NEWTON STEREO VALVE PREAMPLIFIER UPDATE

Tone Control Unit

KIT AVAILABLE
(95131)
Price £39.99 B1

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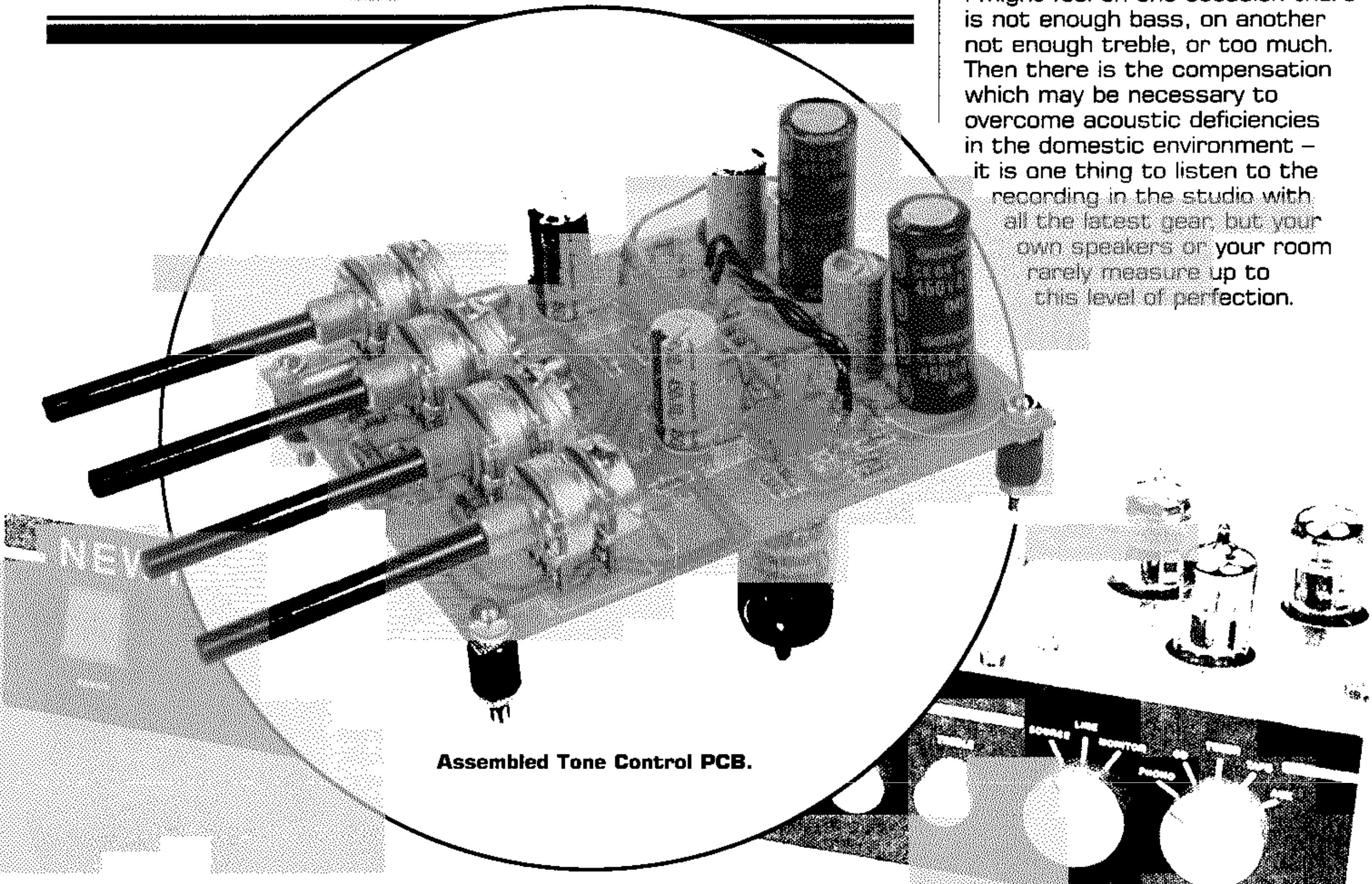

Assembled Tone Control PCB.

This updated version of the Newton Tone Control Unit, previously featured in Issue 86 of *Electronics*, incorporates alterations to the pentode stage to make it operate over a more linear working range of grid bias versus anode current, and to equalise the valve screen grid voltage with the anode voltage.

4
PROJECT
RATING

THERE is currently some heated debate among Hi-Fi fanatics as to whether tone controls *per se* should exist at all. Ideally, what should happen is that the recording (be it record, CD or tape) is accepted as the final version of the mixing and engineering process, since after all, this is how the producer and artists want their finished product to sound like. However, what if the listener has different ideas?

Speaking for myself, I am something of a 'knob twiddler' (if you'll excuse the expression!), because often my moods change and the way in which I perceive sound can also change almost from day to day. Consequently, I might feel on one occasion there is not enough bass, on another not enough treble, or too much. Then there is the compensation which may be necessary to overcome acoustic deficiencies in the domestic environment – it is one thing to listen to the recording in the studio with all the latest gear, but your own speakers or your room rarely measure up to this level of perfection.

FEATURES

* Simple PCB construction
* Compact stereo module
* Versatile connection options
* Passive tone control network
* Wide dynamic range
* Onboard low-impedance O/P buffer

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
Max. permissible input level before onset of clipping:	4V 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 @ 50Hz or 110 to 120V @ 60Hz
Power consumption:	30W approx.

I am, for instance, an advocate of the graphic equaliser (shock, horror, gasp), if only because it allows cassette recordings to be tailored, for listening in the car or from the personal stereo. Also I have come across recordings where the engineer's idea of what the tonal response should be is very strange – I'm sure there must have been something wrong with his hearing! (Could do with a trip to the doctor for a little de-waxing, perhaps.) While we are on the subject, what about listeners with hearing difficulties?

Enough of this. Suffice to say that tone controls have their uses, although they must be used intelligently, ideally set flat, but providing the option to 'tweak' the sound slightly if required. The Newton Tone Control Module not only meets this requirement, but also provides you with another capable line driver to feed the power amplifier(s), freeing the Phono Module's line driver for dedicated 'line out' functions.

A block diagram of the tone module is shown in Figure 1. Detailed specifications are listed in Table 1. It comprises a balanced 'Baxandall' style control network which is passive (i.e., not incorporated into the feedback loop of an amplifier), and driven by a first amplifying stage which adds the necessary gain to provide the bass and treble boost ratio. Rather than take the output directly from the network (as is the case with Mullard's 'two-valve' preamplifier), it is buffered by the line driver, which also allows a balance control to be included.

