Chapter 20
DEMODULATOR, RADIO FREQUENCY 5821-99-948-8104

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Introduction

Purpose of unit

1. The demodulator, radio frequency 5821-99-948-8104, referred to throughout the remainder of this Chapter as the demodulator, is a sub-unit of the data link transmitter-receiver, radio, 5821-99-948-6977 (Type PTR177). This transmitter-receiver is similar to the R/T, transmitter-receiver, radio 5821-99-971-1781 (Type PTR175) (fully described and illustrated in A.P.116D-0116--1) except that the demodulator is fitted in place of the guard receiver. The f.s.k. (frequency shift keying) signal received by the transmitter-receiver is demodulated by a ratio detector circuit in the demodulator to produce a video output waveform similar to the original digital modulating signal. This video output is fed to the signal data converter.

2. The input to the demodulator is derived from the second receiver mixer in the amplifier, intermediate frequency and comprises frequencies of 7·87 MHz corresponding to a binary '0' and 1·83 MHz corresponding to a binary 'l'. i.e. a deviation of 20 KHz about the nominal second i.f. of 1·85 MHz. The input signal is fed via a 1·85 MHz selective filter and four r.f. amplifier stages to a limiter, which removes any amplitude

modulation that may be present, and is then demodulated by the ratio detector. The detector output is passed through a pi-section filter to a directly-coupled amplifier to produce the rectangular waveform required for operation of the converter, signal data. An a.g.c. voltage is applied to all amplifiers of the demodulator.

3. The demodulator uses semi-conductor circuits throughout and is completely miniaturized. It is of open construction, with the majority of the electronic components mounted on eight printed circuit boards and the remaining components individually mounted. The location of all components of the demodulator is silk-screened on the side covers. Except for a coaxial socket, which carries the input from the intermediate frequency amplifier, interconnections between the demodulator and the transmitter-receiver chassis are provided by a fixed multi-pole plug on the underside of the unit. This plug automatically mates with a corresponding socket on the chassis when the unit is fitted in place. Two locating dowels on the underside of the unit guide the plug into the socket and also ensure that the demodulator can be fitted only into its correct position on the chassis. Four captive screws, coloured red, on the underside of the transmitter-receiver chassis secure the demodulator in position. A wiring diagram of the demodulator appears at the end of the Chapter in fig. 3. A circuit diagram of the demodulator is given in Fig. 14 of A.P.116D-0133-10.

Preliminary inspection

4. On receipt of a demodulator for repair, it should be inspected as follows:

(1) Verify that the serial number and modification state are as entered on the repair card accompanying the unit.

(2) Remove the side covers and then the screening cover from the r.f. amplifier. Thoroughly clean the unit of any dust with a portable blower or other approved supply of clean dry air under pressure, if necessary using a soft squirrel hair brush to assist in the process. Since the transmitter-receiver is enclosed within an airtight casing, the presence of dust, dirt or moisture should be fully investigated.

(3) Carefully examine the unit to ensure that it is free from damage and corrosion, with all components securely retained in position. Any loose components must be securely refitted. Should it be necessary to change any components it is important to ensure that they are positioned accurately and correctly connected, particularly in the case of valves, semi-conductors and electro-

