New 30W stereo amplifier project - 3

Full details of construction

This month we'll show you how easy it is to build the new Playmaster 30-30 amplifier. Virtually all of the parts, including the heatsinks, mount on one large printed circuit board.

by ROB EVANS

As you may see from the pictures of our prototype, the assembled printed circuit board (PCB) fits neatly into a medium sized case, with very little interwiring.

The case is in fact one of the standard sizes in the "Horwood" range of instrument cases, but with an added front panel cut from a sheet of 1.5mm aluminium. These cases are readily available, and represent excellent value when compared to a suitable rack mounting case for example.

The overall box dimensions are 305 x 228 x 76mm, with a front panel measuring 325 x 80mm; this means the Playmaster 30-30 is quite a compact unit for its power and facilities.

The PCB (coded 88sa8) measures 220 x 220mm and dominates most of the internal space. The board is supported by the front panel controls and the RCA input sockets, with the main body of the PCB carried by 3 insulated standoffs. The remaining chassis area holds the power transformer, mains wiring, and loudspeaker connectors.

Components

Before discussing the assembly procedure for the Playmaster 30-30, we need to consider a few component choices which will effect the performance and cost of the unit. These choices mainly involve components in the phono preamp, so you may wish to consider if records are your prime listening source, or compact discs and other "line" inputs monopolise your listening time.

Naturally, if you rarely use the phono facility, the extra expense of higher quality components is unnecessary; particularly since this stage delivers quite a creditable performance in its standard form. However, if it's even higher performance you are seeking, the changes are simple.

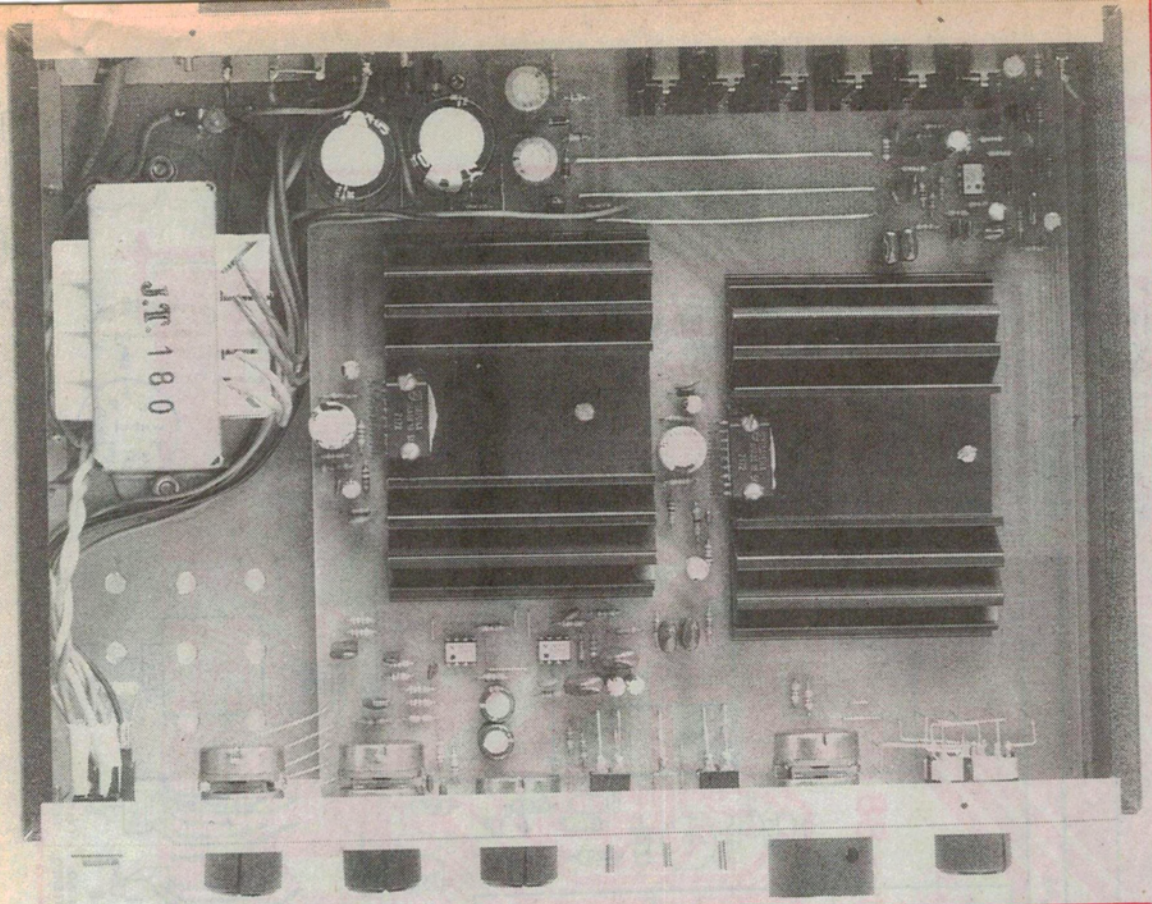
The TL072 op-amp in the phono stage may substituted by an LM833 for example. This is a wide bandwidth low noise device which is pin for pin compatible with most dual op-amps, and will slot directly into the existing circuit. Also, the transistors which form the input differential pair (Q1 and Q2) could be changed for more exotic devices, such as the low noise 2SC2545. However, carefully check the pin configuration of alternative transistors. For example, the 2SC2545 pins happen to be in the reverse order to those of a BC549, and when installed its body must face in the opposite direction to that as shown in the component overlay.

