RADFORD

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MAINTENANCE MANUAL

HD250 High Definition Stereo Control Amplifier

ZD22 High Definition Stereo Pre-amplifier Control Centre

For equipment type HD250/ZD22 Serial No:

Radford Audio Ltd. Bristol BS3 2HZ

ZD22 – HD250 MAINTENANCE MANUAL

1. INTRODUCTION

This manual is concerned with the maintenance of the ZD22 Pre-amplifier and the HD250 Integrated amplifier. The HD250 is in practice a ZD22 Pre-amplifier plus a dual channel power amplifier and a large power supply. The manual is written basically for the HD250 but as the ZD22 circuitry is identical in respect of the pre-amplifier section no special reference is made to the ZD22. It should be noted that the ZD22 physical layout is different from the HD250 in respect of the common modules. This is to obtain maximum advantage from a maintenance point of view of the additional space available on the chassis.

The ZD22 is described in sales leaflet A22 and the HD250 in leaflet A25. These leaflets contain details of design, functions and facilities, and a complete specification. Leaflets B22 and B25 are supplied with the equipments and are concerned with installation of the amplifier. This leaflet (C22/25) is concerned with maintenance, and information contained in the other leaflets is not repeated except where necessary.

2. CONSTRUCTIONAL DETAILS

The HD250 is constructed on a chassis baseplate to which the chassis front and rear panels are attached. The front and rear chassis panels are held together with spacer bars which permits the chassis baseplate to be removed as a separate assembly. The complete unit is sub-divided into modules which are easily detached from the chassis baseplate or from the front and rear chassis assembly. The chassis modules are retained by shakeproof clips and screws. The output heat sinks are secured to the chassis rear panel by bolts and nuts. The line amplifier is retained by screws to spacers on the inside of the front chassis panel. An anodised aluminium extrusion is fitted to the front of the chassis panel to which is added a satin anodised screen printed trim panel. Slots are pierced in the chassis baseplate and the protective cover, for convection cooling.

The removal of modules and sub-assemblies is described in the next section. The construction of the amplifier is fundamentally simple and has been designed for speedy and easy maintenance. It will be appreciated by the maintenance engineer upon inspection of the amplifier that the method of removal of any part is obvious, but simple procedures of accessibility are described, however. The construction is such that the amplifier may be completely disassembled into modules and sub-assemblies, and re-assembled in a very short time.

2.1 Nomenclature

Component	The smallest divisible part, i.e. resistor, capacitor, transformer, unmounted circuit board, etc.
Module	The smallest divisible assembly of components, e.g. a circuit board with components mounted.
Sub-assembly	An assembly of two or more modules which do not form a complete unit.
Chassis	The basic foundation to which modules and/or sub-assemblies are fitted to form a unit.
Sub-chassis	A small chassis on which components can be mounted to form a module.
Unit	An assembly of modules and/or sub-assemblies to form a complete unit, i.e. an HD250.

2.2 Module and sub-assembly detail

The modules detailed below are concerned with the HD250. They are shown for identification only and not for ordering purposes. The list does not include mechanical assemblies.

Details of modules (quantity as for one complete HD250).

No.	*Module*	*Quantity*	*Description*
1	Disc and tape output amplifiers (L&R)	1	Circuit board M3358
2	Line amplifiers (L&R)	1	Circuit board M3357
3	Power amplifier	2	Circuit board M3356
4	Power amplifier output	2	Circuit board M3359
5	Power amplifier heat sink	2	Heat sink with output transistors
6	Power supply	1	Circuit board M3355
7	Power supply heat sink	1	Heat sink with transistor
8	Capacitor	1	4 – Capacitors on sub-chassis
9	Transformer	1	Mains transformer and voltage selector switch
10	Input selection and function switch	1	2 – switch banks on mounting plate
11	Mains supply switch	1	Mains switch on mounting plate

Details of sub-assemblies

No.	*Module*	*Quantity*	*Description*
1	Power output heat sink and circuit board	2	Modules no. 4 and 5
2	Power supply heat sink and circuit board	1	Module no. 6 and 7 on heat sink

3. REPLACEMENT AND REPAIRS

Considerable care is taken in manufacture to obtain a flawless appearance in the finished product. Maintenance engineers are requested to pay particular attention to the handling of the front extrusion and trim panel to ensure that the amplifier is returned to the owner in an undamaged state. Despite heavy anodising the surface of these items is easily damaged. In the factory, extrusions are fitted after the amplifier has completed all tests and ready for final inspection and packing. It is recommended that polyether foam pads cut from sheet, are used in the repair workshop to prevent the extrusion and trim panel coming into contact with benches.

Modules and sub-assemblies may be removed as follows:

3.1 Cover

Release four screws from the chassis baseplate and slide cover to the rear. Note that the cover is retained in a rebate at the rear top of the extrusion.

3.2 Front facia

Remove slide fader knobs which are a simple press fit on a flat tongue. Release the two nuts on either side and one at the top centre at the rear of the chassis front panel.

3.3 Disc amplifier module, Power amplifier module, Power supply assembly

Remove press-on connectors from circuit board and release module or sub-assembly from chassis by two screws in chassis baseplate.

3.4 Capacitor module

Connecting wires are soldered to the capacitor tags but the module may be isolated by disconnecting the press-on connectors at the other ends of the leads. The earth lead is not plugable and should be cut for re-soldering.

3.5 Transformer module

Release four screws and lift transformer clear of chassis on flexible leads. Unsolder external leads but remember that the voltage selector panel is part of the transformer module for replacement purposes. Refitting is quite clear from the module connection diagram in fig. 3 which shows the physical layout of the transformer together with its terminal numbers and lead colours.

3.6 Power output heat sink and circuit board sub-assembly

If it is required to change an output transistor the complete module should be removed from the chassis rear panel. Unscrew the four screws retaining the chassis rear panel to the spacer bars. Remove three screws retaining the chassis rear panel to the chassis baseplate. Pull off removable connectors from the circuit boards and release the heat sink from the rear panel by the four flange screws. Any component on the module can then be replaced simply. If it is found necessary to replace an output transistor be sure that the correct replacement transistor is fitted, and making good thermal contact with the heat sink. Test transistor case to heat sink insulation at 250V/500V before re-fitting heat sink to rear chassis panel.

3.7 Input selection and function switch module

Most of the leads to the switch module have removable connectors on the other end of the cable form and may be removed from the modules to which they are connected. A few wires however are soldered and should be cut for re-soldering. When replacing the switch module ensure that the switch buttons are correctly located in the slot in the trim panel. Clearance holes are provided in the switch module mounting plate to enable this to be done accurately

3.8 Mains supply switch module

This is retained to the front panel by two nuts. Two soldered wires only need be cut.

3.9 Line amplifier module

The modules and components mounted to the chassis front panel are accessible by releasing the four screws retaining the chassis *rear* panel to the spacer bars and the three screws retaining the chassis baseplate to the chassis *front* panel. All the connections to the line amplifier circuit board modules are made by press-on connectors. Care should be taken when replacing the line amplifier module to dress the wiring in its original position. The high signal-to-noise ratio of the amplifier will be degraded unless wires and cable form are correctly dressed. Note: take care not to damage the face of the extrusion, trim panel and knobs of the selector switches in this operation.

3.10 Slide controls

The slide controls are accessible after the removal of the line amplifier module and front extrusion. If a control has been replaced see that it is correctly aligned by making a temporary fitting of the extrusion and trim panel, and checking whether the lateral spacing of the tongue in the trim panel slot is the same at the top and bottom of its travel.

4. TEST EQUIPMENT

4.1 Essential equipment

The minimum amount of test equipment required to service the HD250 is:

1. Model 8 Avometer (or meter with 20,000 ohms/volts sensitivity)
2. Audio oscillator
3. A.C. millivoltmeter
4. Oscilloscope
5. Four 50 watt wire wound resistors, 8 ohms. (Two in parallel for 4 ohms, each channel)

4.2 Desirable additional equipment

1. Radford Low Distortion Oscillator
2. Radford Distortion Measuring Set.
3. Dual beam sensitive high speed oscilloscope
4. L.C.R. Measuring Set
5. Insulation Tester
6. Transistor Tester

5. PERFORMANCE TESTING

5.1 Routine test procedure

Should an amplifier fail in operation basic information can be obtained by checking the static and dynamic voltages at suitable positions in the circuit. Correct voltages are shown for these points on the circuit diagrams and any differences should be investigated.

5.2 Notes concerning performance

5.2.1 Power output

When testing the amplifier for maximum power output, be sure that the load resistors are of sufficient wattage rating. The amplifier is capable of maintaining a constant output voltage into load resistances down to approximately 5 ohms. Below 5 ohms load, voltage sensitive current limiting is in operation. The limiter is working correctly if the clip level output voltage is reduced to 14 to 16V with a 4 ohms load.

5.2.2 Distortion

Conventional audio oscillators are quite unsuitable for distortion measurements on the HD250 amplifier, as their inherent distortion is considerably greater than that of the amplifier. An extremely low distortion oscillator (less than 0.005%) and distortion measuring equipment capable of measuring 0.002% are necessary to measure the distortion of the HD250 when operated below output stage clipping level.

Unless suitable equipment is available, distortion measurement and adjustments cannot be carried out. It should be noted also that the adjustments for minimum crossover spike amplitude cannot be made unless the fundamental test frequency is rejected for oscilloscope observation of the residual waveform. However, the amplifier is carefully adjusted before leaving the factory, and will not need adjustment unless transistors (not output transistors) are changed in the power amplifier.

If suitable measuring equipment is not available the quiescent current of the output stage may be set to the required level by adjustment of P7 to give 0.55v as measured with an Avo 8 between the orange and yellow lead connections on the power amplifier module.

During distortion measurements, the output of the Distortion Measuring Set should be monitored on an oscilloscope to observe the harmonic structure and relative noise amplitude. The distortion products generated in the pre-amplifier section of the HD250 are so low that under normal operating conditions they are completely masked by the inherent circuit noise of the measuring equipment.

When evaluating the distortion performance of the pre-amplifier section at high signal input levels, the volume control should always be adjusted to avoid signal clipping in the power amplifier as this will seriously affect the measured figure. In conditions where line output voltages in excess of 1V are being measured, the signal inputs to the power amplifiers should be disconnected. (N.B. Grey and brown live signal wires only – ground leads must *not* be interrupted. In later amplifiers connections from the pre-amplifier to the power amplifier are effected by jumper leads across the phono sockets on the rear panel.)

5.2.3 Overload capacity

The overload margin of the amplifier should be checked in the following manner:

1. Line input

An initial signal of 100 mV at 1 kHz is applied with the input level control set to 0 dB and the volume control at maximum. This will result in a line output voltage of 1V which is observed on the oscilloscope. The input level from the generator is then gradually increased while the volume control is reduced, in order to keep the output voltage approximately constant. This procedure is continued until the output waveform is clipped, which should occur when the input is not less than 36 dB above the original 100 mV (6.3V).

2. Disc input

With the input level control set to 0 dB and the volume control at maximum, an input signal large enough to give a line output of 1V is applied. (The input level will depend on the frequency at which the overload margin is measured). The input signal is then increased by 20 dB (10 times) and the output level brought back to approximately 1V by adjusting the volume control. Further increase of the input signal is compensated for on the input level control, until the output is clipped. This should occur when the input level is not less than 40 dB above the original level.

(Note: The method outlined here will yield figures which are apparently too low at the high end of the frequency range. This is due to the decrease in supply voltage caused by the heavy loading of the feedback network under these conditions. The dynamic (transient) overload margin, however, is not degraded as the energy will be supplied by the supply smoothing capacitor.)

