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MANUAL IB 165

TYPE RR REED FREQUENCY DIVISION MULTIPLEX

SYSTEM MANUAL

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FOREWORD

This Manual describes the GEC-General Signal Limited type RR Reed Frequency Division Multiplex system. The system uses low audio frequency tones as a means of conveying a number of signalling commands over a two-wire transmission line.

The system described, herein, is specifically designed for application in railway signalling concentrations which are situated in electric traction territory where the industrial power supply frequency is 50 Hertz.

1. INTRODUCTION TO THE TYPE RR REED FREQUENCY DIVISION MUTIPLEX SYSTEM

Contents of Section 1

1 INTRODUCTION TO THE TYPE RR FREQUENCY DIVISION MULTIPLEX SYSTEM

1.1 Frequency Division Multiplex

The Reed system operates by transmitting a number of commands in the form of a.c. signals over a common transmission path, using a different frequency for each command, and detecting each one separately by means of an individual receiver. The frequencies used are within the spectrum 350 - 1000 Hertz.

The maximum number of channels within the system available for vital applications is 16. Additional, non-vital, channels may be used for system monitoring to detect faults occurring in common equipment, or in the line.

The basic system is simplex (one-way) in operation, although duplex (two-way) systems can be designed under certain circumstances. The transmitters and receivers for the various channels do not have to be grouped at the ends of the transmission line, a channel can be connected into, and out of, the line at any point along its length, as required; hence the system is very flexible in its application. The equipment used for a channel can be removed for servicing without disturbing the remainder of the system.

This equipment is fail-safe to the standard required for safety circuits in railway signalling. The design of the system ensures that no reasonable combination of component faults can cause a transmitter to transmit, or a receiver to respond to, an inappropriate signal.

1.2 Glossary of Terms

The following expressions are used in this manual with particular meanings in connection with type RR equipment.

CHANNEL	- A means for the transmission of a single item of information (e.g. a control, or an indication).
CORE	- An individual conductor in a cable.
CROSSTALK	- The common mode interference produced by one circuit of a cable into another circuit by mutual capacitive (or inductive) coupling.
DEDICATED CABLE	- A cable used exclusively for vital reed systems.
DUPLEX	- Two-way.
LINE-PAIR, LINE	- A pair of electrical conductors used for the transmission of signals.
MULTIPLEX	- An arrangement for carrying many channels on a single line.
REED	- A tuned mechanical element used in a filter.
REED FILTER	- An electro-mechanical bandpass filter whose transfer characteristic is controlled solely by two coupled reeds.
SECTIONAL-ISATION	- Division of the line into isolated lengths.
SIMPLEX	- One way.
SYSTEM	- All those channels carried in one line pair, or all the equipment associated with them.
TRANS-POSITION	- An arrangement for reducing crosstalk by interchanging the cores of alternate line pairs in mid-section.

1.3 The Basic Type RR System

1.3.1 Mode of operation

Each channel uses a separate transmitter which generates a signal when a contact is closed in an external circuit. The frequency of its output is determined by a Reed filter; described in section 2.2.

Each transmitter output circuit is connected across a resistor which is wired in series with the line.

Each channel has an individual receiver consisting of a Reed filter, amplifier and follower relay. The Reed filter is a bandpass filter which passes the frequency allocated to the particular channel and rejects all others: its input coil is connected across the line. When the appropriate signal is present on the line, the filter produces an output and drives the amplifier which operates the safety signalling relay.

Thus, the closing of the contact in the control circuit of a given channel causes the relay driven by the corresponding receiver to be energised (exactly as if the circuit had its own pair of conductors). The operation of any channel is completely independent of any other channel in the system.

1.3.2 Method of frequency control and tone selection

The frequency of a transmitted tone and the frequency selectivity of a receiver are entirely dependent upon the Reed filter, which has a highly stable and accurate pass frequency: see section 2.2.

1.3.3 Factors affecting section and system length

For operation over long distances, amplification of the Reed signal is required at intermediate points and is provided by means of the Reed Line Amplifier, described in section 2.7.

Concentrations of transmitters or receivers in a section may load the line excessively and a line amplifier is then used to restore the signal to a satisfactory level. By successively restoring the line level, a type RR system can be operated over a virtually unlimited distance: however, unless preventive action is taken, crosstalk between adjacent pairs in a conventional multicore cable may limit system length. This form of interference can be reduced to an acceptable level by selection and transposition of conductor pairs, or by the use of a "twisted pair" cable, as described in section 3.

1.3.4 Electrical hazards

Induction from high voltage a.c. power distribution lines can give rise to longitudinal voltage in the Reed line conductors, and consideration must be given to the possible consequences of a dangerously high voltage which may develop in unscreened signalling cable. It is established practice to limit the induced voltage by sectionalising the line: in U.K. the maximum permitted section length is 2Km. Elsewhere, the permissible section length is determined by a number of factors: i.e. the magnitude of traction current, the type of traction system used, the degree of screening by nearby earthed conductors and the level of induced voltage deemed acceptable by the Customer.

1.3.5 System protection

To protect the equipment against transverse voltages in the event of cable faults, immunisation units are employed.

Transmitters and line amplifiers are protected against low intensity lightning strokes by surge limiting devices incorporated in their design. In areas of high lightning activity, however, it is recommended that additional protection is used for line amplifiers.

2 THE EQUIPMENT

Contents of Section 2

2.1 General

2.1.1 Physical construction of units

GEC-General Signal type RR Reed equipment is designed to conform physically with other standard railway signalling equipment. Transmitters, receivers and transmitter repeater units are designed to be mounted on British Rail standard plugboards and, therefore, occupy the same space as a B.R. miniature relay except only that the transmitter and receiver are deeper than a relay (the dimensions are 213.5mm x 146mm so that the units project 23mm below the plugboard).

2.1.2 Ambient conditions

Reed equipment is suitable for installation in relay rooms and lineside cupboards in the conditions detailed in B.R. specification 967. It is suitable for environments with high humidity and a temperature range of -20° to $70^\circ C$.

2.1.3 Industrial power supplies

The frequency of the 50 Hz mains supply should be within the range 48.5 to 50.5Hz and the equipment supply voltage should be in the range 93 - 127 volts.

2.1.4 Frequencies

The range of channel frequencies for the supply specified in sub-section 2.1.3 are listed in section 6.

Note, a range of equipment is available for applications in 60 Hz. mains areas: contact GEC-General Signal Limited for further information.

2.2 The Reed Filter

The Reed filter is the basis of the Type RR system, being used to determine the operating frequencies of both transmitters and receivers. It has a very narrow passband with an exceptionally stable and well defined pass frequency determined by mechanical resonance, in the same manner as that characterised by a tuning fork. It is designed so that it will only respond to its fundamental frequency and will not respond to any frequency outside its "pass spectrum" under any reasonable fault condition. This is the basic fail-safe feature of the system.

The filter contains a pair of tuned reeds. Each is a short bar of a special alloy, clamped at one end and shaped so as to vibrate only at the specific frequency to which it has been tuned during manufacture: tuning is the process of adjusting the thickness of each of the two bars near the clamping point until their frequencies are substantially the same. The reed is fixed so that it lies along the axis of a coil with its tip centred between the poles of a permanent magnet, as shown schematically in Figure 2.2-1.

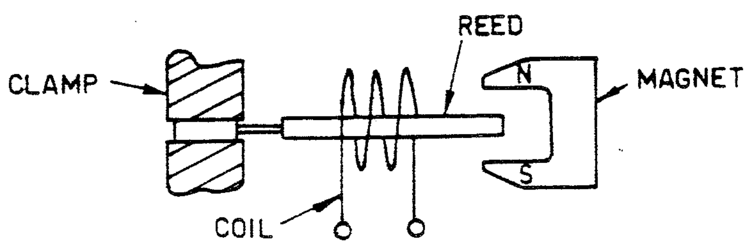


Figure 2.2-1. Reed Assembly Components

If a current flows in the coil, the reed becomes magnetised causing its tip to be attracted towards a pole of the permanent magnet by an amount depending upon its mechanical stiffness, and if the current is made to vary periodically the reed will vibrate under the influence of the alternating magnetic field. At most frequencies the amplitude of this vibration is very small, but if the frequency of the current flowing in the coil coincides with the natural frequency of vibration of the reed, the amplitude becomes very large. Alternatively, if the assembly is vibrated mechanically, the reed will vibrate between the poles of the magnet causing a voltage to appear between the terminals of the coil.

This voltage will be very small unless the frequency of the impressed vibration is the same as the resonant frequency of the reed, in which case it will become much larger (by a factor of several hundred, in practice)

The clamp for the reed takes the form of a brass block on which the coil and the permanent magnet are mounted. The complete Reed filter consists of two of these reed assemblies tuned to virtually the same frequency and coupled together.

In the complete filter, the mounting blocks of two assemblies are joined by a rigid connecting plate, to form a mechanical coupling, and the whole filter is then suspended in its case on resilient mountings. The complete arrangement is shown in Figure 2.2-2. It will be seen that the unit has two pairs of terminals, one pair for each reed coil. Suppose that an a.c. current flows in coil 1. If its frequency is the same as that of the reeds then reed 1 will be excited into a state of vibration at a relatively large amplitude. Since the whole assembly is suspended on a resilient mounting, the vibration will be acoustically coupled via the plate through to reed 2, which will vibrate in sympathy also at a relatively large amplitude. This in turn will cause a large voltage to appear between the terminals of coil 2. If the frequency of the current in coil 1 is not in tune with the reeds, the vibration coupled from one reed to the other will be small, and the voltage produced across coil 2 will be correspondingly small. The device can, therefore, be seen to act as a band-pass filter; only tones having the frequency to which the reeds have been tuned are coupled through from coil 1 to coil 2. Typical figures for an actual Reed filter are as follows: for an input of 300mV across the terminals of coil 1, the output voltage across coil 2 would be 125mV when the frequency at the input coincides with the resonant frequency of the reeds. The band-width is very narrow (typically 0.6 to 0.8Hz between half-power points).

The frequency of free vibration of a reed is determined by its physical characteristics; in particular, by the thickness of the hinge near the clamping point, and by the chemical properties of the material used. Faults which cause the frequency of the reed to alter, while allowing it to continue vibrating, can thus only arise as a result of mechanical damage to the reed and are, therefore, unlikely.

However, if one reed in a filter was so affected, the two reeds of the filter would now have different frequencies and the output would diminish because of the reduced response of the affected reed. Only if the frequencies of both reeds are shifted by exactly the same amount could the filter respond to a frequency other than that to which it was originally tuned, and the probability of this occurring is very small.

The filter has two pairs of stud terminals on its top which engage with corresponding contacts in the base of the amplifier. The front pair of terminals connect to the output coil, and the pair to the rear connect to the input coil.

The filters used for transmitters are different from those used for receivers, because of differences in the fine tuning of the reeds.

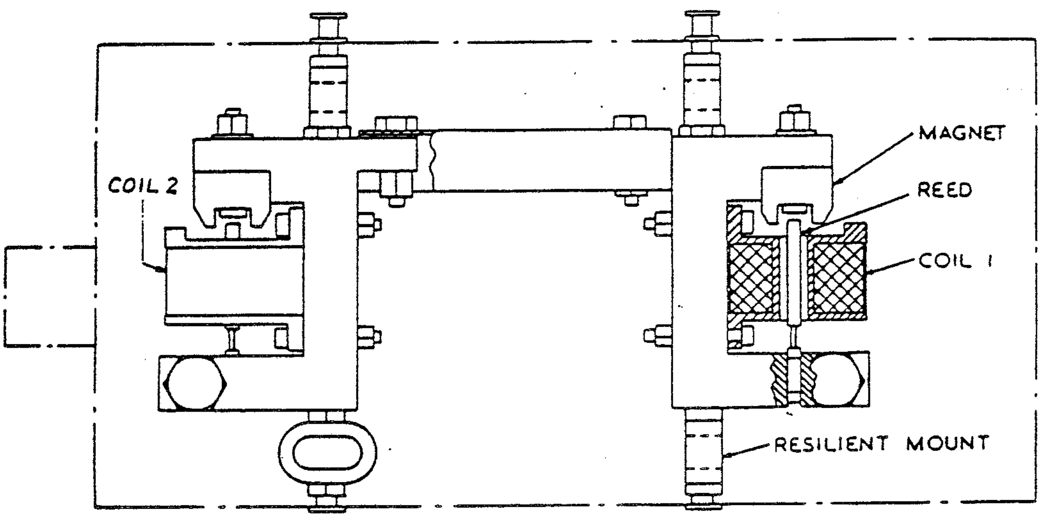


Figure 2.2-2. General Arrangement of Reed Filter

2.3 The Transmitter

2.3.1 Description

The type RR Reed transmitter consists of two parts: a transmitter filter and a transmitter amplifier. The two parts clip together and are held by a retaining screw, to form a single unit which plugs into a BRB standard miniature plugboard.

The circuit of the complete transmitter is shown in Figure 2.3-1. It consists of an oscillator, in which the Reed filter (see section 2.2) is the frequency-discriminating element in the feedback path, and an output stage which includes a double-wound output transformer. All the components, except the actual Reed filter, are contained in the transmitter amplifier. The transmitter produces an output when an external control circuit is completed by a short-circuit.

With one arrangement of connections, which is generally regarded as the standard, the oscillator generates continuously and an immediate output is obtained when the control circuit is switched. The alternative arrangement is to link the control circuit and switch the d.c. supply to the amplifier, the oscillator then has to start from rest thereby producing a delay in the response: see section 2.3.2.

The output of the amplifier is connected across a resistor, usually a 24 ohm, 1 watt metal oxide film type, which is in series with one leg of the line. In normal practice, each lead is fitted with an insulated sleeve, crimped with one of the line wires into a plugboard connector, and inserted into the transmitter plugboard; thus, if a transmitter is removed, continuity of the line is maintained through the resistor.

The terminals of the unit correspond with connectors on the plugboard which are identified in the same way as with miniature relays.

2.3.2 Electrical characteristics

A smooothed and stabilised d.c. supply, nominally 12 volts, is required, connected between terminals A3 (negative) and D3 (positive). The current consumption of one transmitter is 50mA (10mA when not transmitting). For suitable power supply units see section 2.9.

The output from the unit appears between terminals A1 and D2 to which terminals the resistor (see section 2.3.1 above) is connected. When the d.c. supply voltage is 12v, the output voltage should lie between 330 and 390 mV rms, across the resistor.

Note, for special applications such as point detection and duplex (bi-directional) systems, a higher output voltage, which should lie between 580 and 690 mV, rms, is available and the output resistor should be connected between terminals A1 and D1.

For normal operation, the output is obtained by linking terminals A4 and D4 by a control relay contact. With this arrangement, the circuit oscillates continuously, and the closure of the relay contact produces an instantaneous output. If a delayed action feature is required, then A4 and D4 are permanently connected together and the switching contact is connected in the supply lead to terminal D3. This has the effect of switching the power supply to the whole unit, including the oscillator, hence the time taken for the transmission to start from the closure of the control contact includes the response time of the oscillator: this arrangement gives a delay of appproximately 3 seconds.

When the unit is switched off, its impedance looking into the output is sufficiently high to be negligible in parallel with the 24 ohm line resistor; when the output becomes switched on, this impedance drops to a resistive value of approximately 3 ohms.

See section 6 for order references.

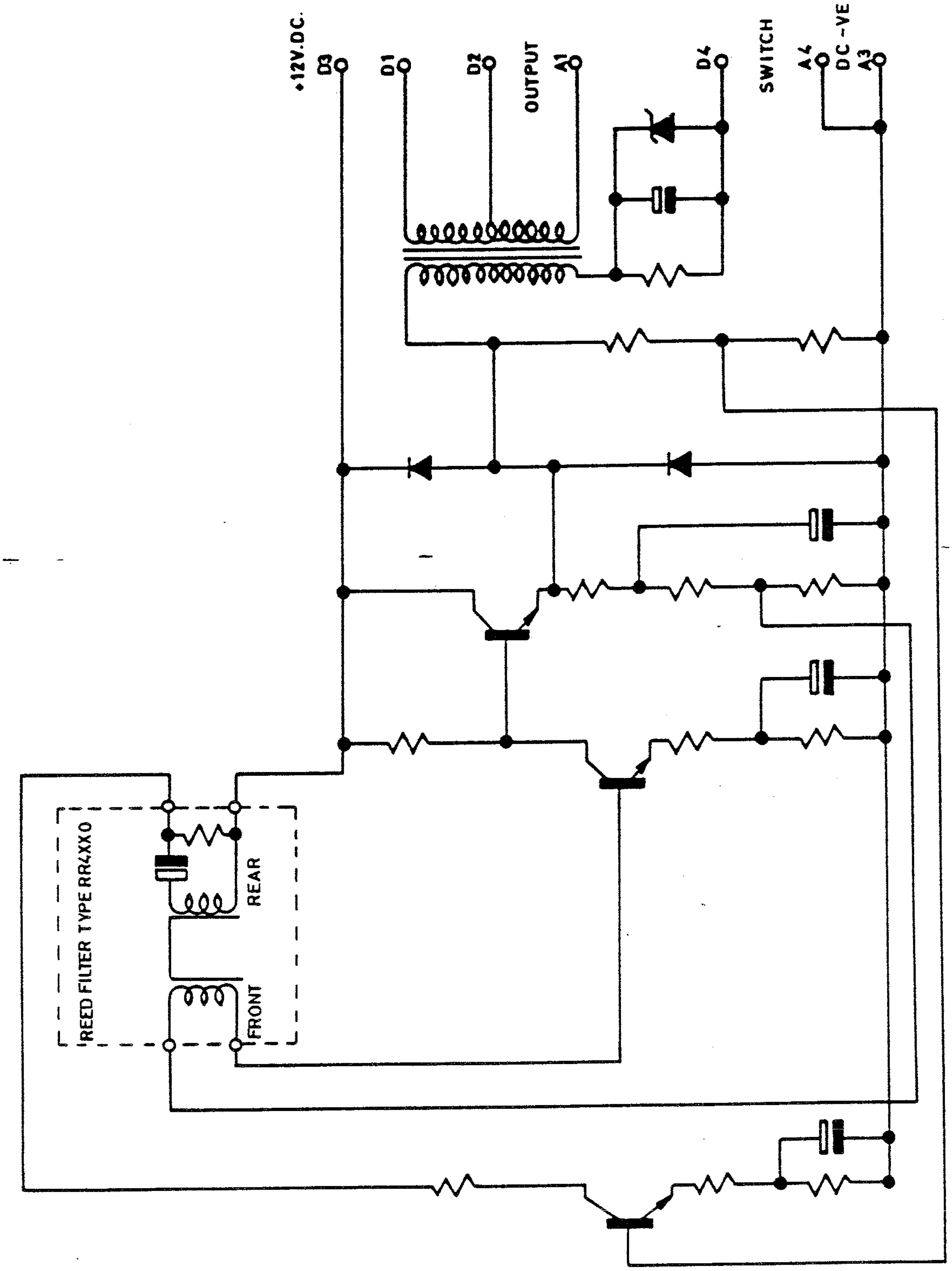


Figure 2·3 - 1   Circuit Diagram of Transmitter

2.4 The Receiver

2.4.1 Description

The type RR Reed receiver, like the transmitter, consists of two parts: a receiver Reed filter, and a receiver amplifier. The two parts clip together, and are held by a retaining screw, to form a single unit which plugs into a BRB standard miniature plugboard.

The circuit of the complete receiver with external connections is shown in Figure 2.4-1. The input coil of the Reed filter (see section 2.2) is connected across the line. If a signal of the frequency to which the filter is tuned is present on the line, then a voltage appears at its output; this is amplified and rectified by the receiver amplifier to give an output to drive a follower relay of standard BR signalling type (see section 2.5) which occupies its own plugboard. The relay is energised only when the appropriate signal is present on the line.

Since each receiver is connected in parallel with the line, an individual one can be removed from the system without affecting the operation of the other channels.

The receiver is protected against radio frequency interference which may be produced by portable a.m. or f.m. equipment.

Where Reed system lines may be exposed to induction from high voltage distribution lines, it is necessary to immunise each Reed receiver (except those of the monitoring channels); see section 2.10.

2.4.2. Electrical characteristics

A smoothed and stabilised d.c. power supply at nominally 12 volts is required, connected to terminals A2 (negative) and D3 (positive). The current consumption of a receiver is approximately 100mA when driving a follower relay (2 mA when quiescent). For suitable power supply units see section 2.9.

