Here are the construction details for the Playmaster 60/60 stereo amplifier Pt.3

This is the easiest to build Playmaster amplifier ever. Virtually all the parts, including the pots, mount on a single large printed circuit board (PCB) and there is very little wiring. Here we present the full construction details.

by JOHN CLARKE & GREG SWAIN

Our prototype amplifier was built into a standard rack mounting case measuring 430 x 82 x 254mm with a front panel measuring 88 x 482mm. Most kit suppliers, however, will be supplying special folded metalwork for the chassis. This will have the same dimensions as the rack mounting case but will make assembly simpler.

The printed circuit board (PCB) measures 420 x 249mm and is coded 86sa5. In the left hand corner is a cutout measuring 111 x 111mm which provides clearance for the toroidal transformer.

The chassis layout of the amplifier can be seen in the photographs. The PCB occupies most of the chassis and is supported at the rear by the PCB-mounted RCA sockets and at the front by the PCB-mounted potentiometers.

Running across the full width of the PCB is a large U-shaped heatsink. This provides heat dissipation for the output transistors and is secured to the PCB with the power transistor mounting bolts. Additional support for the PCB is provided by securing the whole assembly to 25mm standoffs installed on the chassis at either end of the heatsink.

The only components not on the PCB are the power transformer, indicator LED, loudspeaker binding posts, and the power and selector switches. In fact, we have gone to considerable lengths with this design to keep wiring to an absolute minimum.

This has been done to relieve this tedious aspect of construction and to eliminate wiring errors.

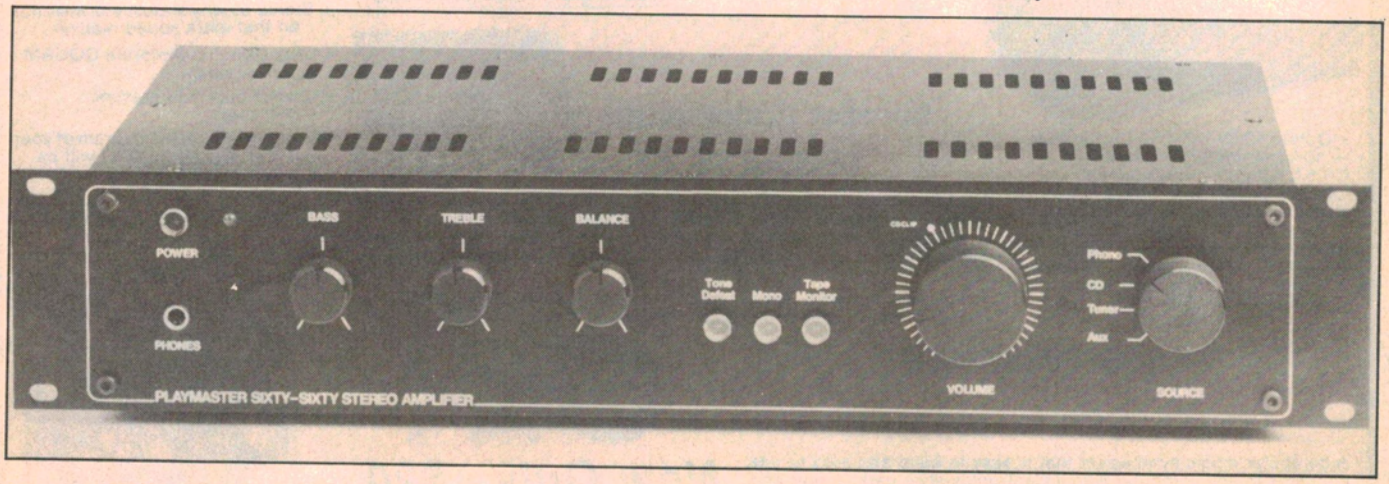
Complete kits will be available from several retailers and will include screen printed front and rear panels, prepunched metalwork, a drilled heatsink and all the necessary parts.

