INSTRUCTION MANUAL

EMERGENCY RUN-DOWN UNIT FOR SUPERCONDUCTING MAGNETS MODEL 2630 A

OXFORD

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MODEL 2630 A

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Note to Readers

The Emergency Run-Down Unit Model 2630A is used with the range of superconducting whole-body imaging magnets manufactured by Oxford Magnet Technology Ltd. to provide an emergency facility for rapid field removal.

HIGH-VOLTAGE WARNING

Voltage in excess of 30 volts RMS can be lethal. Great care should be exercised when working on units requiring exposure to terminals carrying voltage of a higher value; a second person should always be in attendance.

1 GENERAL INFORMATION

1.1 PURPOSE OF EQUIPMENT

This equipment provides an emergency facility for use with large superconducting magnets. The magnets are fitted with electrical heaters within the windings; when these heaters are energised by the Emergency Run-Down Unit, the magnets quench and rapidly de-energise.

This unit provides such emergency power for up to four quench heater circuits from an internal, float-charged Nickel-Cadmium battery. The output from this unit is 4 x 2A at 20V minimum for three to six minutes.

1.2 MOUNTING

This unit should be mounted within easy reach of the operator, in a prominent position in direct line of sight from the magnet.

1.3 SPECIFICATION

Overall size:	Height 200mm Width 300mm Depth 190mm
Weight:	4kg
AC supply:	100-120; 200-24V AC single phase, 50-60Hz 5VA max.
Output current:	2A (max.) each heater
Output voltage:	24V DC nominal
Heater resistance:	12ohm nominal
Battery test:	Fail when insufficient reserve capacity for total 8A output for 3 minutes at 20V
AC supply fuses:	100mA fast blow 20 x 5mm
AC secondary fuse:	250mA semi timelag 20 x 5mm
Heater fuses:	3A wire-ended "picofuse"

2 INSTALLATION AND COMMISSIONING

2.1 UNPACKING

Unpack the unit with care and inspect it for mechanical damage.

2.2 PRE-INSTALLATION CHECK (see diag. 2)

By releasing the captive fasteners on the corners of the front panel, the top may be hinged open. Inspect the components for mechanical damage.

Charge the battery with an initial constant-current charge of 200mA for 16 hours, irrespective of its state of charge on receipt; this ensures a sufficient reserve for proper operation when installed.

The OXFORD Model 2631 battery charger may be used for charging. Alternatively, any 200mA to 220mA constant-current source of 30V to 50V compliance may be used. The charging current is to be fed into XA3 pin A (positive) and XA2 pin H (negative).

2.3 INSTALLATION

> **Caution:**
> *This unit must not be used in magnetic fields of more than 100 gauss, otherwise saturation effects may cause overheating of the AC supply transformer.*

Drop down the panel associated with connector XA1 and ensure that the selector has been rotated to show the figure nearest to the actual AC supply voltage.

Ensure that the large red STOP pushbutton is in the released position (rotate it clockwise to check).

Connect the 2630A to the 19-way connector on the magnet service turret using lead assembly type 610-039.

