PGEI-11431

INSTRUCTION MANUAL

HORIZONTAL SYNCHRONOUS GENERATORS

EN-139530, SERIAL NO. 1044808 to 1044810

with

BRUSHLESS EXCITERS

EN-139482, SERIAL NO. 1044814 to 1044816

and

BASLER REGULATORS

for Diesel-Driven Main Power Generating Sets

MARINE INDUSTRIE LIMITEE

for

CANADIAN COAST GUARD
Type 1100 Navaids Tender/Light Icebreaker
Hull No. 451

MIL Order 451-1
CGE Requisition 9280-250

CANADIAN GENERAL ELECTRIC COMPANY LIMITED
Large Motor and Industrial Electronics Department
107 Park Street North, Peterborough, Ontario K9J 7B5
Canada

November 1985

CONTENTS

CONTENTS (Cont'd)

FOREWORD

These instructions provide descriptive information, suggestions on installation procedures, installation instruction and tolerances, and some guides on operation and maintenance. Alternative installation methods and procedures have not been included as site conditions can vary considerably.

If further information is required, contact the nearest General Electric or Canadian General Electric Installation and Service representative.

SAFETY PRECAUTIONS

WARNING

INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRICAL MACHINERY SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. FAMILIARIZATION WITH NEMA OR EEMAC SAFETY STANDARD FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF INTEGRAL HP MOTORS AND GENERATORS, MG2, LATEST ISSUE, IS RECOMMENDED.

Personnel should be instructed to:

- avoid contact with energized circuits or rotating parts,
- avoid by-passing or rendering inoperative any safeguards or protective devices,
- avoid extended exposure in close proximity to machinery with high noise levels, and
- use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment.

Safe maintenance practice with qualified personnel is imperative. Before initiating maintenance procedures, be sure that all power sources are disconnected from the machine and accessories, to avoid electric shock. High-potential insulation test for this equipment is not recommended; however, should it be required, procedures and precautions outlined in this instruction should be followed.

Failure to properly ground the frame of this machine may cause serious injury to personnel. Grounding should be in accordance with the National or Canadian Electrical Code and local requirements.

REFERENCE PUBLICATIONS

ANSI/NEMA or EEMAC Standard MG1-1978:
Motors and Generators.

ANSI/NEMA or EEMAC Standard MG2-1977:
Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

ANSI/IEEE Standard 4-1978:
Standard Techniques for High-Voltage Testing.

CSA Standard C22.2 No. 0-M1982:
General Requirements - Canadian Electrical Code, Part II.

CSA Standard C22.2 No. 0.4-M1982:
Bonding and Grounding of Electrical Equipment (Protective Grounding).

CSA Standard C22.2 No. 100-M1982:
Motors and Generators.

ANSI/IEEE Standard 43-1974(R1981):
Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

ANSI Standard C50.10-1977:
General Requirements for Synchronous Machines.

ANSI Standard C50.12-1981:
Requirements for Salient-Pole Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications.

ANSI/IEEE Standard 56-1977:
Guide for Insulation Maintenance of Large Alternating-Current Rotating Machinery (10,000 KVA and Larger).

ANSI/IEEE Standard 95-1977:
Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.

ANSI/IEEE Standard 115-1983:
Test Procedures for Synchronous Machines.

ANSI/IEEE Standard 421B-1979:
High-Potential Test Requirements for Excitation Systems for Synchronous Machines.

ANSI/IEEE Standard 432-1976:
Guide for Insulation Maintenance for Rotating Electrical Machinery (5 HP to Less Than 10,000 HP).

Legend:

ANSI....................	American National Standards Institute 1430 Broadway, New York, N.Y. 10018
CSA.....................	Canadian Standards Association 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3
EEMAC.................	Electrical and Electronic Manufacturers Association of Canada 1 Yonge Street, Suite 1608, Toronto, Ontario M5E 1R1
IEEE....................	The Institute of Electrical and Electronic Engineers Inc. 345 East 47 Street, New York, N.Y. 10017
NEMA	National Electrical Manufacturers Association 2101 L Street N.W., Washington D.C. 20037

Should you need service.......

Call the CGE Industrial Service Shop near you.

INDUSTRIAL SERVICE SHOPS
iss

HEADQUARTERS

Peterborough	107 Park St. N.	705-748-7509

Canadian General Electric Co. Ltd.

Toronto	80 Midwest Rd., Unit 11	416-757-3269
Burlington	1150 Walker's Line	416-335-6301
Winnipeg	2033 Dugald Road	204-224-1661
Edmonton	9449 49 Street	403-465-3305
Kamloops	930 Laval Crescent	604-374-9636

Montréal Armature Company Ltd.