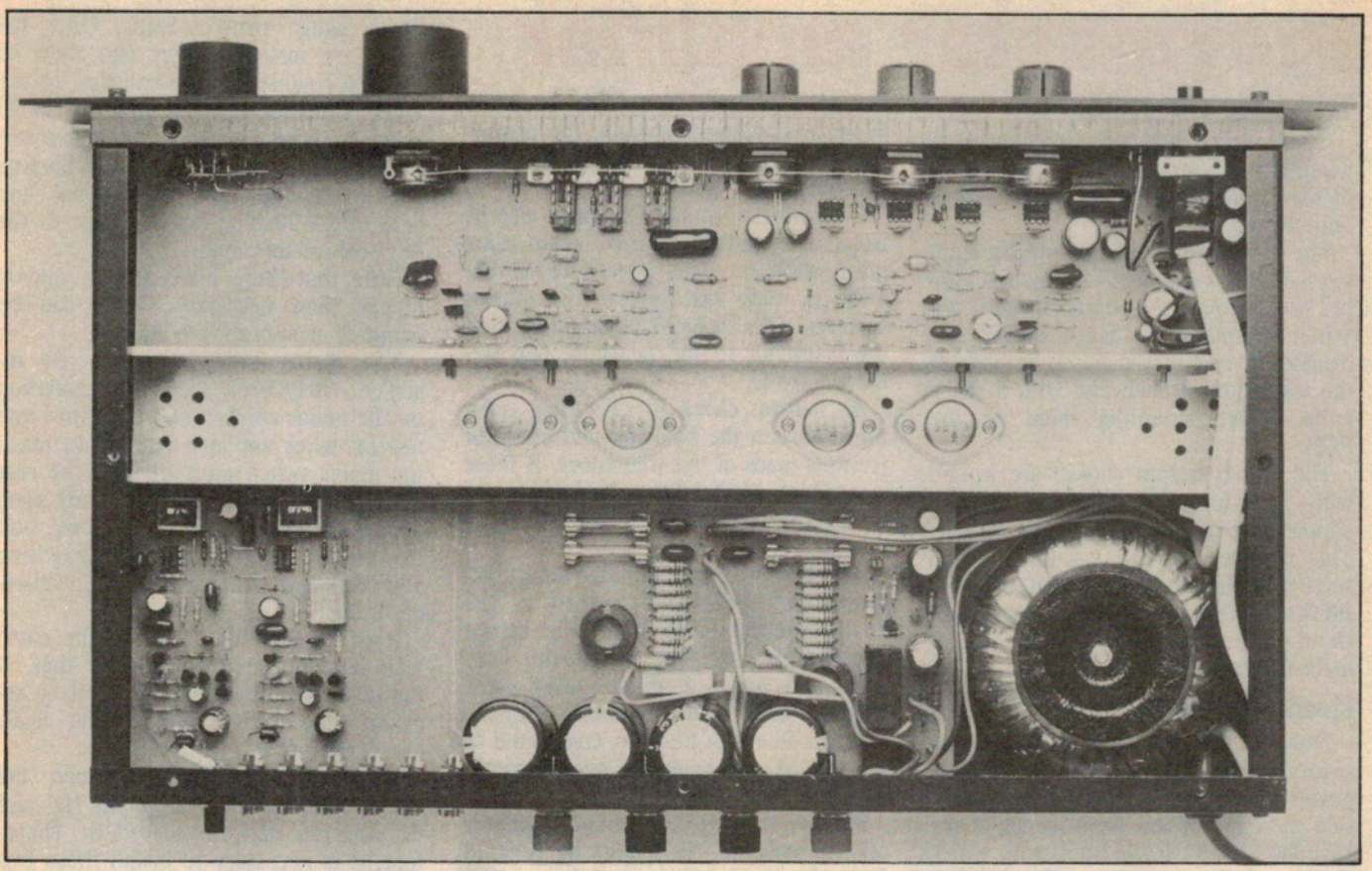
Of course, constructors can make their own metalwork or use an off-the-shelf rack mounting case, and purchase the remaining parts from various sources. Be warned, however, that certain individual parts may be difficult to purchase separately, so check carefully before adopting this approach.

Consider this also: if you have to buy all the parts separately (not having any in your junkbox), the cost is likely to far exceed the price of a complete kit.