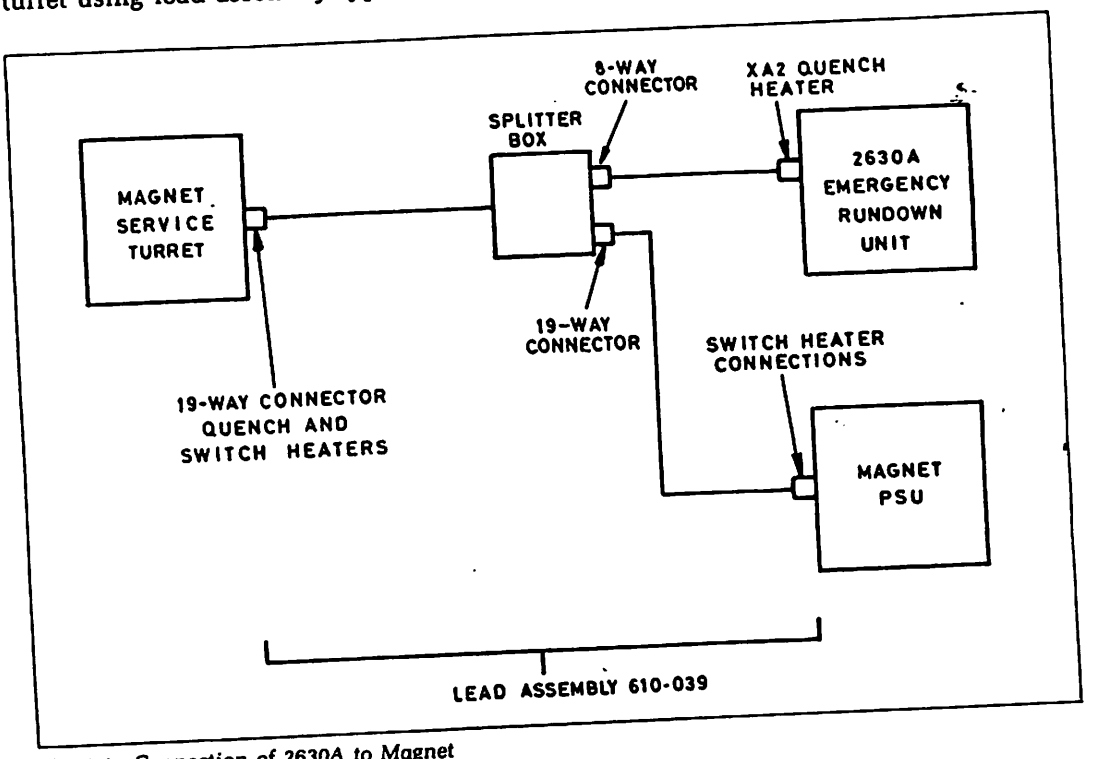


Fig. 2.1 *Connection of 2630A to Magnet*

Connect any remote STOP controls to connector XA3 REMOTE. All remote STOP controls should be normally open, latching pushbutton types, rated for 30V DC 8A minimum, connected in parallel. Ensure that the cable used on any STOP button spur is thick enough to keep the total voltage drop across the spur less than 1 volt at 8A DC.

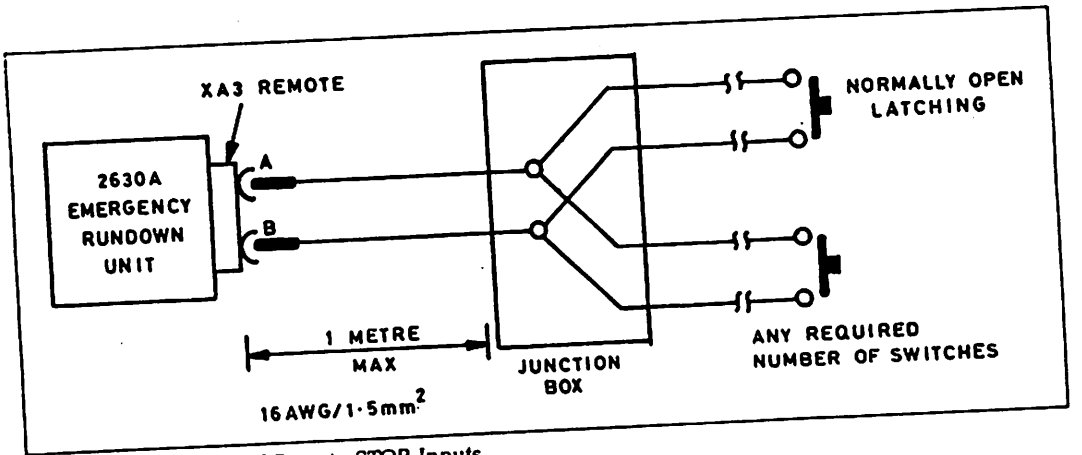


Fig. 2.2 *Connection of Remote STOP Inputs*

eg: Length of spur	Minimum Cable Size
5m	16AWG/1.5mm²
10m	12AWG/3mm²
20m	8AWG/6mm²

The integral STOP button has a normally closed contact rated at 30V 2A brought out to connector XA3 REMOTE. This is available for use as required. If this facility is required from all of the remote STOP switches then it must be provided separately at the switches by additional contacts.

Connect AC power via connector XA1 AC POWER.

Connector Pin Assignment

XA2 QUENCH HEATER

Pin	Function
A	Heater 1+
B	Heater 1–
C	Heater 2+
D	Heater 2–
E	Heater 3+
F	Heater 3–
G	Heater 4+
H	Heater 4–

XA3 REMOTE

Pin	Function
A	Linking these operates
B	quench heaters
C	Internal normally closed contacts
D	open when STOP button operated

2.4 COMMISSIONING TESTS

Press the yellow button in TEST PANEL 1 to test the quench heater circuits. Failure of a circuit is indicated by non illumination of the associated lamp.

