

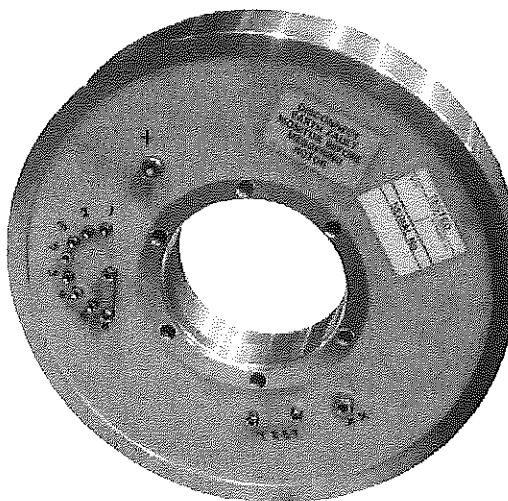
Part Number S960459700

**BRUSH**



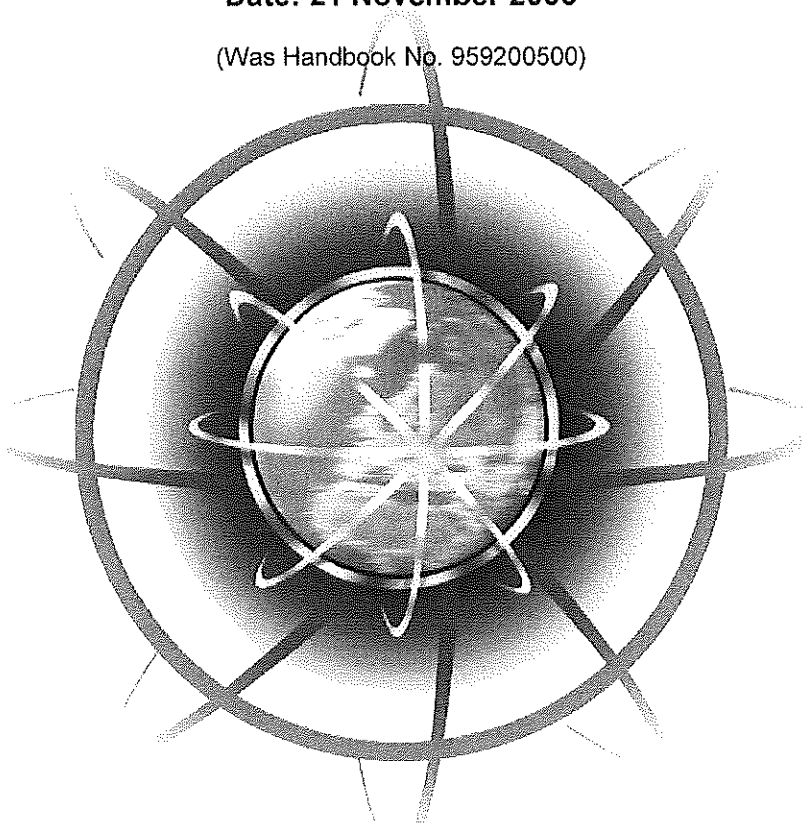
## Instruction Manual

### ROTOR EARTH FAULT MONITOR (RADIO FREQUENCY TYPE)



Manual No: TP0000006 Issue: D  
Date: 21 November 2006

(Was Handbook No. 959200500)



**Brush Electrical Machines Ltd.**

PO Box 18, Loughborough, Leicestershire, LE11 1HJ, England  
Telephone: +44 (1509) 611511 Telefax: +44 (1509) 610440  
E-Mail: [sales@bem.fki-et.com](mailto:sales@bem.fki-et.com) Web Site: <http://www.fki-et.com/bem>

**CONTENTS**

<b>1</b>	<b>INTRODUCTION TO MANUAL</b>	<b>3</b>
1.1	General	3
1.2	How To Use The Manual	3
1.3	Copies	4
1.4	Feedback	4
1.5	Service & Spares	4
1.6	Contact Address	4
1.7	Health & Safety At Work Act (1974)	4
1.8	Protection And Monitoring Devices	5
<b>2</b>	<b>GENERAL</b>	<b>6</b>
2.1	Introduction	6
2.2	Description	6
<b>3</b>	<b>SPECIFICATION</b>	<b>8</b>
<b>4</b>	<b>INSTALLATION</b>	<b>10</b>
4.1	Electrical Connections	10
4.2	Aerial Cable	10
<b>5</b>	<b>COMMISSIONING</b>	<b>11</b>
5.1	General	11
5.2	Meggering	11
5.3	Check Installation	11
5.3.1	Connections	11
5.3.2	Co-Axial Screened Cable	11
5.4	Receiver	12
5.4.1	Supply	12
5.4.2	Operating Frequency	12
5.5	Commissioning Tests	12
<b>6</b>	<b>FAULT FINDING</b>	<b>14</b>
6.1	General	14
6.2	Fault Finding Table	14
6.3	Static Testing	16
6.3.1	General	16
6.3.2	Static Testing With Transmitter On The Shaft	16
6.3.3	Static Testing With Transmitter And Aerial On Bench	17
<b>7</b>	<b>PERIODIC TESTING</b>	<b>18</b>
<b>8</b>	<b>ELECTRICAL CONNECTIONS</b>	<b>19</b>
<b>9</b>	<b>RECEIVER SALIENT FEATURES</b>	<b>20</b>
<b>10</b>	<b>DRAWINGS</b>	<b>21</b>

**1 INTRODUCTION TO MANUAL****1.1 General**

The purpose of this manual is to provide information and advice on supplied equipment.

Warning symbols used in the manual are as follows:



Mandatory Notice - Instruction to be followed.



Danger, General - Caution to be exercised. Appropriate safety measures to be taken.



Danger, Electricity - Caution to be exercised. Appropriate safety measures to be taken.



Danger, Harmful or Irritating - Caution to be exercised. Appropriate safety measures to be taken.

Information is given for guidance only. We do not accept any responsibility for the manner in which the information is used, nor the consequences thereof.

The design and manufacture of equipment is subject to constant review and as a result the information provided herein may vary from that manufactured.

Verbal or written modifications to the information contained herein have no legal status unless confirmed in writing by the Technical Director or his nominated deputy.

The manual, and any amendments, should be maintained for the lifetime of the equipment.



It is important that any persons responsible for equipment installation, commissioning, operation and maintenance, are provided with access to this manual.

**1.2 How To Use The Manual**

Prior to undertaking any installation, commissioning, operation or maintenance activities on the equipment, it is recommended that this manual, and any associated documentation, should be read in their entirety in order to gain an understanding of system operation.

The manual is written as a 'stand-alone' document, but should be read in conjunction with any referenced or associated documentation.

All pages and topic headings are numbered for easy reference. Cross-reference(s) to associated paragraphs and documentation is included where appropriate. When referencing particular paragraphs in communications, it is important to specify the Manual Number and the Issue Reference.

Referenced drawings are attached as additional (unnumbered) pages.

**1.3**     **Copies**

Additional copies of the latest available version of manuals can be obtained from our Service Department at the contact address given hereafter. A nominal charge may be made for this service.

The information provided remains the copyright of *Brush Electrical Machines Ltd.*, and is not to be copied or disclosed to a third party without the written approval of the Technical Director at the contact address given hereafter.

**1.4**     **Feedback**

We are constantly seeking to improve the quality and reliability of our products, and we actively encourage user feedback.

Any comments should be addressed to your usual representative, or to our Service Department at the contact address given hereafter.

**1.5**     **Service & Spares**

Quotations for Service and Spares can be obtained from our Service Department at the contact address given hereafter.

Authorised users can also access spare parts information provided at the Web Site address given hereafter.

**1.6**     **Contact Address**

Brush Electrical Machines Ltd.  
PO Box 18  
Loughborough  
Leicestershire  
LE11 1HJ  
England

Telephone:    +44 (1509) 611511 (Switchboard)  
Telefax:       +44 (1509) 612436 (Service Department)

E-Mail:        [service.sales@bem.fki-et.com](mailto:service.sales@bem.fki-et.com)  
                    [spares.sales@bem.fki-et.com](mailto:spares.sales@bem.fki-et.com)

Web Site:      <http://www.fki-et.com/bem>

**1.7**     **Health & Safety At Work Act (1974)**

The information hereunder is supplied in accordance with Section 6 of the United Kingdom Health and Safety at Work Act 1974 with respect to the duties of manufacturers, designers and installers in providing health and safety information to Customers. The information advises of reasonably foreseeable risks involved with the safe installation, commissioning, operation, maintenance, dismantling, cleaning or repair of products supplied by *Brush Electrical Machines Ltd.*

Every precaution should be taken to minimise risk. When acted upon, the following precautions should considerably minimise the possibility of hazardous incidents.

**Delivery Checks:** Check for damage sustained during transport. Damage to packing cases must be investigated in the presence of an Insurance Surveyor.

**Installation:** Where installation is made by engineers other than *Brush Electrical Machines Ltd.* personnel, the equipment should be installed by suitably qualified personnel in accordance with relevant legislation, regulations and accepted rules of the industry. In particular, the recommendations contained in the regulations with regard to the earthing (grounding) must be rigorously followed.

**Electrical Installation:**

IMPROPER USE OF ELECTRICAL EQUIPMENT IS HAZARDOUS.

It is important to be aware that control unit terminals and components may be live to line and supply voltages.

Before working on a unit, switch off and isolate it and all other equipment within the confines of the same control cubicle. Check that all earth connections are sound.