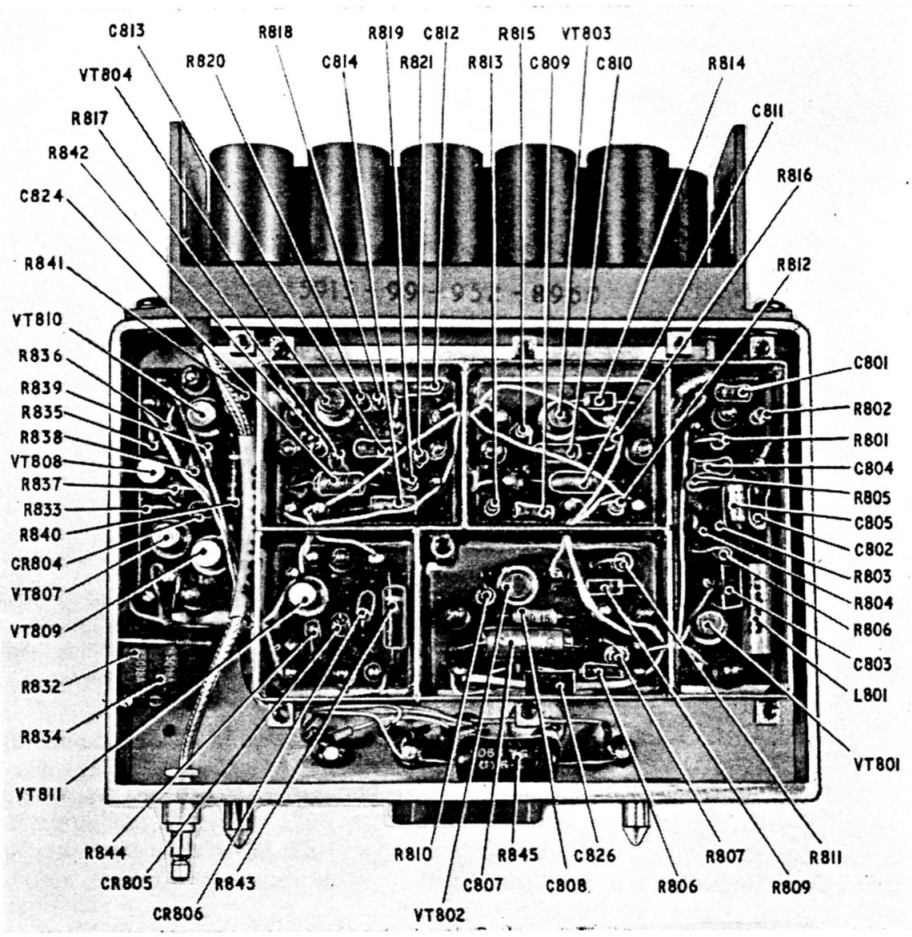

Fig. 1. Demodulator, radio frequency, 5821-99-948-8104: front view

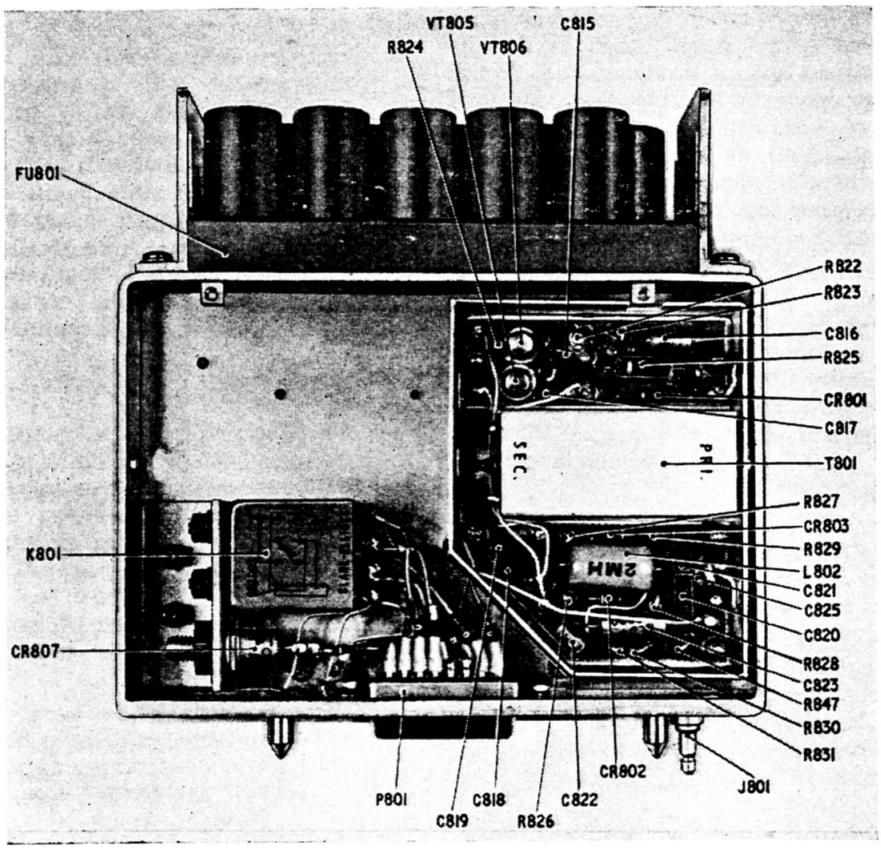

Fig. 2. Demodulator, radio frequency, 5821-99- 948-8104: rear view

lytic capacitors. Screws and nuts removed during examination or servicing and which are not fitted with locknuts or lockwashers, must be locked with approved varnish when refitted.

(4) Examine the unit for accuracy of wiring, neatness of soldering, absence of dry joints and a general satisfactory condition of the wiring and insulation. Particular attention should be paid to the sleeving covering the connections to the multi-pole plug. No inadvertant connections or tracking paths due to excess solder, wire clippings or dirty connections should be permitted. It is important to ensure that the renewal of wiring is done with the correct type of wire, with the gauge, length and routeing exactly the same as the original wiring, except where modifications have brought about changes.

Test equipment

5. The following items of test equipment are required:—

(1) Test set, demodulator, 6625-99-195-5998 (See note below).

(2) Power supply 6130-99-999-7812, for use with item (1).

(3) Headset, telephone, Type 9 (Ref. No. 10AH/14), for use with item (1)

(4) Multimeter CT429, 6625-99-943-8384.

(5) Generator, signal CT452, (Set), 6625-99-913-1420.