Press the orange button in TEST PANEL 2, and hold it for approximately 10 seconds, to test the battery. A steady, green PASS indication should result. If a FAIL indication is obtained from a unit at this stage, the battery should be replaced with a known good fully-charged item.

3 OPERATING INSTRUCTIONS

WARNING:
For the unit to fulfil its emergency function, the AC power supply must have been switched on continuously, except for any short-term power failures, since the battery received its initial conditioning charge.

3.1 EMERGENCY OPERATION

Press the large, red pushbutton in the centre of the front panel firmly. This will cause the magnet to run down in case of an emergency.

3.2 SWITCHING ON

When the AC POWER button is pressed the integral lamp will light.

3.3 ROUTINE TESTS

On TEST PANEL 1, press the yellow button to test the quench heater circuits. Failure of a circuit is indicated by the associated lamp failing to light.

On TEST PANEL 2, press the orange button and hold it depressed for approximately ten seconds. A steady, green illumination from the PASS indicator shows a sufficient state of battery charge.

3.4 FAULTS

1 If the AC POWER pushbutton does not illuminate, first check the AC supply fuses located in XA1

2 Failure of any quench heater circuit must be investigated immediately.

3 A FAIL indication on the battery test may be due either to failure of the battery and/or charging circuits, or due to an insufficient charging-time being allowed since installation or last operation. Excessive use of the battery-test facility will also drain the battery, in which case a full recharge should be given (see Section 2.2).

3.5 RECHARGE AFTER OPERATION

Once the unit has been used to initiate magnet run-down, the battery will be discharged beyond the capability of the internal charger. The method described in Section 2.2 is then required to restore the battery. Following recharge, before the battery is returned to service, the battery must be checked using the battery-test facility. If a FAIL indication results, then the battery has probably been damaged by excessive depth of discharge; in such a case, it must be replaced.

4 TECHNICAL DESCRIPTION

4.1 PRINCIPLES OF OPERATION

All power for the unit is supplied from a 24V, 2Ah Nickel-Cadmium battery which is continuously trickle-charged at approximately 15mA. The run-down function connects the battery voltage directly to the heater circuits via 3A fuses.

4.2 FUNCTIONAL DESCRIPTION (see diag. 3 and 4)

As shown in Fig. 4.1, the circuitry can be considered in four parts: the battery-charging circuit, the operative circuits, the quench-heater test circuits and the battery-test circuit.

4.2.1 Battery-Charging Circuit

The output from transformer T1 is rectified by bridge D1 and smoothed by C1, to develop approximately 50V DC, unregulated. R1 limits the charging-current to approximately 15mA; R1 is rated to withstand continuous short-circuit operation if the battery should fail. If the battery should become open-circuit, D3 limits maximum voltage to 30V.

Other than for battery checks and the run-down function itself, no current is taken from the battery.

4.2.2 Operative Circuits

The run-down function is initiated either by operation of the STOP button or by the REMOTE INPUT. This causes the battery voltage