PCB assembly

Before installing any parts on the PCB, check the copper pattern carefully for possible defects. A thorough check at this stage could prevent a lot of problems later on. Note that there are quite a few earthed guard tracks on the PCB which are only terminated at one end — don't join these to adjacent pads or tracks by mistake.





The new Playmaster 60/60 is easy to build yet offers superb performance. Take care with mains wiring.

The low profile components should be installed first. These include the wire links, diodes and resistors. Follow the parts layout diagram carefully and make sure you orient the diodes correctly.

Use insulated single-strand wire for the long wire links adjacent to the heatsink. Alternatively, you can use tinned copper wire fitted with insulating sleeving for this job. This is to prevent possible shorts between the links and to the heatsink.

Most of the resistors are 0.25W types but be sure to use higher wattage types where specified. These are clearly indicated on the parts layout diagram.

The 1Ω 1W resistors in the amplifier output stages are best installed by first mounting every alternate resistor. The remaining resistors can then be installed by pushing them down onto the board as far as they will go, between the resistors already in place.

PC stakes are used at all external wiring points on the PCB and these can be installed next. There are 26 PC stakes in all and these terminate connections from the source switch, indicator LED, loudspeaker terminals, power supply, and between the power amplifier outputs and the relay contacts.

The ICs and most of the transistors can now be installed but do not mount the power transistors or Q12, Q13 and Q14 at this stage. Check the transistor pinouts against the circuit diagram published last month and make sure that you install the correct type at each location.

Push each transistor down onto the board as far as it will comfortably go before soldering. Note carefully the orientation of the ICs when they are being installed. The bridge rectifier (PO-4) can also be installed at this stage.

Capacitors

The next step is to install the capacitors. This job is straightforward but note that the electrolytics must be oriented correctly and must have the correct voltage rating for each position. Check the parts layout diagram against the circuit diagram if in doubt.

The bipolar electrolytics can be installed either way round.

The main filter capacitors used in the prototype were Elna 2500μF 63V types. However, provision has also been made on the board to accommodate the physically smaller Philips 2200μF 63V capacitors and these may be substituted for a slight loss of output power (about 2W in each channel). Apart from this power loss, no other performance specification will be affected.

Note that 2% capacitors have been specified in the RIAA feedback networks in the phono preamplifiers. Now 2% capacitors are quite expensive and difficult to obtain. For this reason, parts suppliers will be selecting 2% capacitors from standard stock.

These selected capacitors will be marked with a small blob of paint and packaged separately.

The RCA socket panel, fuse clips, relay, headphone socket, trimpots and potentiometers can now be installed. Push the headphone socket and pots down onto the board as far as they will go, so that they will later line up correctly with the front panel.

In some kits, the Tone Defeat, Mono and Tape Monitor pushbutton switches will be supplied in a bank, supported by a metal channel. This metal channel should be bolted to the holes provided in the PCB. If, on the other hand, the switches are not in a bank, they are simply installed separately.

To the uninitiated, the RCA socket panel can be an awkward beast to install. The trick is to install the leads at one end first then, using pliers, progressively locate each of the remaining leads. A short length of tinned copper wire will be required to connect the earth terminal to the PCB.

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Winding the coils

There are only four simple coils to wind: the two ferrite beads at the inputs of the phono preamplifier, and the two output chokes.

The ferrite beads are wound by feeding 5.5 turns of 28 B&S enamelled copper wire through the centre of the bead. When complete, the leads should exit from each end of the bead. Scrape off the insulation at each end with a sharp knife before mounting them on the PCB.

The 6.8μH output chokes are wound with 24.5 turns of 0.8mm enamelled copper wire on an 11mm plastic former. This involves winding on three layers such that the leads exit from opposite sides of the former at the bottom edge. Bend the leads at 90° so that the chokes mate with the holes on the PCB.

Heatsink transistors

Now for the heatsink-mounted transistors. The MJ15003 and MJ15004 power transistors (Q15, Q16) mount inside the "U" of the heatsink while the MJE340 and MJE350 transistors (Q13, Q14), together with the +15V 3-terminal regulator, are bolted to the side of the heatsink.