(6) Generator, signal CT520, 6625-99-944-7666.

(7) Generator, signal Type 16728, 6625-99-999-9604 (a.f. generator).

(8) Indicator, distortion 6625-99-944-7661.

(9) Resistor, fixed, film 470 ohm ± 10%, ¼W, 5905-99-022-1194.

Note . . .

If a test set, demodulator is not available, the following items will be required:—

(*a*) *Transmitter-receiver, radio, Type PTR*177, 5821-99-948-6977.

(*b*) *Test kit* (*AN/ARC*52), 6625-99-943-6904.

(*c*) *Control, radio set, Type C*1607/4, 5821-99-945-5739.

(*d*) *Test kit*, 6625-99-943-7032.

(*e*) *Counter, frequency electronic*, 6625-99-952-0550.

(*f*) *Paper dielectric capacitor of not less than* 3μ*F with a working voltage of not less than* 25*V*.

(g) *Resistor, fixed, film, 2 kilohm ± 2% ¼W*, 5905-99-012-2698.

Servicing notes

Printed circuit boards

6. The printed circuit boards used in the demodulators present special problems with regard to servicing as they may be irreparably damaged by excessive or sustained heat from a soldering iron. This will cause the printed circuit to lift from the board and render it unfit for further use. The recommended method to be adopted when renewing a component on a printed circuit board is as follows:—

(1) Remove the faulty component from the board by clipping the wires as close to the component as possible, thus leaving the wire ends still soldered to the board. In some cases it may be necessary to crush the component, by careful use of a pair of pliers, in order to obtain the maximum possible lengths of wire.

(2) Wrap the wire ends of the new component around the wires attached to the board, using one turn only and ensuring that the new component is fitted so that its value is clearly legible.

(3) Using a suitable heat shunt, solder the wire joints as quickly as possible with a lightweight soldering iron which has been allowed to reach its optimum operational temperature.

7. An alternative method of component renewal is to cut out the faulty component and unsolder its wires from the printed circuit board. The wires of the new component may then be pushed through the holes in the printed circuit board and soldered, as described in the previous paragraph.

8. The printed circuit boards and their components of the PTR177 demodulator are protected against corrosion, damp and vibration by a coating of varnish. After changing a component on one of these printed circuit boards, therefore, the protective coating on the affected area of the board must be renewed as follows:.

(1) Prepare the protective coating by thoroughly mixing three parts of Sterling varnish Type V961/A with one part of Sterling varnish Type V961/B at room temperature and allowing the mixture to stand for half an hour before application. (The pot life of this mixture is approximately five hours at room temperature).

(2) Apply the mixture with a brush to the new component and the affected area on that side of the board and then allow the board to cure as described in sub-para. (3). On completion of the curing process, coat and cure the affected area on the other side of the board in a similar manner.

(3) After coating, allow the board to dry in a dust free atmosphere at room temperature for 24 hours, with the coated face of the board uppermost.

Adjustable cores

9. The adjustable cores of the inductors and transformers in the demodulators are locked, after alignment, with oil, varnish 8010-99-947-7826. Before attempting to adjust any core, the locking varnish should be softened with paint remover 8010-99-947-7825. One application of this solvent with a small pencil brush will usually be sufficient to permit adjustment of the core after two or three minutes. When the solvent has evaporated, the original varnish may well relock the core, but if not, a light application of new varnish should be made. The application of more varnish should be avoided whenever possible. Care should be taken to keep the varnish and its solvent away from naked lights as both are highly inflammable.

Semi-conductors

10. The PTR177 demodulator uses semi-conductors (transistors and diodes) throughout and, although these are extremely robust under normal operating conditions, they require special care during servicing operations. Semi-conductors are particularly prone to damage by the application of excessive heat and can be totally destroyed by voltages of incorrect polarity. The following precautions should be taken, therefore:—

(1) When soldering a semi-conductor into a circuit, always use a heat shunt and solder the joint as quickly as possible with a lightweight soldering iron which has been allowed to reach its optimum operational temperature.

(2) Switch off, or preferably disconnect, power supplies to semi-conductor circuits before performing servicing operations.

(3) Ensure that potentials applied to semiconductors by test equipment are of the correct polarity.

Caution . . .

If a semi-conductor which is not of preferred manufacture (Table 1) is used, degraded performance of the demodulator may be experienced.

1·85 *MHz selective filter*

11. The components of this filter, which is mounted on top of the PTR177 demodulator, are set in resin after alignment by the manufacturer and no servicing is possible, therefore. In the unlikely event of the filter developing a fault it must be renewed as a complete item.

Performance tests

General

12. Remove the demodulator side covers, each of which are retained by two Phillips screws and washers. Ensure that link LKA is in place and that link LKB has been removed. These links are located on the printed circuit board TB8 and are shown on the wiring diagram (fig. 1), LKA being connected between terminals 17 and 18 and LKB between terminals 13 and 15.