The input impedance of a receiver is the impedance of the input coil of the Reed filter. Off-tune, it is equivalent to a resistance of 300 ohms and an inductance of 0.4 Hy in series. Near the filter frequency, it has a magnitude of 550 to 1100 ohms, depending upon the actual frequency (the figures quoted are typical values).

The output to the follower relay, see section 2.5, is obtained from a half-wave rectifier and is, therefore, not pure d.c. The mean value of voltage lies between 11 and 18 volts with an input to the Reed filter of 0.3 volt at the appropriate frequency; the variation depending upon amplifier characteristics and supply voltage.

See section 6 for order references.

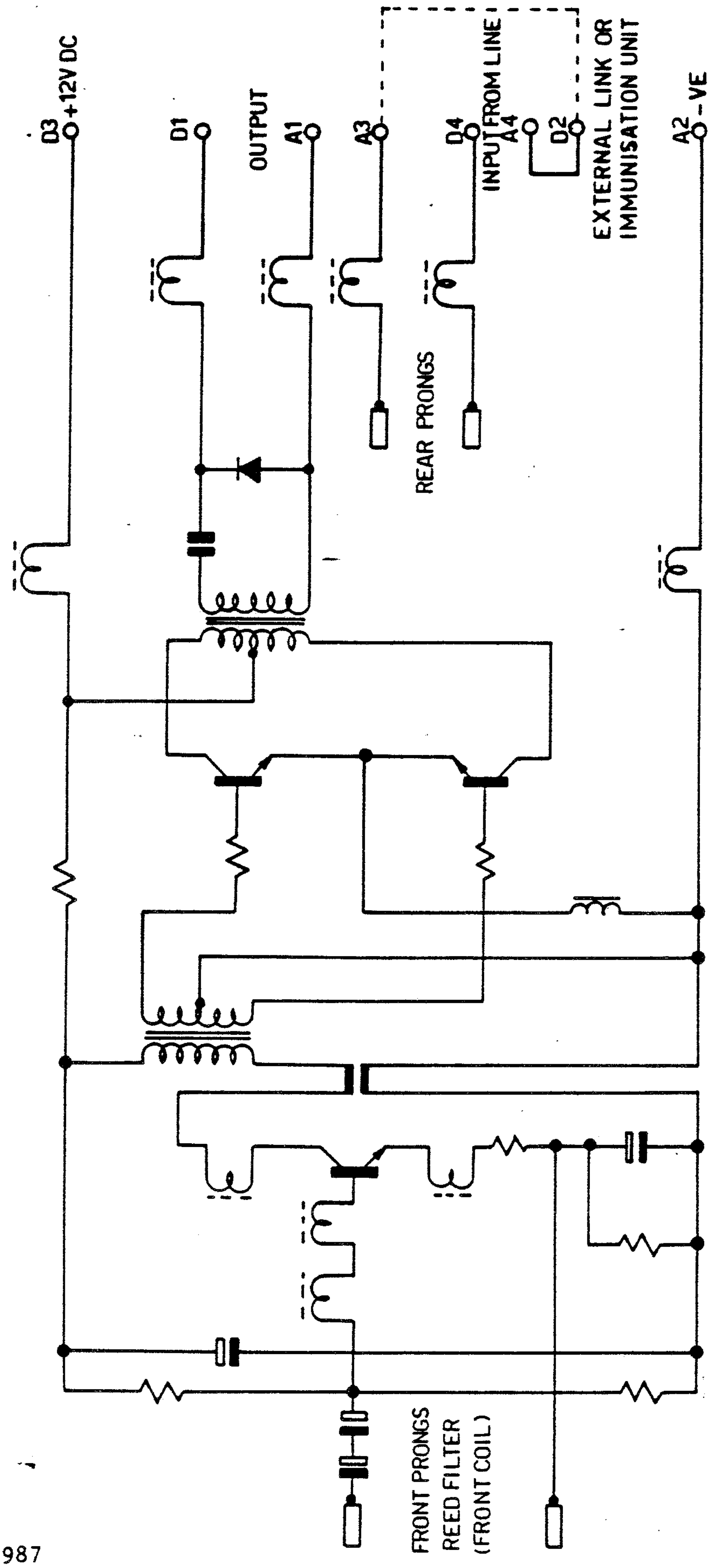


Figure 2.4-1 Circuit Diagram of Receiver

2.5 The Reed Follower Relay

2.5.1 Description

The Reed receiver operates a Reed follower relay which complies with the requirements of the BR 930 series specifications. It has 6F, 3B contacts, and its coil is matched to the receiver amplifier. See section 6 for order reference.

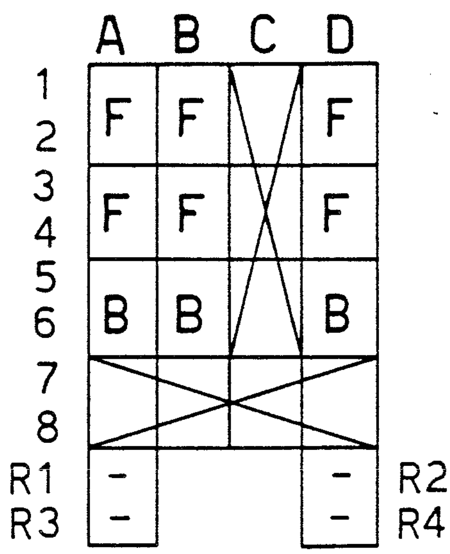
No other type of relay should be used for vital Reed systems other than the type 32M10 which was an earlier equivalent.

For details of installation practice see sub-section 3.8.2.

2.5.2 Electrical characteristics

This relay has an operating value of 8.8 volts maximum and a release value of 5.7 volts minimum, d.c. Note that the output from a Reed receiver is not pure d.c. It is a half-wave rectified voltage and an average indicating meter must be used for measuring.

The arrangement of coil connections and contacts is as follows:



For the current type of relay, terminals R1 and R2 should be used for external coil connections. To enable the earlier type 32M10 relay to be used, the connections are brought to terminals R1 and R4 and a link made between terminals R2 and R3.

2.6 The Transmitter Repeater Unit

2.6.1 Description

In large installations, where many control systems originate at one place, the use of Transmitter Repeater Units (t.r.u.'s) achieves a reduction in the number of transmitters and the amount of space required. One transmitter is provided for each frequency in use and drives up to seven t.r.u.'s, each of which can provide up to three separate outputs. In this way Reed tones for use in up to twenty-one systems can be obtained from one set of master transmitters.

The outputs from the t.r.u. are switched by external contacts, such as relays or switches, and each output is connected across a 24 ohm, metal oxide film, resistor connected in the particular system which it feeds (in exactly the same way as a transmitter output). When a transmitter is used with a repeater unit, it is made to transmit continuously by connecting a permanent link in its switching circuit. The outputs are completely isolated from each other, so that there is no possibility of unwanted connections between systems, or of interference from one system to another.

The unit plugs into a BRB standard plugboard and is the same size as a miniature relay; see section 6 for the type reference.

2.6.2 Electrical characteristics

A diagram of the circuit of the unit is given in Figure 2.6-1. It requires a smoothed and stabilised d.c. supply, at 12 volts, connected between terminals B3 (positive) and A3 (negative), and draws 150 mA. For suitable power supply units see section 2.9.

The input from the transmitter is connected between A1 and A2. The three outputs appear between terminals A7 and A8, B7 and B8, and C7 and C8. They are switched by connecting contacts between A4 and A6, B4 and B6, and C4 and C6 respectively.

The gain of the unit from its input to each output is nominally unity so that the signal level at its outputs is substantially the same as the output level for a transmitter (see sub-section 2.3.2).

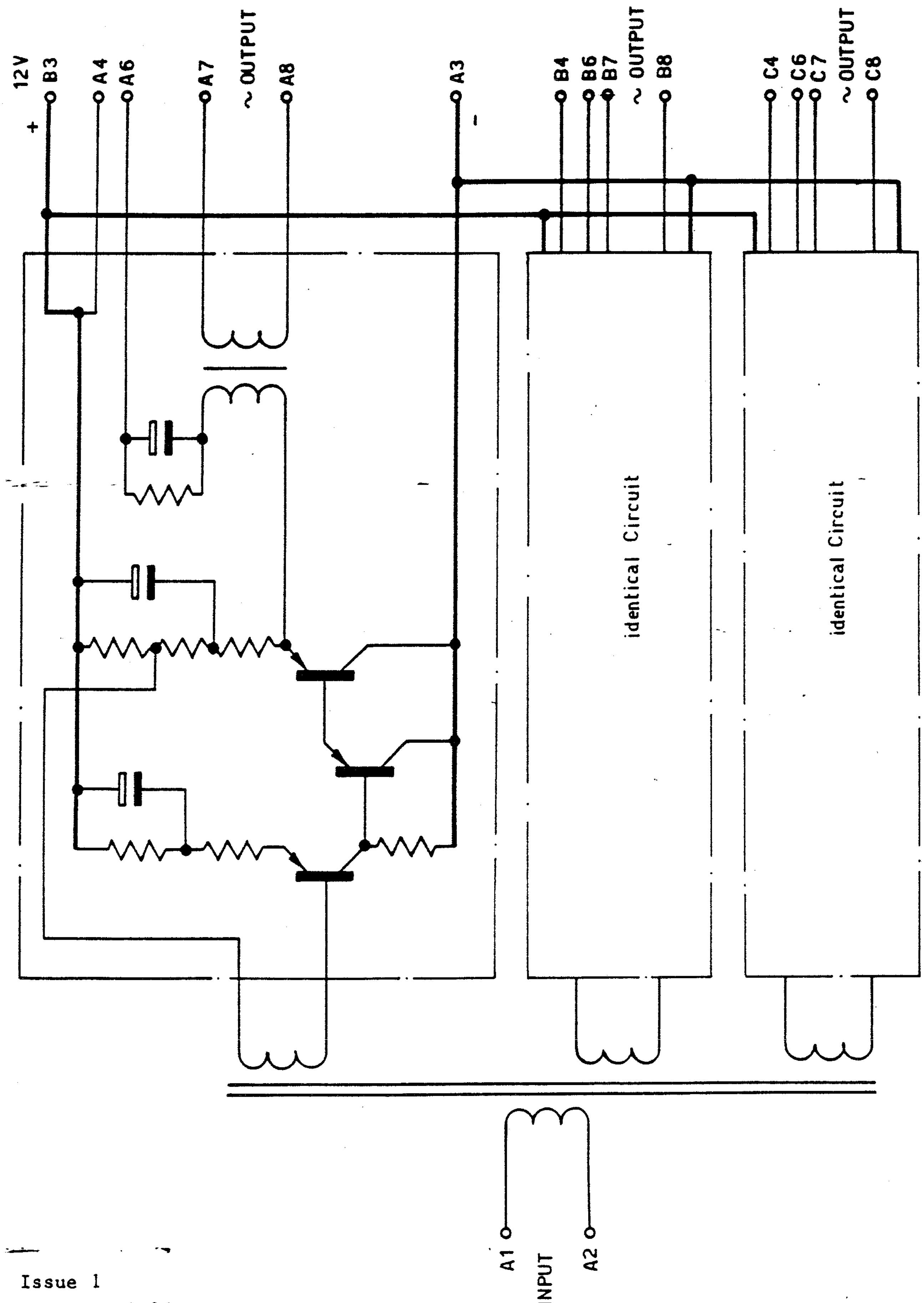


Figure 2.6-1 Circuit Diagram of Transmitter Repeater Unit

2.7 The Line Amplifier and Line Amplifier Supply Transformer

2.7.1 Description of Line Amplifier

For transmission over long distances, amplification is required at intermediate points to counter-act the attenuation caused by line losses. This amplification is provided by means of the Reed Line Amplifier, the circuit of which is shown in Figure 2.7-1. This is a uni-directional amplifier incorporating negative feedback which can be adjusted to set the voltage gain.

The line amplifier also serves to sectionalise the Reed system line where this may be exposed to induction from a high voltage distribution power feeder. In such areas, it is necessary to protect each line amplifier by means of an immunising unit, see section 3.

The amplifier is designed to be mounted on racks or in cupboards, and occupies the space required for four standard miniature plugboards. It has its own built-in rectifying and smoothing circuit, and requires a power supply at nominally 24 volts which can be obtained from the 110v a.c. mains supply, via the Reed Line Amplifier Supply Transformer, see section 2.7.3. Alternatively, it may be supplied from a 24 v, low resistance, d.c. source.

All the external connections to the amplifier, together with the link that sets the gain, are made to a comb fitted with eleven 2BA terminals. The comb attaches to the terminals on the amplifier and makes contact with them. If the amplifier should fail for any reason, it can be replaced without removing the external connections to the comb.

See section 3 for details of lightning protection. In cases where lightning protection for line amplifiers is to be achieved by means of the surge suppression comb, the amplifier may be supplied without the standard comb.

See section 6 for type references.

2.7.2 Electrical characteristics

The power supply, a.c. or d.c., is connected to terminals 10 and 11.

The input signal is connected to terminals 1 and 6 and the output is obtained from terminals 7 and 9. A coarse control over the gain is obtained (by varying the feedback) by connecting a link between terminal 6 and one of the terminals 5,4 or 3, as follows:

Link between terminals	% Feedback	Voltage gain (no load)
6 - 5	100	1.0
6 - 4	75	1.35
6 - 3	50	2.0

Amplifier gain is dependent upon the load impedance hence the figures quoted are approximate: fine control of gain is achieved by the connection of a resistor, or link, between terminals 1 and 2.

The input impedance depends upon the gain setting and load impedance. The output impedance depends upon several factors including the gain setting. Typical values are between 20 ohms and 50 ohms.

Figure 2.7-2 illustrates typical line amplifier characteristics when feeding a line isolating transformer, or a line amplifier without immunisation unit. Figure 2.7-3 shows comparable characteristics with a receiver load: see also section 2.10 when an immunisation unit is used.

Note: Receivers at a line amplifier location should preferably be connected directly to the output terminals, while transmitters may be connected to either side of the immunisation unit (where used).

2.7.3 Line Amplifier Supply Transformer

This transformer is double wound with a primary winding rated at 110 volts, 42 V.A., and a secondary tapped at 24 and 28 volts. It is suitable for supplying one line amplifier.

All connections are by means of 2BA terminals.

The transformer occupies two relay spaces.

For type reference see Section 6.