In addition, the two BC547 quiescent current setting transistors (Q12) are clamped to the side of the heatsink using solder lugs.

First, check that all the holes in the heatsink are free of burrs and metal swarf. This done, mount the heatsink on the top of the PCB and secure it at each end with a bolt and 25mm tapped standoff. Note that the heatsink must be oriented so that the transistor mounting holes align with the holes in the PCB.

The four output transistors (Q15, Q16) can now be installed. These must all be isolated from the heatsink using mica washers and insulating bushes, as depicted in Fig.1. Smear all mating surfaces with heatsink compound before assembly and solder the mounting nuts to the PCB pads after assembly to ensure reliable long term contact.

Note that while the mounting screws must be isolated from the heatsink, they must also connect the transistor cases to the PCB tracks. In some kits, the insulating bushes will be supplied with integral washers. If this is the case, remove the plastic washers from eight of the insulating bushes using a sharp knife (do not touch the remaining ninth bush).

As each transistor is mounted, use your multimeter to check that its case is indeed insulated from the heatsink. When everything is correct, the transistor leads can be soldered to their respective copper pads.

Transistors Q13 and Q14 must also be isolated from the heatsink, again using mica washers. The procedure is the same in each case: smear the mating surfaces with heatsink compound, bolt the transistor to the heatsink, and solder the leads.

As before, check for electrical isolation between the heatsink and collector (centre) leads of the transistors. If there is a short, check the mica washer for punch-through by a piece of metal swarf.

As previously stated, the two BC547 transistors (Q12) are clamped to the heatsink using earth lugs. The colour photographs on page 29 of the May issue and page 35 of the June issue clearly show the mounting details. Apply a smear of heatsink compound to the face of each transistor before installing it on the board.

Finally, the 7815 3-terminal regulator can be installed. This must be isolated from the heasink using a mica washer and an insulating bush with integral washer. The washer goes under the screw head so that no part of the screw can contact the metal tab of the regulator. Don't forget to smear the mating surfaces with heatsink compound.

That completes the PCB assembly. Before moving on to the next stage, it is a good idea to check your work against the parts layout diagram. In particular, check that all resistor and capacitor values are correct and that all diodes, transistors, ICs and electrolytics are correctly oriented.

Wiring

Attention can now be turned to the chassis. Begin by installing the loudspeaker binding posts on the rear panel. Incidentally, these binding posts should be of a reasonable size to accommodate heavy gauge speaker leads. Once the posts are installed, they can then be wired for subsequent connection to the PCB. Connect 12cm lengths of 24/.20 green hookup wire to the negative terminals, 15cm of 24/.20 brown hookup wire to the right positive terminal, and 8cm of 24/.20 blue hookup wire to the left positive terminal.

Note that these leads are all slightly longer than necessary. They can be trimmed as appropriate later on.

The mains wiring can now be installed. Strip back the outer insulation on the mains cord so that the active and neutral wires are long enough to reach the mains switch position from the rear panel, then secure the mains cord using a cord clamp grommet. That done, bolt two solder lugs to chassis (see wiring diagram) and connect the green/yellow earth lead.

It is a good idea to make the earth lead longer than necessary so that, if the mains cord is ever pulled out by accident, the active and neutral leads come adrift first.

The two connections between the chassis and the PCB at points 'D' and 'K' are run beneath the PCB. Therefore, it is necessary to install these two earth leads before installing the PCB in the chassis. Connect a 40cm green/yellow earth lead to point 'D' on the PCB and a 20cm earth lead to point 'K'.

The PCB can now be manoeuvred into position and secured by bolting the 25mm standoffs and the RCA socket panel to the chassis. This done, bolt the toroidal transformer to the chassis using the hardware supplied. One large rubber washer is sandwiched between the transformer and the chassis, while the other goes between the top of the transformer and the metal disc.

Follow the wiring diagram closely when soldering the transformer secondary leads to the PCB. The colours indicated on the layout diagram correspond with the transformer lead colours. The PCB earth leads and the leads from the loudspeaker terminals can also be terminated at this stage.