**WARNING:** Suitable signs should be prominently displayed, particularly on switches and isolators, and the necessary precautions taken to ensure that power is not inadvertently switched on to the equipment whilst work is in progress, or is not yet completed.

Adjustment and fault finding on live equipment must be by qualified and authorised personnel only, and should be in accordance with the following rules:

- Read the Instruction Manual.
- Use insulated meter probes.
- Use an insulated screwdriver for potentiometer adjustment where a knob is not provided.
- Wear non-conducting footwear.
- Do not attempt to modify wiring.
- Replace all protective covers, guards, etc. on completion.

**Operation & Maintenance:** Engineers responsible for operation and maintenance of equipment supplied under this contract should familiarise themselves with the information contained in this manual and with the recommendations given by manufacturers of associated equipment. They should be familiar also with the relevant regulations in force.

- It is essential that all covers are in place and that all guards and/or safety fences to protect any exposed surfaces and/or pits are fitted before the machine is started.
- All adjustments to the machine must be carried out whilst the machine is stationary and isolated from all electrical supplies. Replace all covers and/or safety fences before restarting the machine.
- When maintenance is being carried out, suitable WARNING signs should be prominently displayed and the necessary precautions taken to ensure power is not inadvertently switched on to the equipment whilst work is in progress, or is not yet complete.
- When power is restored to the equipment, personnel should not be allowed to work on auxiliary circuits, eg. Heaters, temperature detectors, current transformers etc.

**1.8****Protection And Monitoring Devices**

**WARNING:** It is essential that any protection or monitoring device for use with generators or ancillary equipment should be connected and operational at all times unless specifically stated otherwise herein. It should **not** be assumed that all necessary protection and monitoring devices are supplied as part of *Brush Electrical Machines Ltd.* scope of supply.

Unless otherwise agreed, it is the responsibility of others to verify the correct operation of all protection and monitoring equipment, whether supplied by *Brush Electrical Machines Ltd.* or not. It is necessary to provide a secure environment that ensures operator safety and limits potential damage to the generator and ancillary equipment. If requested, *Brush Electrical Machines Ltd.* would be pleased to provide advice on any specific protection application issues or concerns.

## 2 GENERAL

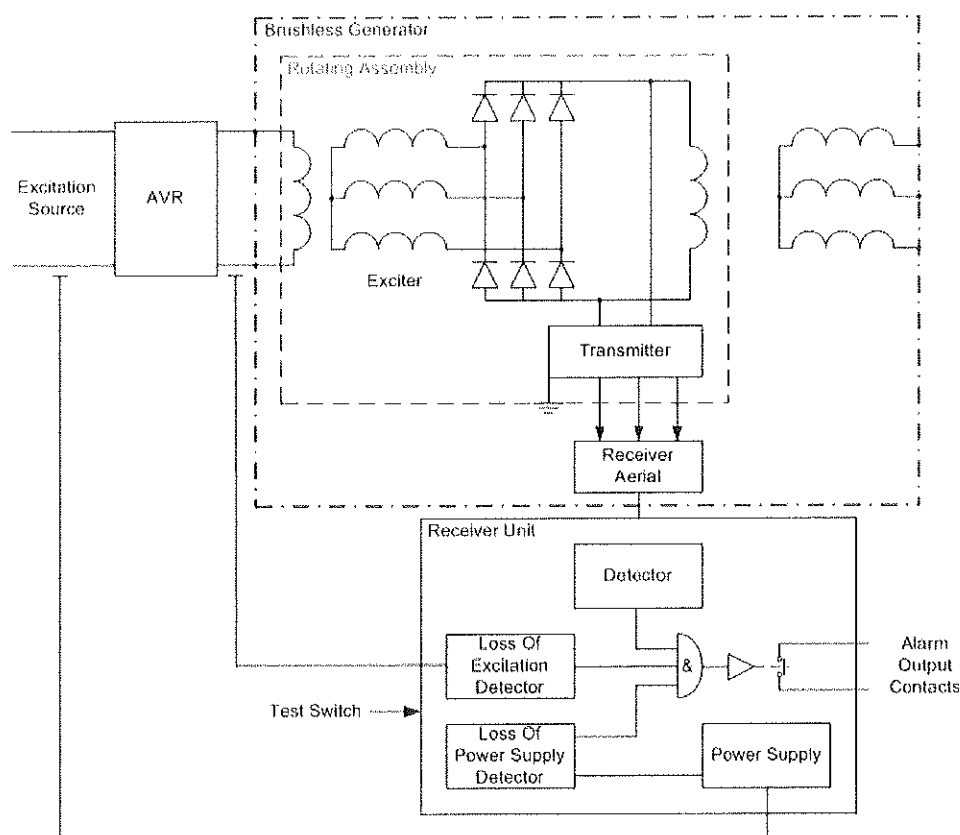
### 2.1 Introduction

General practice in brushless generators is for the rotor field circuit to be fully isolated so that a single earth fault does not cause adverse operating conditions. However, a second earth fault requires the immediate shutdown of the set.

To avoid this occurrence it has been the practice in the past to detect a single rotor earth fault by use of brushes and sensitive earth fault current relays and to take the machine out of service for investigation and repair of the fault at the earliest opportunity.

The *Brush* Rotor Earth Fault Monitor (REFM) dispenses with the need for brushes by using fully static techniques to detect a single rotor earth fault on the shaft and transmit the information to a stationary receiver, thereby giving enhanced reliability and reduced maintenance costs.

### 2.2 Description



**Figure 1: Block Diagram**

Figure 1 shows the basic system.

The transmitter has 3 electrical connections to the rotor; to earth, rotor positive (F1) and rotor negative (F2). The rotor voltage provides the power supply for the unit, from which it generates its own isolated dc source that is used as the earth fault detection supply. The negative of this isolated source is connected to earth (ground), and the positive is connected to the rotor negative (F2). During healthy conditions the current flowing from the isolated dc source is negligible and the transmitter produces a high frequency signal that is detected by the receiver aerial and the receiver indicates no fault.

Any earth fault on the rotating assembly, either on the armature or the rotor winding, will cause a current to flow from the dc source. This current is detected and used to remove the transmitted high frequency signal. By removing the signal, the detection system becomes 'fail-to-safe' in that a loss of transmitted signal is detected as an earth fault condition.

The transmitted signal is sensed by an aerial and is fed, via screened cable and amplifier, into a 'phase locked loop' within the receiver. This device locks onto the transmitted signal and serves to decode the pulse signal as well as filter out any background noise caused by external sources. The decoded signal is used to hold off the output alarm relay after an amplification and time delay stage. In the event of an earth fault condition the alarm relay becomes energised after a short time delay (incorporated to suppress 'nuisance' alarms) thereby giving external indication of the fault condition.

The auxiliary supply required by the receiver for its power supplies is normally provided by the AVR excitation source (usually a permanent magnet generator - PMG). During run up on AVR over flux control or during normal off load transients, the available rotor voltage may be too low to ensure correct transmitter operation. To overcome this, a circuit is incorporated in the receiver to inhibit output relay energisation on either low exciter field voltage or low auxiliary ac supply voltage. A time delay stage within this circuit allows for the rotor voltage to build up prior to giving a permissive output.

**3 SPECIFICATION****(a) Earth Fault Detection Sensitivity**

The fault resistance detected by the unit depends on the position of the fault and the rotor voltage.

The system is least sensitive when the fault is present on the negative of the field and in this case the sensitivity is approximately 15k $\Omega$ .

On a machine with a full load rotor voltage of 250V, the sensitivity to a fault on the positive of the field would be approximately 85k $\Omega$

Fault sensing current: Approximately 1.8mA

Time delay on operation: 1s

**(b) Output Relay Rating**

200VA or 100W (Non Inductive) maximum 5A or 250V

**(c) Receiver Auxiliary Supply**

110V, 220V or 400V,  $\pm 25\%$  - 50Hz to 500Hz, Burden 6VA

**(d) Transmitter Supply (Rotor Voltage)**

Tap	Max Continuous Voltage	Max 10 Seconds Overload Voltage	Min Guaranteed Operating Voltage
1	90	180	20
2	130	260	25
3	165	330	28
4	200	400	31
5	240	480	37
6	275	550	41
7	310	620	45
8	350	700	50

**Note:** The tap selected should correspond to full load, rated pf, hot, rotor voltage.

**(e) Temperature**

Operating: -25°C to +85°C

Storage: -40°C to +100°C

**(f) Low Exciter Field Voltage Inhibit**

Adjustment of the exciter field voltage inhibit is from 3.0V to 25V. Unless the field exceeds this voltage the output alarm is inhibited. On build up of exciter field voltage above the preset level there is a time delay of 3 to 4 seconds before the inhibit is released.

If the exciter field voltage falls below the preset level the inhibit will be applied instantaneously.

The maximum continuous exciter field voltage at this input is 400V dc.

**(g) Loss Of Auxiliary Supply**

The output relay will be inhibited when the supply falls below 75% of the nominal transformer tap rating.

**(h) Distance Between Receiver & Transmitter**

Screened cable capacitance must not exceed 10,000pF total.

**(i) Distance Between Transmitter & Receiver Aerial**

100mm maximum



**(j) Test Facility**

Operation of an external test pushbutton when the machine is running and excited will simulate an earth fault and produce an alarm signal.

**(k) Indication Of Circuit Conditions**

LED1 ON - Low Auxiliary supply inhibit is released.

LED2 ON - Low Exciter field voltage inhibit is released.

