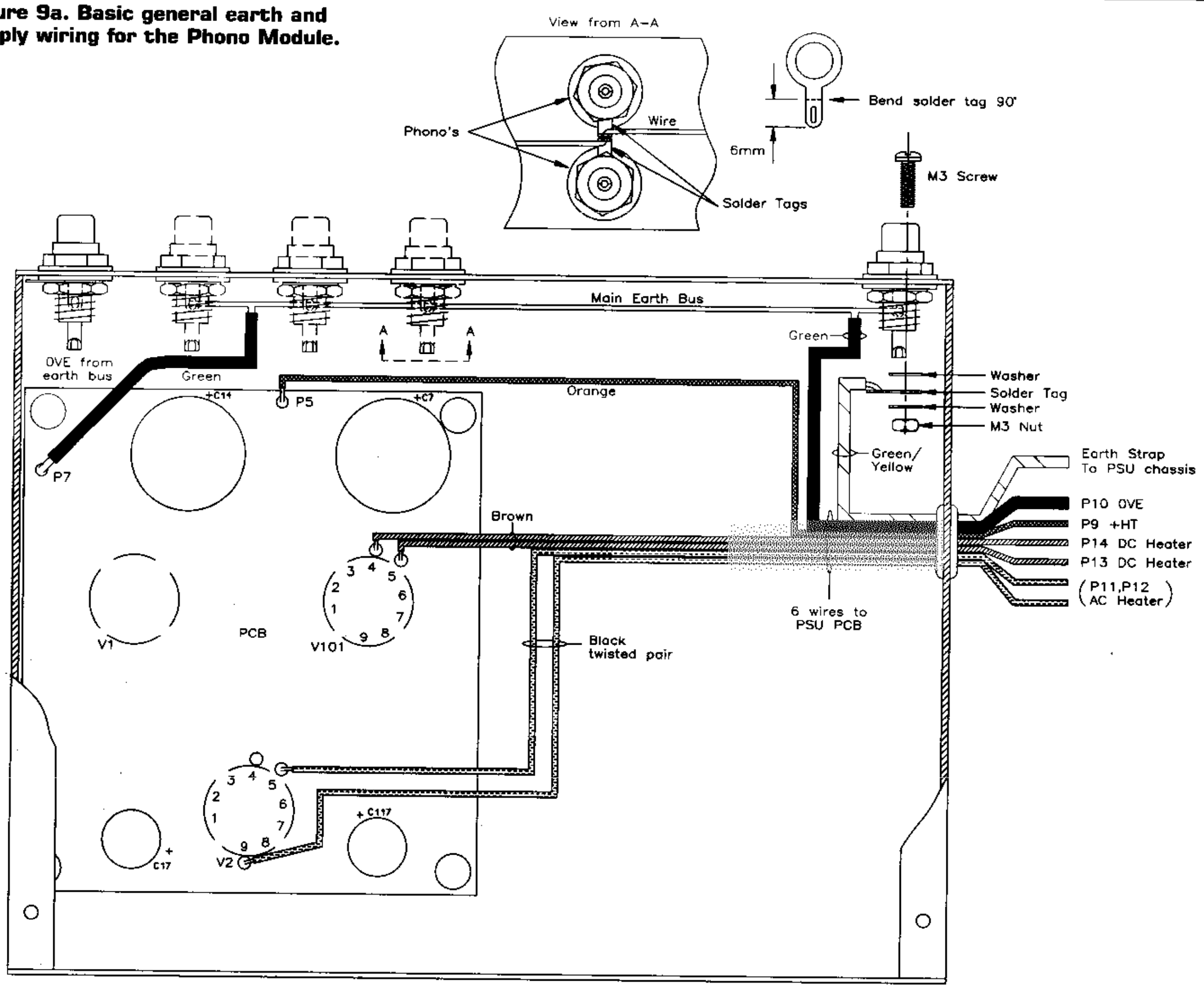