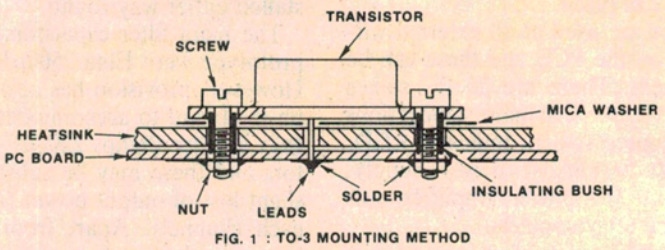
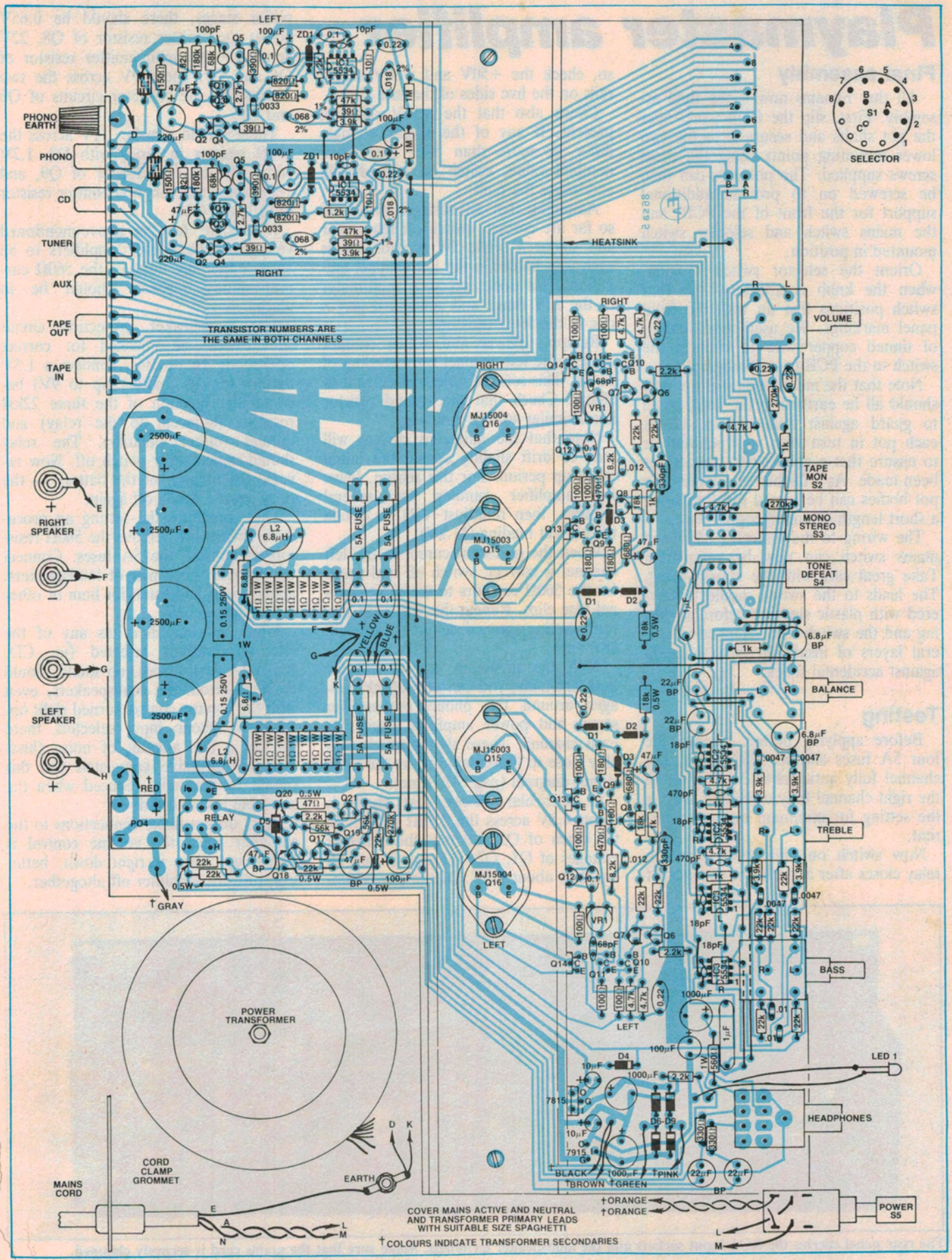


Fig.1: this diagram shows how the Mosfet output transistors are mounted.