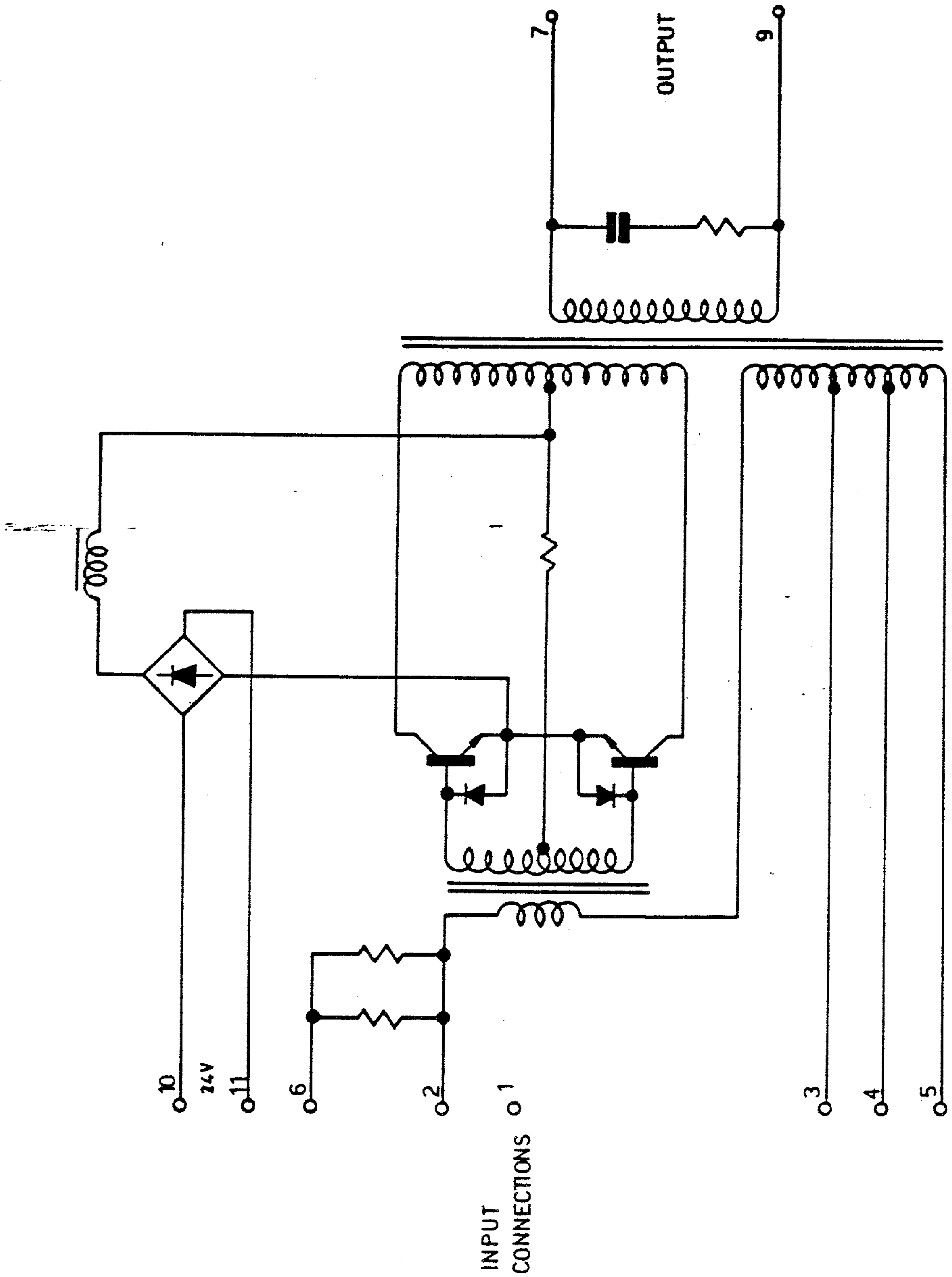


Figure 2.7-1 Circuit Diagram of Line Amplifier

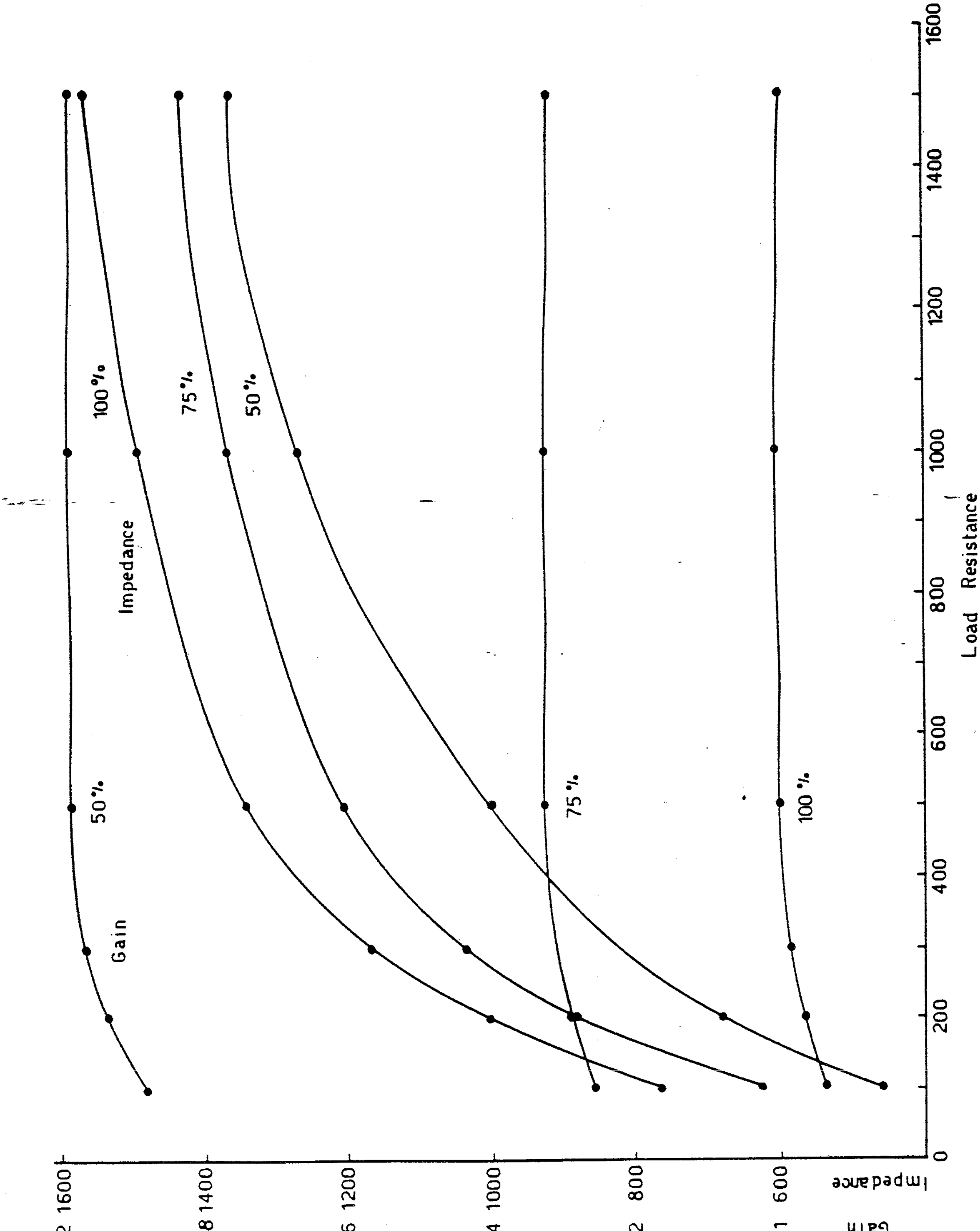


Figure 2·7·2 Characteristics of Typical Line Amplifier

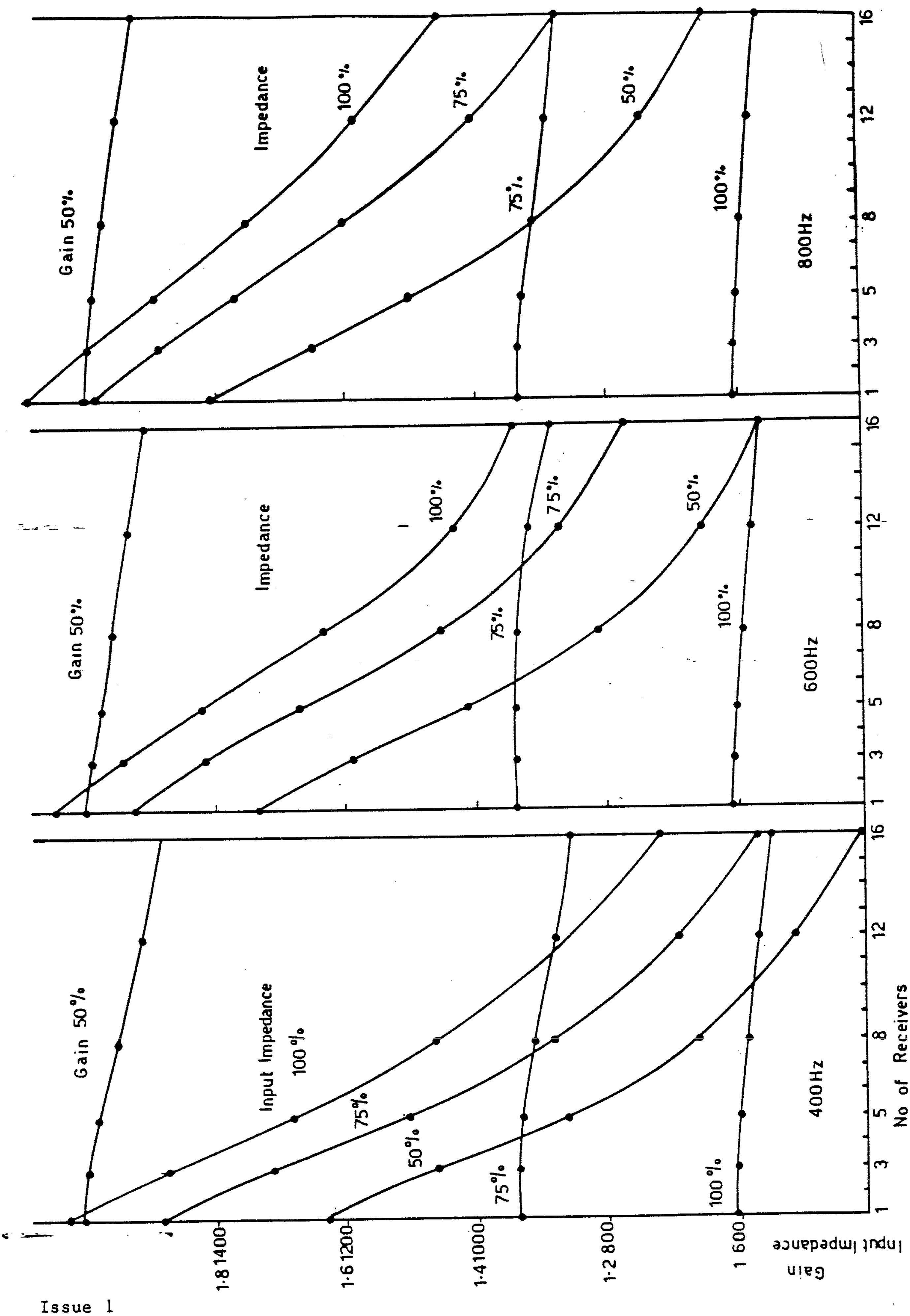


Figure 2·7-3 Characteristics of Typical Line Amplifier

2.8 The Line Isolating Transformer

2.8.1 Description

The double-wound Line Isolating Transformer may be used to sectionalise the line. This transformer can not provide a power gain in the system but it may allow small line voltage adjustment to be made.

The transformer is mounted on a plate which occupies the same space as a B.R. miniature relay.

2.8.2 Electrical characteristics

Six terminals, in the form of a plug and socket terminal block, are provided. T1 and T2 are connected to the primary winding, and are used for terminating the input line section; t1 - t4 are connected to the secondary winding and used for terminating the output line. The turns ratio between the various secondary taps and the primary winding are as follows:

Secondary terminals	Turns ratio
t1 with t2	1 : 1
t1 with t3	1 : 1.2
t1 with t4	1 : 1.4

The taps may be used to provide an increase in signal level, depending upon the loading, to counter-act the attenuation caused by line losses. The amount of voltage that can be obtained in this way is limited by the fact that, as the turns ratio is increased, so the reflected impedance looking into the transformer primary winding decreases and loads the line.

A linear response to all frequencies within the Reed f.d.m. spectrum is obtained by the use of a short-circuited tertiary winding.

The input impedance, with the transformer unloaded, is within the range 450 - 510 ohms.

The resistance of the output winding is approximately 20 - 30 ohms depending upon the tapping which is selected.

See section 6 for order reference.

2.9 Reed Power Supply Units

2.9.1 Description

Reed transmitters and receivers, and also t.r.u.'s, require d.c. power supplies at 12 volts. These are derived from 110v mains by Reed power supply units which are available in two current ratings. Line amplifiers normally derive their power supplies from the Line Amplifier Supply Transformer (see sub-section 2.7), which is also fed from a 110v a.c. mains supply. The only external supplies to cupboards and relay rooms required for Reed equipment, therefore, are 110v a.c. mains.

The signal levels at the outputs of transmitters and receivers increase if the supplied d.c. voltage increases. It is, therefore, essential to the integrity of the system that the output voltage from the d.c. power supplies, and the level of ripple, should not increase significantly even under fault conditions. These requirements are met by an arrangement consisting of a constant-voltage transformer, whose output is rectified by a silicon diode bridge and smoothed by large electrolytic capacitors connected across the d.c. output. The smoothing capacitors are four-terminal devices, connected in such a way that if one should become disconnected then the output circuit would be broken: they have a predicted life in excess of 10 years in temperate zones (7 years in the tropics) and must be replaced after this period has elapsed.

The complete arrangement is as shown in Figure 2.9-1.

The units may be mounted on standard racks in relay rooms or lineside cupboards. Two ratings are available; a 600mA version, occupying the space of two miniature relays, and a 5Amp unit which requires three spaces. Each must be mounted with the terminals protruding to the "wiring" side of the rack.

2.9.2 Electrical characteristics

Since the Reed power supply units employ resonated constant voltage transformers, separate versions are required for use on 50Hz and other frequency supplies. The units have the following characteristics when supplied at any voltage between 95 and 125 volts rms at the appropriate frequency.

Full load current	600mA	5A
Max. ripple at full load (peak to peak)	300mV	700mV
Permissible range of output voltage	11.5 to 13.5	11.5 - 13.5 over the range 2 to 5 amps

For type references, see section 6.

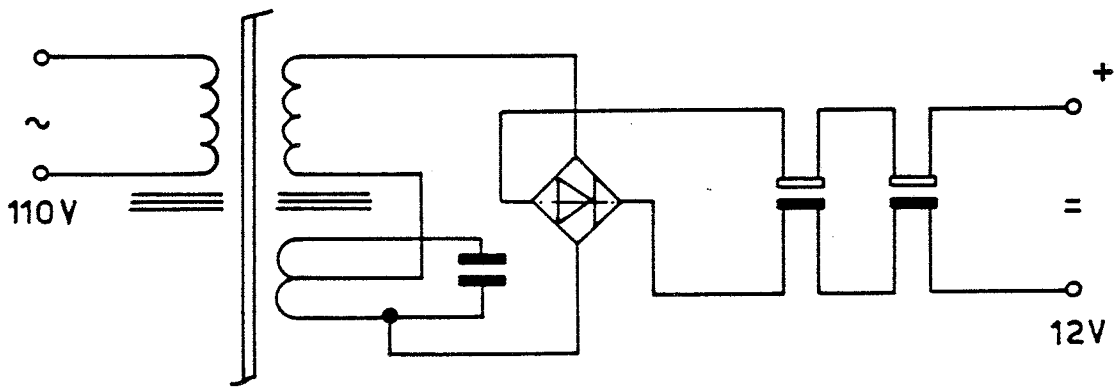


Figure 2.9-1. Circuit of Reed Power Supply Unit

2.10 Immunisation Units

2.10.1 General

When Reed systems carrying vital functions are employed in a.c. electric traction areas, or are in close parallelism with other a.c. power supply lines, it is necessary to protect certain items of equipment against electrical interference from such sources.

2.10.2 Protection of Line Amplifier

For line amplifiers, an immunisation unit is provided which inserts a filter and a fuse into the input circuit and two fuses into the output circuit. The filter consists of a resonated transformer (a capacitor connected across the primary winding) which appears as a low impedance at 50Hz but as a much higher impedance at Reed frequencies. The fuses are rated at 15mA (input) and 100mA (output).

The components of the immunisation unit are housed in a metal box designed to mount on the side of the inductor of the line amplifier.

The line terminals on the immunisation unit are 2BA, and four interconnecting wires are supplied with the unit: the wiring arrangement is illustrated in Figure 2.10-1, and typical transfer characteristics of the combination are shown in Figure 2.10-2.

For type reference, see section 6.

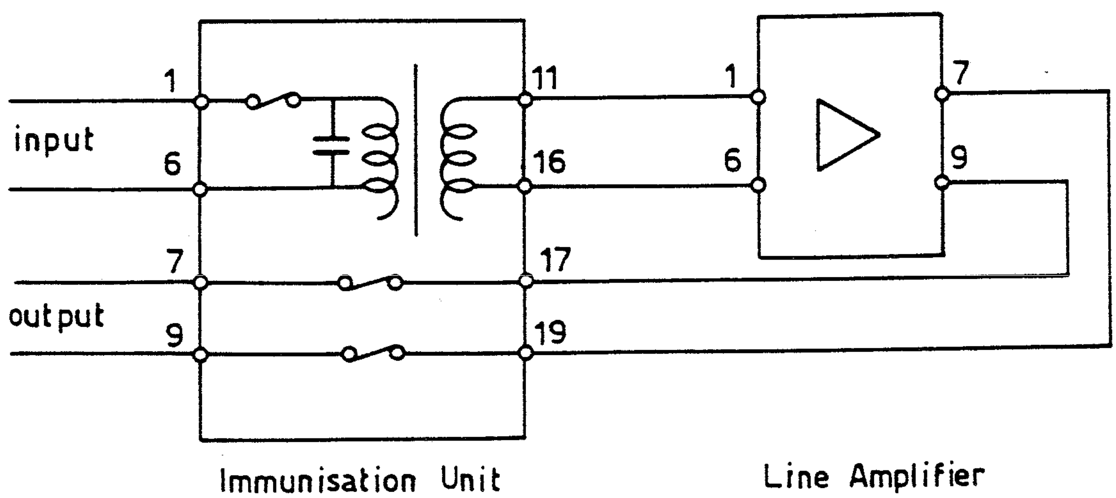


Figure 2.10-1. Interconnection of Line Amplifier and Immunisation Unit

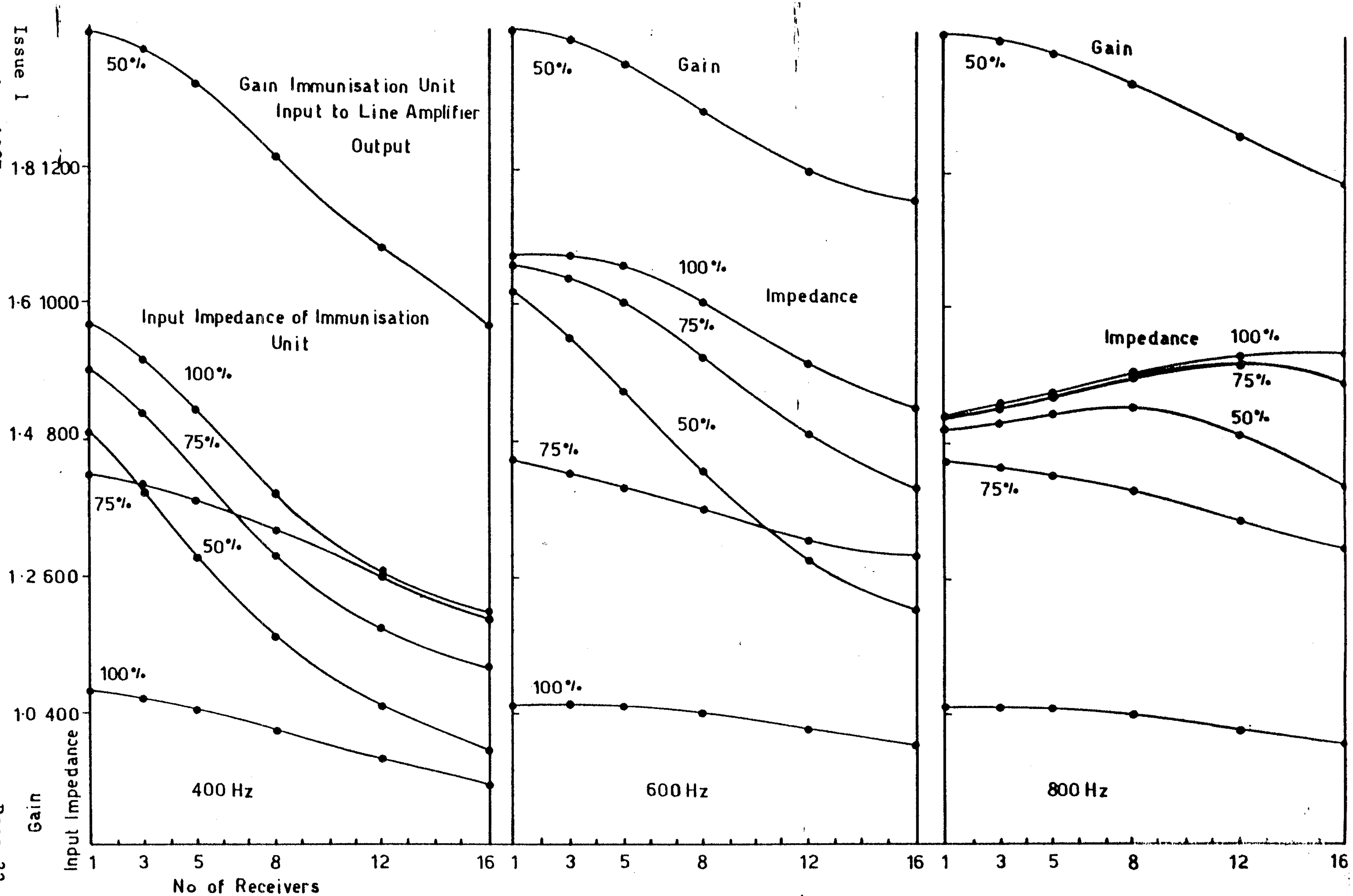


Figure 2·10·2 Characteristics of Combination of Typical Immunisation Unit and Line Amplifier

2.10.3 Protection of Receiver

Reed receivers are protected by means of an immunisation unit comprising a band-pass filter (a series connected capacitor and inductor) and a fuse, rated at 10 mA. These components are enclosed in a sealed metal box hence the fuse can only be replaced in the maintenance workshop.

To cover the range of Reed frequencies, a number of different immunisation units, which are colour coded, are available. An immunisation unit must not be used with a receiver having a frequency for which the unit is not intended.

Each unit is contained in a cylindrical case, 45mm in diameter by 105mm in length, which is painted in an appropriate code colour. It is connected by means of flying leads to terminals A3 and D2 on the associated receiver plugboard instead of the link which is otherwise fitted.

The unit may be fixed to a mounting plate by means of the two M4 studs which protrude at 22mm centres from one end. Alternatively, it may be held by a spring clip. It is convenient to accommodate the immunisation units for two receivers on a single width mounting plate situated between them.

The total loss resistance of the filter and fuse is approximately 150 ohms.

Immunisation is not required for monitoring receivers.

For type references, see section 6.

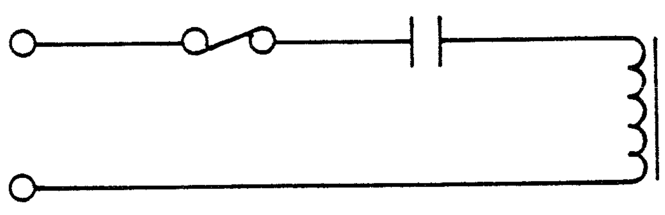


Figure 2.10-3. Circuit Diagram of Receiver Immunisation Unit

2.11 Surge Protection Units

2.11.1 General

To protect receivers and line amplifiers from damage by lightning discharges, and other electrical surges, a range of surge suppressor units are available. These units consist of transient voltage suppression diodes and current limiting resistors. They are designed for use in conjunction with a M.O. Valve Co. type 26A, gas-filled, surge arrestor tube, mounted in a type 53N base with the centre connection earthed: the base is not fitted with spark gaps.

See M.O. Valve Co. data sheet for electrical characteristics.

Transmitters are fitted with internal surge protection and do not normally require external components other than the type 26A arrester and base.

2.11.2 Line Amplifiers

There are two forms of surge suppressor unit for line amplifiers: these have substantially the same suppression components (shown schematically in Figure 2.11-1) but are physically different.

Where no immunisation unit is used, the surge suppressor takes the form of an extended comb connector which attaches to the line amplifier terminals in place of the standard connector comb.

Where an immunisation unit is used, it is necessary to interpose the surge suppressor unit between the immunisation unit and the line. In this instance, the surge suppression components are accommodated on an insulated plate which attaches to the relay mounting frame and occupies the space required for one miniature relay.

Line connections to both forms of surge suppressor unit are identified by the prefix L.

A terminal line amplifier needs special consideration. The internal transmitter or receiver circuit should be connected directly to the appropriate terminals of the line amplifier.

For type references, see Section 6.

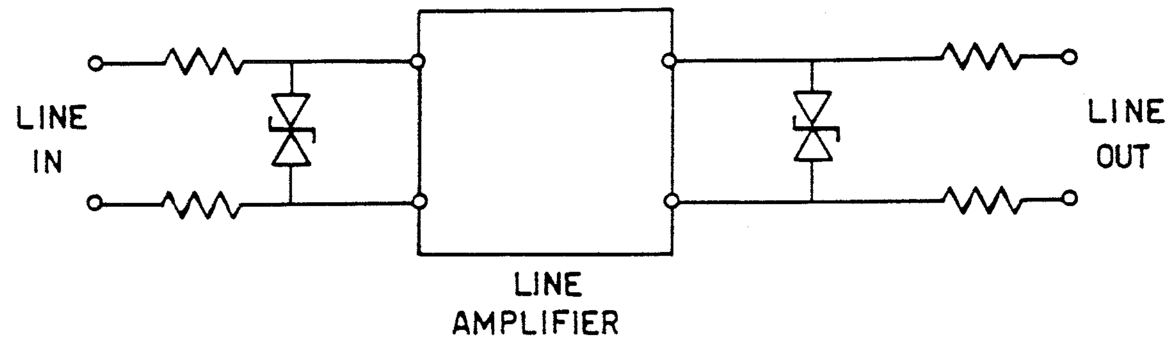


Figure 2.11-1. Schematic diagram of Line Amplifier Surge Suppressor Unit

2.11.3 Receivers

The circuit diagram for a receiver surge suppressor unit is given in Figure 2.11-2. The components are accommodated on an insulated plate which attaches to the relay mounting frame and occupies the space of one miniature relay. The unit is connected between the line and the plugboard terminations of a Reed receiver, or group of receivers, at a location where there is no line amplifier.