LED3 ON - Earth fault condition.

LED4 ON - Auxiliary supply is present.

**4**      **INSTALLATION****4.1**      **Electrical Connections**

The equipment should be wired in accordance with Section 8 - Electrical Connections.

Note that on the later design 961509500 (boxed version) the terminal arrangement is slightly different to the earlier version 960461800 in the following respects:

- (1) Two output relay contacts, 1 - normally open (terminals 7 and 13) and 1 normally closed (terminals 6 & 8) are provided on the later design

To convert to changeover configuration provided on earlier design link terminals 6 and 1.

- (2) On the earlier design, the exciter field voltage negative connection is commoned to the aerial common connection

The later design incorporates an opto-isolator to prevent any voltage that may be present on the exciter field with respect to earth being imposed on the aerial.

Please note that the exciter field should be connected between terminals 5 (+ve) and 15 (-ve) to take advantage of the isolation.

**4.2**      **Aerial Cable**

Single core screened cable fitted with outer sheath is required to connect the aerial to the receiver.

The BNC connector that plugs into the aerial will accept screened cable up to 5.8mm diameter.

The total capacitance of the cable must not exceed 10,000pF (0.01 $\mu$ F). With good quality screened cable the distance between receiver and aerial can be 100 metres or more.

Recommended cable is to specification:

- 'Uniradio 70'
- Capacitance      67.8pF/m
- Outer sheath      0.7mm thick
- Outer Diameter      5.8mm

Suppliers include:

- Farnell stock number 140-470
- Farnell stock number 121-7794 (RoHS compliant)

Suitable cables available in the USA are listed below:

<u>Manufacturer</u>	<u>Part No.</u>	<u>Description</u>
Belden	8219	RG 58A/U
	9311	RG 58A/U
Cable and Connector Warehouse Inc.	XV20CS3135	RG 58A/U
	XV21CS3139	RG 58A/U
REMEE Products Corp	1470	RG 58A/U
	1480	RG 58A/U

**5 COMMISSIONING****5.1 General**

For location of controls, adjustments, test points and indications, see Section 9 - Receiver Salient Features.



**WARNING:** On early designs of receiver (GA number 9604618) the metal body of the aerial plug and screen on the cable connecting the plug and receiver terminals may be live with respect to earth due to the receiver being connected to the exciter field.

The receiver referred to in this handbook may be used as a replacement for the earlier version and this unit incorporates an opto-isolator to reduce the voltage on the aerial.

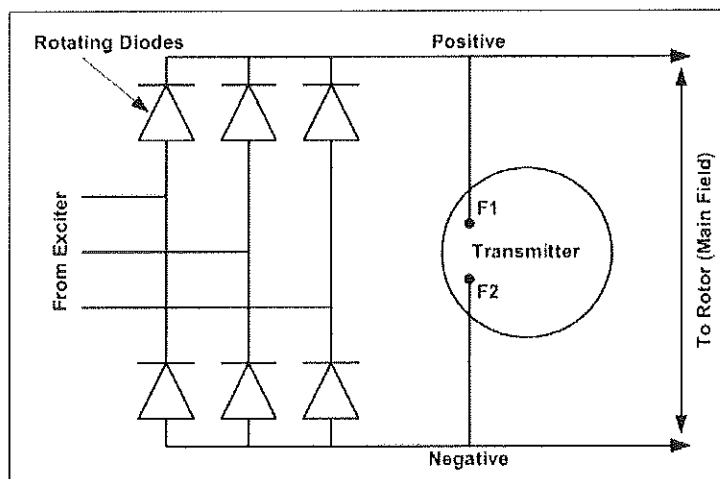
The instructions regarding safety located at the beginning of this handbook should be observed.

**5.2 Meggering**

Disconnect the transmitter unit from the rotor before meggering rotor to earth to avoid false Megger reading and damage to the transmitter.

**5.3 Check Installation****5.3.1 Connections**

Ensure that the correct voltage tap is selected on the transmitter according to the transmitter supply table (Clause 3(d)). Polarity is important and it is usually possible to determine this by physical examination of the leads in relation to the rotating diodes, the polarities of which are normally marked on the diode bodies. The circuit will, in general, be as shown in Figure 2 below.



**Figure 2: Circuit Diagram (Fuses Omitted For Clarity)**

**5.3.2 Co-Axial Screened Cable**

Ensure that the co-axial screened cable connecting aerial and receiver comply with the requirements given in Clause 4.2.

**5.4 Receiver****5.4.1 Supply**

Ensure that the receiver is connected on the correct voltage terminal and that the handbag links are in correct position according to the table below. (See Section 9 - Receiver Salient Features for link location)

Nominal Supply Voltage	Terminals	Link Arrangement
110V $\pm$ 25%	11 & 12	Fit LK1, Omit LK2,3,4
220V $\pm$ 25%	10 & 12	Fit LK2, Omit LK1,3,4
264V $\pm$ 25%	9 & 12	Fit LK2,4, Omit LK1,3
400V $\pm$ 25%	9 & 12	Fit LK2,3, Omit LK1,4

**5.4.2 Operating Frequency**

Select the unit for the 'RF' transmitter frequency by setting switches 1 to 4 'OFF' and 5 to 8 'ON', (See Section 9 - Receiver Salient Features).

**5.5 Commissioning Tests**

Where the capacitance of the cable connecting the aerial to the receiver exceeds the limit of 10,000pF given in the specification, the excess capacitance may attenuate the signal strength at the receiver terminals. It is recommended that the procedure given in Item (10) below be carried out prior to commissioning tests (1) to (9).

- (1) Run the set up to rated speed with auto excitation selected using the AVR overflux limiter to allow the voltage to build up gradually. If the overflux limiter is not included in the AVR switch on excitation at rated speed.
- (2) Check supply present LED4 is illuminated
- (3) Set up the supply inhibit circuit by adjusting RV1 so that the dc voltage on TP4 with respect to TP1 is 1.3 times the voltage measured across TP5 and TP1 (approx. 6V).

Check that the supply inhibit released, LED1 is illuminated.

- (4) Set up the exciter field voltage inhibit circuit as follows:- Rotate RV2 fully anti-clockwise and check that LED2 is on.

Rotate RV2 slowly clockwise until LED2 is turned off, then anti-clockwise approximately 20°. If LED2 remains on, leave RV2 fully clockwise.

- (5) Check that no alarm signal is given and protection operated LED3 is off
- (6) Suppress excitation and again check that no alarm signal is given, check that LED2 is off.
- (7) Apply excitation and check that no alarm signal is given as the excitation builds up. Operate the test pushbutton and check that an alarm is given after approximately 1 second. Release the test button and check that the alarm is cancelled.
- (8) If the normal mode of operation is to run down the machine with the excitation turned on, the machine should be run down with excitation on to confirm that no earth fault alarm is given.
- (9) Functional Check.

Having followed the preceding commissioning procedure it is desirable to check that an earth fault condition is correctly detected. It is imperative that prior to this test it is confirmed that no rotor earth fault exists. (This should have been verified by the preceding commissioning checks).

Using a short light gauge wire (22 SWG or less) put an earth fault on the rotor between transmitter F2 stud and the adjacent earth screw connection. Run the set up to speed and check that when auto excitation is selected an earth fault indication is given. Switch off excitation, shut down the set and remove the earth fault.

(10) Tuning The Aerial To Receiver Connecting Cable For Maximum Signal At The Receiver Terminals

The receiver will function reliably with an input signal to terminals 1 and 2 of 100mV peak to peak, and in normal circumstances a signal of at least this amplitude will be present with the machine excited to nominal voltage on no-load

In cases where intermittent operation is experienced, or it is known that the cable capacitance between aerial and receiver is greater than 10,000pF, it is recommended that the amplitude of the signal is adjusted to a maximum by measuring the signal at the receiver end of the cable at terminals 1 and 2 of the receiver with an oscilloscope and adding capacitance across terminal block TB2, terminals 1 and 2. Small, low voltage plastic capacitors (polyester or polycarbonate) are suitable and it is suggested that the capacitance is increased in increments of 0.01 $\mu$ F (10pF) until the signal reaches maximum amplitude. If the first capacitor added to TB2 reduces the signal amplitude, then capacitor C26 should be removed from the receiver before continuing to add capacitors to TB2. When the optimum capacitor has been determined it should be fitted permanently across the terminals with minimum lead length.

If fitting a replacement receiver of the same type, all that is required is to fit the same value capacitor across TB2.

**6 FAULT FINDING****6.1 General**

If the equipment is not operating correctly ensure that it has been installed according to Section 4 and commissioned according to Section 5.

The fault finding table below (Clause 6.2) shows the action to be taken for various types of fault.

Clause 6.3 details Static Testing Procedures for the transmitter, aerial and receiver.

**6.2 Fault Finding Table**

Symptom	Possible Cause	Action/Remedy
Continuous indication of Fault (Alarm on and Protection Operated LED on at Receiver)	Earth Fault present on Rotor.	Confirm earth fault does not exist by meggering rotor as described in machine Operating & Maintenance Manual. Disconnect transmitter before meggering.
	Transmitter F1 & F2 connections reversed.	Check as Described in Clause 5.3.1.
	Connection between Aerial and Receiver Faulty.	With machine at standstill or receiver completely isolated check wiring between aerial and receiver.
	Test Switch set to test.	Return Test Switch to Normal Running Position.
	Receiver 'off tune'.	With Set running monitor voltage at TP13 with respect to TP1 (0V) using a digital multimeter on 20 Vdc range. Adjust RV4 to give a minimum reading which will be between 0.5V and 5V depending on background noise and aerial tuning. Due to built in time delays, these adjustments should be made slowly to allow time for the decoder to settle between adjustments.
	Low signal strength.	Measure according to Clause 5.5(10) and fit tuning capacitors to maximise input signal amplitude.
	Transmitter, Aerial or Receiver Faulty.	Check as described in Clause 6.3.aerial tuning.