Bathurst	Industrial Park	506-548-8848
Montréal	7420 Ouest rue St. Jacques	514-481-0441
Sept-Iles	425 avenue Québec	418-962-5538

W.L. Stevens Ltd.

Burnaby, B.C.	7485 19 Street	604-522-5781

CGE Canadian General Electric

RECEIVING, HANDLING AND STORAGE

RECEIVING

Each shipment should be carefully examined upon arrival. Any damage to either packaging or contents should be photographed and reported to the carrier and to the nearest CGE office. The generator is shipped disassembled, with the major components consisting of:

1. Stator assembly (weighing approximately 12,000 pounds or 5450 kg net) complete with air shields.

2. Rotor assembly (weighing approximately 13,000 pounds or 5900 kg net) complete with the exciter armature.

3. Bearing and pedestal assembly, exciter magnet frame and exciter cover (weighing approximately 1400 pounds or 635 kg net).

4. Exciter support (weighing approximately 300 pounds or 140 kg net).

5. Side and top enclosure (weighing approximately 4300 pounds or 1950 kg net) complete with cooler and make up air system.

All items for one generator are shipped in one semi-trailer, which is covered by a tarpaulin. Proceed promptly with either installation or storage in accordance with the following instructions.

HANDLING

The stator and rotor are skidded and packed for shipment. Lifting points are marked on the packaging. When unpacked, stator lifting points are shown on the outline drawing. When handling the unpacked rotor, padded slings may be used around the rotor core; otherwise, sling around appropriate points of the shaft. Slings or blocking should never be used around or bearing against the amortisseur rings or bearing journals. If lifting a stator with the rotor threaded into it, use non-metallic sheet shimming in the air gap and lift by the stator frame lifting provisions using balancing slings whenever necessary.

STORAGE

These instructions are offered as a guide to the storing agency that is responsible for the components at this stage. Any remaining warranty responsibility of Canadian General Electric Company Limited will be invalidated by non-compliance.

<u>Outdoor storage is not permitted</u> because variations in temperature and humidity can cause condensation, producing rust on unprotected metal parts and deterioration of the electrical insulation. Therefore, the following covers the minimum acceptable storage arrangements, in an unheated but protected environment. It is preferable to use a heated facility, which would simplify meeting these conditions. When outdoor storage cannot be avoided, contact CGE for recommendations to minimize deterioration, giving full particulars of the circumstances.

STORAGE FACILITY REQUIREMENTS

The storage facility must provide protection from contact with rain, hail, snow, blowing sand or dirt, accumulations of ground water, corrosive fumes and infestation by vermin or insects. There should be power service for space heaters and illumination. There should be fire detection and a fire-fighting plan.

The components must not be stored where they are liable to accidental damage or exposed to weld spatter, exhaust fumes or dirt and stones kicked up by passing vehicles. If necessary, erect suitable guards or separating walls to provide adequate protection. Avoid storage in an atmosphere containing corrosive gases, particularly chlorine, sulphur dioxide and nitrous oxides.

TEMPERATURE CONTROL

Whenever the stator or rotor temperature is equal to or below room temperature and relative humidity is above 60%, water vapor can condense on and within the component to promote rapid deterioration. To prevent condensation, provide space heaters to keep the component temperature above room temperature by at least 3°C at all times. Note that the stator is provided with space heaters in accordance with group 1 of drawing 4003C1109AE. They are connected in series for an effective output of 1172 watts on a 600 volt, single phase power supply.

CAUTION

> If a component is boxed or covered in any way when the space heaters are energized, there should be thermostatic control and sufficient surveillance to quickly detect an over-temperature condition. Ensure that temporary packaging does not contact the space heaters.

When electrical windings are sound and their insulation resistance is well above the formula minimum discussed below, low temperature is not a problem. However, if the insulation resistance drops, windings can be permanently damaged by freezing. Therefore, the component temperature should be kept above the freezing point. The storage agency is advised to develop whatever assurance systems and records are necessary to demonstrate compliance with this requirement.

STORAGE RECORD

Maintain a storage record regardless of the storage period. Enter the following information into the record:

1. Name of the storage agency.

2. Location and description of the storage facility.

3. Identification of the stored component, including CGE serial and model numbers of the generator to which the component belongs.