Another refinement of the phono preamp's performance is to include close tolerance components (1% or 2%) in the RIAA feedback network, including R8 to R10 and C5 to C7. This will ensure that the frequency response on the phono input will at least match the accuracy of our prototype, which tracked the RIAA curve within +/- 0.5dB.

At this point you may also wish to consider if the CD attenuating resistors are required. If you have a CD player with a nominal output of around 2 volts, values of 47k and 6.8k for Rx and Ry respectively should match the CD player's output to the amplifiers 250mV rating. Other attenuation levels may be easily calculated using standard voltage divider techniques.

The remaining component considerations involve the question of compatibility, rather than performance. These are the choice of filter capacitors and the power transformer.

The filter capacitors used in our prototype (5600uF 40V), are a neat fit



The neat internal layout and simple construction of the 30-30 amplifier is due to careful PCB design, and the use of integrated power amplifier ICs.

amongst the other PCB components, leaving little space for units that are physically larger. If capacitors of this size are unavailable, 4700uF 35V types should easily fit, resulting in a slight drop in the amplifier's maximum output power. Alternatively, extra space could be generated by juggling the position of the mounting holes, and physically larger capacitors of the specified value installed.

The power transformer for this amplifier must have a secondary voltage of 22-0-22 volts or less, due to the maximum voltage limitations of the TDA1514A chips. Depending on the rating method of the manufacturer, a 22-0-22 volt transformer may have a secondary voltage as high as 25-0-25 volts when lightly loaded. This would produce supply rails of about +/-35 volts, which significantly exceeds the +/-30 volt maximum rating of TDA1514A chips. The power transformer chosen for the Playmaster 30-30 amplifier *must not* produce supply rails that exceed this +/-30 volt rating, or the power ICs may be damaged.

Fortunately, the suitability of a transformer may be easily tested by measuring its off-load secondary voltage, which should be about 22-0-22 volts or less. In fact, a conservatively rated 20-0-20 volt transformer may be quite appropriate, since its off-load voltage would be around the required 22-0-22 volts. These voltage levels will depend on the local mains voltage, which should be taken into consideration during these measurements and the initial amplifier testing. Note that the published performance specifications of our prototype were achieved with a 22-0-22 volt, 1.5 amp transformer labeled JT180.

Wiring the PCB

The first step before installing components on any PCB, is to check the pattern for anomalies such as broken or bridged tracks. Also check the various bolt holes for correct sizing; it's much easier to re-drill them now, rather than dodging components later.

Begin the actual assembly by mounting the lower profile parts first while carefully following the component overlay, noting component positions and polarities (if applicable). Start with the links and work your way through to the larger components. There are 10 links on the PCB, including three long connections between the power supply and the phono stage; these should be constructed from insulated wire which will prevent contact with other components.

All of the resistors may mount flush with the PCB, except those with a higher power rating. These resistors are numbered R28 to R33, and should be positioned slightly above the board to assist their cooling. The larger capacitors should also mount flush with the PCB to provide maximum mechanical stability (note that the main filter capacitors have a third mounting pin).