Symptom	Possible Cause	Action/Remedy
No indication of fault during commissioning test. (Clause 5.5 Item (9)).	Receiver supply inhibit not released (LED 1 is off).	Check RV1 is set according to Clause 5.5(3).
	Exciter field voltage inhibit not released. (LED2 is off).	Check voltage on auxiliary terminals is consistent with Clause 3(c).  Check exciter field voltage is applied to terminals 5 (+ve) and 15, and is at least 2.5V dc on no load.  If LED2 is off adjust RV2 as in Clause 5.5(4).
	Receiver Faulty.	If supply inhibit and field inhibit released LED's are on. Set the test switch to 'Test' and an earth fault alarm should result. If not, the unit should be replaced.
Occasional or spurious fault indication	Exciter field voltage inhibit set too low.	Set RV2 so that LED2 is turned off when the exciter field voltage is reduced to approximately 80% of the no-load (cold) level. Run on manual control to set this up if required.
	Receiver nearly 'off tune'.	With Set running monitor voltage at TP13 with respect to TP1 (0V) using a digital multimeter on 20 Vdc range. Adjust RV4 to give a minimum reading which will be between 0.5V and 5V depending on background noise and aerial tuning. Due to built in time delays, these adjustments should be made slowly to allow time for the decoder to settle between adjustments.
	Aerial output signal too weak.	Check wiring between aerial and receiver.  If none of above is successful, perform static test described in Clause 6.3.

**6.3 Static Testing****6.3.1 General**

If the transmitter, aerial or receiver are suspected to be faulty the combination can be statically tested either on the bench or with transmitter and aerial mounted on the machine, and the receiver in situ.

Static testing with the components mounted in position on the machine is more realistic since the position of the aerial relative to the transmitter is not changed. It may also be easier since the transmitter need not be removed from the shaft.



**WARNING:** When working on the transmitter ensure machine shaft will remain stationary throughout. This may mean temporarily turning off barring gear

**6.3.2 Static Testing With Transmitter On The Shaft**

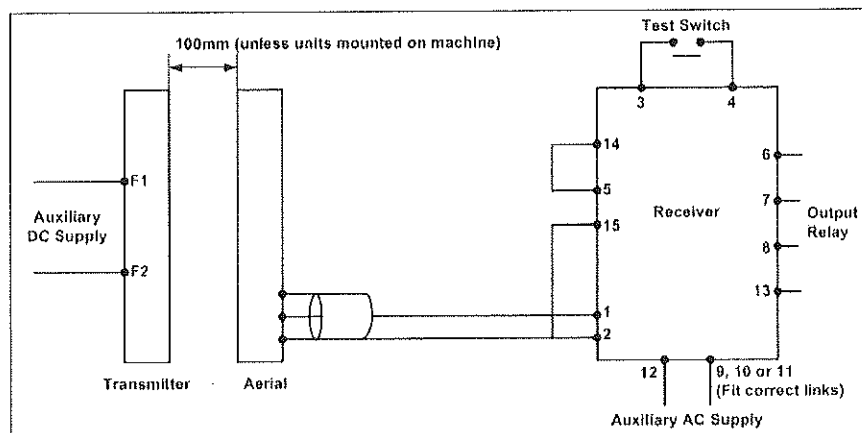
- (a) Disconnect the rotor connections F1 and F2 from the transmitter terminals, mark the cables to ensure correct re-connection, wrong connection will not cause damage but will inhibit operation.

Supply the transmitter from a convenient dc power source, this should be isolated from earth, see note below. If the source is adjustable set to between 100% and 200% of the minimum guaranteed operating voltage for the tapping selected, see Clause 3(d). If it is necessary to adjust the tapping link to suit the available supply record the setting and reset after test.

If a smoothed and regulated dc supply is not available the unit may be supplied from a full wave rectified ac supply but in this case a smoothing capacitor of 22 $\mu$ F - 100  $\mu$ F must be connected across the bridge output. A discharge resistor of 22 - 220 k $\Omega$  should be connected in parallel.

If the dc supply is earthed on either pole or centre point the TEST link must be opened. When applying an earth to transmitter terminals F1 or F2 in test (d) below the connection should be made to the side of the link furthest from the XX terminal and not to the side connected directly to the case as this may rupture supply fuses. Replace link after testing.

- (b) Connect the receiver as shown in Figure 3 below. It may be necessary to temporarily select different power supply links to suit the ac supply available for testing.



**Figure 3: Static Testing Connections**

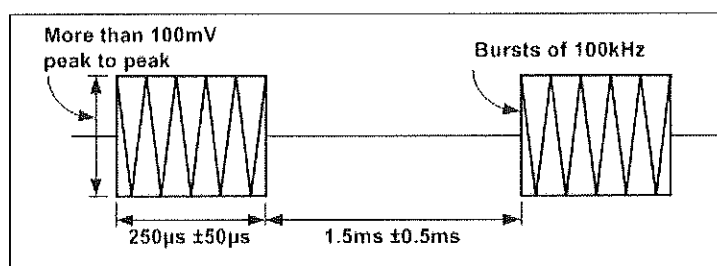
The exciter field voltage signal required at receiver terminals 15 and 5 may be obtained by linking terminals 14 to 5, and terminals 2 to 15, after temporarily disconnecting the cable connected to terminal 5.



- (c) No earth fault (LED3 should be OFF) should be given when the receiver and transmitter supplies are on. The supply present (LED4) indicator should be ON, and both inhibit release LED's (LED1 and LED2) should be ON.
- (d) Temporarily link transmitter terminal F1 then F2 to the transmitter casing, or if an earthed supply is used the Test link, and check that the receiver gives earth fault indication (LED3 ON) in each case.

**Notes On Above Tests**

- (1) If test (c) results in a continuous earth fault indication, it is suggested that the transmitter/aerial are checked by observing the waveform at terminals 1 and 2 of the receiver with an oscilloscope.
- (2) With no earth fault, the signal should comprise a burst of 100kHz of amplitude greater than 100mV of duration  $250 \pm 50 \mu\text{s}$ , followed by a pause of  $1.5 \text{ ms} \pm 0.5 \text{ ms}$ . See Figure 4 below. Absence of this signal indicates a faulty aerial or transmitter.

**Figure 4: Aerial Output Waveform**

- (3) With the simulated earth fault of test (d), the 100kHz signal should be completely removed. If the signal is not removed the transmitter is faulty.
- (4) If the signal is present at the receiver and an earth fault alarm still persists, ensure that the test switch is set to the normal running position, and then adjust the tuning as described in Clause 6.2. If it is not possible to tune in the receiver, then a faulty receiver is indicated.

After completion of testing, return both transmitter and receiver wiring and links to original condition before returning machine to service.

**6.3.3****Static Testing With Transmitter And Aerial On Bench**

Remove transmitter and aerial from the machine and connect to the receiver as shown in Figure 3. The rest of the static bench test is as described in Clause 6.3.2 above.

**7****PERIODIC TESTING**

In common with other protection equipment it is recommended that correct operation is confirmed periodically by operation of the test pushbutton whilst the machine is running, to check that an alarm is given.

In addition the ability of the transmitter to detect an earth fault should be confirmed annually by performing the functional test described in Clause 5.5(9) of this manual.