At a location where receivers are connected to a line amplifier, and are, therefore, protected by a line amplifier surge suppressor unit, separate protection is not required.

For type reference, see Section 6.

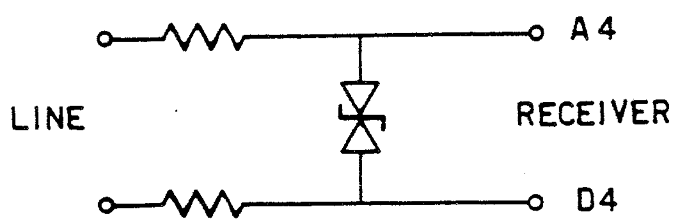


Figure 2.11-2. Circuit diagram of Receiver Surge Suppressor Unit

3. APPLICATION OF THE EQUIPMENT

Contents of Section 3

3 APPLICATION OF THE EQUIPMENT

3.1 Design of Vital Type RR Systems

The basic principles of type RR equipment have been described in the previous sections. In this section it will be shown how this equipment and the line are combined to form complete systems.

3.2 The Line and Line Equipment

3.2.1 General considerations

The type RR system will function using virtually any pair of line conductors and does not require a balanced transmission line. In general, pairs of conductors in unscreened signalling cable, telecommunications type cable and overhead open line are suitable for Reed systems. It is not feasible to match the terminations of of Reed f.d.m. lines, therefore the procedure for mismatched lines must be followed when system design calculations are carried out.

The series resistive loss of a line is one factor to be considered (together with the electrical characteristics of the equipment) in determining the permissible length of a line section; the acceptable level of crosstalk interference is another. A rational system design has been developed based upon the use of multicore cable of 1/0.85mm conductor to BR specification 872, which, with the optimum use of line equipment, permits a maximum line section length of 2km on BR in electrified areas. For applications on overseas railways, prospective users should consult GEC-General Signal Limited. Generally, it is possible to apply a set of rules for design, and these can be used satisfactorily for most systems. The rules are set out in sections 3.3.2 to 3.3.5.

In special cases, telephone circuits in phantom connection may be used: further information is available from GEC-General Signal Ltd.

3.2.2 Safety considerations

Where high voltage distribution lines are in parallelism with the Reed system it is necessary to consider the magnitude of induced voltage in the system lines, in relation to personnel safety, when determining the acceptable length of continuous line.

Line isolating transformers or line amplifiers are used to sectionalise the line and so limit the magnitude.

3.2.3 Line transposition: core conductor selection

When multicore cable is used, the twisted pair type generally to BR specification 872 is recommended: however, standard multicore cable to the same general specification can be used provided the following conditions are observed.

(1) The cable must be of a type in which successive layers of cores are contra-wound (ie, NOT uni-lay).

(2) The conductors of a line pair must be adjacent cores in the same layer.

(3) Where line pairs lie adjacent to one another within a layer, alternate pairs should be transposed approximately mid-way between line sectionalising points. This has the effect of cancelling out crosstalk in each half-section. The transposition point should be not more than 20% of the section length from the mid point i.e. 400m with a section length of 2km.

Pairs in telecommunications type cable are normally twisted in quads and are, therefore, continuously transposed.

3.2.4 Line levels

Crosstalk exists between any two systems which share a common cable, therefore it is necessary to limit the transmission levels in all the Reed systems to achieve an acceptable level of crosstalk interference. Systems must be designed so that the amplitude of any Reed tone transmission does not exceed 420mV at any point throughout the transmission line. With the use of transposed cable pairs, this limited amplitude ensures that the worst case level of fault crosstalk is less than the channel release value. There are two exceptions which are given below:

(1) The attenuation of a receiver immunising unit varies over the reed f.d.m. frequency range; being 60mV at the lower frequency end and 30mV at the higher. A corresponding increase in line level, to compensate, is, therefore, necessary when an immunisation unit is used.

(2) Non-vital Reed f.d.m. systems, operating at up to 700mV per channel, are permitted within the same cable provided that none of the following channels are used: f3,42,47,48 and 85.

When pairs in telecommunications cable are used, attention is drawn to the peak level of transmission in a Reed system which may exceed the CCITT specified limiting value, and could produce unacceptably high crosstalk levels in adjacent circuits. Such applications require special consideration and GEC-General Signal Limited engineers should be consulted.

3.3 Guidelines on System Design

3.3.1 Basic considerations

The equipment parameters are given in section 2 and these may be used to design systems by calculation. It is impossible to match the terminations of Reed f.d.m. lines, therefore the procedure for mismatched lines must be followed to calculate the system performance. However, a set of rules for design can be applied to most systems and these can be used satisfactorily without the need for detailed calculations. The rules are set out in sections 3.3.2 to 3.3.6.

3.3.2 Line characteristics

Line characteristics depend upon the type of transmission line under consideration, however, for signalling cable constructed to British Rail specification BR 872, the following parameters apply:

Resistance: 66 ohms per loop km: at 20°C
Capacitance: nominally 0.15 microfarad per km pair
Other cable parameters are of no significance in Reed system design.

3.3.3 The use of line equipment

The attenuation of a Reed signal, due to line losses, is restored by means of a line amplifier. The amplifier can not be considered in isolation because the length of line, the distribution of Reed equipment, the terminating impedance and loading in the successive line section affect the gain requirement.

Amplifiers are positioned in the line so as to maintain the operating line level to within the limits given in section 3.2.4.

The effects of loading and gain adjustment on the input impedance are illustrated in Figures 2.7-2 and 2.7-3. Subject to the requirements of sections 3.3.4 and 3.3.5 below, it is not always necessary to use a line amplifier at successive isolating points and a line isolating transformer may be used alternately; thereby giving the most economical arrangement.

Transformers must NOT be used in succession.

3.3.4 Additional line amplifiers

An additional line amplifier should be inserted into the system or substituted for a line isolating transformer in accordance with the following rules.

(1) if more than 4 transmitters would have occurred in the input to a line isolating transformer.

(2) if any receivers would have occurred within a line section connected to a line isolating transformer, other than directly at the output of the preceding amplifier.

(3) if more than 4 receivers would have occurred within a line section, other than directly at the output of a line amplifier

(4) if more than 4 receivers occur in a given line section, the two preceding isolation points must be fitted with line amplifiers.

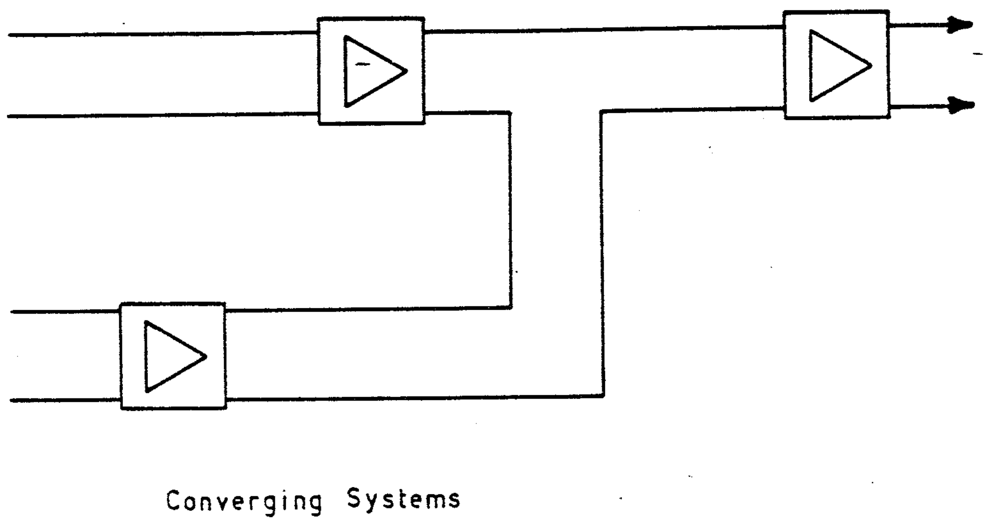
3.3.5 System terminal amplifier

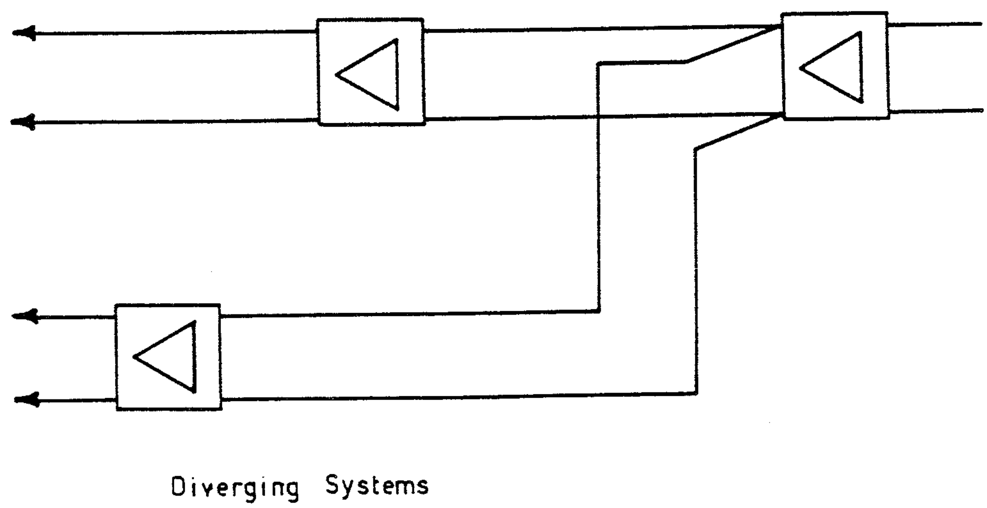
A line amplifier is always interposed between the line and the receivers at the end of an indication system. Similarly, an amplifier is used between the transmitters or t.r.u.'s of a control system and the line.

The nearest isolating point to the terminal amplifier of an indication, or non-distributed control, system should also be fitted with a line amplifier, and not an isolating transformer.

3.3.6 <u>Branched systems</u>

Where the length of the proposed system is significantly less than the length of an isolated line section, it may be treated as part of the line section of the main system, and ancilliary line equipment would not be required. This section would be subject to the considerations regarding the number of transmitters or receivers permitted between amplifiers. Where the loading or length is greater than can be accommodated as described above, the branch should be isolated by a line amplifier in accordance with Figure 3.3-1. Provided the applications rules are observed, the branch circuit may be of virtually unlimited length. The main constraint is that the branch circuit must not re-connect to the main system.





<u>Figure 3.3-1. Connections of Branched Systems.</u>

3.3.7 Monitoring

Monitoring channels may be incorporated within systems as an aid to fault localisation. They are of particular benefit where the signalling channel equipments are not proportionately distributed throughout the system. A typical application, using three monitoring points, is shown in Figure 3.3-2.

The transmitter in the control system is arranged to function continuously and the three receivers, all of the same frequency, will be energised if the system is fault-free. A contact of each follower relay causes corresponding transmitters in the indication system to function and to operate appropriate receivers in the relay room. These receivers may control lamps on a mimic diagram.

It is not necessary to use an immunisation unit with a monitoring receiver. A resistor should be connected in its place and the value selected during setting-up (section 4.3.1.1).

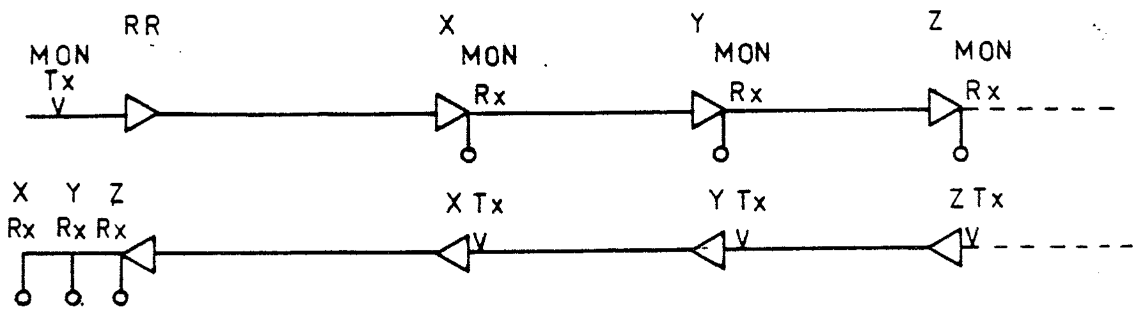


Figure 3.3-2. Typical Application of System Monitoring

In normal circumstances all three receivers would be energised. A line fault would be revealed by release of the monitoring channel receiver associated with the faulty line section, as given below:

Energised Receivers	Fault Between Locations
X & Y	Y & Z
X	X & Y
Nil	RR & X

A range of channels suitable for monitoring or other non-vital use is given in Section 6.

3.4 Selection of Frequencies

Although the frequency response of the line amplifier and the line isolating transformer (tertiary winding type) is almost linear within the type RR Reed system spectrum, there is a slight relative increase in response at the higher frequencies. The effect is enhanced by the unequal frequency response of any receivers that may be connected. To counter this, the following rules should be observed.

(1) Channels should be arranged such that those with the higher frequencies transmit over the longer distances.

(2) Where the full number of channels is not required for a system, those in the middle of the frequency band should be used in preference to those near its ends.

(3) Within each line section, frequencies should be grouped as closely as possible.

(4) A few spare frequencies should be left unused throughout the range so that, if additions are required after installation, they can be made without infringing the above rules.

Note that a list of frequencies and their associated channel numbers is to be found in section 6.

3.5 Lightning and Surge Protection

When considering the provision of lightning protection, it is advisable to weigh the cost of protection against the anticipated risk of injury to personnel and damage to the equipment. In regions with a very high incidence of electrical storms, the provision of full protection, incorporating surge arrestors and transient suppression devices, to limit transverse line voltages, is recommended. Use of the M.O. Valve Company type 26A, gas-filled, lightning arrester, mounted in a type 53N base with its centre electrode connected to earth, is recommended for the protection of personnel against high voltage which is developed between line conductors and local earth by the conduction of transient current in the ground.

Where immunisation units (see section 2.10) are used with the line amplifiers or receivers, these should be protected by surge suppression units.

See section 2.11 for details of the equipment.

3.6 Earth Faults

To maintain the high standard of safety of the system, it is necessary to guard against the occurrence of earth faults.

The equipment is designed to have high insulation resistance between terminals and the mounting frame. As part of this philosophy, it is recommended that insulated crimp terminals are used for cable connections. These also provide protection against accidental short-circuit and inadvertant disconnection.

3.7 Immunisation Against Mains Interference

Electromagnetic induction into a Reed f.d.m. line from the traction power system produces a longitudinal voltage in the core conductors, and, if two separate earth faults on the line should occur, a transverse voltage may develop across the line termination. The line amplifier immunising filter and receiver filter (see section 2.10) safeguard the f.d.m. systems against this form of interference.

3.8 Layout of Equipment

3.8.1 Standard requirements

Care must be taken in the layout of f.d.m. equipment to safeguard against the effects of external magnetic fields. Such fields may be generated by certain items of equipment used in the system.

The following must be observed:

(1) All items of Reed f.d.m. equipment must be installed with their terminals at the wiring side of the mounting frame.

(2) Reed follower relays and reed receivers must not be mounted side by side.

(3) All equipment must be mounted so as to conform with the wiring constraints detailed in section 3.10.

3.8.2 Proximity to type RT track circuit equipment

It is recommended that separate apparatus cases are used for housing Reed f.d.m. and track circuit equipments. These may, however, be housed together provided that the following constraints are applied.

F.D.M. receivers and Reed track circuit equipment must not be mounted on the same row and must be separated by at least two rows, or 300mm. In relay rooms, these equipments must be mounted on separate racks.

3.8.3 Proximity to other items of equipment

Consideration must be given to the possibility of electrical interference from other items of equipment. It is necessary to ensure particularly that such items which have an "open" electromagnetic circuit are not mounted so that they cause interference.

3.9 Power Supply Units

3.9.1 Types of power supply unit

The power supply units listed in section 2.9 of this manual are proof against a short-circuit and do not require output fuses. No other type of unit should be used without reference to GEC-General Signal Limited.

3.9.2 Provision of power supply units

In a relay room, it is normal practice to provide a 5 amp rated power supply unit for all the transmitters or receivers of a system. This type of unit is also suitable for use with transmitter repeater units (where these are employed) and will supply up to 32. However, it may be considered preferable to use a number of 0.6 amp rated units to reduce the effects of a power supply unit failure.

Since both these types of power supply unit operate in a state of magnetic saturation, they become very hot. The effect that this may have on other equipment should be considered when their mounting position is being settled. If there are a number of units it may be preferable to mount these at the top of a rack in situations where there is little ventilation, or the situation may justify a separate rack; each case ought to be considered on its own merits.

Either of these power supply units may be used in apparatus cases depending upon the number of Reed units to be supplied.

The maximum loading for a 0.6amp unit is: 12 Transmitters, or
6 Receivers.

A separate power supply unit must be provided for each system, though the same unit may be used for both transmitters and receivers of a system where these occur together, provided they are of different frequency.

3.10 Wiring of the Equipment

3.10.1. General

The recommended wire is 9/0.30mm to BR specification 872.

Connections between equipment wiring and multicore cable should be by means of insulated crimp terminals.

The number of Reed units which may be supplied by one power supply output circuit is restricted as listed below:

12 Transmitters or
4 Transmitter Repeater Units, or
12 Receivers (6 with a 0.6Amp rated power supply unit)

To facilitate the connection of multiple feeder circuits, the 5 amp unit has 3 sets of output terminals.

All the Reed units to be supplied by one feeder circuit must be mounted adjacent to each other.

The feeder circuit between the power supply unit and the first Reed unit must be a twisted conductor pair, not exceeding 3m in length. Connections between subsequent units must be run directly between plugboards as a twisted pair whenever this is possible: if single core cable is used the wire must not be of such a length as to permit loops to be formed.

3.10.4 Transmitter switching circuit

There is no restriction on the length of the switching circuit of a transmitter (see section 2.3) within a relay room or location area. Twisted pair cable must be used wherever possible.

3.10.5 Transmitter Repeater Unit input circuit

The input circuit of a transmitter repeater unit (see section 2.6) from its master transmitter must be run in screened twin cable, typically 16/0.20mm. One end of all screens should be connected together and taken to a single, independent, low impedance earth.

3.10.6 Transmitter Repeater Unit output circuit

The outputs of successive transmitter repeater units within a system should be connected in antiphase: e.g. A8 of t.r.u. 1 to A8 of t.r.u. 2, A7 of t.r.u. 2 to A7 of t.r.u. 3 etc.

3.10.7 Receiver output circuit

The output circuit from the receiver amplifier to its follower relay should be run in twisted pair cable, and should not exceed a length of 20m.

3.10.8 Apparatus cases

The requirements for wiring in apparatus cases are generally as described above. Looping between individual cupboards at a location area is permitted except for power supply circuits. Separate power supply units are required if all the Reed units connected to a system are not in the same cupboard.

4 TESTING AND COMMISSIONING

Contents of Section 4

4 TESTING AND COMMISSIONING

4.1 Initial Procedures

4.1.1 The line

Before any equipment is connected to the line, normal cable testing should be carried out to ensure continuity, insulation resistance and freedom from extraneous voltage. This should be done for each section of line.

A system of communication is advantageous for this and subsequent setting up of the system.

4.1.2 Relay rooms and apparatus cases

The following procedure is based upon the assumption that the equipment has been installed and wired strictly in accordance with the appropriate diagrams.

Before any Reed transmitter, receiver or transmitter repeater units are plugged in, the Reed power supply units should be energised and the polarity of the power supply connections checked at each plugboard. This is most important as incorrect polarity will damage the amplifiers. It should be noted that the open circuit voltage may be higher than specified in section 2.9. When the connections have been proven, the power supplies should be left connected and the equipment plugged in, checking that only the correct holes have been drilled in the plugboards: see the registration codes listed in section 6.