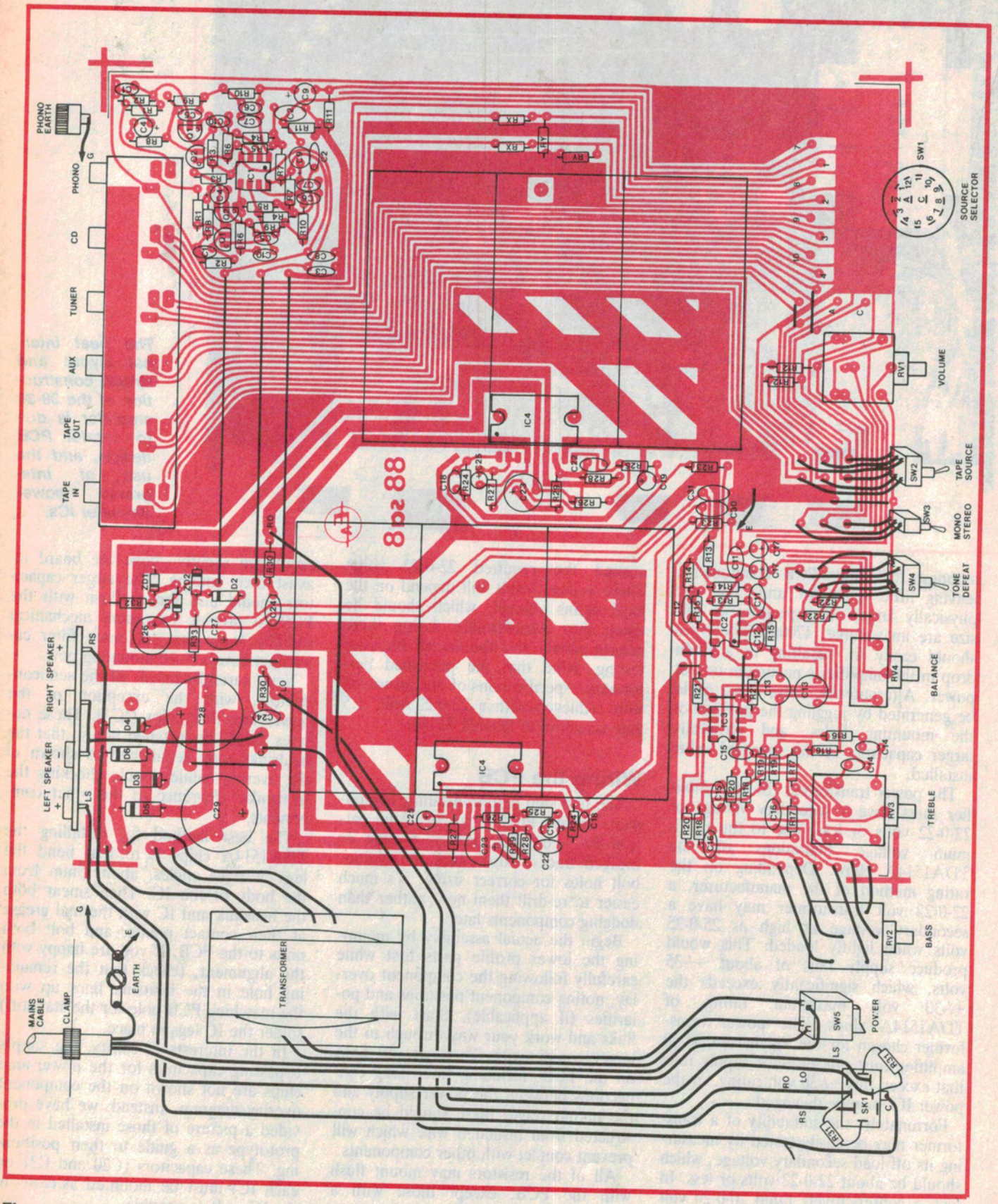
Next, carefully install all the semiconductors, with the exception of the power amplifier chips (IC4). These devices should be installed last so that the heatsinks may be aligned as shown in the overlay, while double checking the heatsinks' clearance to the other components.

The best method for installing the TDA1514A chips is to first bend the legs at right angles, about 5mm from the body of the IC. Then smear both the heatsink and IC with thermal grease at their contact points, and bolt both units to the PCB. If you are happy with the alignment, (check that the remaining hole in the heatsink lines up with the matching PCB hole for the standoff) solder the IC legs in place.

In the interests of clarity, the supply bypassing capacitors for the power-amp chips are not shown on the component overlay diagram. Instead, we have provided a picture of those installed in the prototype as a guide to their positioning. These capacitors (C20 and C21 on each IC) must be mounted as *close* to the IC pads as possible.