4. Date and condition of the component when first placed in storage.

5. Date and results of in-storage inspections and tests.

6. Date and description of storage maintenance operations.

7. Component and room temperature and relative humidity records.

8. Date and condition of the component when withdrawn from storage.

Start the storage record by noting that the requirements of PREPARATION FOR STORAGE have been met. Record the tests and inspections described in MONTHLY TESTS AND INSPECTIONS below. This should be the most detailed and thorough inspection performed during the storage period since it will establish the standard for evaluating subsequent inspections and for forming judgements as to changing the storage facility or component conditions. The record of this inspection must be as detailed and through as the inspection itself.

PREPARATION FOR STORAGE

1. Remove the polyethylene shroud, but leave the component mounted on its skid.

2. Ensure that all unpainted machined surfaces (such as the forged flange and mounting feet) have rust preventatives in place and in good condition.

3. Ensure that there is a moisture barrier (two layers of MIL Spec. B-121-C, Grade C, Type 1, Class 2 cloth) between the machined feet and the skid timbers.

4. Land the skidded component on firm supports in its normal mounting position.

5. Provide an overhead cover of polyethylene to protect against settling dust, dirt or debris, but ensure that there is adequate clearance for good ventilation around the component.

6. Provide sufficient access around each component in storage to carry out all of the specified tests and inspections.

PROTECTIVE COATINGS, SEPARATORS, CLEANERS AND SOLVENTS

1. If fire insurance or other ordinance requires fire-proofing of timbers, ensure that the materials used do not give off corrosive fumes.

2. For the moisture barrier, use MIL spec. B-121-C Grade C, Type 1, Class 2 cloth.

3. For the cleaning agent, use mineral spirits.

4. For fingerprint suppressor, use alcohol designated DAG no. 2D by the Federal Government, CGE material 2088 or Gulf Oil Coat T.

5. For the protective coating of machined surfaces, use CGE material DQ6C6B1 or Tectyl no. 506 from the Valvoline Company, Toronto, Ontario.
   (a) Before applying, remove all rust with fine emery papers and polish with Scotch-Brite. On threads, use a wire brush.
   (b) While wearing rubber gloves, swab with mineral spirits. Within five minutes, apply the fingerprint suppressor. Remove

any excess suppressor with a clean, dry cloth, taking care not to touch the machined surface with bare hands.

(c) Apply a heavy, even layer of protective coating. Allow to dry completely (at least four hours).

(d) Check with an Elcometer (deposit measuring gauge) that the coating is at least 0.003 inches (0.076 mm) thick. Alternatively, visual inspection should show a uniform dark brown colour.

(e) If the protected surface is to be in contact with a wooden surface, apply two layers of a moisture barrier between them.

MONTHLY TESTS AND INSPECTIONS

These tests and inspections are designed to reveal deteriorations or failures of protective systems (shelter, coatings and temperature control) or of the component itself or both. Correct any deteriorations or failures without delay. Inspect the storage area to the criteria specified above and inspect the stored component for:

1. Physical damage.

2. Cleanliness.

3. Signs of condensation.

4. Integrity of protective coatings.

5. Condition of paint.

6. Signs of vermin or insect activity.

7. Satisfactory space heater operation. It is recommended that an alarm system be in place to operate on interruption of power to the space heaters. Alarms should be responded to immediately.

8. Measure and record the ambient temperature and relative humidity adjacent to the component, the winding temperature and the insulation resistance. Record all readings. The stator winding temperature is taken by its RTD's with the space heaters on. The rotor winding temperature is calculated from its resistance, also with the space heaters on.

WINDING INSULATION RESISTANCE MEASUREMENT

Use a 500 volt insulation resistance meter and apply for one minute. Record this reading and correct it to a 40°C basis using the graph of instruction TPP-8501. If this corrected value is less than 1.6 megohms, check first for possible causes of an erroneous reading. For further detail, see ANSI/IEEE standard 43-1974 "Recommended Practice for Testing Insulation Resistance of Rotating Machinery".