TABLE 1

Semi-conductors

Circuit Ref. No.	C.V. No.	N.A.T.O. Stock No.	Preferred manufacturer (see para. 10, caution)
VT801	CV7477	5960-99-037-3669	
VT802	CV7477	5960-99-037-3699	
VT803	CV7477	5960-99-037-3669	
VT804	CV7477	9606-99-037-3669	
VT805	CV7477	5960-99-037-3669	
VT806	CV7477	5960-99-037-3669	
VT807	CV7477	5960-99-037-3669	
VT808	CV7477	5960-99-037-3669	
VT809	CV9029	5960-99-952-0674	
VT810	CV7477	5960-99-037-3669	
VT811	CV7477	5960-99-037-3669	
CR801	CV7101	5960-99-037-2201	
CR802	CV5196	5960-00-617-4113	Hughes (Type HD6616)
	or CV8825	5960-99-037-4115	Transitron (Type SG5134)
CR803	CV5196	5960-00-617-4113	Hughes (Type HD6616)
	or CV8825	5960-99-037-4115	Transitron (Type SG5134)
CR804	CV7106	5960-99-037-2206	
CR805	CV8984	5960-99-037-4259	
CR806	CV7105	5960-99-037-2205	
CR807	CV7214	5960-99-037-2621	

13. If a demodulator test set (para. 5 (1)) is available, proceed as follows:—

(1) Fit the demodulator to the interconnecting box supplied as part of the test set and tighten the retaining screws.

(2) Using the cable assemblies supplied as part of the test set, connect the socket SKTF on the interconnecting box to the signal input plug P802 on the underside of the demodulator, the INTERCONNECTING BOX and SIG. GEN. OUTPUT sockets on the test set front panel to the plug PLB and the socket SKTD respectively on the interconnecting box, and the output of the signal generator CT452 to the SIG. GEN. INPUT socket.

(3) Connect the output of the power supply (para. 5 (2)) to the P.S.U. 130V plug on the test set front panel by means of the connector provided with the power supply and, with h.t. and l.t. inputs to the test set of 130V d.c. and 6·3V d.c. respectively, set the test set HT and DATA switches to ON.

14. If a test set is not available, the demodulator may be tested by employing a serviceable transmitter-receiver with its demodulator removed. The procedure is as follows:—

(1) Remove the transmitter-receiver from its cover, as described in Chap. 16, disconnect the flying lead from the demoulator coaxial plug P802 and remove the demodulator from the chassis.

(2) Connect the multi-pole plug P801 of the demodulator under test to the socket J1508 of the chassis by means of the electrical power cable assembly, 5995-99-932-1908 (part of the test kit).

(3) Ensure that the change-over switch on the right-hand side of the radio control set is set to the yellow D/L (data link) position and that the function switch on the front panel is turned to OFF.

(4) Interconnect the transmitter-receiver and the radio control set by means of the interconnecting box and connectors of the test kit and connect the 27·5V d.c. supply. (Full details of the test kit are given in A.P.116D-0133-1B). Connect the output of the signal generator CT452 to the demodulator input at the plug P802.

(5) Turn the function switch on the radio control set to DL and CHAN switch to any channel but G. Allow 15 minutes for the equipment to reach its operating temperature before proceeding further.

Note . . .

The d.c. supply to the equipment must be maintained at 27·5V throughout the performance tests.

Frequency calibration

15. During performance tests, the output frequency of the signal generator CT452 must be accurately set to the specified frequency, either by calibration with the crystal oscillator incor-

porated in the test set, demodulator or by measurement with the frequency counter. If a test set is used, the procedure is as follows:—

(1) Connect the telephone headset (para. 5 (3)) to the PHONE jack socket.

(2) Set the signal generator CT452 and the CAL. OSC. switch to the required frequency.

(3) Adjust the signal generator frequency to obtain zero beat in the telephone headset.

(4) Turn the CAL. OSC. switch to OFF.

Ratio detector alignment

16. The alignment procedure is as follows:—

(1) Connect the 470 ohm damping resistor (para. 5 (a)) and the multimeter CT429, adjusted to measure a.c. voltages, between the terminals of link LKB, i.e. across the secondary winding of the ratio detector transformer T801. If a test set is being used, turn the TEST SWITCH to the VOLTS UNLOADED position and the D.C. V.V. SELECTOR switch to the D.C. LEVEL position.

(2) Set the signal generator CT452 to a frequency of 1·85 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and unscrew the cores of the primary and secondary windings of transformer T801 to their full extent. Adjust the primary core to obtain maximum deflection on the multimeter.

(3) Disconnect the damping resistor and the multimeter from the terminals of link LKB and disconnect the demodulator output stages by removing link LKA from printed circuit board TB8.