5.2.4 Frequency response

1. Disc input

The gain variation specified in the RIAA standard (BS1928:1961) specification is nearly 40 dB over the frequency range of 20 Hz to 20 kHz. As the object is to obtain a flat response, overall, it follows that the best way to measure the characteristic is to vary the input voltage for each frequency to obtain a constant output. For routine checks, the spot frequency measurements outlined in Test Table steps 18, 19 & 20 are normally sufficient. The complete response, however, can be measured conveniently and accurately by using an inverted RIAA correction network (fig. 3) between the oscillator and the disc input. Using this network, the response characteristic should be flat to within 0.5 dB between 50 Hz and 20 kHz. Below 50 Hz the response should roll off, being 3 dB down at 30 Hz, and 10 dB down at 17 Hz. (See response curve in leaflet A25.)

For reference, a table of the RIAA characteristic is given below:

Table 1

HZ	dB	kHz	dB
20	+19.3	1	0
30	+18.6	2	—2.6
40	+17.8	4	—6.6
60	+16.1	6	—9.6
80	+14.5	8	—11.9
100	+13.1	10	—13.7
150	+10.2	12	—15.3
200	+ 6.7	15	—17.2
500	+ 2.6	20	—19.6

2. Line input

With the tone controls set to their mid position and the 'tone cancel' button released, the response measured at the line output should be flat to within 0.5 dB between 20 Hz and 20 kHz. With a 300 Hz square wave applied to the input, the output waveform should be identical to that obtained with the 'tone cancel' switch depressed.

Bass and treble variation ranges should be ±11 dB at 30 Hz and ±12 dB at 20 kHz, respectively.

5.2.5 Hum and noise

As will be seen from the specification, two sets of noise figures are quoted, one 'flat' and one 'A'-weighted. The 'A'-weighted figure is measured with a special network included in some voltmeters which contours the frequency response characteristic to correlate with the subjective response of the human ear.

The 'flat' figure is measured as a nominally flat response over the audio band. Frequencies outside the audio range are attenuated by a simple H.F. roll-off network which limits the noise bandwith to approximately 23 kHz. Such a network is shown in fig. 4. It should be used for the noise measurements outlined in the test table, steps 9, 10 & 11. The noise tests detailed in the table are measured at the loudspeaker terminals. If it is required to measure noise at the pre-amplifier output a low noise pre-amplifier will be necessary as standard millivoltmeters are not sensitive enough. The circuit diagram of such a pre-amplifier is shown in fig. 5, note that the circuit includes the H.F. roll-off described above.

In order not to degrade the exceedingly low hum figures great care must be taken (if it is required to move the line amplifier board) to disturb the connecting wires to the board as little as possible. The procedure, for minimizing hum induced into the wiring on each channel is given below. It is given for completeness but should not be found necessary.

1. Set volume control to maximum and input level control to minimum. Carefully adjust the position of the wire leading to top of volume control to obtain minimum hum in the output.
2. Insert shorting plug into tuner socket, select tuner input, set input level control to maximum and repeat the process for wire leading to top of input level control.
3. Insert shorting plug into disc socket, select disc input and adjust position of resistor R8 on disc amplifier board to obtain minimum hum in the output.

Note: As the hum output is extremely low, it is necessary to use the low noise pre-amplifier for adjusting hum to the absolute minimum level.

6. MAINTENANCE TESTING AND CIRCUIT BOARD MODULE DETAILS

Maintenance tests for fault finding may be made under static and dynamic conditions. The circuit diagrams are marked to show the d.c. voltage existing at various points under static conditions when the supply voltage is correctly set at 70 volts. Diagrams are also marked with the r.m.s. voltage existing at various points when a sine wave signal of 1 kHz, 100 mV, is connected to the line input sockets, and a 1 kHz 2 mV signal to the disc input sockets (Channel balance controls set to 0 dB and Volume control at maximum).

7. CHANGES TO HD250

Changes incorporated in the design of the HD250 since its inception are detailed below. These modifications are as a result of the knowledge obtained during the production of the first 500 amplifiers and from reports received from users.

7.1 *Concerning:* Radio frequency interference.
Module affected: Disc and tape output amplifiers. Pt. No. M3358.
Modification: Fig. 6a shows the input circuit of the disc amplifier as in the original circuit. This has now been modified in accordance with Fig. 6b. If radio frequency interference or switching transients in any particular installation are bad, Resistor R3 may be increased up to 1k ohms. This degrades the signal-to-noise ratio by approximately 3 dB.

Some amplifiers have been made with capacitor C3 connected from base to emitter of TS1 as shown dotted in fig. 6b, but it has been found that connection between base and ground is more effective.
Components affected:
R3 was 100 ohms and is now 390 ohms
C3 was 150 pf and is now 47 pf.
R5 is deleted.

Comment: The HD250 is completely screened against radio frequency radiation into its wiring and components. The mains transformer is wound with a screen between the primary and secondary windings to prevent mains born interference entering the amplifier. Radio frequency interference therefore can only enter through the signal leads. Great care should be taken to ensure that:

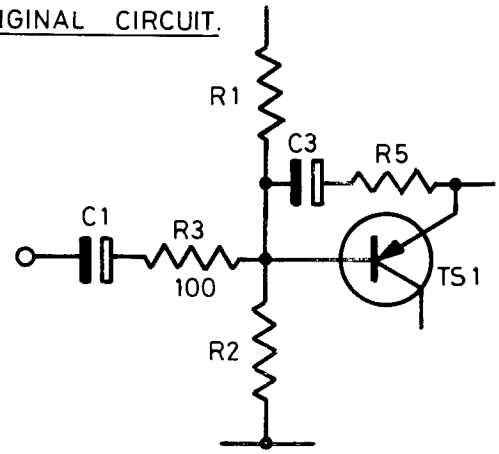
1. All input leads and circuits connected to the input are completely screened from the cartridge to the input socket. Some gramophone players contain shorting switches in the signal leads to suppress clicks from the motor mains switch. The signal switches are frequently unscreened and are a source of r.f. pickup.
2. All metal parts, particulary a metal tone arm, are effectively grounded to the earth terminal on the amplifier.

Recommendation: Essential modification if interference experienced, otherwise optional.

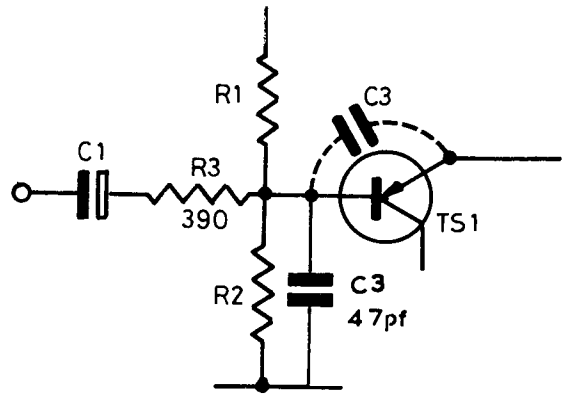
FIG.6. RADIO FREQUENCY INTERFERENCE (CIRCUIT CHANGE IN DISC AMPLIFIER INPUT)

ORIGINAL CIRCUIT.

a



b. MODIFIED CIRCUIT.



7.2 *Concerning:* Instability.
Purpose: To ensure absolute stability of the complete amplifier under transient conditions within the component tolerances actually found in manufacture. A tendency to instability exhibits itself in listening as distortion on transients, and in measurement as poor crosstalk performance.
Modules affected:
Disc and tape output amplifier Pt. No. M3358
Lineamplifier Pt. No. M3357
Modification (1): Disc and tape amplifiers. M3358.
The modification is to increase the value of the series resistor from the Tape Input tag to the base of transistor TS6.

Components affected: R23 was 1k ohm and is now 2k2 ohms.

Modification (2): Line amplifiers M3357.

The modification is to insert a resistor between the emitter output of TS11 and the capacitance loads C33, C36 and C37. In manufacture this has been effected by a change of circuit board layout. The original circuit is shown in Fig. 7a and the new circuit in Fig. 7b. If it is required to modify existing boards it is suggested that it is simpler to shunt R50 with a 47 pf capacitor as shown in Fig. 7a which is adequately effective in practice.

Components affected: R58.

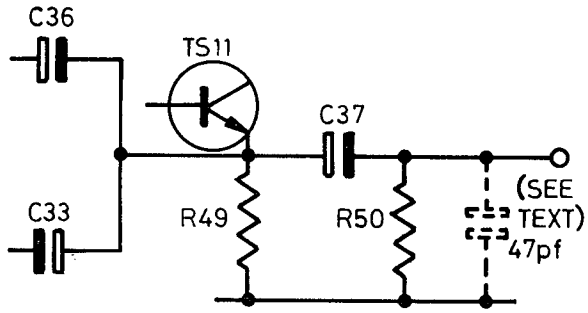
100 ohms added, or optionally a 47 pf capacitor on existing amplifiers.

Recommendations: Essential if subjective performance suspect, and/or measured crosstalk poor, otherwise optional.

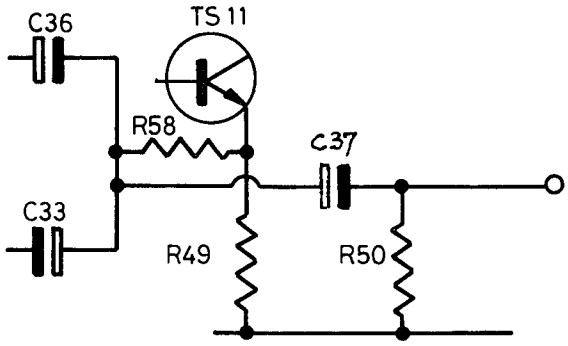
FIG. 7. STABILITY IMPROVEMENT CIRCUIT

CHANGE IN LINE AMPLIFIER

a ORIGINAL CIRCUIT.



b. MODIFIED CIRCUIT



7.3 *Concerning:* Quiescent current adjustment.

Purpose: To improve the adjustment range of quiescent current of output transistors TS23 and TS24 within component production tolerances.

Module affected: Power amplifier Part No. M3356.

Modification: Series resistor from base to emitter of TS16 decreased in value.

Component affected: R71 was 2k7 ohms and is now 2k2 ohms.

Recommendation: Modification unnecessary. Concerns production tolerances only

7.4 Layout of chassis front panel assembly.

Purpose: To simplify wiring and assembly in manufacture.

Module affected: Line amplifier part no. M3357.

Modification: Circuit board dimensions changed. R57 moved to different position on board.

Recommendation: No action required.

7.5 *Concerning:* Location of some resistors.

Purpose: To improve layout.

Modification: Two off each 1 k ohm resistors R110, R111 and R112, have been relocated. Originally they were inserted in the wiring from the phono sockets but are now fitted across contacts of the input and function switches. (Refer to wiring schematic diagram.)

Recommendation: No action required.

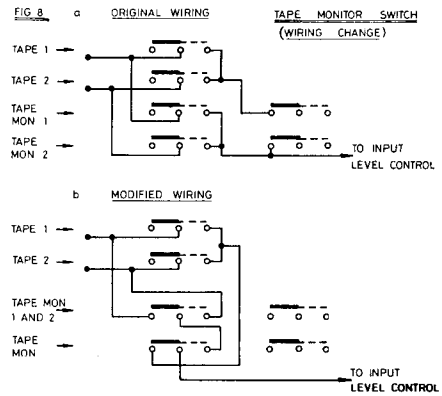
7.6 *Concerning:* Tape monitor switching.

Purpose: To simplify the operation of tape monitor switching.

Modules affected: Function switch bank.

Modification: The Tape Monitor 1 and Tape Monitor 2 mechanisms were mutual release but have now been changed to independent self-latching. Circuit changes are shown in Figs. 8a/8b.

Recommendation: Modification unnecessary. Concerns new production only



7.7 *Concerning:* Isolation of pre-amplifier output and power amplifier input.

Purpose: To enable the pre-amplifier and power amplifier sections of the HD250 to operate independently of each other. This permits the interposing of an intermediate unit such as a quadraphonic decoder or an electronic crossover network between the pre-amplifier and the power amplifier.

Sub-assembly affected: Rear chassis panel.