Link the control circuits of each transmitter/t.r.u. and check the output of each unit, as described in section 4.2.2. If terminals A4 and D4 of a transmitter (other than a master transmitter) are fitted with a permanent link, refer to the wiring diagram for details of the control circuit.

Check that line isolating transformers are set to unity transfer ratio. Check also that line amplifiers are at unity gain before they are supplied with power.

This procedure should be carried out progressively on all systems.

4.2 Taking Measurements

4.2.1 Instrumentation

An electronic multimeter must be used to take all measurements on type RR systems.

To enable the signal output of a Reed receiver filter to be measured, a test amplifier is available: see section 6 for ordering reference.

4.2.2 Measurement of reed signal

4.2.2.1 Transmitter

Measurement of a Reed signal from an energised transmitter is made by connecting the instrument across the associated output resistor. The reading, which is an alternating voltage, will depend upon which output level from the transmitter is selected (see section 2.3) and on the value of the transmitter power supply voltage, as shown below. The voltage across the line resistor is not significantly affected by other channels which may be operating in the same system.

Output Level	Power Supply Voltage 12v	13.5v	
Low	0.33v min.	0.43v max.	
High	0.59v min.	0.75v max.	* see below

4.2.2.2 Transmitter Repeater Unit

Measurement of Reed signal from an energised transmitter repeater unit is made in the same manner as for a transmitter.

Output Level	Power Supply Voltage 12v	13.5v	
Low	0.32v min.	0.45v max.	
High	0.57v min.	0.8v max.	* see below

* This output to be used only in special applications.

4.2.2.3 Line voltage measurement

On a working system the line voltage will be in the order of 1 volt and will vary continuously. As it is dependent upon the number of energised channels, the exact value will have little significance, beyond that of indicating the presence of a line signal.

Measurement of the level of an individual frequency on the line, while setting up a system, at a point remote from the function receiver, requires the use of a Reed receiver filter of the appropriate frequency.

4.2.2.4 Reed Receiver Filter

Measurement of the output of a Reed receiver filter is made at the terminals of the secondary reed coil. To enable this to be achieved in a convenient manner, the test unit (see section 4.2.1) is attached to the filter in place of the amplifier and the composite unit inserted in the plugboard. Terminals are provided on the front of the test unit to which the voltmeter is connected. Besides proving the correct voltage level, this measurement also ensures that the wiring and the receiver immunisation unit are correct.

To obtain a measurement at other points along the line, the line should be connected to the input terminals of the Reed filter (those at the plugboard end) by means of wander leads, and the voltmeter connected to the other terminals.

Recommended voltage levels are given in section 4.3.1.

4.2.2.5 Receiver output and follower relay input

The d.c. voltage measured across terminals A1 and D1 of the Reed receiver plugboard should be between 11 and 18 volts.

The d.c. input voltage to the follower relay should normally be measured on terminals R1 and R2 of the relay plugboard and the value should correspond to the output voltage of the receiver amplifier. At installations where a link has been connected between terminals R2 and R3 to permit the use of type 32M10 Reed follower relays, the external connections to the relay are R1 and R4.

4.2.2.6 Receiver background output

'Background' is the level of residual noise which can pass through the Reed filter from the line when the corresponding transmitter is switched off. It arises from the combination of all the other frequencies present in the system and crosstalk from other systems. It is measured in the same way as receiver output.

4.3 Setting of Systems

4.3.1 General

Before attempting to set any system, ensure that all equipment has been installed, the preliminary checks detailed in section 4.1 have been carried out and that all power supply units are functioning, including those for line amplifiers.

All measurements should be made in the manner described in section 4.2.

To ensure safe and reliable operation of systems, the signal level applied to each channel receiver must be set by adjustment of the voltage gain settings of line amplifiers and isolating transformers (see sections 2.6 and 2.7 respectively). The optimum range is 105 to 150mV when measured at the output of the test unit, as described in section 4.2.2.4.

When measurement is made at a point remote from the installed receivers, the filter output should not exceed 200mV where immunisation units are used. In d.c. traction areas, where immunisation units are not used, individual channel levels in the line must not exceed 175mV at the output of the filter.

These measurements may be made at a line amplifier by connecting the nominated Reed filter (see sections 4.3.2 and 4.3.3) to the output terminals.

When measurement is made at a line isolating transformer, connection of the Reed filter to the normal output terminals will excessively load the system and give a false reading. To overcome this, the Reed filter may be connected to a portion of the secondary winding and a correction factor applied to the measured output of the filter. This provides a closely approximate equivalent to a filter measurement taken across the line without loading it significantly.

Meaningful measurements can only be achieved when the line is terminated on the transformer terminals.

A different factor must be applied to the measurement obtained for each of the alternative output tappings of the transformer to which the line is connected.

The following procedure may be adopted to determine which of the output tappings is most suitable for use in the system.

During the preliminary setting-up, it will have been established that the output line section is connected to terminals t1-t2 of the transformer. Connect the nominated Reed filter to terminals t2-t3 of the transformer and measure its output as described in section 4.2.2.4. Multiply the reading by 5 to obtain the equivalent reading on the line terminals (t1-t2). If this equivalent is substantially below the maximum permitted level, transfer the line connection from t2 to t3 (reconnect the Reed filter to terminal t2 if this connection has been disturbed) and multiply the Reed filter output voltage by 6 to obtain the equivalent reading on the line terminals.

If this is considered still to be insufficient, transfer the line connection from t3 to t4 and again measure the filter output (while it is still connected to terminals t2 and t3). Multiply the reading by 7 to obtain the equivalent reading on the line terminals.

The final choice of transformer output tapping may now be decided. It should be noted that it may not be possible to achieve the voltage level obtained at the output of the preceding line amplifier because of the loading effect of the transformer (this will depend upon a number of parameters within the system). However, in this case the line voltage may be restored at the subsequent line amplifier.

4.3.1.1 Monitoring receivers

It is desirable to operate monitoring receivers at a lower voltage than signalling fuction receivers, as this may give early indication of impending failure within the system and enable corrective measures to be adopted. The link between plugboard terminals A3 and D2 should be replaced by a resistor of a value which produces a reading of approximately 100mV at the output of the test unit.

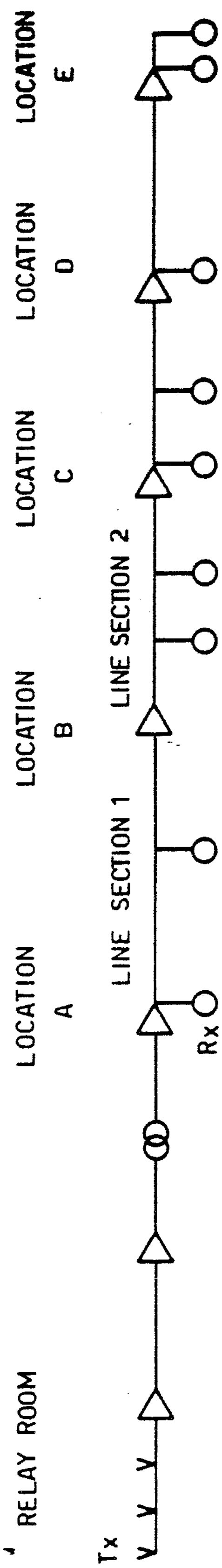


Figure 4:3-1 Typical Distributed Control System

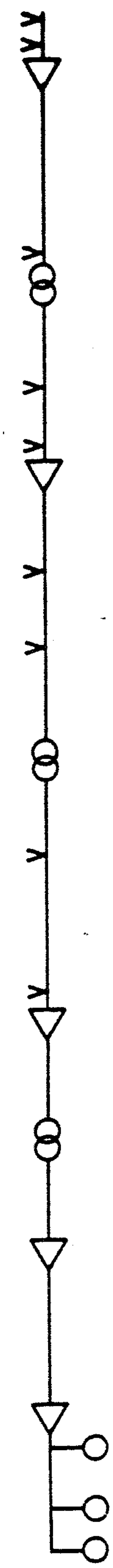


Figure 4.3-2 Typical Distributed Indication System

4.3.2 Control systems

4.3.2.1 Distributed control systems

Systems in which the receivers are housed at a number of different locations with the transmitters at one place, typically a relay room, as shown in Figure 4.3-1, may be described as distributed control systems and may be set in the following manner.

To set the line level, connect a Reed receiver filter of the same channel as one of the receivers installed at location A across the output terminals of the relay room line amplifier, in the manner described in Section 4.2.2.4, and adjust the amplifier gain until the output voltage of the test filter is in accordance with the level given in Section 4.3.1. Make a note of the measurement and then remove the filter. Great care must be taken to ensure that the voltage applied to the test filter does not exceed the level specified or damage may occur.

Proceeding from the relay room, check and adjust the signal as closely as possible to the above level for the selected channel at any intermediate isolating points until location A in the diagram is reached. At this point the level must be set to a value not exceeding 150mV using the test unit as described in Section 4.2.2.4. Remove the test unit and refit the receiver amplifier. Check that the follower relay is energised and that the voltage is between 11 and 18volts d.c. A reading in the order of 50volts will be observed if the relay circuit is open. A significantly lower reading would suggest a faulty receiver amplifier or power supply unit, which should be changed. Check that the test unit output for all other receivers at this location, and those distributed in line section 1, is between 105 and 150mV: making fine adjustment, as necessary.

Adjust the gain setting at the isolating point B for receivers in line section 2, and so on throughout the remainder of the system.

Remove sufficient temporary links from transmitters such that only the normal number of channels are operating. Reconnect the test filter to the output of the relay room amplifier and adjust its gain, if necessary, to obtain (approximately) the original value.

4.3.3 Indication systems

4.3.3.1 Distributed indication systems

Systems in which the transmitters are housed at a number of different locations with the receivers at one place, typically a relay room as shown in Figure 4.3-2, may be described as distributed indication systems and may be set in the following way.

Commencing at the most distant line amplifier (location E in the diagram), connect a receiver filter of the channel of the highest frequency in the system to the output terminals. Adjust the line amplifier such that the Reed filter output is as given in section 4.3.1.

Proceed towards the relay room, setting any intermediate line sections to maintain the signal level. At the relay room the line amplifier should be set such that the output of the test receiver is within the recommended range of 105 to 150mV. Check that the output of all other receivers is within this range, making adjustment as necessary.

4.3.4 Non-distributed systems

Systems in which all the transmitters are installed at one end of the line with all the receivers at the other, may be called non-distributed systems. Proceed by making sure that all the transmitters or t.r.u.'s, are switched on by measuring each output. Connect a receiver filter of the channel of the highest frequency in the system to the output of the line amplifier, and adjust this line amplifier, as though it were in a control system, to achieve the voltage level given in sub-section 4.3.1.

Continue setting the line level at each isolation point along the system in the same manner until the final location is reached in which the receivers are housed. Fit the test filter to the plugboard and measure its output, adjusting the amplifier gain until the output level is between 105 and 150mV.

Check that the output of all other receivers is within this range, making adjustment as necessary.

4.3.5 Background level

When all systems have been set, and after establishing that the receiver of a nominated channel is functioning correctly, arrange for its transmitter to be switched off. Measure the residual relay voltage across the amplifier output.

This should be less than 0.3 volt.

Replace the receiver amplifier by the test unit and measure the filter output voltage (background).

This noise level should be less than 10mV at the output of the test unit.

If these voltages are correct, refit the receiver and arrange for the channel to be re-energised. If either of these voltage limits is exceeded, the cause should be investigated.

Measure the background levels of the remaining channels in the system in a similar manner.

4.3.6 Practical considerations

The above discussion describes the method for setting individual control and indication systems. Where there is more than one system involved in the setting-up process, the following procedures will minimise the work.

(1) All transmitter control circuit links should be identified and a record made of their disposition: at the completion of testing, all links must be accounted for.

(2) After the preliminary work in the relay room, take the receiver filter having the lowest type reference number used in each indication system into the field for measuring line voltage levels.

(3) Proceed through the installation carrying out the preliminary checking: the checking of both control and indication systems at each location can be carried out at the same time.

(4) On the return journey, the receiver with the highest type reference number in each control system should be collected and taken to the relay room for use in system setting.

(5) When the furthermost location has been reached (all the transmitters in the systems should be operating), setting of the indication system(s) can proceed using the appropriate filter.

(6) At the relay room, re-install the Reed filter(s) with the test amplifier, and adjust the line amplifier of each indication system as necessary. Take note of any channel voltage readings which do not conform with the recommended levels and require adjustment at locations.

(7) Using the appropriate test filter adjust the relay room amplifier of each control system.

(8) Progress through the installation setting the gain of line amplifiers and the transfer ratio of line isolating transformers. When the location is reached from which the test filter was obtained, the unit should be installed, with the test amplifier, and the signal level adjusted as necessary to within the recommended range.

(9) Continue with this procedure throughout the remainder of the system(s).

(10) It is convenient to make any necessary adjustments to the indication system(s) at the same time.

4.3.7 Reed point detection circuits

For the application of Reed equipment in point detection circuits, see GEC-General Signal Limited publication I.B.164.

5 MAINTENANCE AND FAULT LOCALISATION

Contents of Section 5

5 MAINTENANCE AND FAULT LOCALISATION

5.1 Introduction to Maintenance

The type RR System incorporates easily replaceable units, hence maintenance, apart from the routine monitoring of the performance of the system, involves only the tracing of any fault which may occur and the replacement of the affected unit to restore the system to normal operation.

Fault finding at component level and rectification within the units themselves is a workshop function, and should not be attempted on site. It is important that the fault report on any unit replaced in the course of maintenance should give as much detail as possible regarding the symptoms and circumstances of the failure.

The detachable amplifier portion of the transmitter is a unit common to all transmitters, and the number of spare amplifiers to be held will be related to the total number of transmitters in the installation; probably varying from 5% in larger installations to 10% in smaller ones. The same applies to the detachable amplifiers of receivers.

The filter portion of transmitters and receivers can be replaced only by a filter of the same frequency and type number, a non-interchangeability pin arrangement ensuring this feature. Consequently, it will be necessary to hold at least one transmitter and receiver filter of each frequency used on the installation. Transmitter filters and receiver filters of the same frequency are not interchangeable.

All type RR equipment should be stored under dry conditions and when handled and transported should be treated with similar consideration as that shown to safety relays. Until actually installed, the equipment should continue to be housed in the individual packs in which it is supplied. Labels on the packs fully identify the contents.

5.2 Routine Checks and Records

It will assist in monitoring the performance of the system if routine records are made of the operating levels of the system. These checks might reasonably be made at six-monthly intervals for the first twelve months, and then every twelve months thereafter. Measurements should be made, in the manner described in the previous section, of the following voltages:

Transmitter output, t.r.u. output, transmitter power supply, receiver output and receiver power supply.

5.3 Fault Localisation

5.3.1 Initial considerations

First priority is to determine whether the fault is in the Reed equipment or the signalling equipment, and, if in the "Reed", whether the control or the indication system is involved. It may be possible to determine this by operating various controls and observing the corresponding indications on the control panel. This initial diagnosis (which should include reference to the monitoring channels where provided, see Section 3.3.7) should be made before carrying out tests in the field.

Reed system failure will become evident through:

(1) the failure of one or more indications to be displayed as expected when a route is set up or some function operated, or

(2) the appearance of an apparently incorrect indication, or group of indications unrelated to any function being operated, or known train movement.

Failures of the first type may be caused by a fault in the Reed control or indication system, or a failure of signalling equipment in the field.

Failures of the second type will normally be due to a fault in the signalling equipment in the field or in the Reed indication system, but, in certain instances, may be due to a control system fault.

5.3.2 Reed system faults

5.3.2.1 Single channel faults

These are characterised by the apparent failure of a control or its asssociated indications, or possibly two or three such controls or indications, without there being any obvious geographical or operational association between them. In view of the inherent integrity of the system, the failure would be expected to be 'right side', i.e. such that a Reed signal that should be present had disappeared,

If the fault is on the Reed system, control or indication, then it is most likely to be associated with a particular Reed channel, and the transmitter, receiver or individual power supply unit associated with that channel should be checked.

5.3.2.2 Geographical group faults

Failure of a group of channels associated with a particular location, while channels to nearer and more distant locations remain functional, would suggest a possible failure of the signalling equipment, or of the Reed power supplies at that location.

5.3.2.3 System group faults

Failure of a group of channels related sequentially in a particular system, would normally imply the failure of common equipment or of the line. Checking should commence with the line amplifier and its power supply before the last location to which the system appears to be working, since a failed line amplifier could permit the system to work up to its input, but may fail the system beyond its output (although, under certain circumstances, a system may continue to work beyond a failed line amplifier, because of the transformer coupling of the input and output circuits).

The line itself should be checked carefully for faults, with particular attention being paid to through-crimps and terminals.

In normal control and indication systems:

An open line	(1)	will fail control channels terminating beyond the line break.
	(2)	will fail indications originating in the faulty section and in preceding sections.
A short-circuit or earthy line	(1)	will fail controls terminating beyond the fault.
	(2)	may fail controls terminating between the fault and the preceding line amplifier.
	(3)	may fail controls terminating in the section of line prior to the faulty section.
	(4)	will fail indications from transmitters in line sections preceding the fault.

5.3.2.4 Complete system faults

The failure of all channels on a system can be due to failure of:

(1) power supplies feeding transmitters/receivers for that system in the relay room.

(2) the line amplifier or its power supply in the relay room.

(3) a line amplifier or its power supply in the field.

(4) a cable fault, or a faulty connection, in the part of the line which carries all the functions in the system (beware of intermittent faults which can be caused by faulty crimps, terminals, etc.

5.3.2.5 Multi-system faults

If all systems fail simultaneously, check the main power supply. Failure of several systems in one geographical direction would indicate a local power failure, or a severed cable; these faults can be located by checking which functions are still working.

In installations employing master transmitters and t.r.u.'s, failure of the same channel number in just three systems would indicate a fault in the appropriate t.r.u. in the relay room; failure of the same channel number in many systems would indicate a master transmitter fault.

If a group of functions in the same geographical location, but on different systems, fail, check the local power supplies, and the possibility of lightning or similar damage.

5.4 Summary Chart - System Fault Finding

This chart is arranged to show the quickest way to the most likely cause of failure. Decide, first, which category of fault fits the circumstances and then check units in the order suggested, continuing until the faulty unit or condition is discovered and rectified. If none of the suggested checks reveals the fault, consider the next most likely category, and so on. Refer to Section 5.5 for details of unit checking.

REMEMBER, the Reed system will show you SIGNALLING FAILURES : IT IS NOT NECESSARILY THE REED WHICH IS AT FAULT.

	Indication Only Faults	Indication or Control Faults: Indication System	Indication or Control Faults: Control System
INDIVIDUAL FAULT.	In Box 1 Check Receiver. In Field 2 Check Transmitter. 3 Check power supply unit.	In Box 2 Check Receiver. In Field 3 Check Transmitter. 4 Check power supply unit.	In Box 1 Check Transmitter/t.r.u. In Field 5 Check Receiver. 6 Check power supply unit.
GEOGRAPHICAL GROUP FAULT.	In Box 1 Check that the failed transmitters or receivers do not have common circuitry or power supply which could be the cause. In Field 2 Check location power supply units. 3 Check Transmitters. If several faulty, look for signs of lightning damage.	In Box In Field 2 Check location power supply units. 3 Check Transmitters. If several faulty, look for signs of lightning damage.	In Box In Field 4 Check Receivers.