(4) If a test set is being used, connect the multimeter, adjusted to measure d.c. voltages, to the D.C. V.V. PROBE socket. Otherwise, connect the multimeter between pole 8 of plug P801 and earth. Adjust the secondary core of the transformer T801 to obtain zero ◀ ±0·1V ▶ deflection on the multimeter.

(5) Set the signal generator to a frequency of 1·8 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level of not less than +0·8V.

(6) Set the signal generator to a frequency of 1·9 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level more negative than —0·8V.

(7) Set the signal generator to a frequency of 1·85 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level of between +0·1V and —0·1V.

(8) Set the signal generator to a frequency of 1·83 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level of not less than +0·3V. Note the reading obtained.

(9) Set the signal generator to a frequency of 1·87 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level more negative than —0·3V and which differs in magnitude from the reading noted in sub-para. (8) by not more than 8%. Reconnect link LKA and, if a test set is not being used, disconnect the multimeter.

Output amplifier setting up

17. If a test set is being used, turn the D.C. V.V. SELECTOR switch to DATA. Otherwise, connect the multimeter, adjusted to measure d.c. voltages, between pole 7 of plug P801 and earth. Proceed as follows:—

(1) Set the signal generator CT452 to a frequency of 1·85 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and adjust the preset potentiometer R834 (SET DC LEVEL) to obtain a multimeter indication of —4·0V. Disconnect the signal generator from the test set or plug P802.

(2) Connect the signal generator CT520, frequency modulated by the signal generator Type 16728, to the SIG. GEN. INPUT socket, or, if a test set is not being used, to the demodulator input plug P802. Set the signal generator to a frequency of 1·85 MHz at an output level of 10 mV r.m.s. (open-circuit voltage), frequency modulated to a deviation of ± 20 kHz by a 2·5 kHz sinusoidal waveform. Set the multimeter to measure a.c. voltages and, if a test set is being used, transfer the multimeter to the A.C. V.V. PROBE socket. Adjust the preset potentiometer R832 (SET GAIN) to obtain a multimeter indication of 3·5V r.m.s. Set the multimeter to measure d.c. voltages and, if a test set is being used, transfer the multimeter to the D.C. V.V. PROBE socket. Disconnect the signal generator CT520 and substitute the signal generator CT452.

(3) Repeat the procedures described in sub-para. (1) and (2) until the specified voltages are obtained.

(4) Set the signal generator CT452 to a frequency of 1·87 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level of —9·0V ± 0·5V.

(5) Set the signal generator CT452 to a frequency of 1·83 MHz at an output level of 10 mV r.m.s. (open-circuit voltage) and verify that the multimeter indicates a d.c. level of +1V ± 0·5V. Disconnect the signal generator.

Harmonie distortion

18. Connect the signal generator CT520, modulated by the signal generator Type 16728 to the SIG. GEN. INPUT socket or, if a test set is not being used to the demodulator input plug P802. Proceed as follows:—

(1) Set the signal generator CT520 to a nominal frequency of 1·85 MHz at an output level of not less than 10 mV r.m.s. (open-circuit voltage), frequency modulated to a nominal deviation of ± 20 kHz by a

5 kHz sinusoidal waveform from the signal generator Type 16728.

(2) Adjust the frequency of the signal generator CT520 to obtain a d.c. level of —4·0V, as indicated by the multimeter.

(3) Set the multimeter to measure a.c. voltages and, if a test set is being used, transfer the multimeter to the A.C. V.V. PROBE socket. Adjust the deviation of the signal generator to obtain an a.c. level of 3·5V r.m.s. as indicated by the multimeter, note the deviation indicated by the signal generator deviation meter and ensure that this deviation is maintained throughout the following tests.

(4) Disconnect the multimeter and, if a test set is being used, turn the TEST switch to DIST. and connect the distortion indicator between the D.F.M. and EARTH terminals on the test set front panel. Otherwise, connect the distortion indicator between pole 7 of the plug P801 and earth. Verify that the percentage distortion of the output waveform, as measured by the distortion indicator, does not exceed 5% at the following modulation frequencies:—

100 Hz, 1000 Hz, 2500 Hz, 5000 Hz and 7500 Hz.

(5) Disconnect the multimeter and the distortion indicator. If a test set is being used, turn the TEST switch to the VOLTS UNLOADED position and connect the multimeter, adjusted to measure d.c. voltages, to the D.C. V.V. PROBE socket. Otherwise, connect the multimeter to pole 7 of the plug P801. Switch off the modulation and verify that the mean d.c. level of the output, as measured by the multimeter, does not change by more than 5%.

Output impedance

19. Proceed as follows:—

(1) Set the signal generator CT520 to a nominal frequency of 1·85 MHz at an output level of not less than 10 mV r.m.s. (open-circuit voltage), frequency modulated to a nominal deviation of ± 20 Hz by a 2·5 Hz sinusoidal waveform by the signal generator Type 16728.

(2) With the multimeter set to measure d.c. voltages, adjust the frequency of the signal generator CT520 to obtain an d.c. level of —4·0V, as indicated by the multimeter.