REMOVAL FROM STORAGE

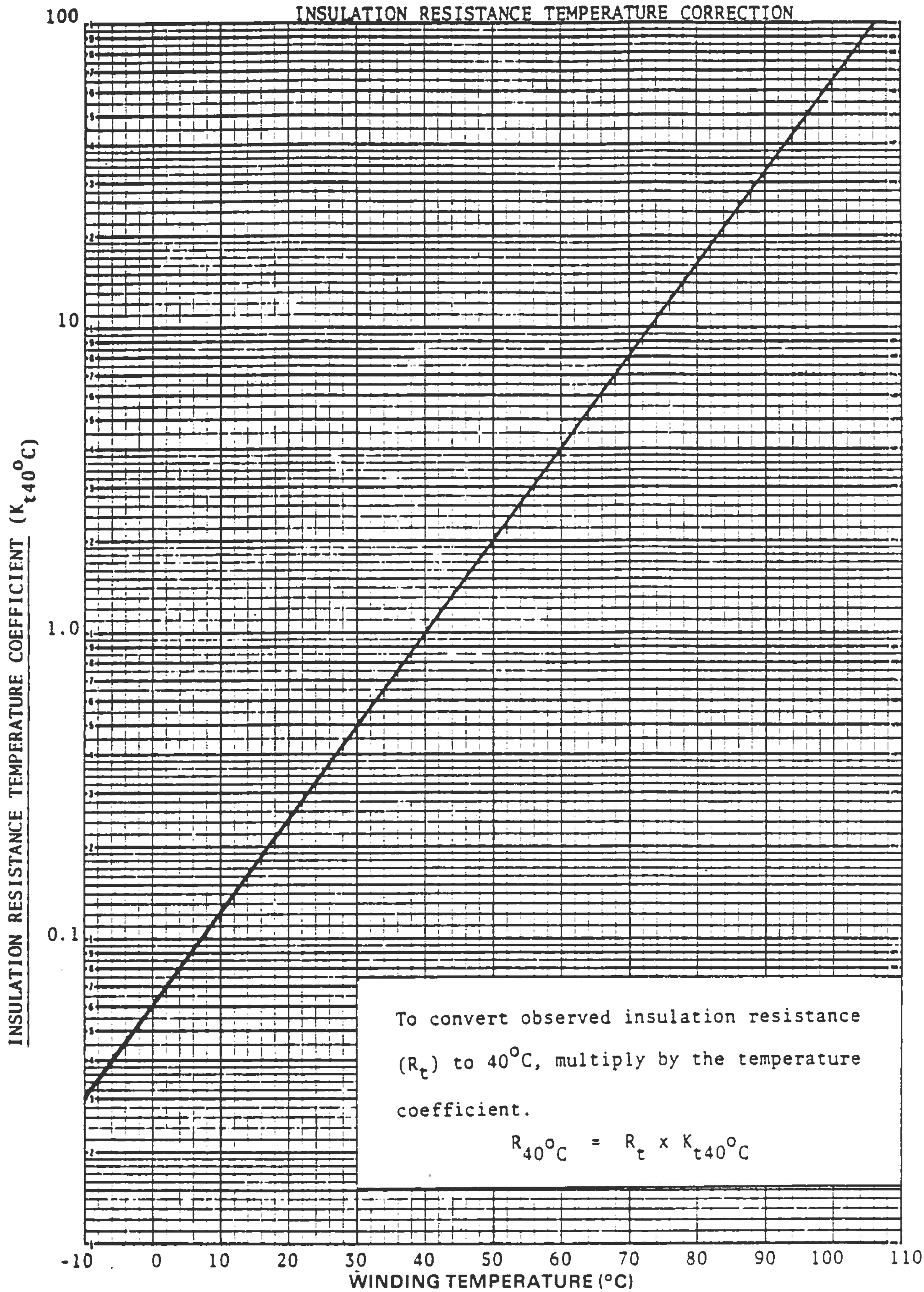
1. Disconnect the space heaters and remove any associated storage provisions.

2. Remove the polyethylene dust covers.

3. If the component is to be transported over a considerable distance to the installation site, package it suitably for the particular mode of transport.

4. A copy of the storage record is to accompany the generator components to the installation site.

5. Whenever the generator is shipped assembled to the diesel engine, protect the generator bearing in accordance with drawing 4001A1176EB.


INSULATION RESISTANCE TEMPERATURE CORRECTION
100
10
1.0
0.1
INSULATION RESISTANCE TEMPERATURE COEFFICIENT (K_{t40^oC})
To convert observed insulation resistance (R_t) to 40°C, multiply by the temperature coefficient.
$R_{40^oC} = R_t \times K_{t40^oC}$
-10
0
10
20
30
40
50
60
70
80
90
100
110
WINDING TEMPERATURE (°C)