Modification: Previously the pre-amplifier output was connected directly to the power amplifier as well as to the pre-amplifier output sockets. The modification involves a change in the layout of the rear chassis panel and the fitting of an additional twin phono socket connected to the power amplifier input circuit. The pre-amplifier output is joined to the power amplifier input externally by phono link connectors.

Recommendations: Modification not possible. Concerns new production only.

7.8 *Concerning:* Addition of headphone output.

Purpose: The modification provides a facility for the use of headphones directly from the output of the power amplifier. Series resistors are used in the headphone supply leads to limit the power available. The value of the resistors has been selected to suit headphones of average sensitivity from 8 ohms to 1000 ohms impedance. The resistors may be changed to suit any desired sensitivity.

Sub-assembly affected: Front chassis panel and extrusion with trim panel.

Modification: The modification is the fitting of a headphone jack socket to the front chassis panel and connecting to the output terminals through series resistors.

Recommendations: Modification not possible. Concerns new production only.

FIG. 1 LAYOUT OF COMPONENTS HD250

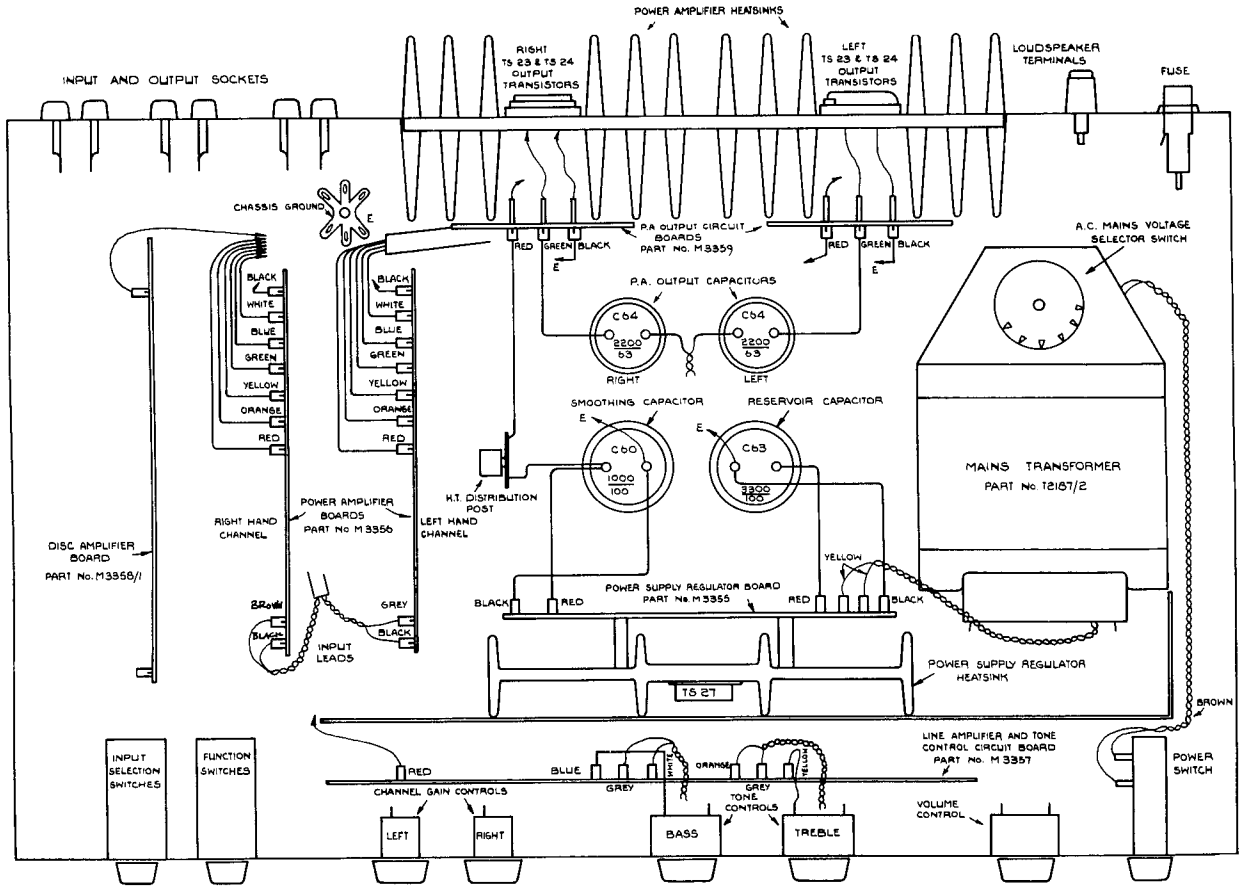


FIG. 2 LAYOUT OF COMPONENTS ZD22

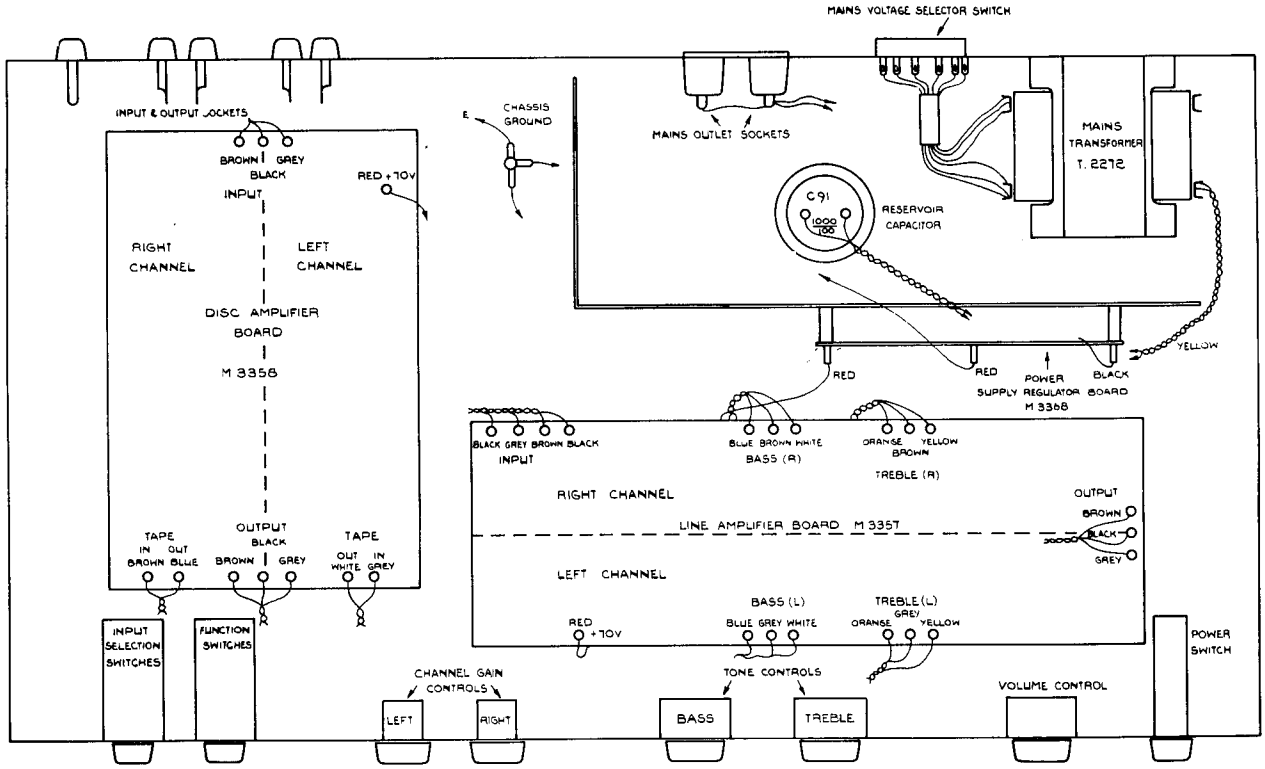


FIG. 9 SCHEMATIC DIAGRAMS HD250

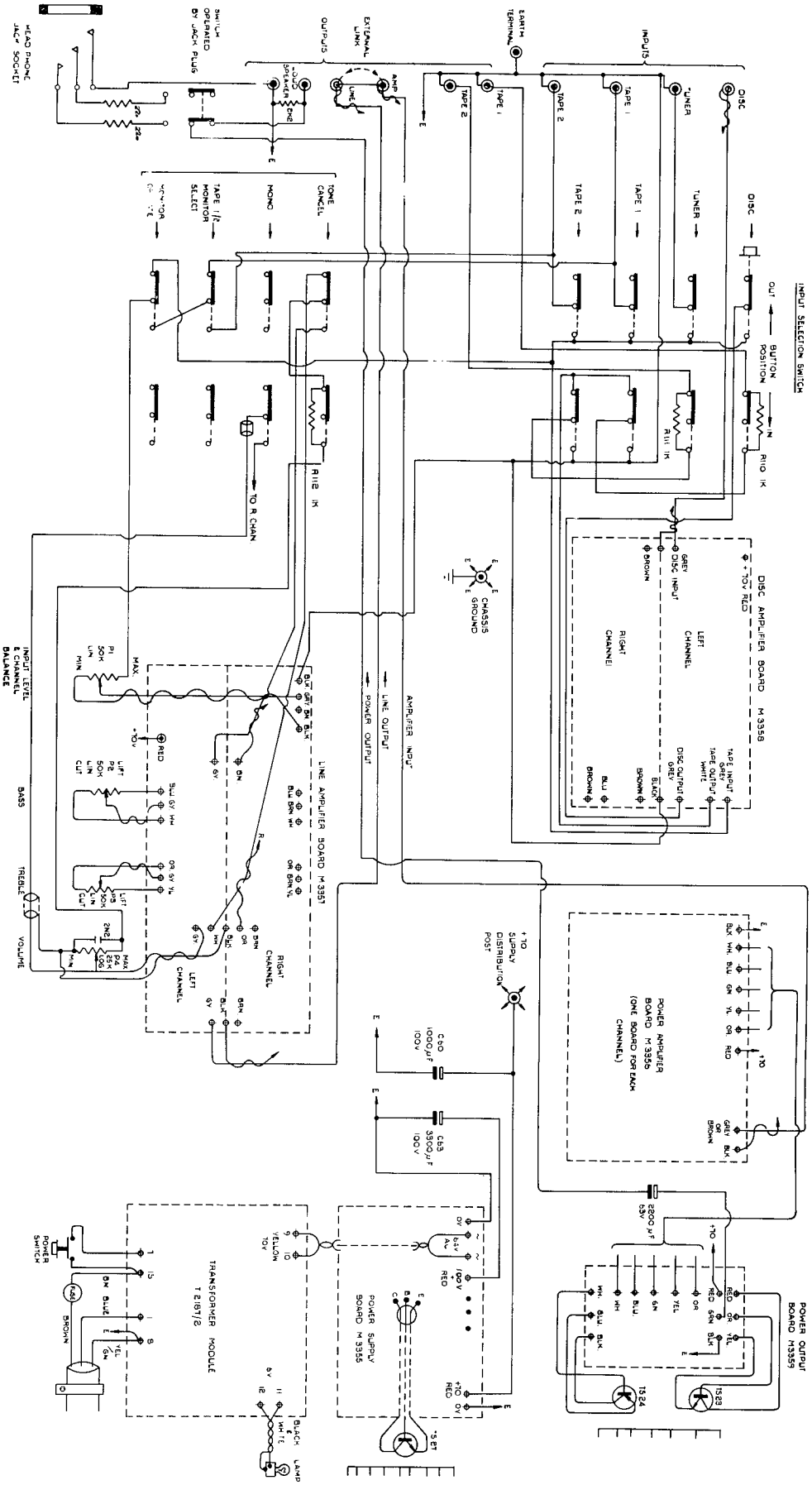
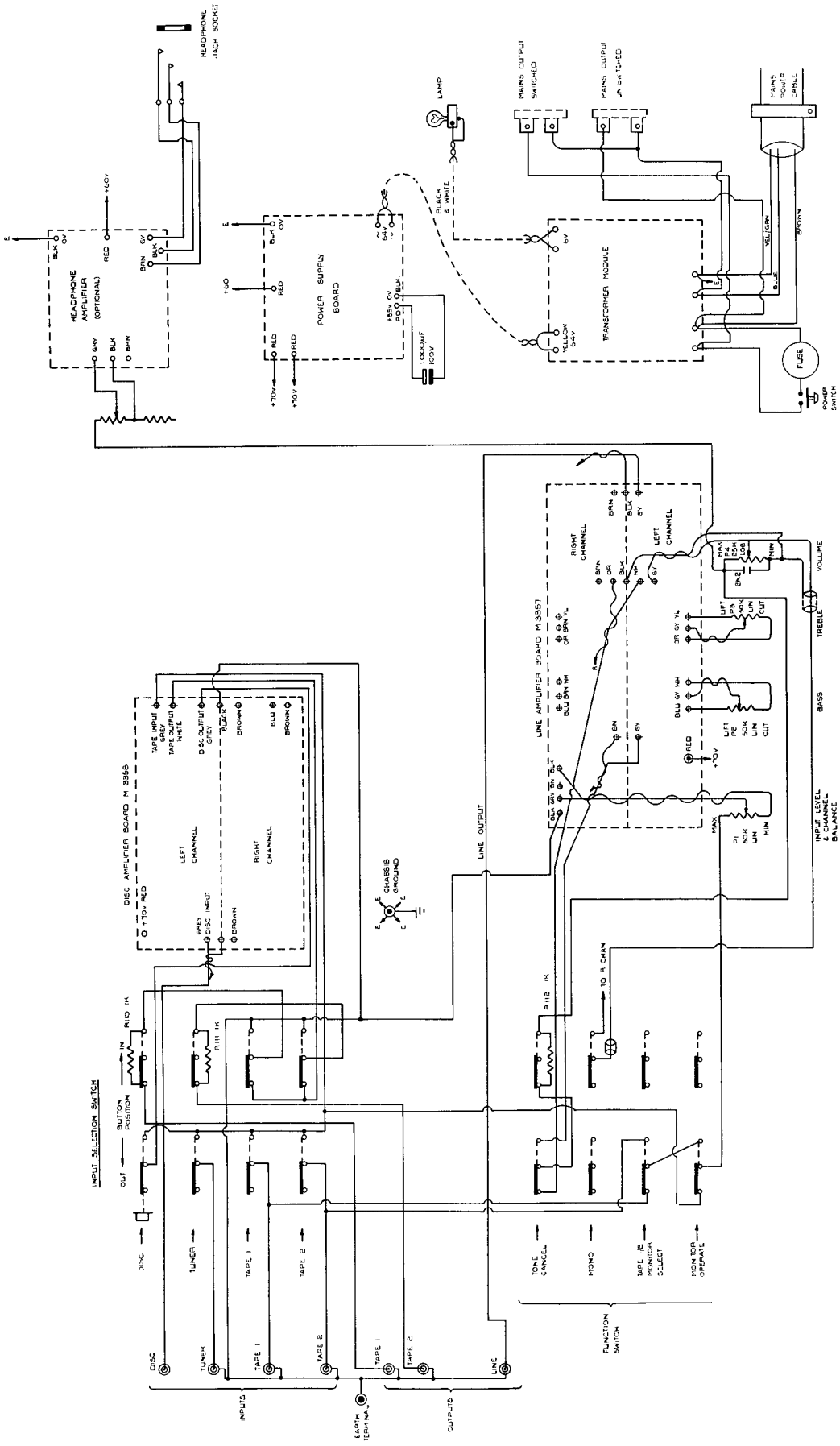