LEFT
RIGHT
PHONO EARTH
PHONO
CD
TUNER
AUX
TAPE OUT
TAPE IN
TRANSISTOR NUMBERS ARE THE SAME IN BOTH CHANNELS
SELECTOR
S1
HEATSINK
VOLUME
TAPE MON S2
MONO STEREO S3
TONE DEFEAT S4
BALANCE
TREBLE
BASS
POWER S5
HEADPHONES
LED 1
RIGHT SPEAKER
LEFT SPEAKER
MJ15004 Q16
MJ15003 Q15
5A FUSE
RELAY
POWER TRANSFORMER
CORD CLAMP GROMMET
MAINS CORD
EARTH
COVER MAINS ACTIVE AND NEUTRAL AND TRANSFORMER PRIMARY LEADS WITH SUITABLE SIZE SPAGHETTI
†COLOURS INDICATE TRANSFORMER SECONDARIES
†GRAY
†BLACK
†BROWN
†GREEN
†PINK
†ORANGE
†ORANGE
YELLOW
BLUE
RED

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Final assembly

All that remains now is the final assembly. First, slip the front panel over the pot shafts and secure it to the two lower mounting points using the dress screws supplied. The pot nuts can then be screwed on to provide additional support for the front of the PCB, and the mains switch and selector switch mounted in position.

Orient the selector switch so that, when the knob is attached, the four switch positions line up with the front panel markings. We used short lengths of tinned copper wire to connect the switch to the PCB (see photograph).

Note that the metal bodies of the pots should all be earthed to the front panel to guard against hum pickup. Check each pot in turn with your multimeter to ensure that a good earth contact has been made. As a further precaution, the pot bodies can be joined together using a short length of tinned copper wire.

The wiring to the indicator LED and mains switch can now be completed. Take great care with the mains wiring. The leads to the switch should be covered with plastic sleeving before soldering and the switch then wrapped in several layers of insulation tape to guard against accidental shock.

Testing

Before applying power, remove the four 5A fuses and set VR1 in the left channel fully anticlockwise and VR1 in the right channel fully clockwise. This is the setting for minimum quiescent current.

Now switch on and check that the relay closes after about three seconds. If so, check the +50V and −50V supply rails on the live sides of the fuse clips.

Check also that the +15V rails are present. If any of the supply voltages differ by more than 10% from their nominal value, switch off immediately and locate the fault.

Assuming that all voltages measured so far are correct, switch off the power and solder a 560Ω 5W resistor across each fuse holder in the left channel amplifier. This done, set your multimeter to the 20V range and connect it across one of the 560Ω resistors.

Re-apply power and adjust trimpot VR1 in the left channel for a reading of 11.2V. This sets the quiescent current to 20mA. Check that the second resistor has a similar voltage across it.

Note that the quiescent current will tend to drift slightly during the initial warm-up period. For this reason, leave the amplifier running for several minutes, then re-adjust VR1 to obtain the correct reading (11.2V).

When the quiescent curent in the left channel is correct, switch off and transfer the 560Ω resistors to the right channel fuse clips. Repeat the quiescent current setting procedure for the right channel.

With the quiescent current set for both channels, you can now check voltages around the phono preamplifier stages and power amplifier stages for each channel. These should be reasonably close to those depicted on the main circuit diagram (page 37, June).

In particular, check that there is about 4.8V across the 2.7kΩ resistor in the drain of Q5 and that the collector voltages of Q1, Q2, Q3 and Q4 are all equal at about 4.9V. In the power amplifier stages, there should be 0.65V across the emitter resistor of Q8, 22V across the common emitter resistor of Q6 and Q7, and 1.9V across the two resistors in the collector circuits of Q6 and Q7.