(3) Set the multimeter to measure a.c. voltages and, if a test set is being used, transfer the multimeter to the A.C. V.V. PROBE socket. Adjust the deviation of the signal generator CT520 to obtain an a.c. level of 3·5V r.m.s. as indicated by the multimeter.

(4) Turn the TEST switch to the VOLTS LOADED position. If a test set is not being used, disconnect the multimeter from pole 7 of the plug P801, connect the 3μF capacitor and the 2 Kilohm resistor (para. 5 note) in series between pole 7 of the plug P801 and earth and connect the multimeter, adjusted to measure a.c. voltages, across the resistor. In either case, verify that the a.c. level indicated by the multimeter is not less than 1·75V r.m.s. Note the reading obtained.

Output frequency response

22. Using the reading obtained in para. 19 (4) as a reference level, verify that the a.c. level indicated by the multimeter is within the limits shown at each end of the modulating frequencies listed in Table 2.

TABLE 2

Demodulator, radio frequency—output frequency response

Modulating frequency Hz	Limits of deviation from reference level (dB)
80	±1·0
300	±0·5
1000	±0·5
2500	reference level
5000	±1·0
7500	±1·0

21. On satisfactory completion of the performance tests, set the test set HT switch to the OFF position or turn the function switch on the radio set control to OFF and switch off the power supplies. Disconnect all test equipment and disconnect the demodulator under test from the interconnecting box or the transmitter-receiver. Lock the adjustable cores of the ratio detector transformer T801 and refit the demodulator side covers. Refit the demodulator removed from the transmitter-receiver and refit the transmitter-receiver in its case.

TABLE 3
Modifications

Mod. No.	Class	Topic - 2 Leaflet A.L.	Label No.	Brief details of change
0603	B/3 on 3rd line repair (RAF)		1	Repositioning resistor R823 and diode CR801 to remedy variation of waveform characteristics with module temperature. Value of resistor R823 and R825 changed from 3·3 kilohm to 10 kilohm and 1 kilohm to 3·9 kilohm respectively, and the deletion of CR808 and R846; this changed limiter supply from 12V to 30V to minimise the effect of voltage changes on the limiter circuit.

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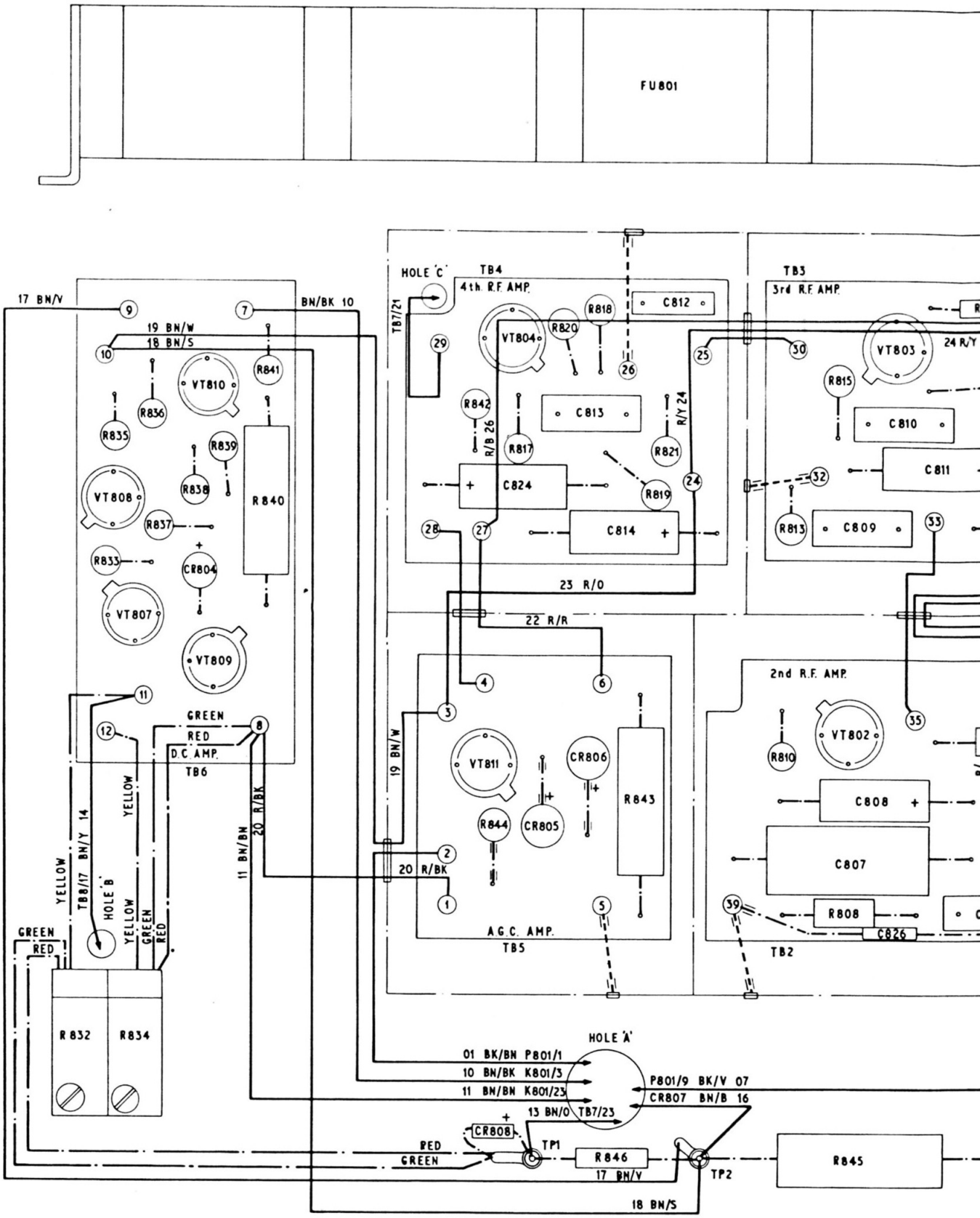