FIG. 10 SCHEMATIC DIAGRAMS ZD22



CIRCUIT REFERENCE	PART No.	DESCRIPTION				QUANTITY
RESISTORS						
Disc, and tape buffer amplifier (circuit board M3358)						
R1	R1648	MO	0.5w	82k	2%	2
R2	R1825	MO	0.5w	120k	2%	2
R3	R1832	MO	0.5w	390E	5%	2
R4	R1568	MO	0.5w	47k	2%	2
R5		Not used				
R6	R1750	CF	0.25w	47E	5%	2
R7	R1699	MO	0.5w	6k8	2%	2
R8	R1827	MO	0.5w	47E	2%	2
R9	R1808	MO	0.5w	3k3	2%	2
R10	R1510	MO	0.5w	22k	2%	2
R11	R1668	MO	0.5w	10k	2%	2
R12	R1674	MO	0.5w	8k2	2%	2
R13	R1744	CF	0.25w	56k	5%	2
R14	R1752	CF	0.25w	5k6	5%	2
R15	R1589	MO	0.5w	5k6	5%	2
R16	R1750	CF	0.25w	47E	5%	2
R17	R1750	CF	0.25w	47E	5%	2
R18	R1731	CF	0.25w	1k	5%	2
R19	R1795	CF	0.25w	2k7	5%	2
R20	R1725	CF	0.25w	68k	5%	2
		Not used				
		Not used				
R23	R1731	CF	0.25w	2k2	5%	2
R24	R1726	CF	0.25w	100k	5%	2
R25	R1726	CF	0.25w	100k	5%	2
R26	R1726	CF	0.25w	100k	5%	2
R27	R1796	CF	0.25w	10k	5%	2
R28	R1726	CF	0.25w	100k	5%	2
		Not used				
Line amplifier (circuit board M3357)						
R30	R1735	CF	0.25w	120k	5%	2
R31	R1760	CF	0.25w	27k	5%	2
R32	R1719	CF	0.25w	2k2	5%	2
R33	R1751	CF	0.25w	3k3	5%	2
R34	R1764	CF	0.25w	1k5	5%	2
R35	R1734	CF	0.25w	47k	5%	2
R36	R1751	CF	0.25w	3k3	5%	2
R37	R1722	CF	0.25w	15k	5%	2
		Not used				
R39	R1722	CF	0.25w	15k	5%	2
R40	R1751	CF	0.25w	3k3	5%	2
R41	R1722	CF	0.25w	15k	5%	2
R42	R1745	CF	0.25w	2M7	10%	2
R43	R1735	CF	0.25w	120k	5%	2
R44	R1729	CF	0.25w	470k	5%	2
R45	R1734	CF	0.25w	47k	5%	2
R46	R1726	CF	0.25w	100k	5%	2
R47	R1726	CF	0.25w	100k	5%	2
R48	R1758	CF	0.25w	22k	5%	2
R49	R1743	CF	0.25w	4k7	5%	2
R50	R1726	CF	0.25w	100k	5%	2
R51	R1763	CF	0.25w	680k	5%	2
R52	R1725	CF	0.25w	68k	5%	2
R53	R1719	CF	0.25w	2k2	5%	2
R54	R1743	CF	0.25w	4k7	5%	2
R55	R1779	CF	0.25w	820E	5%	2
R56	R1726	CF	0.25w	100k	5%	2
R57	R1543	CF	0.5w	220E	5%	2
R58	R1712	CF	0.25w	100E	5%	2
R59	R1731	CF	0.25w	1k	5%	2
Power amplifier (2 off circuit boards M3356)						
R60	R1719	CF	0.25w	2k2	5%	2
R61	R1762	CF	0.25w	39k	5%	2
R62	R1734	CF	0.25w	47k	5%	2
R63	R1749	CF	0.25w	82k	5%	2
R64	R1716	CF	0.25w	470E	5%	2
R65	R1750	CF	0.25w	47E	5%	2
R66	R1719	CF	0.25w	2k2	5%	2
R67	R1734	CF	0.25w	47k	5%	2
R68	R1708	MO	1w	1k	5%	2
R69	R1731	CF	0.25w	1k	5%	2
R70	R1719	CF	0.25w	2k2	5%	2
R71	R1719	CF	0.25w	2k2	5%	2
R72	R1731	CF	0.25w	1k	5%	2
R73	R1557	CF	1w	470E	5%	2
R74	R1557	CF	1w	470E	5%	2
R75	R1703	MO	0.5w	3k	2%	2
R76	R1750	CF	0.25w	47E	5%	2
R77	R1750	CF	0.25w	47E	5%	2
R78	R1703	MO	0.5w	3k	2%	2
R79	R1753	CF	0.25w	150E	5%	2
R80	R1753	CF	0.25w	150E	5%	2
R81	R1716	CF	0.25w	470E	5%	2
R82	R1716	CF	0.25w	470E	5%	2
R83	R1754	CF	0.25w	68E	5%	2
R86	R1754	CF	0.25w	68E	5%	2
R87	R1777	CF	0.25w	2E2	5%	2
R88	R1777	CF	0.25w	2E2	5%	2

CIRCUIT REFERENCE	PART No.	DESCRIPTION				QUANTITY
RESISTORS						
Power output (2 off circuit boards M3359)						
R84	R1756	WWS	3w	0.4E	5%	2
R85	R1756	WWS	3w	0.4E	5%	2
R89	R1755	CF	0.25w	10E	5%	2
R90	R1777	CF	0.25w	2E2	5%	2
R92	R1829	CF	0.25w	22E	5%	2
R93	R1829	CF	0.25w	22E	5%	2
R94		Not used				
Power supply (circuit board M3355)						
R95	R1732	CF	0.25w	8k2	5%	1
R96	R1747	CF	0.25w	3k9	5%	1
R97	R1743	CF	0.25w	4k7	5%	1
R98	R1743	CF	0.25w	4k7	5%	1
R99	R1748	WWS	10w	0.2E	5%	1
R100	R1720	CF	0.25w	6k8	5%	1
R101	R1758	CF	0.25w	22k	5%	1
R102	R1731	CF	0.25w	1k	5%	1
R103	R1762	CF	0.25w	39k	5%	1
R104	R1712	CF	0.25w	100E	5%	1
R105	R1731	CF	0.25w	1k	5%	1
R106	R1716	CF	0.25w	470E	5%	1
R107	R1725	CF	0.25w	68k	5%	1
		Not used				
		Not used				
Chassis rear panel sub-assembly						
R91	R1719	CF	0.25w	2k2	5%	2
Chassis front panel sub-assembly						
R110	R1731	CF	0.25w	1k	5%	2
R111	R1731	CF	0.25w	1k	5%	2
R112	R1731	CF	0.25w	1k	5%	2
CAPACITORS						
Disc, and tape buffer amplifier (circuit board M3358)						
C1	C1378	E	22uF	25V		2
C2	C1443	E	22uF	63V		2
C3	C1447	CR	47pF	63V		2
C4	C1445	CR	2N2	40V		2
C5	C1195	PR	0.047uF	100V	2%	2
C6	C1195	PR	0.047uF	100V	2%	2
C7	C1328	E	47uF	40V		2
C8	C1423	E	33uF	40V		2
C9	C1446	PR	0.033µF	100V	2%	2
C10	C1444	E	1.5uF	63V		2
C11	C1335	CR	10pF	68V		2
C12	C1328	E	47uF	40V		2
C13	C1360	PR	3300pF	100V	5%	2
C14	C1418	E	220uF	63V		2
C15	C1323	E	6.8uF	40V		2
C16		Not used				
C17		Not used				
C18		Not used				
C19		Not used				
C20	C1323	E	6.8uF	40V		2
C21	C1323	E	6.8uF	40V		2
C22	C1323	E	6.8uF	40V		2
		Not used				
		Not used				
Line amplifier (circuit board M3357)						
C25	C1323	E	6.8µF	40V		2
C26	C1334	CR	47pF	63V		2
C27	C1323	E	6.8µF	40V		2
C28	C1195	PR	0.047µF	100V	2%	2
C29	C1259	PR	1000pF	400V	5%	2
C30	C1195	PR	0.047µF	100V	2%	2
C31	C1323	E	6.8µF	40V		2
C32	C1323	E	6.8µF	40V		2
C33	C1323	E	6.8µF	40V		2
C34	C1447	CR	47pF	63V		2
C35	C1443	E	22µF	25V		2
C36	C1443	E	22µF	25V		2
C37	C1323	E	6.8µF	40V		2
C38	C1323	E	6.8µF	40V		2
C39	C1334	CR	47pF	63V		2
C40	C1323	E	6.8µF	40V		2
C41	C1418	E	220µF	63V		2
C43		Not used				
C44		Not used				