There should also be 1.1V across the 180Ω resistor in series with D3, 1.2V across the emitter resistor of Q9, and 1.3V across the common emitter resistor of Q10 and Q11.

Note that, for the above-mentioned voltages in the power amplifiers to be valid, either the fuses or the 560Ω current-limiting resistors should be in place.

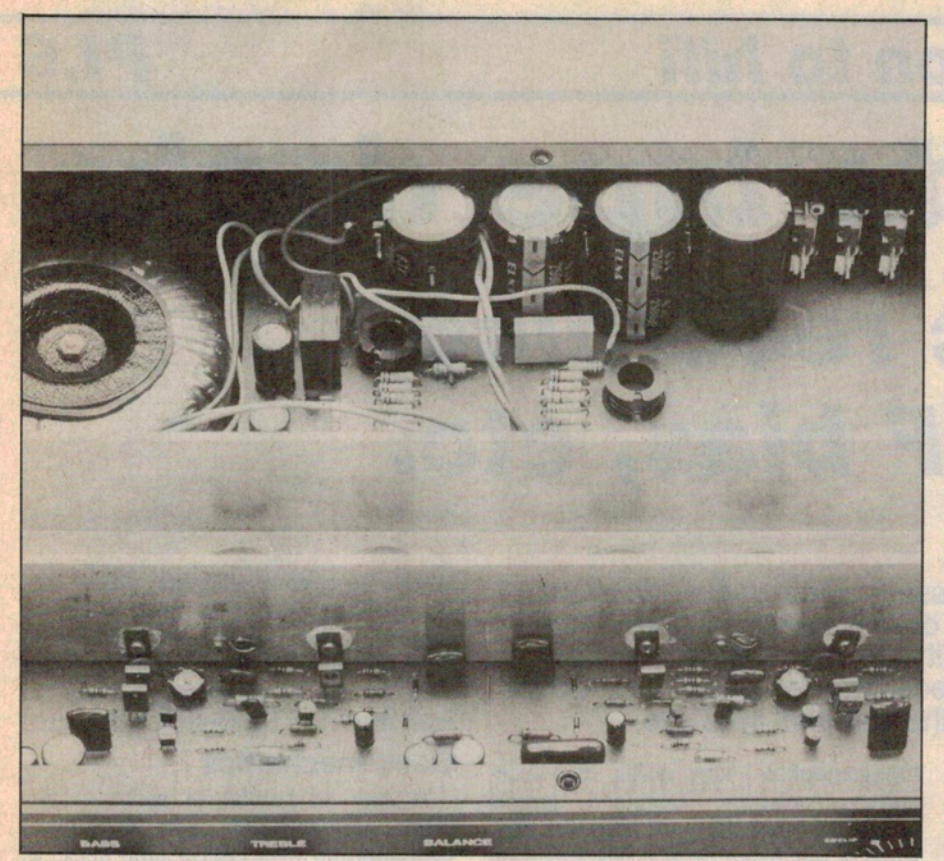
The loudspeaker protection circuit should now be checked for correct operation. To do this, connect a 1.5V battery (or any battery up to 9V) between the junction of the three 22kΩ resistors (adjacent to the relay) and ground (either polarity). The relay should immediately switch off. Now reverse the polarity of the battery — the relay should switch off again.

That completes the setting up procedure. Switch off, remove the 560Ω resistors and install the 5A fuses. Connect the amplifier to a pair of loudspeakers, apply power and listen for hum or other unpleasant sounds.

When the amplifier has any of the line level inputs selected (ie, CD, Tuner, Aux or Tape), no sound should be heard from the loudspeakers, even with the volume control turned right up. With the phono input selected, there will be a fair amount of noise (hiss) with no turntable connected but this should be markedly reduced when the turntable is connected.

Note: do not make connections to the amplifier when the volume control is turned up. Turn it right down; better still, turn the amplifier off altogether.

The rear panel carries the RCA input sockets and the loudspeaker terminals. Make sure that the mains cord is securely clamped.



This close-up view shows how the driver transistors (Q13 and Q14) and the quiescent current setting transistors (Q12) are mounted on the heatsink (see text).