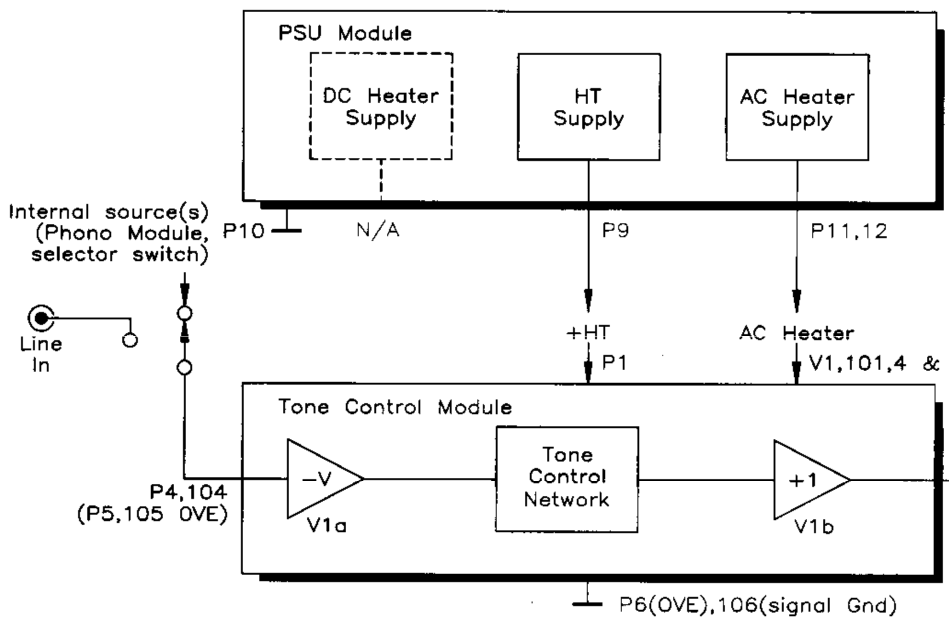

Figure 1. Block diagram of Tone Control Module.

Circuit Description

The complete circuit diagram of the module is shown in Figure 2. Note that only one channel of a stereo pair is illustrated, although these share common supply components (R1, R2, C1, C2, C3 & C4). The tone control network is recognisable by the familiar Baxandall pattern (C11 to 15, R12 to 15, and RV1 & RV2), and is borrowed more or less complete and unchanged from Mullard's 'two-valve' circuit. However, I have been asked more than once why the potentiometers are logarithmic, and why the components on either side differ in value by a factor of 10:1.

The simple reason is because the network is passive, not 'active'. In the 'active' version, the 'high side' of the network forms a feedback chain for an amplifier, the 'output' (from the potentiometer 'wipers') being returned to the non-inverting input. The 'lower side' of the network then feeds the amplifier, operating in 'virtual earth' input mode. (The amplifier is typically an op amp, although before this a single inverting transistor stage was common.) The effect of this was that, while all scales in the network were linear (linear potentiometers, etc.), when the position of a control was mechanically changed by a linear degree, the actual gain of the amplifier was altered twofold, either up or down. This twofold, or doubling or halving, effect gives rise to the equivalent logarithmic increase or decrease of signal gain that is necessary to match the logarithmic response of the human ear to 'loudness'.

Consequently, if the active component (the amplifier) is removed, this does not happen. Hence it is necessary for the network itself to provide the logarithmic ratios of change. RV1 & RV2 are logarithmic so that while each is in a mechanically central position, the portion of track on the anticlockwise side of the wiper is one quarter (approximately) the value of the remainder of the track on the other side. Used to tap a proportion of a signal applied across the whole track, rotating the wiper fully clockwise will result in a fourfold increase (12dB) of signal level. Rotating it anticlockwise decreases the signal with similar behaviour. The reactances of the capacitors C11 & C12 and C13 set the maximum and minimum limits for the treble section, R13 & R14 the bass section. Note that C11 & 12 combined equal 820pF, one tenth the value of C13, similarly R13 & 14 are of the same ratio.

The one disadvantage of using logarithmic pots is that the accuracies of their track

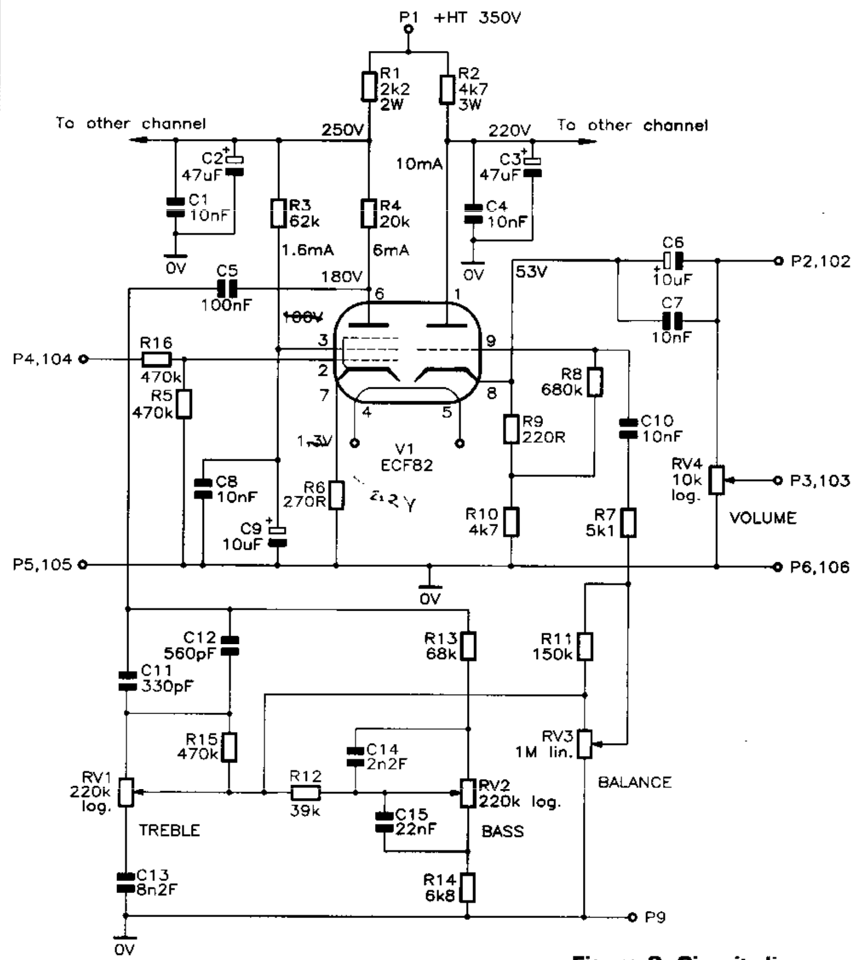

Figure 2. Circuit diagram.