CIRCUIT REFERENCE	PART No.	DESCRIPTION	QUANTITY
Power amplifier (2 off circuit boards M3356)			
C45	C1323	E 6.8µF 40V	2
C46	C1443	E 22µF 63V	2
C47	C1449	E 680µF 25V	2
C48	C1448	CR 1500pF 100V 10%	2
C49	C1328	E 47µF 40V	2
C50	C1336	CR 220pF 63V	2
C51	C1326	CR 220pF 63V	2
C52	C1360	CR 3300pF 100V 10%	2
C53	C1360	CR 3300pF 100V 10%	2
C54	C1317	PR 0.047µF 100V 20%	2
C55	C1317	PR 0.047µF 100V 20%	2
C58	C1282	PR 1µF 100V 10%	2
Power output (2 off circuit boards M3359)			
C56	C1327	PR 0.01µF 250V 10%	2
C59	C1282	PR 1µF 100V 10%	2
Power supply (circuit board M3355)			
C61	C1298	E 100µF 63V	1
C62	C1334	CR 47pF 63V	1
Capacitor Module			
C60	C1450	E 1000µF 100V	1
C63	C1241	E 3300µF 100V	1
C64	C1375	E 2200µF 63V	2
Chassis front panel sub-assembly			
C42	C1359	PN 2N2 100V 5%	2
Power output heatsink (2 off)			
C57	C1143	PR 0.1µF 400V 20%	2
TRANSISTORS			
Disc, and tape buffer amplifier (circuit board M3358)			
TS1	TS4552	2N3964	2
TS2	TS4587	ZTX107B	2
TS3	TS4588	ZTX109C	2
TS4	TS4586	2N2219A	2
TS5	TS4585	2N2905A	2
TS6	TS4587	ZTX107B	2
Line amplifier (circuit board M3357)			
TS7	TS4587	ZTX107B	2
TS8	TS4563	ZN2905A	2
TS9	TS4587	ZTX107B	2
TS10	TS4587	ZTX107B	2
TS11	TS4587	ZTX107B	2
TS12	TS4587	ZTX107B	2
TS13	TS4563	2N2905A	2
Power amplifier (2 off circuit boards M3356)			
TS14	TS4516	40361	2
TS15	TS4535	40410	2
TS16	TS4540	ZTX107B	2
TS17	TS4536	BFW60	2
TS18	TS4537	BFW90	2
TS19	TS4516	40361	2
TS20	TS4517	40362	2
TS21	TS4535	40410	2
TS22	TS4534	40409	2
Power supply (circuit board M3355)			
TS25	TS4533	40408	1
TS26	TS4533	40408	1
TS28	TS4573	40349V1	1
TS29	TS4574	MPSL01	1
TS30	TS4571	MPSA93	1
Power output heatsink (2 off)			
TS23	TS4569	Z170	1
TS24	TS4570	Z171	1
Power supply heatsink			
TS27	TS4542	2N4348	1

CIRCUIT REFERENCE	PART No.	DESCRIPTION	QUANTITY
RECTIFIERS AND DIODES			
Disc, and tape buffer amplifier (circuit board M3358)			
D1	RD7832	BAX16	2
D2	RD7832	BAX16	2
D3	RD7832	BAX16	2
D4	RD7832	BAX16	2
Power amplifier (2 off circuit boards (M3356)			
D5	RD7832	BAX16	2
D6	RD7832	BAX16	2
D7	RD7848	IN4003	2
D8	RD7848	IN4003	2
Power supply (circuit board M3355)			
D9	RD7836	BZX61	1
D10	RD7832	BAX16	1
D11	RD7832	BAX16	1
D12	RD7832	BAX16	1
D13	RD7869	60S2	1
D14	RD7837	BYX38300	1
D15	RD7837	BYX38300	1
D16	RD7838	BYX38300R	1
D17	RD7838	BYX38300R	1
General			
Transformer module			
T1	T2187/2	Transformer mains	1
G2	G55	Voltage selector	1
Switches			
S1	S2541	Switch mains (complete with button)	1
S2	S2542	Switch input selector	1
S3	S2543	Switch function selector	1
Potentiometers			
P1	P6082	Pot 2w CM 50k lin 10%	2
P2	P6081	Pot 2w CM 50k lin. dual 10%	1
P3	P6081	Pot 2w CM 50k lin. dual 10%	1
P4	P6080	Pot 2w CM 25k log dual 10%	1
Plugs and sockets			
PS1	PS7318	Phono socket 2 way	7
PS2	PS7300	Phono lead 4' grey	2
PS3	PS7301	Phono lead 4' brown	2
Terminals			
TM1	TM7109	Terminal 4 mm red push	2
TM2	TM7110	Terminal 4 mm black push	2
TM3	TM7111	Terminal 4 mm green push	1
Fuses and Fuseholders			
F1	F7023	Fuse 20 mm 2,5A A/S	1
F2	F7011	Fuseholder 20 mm x 5 mm	1
Miscellaneous			
G1	G62	Cable clamp	1
L1	G100	Inductor 1-2 µH	2
	L7400	Lamp 6.3v 0.115A	2
	L7402	Lampholder MES	1

TABLE 2 TEST PROCEDURE HD250 & ZD22

Step	Test	Sine Wave Signal Source Connected to	Output Taken from	Frequency	Input Level	Adjustment or Control Test	Action or Observation
1.						Ensure that all SELECTOR and FUNCTION buttons are in 'OUT' position.	Connect 8 ohm 50 watt resistor across loudspeaker terminals of each channel.
2.						Set P5, P6 and P7 to mid position on both power amplifier boards.	Adjust voltage selector to mains supply voltage. Release selector and function switches to button 'out' positions. Switch on 'POWER'. Carry out following tests on both channels.
3.	Supply voltage					Adjust P8 on power supply board	Measure voltage on C60 (1000uF) capacitor and set P8 for 70 volts.
4.	Symmetrical clipping & power output	Tuner input	Across output load	1 kHz	100mV approx.	Adjust P5 on Power amplifier board for symmetrical clipping	Select Tuner input, set input level control to 0 dB and volume control to max. Adjust oscillator until amplifier just clips (allow 10 mins. warm up time before setting P5). Check that output voltage is at least 20V at onset of clipping.
5.	Distortion	Tuner input	Across output load	1 kHz	70mV	Adjust P6 Crossover spikes) Adjust P7. (Distortion)	Connect Distortion Measuring Set to amplifier output and oscilloscope to D.M.S. output. Reject fundamental and measure distortion. Adjust P6 for minimum amplitude of crossover spikes as observed on oscilloscope and P7 for minimum distortion. (See text, 4.3)
6.							Change output load to 4 ohms and connect oscilloscope to load.
7.	Protection circuit & power output	Tuner input	Across output load	1 kHz	70mV approx.	Drive amplifier to onset of clipping.	Check that output voltage is reduced to approx. 15V r.m.s. (see text 5.2.1) and power v. impedance curve in sales leaflet.
8.							Change output load to 8 ohms.
9.	Noise		Across output load			Set volume control to minimum.	Check that output noise is less than 0.3mV measured with high frequency roll off (See text 5.2.5 and Fig. 5).
10.	Noise		Accross output load			Insert shorting plug into 'DISC' input. Set Input Level control to 0 dB and Volume Control to maximum.	Check that output noise is less than 3.8mV as above
11.	Noise		Across output load			Insert shorting plug into tuner and select tuner input. Release TONE CANCEL switch.	Check that output noise is less than 2.2mV as above.
ZD22 and pre-amplifier section of HD250							
12.	Tone controls	Tuner input	Pre-amplifier (line) output socket	30 Hz and 20 kHz	25mV	Adjust Bass control to max. then min. positions. Adjust treble control to max. then min. positions.	Connect millivoltmeter to pre-amplifier output. Check that maximum bass lift and cut is approximately 11 dB at 30 Hz. Check that maximum treble lift and cut is approximately 12 dB at 20 kHz.
13.	MONO operation	Tuner input	Pre-amplifier (line) output socket	1 kHz	100mV	Depress Function switch to 'MONO'.	Check that output is equal on both channels.
14.	Input Selection	Tuner input	Tape 1 output	1 kHz	100mV	Release Function switch to 'STEREO'.	Check that 100mV is obtained at Tape 1 output.
15.	Input Selection	Tuner input	Tape 2 output	1 kHz	100mV		Check that 100mV is obtained at Tape 2 output.
16.	Input Selection	Tape 1 input	Pre-amplifier	1 kHz	100mV	Select Tape 1 input	Check that 1 volt output is obtained.
17.	Input Selection	Tape 2 input	Pre-amplifier	1 kHz	100mV	Select Tape 2 input	Check that 1 volt output is obtained.
18.	RIAA characteristic	Disc input	Pre-amplifier	1 kHz	2mV approx.	Select Disc input. Cancel Tone Control.	Adjust input level to obtain 1V output.
19.	RIAA characteristic	Disc input	Pre-amplifier	100 Hz	2mV approx.		Check that output rises to 4.5V.
20.	RIAA characteristic	Disc input	Pre-amplifier	10 kHz	2mV approx.		Check that output falls to 205mV. (For a complete RIAA response test see text 5.2.4.)