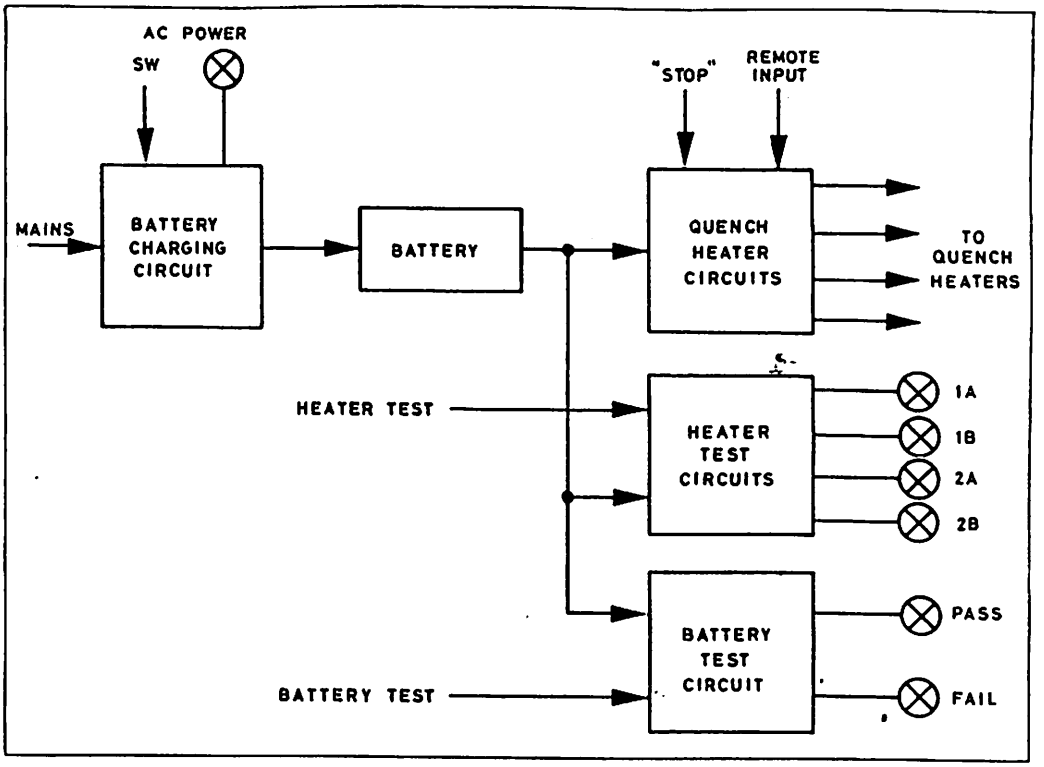


Fig. 4.1 *Functional Block Diagram*

to be connected to the heater circuits via a diode and a 3A fuse (D4 to D7 and F2 to F5, respectively).

4.2.3 Quench-Heater Test Circuits

These four circuits are similar: this description applies specifically to the circuit associated with lamp 1A (heater 1).

Operation of the HEATER TEST switch applies + 24V DC (via R2) to the heater circuit and to the reference-voltage circuit R6, R7, R8, R9 and D8. U1 compares the voltage developed across the heater circuit with the upper and lower-limit voltages from the reference-voltage circuit. A low voltage from the heater circuit (i.e. short-circuit) causes U1 pin 2 to go low, switching off Q3 and preventing lamp 1A from lighting. A high voltage from the heater circuit (i.e. open-circuit) causes U1 pin 1 to go low, switching off Q3 and preventing lamp 1A from lighting. Any voltage that lies between the two limits enables Q3 to conduct, and lamp 1A will light to indicate a pass condition.

4.2.4 Battery Test Condition

Operation of the BATTERY TEST switch applies battery voltage to load resistors which draw approximately 2.2A. The voltage is also applied to comparator U3 via the voltage-divider circuit R10, R19 and R12. U3 compares the output from the voltage-divider with a precision reference-voltage developed by D9. If the battery voltage exceeds 24V, U3 switches Q1 on, causing the PASS lamp to light. If the battery voltage does not exceed the preset level, U3 switches Q2 on, causing the FAIL lamp to light.

5 PREVENTIVE MAINTENANCE

5.1 ROUTINE MAINTENANCE

Other than the routine tests described in Section 3.3, it is only necessary to ensure that the connectors on the unit are clean, dry and fully mated.

5.2 ENVIRONMENTAL CONSIDERATIONS

This unit must not be used in magnetic fields of more than 100 gauss, otherwise saturation effects may cause overheating of the AC supply transformer.

The capacity of the battery is significantly reduced at temperatures outside the range 10°C to 30°C. The specification requirements are met over the range 0°C to 40°C, but safety margins are correspondingly reduced.

6 FAULT DIAGNOSIS AND CORRECTIVE MAINTENANCE

6.1 FAULT INDICATIONS

The most likely faults are as follows:

1 AC POWER lamp does not light when the button is pressed. In this case, either the lamp itself or the fuses in connector XA1 should be examined and changed, if necessary.

2 FAIL lamp on TEST PANEL 2 lights during a battery test. Provided that the battery has received a full commissioning charge and has also been on trickle-charge since (i.e. AC supply on), check the charging-circuit as described below. If no fault is found, check the battery-test circuit itself as described below. If all circuitry is functional, it may be sufficient to recharge the battery as described in Section 2.2. If this fails to restore a PASS indication, however, then replace the battery with a new, fully-charged one.

3 If any of the lamps 1A, 1B, 2A or 2B fail to light during a quench-heater test, check the appropriate operative circuit as described below. If no fault is found, check the heater test circuit itself, as described below.