Specification	
Volume setting:	Maximum
Bass setting:	Flat
Treble setting:	Flat
Balance setting:	Centre
Input signal level:	0dB
Input source impedance:	600Ω via 1·5m screened lead
HT supply:	320V + 100mV ripple @ 100Hz
Input impedance:	1MΩ
Output impedance:	<10kΩ
Overall gain:	~~0dB~~
Frequency response:	20Hz to 20kHz ±0.5dB, 2dB @ 100kHz
Output noise:	<200μV peak maximum
Signal to noise ratio:	60dB for 100mV input level
Maximum permissible input level before onset of clipping:	6V Pk-to-Pk
Maximum bass boost:	+16dB @ 20Hz
Maximum bass cut:	12dB @ 20Hz
Maximum treble boost:	+18dB @ 20kHz
Maximum treble cut:	19dB @ 20kHz
Maximum balance offset extra gain:	+3dB
Minimum balance offset gain:	Zero output
Pentode stage gain:	29dB, constant
Triode stage gain:	0dB
Tone control network type:	Passive Baxandall
Power requirements:	
HT supply:	300 to 350V DC
HT current consumption:	30 to 40mA
Heater supply:	6·3V AC @ 900mA

Table 1. Tone Control Module specification.

resistances are less precise than that for linear pots, giving rise to offsets, relative to the mechanical position, and possible mismatching between ganged tracks. Generally, the differences are small and can be ignored, however, some comments from 'reviewers' of the prototype suggested that the treble could do with improvement, that is, the control has to be increased slightly from the centre position to make the response truly 'flat'. This is all very subjective and at the mercy of the vagaries of track matching, however, a little treble boost (to recover losses due to the reactive input impedance of the network) is not out of place. R15 provides this by bridging the top half of RV1, shifting the centre point slightly in the opposite direction. If you find that in practice this is not necessary, then it can be removed. (In the Mullard 'two-valve' circuit, the network has a 47kΩ resistor on the other side, presumably to cut the treble.)

The reactive input impedance of the network can be a bit of a problem for the driving valve, becoming a considerable load at high frequencies, where the impedances of all the capacitors are at their lowest. The Mullard circuit employed an EF86 to drive its network, but it was not found ideal, as this valve typically has a high output impedance, and is not well matched to the task. Gain such as can be provided by a pentode is required, however, since to achieve the necessary boost levels for both treble and bass, a high signal level has to be put into the network in the first place, if only to ensure unity gain throughput in the 'flat' position.

The device that was finally chosen, and which I have had experience with in the past, is the ECF82 triode pentode. The pentode section is employed to drive the network, while the triode section forms the output buffer.

The ECF82 neatly combines a high current, wide band pentode with an even higher current triode in one B9A envelope. These are basically video valves, and the ECF82 was once commonly used in vision amplifiers and other forms of video processing in television broadcast applications. It has even been employed as the front-end for AM receivers, using the pentode as the mixer and the triode as the local oscillator. It is a very capable device in the AF range

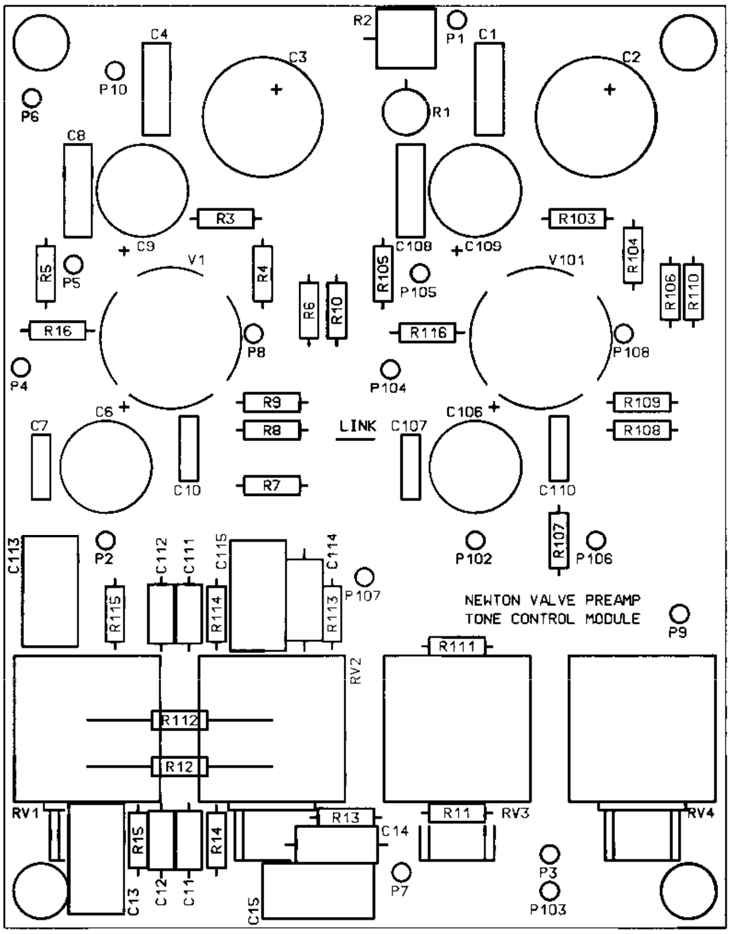

Figure 3. PCB legend.

Pin No.	Function	Channel
P1	+HT supply	Common
P2	Buffered output direct	Left
P3	Volume control output	Left
P4	Tone control main input	Left
P5	Input screen 0V	Left
P6	Supply 0VE from earth bus (PSU)	Common
P102	Buffered output direct	Right
P103	Volume control output	Right
P104	Tone control main input	Right
P105	Input screen 0V	Right
P106	Signal 0V for outputs and buffer	Common
P7	C5 to tone control network	Left
P8	V1 pin 6 to C5	Left
P107	C105 to tone control network	Right
P108	V101 pin 6 to C105	Right
P9	0VE for potentiometer screening	Common
P10	Buffer HT supply to valve holders	Common
V1 pins 4,5:	6·3V AC heater	Left
V101 pins 4,5:	6·3V AC heater	Right

Table 2. Tone Control PCB pin designations.

and is still used in at least one design of a modern Hi-Fi valve power amplifier.