FIG. 17 TRANSFORMER MODULE HD250

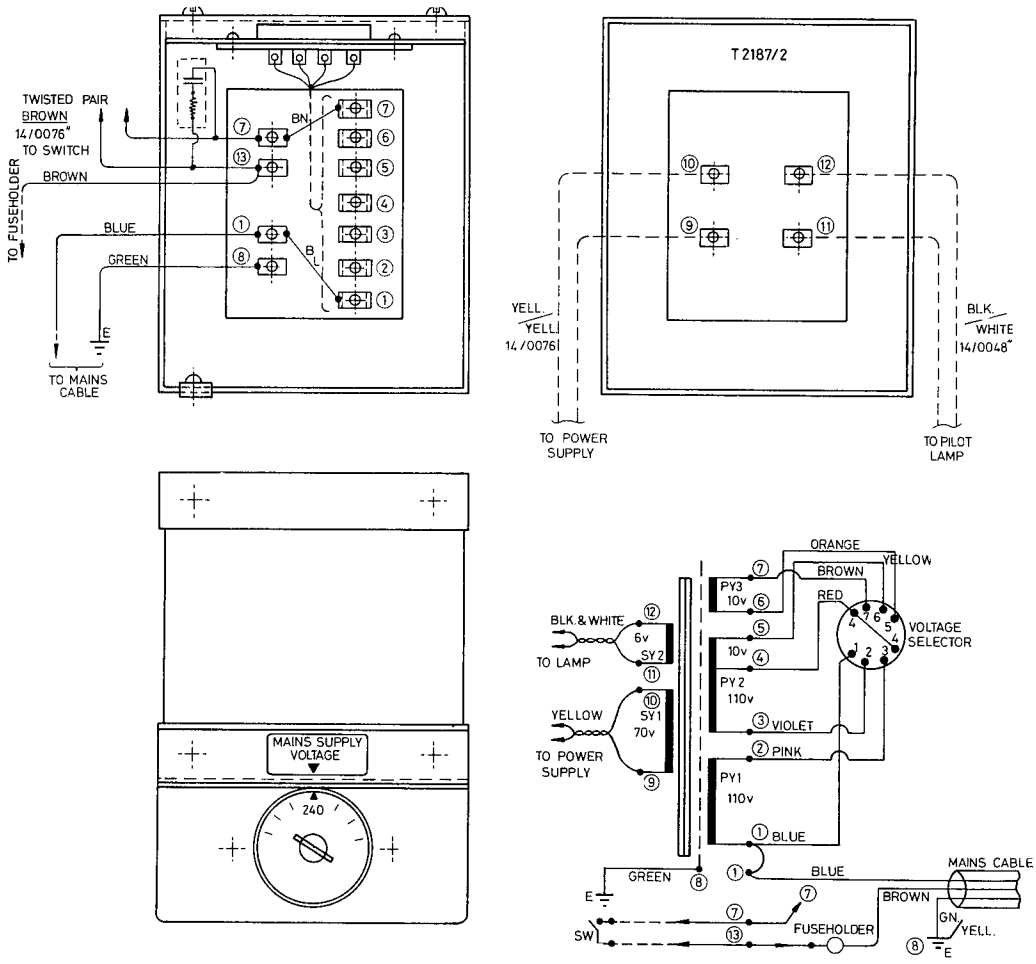


FIG. 18 TRANSFORMER MODULE ZD22

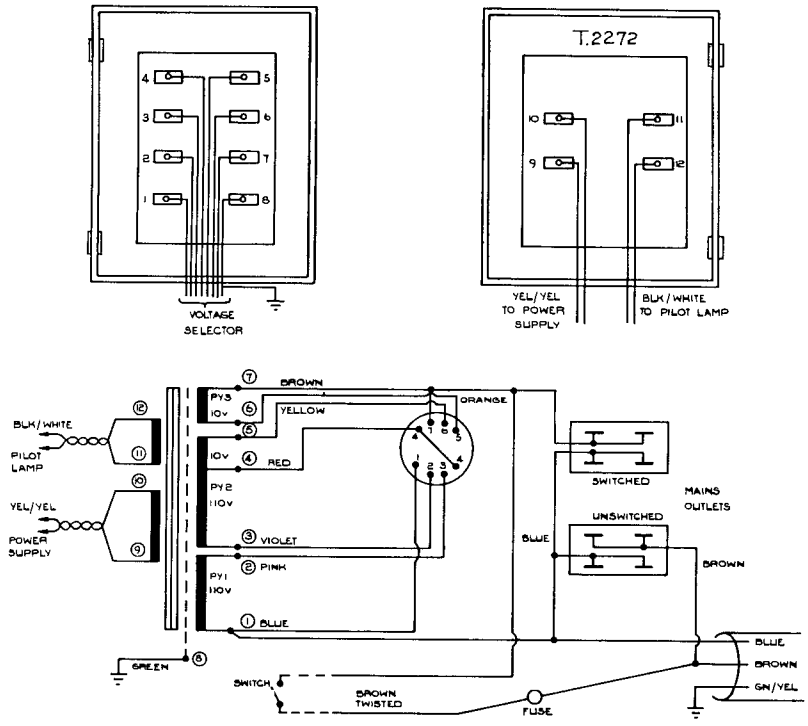
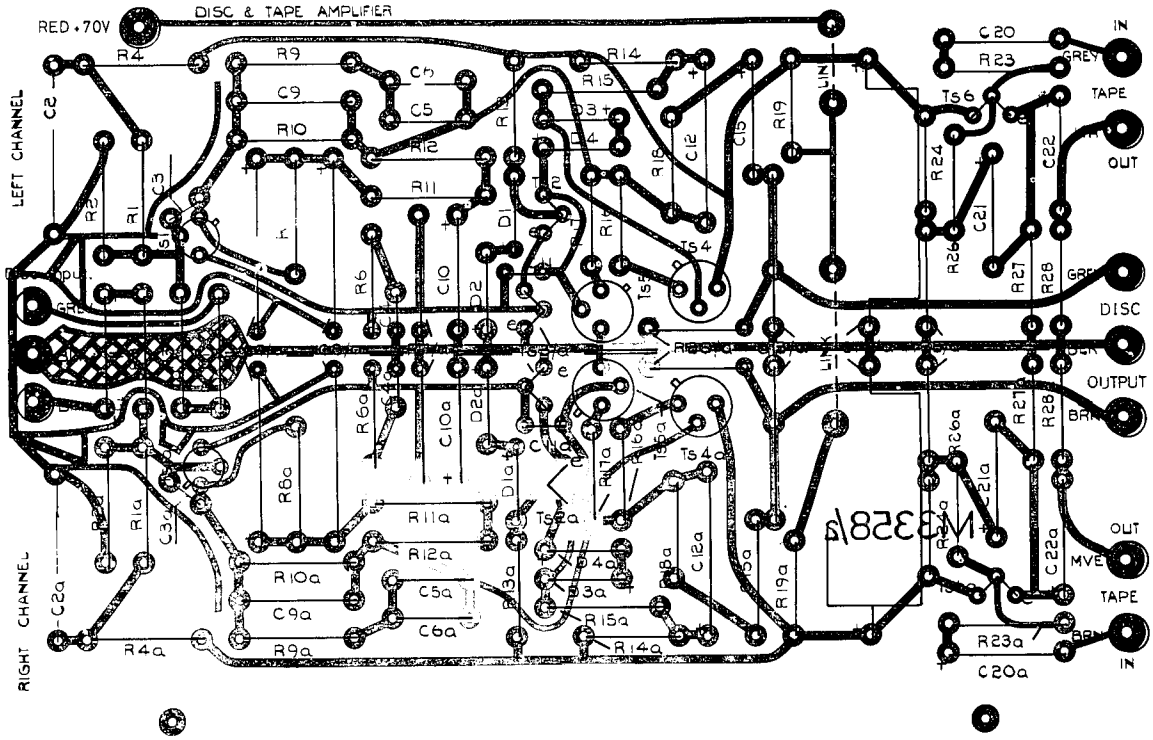
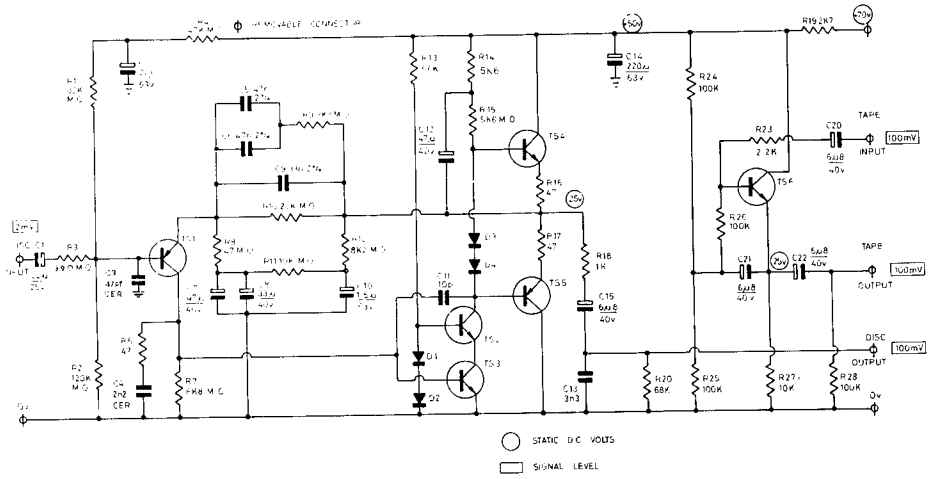


FIG. 11 DISC AMPLIFIER MODULE HD250 & ZD22



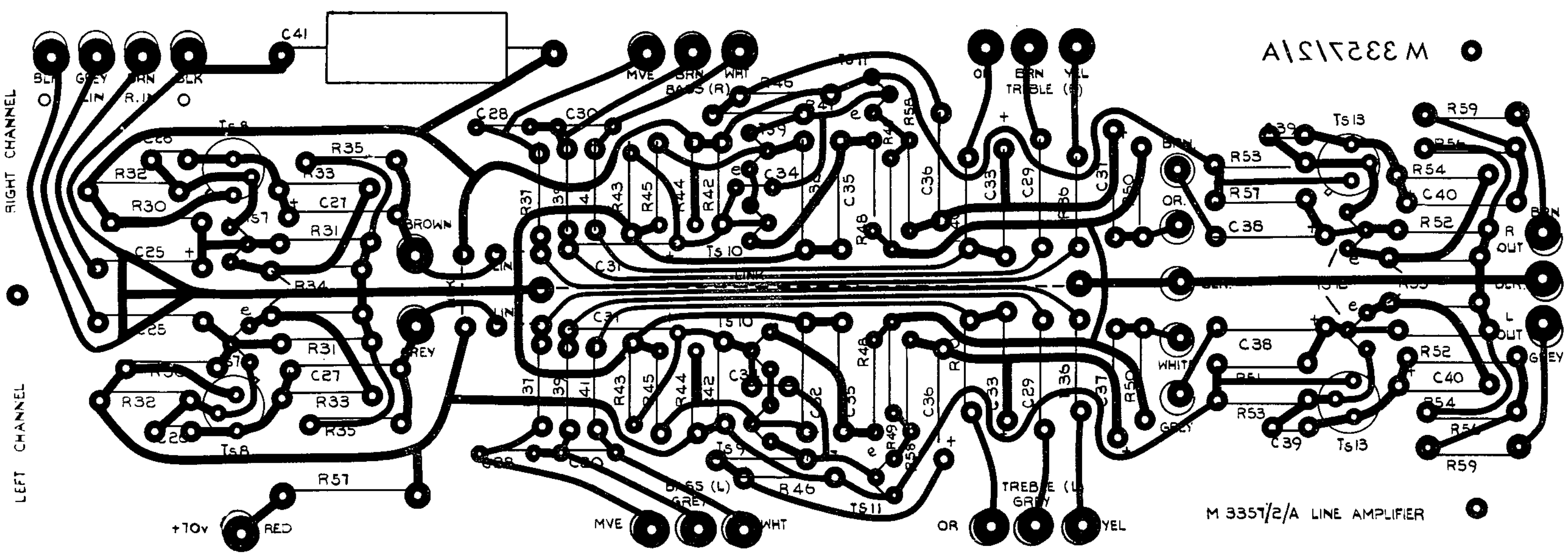


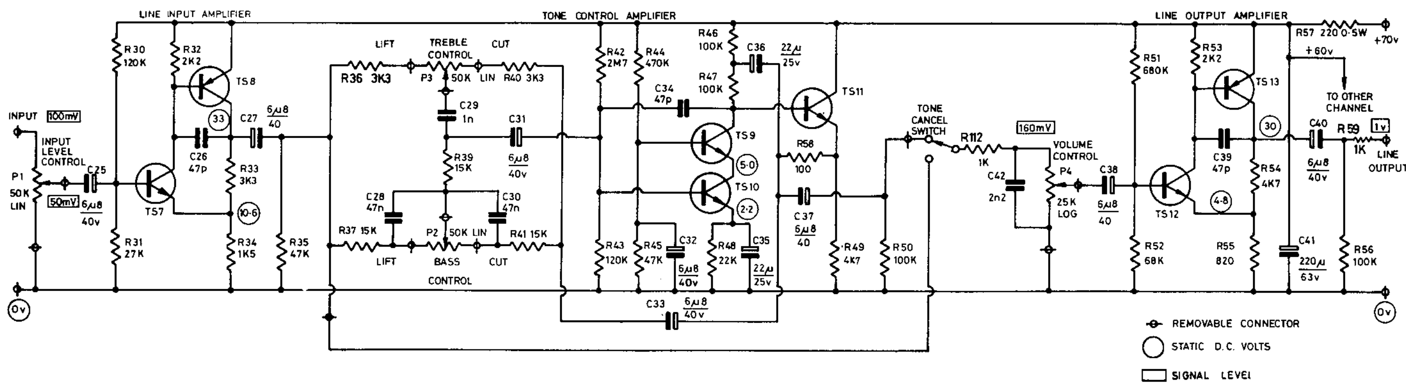
R1	MO	0.5w	82k	2%
R2	MO	0.5w	120k	2%
R3	MO	0.5w	390E	5%
R4	MO	0.5w	47k	2%
R5		Not used		
R6	CF	0.25w	47E	5%
R7	MO	0.5w	6k8	2%
R8	MO	0.5w	47E	2%
R9	MO	0.5w	3k3	2%
R10	MO	0.5w	22k	2%
R11	MO	0.5w	10k	2%
R12	MO	0.5w	8k2	2%
R13	CF	0.25w	56k	5%
R14	CF	0.25w	5k6	5%
R15	MO	0.5w	5k6	5%
R16	CF	0.25w	47E	5%
R17	CF	0.25w	47E	5%
R18	CF	0.25w	1k	5%
R19	CF	0.25w	2k7	5%
R20	CF	0.25w	68k	5%