6.2 CHECKS AND ADJUSTMENTS (see diag. 3 and 4)

6.2.1 Battery Charging-Circuit Test

With AC POWER switched ON (AC POWER lamp lights), proceed as follows:

1 Measure the voltage across C1 and check that it is between 45V and 60V (nominally 56V DC).

2 Measure the voltage across R1 and check that it is between 15V and 40V (nominally 28V DC).

3 Measure the voltage across the battery and check that it is between 20V and 28V (nominally 24V DC).

6.2.2 Battery-Test Circuit Test

With the battery-test button depressed, proceed as follows:

1 Measure the voltage between TP1 and TP2 and check that it is between 24V and 28V (24V DC is the PASS/FAIL threshold).

2 Measure the voltage across D9 and check that it is 1.23V ± 0.05V DC.

3 Check that the PASS lamp lights.

6.2.3 **Battery-Test Circuit Adjustment**
If the battery-test circuit needs re-adjusting proceed as follows:

1 Disconnect the AC supply.

2 Disconnect the battery from circuit.

3 In place of the battery, connect a variable DC supply of at least 2.5A rating, and set it for 24V output.

4 Press the battery-test button and adjust R19 until the PASS lamp just lights.

5 Disconnect the power supply and re-connect the battery.

6.2.4 **Quench-Heater Operative-Circuit Test**
For each heater output in turn, proceed as follows:

1 Connect a 12-ohm, 50W resistor across the output pins.

2 Press the STOP button and check that the voltage across the resistor is at least 20V DC.

3 Release the STOP button and repeat the voltage check by shorting the REMOTE INPUT.

6.2.5 **Quench-Heater Test-Circuit Test**
Proceed as follows:

1 Connect a 12-ohm, 50W resistor across each heater output.

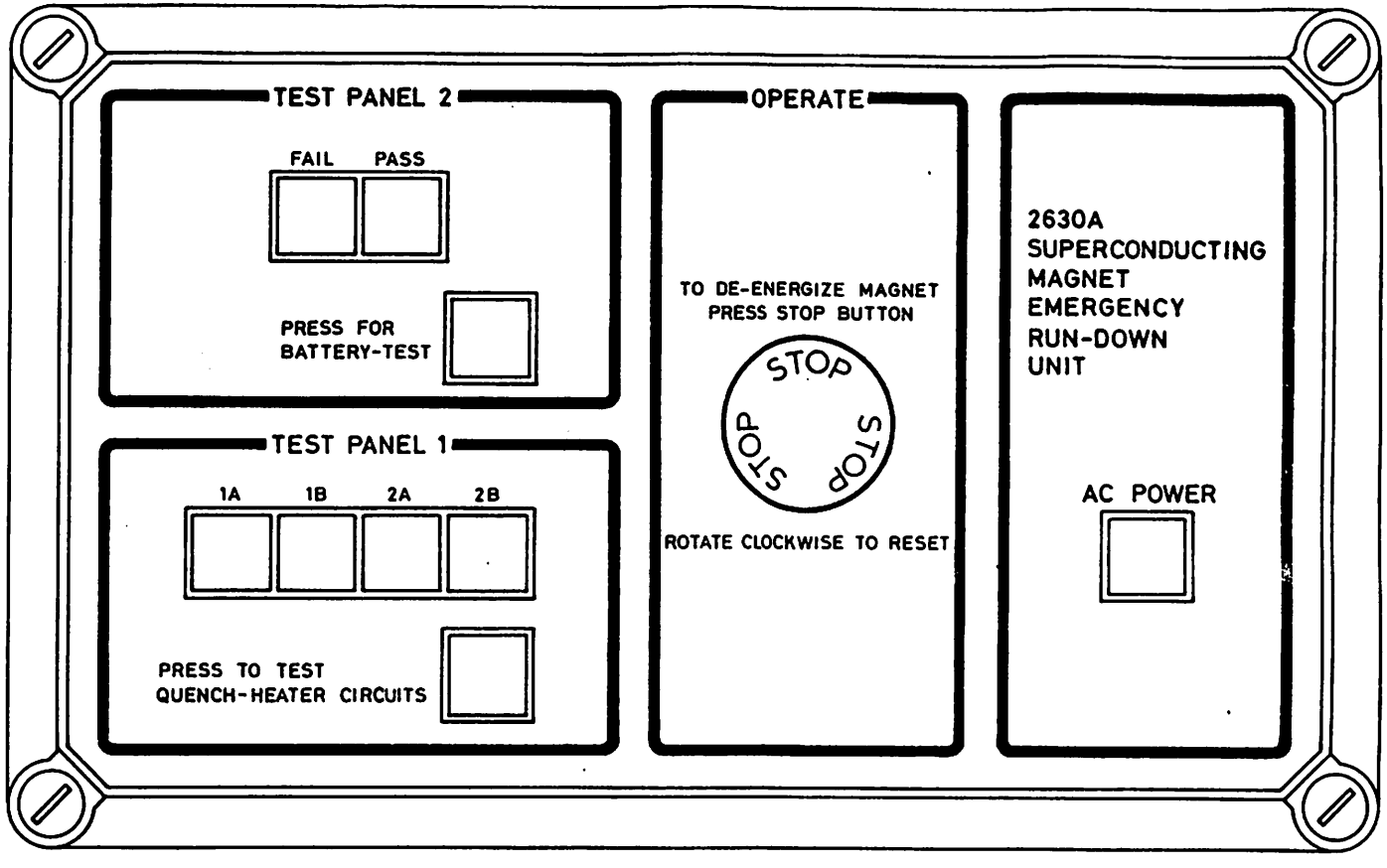
2 With the heater-test button depressed, check that the test lamps 1A, 1B, 2A and 2B all light, and that the voltage across D8 is 4.7V ± 0.4V DC.