In the Tone Control Module, the pentode, V1a, provides 29dB of flat gain from the line level signal at pin P4, raising it to an amplitude sufficient for the tone controls to work with. An anode load resistor of 15kΩ (R4) maintains a current of 6mA, while the screen grid current is slightly starved, producing a screen grid voltage of 100V DC compared with the anode's 175V DC. This has the effect of boosting the gain of the valve. Some local negative feedback is provided by cathode resistor R6 not being decoupled to signal ground. The gain of this stage limits line input level at around 3V peak; overload distortion becomes apparent at approximately 4V peak.

Some HF roll-off is apparent at the anode, which can be graphically shown by an oscilloscope while monitoring a squarewave at this point. This is caused by the combined reactive impedances of the capacitors in the network loading the valve in the HF range. However, the 'scope will also show the squarewave shape being recovered at the output of the network, which has absorbed the HF energy, not wasted it.

Both left and right channel pentode stages are supplied with HT via R1 and decoupled by C1 and C2, C1 removing any high-frequency components on the supply line, but each screen grid is decoupled separately by C8 & 9, and C108 & 109.

The common output of the tone control network goes to the dual ganged balance control, RV3, which has reverse connected tracks to achieve the left/right channel boost/cut action. R11 (and R111) is added to limit the degree of signal boost when one side is increased over the other, which might cause overloading problems for amplifiers further along the chain. It also recovers some of the 6dB loss of the balance control when in the 'centre' position. RV3 is 1MΩ, providing absolute minimum loading of the tone control network.

At the output of RV3, overall 'flat' gain is 6dB, all due to the gain of V1a. The high output impedance, at this point, is unsuitable for long lengths of screened lead and whatever may be the input impedance of the power amplifier, so a common cathode, non-inverting buffer is added, V1b. Cathode bias is properly derived from a series resistor chain, R9 and R10. The bulk of the voltage drop, which allows a sizeable signal voltage swing, is across R10 and is derived from an anode current of 10mA. This leaves R9 to develop the actual cathode bias of 2V, with the lower end communicated to the signal grid via the grid leak resistor R8. Both the pentode and triode of the ECF82 should have fairly high anode currents to ensure that each is maintained in the linear region of its operating curve.

As with the Phono Module's line driver, the input impedance of the stage is not determined by the value of R8 alone. The action of the cathode following the signal grid results in an impedance multiplying effect for R8, so that instead of being 680kΩ the actual input impedance is nearer to 10MΩ. The small value of the polycarbonate capacitor, C10, which AC couples the input, is more than ample for this.

AC coupling at the output is via C6, 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. HF performance is assured, however, by C7. 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.

R7, in series with C10 and the signal grid, is a 'grid-stopper' (to use the vernacular), and serves to limit the bandwidth of the buffer stage. It should not be omitted, else the triode will go into common grid mode whenever the balance control is reduced to minimum, connecting the input directly to 0V. Where's the harm in that, you may ask? None, except that in this condition, the triode suddenly becomes a very capable RF noise generator whose output range extends into the UHF. While this may be very useful in different circumstances, it is not desirable here! This is a form of instability, prevented by R7.

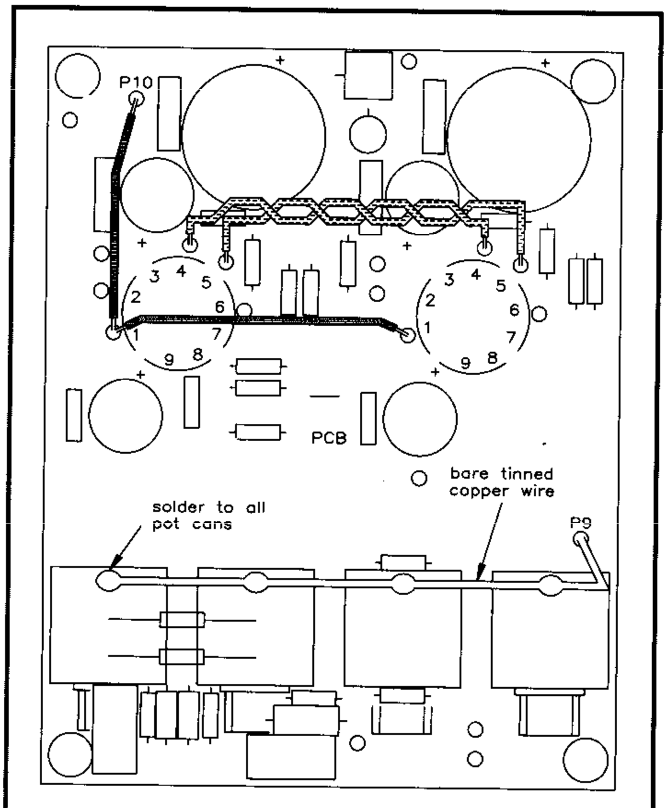

Figure 4. Onboard heater, supply and earth wiring.

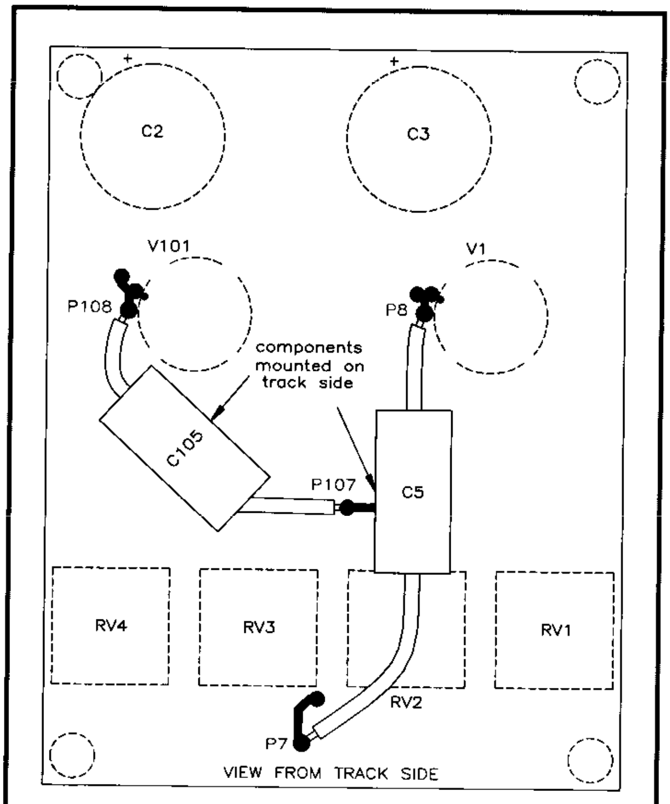

Figure 5. Mounting C5 and C105 on the track side.