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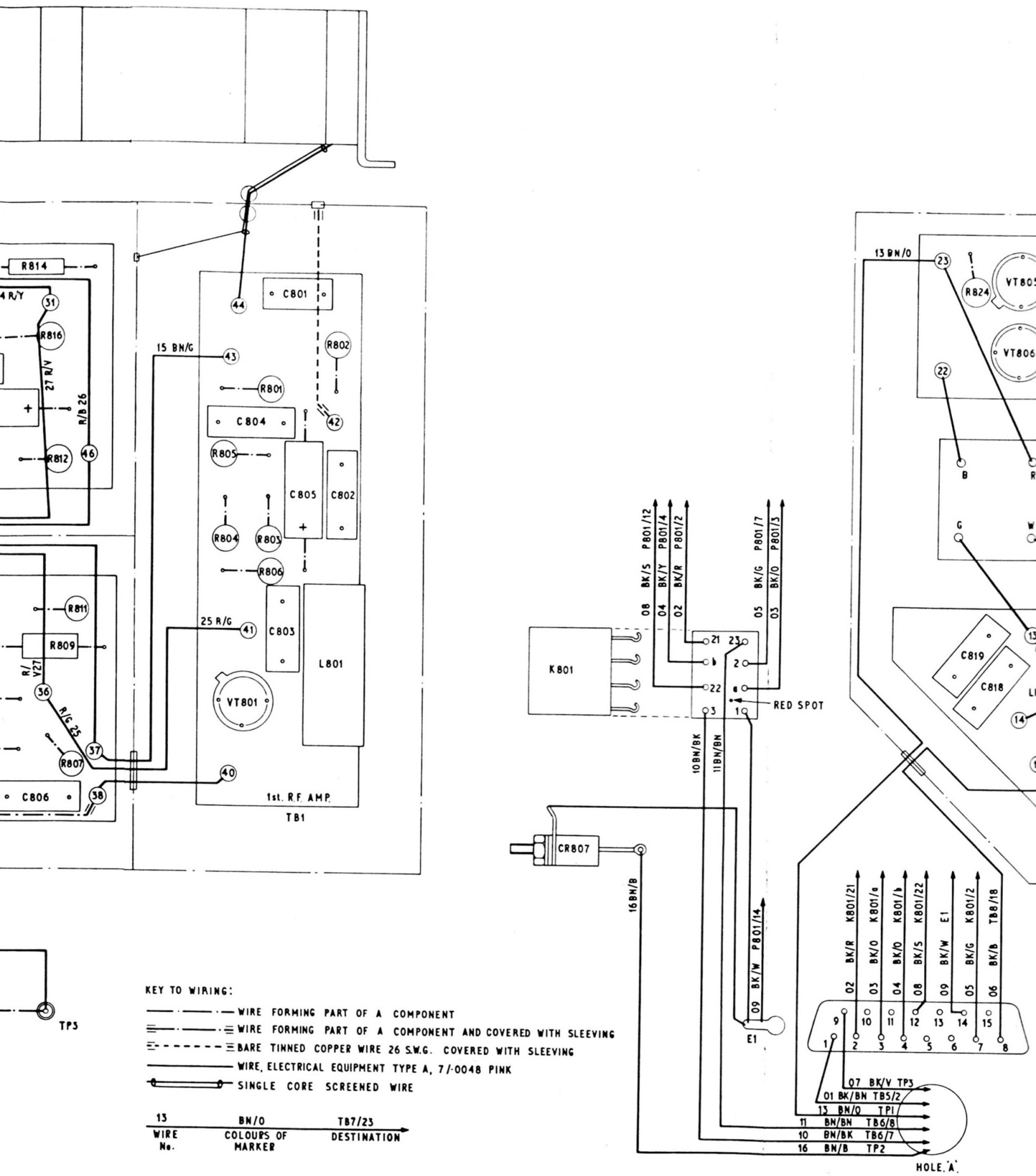
Fig. 3