Don't forget these capacitors, because

30W stereo amplifier



The component overlay and wiring diagram. The PCB pattern and front and rear panel artwork are too large to reproduce on these pages, however copies may be ordered through the EA Reader Services section.

the high bandwidth and slew rate of the TDA1514A chips may induce some instability if they are omitted.

The next step is mounting the potentiometers, switches and RCA sockets, all of which locate the PCB within the box. The pots should be temporarily mounted on the PCB (not soldered in place), so that the mounting points may be compared to the box dimensions, which tend to vary from unit to unit. The PCB has been designed so that the distance between the RCA sockets and the pots threads is slightly shorter than the depth of the specified box. This allows room for adding spacers to the pot shafts, making the whole assembly a neat fit within the box. By measuring the distance on the PCB assembly (in its temporary form), we can decide how many spacers are required or if the pot legs need to be bent either way.

If the pot shaft threads are too short for the required number of spacers, you may need to leave a small gap between the RCA sockets and the rear panel in the final assembly stage. This won't significantly restrict access to the RCA sockets, and prevents the need for any component repositioning. When calculating this spacing, remember to include the small dimension added by the front panel.

Finally, remove the pots and cut the shafts to match the depth of the knobs. Then re-install the pots and solder them in place, while double checking their vertical alignment with a ruler. Install the remaining components, while carefully referring to the component overlay diagram. The switches and bass pot are attached to the PCB by short tinned copper wire stalks', which may be trimmed or aligned after the PCB assembly has been installed in the box.

Preparing the box

If the "Horwood" style of box is to used to house the Playmaster 30-30, the front dress panel will need to be attached before installing any electronics. On our prototype, this was located by 4 countersunk bolts to maintain an even surface for the addition of a "Dynamark" (or Scotchcal) panel. The mounting holes in the front and rear panels should be drilled using the panel artwork as a guide, while double checking each component for a neat fit.

Check that the headphone socket has enough thread to clear both the box front panel, and the additional dress panel. If more thread is required to install the locking nut, enlarge the hole in the box front panel only, leaving the threaded bush to penetrate the single thickness of the dress panel.

Next, temporarily install the PCB assembly in the box to serve as a guide for the remaining holes and components. With the bottom panel in place, mark the holes for the transformer, earth lug and PCB supporting spacers. When drilling these holes, take the opportunity to prepare the panel fixing screw holes around its perimeter.

The top and bottom box panels will need to be perforated with a number of holes. This will allow air to flow through the box, cooling the PCB mounted heatsinks. Drill as many holes as your patience will allow – it's better if the heatsinks are over-cooled than under-cooled. However, avoid the transformer mounting area on the bottom panel, as too many holes may cause the metal to flex due to the substantial weight of the transformer.

With the PCB assembly removed, the next step is to attach the front and rear "Dynamark" panels. This can be a little tricky since Dynamark panels must be aligned correctly on the first attempt; they cannot be removed without being damaged.

A successful method for aligning these panels is to first pierce small holes to mark the centre of the panel holes or cutouts. Then tape the panel face down on a smooth flat surface (make sure this surface won't scratch the artwork), with the protective backing paper removed. The box panel may then be carefully pressed onto the Dynamark panel using the holes as a guide. Then trim the artwork to size with an art knife or scapel.

The PCB assembly may now be permanently installed in the box, but leave the top and bottom panels off for the moment so the final wiring may be completed.