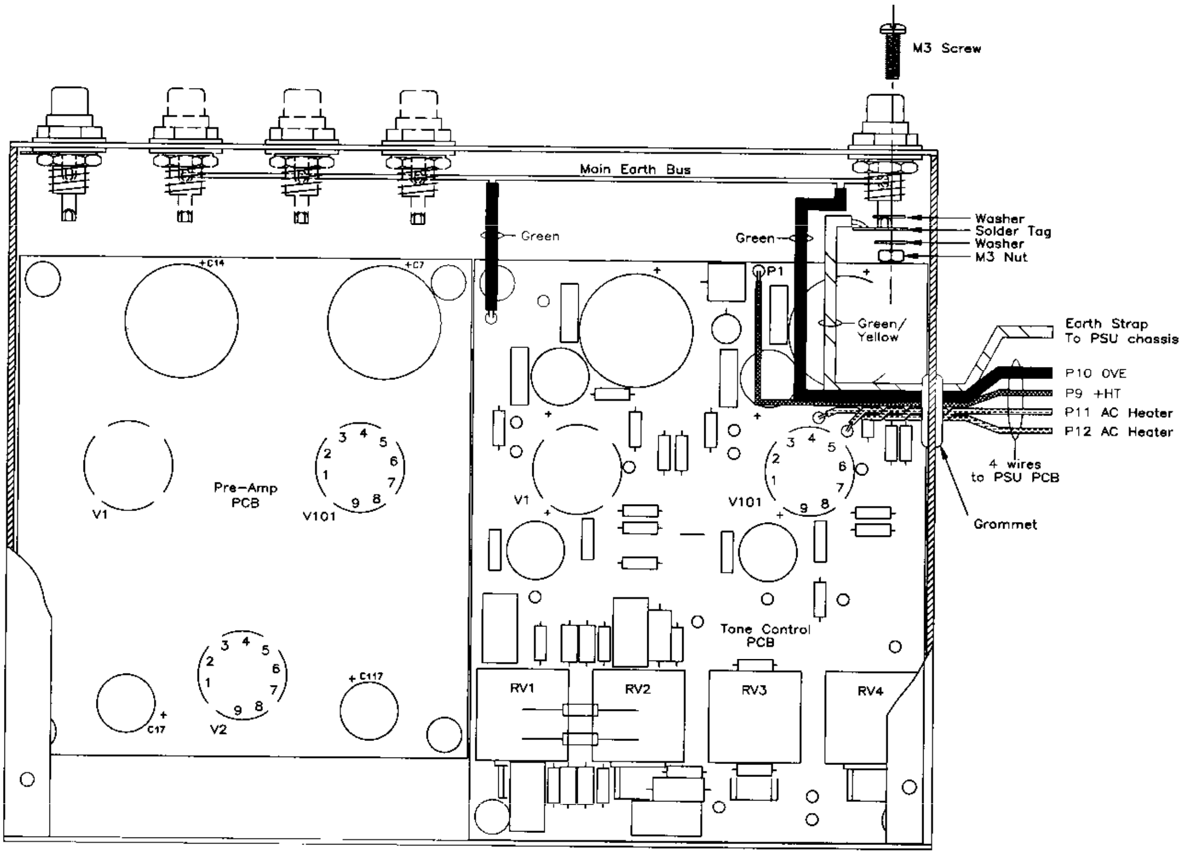

Figure 6. Basic supply and earth wiring of installed PCB.

Finally, a stereo ganged logarithmic volume control, RV4, connects across the output. The 10kΩ track is usually of low enough impedance to drive most types of screened lead with no discernible loss in HF performance. Alternatively, the buffer output is directly available at P2 (P102). You may use this if the power amplifier has its own volume control, or if you want to mount the preamplifier's volume control somewhere else on the front panel and fitted with a large knob, as some people prefer. In this case, RV4, normally mounted on the PCB, is located somewhere else and hard wired to P2, P102 and P106 (the common signal ground). Due to the low impedances here, screened lead is not necessary.

If no volume control at all is used (RV4 omitted), you MUST substitute the RV4 positions on the PCB with 10kΩ resistors, to ensure that the output side of C6 is referenced to 0V DC at all times. This is so that the buffer does not deliver a hefty pulse down the line to the rest of the system as C12 charges up! One concern here was the 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, PROVIDED RV4 or equivalent resistors are fitted.

Tone Control Module Construction

Refer to Figure 3 for the PCB legend. The PCB is a simple 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. 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.

Begin construction by inserting and soldering the 30 PCB pins at P1 to P6, P10, P102 to P106, and also at the two 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 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 (don't be sparing with the solder). If the wire insists on slipping off the valve holder pin then bend the pin inward to form a hook. The wire loop must be soldered to both pins. A wire-wrapping pen may be useful here if you are in the habit of using one. Attach and solder a pair of opposing pins first and double-check that the valve holder remains true before continuing.

Some 'spare' holes will be left over; P7 to P9, and P107 & P108. These do not have PCB pins. (Table 2 lists the functions of the various pins and links.)

Next begin installing components by fitting the smallest first, working up to the largest. With the aid of the parts list and circuit diagram of Figure 2, identify, fit and solder all the small resistors. An ohmmeter will aid identification of values if you are unsure of the colour codes. Using an offcut of resistor lead, insert and solder the short wire link at the position on the PCB marked 'LINK'. Then fit and solder all the small polycarbonate capacitors C7, C10, C107, C110. Fit and solder the polystyrene capacitors C11 to C15, and C111 to C115. CAUTION: these components can be damaged by overheating.

Install the ceramic disc capacitors C1, C4, C8 and C108. Fit the 2W metal film resistor R1. Note that this stands on end to conserve space on the PCB and to aid cooling in use. Bend one lead to lay flat against the body of the resistor, and insert the component vertically orienting it to the PCB legend. Similarly, mount R2, the white ceramic encapsulated 3W wirewound resistor according to the legend. In this case, include the ferrite bead, by sliding it over the lower wire that will be inserted completely through the PCB, so that the component is raised off the surface of the board by the thickness of the bead when in place. R2 can get quite hot and the bead, acting as a spacer, protects the PCB. The lead from the top end of R2 may need to be extended by adding tinned copper wire (twist together and solder) to reach the other PCB hole.