<table>
<tr><th rowspan="2"></th><th rowspan="2">Indication Only Faults</th><th colspan="2">Indication or Control Faults</th></tr>
<tr><th>Indication System</th><th>Control System</th></tr>
<tr><td rowspan="4">SYSTEM GROUP FAULT</td><td><u>In Field</u></td><td><u>In Field</u></td><td><u>In Field</u></td></tr>
<tr><td colspan="3">1 Go to line amplifier on box side of first failed indication or control system receiver. Check line amplifier and power supply. Check for open circuit line.</td></tr>
<tr><td colspan="2">2 Check next line amplifier out from box for open circuit on output.</td><td>2 Check next line amplifier out from box for short circuit on input.</td></tr>
<tr><td>3 Check line for open circuit.</td><td>3 Check line for open circuit.</td><td>3 Check line for open circuit or short circuit beyond last operating control receiver.</td></tr>
<tr><td rowspan="2">SYSTEM FAULT.</td><td><u>In Box</u>
1 Check power supply unit feeding system receivers.</td><td></td><td><u>In Box</u>
1 Check for continuity of line circuit connecting output resistors of transmitters/t.r.u.'s.</td></tr>
<tr><td><u>In Field</u>
2 Work outwards from box checking line amplifiers and power supplies and the line, until the transmitter is reached or the fault found.</td><td><u>In Box</u>
2 Check receiver power supply unit.
<u>In Field</u>
3 Work outward from box checking line amplifiers and power supplies and the line until the first transmitter * is reached or the fault found.</td><td><u>In Field</u></td></tr>
</table>

(*receiver in the case of a control system)

<table>
<tr><th rowspan="2" colspan="2"></th><th rowspan="2">Indication Only Faults</th><th colspan="2">Indication or Control Faults</th></tr>
<tr><th>Indication System</th><th>Control System</th></tr>
<tr><td rowspan="2">ALL–SYSTEM FAILURES</td><td>(COMPLETE)</td><td colspan="3">1 Check for major power supply failure in box or in field.
2 Check for damaged multicore cable affecting all systems.
3 Check power supply to line amplifiers at box and at all locations on all systems where these occur.</td></tr>
<tr><td>(PART)</td><td></td><td></td><td>4 If same channel numbers fail in all systems, check the master transmitter power supply. If same channel numbers fail in same system only, check t.r.u. power supplies.</td></tr>
</table>

5.5 Procedure for Checking Units with Suspected Faults

5.5.1 Checking a Transmitter

Step 1 - Measure output on line resistor.

If correct, unit probably O.K. but try changing Reed filter.

If low or zero, go to step 2.

Step 2 - Measure d.c. supply on terminals D3 (+) and A3.

If correct, go to step 3.

If low or zero, check power supply unit.

Step 3 - Remove the transmitter from the plugboard and re-insert the same unit. Measure output on line resistor.

If correct, unit O.K., but examine and if necessary clean plugboard contacts.

If low or zero, go to step 4.

Step 4 - Remove the transmitter from the plugboard and measure the resistance between plugboard terminals A4 and D4.

If <40 ohms, switching circuit or link correct: go to step 5.

If high, unit probably O.K. but examine switching circuit for open circuit or high resistance.

Step 5 - Exchange transmitter amplifier with a unit of the same type. Replace the complete transmitter on the plugboard. Measure output on line resistor.

If correct, original transmitter amplifier was faulty. Report fault and return unit for workshop repair.

If low or zero, go to step 6.

Step 6 - Remove the transmitter from the plugboard and exchange the transmitter filter with a unit of the same type. Replace the complete transmitter on the plugboard. Note that the transmitter filter type reference identifies the particular channel frequency and only a filter of the same frequency will fit the plugboard. Measure the output on the line resistor.

If correct, original transmitter filter was faulty. Report fault and return unit for workshop repair. Go to step 7.

Step 7 - Recheck with original transmitter amplifier and new transmitter filter. Measure output on line resistor.

If correct, original transmitter amplifier was O.K. Return spare to stock.

If low or zero, original amplifier was faulty. Report and return unit for workshop repair. Replace with a good spare transmitter amplifier.

It may be an advantage to carry out the above routine using a separate test plugboard drilled to receive all pin codes. Such a plugboard should be wired with a 12 volt, smoothed, constant voltage d.c. supply on terminals D3 (+) and A3 and an output resistor, of 24 ohms, wired across terminals A1 and D2. A switch should be connected between A4 and D4. The switch should normally be closed for the above tests.

5.5.2 Checking a Transmitter Repeater Unit (T.R.U.)

Step 1 - Measure the output on the appropriate line resistor.

If correct, unit O.K.

If low or zero on all outputs, go to step 2.

Step 2 - Measure d.c. supply on terminals B3 (+) and A3.

If correct, go to step 3.

If low or zero, check mains supply and corresponding power supply unit.

Step 3 - Remove the t.r.u. from the plugboard and reinsert the same unit. Measure each output on corresponding line resistor. CAUTION: removal of the t.r.u. will affect all systems in which it operates.

If correct on all outputs, unit O.K., but examine and if necessary clean the plugboard contacts.

If low or zero on one or more outputs, go to step 4.

Step 4 - Remove the t.r.u. from the plugboard and measure the resistance between plugboard contacts A4 and A6, B4 and B6 or C4 and C6 as appropriate.

If <40 ohms, switching circuit correct: go to step 5.

If high, examine switching circuit.

Step 5 - Replace t.r.u. with another unit of the same type.
Check for correct outputs.
Report defective unit for workshop repair.

5.5.3 Checking a Receiver

Step 1 - Check, if possible, that the associated transmitter is providing the correct level of signal. Check that the line signal is present at terminals A4 and D4 on the receiver plugboard. If an immunising unit is fitted, check that the signal (at a correspondingly reduced level) is also present on terminals A3 and D4.

Step 2 - Measure the d.c. output to the follower relay on plugboard terminals A1 and D1.

If correct, unit O.K.

If low or zero, go to step 3.

If high (over 20 volts), check continuity of circuit to relay coil.

Step 3 - Remove the receiver from its plugboard and reinsert the same unit. Measure d.c. output to follower relay on the plugboard terminals again.

If correct, unit O.K., but examine and, if necessary, clean the plugboard contacts.

If low or zero, go to step 4.

If high (over 20 volts), proceed as in step 2.

Step 4 - Measure d.c. supply on plugboard terminals.

If correct go to step 5.

If low or zero, check power supply unit.

Step 5 - Remove filter and fit the test amplifier, if available, in place of the receiver amplifier and measure its output. If test amplifier is not available, go to step 6.

If correct, receiver amplifier was faulty. Fit a replacement amplifier, report fault and return unit for workshop repair.

If low or zero, filter may be faulty. Replace with a unit of the same type reference.
Measure the test amplifier output.

If now correct, original filter was faulty.
Report fault and return unit for workshop repair.

If still low or zero, check transmitter.

Step 6 - Remove receiver from plugboard, exchange the receiver amplifier with a unit of the same type and replace receiver on plugboard. Measure d.c. output to follower relay.

If correct, original receiver amplifier was faulty.
Report fault and return unit for workshop repair.

If low or zero, change the Reed filter with one of the appropriate type reference.

If now correct, the reed filter was faulty, go to step 7.
Report fault and return unit for workshop repair.

If still low or zero, check the transmitter.

If high (over 20 volts), proceed as in step 2.

Step 7 - Re-check with original receiver amplifier and the new filter. Measure d.c. output to follower relay on plugboard terminals.

If correct, original receiver amplifier was O.K. Return spare to stock.

If low or zero, original receiver amplifier was faulty. Replace with the spare receiver amplifier and report fault: send faulty unit for workshop repair.

If high (over 20 volts), proceed as in step 2.

5.5.4 Checking a Power Supply Unit

Step 1 - Measure d.c. output.

If correct, unit O.K.

If low or zero, go to step 2.

Step 2 - Measure a.c. input voltage.

If low or zero, check the 110 volt supply.

If correct, go to step 3.

Step 3 - Remove all connections from the output positive (+) terminal and again measure the output voltage.

If low or zero, fit new unit, and return faulty unit for repair.

If correct, there is a fault on an individual transmitter or receiver amplifier, restore the wiring: go to step 4.

Step 4 - Remove the amplifiers one by one whilst monitoring the power supply output voltage to determine the faulty item. Note that the power supply unit will not have been damaged if connected to a faulty amplifier.

5.5.5 Checking a Line Amplifier

Step 1 - Check whether an a.c. immunisation unit (see Section 2.10) is fitted to the amplifier.

If no, go to step 2.

If yes, short out the immunisation unit by connecting links between terminals 1 and 11, 6 and 16, 7 and 17 also 9 and 19. Check whether the fault has now cleared.

If yes, the immunisation unit is faulty and requires changing and returning for workshop repair.

If no, remove the links and go to step 2.

Step 2 - Check that the power supply (normally 24 volts) is present between terminals 10 and 11. Note that usually an a.c. supply is used but d.c. can also be used either as the normal supply or as a standby for a normal supply.

If yes, go to step 3.

If no, check the mains supply and fuses.

Step 3 - Measure the input from the line between terminals 1 and 6, and the amplifier input between terminals 2 and 6. Check that these two readings correspond, making allowance for the resistor or link connected between terminals 1 and 2.

If both are normal, go to step 4.

If the line signal (1 and 6) is normal and the input (2 and 6) low, the resistor requires replacing <u>WITH ONE OF THE SAME NOMINAL VALUE</u>.

If the line signal (1 and 6) is low go to step 6.

Step 4 - Measure the amplifier output between terminals 7 and 9, and check that it corresponds with the input reading between terminals 2 and 6: making allowance for the setting of the feedback link between terminal 6 and one of 5,4 and 3.

The approximate values of gain to be expected are:

link between terminals	gain
6 - 5 (100%)	1
6 - 4 (75%)	1.3
6 - 3 (50%)	1.9

If the readings correspond, the amplifier is O.K. and the fault lies elsewhere.

If the output is low or zero, go to step 5.

Step 5 - Remove outgoing leads from terminals 7 and 9 then measure line output voltage.

If it is normal, fault is not in the line amplifier. Restore line connections to terminals 7 and 9. Check the line section ahead and the next line amplifier.

If it is low or zero, change the line amplifier and go to step 7.

Step 6 - Remove the wires from terminals 1 and 6 and measure the input from the line between these wires.

If it is now normal, change the amplifier and go to step 7.

If it is still low or zero, the fault is probably in the preceding line section or previous line amplifier.

Step 7 - Check that the fault has now cleared. If it has not, go back to step 3.

5.5.6 The Effect of the Line Amplifier Lightning Protection Unit

In some instances, lightning protection (see Section 2.11 for details of the protection unit) is included in the line amplifier terminations. This unit includes a resistor connected in each line conductor at the input and output. The effect of the resistors on the input voltage is negligibly small, however some voltage drop will occur across the resistors in the output: this will depend upon the output line loading. If no receivers are connected, the drop will be small.

The incoming line terminates on the input to the lightning protection unit: terminals L1 and L6. The line amplifier input connects to terminals 1 and 6. The outgoing line terminates on the output of the lightning protection unit, L7 and L9, while the output of the line amplifier is taken from the amplifier terminals 7 and 9.

6 ORDERING INFORMATION

Contents of Section 6

6.1 Transmitter

The transmitter is described in Section 2.3.

6.1.1 Transmitter Amplifier (detachable top portion of composite unit).

Current type: RR 1002 (some units have blue coloured covers and others have black).

Special Note: this unit must NOT be inserted in a plugboard where terminals A2 and D2 are connected to the switching control circuit (for slow start operation).

Earlier Types: RR 1001 (high output only).
RR 1000 series (high output only).

Note: (1) both types are equipped with slow start facility,
(2) both types are incompatible with the sixteen channel vital system.

6.1.2 Transmitter Reed Filter

Table 1: a range of 16 transmitter filters for vital applications

TYPE REF.	CHANNEL No.	FREQ.Hz.	PLUGBOARDS	DRILLING
RR 4010	f401	817	RY1169 RW1169	EFGJL
RR 4020	f402	770	RY1171 RW1171	EFHJL
RR 4030	f403	765.25	RY1173 RW1173	EFJKL
RR 4040	f404	663	RY1175 RW1175	EGHKL
RR 4050	f405	624.5	RY1177 RW1177	EHJKL
RR 4060	f406	620.5	RY1211 RW1211	EFKMN
RR 4070	f407	568.75	RY1213 RW1213	EGHJN
RR 4080	f408	477.5	RY1215 RW1215	EGHLN
RR 4090	f409	473	RY1217 RW1217	EGJKN
RR 4100	f410	466.5	RY1249 RW1249	FGHLN
RR 4110	f411	462	RY1253 RW1253	FGJMN
RR 4120	f412	430.25	RY1223 RW1223	EHJKN
RR 4130	f413	425.75	RY1255 RW1255	FGKMN
RR 4140	f414	419.75	RY1153 RW1153	DGJLN
RR 4150	f415	414.75	RY1257 RW1257	FHJKN
RR 4160	f416	410.25	RY1155 RW1155	DGKLN

Table 2: a range of 8 transmitter filters which may be used with the above in the same system, but are suitable only for non-vital (e.g. monitoring) applications.

TYPE REF.	CHANNEL No.	FREQ.Hz.	PLUGBOARDS	DRILLING	
RR 1010	f1	879.5	RY1061 RW1061	DEGHL	*
RR 1920	f92	842	RY1243 RW1243	FHJKM	
RR 1880	f88	736.75	RY1235 RW1235	FGJKL	
RR 1180	f18	692	RY1095 RW1095	DFGLM	
RR 1200	f20	682.5	RY1099 RW1099	DFJKM	
RR 1860	f86	632	RY1231 RW1231	EJLMN	
RR 1270	f27	607.75	RY1113 RW1113	DEFHN	
RR 1840	f84	533.75	RY1227 RW1227	EHKMN	

* non-preferred channel

6.2 Receiver

The Receiver is described in Section 2.4.

6.2.1 Receiver Amplifier (detachable top portion of composite unit)

Current Type: RR 2003C fitted with radio suppression inductors and has revised circuit design.

Earlier Types: RR 2003B fitted with radio suppression "beads"; functionally compatible.

RR 2003 functionally compatible with later types, but is not immune to radio interference.

6.2.2 Receiver Filter (the lower portion of the composite unit)

The type reference depends upon the operating frequency of the reeds: for details see below.

Table 1. A range of 16 receiver filters for vital applications.

TYPE REF.	CHANNEL No	FREQ.Hz.	PLUGBOARDS	DRILLING
RR 7010	f401	817	RY1170 RW1170	EFGKL
RR 7020	f402	770	RY1172 RW1172	EFHKL
RR 7030	f403	765.25	RY1174 RW1174	EGHJL
RR 7040	f404	663	RY1176 RW1176	EGJKL
RR 7050	f405	624.5	RY1178 RW1178	EFGHM
RR 7060	f406	620.5	RY1212 RW1212	EFLMN
RR 7070	f407	568.75	RY1214 RW1214	EGHKN
RR 7080	f408	477.5	RY1216 RW1216	EGHMN
RR 7090	f409	473	RY1218 RW1218	EGJLN
RR 7100	f410	466.5	RY1250 RW1250	FGHMN
RR 7110	f411	462	RY1254 RW1254	FGKLN
RR 7120	f412	430.25	RY1224 RW1224	EHJLN
RR 7130	f413	425.75	RY1256 RW1256	FGLMN
RR 7140	f414	419.75	RY1154 RW1154	DGJMN
RR 7150	f415	414.75	RY1258 RW1258	FHJLN
RR 7160	f416	410.25	RY1156 RW1156	DGKMN

Table 2. A range of 8 receiver filters which may be used with the above in the same system, but are suitable only for non-vital (e.g. monitoring) applications.

TYPE REF.	CHANNEL No.	FREQ.Hz.	PLUGBOARDS	DRILLING
RR 2010	f1	879.5	RY1062 RW1062	DEGJL *
RR 2920	f92	842	RY1244 RW1244	FHJLM
RR 2880	f88	736.75	RY1236 RW1236	FHJKL
RR 2180	f18	692	RY1096 RW1096	DFHJM
RR 2200	f20	682.5	RY1100 RW1100	DFJLM
RR 2860	f86	632	RY1232 RW1232	EKLMN
RR 2270	f27	607.75	RY1114 RW1114	DEFJN
RR 2840	f84	533.75	RY1228 RW1228	EHLMN

* non-preferred channel

6.4 Transmitter Repeater Unit

The transmitter repeater unit is described in Section 2.5.

Current type: RR 1990.

6.5 Line Amplifier

The line amplifier is described in Section 2.6.

Current types: RR 8102A (with standard connector comb).
RR 8112 (without comb for use with surge suppressor unit type RR 8412).

Earlier types: RR 8102, RR 8101 and RR8100.

Note: Provided the connections made to the amplifier are as the current type, the earlier versions are compatible; but there is no internal surge suppression.

6.6 Line Amplifier Supply Transformer

The line amplifier supply transformer is described in section 2.7.

Current type: RR 9211.

Earlier type: RR 9210 had additional 20 volt tapping but is otherwise compatible.

6.7 Line Isolating Transformer

The line isolating transformer is described in section 2.8.

Current type: RR 8232.

Earlier type: RR 8200 had non-linear frequency response and is not interchangeable.

6.8 Reed Follower Relay

The Reed Follower Relay is described in section 2.8.

Current type: ZS 2411.

Plugboard: RY 0133 or RW 0133.

Earlier type: 32M10 requires special wiring, see section 2.8.

6.9 Reed Power Supply Units

The Reed power supply units are described in section 2.9.

Current types: RR 9121 600mA rating (occupies two spaces).
RR 9131 5 Amp rating (occupies three spaces).

Earlier types: RR 9110 100mA rating (occupies one space).
RR 9120 600mA rating (occupies one space).
RR 9130 5 Amp rating (occupies three spaces).

Note: these earlier types may be used as replacements where the rating is suitable for the load.

Note: RR 9122 does not supersede RR 9121 and must not be used on vital Reed applications.

6.10 Immunisation Units

The immunisation units are described in section 2.10.

6.10.1 Immunisation Units for Receivers

Current types: RR 8510 for receiver filters with type reference numbers in the range RR 7010 - RR 7070: colour code green.
RR 8520 for receiver filters with type reference numbers in the range RR 7080 - RR 7160: colour code brown.
RR 8530 for use in small systems where all receiver filter type reference numbers are in the range RR 7040 - RR 7110: colour code white.

6.10.2 Immunisation Unit for Line Amplifier

Current type: RR 8601.

6.11 Surge Protection Units

Surge (lightning) protection units are described in section 2.11.

6.11.1 Surge protection units for line amplifiers:

6.11.1.1 Where no immunisation unit is fitted

Current type: RR 8412 replaces standard comb connector on type RR 8102A line amplifier or attaches directly to type RR 8112 line amplifier.

6.11.1.2 Where an immunisation unit is fitted

Current type: RR 8421 attaches to relay mounting frame.

6.11.2 Surge protection unit for receivers

Current type: RR 8431 used where there is no line amplifier and attaches to relay mounting frame.

6.12 Outline drawings

Outline drawings of all the above items of equipment are given in Figures 6.12-1 to 6.12-12.

6.13 Test Unit

The test unit is not part of the system.
It is used in conjunction with a transistorised voltmeter to measure the output of a channel receiver filter.
Its use is described in section 4.2.2.4.

Current type: XV 1018.