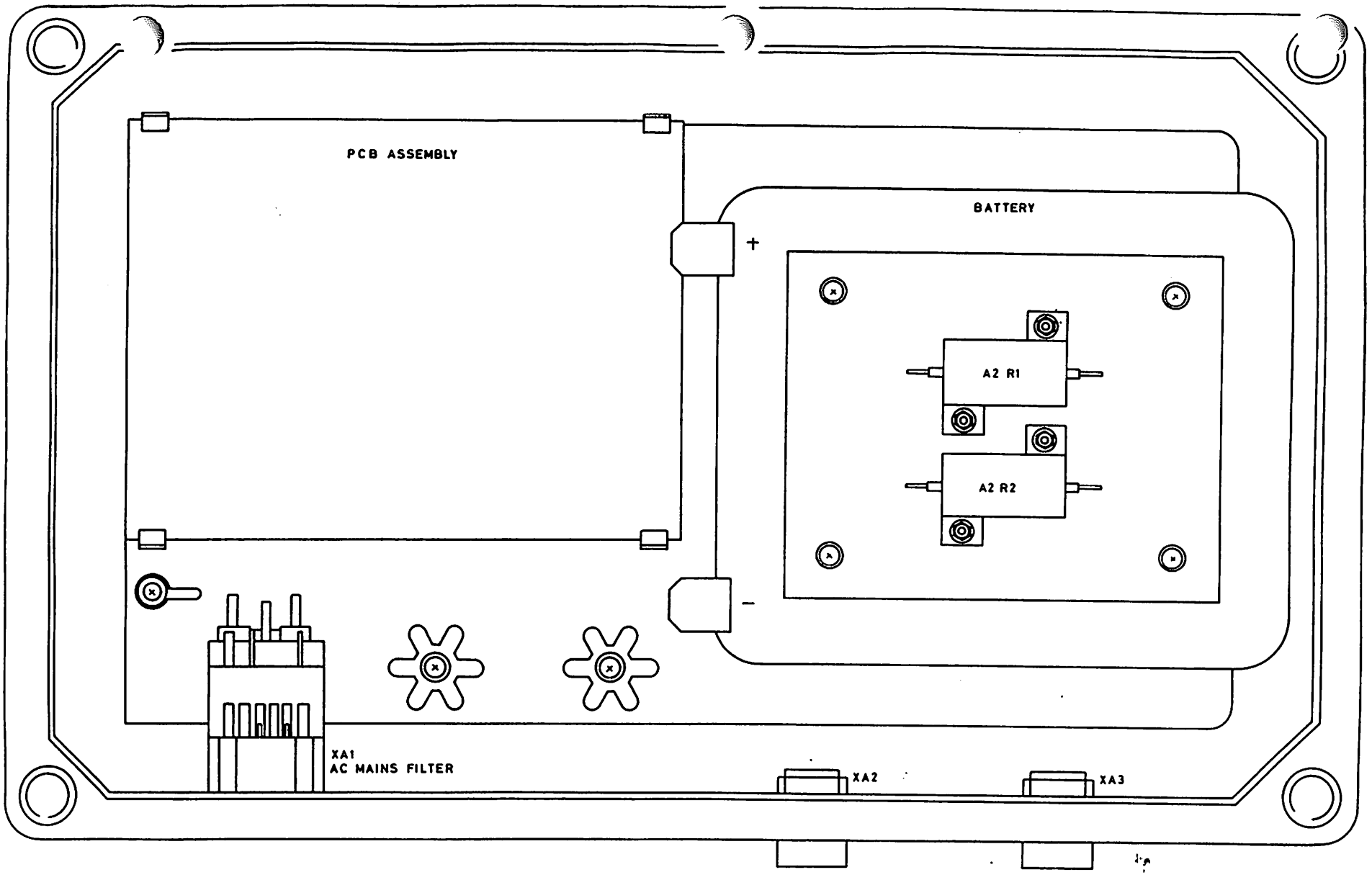
3 Short each resistor in turn and check that the appropriate test lamp goes out.