Install all the four smaller radial electrolytic capacitors, taking care to orientate them correctly according to the PCB legend. In each case, the negative lead is identified by a stripe and '–' symbol on the body. Insert the indicated wire lead into the hole OPPOSITE that marked as '+' on the legend. Next, insert and solder the two 47_F 450V capacitors into the PCB. Make sure that all the electrolytics are seated fully onto the PCB.

At this stage, check the quality of the work before installing the potentiometers, which make it difficult to access smaller components nearby, due to their size. Look for bad solder joints, solder bridges and misplaced components and rectify where necessary. It is still possible to double-check resistor values, as there are hardly any leakage paths to upset ohmmeter readings.

If you know the exact final length required for each potentiometer control spindle, you can cut them back with a junior hacksaw (while gripping the spindle, NOT the potentiometer body, in a vice). Otherwise, you can leave this operation until the PCB is installed in the chassis, as it is not difficult. The nuts and lockwashers are not necessary and can be discarded. Identify one of the 220k logarithmic potentiometers and install it the RV1 position, and then the other 220k potentiometer in the RV2 position. Note that these physically hide some small components nearby, especially R12 & R112, although there is plenty of space underneath the pots. DO ensure that the pots are seated fully on the board or the shafts will be off-centre and not line up.

Similarly, fit the 1MΩ linear potentiometer at RV3, and the 10kΩ logarithmic potentiometer at RV4. Next, it is necessary to connect the metal bodies of all four potentiometers to 0V. This is to provide screening of the internal tracks and wipers, which normally occurs if the pots are mounted in earthed metalwork. However, because in this case they are not physically attached to any metalwork, unwanted noise pickup

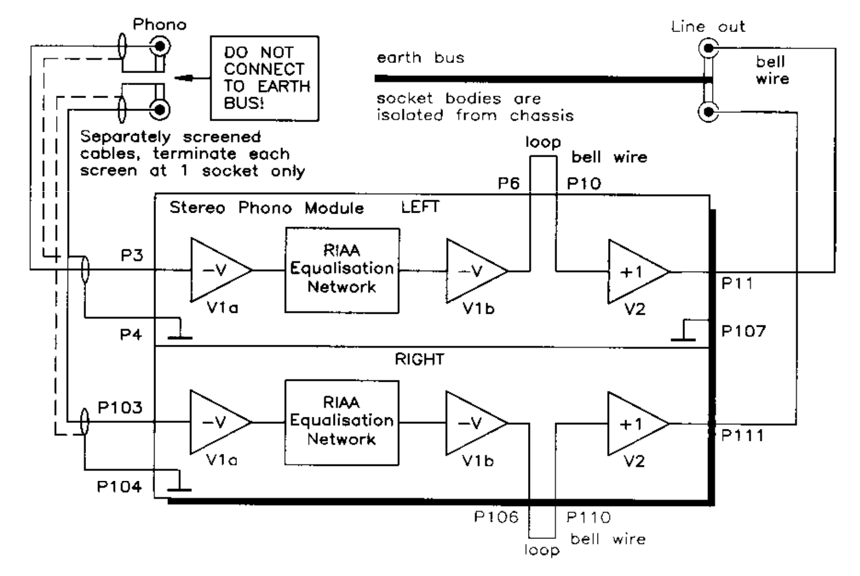

Figure 7. Signal wiring for minimum system.

can result, aggravated by the bodies themselves acting as 'aerials'. Using tinned copper wire or stripped bell wire, join all four cans together with a single length, with a solder joint at top rear of each can, with one end terminated at P9 on the PCB (0V), see Figure 4. This could be awkward to do unless you have a powerful soldering iron (25W minimum), but the screens are normally plated steel and take solder readily.

With two lengths of black bell wire tightly twisted together, join V1 pin 4 to V101 pin 4, and V1 pin 5 to V101 pin 5, wrapping them around the PCB pins – see 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. Using orange bell wire, join together V1 pin 1 to V101 pin 1, allowing some slack to avoid the other valve holder PCB pins. Also connect V1 pin 1 to P10 near C4. This provides HT for the output buffers, see Table 2.

Due to their physical size, it is more convenient, if a little unconventional, for the large yellow polypropylene capacitors C5 and C105 to be mounted on the track side, as illustrated in Figure 5. The way in which the PCB is mounted in the chassis allows plenty of room. Cover exposed lengths of lead with the sleeving supplied in the kit. C5 connects between P7 and P8, while C105 is between P107 and P108, ON THE TRACK SIDE. The leads are pushed through the holes, bent over and cropped as usual, but soldered on the track side where they enter each hole.PCB and hole designations are listed in Table 2.

Finally, fit the four rubber couplings. These will be used as mounting pillars for the PCB. Remove the spring washers from each, 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 two valves will protrude through holes in the chassis top panel. Temporarily set aside the assembled PCB while you prepare the chassis, if you have not already done so.

Preparing the Amplifier Chassis

An 8 × 6 × 2½in. chassis is supplied with the Phono Module Kit (LT76H), and instructions for

HT+ = 320V; junction of R1, C2, R3 & R4 = 250V

V1a Pin No.	Volts	V1b Pin No.	Volts	
7	~~1.5~~ 2.2	8	55	cathode
2	0	9	53	signal grid
3	~~100~~ 125–150	–	–	screen grid
6	~~175~~ 125–150	1	225	anode

Table 3. Voltage test points.

preparing it for both Phono and Tone Control PCBs are included in leaflet XV11M.

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 16swg aluminium sheet. All frontal holes will be duplicated in this panel. It can be any height you like (the prototype is 4in. 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 the countersunk screws allow a stick on design to be attached, completely hiding the fixings.

Installing the Tone Control 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 than the Phono PCB and a little awkward to install due to the protruding spindles. The Tone Control module has to be inserted at an angle to push the control spindles through the front panel and at the same time, clear the flange at the end of the chassis. Once clear of the flange, it can be pushed down and straightened up, and the four mounting studs pushed through the top panel. Because of this, it is impossible to install or remove the Tone Control Module while the Phono Module is in place, as it is in the way. Since the mountings are flexible, it is a simple matter to 'hook' the studs through the chassis panel with a thin-bladed screwdriver if they do not go first time. Secure all four studs with the four M4 nuts and DO NOT over-tighten, or there is a risk of damage to the rubber. Rotary switches are fitted only after the Phono Module is installed.