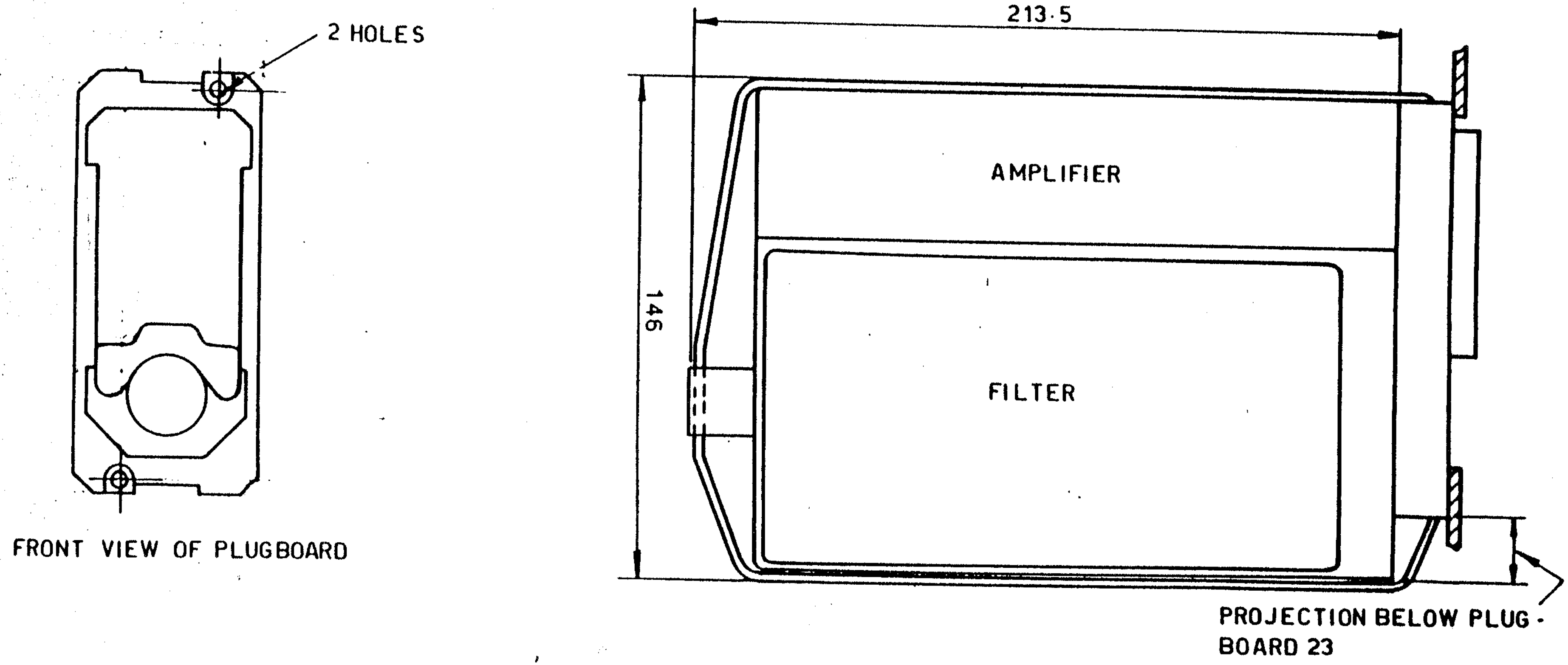


Figure 6.12-1 Outline of Reed Filter and Amplifier

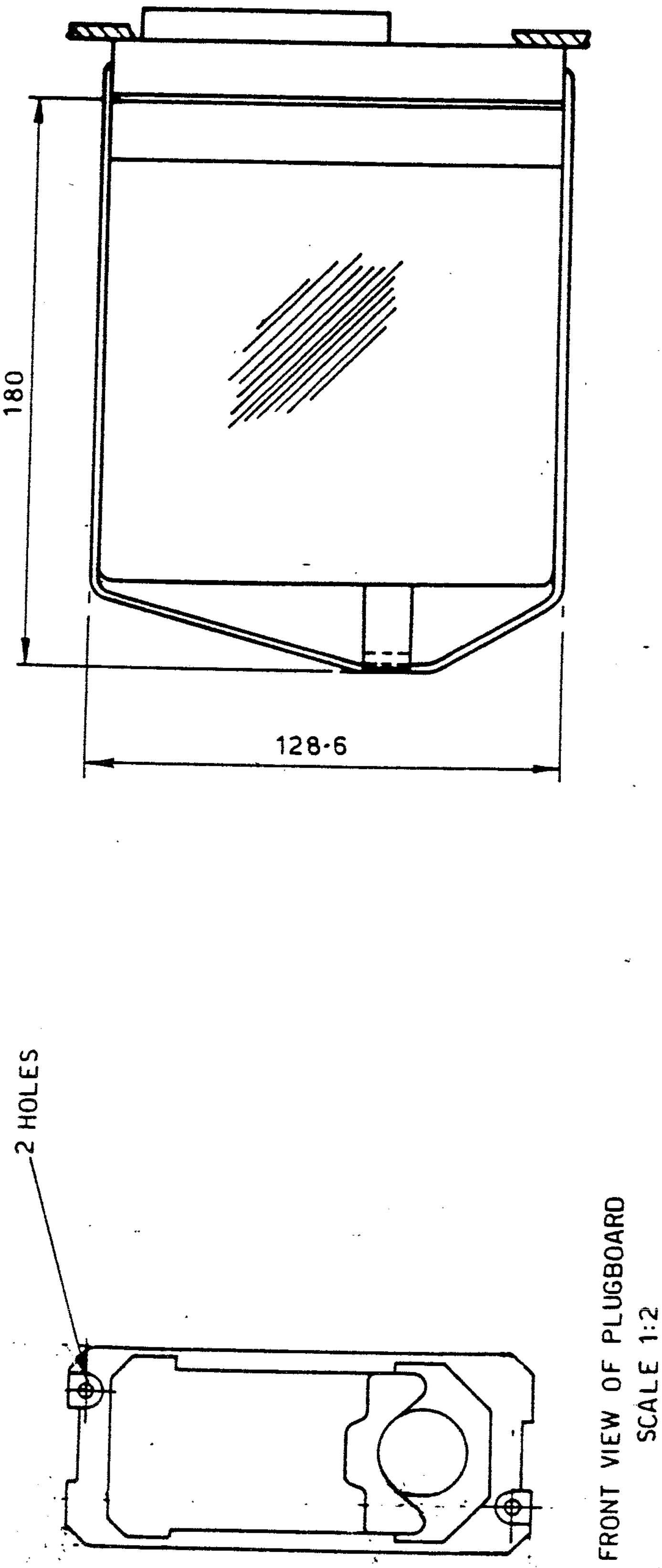


Figure 6·12·2 Outline of Transmitter Repeater Unit and Reed Follower Relay

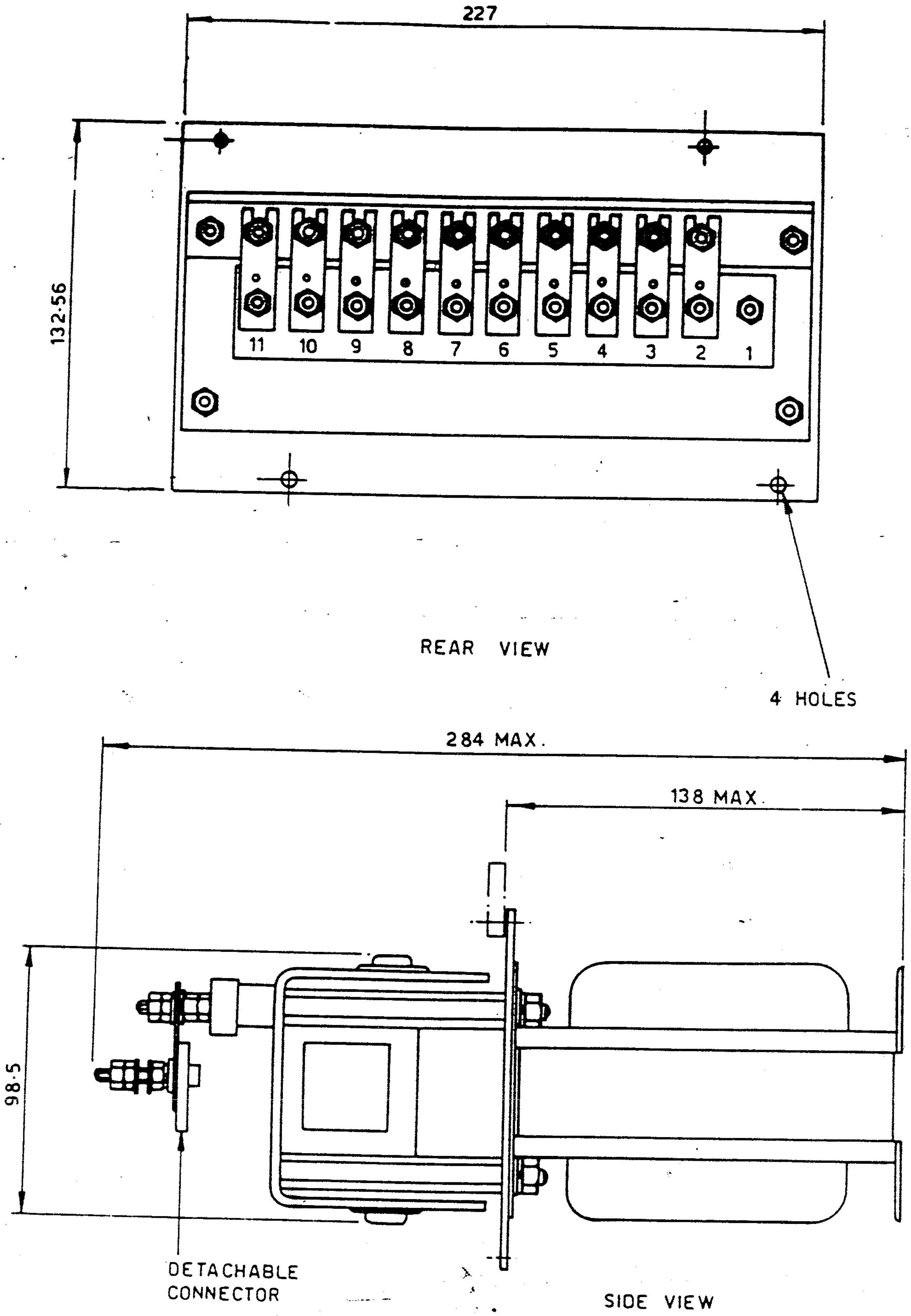


Figure 6·12-3 Outline of Line Amplifier

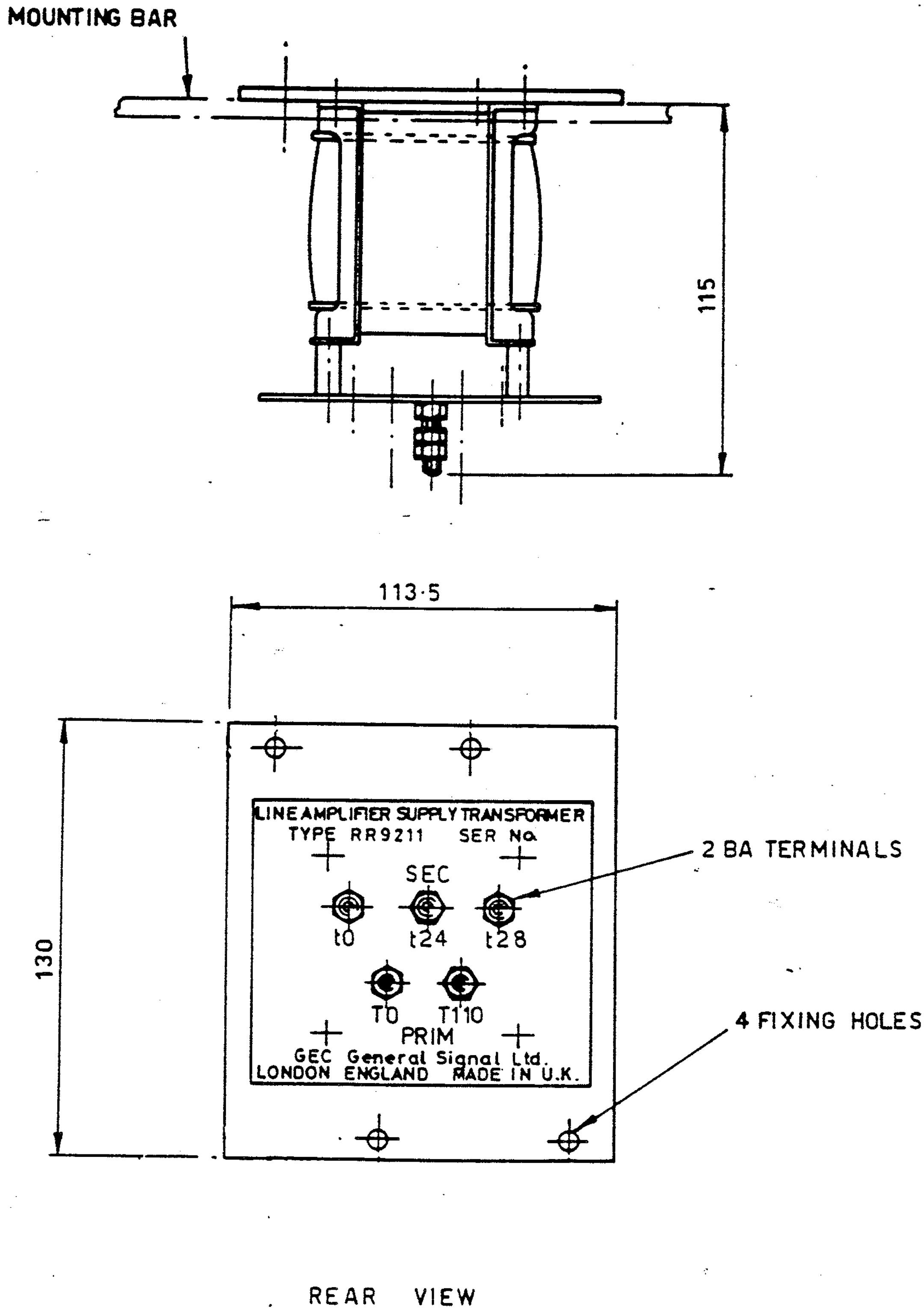


Figure 6·12·4 Outline of Line Amplifier Supply Transformer.

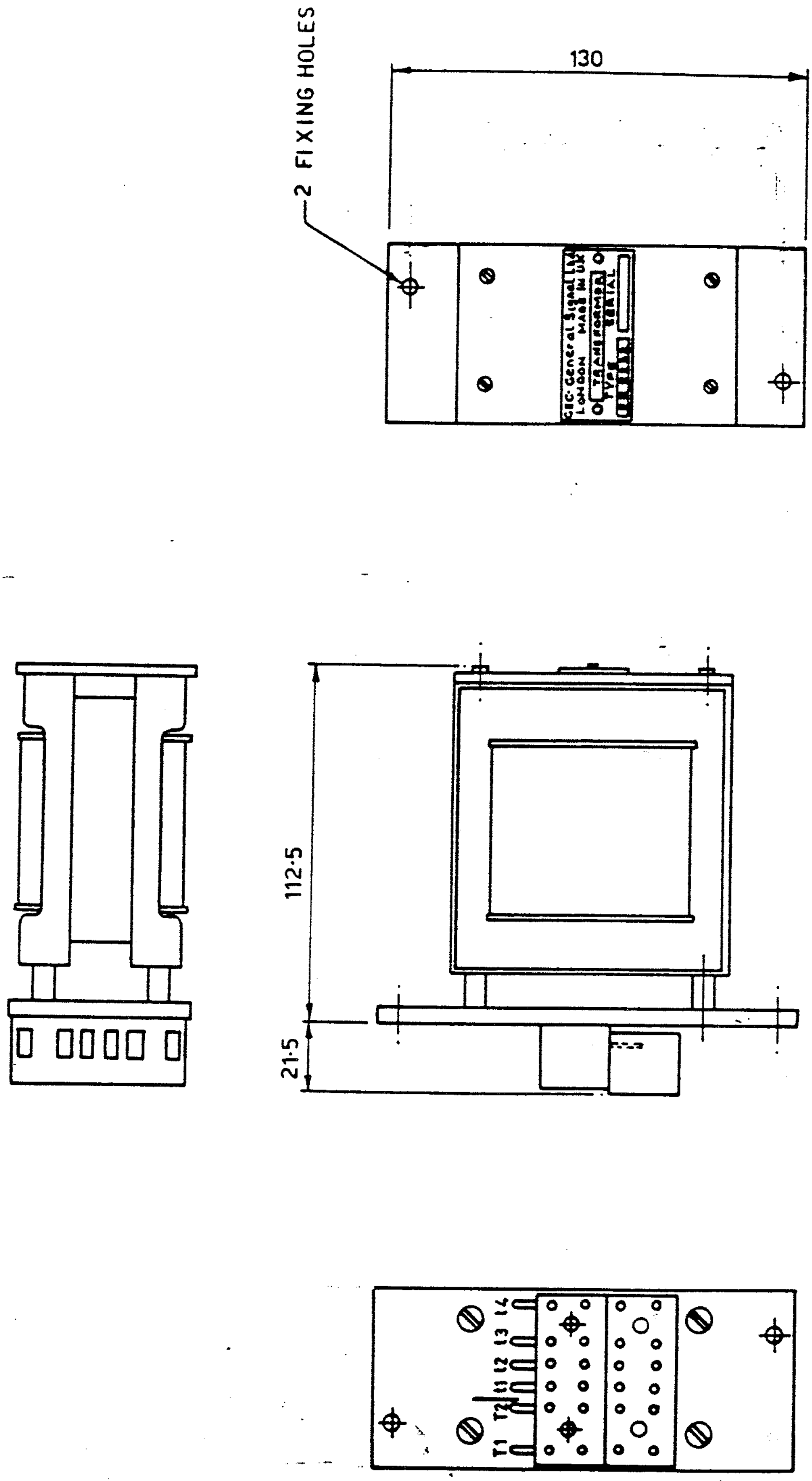


Figure 6·12·5 Outline of Line Isolating Transfomer.

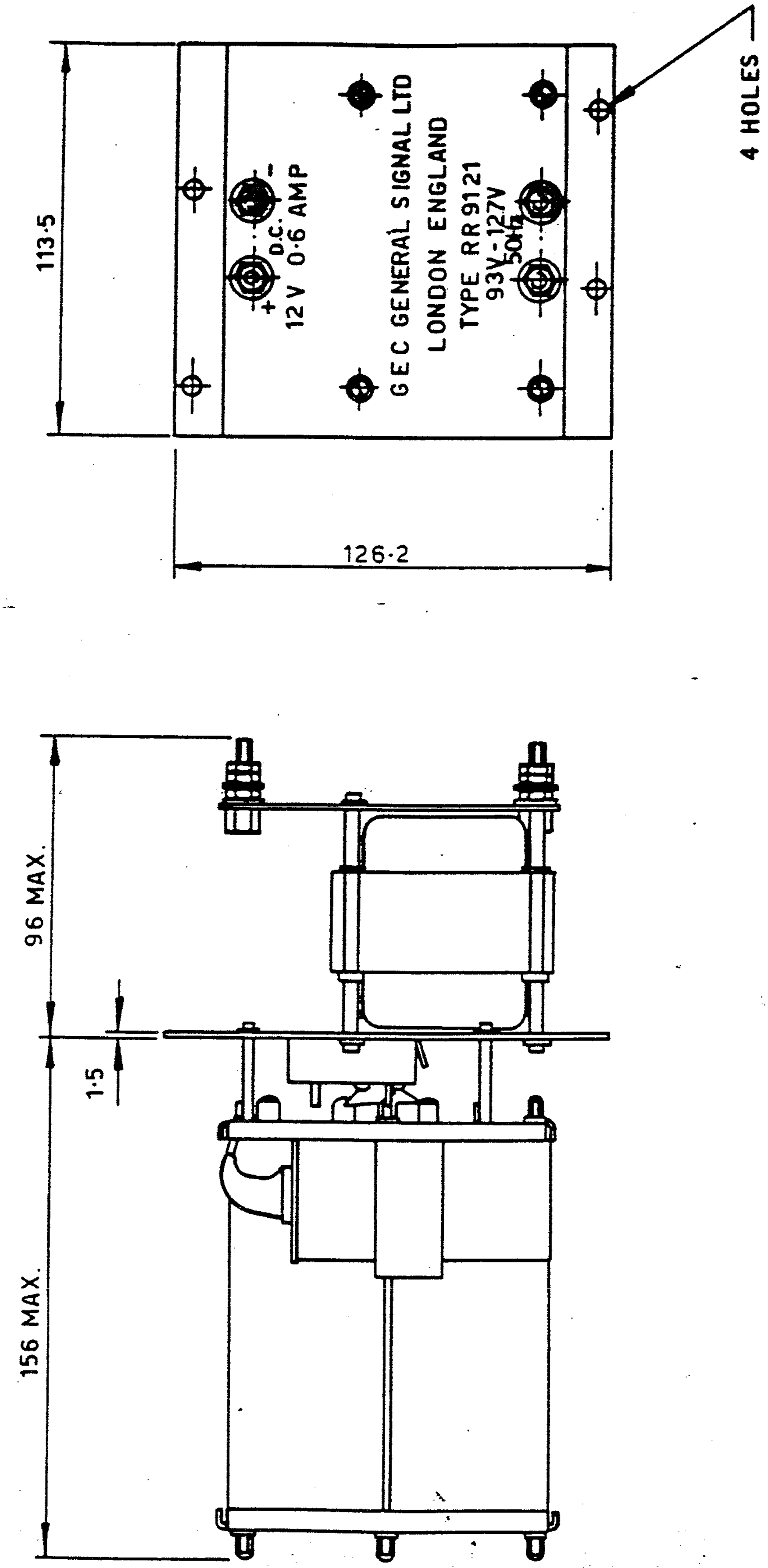


Figure 6·12·6 Outline of 0·6 Amp Reed Power Supply Unit.