8

### ELECTRICAL CONNECTIONS

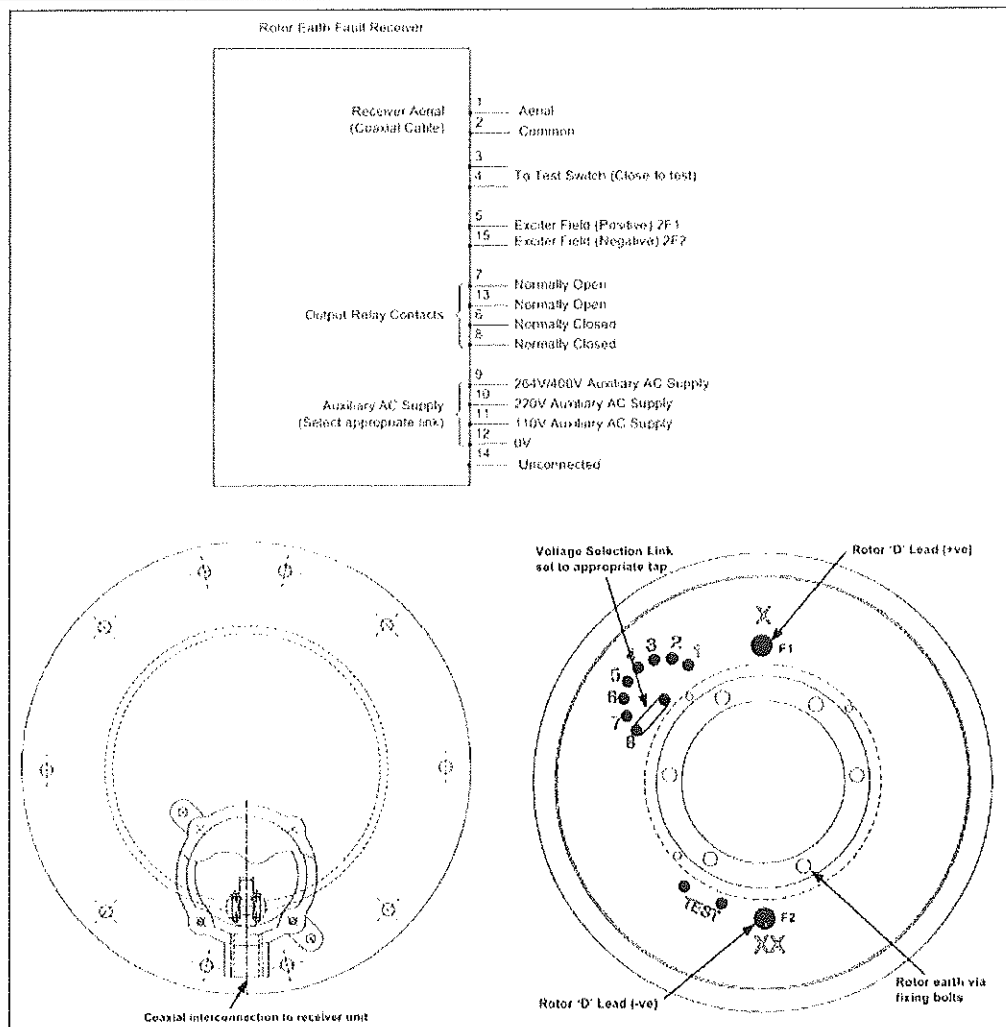


Figure 5: Electrical Connections

9

### RECEIVER SALIENT FEATURES

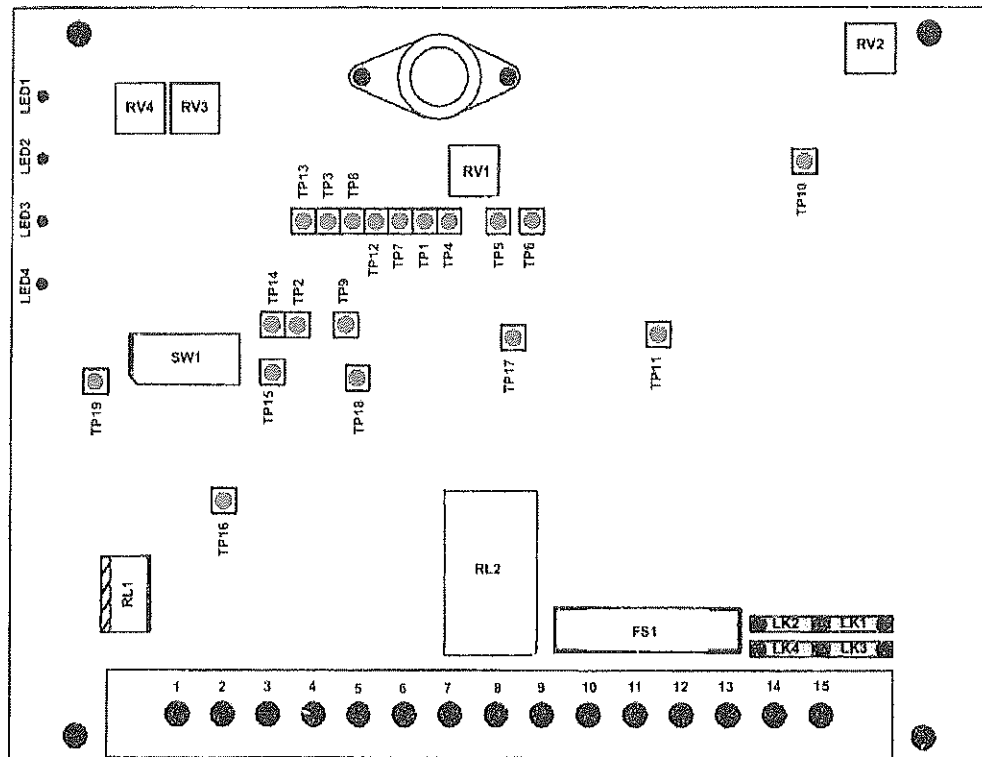


Figure 6: Receiver Salient Features

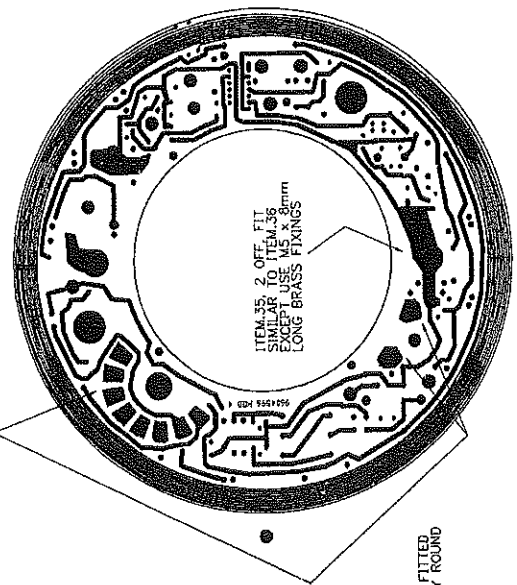
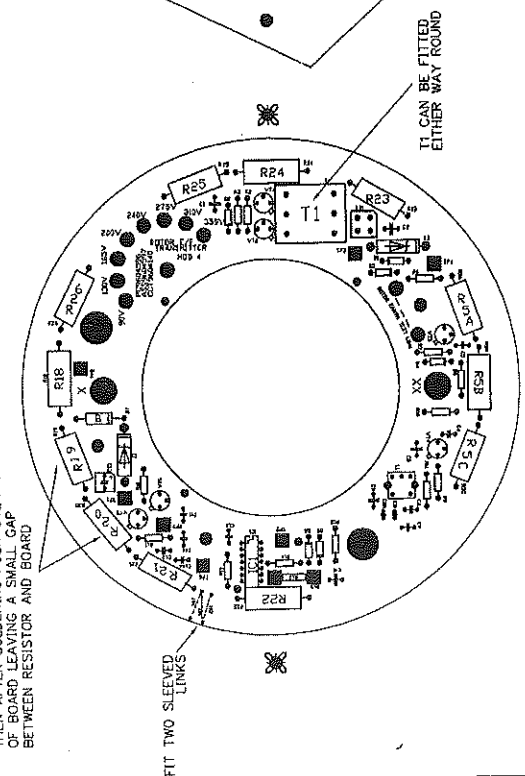
**10****DRAWINGS**

The following drawings are attached as separate additional pages:

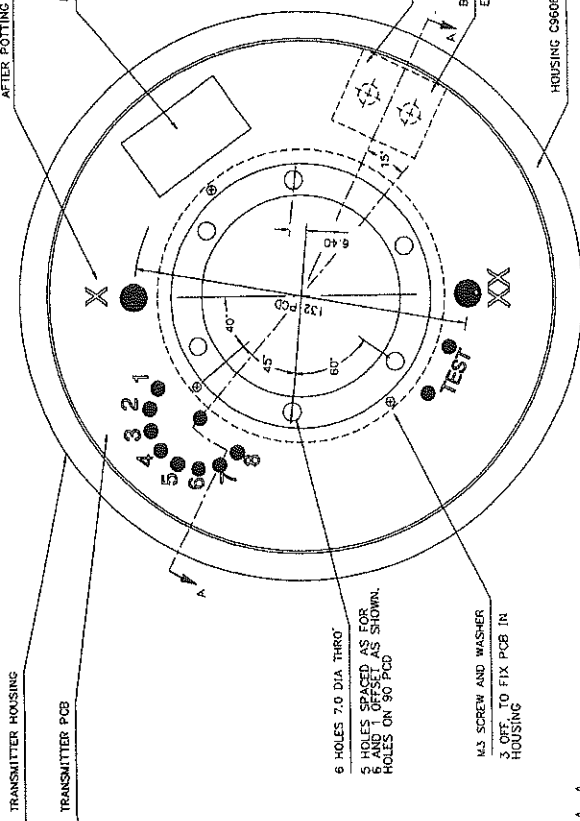
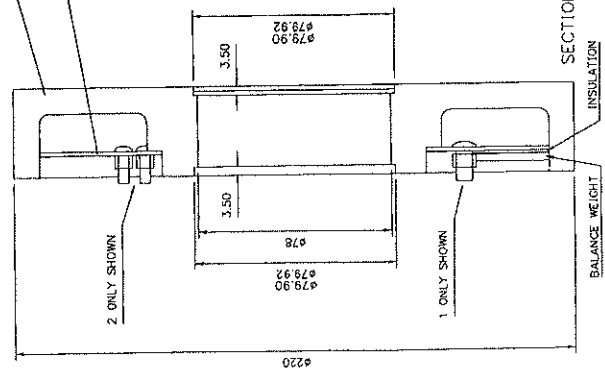
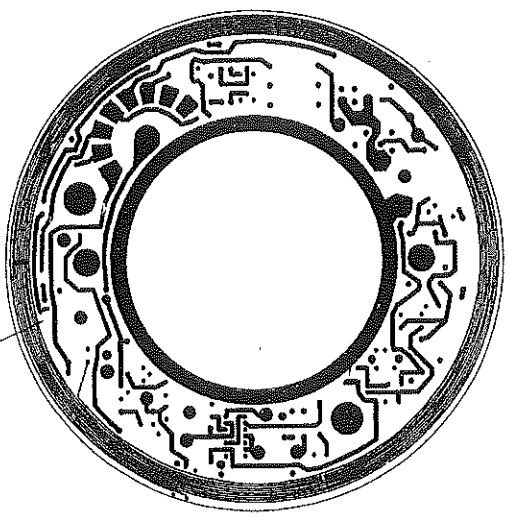
960414000	Transmitter & Receiver, Circuit Diagram
960459700	Transmitter, General Arrangement
960462000	Aerial, General Arrangement
961503300	Receiver PCB, General Arrangement
961503800	Receiver, Circuit Diagram
961509500	Receiver (Boxed), General Arrangement

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

FIT WIREWOUND RESISTORS APPROX. 3mm OFF BOARD. THEN AFTER SOLDERING PUSH OVER AWAY FROM CENTRE OF BOARD LEAVING A SMALL GAP BETWEEN RESISTOR AND BOARD.