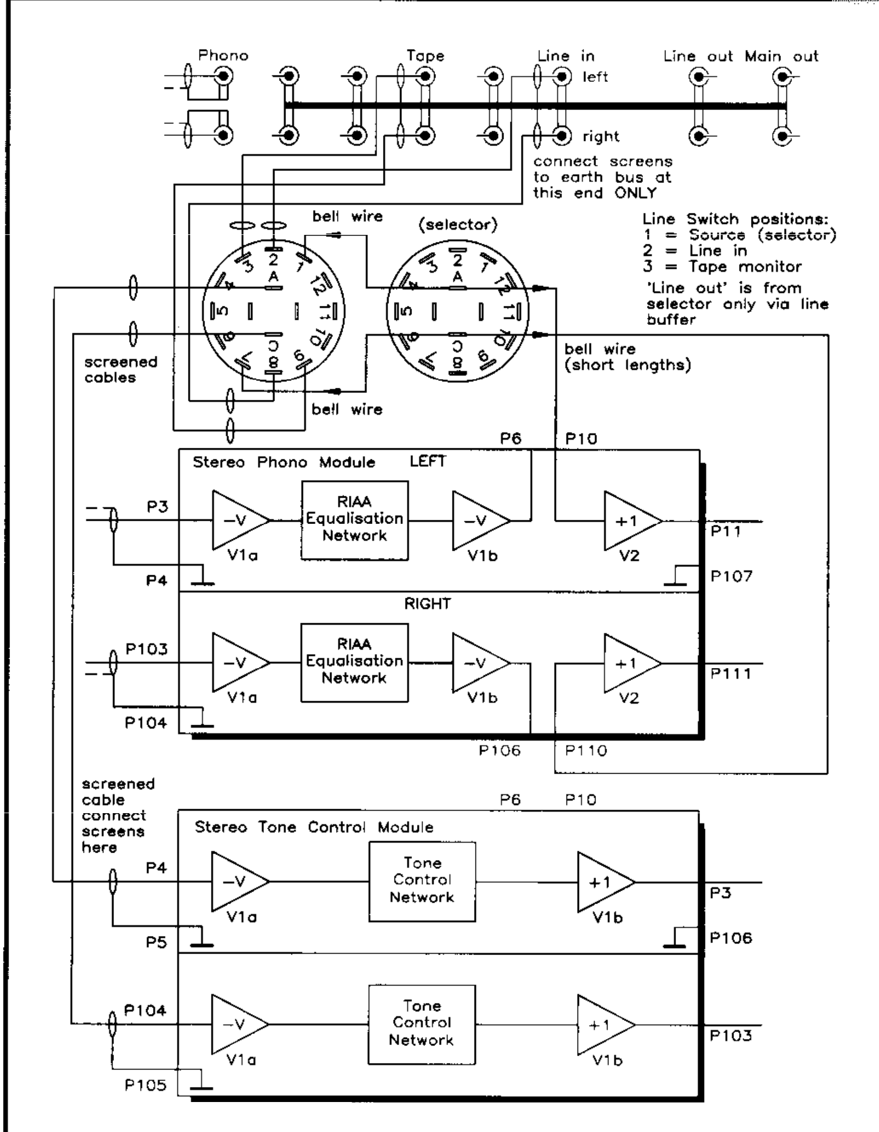

Figure 8, as 'a' with added Tone Control Module and line switching functions.

Power Supply Wiring

Figure 6 shows the power supply, earth and heater wiring. As described in Part 1 (Issue 73 of *Electronics*), the screen tags of all input and output sockets (EXCEPT 'Phono'!) are linked together by a length of tinned copper wire, connected at one end to P10 (0VE) on the PCB using green 6A power connection wire. This is the common 'earth bus', a reference point for most signal earth returns. P6 on the Tone Control PCB must be linked to the earth bus with green 6A wire. The heavy gauge of the wire ensures minimal resistance to ground for best performance of the system. HT is connected from P9 on the PSU PCB to P1 on the Tone Control PCB using orange bell wire. The AC heater supply is connected from P11 & P12 on the PSU PCB, directly to V101 pins 4 & 5, using a tightly twisted pair of black bell wires (see also Table 2). All these connections are via the grommet in the PSU chassis. These are the essential basic connections to the Tone Control Module which must be carried out as described, with no deviations.

Testing the Tone Control Module

As this point the module can be fired up and initially tested for correct operation. Plug in the two ECF82 valves and turn the chassis upside down and support it to keep the valves clear of the work surface. Reconnect the euro mains lead and switch on. In a short time, you should be able to establish that the heaters 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.

If the DC tests are good you may go on to AC testing if you have the necessary 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. If a fault is found, carry out the complete SIDE procedure before rectifying it. At this stage, the PCB may be more easily disconnected and removed, AFTER the valves have been unplugged!

Signal Wiring

Various configurations are possible, from the simplest to the more sophisticated. Figures 7 and 8 illustrate two configurations for a finished preamplifier system in wiring diagram form, using the versatile 'Newton' modules. Although the diagrams are self explanatory, clarification of some finer points may be in order.

Good quality screened cable, such as the 'single mic cable' (see Parts List) is recommended for all left and right channel signal input sockets. It may be possible to employ multi-core screened cable, sharing a common outer screen, to make life simpler where many inputs to a selector switch arrangement are desired. However, use this ONLY IF it is known that there is not likely to be two or more signals coming in simultaneously, or crosstalk between the conductors may result. This is because of the high input impedance of both the line drivers (Phono Module) and the Tone Control module.

For each left and right channel 'phono' input, the body of the socket connects to the equivalent input 0V pin on the Phono PCB ONLY via the cable screen. The cable becomes merely an extension of the record player's twin signal leads; the socket bodies must not be connected to the earth bus, or linked together. A 'hum-loop' will most definitely be the result in either case.

Where extra line level inputs are desired (Figure 8), the cable screens are connected to the earth bus ONLY. At the other ends, cut back the screen braid and wrap with insulation tape, so that only the centre conductors are free to connect to the relevant pins on the selector switch. Signal ground for each PCB is already referenced to the earth bus, so connecting these screens to 0V at both ends only causes hum-loops. Similarly, the screened leads linking the selector (or line switch, Figure 8) moving contacts to the Tone Control input have their screens earthed at the Tone Control PCB only. In practice, this makes wiring in the switching area very much easier, as only signal paths are involved.