R23	CF	0.25w	2k2	5%
R24	CF	0.25w	100k	5%
R25	CF	0.25w	100k	5%
R26	CF	0.25w	100k	5%
R27	CF	0.25w	10k	5%
R28	CF	0.25w	100k	5%
C1	E	22uF	25V	
C2	E	22uF	63V	
C3	CR	47pF	63V	
C4	CR	2N2	40V	
C5	PR	0.047uF	100V	2%
C6	PR	0.047uF	100V	2%
C7	E	47uF	40V	
C8	E	33uF	40V	
C9	PR	0.033µF	100V	2%
C10	E	1.5uF	63V	
C11	CR	10pF	68V	
C12	E	47uF	40V	
C13	PR	3300pF	100V	5%

C14	E	220uF	63V
C15	E	6.8uF	40V
C20	E	6.8uF	40V
C21	E	6.8uF	40V
C22	E	6.8uF	40V
TS1		2N3964	
TS2		ZTX107B	
TS3		ZTX109C	
TS4		2N2219A	
TS5		2N2905A	
TS6		ZTX107B	
D1		BAX16	
D2		BAX16	
D3		BAX16	
D4		BAX16	

FIG. 12 LINE AMPLIFIER MODULE HD250 & ZD22





R30	CF	0.25w	120k	5%
R31	CF	0.25w	27k	5%
R32	CF	0.25w	2k2	5%
R33	CF	0.25w	3k3	5%
R34	CF	0.25w	1k5	5%
R35	CF	0.25w	47k	5%
R36	CF	0.25w	3k3	5%
R37	CF	0.25w	15k	5%
R39	CF	0.25w	15k	5%
R40	CF	0.25w	3k3	5%
R41	CF	0.25w	15k	5%
R42	CF	0.25w	2M7	10%
R43	CF	0.25w	120k	5%
R44	CF	0.25w	470k	5%

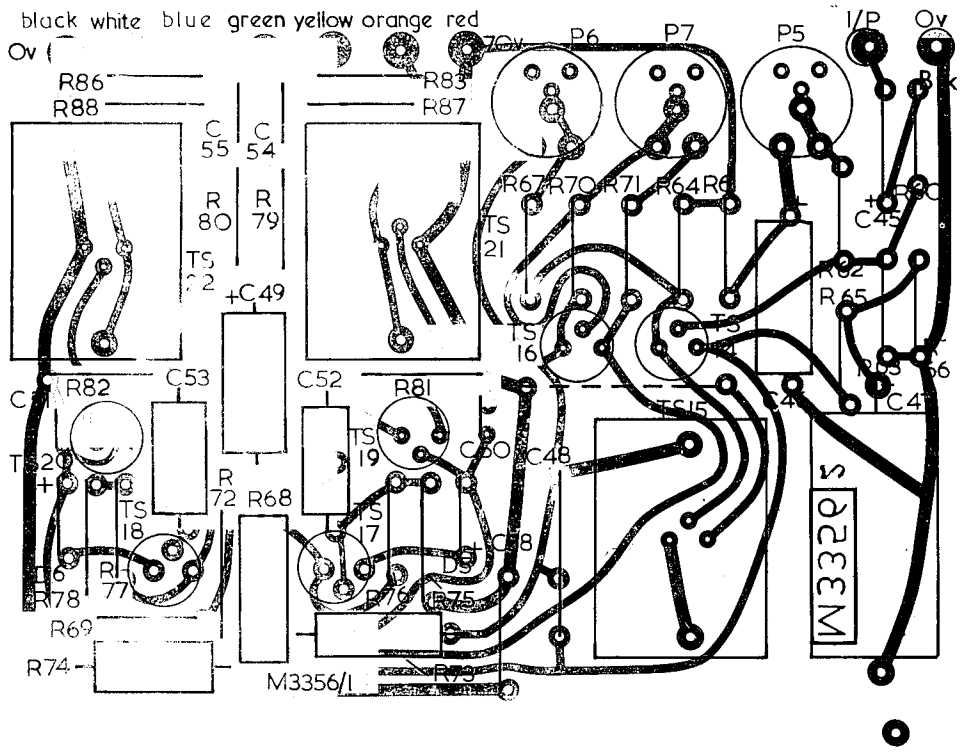
R45	CF	0.25w	47k	5%
R46	CF	0.25w	100k	5%
R47	CF	0.25w	100k	5%
R48	CF	0.25w	22k	5%
R49	CF	0.25w	4k7	5%
R50	CF	0.25w	100k	5%
R51	CF	0.25w	680k	5%
R52	CF	0.25w	68k	5%
R53	CF	0.25w	2k2	5%
R54	CF	0.25w	4k7	5%
R55	CF	0.25w	820E	5%
R56	CF	0.25w	100k	5%
R57	CF	0.5w	220E	5%
R58	CF	0.25w	100E	5%
R59	CF	0.25w	1k	5%

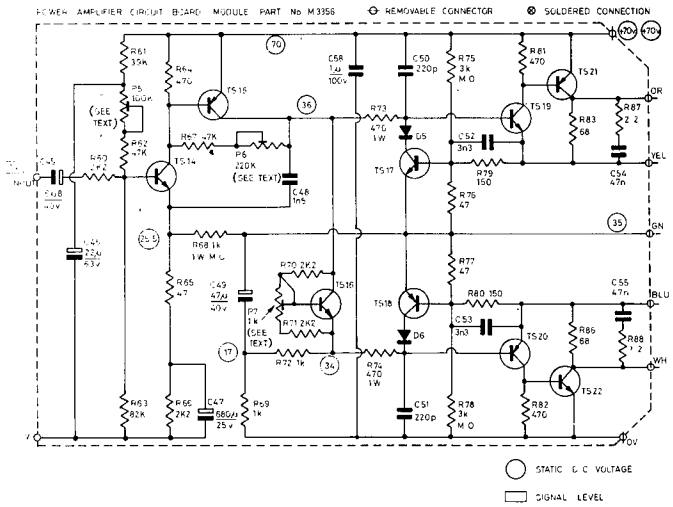
C25	E	6.8μF	40V	
C26	CR	47pF	63V	
C27	E	6.8μF	40V	
C28	PR	0.047μF	100V	2%
C29	PR	1000pF	400V	5%
C30	PR	0.047μF	100V	2%
C31	E	6.8μF	40V	
C32	E	6.8μF	40V	
C33	E	6.8μF	40V	
C34	CR	47pF	63V	
C35	E	22μF	25V	
C36	E	22μF	25V	
C37	E	6.8μF	40V	
C38	E	6.8μF	40V	

C39	CR	47pF	63V
C40	E	6.8μF	40V
C41	E	220μF	63V

TS7	ZTX107B
TS8	ZN2905A
TS9	ZTX107B
TS10	ZTX107B
TS11	ZTX107B
TS12	ZTX107B
TS13	2N2905A

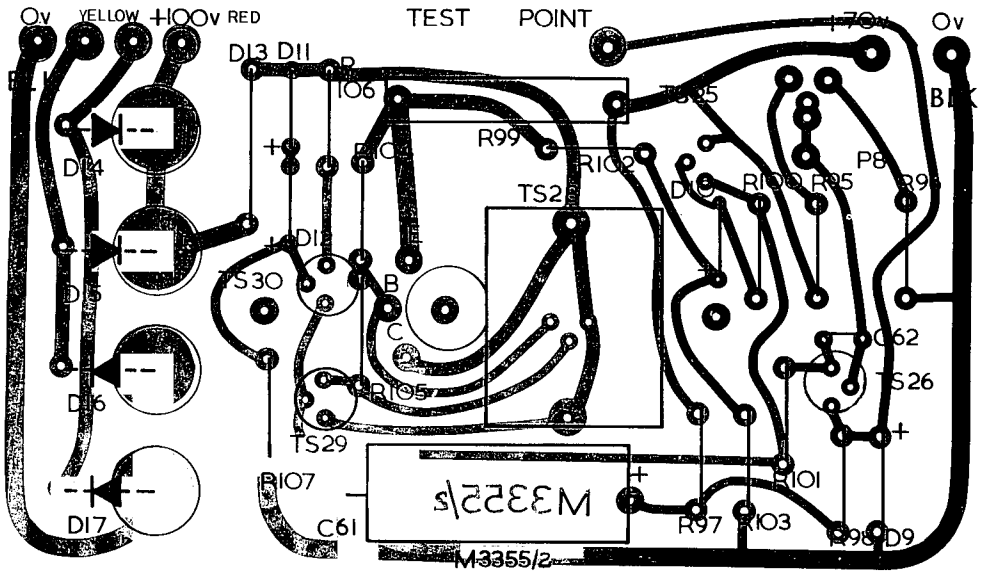
FIG. 13 POWER AMPLIFIER MODULE HD250

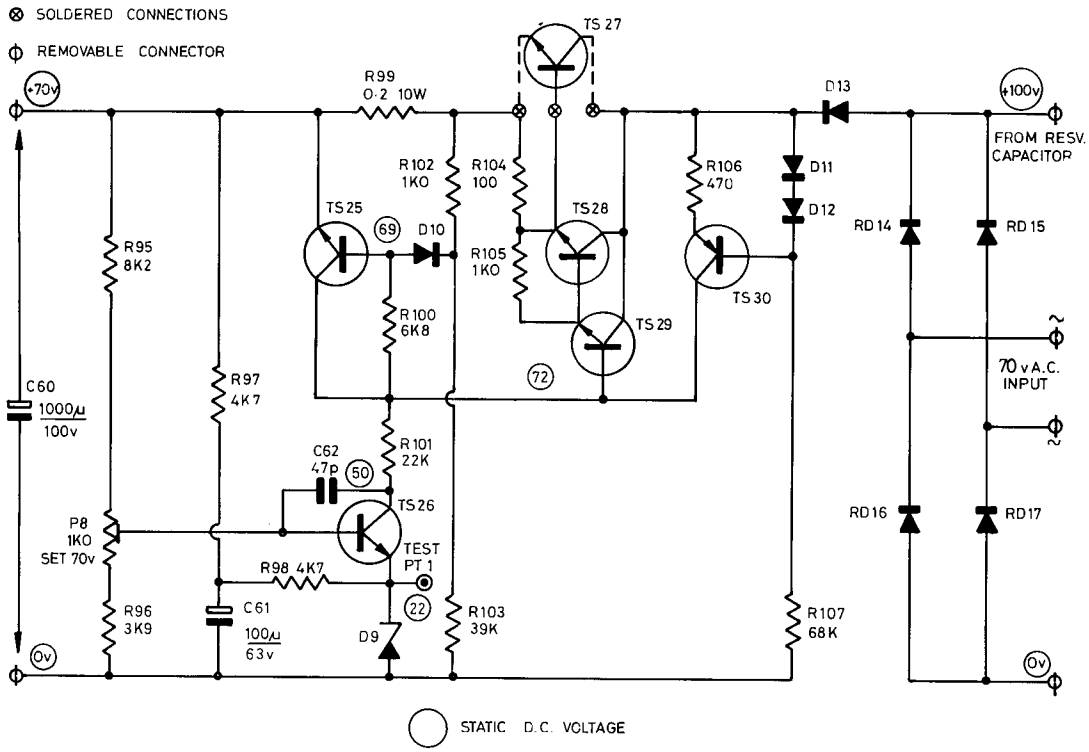




R60	CF	0.25w	2k2	5%	R81	CF	0.25w	470E	5%	TS14	40361
R61	CF	0.25w	39k	5%	R82	CF	0.25w	470E	5%	TS15	40410
R62	CF	0.25w	47k	5%	R83	CF	0.25w	68E	5%	TS16	ZTX107B
R63	CF	0.25w	82k	5%	R86	CF	0.25w	68E	5%	TS17	BFW60
R64	CF	0.25w	470E	5%	R87	CF	0.25w	2E2	5%	TS18	BFW90
R65	CF	0.25w	47E	5%	R88	CF	0.25w	2E2	5%	TS19	40361
R66	CF	0.25w	2k2	5%						TS20	40362
R67	CF	0.25w	47k	5%						TS21	40410
R68	MO	1w	1k	5%						TS22	40409
R69	CF	0.25w	1k	5%							
R70	CF	0.25w	2k2	5%							
R71	CF	0.25w	2k2	5%	C45	E	6.8µF	40V			
R72	CF	0.25w	1k	5%	C46	E	22µF	63V			
R73	CF	1w	470E	5%	C47	E	680µF	25V			
R74	CF	1w	470E	5%	C48	CR	1500pF	100V	10%		
R75	MO	0.5w	3k	2%	C49	E	47µF	40V			
R76	CF	0.25w	47E	5%	C50	CR	220pF	63V			
R77	CF	0.25w	47E	5%	C51	CR	220pF	63V			
R78	MO	0.5w	3k	2%	C52	CR	3300pF	100V	10%	D5	BAX16
R79	CF	0.25w	150E	5%	C53	CR	3300pF	100V	10%	D6	BAX16
R80	CF	0.25w	150E	5%	C54	PR	0.047µF	100V	20%		
					C55	PR1	0.047µF	100V	20%		
					C58	PR	1µF	100V	10%		