ITEM 36, 11 OFF FIT ON NON COMPONENT SIDE. HEX END TO BOARD. FIT M3 x 6mm LONG BRASS SCREW AND WASHER THROUGH FROM COMPONENT SIDE. TIGHTEN SECURELY THEN SOLDER PILLAR TO PCB COPPER.



STAGE 1 ASSEMBLY INTO CUP  
PLACE THE PCB INTO THE CUP AFTER ENSURING THAT THE INNER ANNUAL RING OF THE PCB WILL COME INTO ELECTRICAL CONTACT WITH THE CUP. PLACE THE INSULATING STRIP (E9611508) AND THE BALANCE WEIGHT (E9611703) IN THE POSITION SHOWN USING TWIN-PACK RAPID AERADITE TO SECURE THE STRIP TO THE PCB AND THE BALANCE WEIGHT TO THE CUP. ALLOW THE AERADITE TO SET BEFORE PROCEEDING

STAGE 2 POTTING AND FINISHING  
MIX THE EPOXY RESIN TO PS2523 AND POUR INTO THE CUP CAREFULLY TO AVOID ANY TRAPPED BUBBLES. FILL TO WITHIN 1mm OF THE LIP OF THE CUP. LEAVE TO CURE. COMPLETE LABELING AND FIT LINK IN POSITION 8 AND THE TEST LINK.

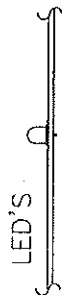
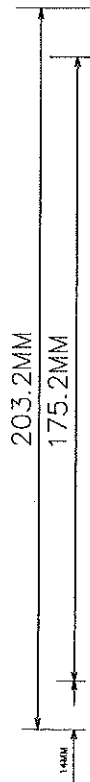
THIS UNIT MUST BE TESTED BEFORE AND AFTER POTTING

MOD 4

REVISIONS				PROJECTS			
REV	DATE	BY	APP	REV	DATE	BY	APP
1	18/11/78			1	18/11/78		
2	18/11/78			2	18/11/78		
3	18/11/78			3	18/11/78		
4	18/11/78			4	18/11/78		
5	18/11/78			5	18/11/78		
6	18/11/78			6	18/11/78		
7	18/11/78			7	18/11/78		
8	18/11/78			8	18/11/78		
9	18/11/78			9	18/11/78		
10	18/11/78			10	18/11/78		
11	18/11/78			11	18/11/78		
12	18/11/78			12	18/11/78		
13	18/11/78			13	18/11/78		
14	18/11/78			14	18/11/78		
15	18/11/78			15	18/11/78		
16	18/11/78			16	18/11/78		
17	18/11/78			17	18/11/78		
18	18/11/78			18	18/11/78		
19	18/11/78			19	18/11/78		
20	18/11/78			20	18/11/78		
21	18/11/78			21	18/11/78		
22	18/11/78			22	18/11/78		
23	18/11/78			23	18/11/78		
24	18/11/78			24	18/11/78		
25	18/11/78			25	18/11/78		
26	18/11/78			26	18/11/78		
27	18/11/78			27	18/11/78		
28	18/11/78			28	18/11/78		
29	18/11/78			29	18/11/78		
30	18/11/78			30	18/11/78		
31	18/11/78			31	18/11/78		
32	18/11/78			32	18/11/78		
33	18/11/78			33	18/11/78		
34	18/11/78			34	18/11/78		
35	18/11/78			35	18/11/78		
36	18/11/78			36	18/11/78		
37	18/11/78			37	18/11/78		
38	18/11/78			38	18/11/78		
39	18/11/78			39	18/11/78		
40	18/11/78			40	18/11/78		
41	18/11/78			41	18/11/78		
42	18/11/78			42	18/11/78		
43	18/11/78			43	18/11/78		
44	18/11/78			44	18/11/78		
45	18/11/78			45	18/11/78		
46	18/11/78			46	18/11/78		
47	18/11/78			47	18/11/78		
48	18/11/78			48	18/11/78		
49	18/11/78			49	18/11/78		
50	18/11/78			50	18/11/78		
51	18/11/78			51	18/11/78		
52	18/11/78			52	18/11/78		
53	18/11/78			53	18/11/78		
54	18/11/78			54	18/11/78		
55	18/11/78			55	18/11/78		
56	18/11/78			56	18/11/78		
57	18/11/78			57	18/11/78		
58	18/11/78			58	18/11/78		
59	18/11/78			59	18/11/78		
60	18/11/78			60	18/11/78		
61	18/11/78			61	18/11/78		
62	18/11/78			62	18/11/78		
63	18/11/78			63	18/11/78		
64	18/11/78			64	18/11/78		
65	18/11/78			65	18/11/78		
66	18/11/78			66	18/11/78		
67	18/11/78			67	18/11/78		
68	18/11/78			68	18/11/78		
69	18/11/78			69	18/11/78		
70	18/11/78			70	18/11/78		
71	18/11/78			71	18/11/78		
72	18/11/78			72	18/11/78		
73	18/11/78			73	18/11/78		
74	18/11/78			74	18/11/78		
75	18/11/78			75	18/11/78		
76	18/11/78			76	18/11/78		
77	18/11/78			77	18/11/78		
78	18/11/78			78	18/11/78		
79	18/11/78			79	18/11/78		
80	18/11/78			80	18/11/78		
81	18/11/78			81	18/11/78		
82	18/11/78			82	18/11/78		
83	18/11/78			83	18/11/78		
84	18/11/78			84	18/11/78		
85	18/11/78			85	18/11/78		
86	18/11/78			86	18/11/78		
87	18/11/78			87	18/11/78		
88	18/11/78			88	18/11/78		
89	18/11/78			89	18/11/78		
90	18/11/78			90	18/11/78		
91	18/11/78			91	18/11/78		
92	18/11/78			92	18/11/78		
93	18/11/78			93	18/11/78		
94	18/11/78			94	18/11/78		
95	18/11/78			95	18/11/78		
96	18/11/78			96	18/11/78		
97	18/11/78			97	18/11/78		
98	18/11/78			98	18/11/78		
99	18/11/78			99	18/11/78		
100	18/11/78			100	18/11/78		

OR'N		ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'N	ZONE	OR'
------	--	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-----

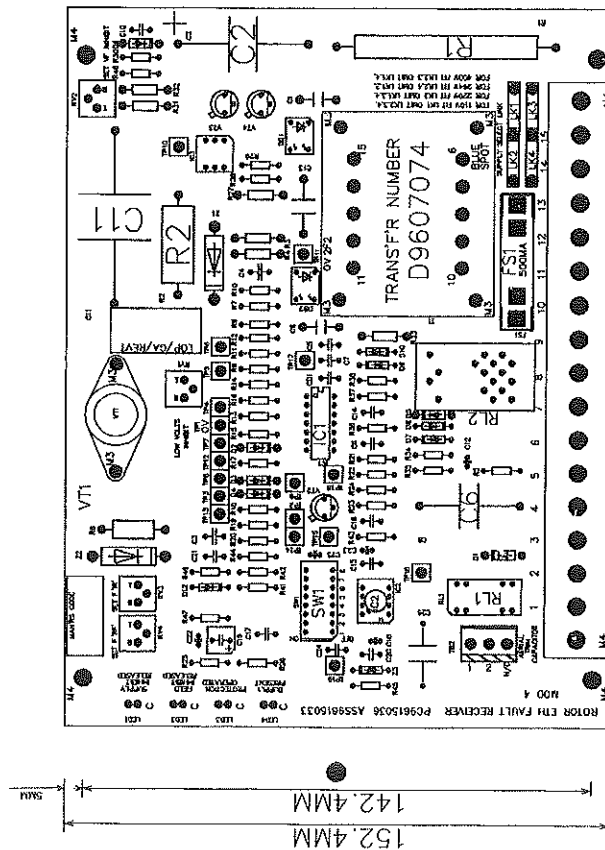




PIN POSITIONS INDICATED BY SQUARE.

FIT CERAMIC BEADS ON R1,R2,R6.