In the drawings, 6-way rotary ('wave-change' type) switches are shown. Although you can use alternative switches, this type is, on the whole, very reliable, and probably second only to good quality wafer switches. This switch (FF74R) has 12 fixed contact pins and 2 moving contact pins, organised into 2 × 6-way, with an adjustable stop from 2-way to 6-way. The fixed contacts are numbered on the back, anticlockwise from '1' to '12', while the moving contacts are 'A' and 'C' ('B' and 'D' not used).

'A' connects to '1' to '6', while 'C' simultaneously connects to '7' to '12', hence if 'A' is set to '2' then 'C' is set to '8', and so on. For wiring up a stereo switching arrangement, it is simple to remember that this layout ensures that each pair of fixed contacts for left and right inputs are exactly diametrically opposite one another.

When the switch is fitted, it might be a good idea to introduce a very short squirt of WD40 through one of the four holes in the front of the plastic switch body (after removing the nut and washer). This ensures smooth operation and will keep oxides at bay for a reasonable time.

Line input impedance is about 1MΩ if the Tone Control Module is included, even when it shares the selector with the line driver input (Figure 8). This is because the line driver has a much higher impedance. In Figure 8, selector input impedance will rise to nearly 10MΩ where the 'Line' switch is set to a different function, removing the Tone Control impedance from the selector line. In this example, 'Line out' will always be the signal currently selected from one of the programme inputs (Phono, CD, Tuner, etc.), buffered with an output impedance of 1kΩ. 'Line out' and 'Line in' allow a 3-head tape recorder with monitoring facility, or a graphic equaliser, to be linked into the system. Tape monitoring to the line function switch is shown taken from the 'Tape' input sockets via screened lead, but in practice, it is easier to link across to the relevant pins on the nearby selector switch with bell wire. In fact, all connections between both switches and the Phono and line driver PCB can be made with plain bell wire, even though the line impedance can be high, as the connections are very short.

The long-wire connections between the line driver outputs, Tone Control outputs and the output sockets are again bell wire, as the output impedances are low.

Conclusion

Figures 7 and 8 illustrate how the 'Newton' modules can be configured in different ways to create a customised preamplifier. My own version (the prototype in the photos) follows the pattern of Figure 8, but having tape input and monitoring for two recorders, and two unswitched and four switched Euro mains outlets for six other components of the stereo system. If you play CDs more often than records, you might consider adding a miniature toggle switch to the rear panel of the PSU chassis, to turn off the phono preamp DC heater and preserve the life of the valves while they are not being used.

I think we all agree that the valve technology resurrection has coincided nicely with the increased availability of compact discs and players, and valves generally make the most of them. They are in their element, as it were, given the CD's high output and wide dynamics. This is very interesting, because it just goes to show how much the early valve equipment was compromised not only by some inferior electrical components (by modern standards), but also by the quality of the transducers of the time, all contributing to even less perfect recordings to be replayed. CDs are an improvement out of all proportion and don't seem to faze the modern valve amplifiers at all, in fact, they have given them a new lease of life. An interesting demonstration CD is available from Maplin (AY00A), which includes test tones, an organ recital, a drum solo and various far-out sound effects, including a jet fighter flypast!

What advantages are offered by the passive RIAA equalisation is still a moot point, though I will admit to hearing at least one extra instrument in a record I played recently. The record is over ten years old, but I've never noticed this detail before! Generally, records play really well and it's nice to have an output level on a par with other sources, such as CD. ■

NEWTON TONE CONTROL UNIT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)

R1	2k2 2W 1% Metal Film	1	(D2K2)
R2	4k7 3W Wirewound	1	(W4K7)
R3,103	62k	2	(M62K)
R4,104	20k	2	(M20K)
R5,15,16, 105,115,116	470k	6	(M470k)
R6,106	270Ω	2	(M270R)
R7,107	5k1	2	(M5K1)
R8,108	680k	2	(M680K)
R9,109	220Ω	2	(M220R)
R10,110	4k7	2	(M4K7)
R11,111	150k	2	(M150K)
R12,112	39k	2	(M39K)
R13,113	68k	2	(M68K)
R14,114	6k8	2	(M6K8)
RV1,2	220k Dual Logarithmic Potentiometer	2	(FX13P)
RV3	1MΩ Dual Linear Potentiometer	1	(FW91Y)
RV4	10k Dual Logorithmic Potentiometer	1	(FX09K)

CAPACITORS

C1,4,8,108	10nF HV Ceramic Disc	4	(BX15R)
C2,3	47μF 450V Radial Electrolytic	2	(JL18U)
C5,105	100nF HV Ceramic Disc	2	(FA21X)
C6,9,106,109	10μF 450V Radial Electrolytic	4	(JL11M)
C7,10,107,110	10nF Poly Layer	4	(WW29G)
C11,111	330pF 1% Polystyrene	2	(BX51F)
C12,112	560pF 1% Polystyrene	2	(BX54J)
C13,113	8n2F 1% Polystyrene	2	(BX85G)
C14,114	2n2F 1% Polystyrene	2	(BX60Q)
C15,115	22nF 1% Polystyrene	2	(BX87U)

VALVES

V1,101	ECF82 HF Triode Pentode	2	(ST30H)

MISCELLANEOUS

1mm PCB Pins	1 Pkt	(FL24B)
B9A Valve Base	2	(CR32K)
Rubber Coupling	4	(FB98G)
Anti-parasitic Beads	1 Pkt	(LB62S)
M4 Steel Nut	1 Pkt	(JD60Q)
Single Mic Cable	1m	(XR16S)
0·71mm 22swg Linned Copper Wire	1 Lenth	(BL14Q)
Bell Wire Black	1 Lenth	(BL85G)
Bell Wire Orange	1 Lenth	(BL90X)
Systoflex 2mm Black	1 Lenth	(BH06G)
Instruction Leaflet	1 Lenth	(XV12N)
PCB	1	(95132)
Constructor's Guide	1	(XH79D)

OPTIONAL

Knob K8A	4	(YR64U)

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 a kit which offers a saving over buying the parts seperately.
Order As 95131 (Newton Tone Control Module) Price £39.99 A1

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 item (which is included in the kit) is also available separately, but is not shown in the 1996 Maplin Catalogue
Tone Control Module PCB **Order As 95132 Price £4.99**