2

GENERATOR DATA

APPLICATION:	Main power generating sets; diesel-driven.
TYPE:	ATI Synchronous Generator with one insulated pedestal sleeve bearing (oil-lubricated) and integrally-forged half coupling.
MODEL:	EN-139530
SERIAL NO.:	1044808, 1044809 and 1044810
KW:	2100
KVA:	2625
VOLTS/PHASE/HERTZ:	600/3/60
FULL LOAD AMPERES:	2526
POWER FACTOR:	0.80 Leading
SPEED:	900 RPM
SERVICE FACTOR:	1.10 for 2 hours
TEMPERATURE RISES:	
- STATOR (Class F Insulated):	85°C by RTD at rated output.
- ROTOR (Class F Insulated):	85°C by resistance at rated output.
ENCLOSURE:	Totally enclosed, water-to-air cooled.
EXCITATION:	AC Brushless Exciter EN-139482 and Basler Regulator (see Part 7 of this manual).
MOUNTING:	By Bombardier (See outline drawing 4005E1203CR for the generator and exciter components only).

NOTE

Also see Part 4 of this manual and the test data in Part 10.

ACCESSORIES

Stator Winding RTD's (6):	100 ohm platinum resistance temperature detectors embedded in the stator winding, two per phase. See instruction TPP-8402 in Part 8 of this manual for the resistance-temperature data.
Bearing RTD (1):	Minco model S53, 100 ohm platinum resistance temperature detector in a model F113 holder and with a model F102-2T terminal head; to CGE drawing 4001A1176BS; assembled in accordance with part 20 of drawing 4004D1025HT.
Bearing Temperature Indicator (1):	Teston thermometer to part 1 of CGE drawing 4002B1142PH; assembled in accordance with part 21 of drawing 4004D1025HT.
Air Temperature RTD (1):	Minco model S51, 100 ohm platinum resistance temperature detector in a model F122 fitting; to part 6 of CGE drawing 4002B1154AD; assembled in accordance with part 14 of drawing 4005E1200EA to detect the temperature of air going into the cooler.
Air Temperature Indicators (2):	Teston thermometers; one to CGE drawing 4002B1142PM, assembled in accordance with part 16 of drawing 4005E1200EA to indicate the temperature of air going into the cooler and one to group 2 of CGE drawing 4002B1142PL, assembled in accordance with part 15 of drawing 4005E1200EA to indicate the temperature of air coming out of the cooler.
Water Leak Detector (1):	Barksdale catalog no. DIT-H2 pressure switch to CGE drawing 4002B1114BA, assembled in accordance with group 5 of drawing 4005E1200EA (part 50).
Lighting System (1):	Two light fixture assemblies in accordance with group 1 of CGE drawing 4002B1427HM and one Kondu catalog no. V-3120 switch, assembled in accordance with group 7 of drawing 4005E1200EA (parts 17 and 18).
Make Up Air System (1):	Novenco model LM-4A blower driven by a CGE model 31102FA11 motor and complete with a Novenco model LM-4 inlet filter in accordance with part 3 of CGE drawing 4001A1128GF, assembled in accordance with group 3 of drawing 4005E1200EA.

Space Heaters (4): Chromalox catalog OT-2475 strip heater elements, each rated 750 watts, 240 volts; connected in series for an effective output of 1172 watts on a 600 volt, single phase power supply.

Current Transformers (3): 50/5 ampere ratio; CGE type BR to group 1 of specification 31467. See drawing 497HA146 for secondary excitation characteristics.

NOTE

Connections for all of the above items are given on CGE drawing 4004D1001NW.

Oil Level Gauge (1): Gits style CW-20, item no. 04035.

SPECIAL FEATURES

1. Each generator is designed for marine application, including:
   (a) Internal lighting in accordance with group 7 of drawing 4005E1200EA.
   (b) The painting described in instruction TPP-8401 is modified. Item 4 of EXTERNAL PAINT FINISH becomes two coats of ANSI no. 61 light grey and the inner surfaces of the enclosure are treated as if they were external surfaces and are finished with no. S-800 white carboline epoxy paint.
   (c) The covers are watertight to the bottom of the shaft when the underside of the generator is sealed by others.
   (d) A separate cooler is provided in the bearing pedestal.
   (e) A relay is provided in the make up air circuit in accordance with part 11 of drawing 4005E1200EA.
   (f) Shaft grounding in accordance with drawing 4002B1114BG.
   (g) Shaft jacking in accordance with part 19 of drawing 4004D1025HT.

2. A bearing wear-down gauge is provided in accordance with group 2 of drawing 499C696PP.

3. An air gap (lifting) shim is provided for use when lifting the stator with the rotor threaded into it.

CGE

BRUSHLESS SYNCHRONOUS GENERATOR CONTROL DATA SHEET

CUSTOMER 1100 NAVAIDS - Marine Industries Ltd. Requisition 9280-250-200

GENERATOR Eng'g Notice 139530 Serial No. 1044806,-07,-08 Control Req.