Assuming everything checks out, connect a suitable signal source (CD player, tuner etc) and check all controls for correct operation. The amplifier should deliver clean undistorted power.

Troubleshooting

For those who don't reach the happy state of affairs outlined in the previous paragraph, the following troubleshooting procedure will help track down the cause of your woes. We'll assume that all component values are correct and that all parts have been correctly installed.

Let's start with the preamplifier stage. Ths first thing to do is to check the ±15V supply rails. If the +15V rail is incorrect, check the 7815 regulator. Similarly, if the −15V rail is incorrect, check the 7915 regulator. Note that the pinouts for the two regulators are different. They are both installed with their metal tabs facing towards the heatsink.

Next, check the voltage across the two zener diodes (ZD1) in the phono preamplifier. You should get a reading of 5.6V. If the voltage is incorrect, the zener may be faulty.

If there is a fault in the phono preamplifier, check the voltages marked on the circuit diagram. If you can't get −5.5V on the drain of Q5, then Q5 is suspect. If the voltages on the collectors of Q1, Q3 and Q2, Q4 are incorrect, then IC1 or one of the transistors could be faulty.

Perhaps the most likely source of trouble in the preamplifier stages are the NE5534 ICs. Our experience with these devices indicates that they can be rather fragile. They may not fail completely but may exhibit symptoms of distortion, poor gain, and high noise.

If noise and distortion is evident on all inputs but disappears when the tone defeat switch is pressed, then IC3 is suspect. If the problem persists regardless of the position of the tone defeat switch, IC2 is suspect. If the problem is only present when phono is selected, IC1 is suspect.

The loudspeaker protection circuit is quite easy to troubleshoot. This circuit uses several different types of transistors so check first that the correct transistor has been installed at each location.

If the relay fails to operate at switch on, short the collector and emitter of Q20. If the relay still refuses to operate, Q21 is suspect. If, on the other hand, the relay now operates, the fault lies in either Q17, Q18, Q19 or Q20. You can check Q20 by temporarily removing Q18 and Q19.

If the relay fails to operate when the positive terminal of the 1.5-9V battery is connected to the junction of the three 22kΩ resistors, Q19 is suspect. If the relay fails to operate when the negative terminal is connected to the same point, Q17 and Q18 are suspect.

Troubleshooting in the power amplifier stages should be carried out with the 560Ω resistors wired across the fuseholders in place of the 5A fuses. Begin by checking the ±50V supply rails. Note that these rails can vary by about ±5%, depending on the mains.

If the supply voltages are incorrect, check the transformer connections, the PO-4 bridge rectifier and the 2500μF filter capacitors.

The remaining voltages should all be fairly close to those marked on the circuit (within ±10%). Note that all transistors in the power amplifier stages should have a base-emitter voltage of 0.6-0.8V. If not, then the transistor is suspect or there is a fault in the preceding stage.

There should be about 22V across the 22kΩ resistor in the collector circuit of Q8. If this voltage is much higher, Q8 may be short circuit. If the voltages across the 4.7kΩ resistors are much higher than 1.9V, check Q6 and Q7.

Similarly, if the voltage across the 100Ω resistor is much higher than 1.3V, check Q10 and Q11. And if the voltage across the 180Ω resistor in the emitter circuit of Q9 is higher than 1.2V, check Q9.

Check the offset voltage at the amplifier output — ie, across the loudspeaker terminals. If there is a large positive offset voltage, Q9 or Q10 may be short circuit. If there is a large negative offset voltage, Q11 is suspect.

Q12 sets the quiescent current. If there is little or no quiescent current (ie, no voltage across the 560Ω resistor), then Q12 is suspect. Q12 is also suspect if the quiescent current cannot be varied by VR1 (ie, the voltage remains constant).

Note that an open circuit driver or output transistor (Q13-Q16) will also result in zero quiescent current.

Finally, if the voltage across the 560Ω resistor is almost at full supply (ie 50V), check the corresponding output transistor and its driver stage (Q13-Q16). One of these transistors may be short circuit between collector and emitter, or may be shorted to the heatsink. The 560Ω resistor will become quite warm under these conditions.

That's it. You'll find that this is a superb amplifier.