4 Open-circuit each resistor in turn and check that the appropriate test lamp goes out.

7 DIAGRAMS

Diagram	*Title*
1	Model 2630A Front Panel
2	Model 2360A Internal Layout
3	Model 2630A PCB Component Layout
4	Model 2630A Circuit Diagram


TEST PANEL 2
FAIL
PASS
PRESS FOR
BATTERY-TEST
TEST PANEL 1
1A
1B
2A
2B
PRESS TO TEST
QUENCH-HEATER CIRCUITS
OPERATE
TO DE-ENERGIZE MAGNET
PRESS STOP BUTTON
STOP
STOP
STOP
ROTATE CLOCKWISE TO RESET
2630A
SUPERCONDUCTING
MAGNET
EMERGENCY
RUN-DOWN
UNIT
AC POWER



Model 2360A Internal Layout

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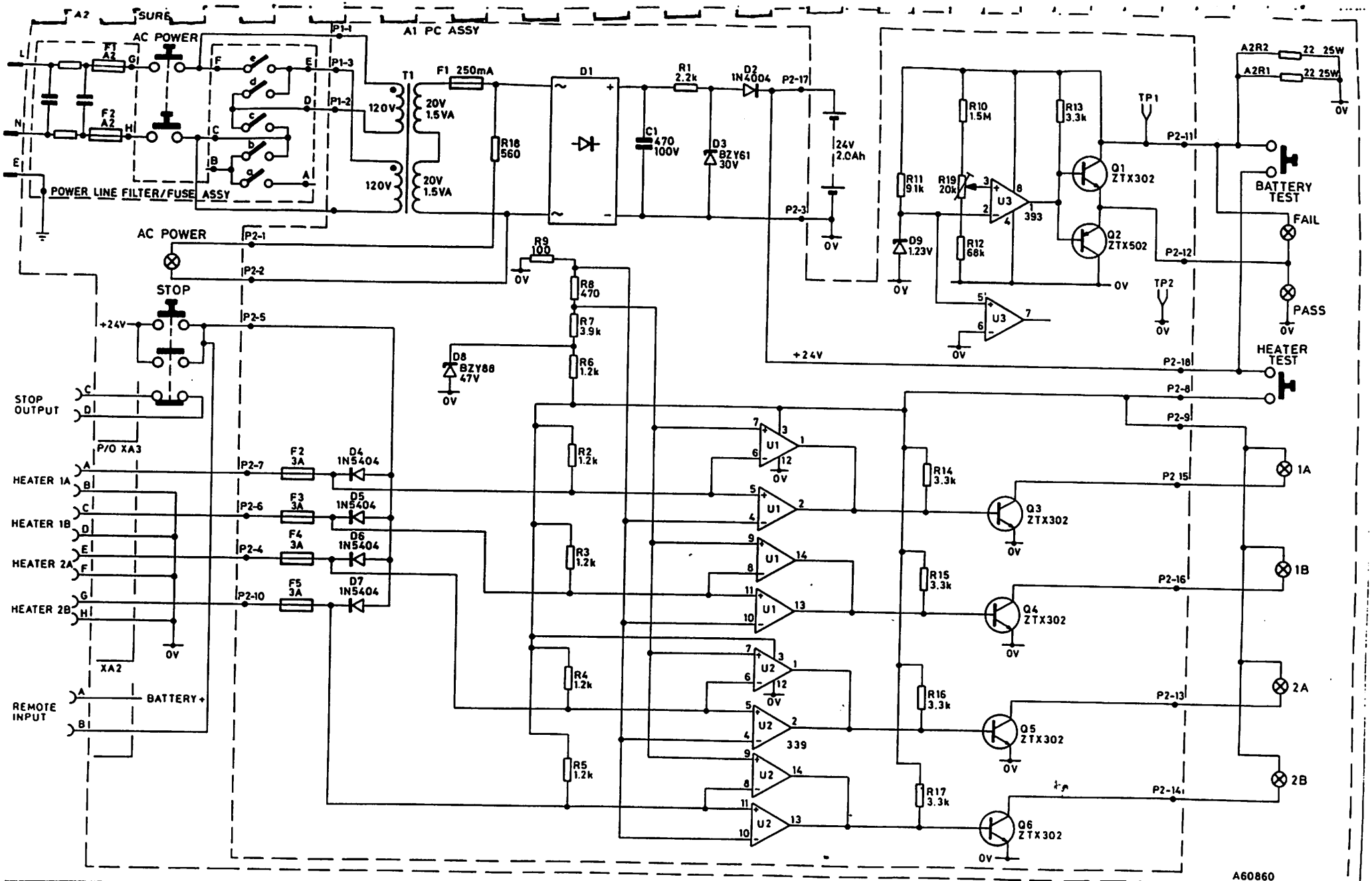