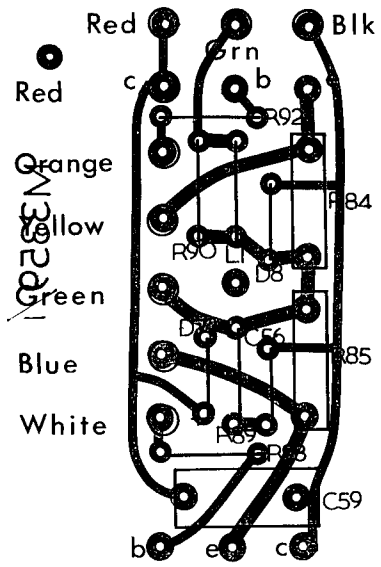
FIG. 14 POWER SUPPLY MODULE HD250

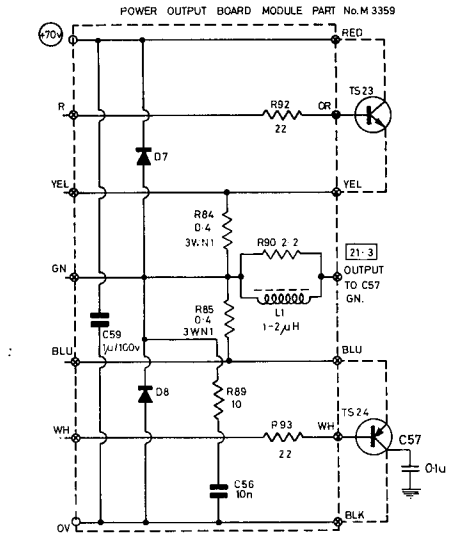




R95	CF	0.25w	8k2	5%		C61	E	100µF	63V	D9	BZX61
R96	CF	0.25w	3k9	5%		C62	CR	47pF	63V	D10	BAX16
R97	CF	0.25w	4k7	5%						D11	BAX16
R98	CF	0.25w	4k7	5%						D12	BAX16
R99	WWS	0.2E	10w	5%						D13	60S2
R100	CF	0.25w	6k8	5%						RD14	BYX38300
R101	CF	0.25w	2k2	5%						RD15	BYX38300
R102	CF	0.25w	1k	5%						RD16	BYX38300R
R103	CF	0.25w	39k	5%						RD17	BYX38300R
R104	CF	0.25w	100E	5%							
R105	CF	0.25w	1k	5%							
R106	CF	0.25w	470E	5%							
R107	CF	0.25w	68k	5%							
						TS25		ZTX107B			
						TS26		40408			
						TS28		40349V1			
						TS29		MPSL01			
						TS30		MPSA93			

FIG. 15 POWER OUTPUT MODULE HD250



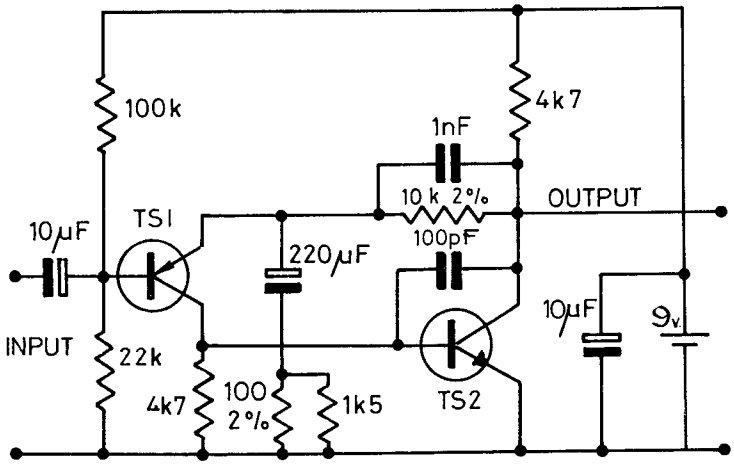


R84	WWS	3w	0.4E	5%
R85	WWS	3w	0.4E	5%
R89	CF	0.25w	10E	5%
R90	CF	0.25w	2E2	5%
R92	CF	0.25w	22E	5%
R93	CF	0.25w	22E	5%

D7		IN4003		
D8		IN4003		
L1		Inductor 1-2 μH		
C56	PR	0.01μF	250V	10%
C59	PR	1μF	100V	10%

Fig. 4 Network for nominally 'flat' response roll off

Fig. 5 Amplifier for hum and noise measurement ZD22



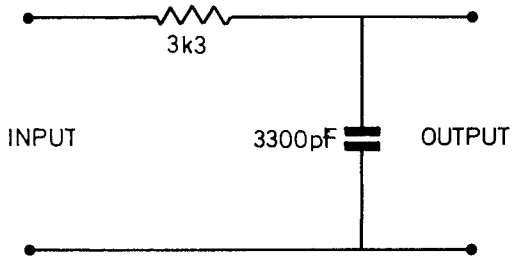


Fig. 3 RIAA Frequency characteristic inverter

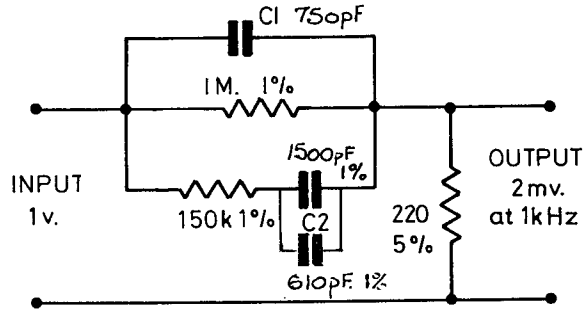
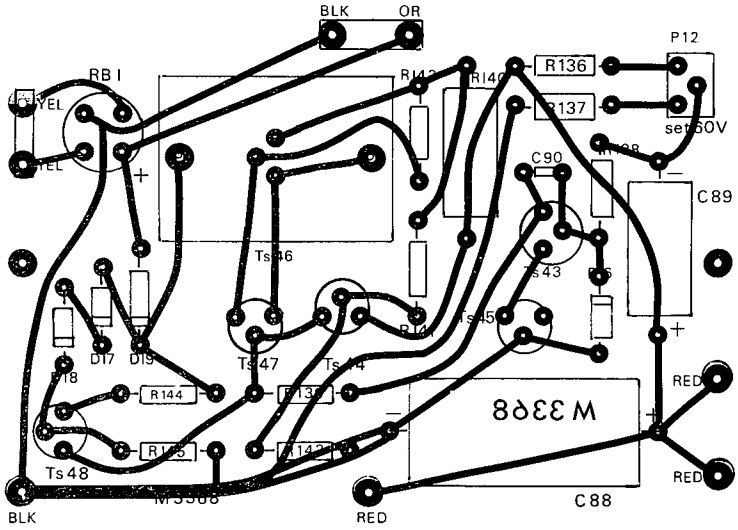
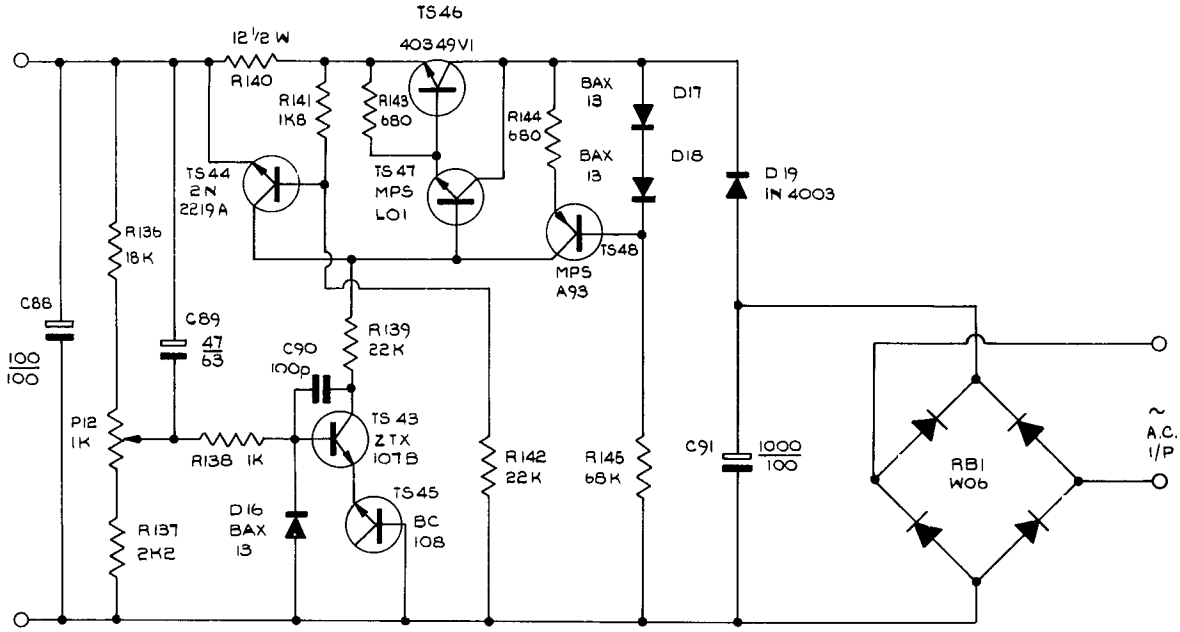


FIG. 16 POWER SUPPLY MODULE ZD22





R136	R1723	CF	0.25W	18K	5%	C88	C1418	CapE	100uF 100V	Ts43	Ts4587	ZTX107B
R137	R1795	CF	0.25W	2K2	5%	C89	C1459	CapE	22u F 63V	Ts44	Ts4586	2N2219A
R138	R1731	CF	0.25W	1K	5%	C90	C1371	CapCr	100pF 63V	Ts45	Ts4587	ZTX107B
R139	R1758	CF	0.25W	22K	5%	C91	C1338	CapE	100uF 100V	Ts46	Ts4573	40349V1
R140	R1843	CF	0.5W	12E	5%					Ts47	Ts4574	MPSL01
R141	R1768	CF	0.25W	1K8	5%	D16	RD7833	BAX13		Ts48	Ts4571	MPSA93
R142	R1758	CF	0.25W	22K	5%	D17	RD7833	BAX13				
R143	R1718	CF	0.25W	680E	5%	D18	RD7833	BAX13				
R144	R1718	CF	0.25W	680E	5%	D19	RD7848	IN4003				
R145	R1725	CF	0.25W	68K	5%	RB1	RD7840	W06				