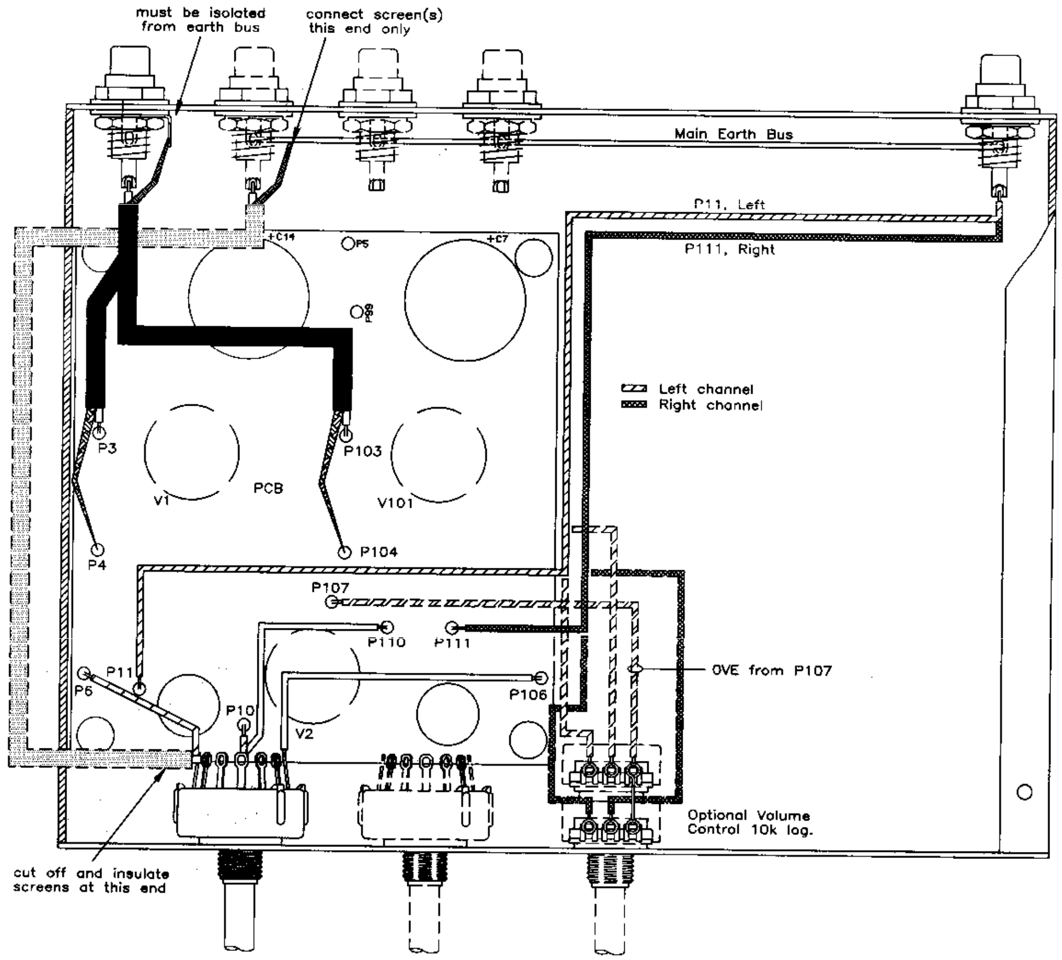