Final assembly

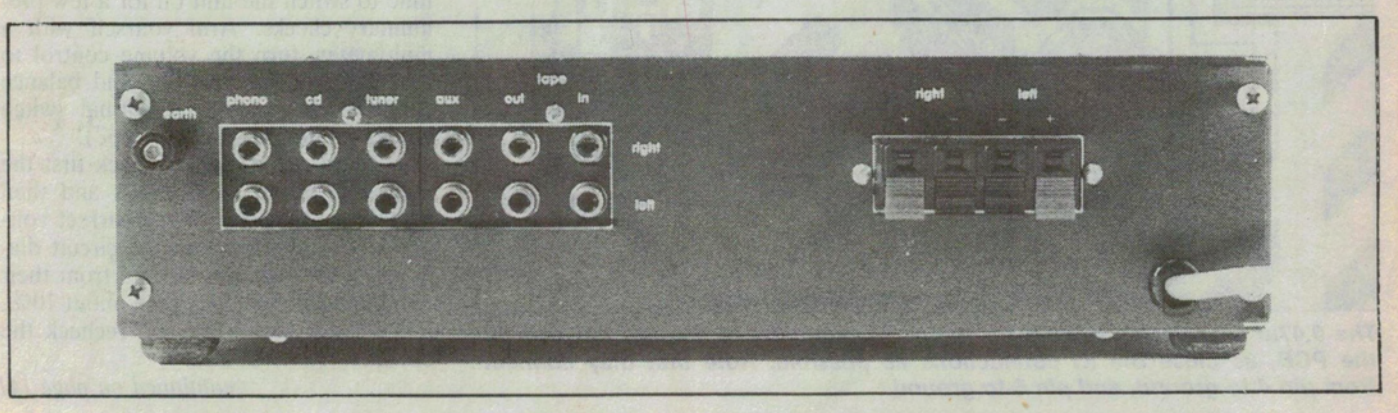
These final stages are quite straightforward since most of the amplifier's wiring is an integral part of the PCB. The remaining wiring carries the mains power and speaker signals.

Before commencing any wiring, the supporting spacers should be screwed to the PCB with extra washers used to increase their length. This length may be checked with a ruler held where the bottom panel normally lies. Note that these spacers must be of the insulated type, because the mounting face of the power ICs, and therefore the heatsinks, are connected to the negative supply rail. Also, before bolting the mains earth lug in place, its mating surface on the bottom panel should be cleaned with a file or sandpaper to ensure a reliable contact.

Begin the final wiring by connecting generous lengths of heavy gauge hookup wire to the four speaker pads on the PCB. Also connect lengths of wire to the PCB central earthing point (on the underside of the board near C30 and C31) and the phono earthing post. The latter wires may lay under the PCB when finally connected to the chassis earth lug.

Note that one of the two leads coming from the two "common" speaker pads on the PCB connects to the headphone socket, while the other connects to both negative speaker terminals.

To connect the power transformer's secondary leads lay the box on its side, place the transformer loosely inside and solder the wires to the appropriate



pads. Pay particular attention to these wires; they should be cleaned and carefully soldered so as to avoid dry joints, and the two inner connections taken to the common pads for a centre-tapped configuration.

The bottom panel may now be screwed in place, the transformer secured and the remaining wires connected. Once again, refer to the component overlay for the earth connections, the speaker/headphone wiring and mains connections. Note that the headphone socket must be of the insulated switching type, and the *normally closed* contacts are used.

The mains wiring at the power switch terminals *must be insulated* with protective sleeving, and the cable solidly locked with a cable clamp at the box entry point. Also ensure that the green/yellow lead of the mains cable is connected to the earth lug.

The "Horwood" style box has a metal bottom panel which may tend to vibrate due to the power transformer's electrical influence. This may be cured by inserting a thin rubber or plastic spacer under the transformer's main body, to hold the panel firmly in place. However, make sure the mounting tags remain directly connected to the panel; this will maintain continuity to the transformer's frame and electrical shield. At this stage, it may be worth checking the transformer, pots, switches, and all box panels for continuity to the earth lug.

The test flight

Now that the amplifier is completed, it's worth spending a few extra minutes to double check the wiring and component orientation against the overlay diagram. Pay particular attention to the orientation of the semiconductors and polarised capacitors.

PARTS LIST

1 printed circuit board, code 88sa8, 220 x 220mm
1 box, 305 x 76 x 228mm
2 heatsinks, 75 x 105mm
1 power transformer, 22-0-22VAC at 1.5A (see text)
1 4-way spring push speaker terminals
2 3 x 2 way PC mount RCA sockets
1 4mm binding post (black)
4 rubber feet
1 stereo insulated 6.5mm socket, with DPDT contacts
1 DPDT illuminated miniature rocker switch (mains rated)
2 DPDT miniature toggle switches
1 SPDT miniature toggle switch
1 2-pole 4-position sealed rotary switch
4 22mm black anodised knobs
1 30mm black anodised knob
1 mains cord clamp
1 mains cord and plug
1 earth lug
3 15mm tapped insulated standoffs

Semiconductors

2 Philips TDA1514A power-amp ICs
3 TL072 op-amps (see text)
4 BC549 NPN transistors (see text)
2 15V 1W zener diodes
2 1N4002 diodes
4 1N5404 power diodes