gram 4 Model 2630A Circuit Diagram

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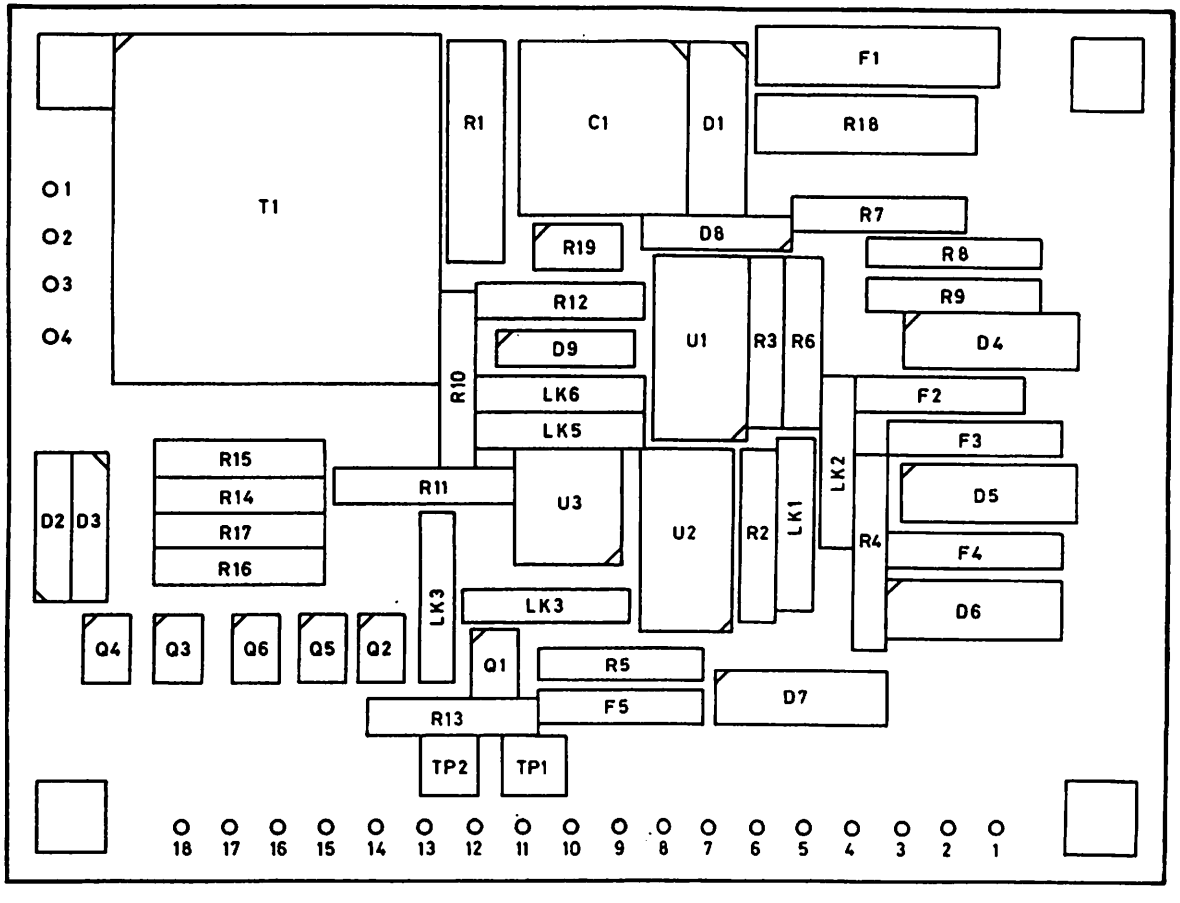

Diagram 3 Model 2630A PCB Component Layout