EXCITER Eng. Notice 139482 Serial No. 1044812,-13,-14

RATING

Type AT1 Poles 8 KW 2100 KVA 2625 RPM 900 Volts 600 Phases 3

Hz 60 PF 0.8 Amps 2526 Temperature rise 75 °C by Res.

Overload 10 % for 2 Hours Driven by Bombardier 16 Cyl. Diesel

EXCITER FIELD DATA

*Including 12-OHM External Resistor.

Field amps at rated load 3.3 Resistance at 25°C 29.1* Ohms

Rated Excitation Volts 116 Ceiling Volts 360.*

Minimum Field amps † 1.40 Minimum Field volts (cold) 41*

Overload field amps 3.5 Overload Field volts (hot) 123*

Limit Field Amp to Limit IAC on 3-phase short circuit to 3.5% for 30 sec.

REGULATOR DATA

Manufacturer Basler Electric

Type AVR SR250H3 PAR'L CT BE11976-001

CBS 377 MIN/MAX Excitation Limiter

SBS BE14032001(2) UV Relay BE1-27(2)

UFOV 260A/X & CCT Breaker

GENERATOR STATOR DATA

Stator amps at rated load 2526 Stator amps at overload 2779

Suggested temperature settings for protection equipment using embedded stator RTD's **

alarm 125 °C, trip 135 °C

SPECIAL DATA *

Xd .74 X'd .115 Xd'(sat) .103 X"d .087 X"d(sat) .083

Xq .380 X"q .086 X"q(sat) .082 X0 .036 X2 .086 SCR 1.92

T'd0 5.03 sec T'd .78 sec T"d .031 sec Tao sec

$\frac{X}{R}$ Ratio = $\frac{X"d}{ra}$ = 21.1

REGISTERED PROFESSIONAL ENGINEER J. R. FLEMING PROVINCE OF ONTARIO

Notes: † Minimum excitation volts is that required to give 80% rated AC volts at no load rated speed with cold field unless some other requirement is stated.

* All reactances and time constants are for unsaturated conditions unless otherwise noted.

\- Changes since last issue.

** Based on 40°C ambient cooling air and temperature rise by RTD, at full or S.F. load whichever is greater

Prepared by J.R. Fleming Date 84 04 02

APP 4647 1/78

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

STANDARD EXTERNAL PAINT FINISH

1. Prepare the surfaces by removing all rust, weld spatter, oil, chips and dirt. Gross surface imperfections (such as cavities, sharp edges, burrs, poor quality welds and heavy epoxy) must be repaired before any finishing is done.
2. Mask or remove whatever is not to be painted.
3. Prime paint the entire exterior (except finish-machined surfaces) with one coat of 7635 red primer).
4. Finish paint all primed surfaces with one coat of 4339 medium light-grey paint.

STANDARD INTERNAL PAINT FINISH

1. Prepare the surfaces as in item 1 above.
2. After fabrication and grit-blasting, but before any machining, prime-paint the entire interior (except buttress punchings, space blocks and oil reservoirs) with one coat of 7635 red primer. On buttress punchings and space blocks, use one coat of 7046 aluminum high-temperature varnish. Note that vacuum-pressure impregnation with an epoxy varnish is inherent in the manufacture of wound stators.
3. On oil reservoirs, use one coat of self-priming, oil-resistant 7047 aluminum paint. On all other surfaces (except shaft extensions and bearing journals), use one coat of 5668 tan epoxy.

Material Spec.	Approved Vendor	Vendor's Designation
4339	CGE - Chemical Materials	G2218
5668	GE - Insulating Material Dept.	74004 plus 74010
7046	Mobil Chemical Canada Ltd.	37-A-10 Aluminum Varnish
7047	Matcote Inc.	PH6297
7635	CGE - Chemical Materials	G7635

3

INSTALLATION INSTRUCTIONS

This generator is shipped disassembled. It is designed for indoor operation. Before the generator is put into service at any time, ensure that the requirements of the notes on outline drawing 4005E1203CR are fulfilled.

BOLTED JOINTS

Refer to drawings 4004D1009DA and 4004D1041BH. Examine the rotor for loose nuts or bolts. Correct any deficiencies and ensure that each nut is locked with either lockwashers or a turned-up corner of a locking plate. It is recommended that a corner be turned up only once to minimize the possibility of a failure in service. With two corners available for locking, the locking plate should be replaced on the third assembly or second re-tightening of that joint. Unless otherwise specified, the torque values to be used are given in table 1 of instruction TPP-7515 in Part 5 of this manual.