**Figure 9b. Signal wiring diagram.**



switch are purely optional, as is the dual ganged volume control (alternatively two singles can be considered). Volume controls should preferably follow the line driver, as this keeps the signal to noise ratio proportional to the output level at all settings. Signal source and switching options will be discussed in more depth in Part 3 (see also Figure 1).

The signal earths of the stereo pair of 'real' phono input sockets should *not* be included in the earth bus arrangement; due to the sensitivity of the amplifiers and the low signal level this is not possible without unacceptable noise and pickup. Consequently the metal body of each is connected to signal 0V on the PCB (P4, 104) via the screen of its own connecting cable ONLY. Furthermore the socket earths should not be linked together, or to the earth bus as well, or a 'hum-loop' will be formed. Ultimately each socket completes a circuit with its own side of the magnetic cartridge in the record player, the two signal returns remaining isolated along their length. Note that the centre conductors of the internal screened cables should be as short as possible at the phono socket tags and at P3 & P103. The distance to the signal 0V pins P4 & P104 is made with the screen braid only.

Part 3 will describe the Tone Control Module and more detailed signal wiring options for a complete valve preamplifier.

## NEWTON VALVE PREAMP RIAA (PHONO) MODULE PARTS LIST

| | | | |
|---|---|---|---|
| RESISTORS: All 0·6W 1% Metal Film (Unless specified) | | | |
| R1,101 | 51k | 2 | (M51K) |
| R2,8,102,108 | 100k | 4 | (M100K) |
| R3,103 | 240k | 2 | (M240K) |
| R4,104 | 36k | 2 | (M36K) |
| R5,10,105,110 | 1k8 | 4 | (M1K8) |
| R6,11,17,106, 111,117 | 1M | 6 | (M1M) |
| R7,107 | 39k | 2 | (M39K) |
| R9 | 12k 2W | 1 | (D12K) |
| R12,13 | 2k2 2W | 2 | (D2K2) |
| R14,114 | 680k | 2 | (M680K) |
| R15,115 | 1k | 2 | (M1K) |
| R16,116 | 10k | 2 | (M10K) |
| CAPACITORS | | | |
| C1,6,13,101 | High-Voltage Disc Ceramic 10nF 500V | 4 | (BX15R) |
| C2,102 | Radial Electrolytic 10µF 450V | 2 | (JL11M) |
| C3,103 | 1% Polystyrene 330pF 500V | 2 | (BX51F) |
| C4,11,104,111 | Low ESR Radial Electrolytic 47µF 50V | 4 | (JL47B) |
| C5,105 | Polyester Film 22nF 400V | 2 | (BX72P) |
| C7,14 | Radial Electrolytic 47µF 450V | 2 | (JL18U) |
| C8,108 | 1% Polystyrene 560pF 125V | 2 | (BX54J) |
| C9,109 | 1% Polystyrene 8n2F 63V | 2 | (BX85G) |
| C10,110 | 1% Polystyrene 3n3F 63V | 2 | (BX62S) |
| C12,112 | Polypropylene 100nF 1000V (Class X/Y) | 2 | (FA21X) |
| C15,16, 115,116 | Polyester Layer 10nF 400V | 4 | (WW29G) |
| VALVES | | | |
| V1,101 | ECC83 | 2 | (CR27E) |
| V2 | ECC82 | 1 | (CR26D) |
| MISCELLANEOUS | | | |
| | Single Ended 1mm PCB Pin | 1 Pkt | (FL24B) |
| | PCB B9A Valve Base | 3 | (CR32K) |
| | Aluminium Chassis AC86 | 1 | (XB68Y) |
| | Single Screened Cable | 1 | (XR16S) |
| | 1·5A Solid Core Wire Orange (10m) | 1 Pk | (BL90X) |
| | 1·5A Solid Core Wire Black (10m) | 1 Pk | (BL85G) |
| | 1·4A Wire Brown (10m) | 1 Pk | (BL02C) |
| | 6A Green Wire | 1m | (XR35Q) |
| | Rubber Coupling | 4 | (FB98G) |
| | M3 × 10mm Steel Bolt | 1 Pkt | (JY22Y) |
| | M3 Steel Nut | 1 Pkt | (JD61R) |
| | M3 Shakeproof Washer | 1 Pkt | (BF44X) |
| | M4 Steel Nut | 1 Pkt | (JD60Q) |
| | Front Panel Label | 1 | (KP75S) |
| | PCB | 1 | (GH99H) |
| | Instruction Leaflet | 1 | (XV11M) |
| | Constructors' Guide | 1 | (XH79L) |
| OPTIONAL (Not in Kit) | | | |
| | Square Stick-on Feet | 1 Pkt | (FD75S) |
| | 2-pole 6-way Rotary Switch | As Req. | (FF74R) |
| | 4-pole 3-way Rotary Switch | As Req. | (FF76H) |
| | Twin Phono Socket | As Req. | (JK15R) |
| | Quad Phono Socket | As Req. | (BW74R) |
| | Octal Phono Socket | As Req. | (JK17T) |
| | Gold Phono Socket Black | As Req. | (JZ05F) |
| | Gold Phono Socket Red | As Req. | (JZ06G) |
| | Grounding Post | As Req. | (JL99H) |
| | Aluminium Sheet 16 swg | 1 Sht | (LH13P) |
| | Knob K8C | As Req. | (YR66W) |
| | M3 Shakeproof Washer | 1 Pkt | (BF44X) |
| | M3 Steel Nut | 1 Pkt | (JD61R) |
| | M3 × 10mm Steel Bolt | 1 Pkt | (JY22Y) |

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 LT76H (Newton Phono Kit) Price £34.99A1**

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 Phono PCB **Order As GH99H Price £3.99**

Newton Preamp Label **Order As KP75S Price £2.99**