COMPONENT SIDE



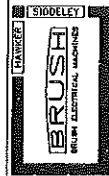
HEIGHT ABOVE BOARD = 90 MM  
DEPTH BELOW BOARD = 15 MM

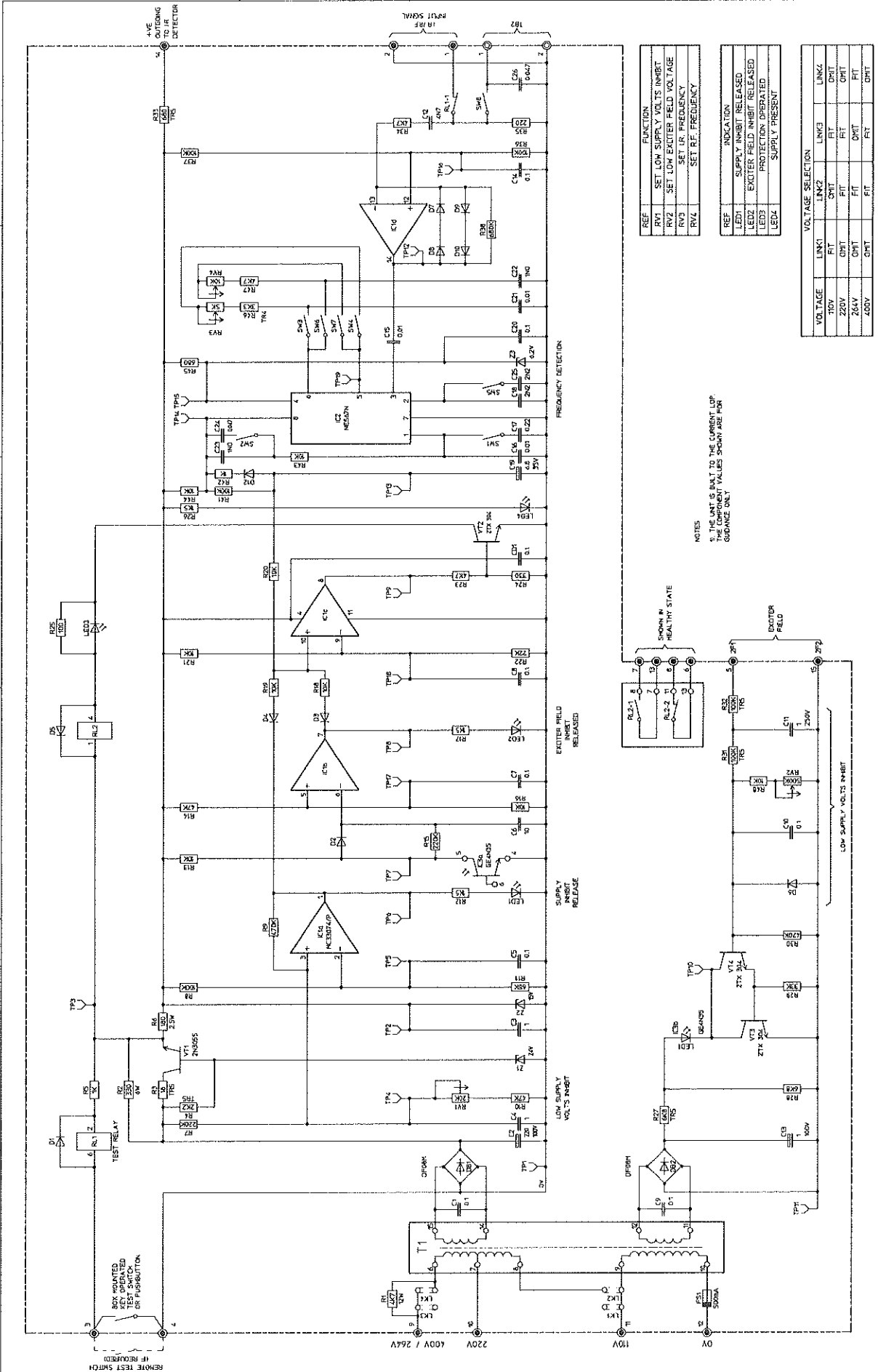
MOD 4

FIT SPREADER  
FIT BASE  
DO NOT FIT SW1 & RELAYS UNTIL AFTER MACHINE CLEANING

E DRAWING INSERTED ON 'CAD' BORDER.		DRN	QM	ZONE	C	CARN 7012 REDRAWN / MOD 3	DRN	AP	ZONE	CIRC.R	1ST CONTRACT No. DRG. REF. STD		CAD. REF. 1503301E	DRN: AP	POWER CONTROL ENGINEERING
ISS		APP	DATE 15/07/89	ISS			APP	DATE 15/07/89	CARN		CH'D: PUY		SCALE: 1:1	CH'D: PUY	1:1
D CLEARANCES INCREASED AROUND R1 & C2.		DRN	AP	ZONE	B		DRN	AP	ZONE		APP: PUY		DATE: 8/2/89	APP: PUY	DATE: 8/2/89
ISS MOD 4		APP	DATE 29/8/89	ISS			APP	DATE 29/8/89	CARN		C 9615033		ISSUE E	SHEET 1 OF 1	ISSUE E

This drawing is confidential and the copyright of BRUSH ELECTRICAL MACHINES LIMITED © 1997 LOUGHBOROUGH, ENGLAND. It must not be copied or passed to a third party without written consent.





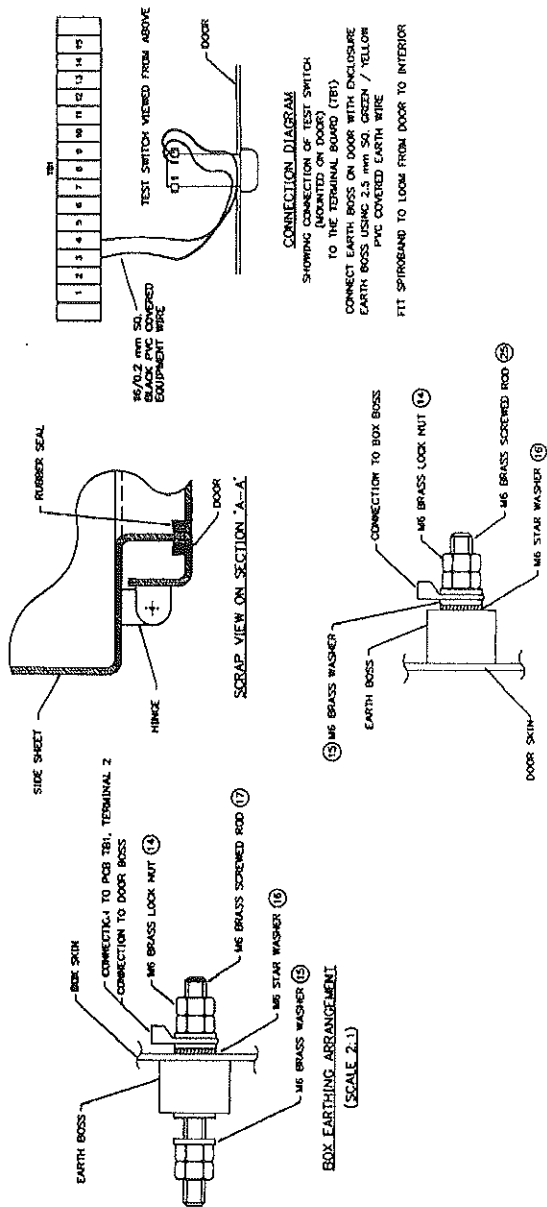
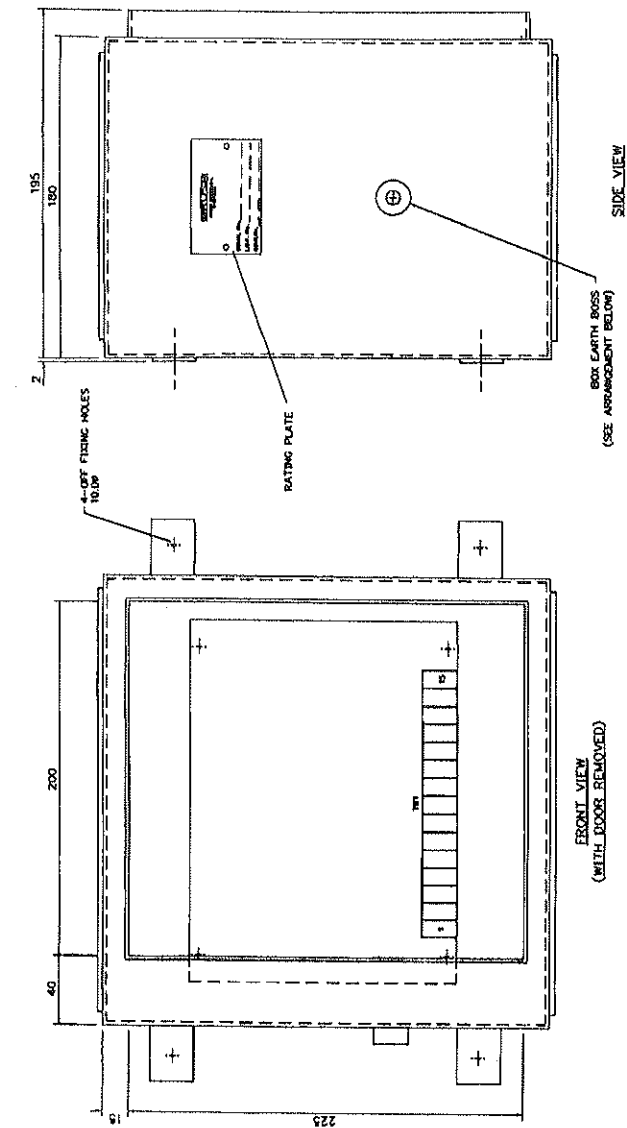
REF	FUNCTION
RV1	SET LOW SUPPLY VOLTS INHIBIT
RV2	SET LOW EXCITER FIELD VOLTAGE
RV3	SET IR FREQUENCY
RV4	SET RF FREQUENCY