Capacitors

2 5600uF 40V PCB mount electrolytics
2 1000uF 16V PCB mount electrolytics
2 220uF 63V PCB mount electrolytics
4 33uF 16V PCB mount electrolytics
2 10uF 63V PCB mount electrolytics
2 6.8uF 50V PCB mount bipolar electrolytics
4 1uF 16V PCB mount electrolytics
4 0.47uF 100V metallised polyesters
2 0.15uF 100V metallised polyesters
6 82nF 100V metallised polyesters
2 39nF 100V metallised polyesters
4 22nF 100V metallised polyesters
2 4.7nF 100V metallised polyesters
4 3.9nF 100V metallised polyesters
2 3.3nF 100V metallised polyesters
2 1.5nF 100V metallised polyesters
4 1nF 100V metallised polyesters
2 390pF ceramics
2 100pF ceramics

Resistors (all 0.25W, 5% unless noted)

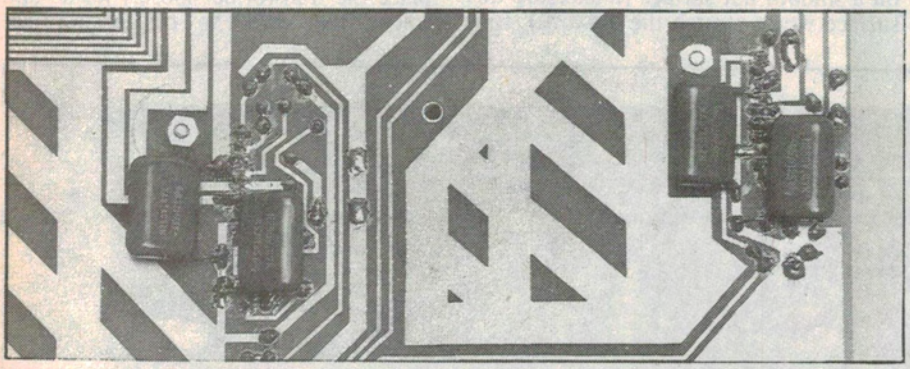
2 x 820k, 2 x 680k, 2 x 270k, 2 x 150k, 2 x 82k, 2 x 68k, 2 x 56k, 2 x 47k, 6 x 27k, 6 x 15k, 2 x 12k, 2 x 10k, 2 x 5.6k, 2 x 4.7k, 4 x 3.9k, 4 x 2.7k, 2 x 1.2k, 2 x 820 ohms (0.5W), 2 x 680 ohms, 2 x 330 ohms (0.5W), 2 x 220 ohms (0.5W), 2 x 120 ohms,
2 x 47 ohms (0.5W), 2 x 6.8 ohms (0.5W)

Potentiometers

1 PC mount dual gang 100k linear
1 PC mount dual gang 50k log
1 PC mount dual gang 25k linear
1 PC mount single gang 25k linear

Miscellaneous

hookup wire, nuts and bolts and washers, heatsink compound



The 0.47uF stability capacitors for the power amplifier ICs mount underneath the PCB, as close the IC connections as possible. Note that they connect from pin 4 to ground, and pin 6 to ground.

If you are satisfied that all is well, it's time to switch the unit on for a few preliminary checks. Arm yourself with a multimeter, turn the volume control to minimum, centre the tone and balance controls, and select the normal switch modes (all toggle switches "up").

Switch on, and quickly check first the main DC power supply rails and then the pre-amp supply for the correct voltage levels, as shown on the circuit diagram. If the readings deviate from their nominal value by more than about 10%, immediately switch off and recheck the circuit.

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If all is well, check the other voltages shown around the power-amp chip (IC4), and the phono pre-amp stage (Q1, Q2 and IC1). When checking voltages around the circuit, don't forget that the heatsinks may be at the negative supply rail potential, and should not be inadvertently grounded. This will depend on the electrical, as opposed to thermal contact between the TDA1514A chips and the heatsink.

That's about it for the preliminary checks of the amplifier; there is no quiescent current to be set, no DC offsets to adjust, or thermal tracking to be checked. However, the TDA1514A chips (and the heatsinks) will normally be quite warm, so the unit should be monitored over a reasonable length of time for any limitations of the box ventilation. Also, the quiescent current of the TDA1514A chips will significantly increase if the power supply rails are beyond the recommended limit, which of course depends on the chosen transformer.

As a final check, connect a suitable input to the RCA sockets and check the controls and switches for their correct operation. After that, you are ready to experience the high performance of your new Playmaster 30-30 amplifier. EA