INSTALLATION PROCEDURE

1. Prepare the base (supplied by others).

2. Inspect the pedestal and bearing. Ensure that they are clean internally and that the mounting surfaces are also free from dirt and burrs. Position the pedestal on the base using the materials identified in group 1 on drawing 4003C1119MC. Partially tighten the pedestal hold-down bolts. Ensure that the insulation resistance to ground (by multimeter) of the pedestal is at least 20,000 ohms. All electrical and mechanical connections must be electrically insulated from this pedestal. Apply an oil film on the bearing spherical seat to prevent rusting and to facilitate bearing alignment. Remove the slushing compound from the shaft and lubricate the journal with oil. Position the lower half of the bearing in place.

3. Remove the air shields from both ends of the stator. Measure the insulation resistance of the stator winding. If the value is less than 1.6 megohms when corrected to 40°C, maintenance is required in accordance with Part 5 of this manual.

4. Measure the insulation resistance of the generator rotor and the exciter armature winding as described in Part 7 of this manual. If the reading is equal to or less than 1.4 megohms when corrected to 40°C, isolate the various system components to locate the faulty one. Refer to Part 5 of this manual if maintenance is required.

5. To facilitate air gap measurements at a later stage, remove any excess epoxy paint from each end at the centre of one field pole and from each end of the stator core tooth nearest the top centerline and at 90° intervals around the inner bore of the stator.

6. The rotor may be carried in the stator when the lifting shim (supplied) is in the air gap. Thread the rotor carefully into the stator. Take care to avoid damaging the stator winding, core, rotor winding and exciter armature.

7. Place the estimated requirement of stator foot shims on the cleaned base. Lift the stator and rotor onto the base, carefully guiding the shaft journal onto the lower bearing half. Place the rotor in the bearing so that the face of the shaft flange is in the proper axial position with respect to the flywheel (assuming that the flywheel is supported by the diesel engine, which should also contain the fixed bearing for the set). Move the bearing pedestal so that the clearance at each end of the bearing is 0.20 inches (5.1 mm).

   Move the bearing pedestal transversely so that the flange is aligned in the horizontal plane. Ensure that the lower half of the bearing is axially in line with the shaft journal by measuring the clearance between the shaft and the four top corners of the bearing half.

   Adjust the number of shims under the pedestal to obtain alignment in the vertical direction. Normally, the shaft should be horizontal within 0.010 inches (0.25 mm), with the outboard end raised slightly to compensate for shaft deflection. This measurement should be taken from the top of the shaft journal. An allowance for generator shaft movement from ambient to running temperature should be calculated using a temperature coefficient of linear expansion of 0.0000114 per °C for the pedestal.

   Alignment should be checked in accordance with instructions by the engine manufacturer.

8. Couple the generator to the flywheel in accordance with instructions by the engine manufacturer.

9. Refer to drawing 4004D1025HT. Pour a small amount of oil over the shaft journal. Assemble the top half of the bearing. Assemble the bearing pedestal cap, which has a locating dowel. Fill the pedestal chamber to the centre of the gauge -0 + 0.4 inches (10 mm - approximately 5 Imperial gallons or 23 liters) with oil that meets CGE specification DQ6B6B. This material specification is met by Imperial Oil Teresso 68 Gulf Harmony 68, Shell Turbo 68, Texaco Regal 68 or Sunoco SW-931. The oil is to be free of water, sediments, resin, soaps or detergents. It can contain corrosion and rust inhibitors. Do not use automotive engine oil or oil containing high-pressure or slippery additives. The oil should be filtered through a 10 micron filter as it goes into the reservoir.

10. The air gap is measured at each end between the centre of one field pole and a stator tooth in 90° intervals in the areas that were scraped ahead of time. Rotate the rotor by manual means to use the same pole. Equalize the air gap on each end separately so that the top measurement is the same as the bottom one and the two side measurements are equal. The stator should be set to obtain these measurements as close as practical. A difference in the diametrically-opposite readings of 5% from their average is a good setting. The maximum difference between any pair of diametrically-opposite readings should not exceed 0.015 inches (0.38 mm).

    Final measurements should be taken with the stator feet hold-down bolts tightened. When the air gap is properly adjusted, the stator feet and the pedestal should be dowelled to the base in accordance with groups 3 and 1 respectively of drawing 4003C1119MC.