REF	INDICATION
LED1	SUPPLY INHIBIT RELEASED
LED2	EXCITER FIELD INHIBIT RELEASED
LED3	PROTECTION OPERATED
LED4	SUPPLY PRESENT

VOLTAGE	LINK1	LINK2	LINK3	LINK4
110V	FIT	FIT	FIT	OMIT
220V	OMIT	FIT	FIT	OMIT
244V	OMIT	FIT	OMIT	FIT
400V	OMIT	FIT	FIT	OMIT

NOTES  
1. THE UNIT IS BUILT TO THE CURRENT LIST  
THE COMPONENT VALUES SHOWN ARE FOR  
GUIDANCE ONLY

E		REWORK ON NEW FUNCTION & INDICATION TABLES. NOTE 1 AND RL2 SHOWN IN E-4774 STATE TEST ADDED		DATE: 05 AUG 78		ISS: 05 AUG 78		AP: PLY		ISS: 05 AUG 78		E	
D		PDC		PDC		PDC		PDC		PDC		PDC	
C		PDC		PDC		PDC		PDC		PDC		PDC	
B		PDC		PDC		PDC		PDC		PDC		PDC	
A		PDC		PDC		PDC		PDC		PDC		PDC	
1		PDC		PDC		PDC		PDC		PDC		PDC	
2		PDC		PDC		PDC		PDC		PDC		PDC	
3		PDC		PDC		PDC		PDC		PDC		PDC	
4		PDC		PDC		PDC		PDC		PDC		PDC	
5		PDC		PDC		PDC		PDC		PDC		PDC	
6		PDC		PDC		PDC		PDC		PDC		PDC	
7		PDC		PDC		PDC		PDC		PDC		PDC	
8		PDC		PDC		PDC		PDC		PDC		PDC	
9		PDC		PDC		PDC		PDC		PDC		PDC	
10		PDC		PDC		PDC		PDC		PDC		PDC	
11		PDC		PDC		PDC		PDC		PDC		PDC	
12		PDC		PDC		PDC		PDC		PDC		PDC	
13		PDC		PDC		PDC		PDC		PDC		PDC	
14		PDC		PDC		PDC		PDC		PDC		PDC	
15		PDC		PDC		PDC		PDC		PDC		PDC	
16		PDC		PDC		PDC		PDC		PDC		PDC	
17		PDC		PDC		PDC		PDC		PDC		PDC	
18		PDC		PDC		PDC		PDC		PDC		PDC	
19		PDC		PDC		PDC		PDC		PDC		PDC	
20		PDC		PDC		PDC		PDC		PDC		PDC	
21		PDC		PDC		PDC		PDC		PDC		PDC	
22		PDC		PDC		PDC		PDC		PDC		PDC	
23		PDC		PDC		PDC		PDC		PDC		PDC	
24		PDC		PDC		PDC		PDC		PDC		PDC	
25		PDC		PDC		PDC		PDC		PDC		PDC	
26		PDC		PDC		PDC		PDC		PDC		PDC	
27		PDC		PDC		PDC		PDC		PDC		PDC	
28		PDC		PDC		PDC		PDC		PDC		PDC	
29		PDC		PDC		PDC		PDC		PDC		PDC	
30		PDC		PDC		PDC		PDC		PDC		PDC	
31		PDC		PDC		PDC		PDC		PDC		PDC	
32		PDC		PDC		PDC		PDC		PDC		PDC	
33		PDC		PDC		PDC		PDC		PDC		PDC	
34		PDC		PDC		PDC		PDC		PDC		PDC	
35		PDC		PDC		PDC		PDC		PDC		PDC	
36		PDC		PDC		PDC		PDC		PDC		PDC	
37		PDC		PDC		PDC		PDC		PDC		PDC	
38		PDC		PDC		PDC		PDC		PDC		PDC	
39		PDC		PDC		PDC		PDC		PDC		PDC	
40		PDC		PDC		PDC		PDC		PDC		PDC	
41		PDC		PDC		PDC		PDC		PDC		PDC	
42		PDC		PDC		PDC		PDC		PDC		PDC	
43		PDC		PDC		PDC		PDC		PDC		PDC	
44		PDC		PDC		PDC		PDC		PDC		PDC	
45		PDC		PDC		PDC		PDC		PDC		PDC	
46		PDC		PDC		PDC		PDC		PDC		PDC	
47		PDC		PDC		PDC		PDC		PDC		PDC	
48		PDC		PDC		PDC		PDC		PDC		PDC	
49		PDC		PDC		PDC		PDC		PDC		PDC	
50		PDC		PDC		PDC		PDC		PDC		PDC	
51		PDC		PDC		PDC		PDC		PDC		PDC	
52		PDC		PDC		PDC		PDC		PDC		PDC	
53		PDC		PDC		PDC		PDC		PDC		PDC	
54		PDC		PDC		PDC		PDC		PDC		PDC	
55		PDC		PDC		PDC		PDC		PDC		PDC	
56		PDC		PDC		PDC		PDC		PDC		PDC	
57		PDC		PDC		PDC		PDC		PDC		PDC	
58		PDC		PDC		PDC		PDC		PDC		PDC	
59		PDC		PDC		PDC		PDC		PDC		PDC	
60		PDC		PDC		PDC		PDC		PDC		PDC	
61		PDC		PDC		PDC		PDC		PDC		PDC	
62		PDC		PDC		PDC		PDC		PDC		PDC	
63		PDC		PDC		PDC		PDC		PDC		PDC	
64		PDC		PDC		PDC		PDC		PDC		PDC	
65		PDC		PDC		PDC		PDC		PDC		PDC	
66		PDC		PDC		PDC		PDC		PDC		PDC	
67		PDC		PDC		PDC		PDC		PDC		PDC	
68		PDC		PDC		PDC		PDC		PDC		PDC	
69		PDC		PDC		PDC		PDC		PDC		PDC	
70		PDC		PDC		PDC		PDC		PDC		PDC	
71		PDC		PDC		PDC		PDC		PDC		PDC	
72		PDC		PDC		PDC		PDC		PDC		PDC	
73		PDC		PDC		PDC		PDC		PDC		PDC	
74		PDC		PDC		PDC		PDC		PDC		PDC	
75		PDC		PDC		PDC		PDC		PDC		PDC	
76		PDC		PDC		PDC		PDC		PDC		PDC	
77		PDC		PDC		PDC		PDC		PDC		PDC	
78		PDC		PDC		PDC		PDC		PDC		PDC	
79		PDC		PDC		PDC		PDC		PDC		PDC	
80		PDC		PDC		PDC		PDC		PDC		PDC	
81		PDC		PDC		PDC		PDC		PDC		PDC	
82		PDC		PDC		PDC		PDC		PDC		PDC	
83		PDC		PDC		PDC		PDC		PDC		PDC	
84		PDC		PDC		PDC		PDC		PDC		PDC	
85		PDC		PDC		PDC		PDC		PDC		PDC	
86		PDC		PDC		PDC		PDC		PDC		PDC	
87		PDC		PDC		PDC		PDC		PDC		PDC	
88		PDC		PDC		PDC		PDC		PDC		PDC	
89		PDC		PDC		PDC		PDC		PDC		PDC	
90		PDC		PDC		PDC		PDC		PDC		PDC	
91		PDC		PDC		PDC		PDC		PDC		PDC	
92		PDC		PDC		PDC		PDC		PDC		PDC	
93		PDC		PDC		PDC		PDC		PDC		PDC	
94		PDC		PDC		PDC		PDC		PDC		PDC	
95		PDC		PDC		PDC		PDC		PDC		PDC	
96		PDC		PDC		PDC		PDC		PDC		PDC	
97		PDC		PDC		PDC		PDC		PDC		PDC	
98		PDC		PDC		PDC		PDC		PDC		PDC	
99		PDC		PDC		PDC		PDC		PDC		PDC	
100		PDC		PDC		PDC		PDC		PDC		PDC	



DOOR EARTHING ARRANGEMENT  
(SCALE 2:1)

K		CONNECTION TO FIBER OPTIC		J		DOOR EARTHING ANTI-CORROSION ADDED		G		REAR TRUCK ATTACHED TO FRAME		F		SPRINKLER MOUNT ADDED		E		DOOR THRESHOLD ADDED		D		C		B		A		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100		101		102		103		104		105		106		107		108		109		110		111		112		113		114		115		116		117		118		119		120		121		122		123		124		125		126		127		128		129		130		131		132		133		134		135		136		137		138		139		140		141		142		143		144		145		146		147		148		149		150		151		152		153		154		155		156		157		158		159		160		161		162		163		164		165		166		167		168		169		170		171		172		173		174		175		176		177		178		179		180		181		182		183		184		185		186		187		188		189		190		191		192		193		194		195		196		197		198		199		200		201		202		203		204		205		206		207		208		209		210		211		212		213		214		215		216		217		218		219		220		221		222		223		224		225		226		227		228		229		230		231		232		233		234		235		236		237		238		239		240		241		242		243		244		245		246		247		248		249		250		251		252		253		254		255		256		257		258		259		260		261		262		263		264		265		266		267		268		269		270		271		272		273		274		275		276		277		278		279		280		281		282		283		284		285		286		287		288		289		290		291		292		293		294		295		296		297		298		299		300		301		302		303		304		305		306		307		308		309		310		311		312		313		314		315		316		317		318		319		320		321		322		323		324		325		326		327		328		329		330		331		332		333		334		335	
---	--	---------------------------	--	---	--	------------------------------------	--	---	--	------------------------------	--	---	--	-----------------------	--	---	--	----------------------	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	---	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--