Demodulator,

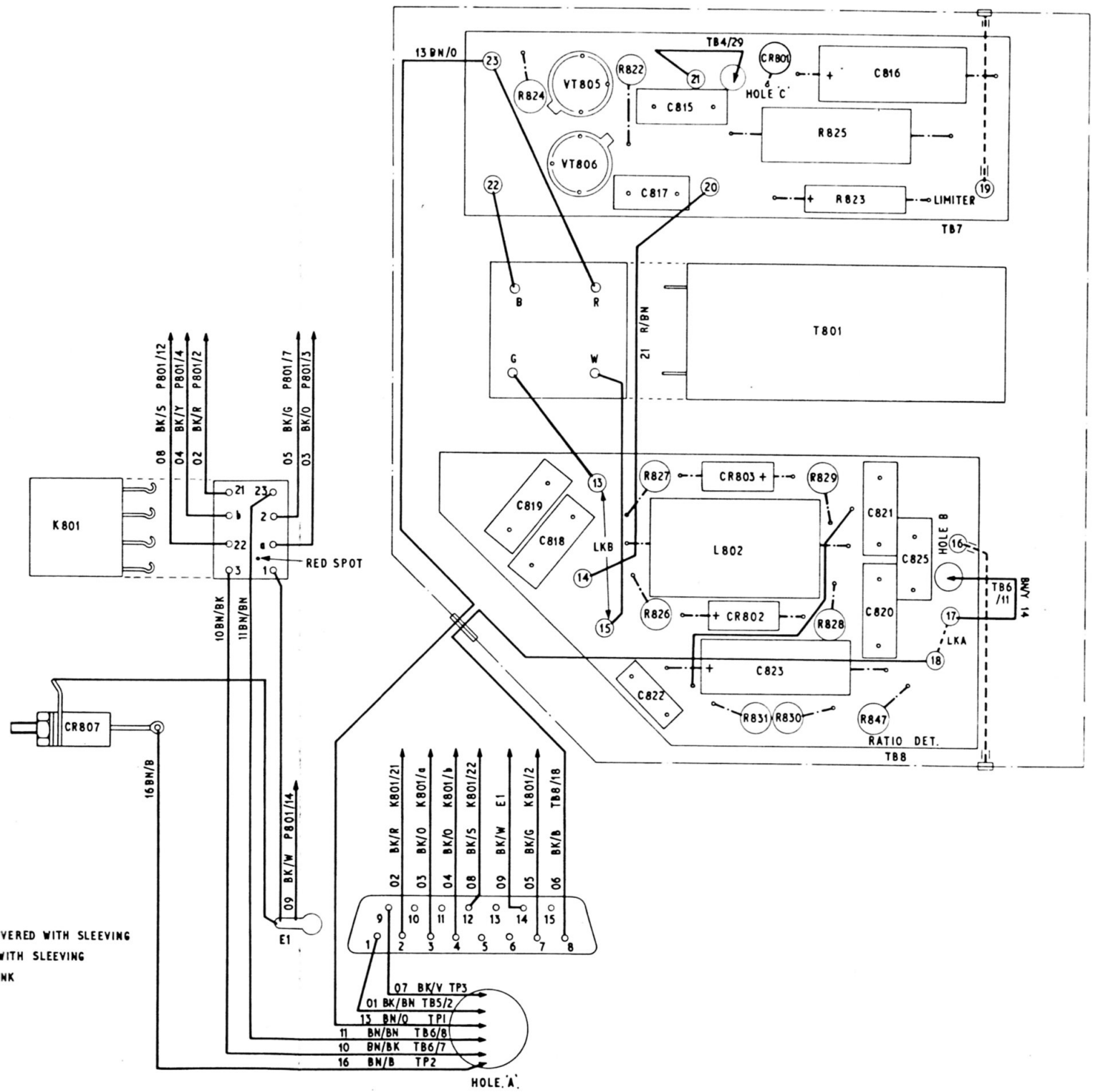


KEY TO WIRING:

- WIRE FORMING PART OF A COMPONENT
- WIRE FORMING PART OF A COMPONENT AND COVERED WITH SLEEVING
- BARE TINNED COPPER WIRE 26 S.W.G. COVERED WITH SLEEVING
- WIRE, ELECTRICAL EQUIPMENT TYPE A, 7/-0048 PINK
- SINGLE CORE SCREENED WIRE

13 — WIRE No. — BN/O — COLOURS OF MARKER — TB7/23 — DESTINATION

r, radio frequency, 5821-99-948-8104: wiring diagram



8104: wiring diagram

Fig. 3