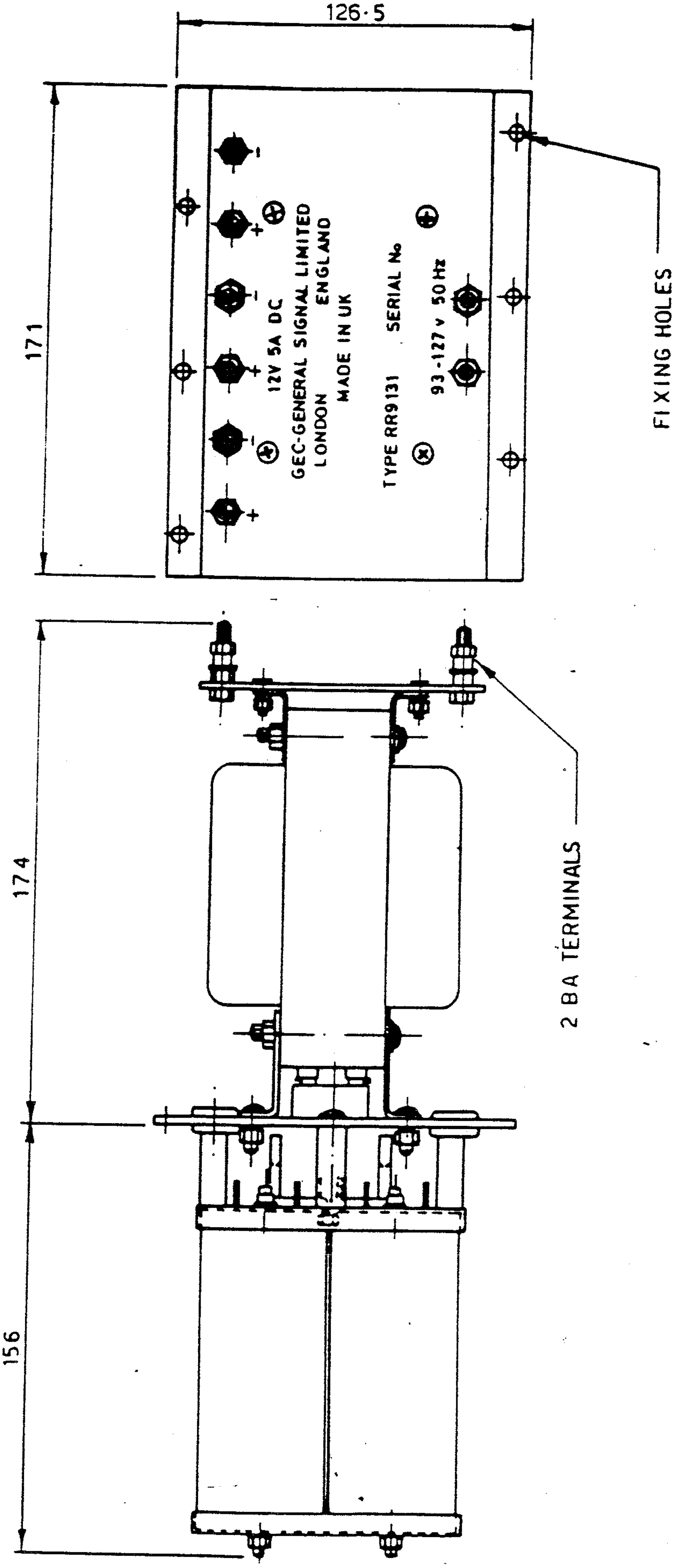


Figure 6·12·7 Outline of 5 Amp Reed Power Supply Unit.

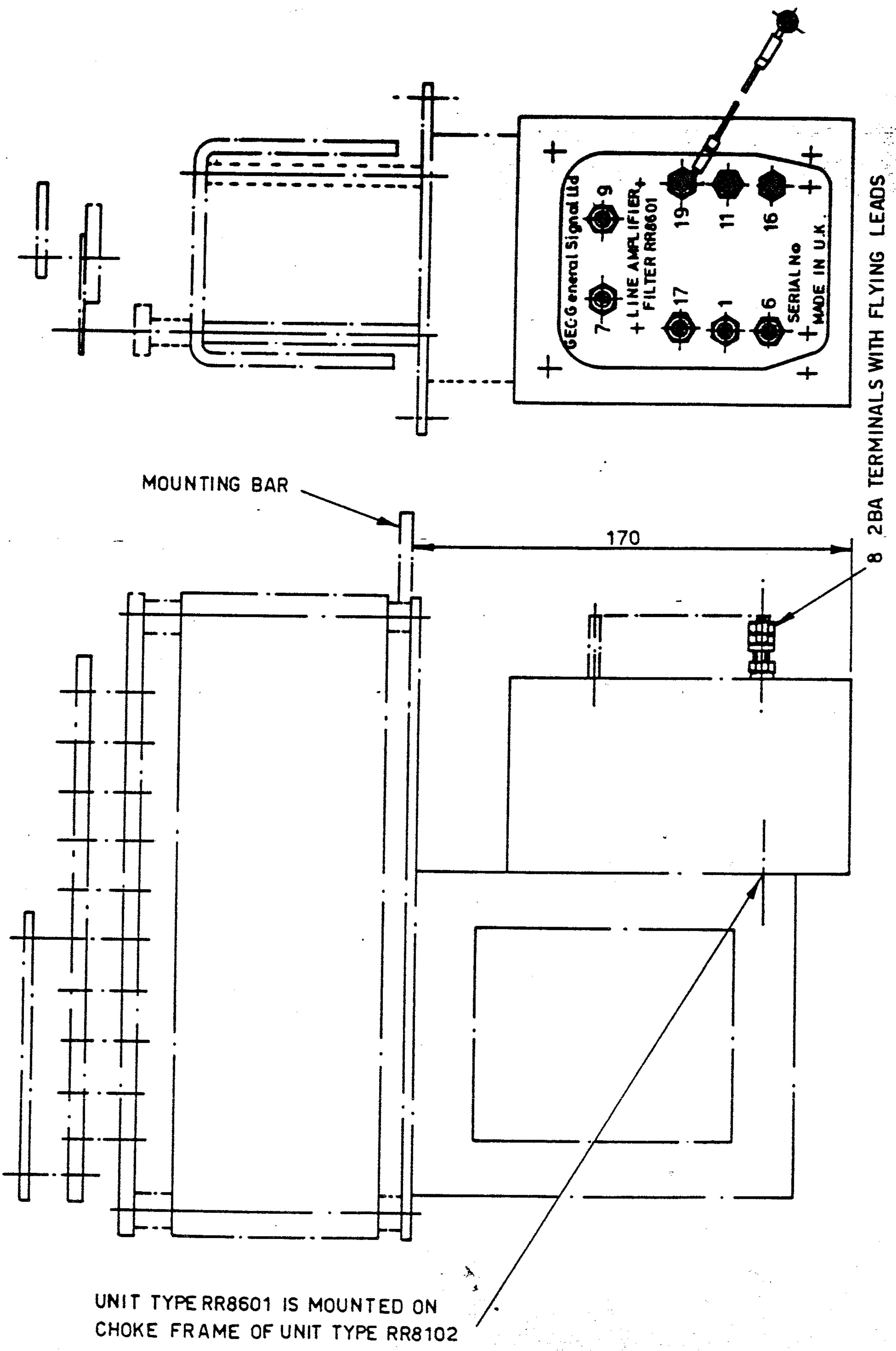
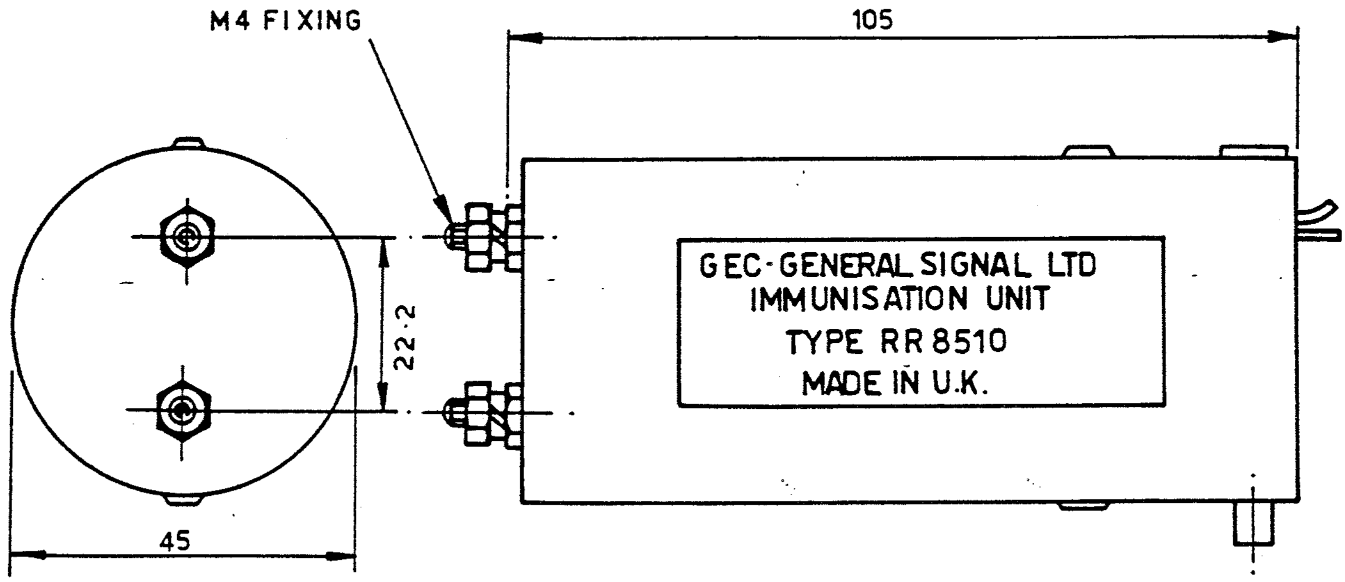


Figure 6·12·8 Outline and Attachment of Line Amplifier Immunisation Unit.



TYPE RR 8510: COLOUR OF CASE - GREEN
TYPE RR 8520: COLOUR OF CASE - BROWN
TYPE RR 8530 COLOUR OF CASE - WHITE

Figure 6·12·9 Outline of Receiver Immunisation Unit

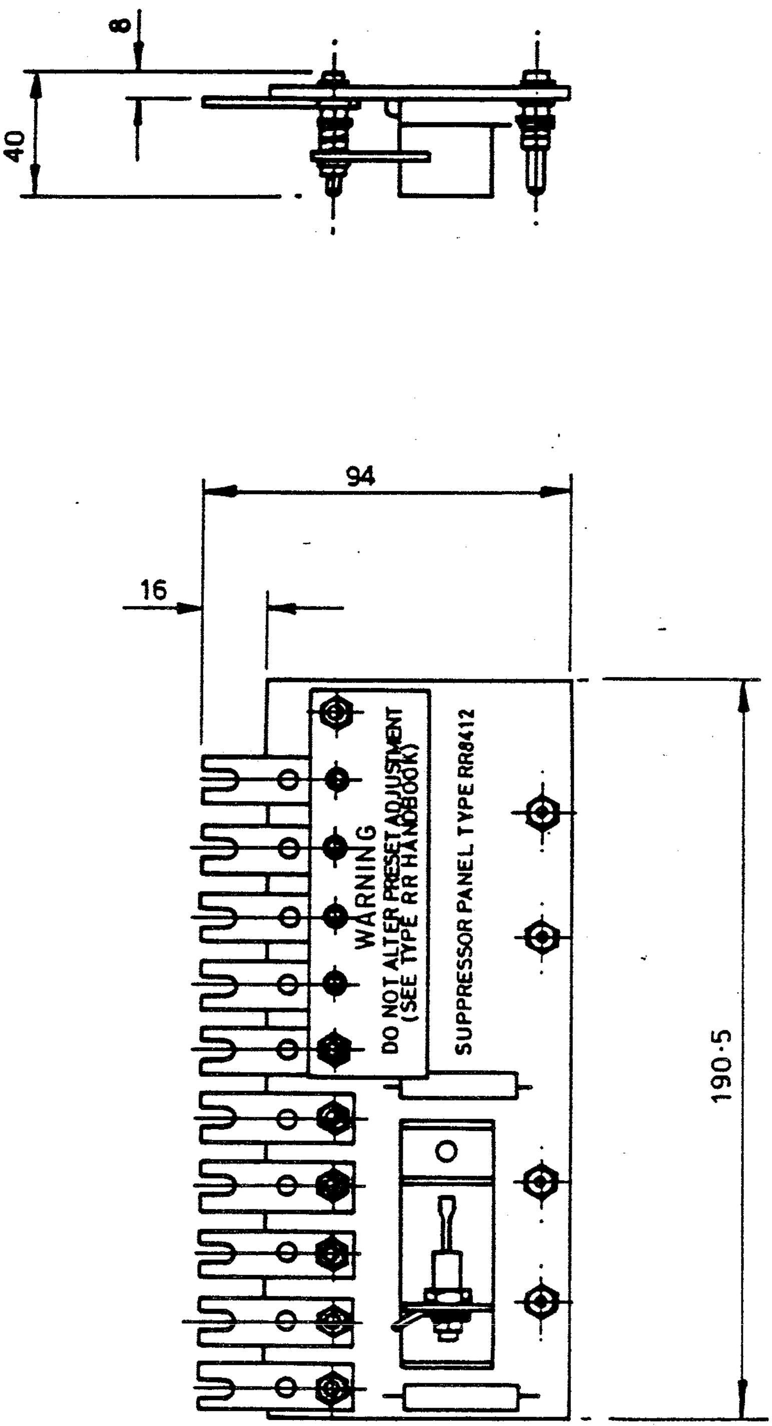


Figure 6·12-10 Outline of Line Amplifier Surge Suppressor Unit (Comb Type)

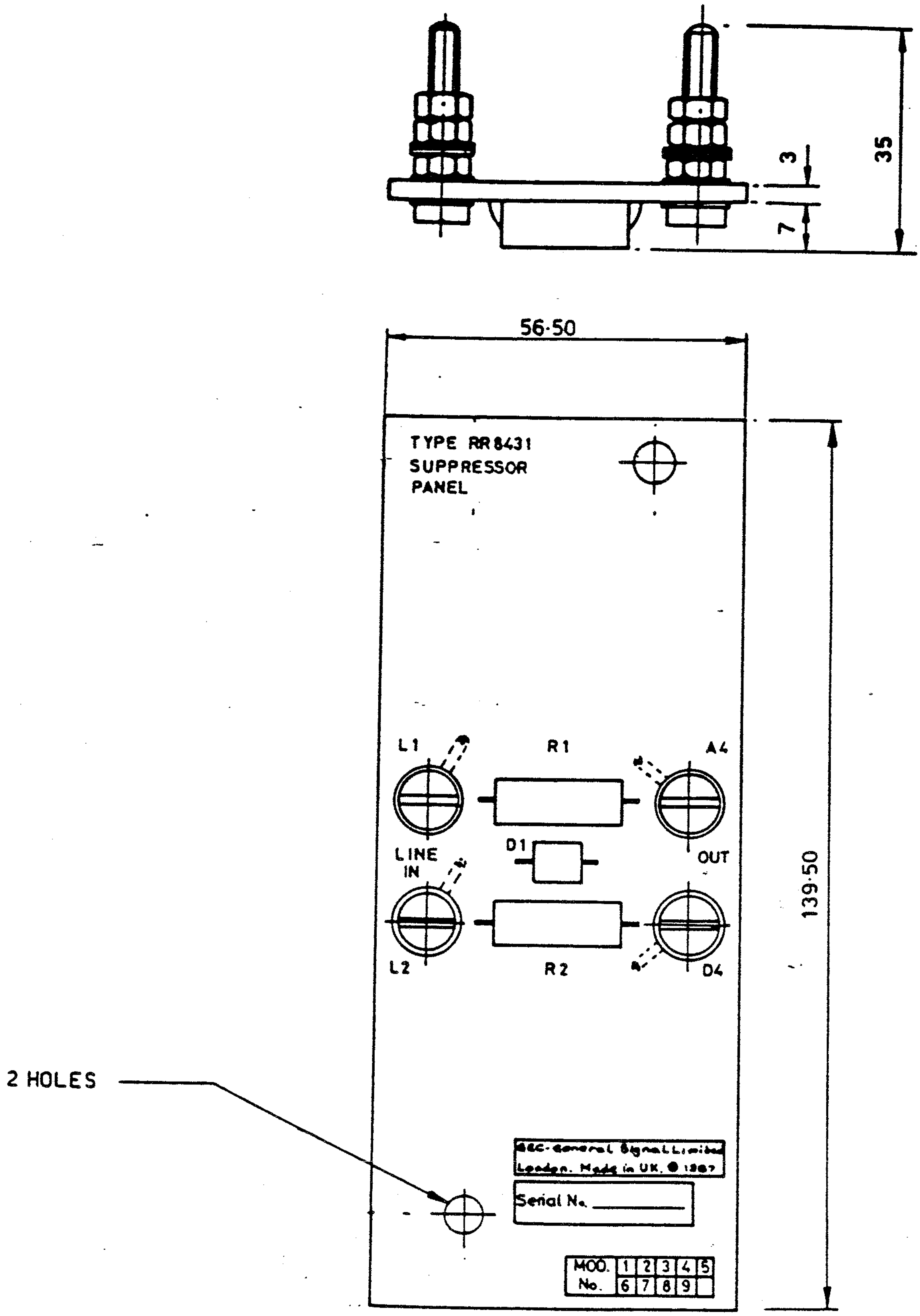


Figure 6-12-11 Outline of Line Amplifier Surge Suppressor Unit (Relay Frame Mounted Type)

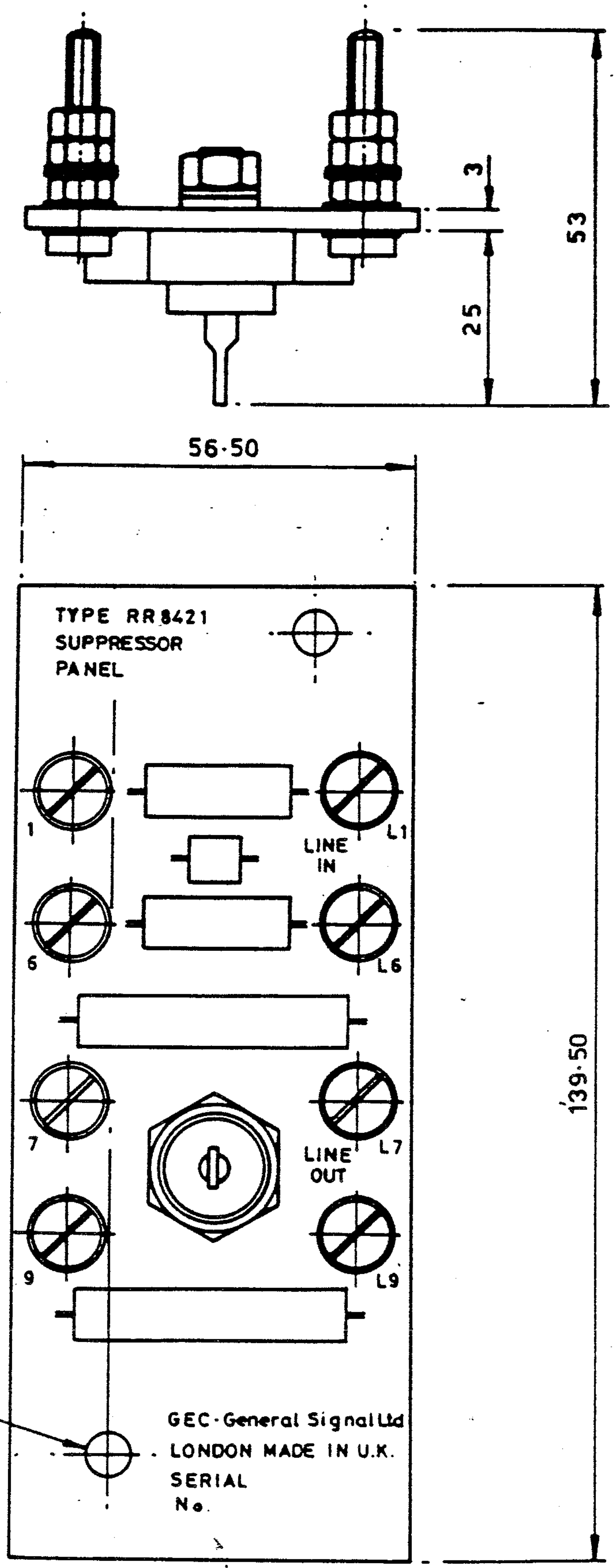


Figure 6·12·12 Outline of Receiver Surge Suppressor Unit