11. Refer to drawing 4004D1041BH. Remove the covers from the exciter magnet frame. Ensure that the field leads at both terminal blocks near the split in the magnet frame are connected. Measure the insulation resistance of the exciter field winding (F1,F2). If the value is less than 1.1 megohms when corrected to 40°C, maintenance is required in accordance with Part 5 of this manual.

12. Mount the support for the exciter in accordance with group 2 of drawing 4003C1119MC.

13. Refer to drawing 4004D1041BH. Disconnect the field leads at the two terminal blocks at the split in the magnet frame. Split the magnet frame, then mount it around the armature and on the exciter support to align their cores and to equalize the air gap (nominally 0.100 inches or 2.54 mm). Connect the loose ends of the F1,F2 leads to their terminal block on the magnet frame. Assemble the exciter covers. Dowel the magnet frame feet to the base in accordance with instruction TPP-7529 or equivalent.

14. Refer to drawing 4002B1114BG. Remove the brush (part 2) from its holder (part 3). Remove the shipping wrapping from the shaft and thoroughly clean the shaft. Install the brush in its holder in accordance with the drawing.

15. Assemble the stator shields at both ends of the generator, leaving the upper half off at the exciter (connection) end.

16. Refer to drawing 4005E1200EA. Make the T1 through T6 connections between the stator winding and the conduit box and insulate them for 5000 volts in accordance with instruction TPP-7536 or equivalent. Mount the remaining half of the stator shield.

17. Refer to drawing 4005E1200DW. Mount the top hat assembly above the stator frame and fasten it with parts 42, 48 and 103. Assemble the enclosing covers except those for the conduit box and the upper end of the stator at the connection end. Check to ensure that all gasketing is in good condition. If repairs are necessary, use closed cell, adhesive-backed sponge neoprene in the following sizes:
    (a) part 38 is 1/4 by 1 inch (6 by 25 mm).
    (b) part 39 is 1/4 by 1 1/2 inches (6 by 38 mm).
    (c) part 40 is 1/2 by 1 inch (13 by 25 mm).

    Ensure that all covers mate flush with the mounting surfaces. If any gaps are apparent where there may not be a gasketing seal, fill the gap with RTV. Use Loctite on the threads of capscrews for covers that are to maintain watertight enclosures.

18. Refer to drawing 4004D1001NW. Make the connections from the leads bundled on the stator into the conduit box for the excitation (F1,F2), space heaters (H1,H1A,H2,H2A) and six stator RTD's. Note that this should complete the internal connections so that the remaining stator covers may now be assembled but not the conduit box covers.

MANUAL ROTATION

Rotate the rotor by manual means to ensure that it does not rub or scrape. If possible, ten revolutions are recommended.

ENCLOSURE AND VENTILATION

The assembled generator components are totally enclosed water-to-air cooled, watertight to the bottom of the shaft and splashproof from above when all covers, closures and seals are in place. Provide water to the generator and bearing coolers in accordance with notes 5 and 6 on the outline drawing. Note that the water lines to the bearing cooler are insulated from the pedestal by a gasket (part 22 of drawing 4004D1025HT). Condensation drainage from the generator cooler is provided in accordance with drawing 4003C1119LW.

ACCESSORY CONNECTIONS

Refer to drawing 4004D1001NW.

1. Connect the 600 volt, single phase power cables for the 1172 watt space heaters.

2. Connect the stator winding RTD's to the instrumentation. Suggested settings are to alarm at 120°C and to trip at 130°C.

3. Connect the bearing temperature detector to its instrumentation. Suggested settings are to alarm at 80°C and to trip at 90°C.

4. Connect the air temperature detector to its instrumentation. Suggested settings are to alarm at 78°C and to trip at 85°C.

5. Connect the secondaries of the current transformers to the metering.

6. Connect the 600 volt, three phase power cables for the 1/4 HP make up blower motors.

7. Connect the 120 volt, single phase power cables for the 100 watt lighting circuit.

8. Connect any other accessories that may have been supplied by others.

9. Make the interconnections for the excitation circuit in accordance with separate instruction manual PGEI-11514.

CONNECTING TO LOAD, EXCITATION AND GROUNDING

1. Ensure that the main conduit box is grounded to the frame and the frame is connected to the vessel ground.

2. Ensure that the circuit breaker to the power line or load is open. Make the T1,T2,T3 connections to the circuit breaker and insulate them for 5000 volts in accordance with instruction TPP-7536 or equivalent.

NOTE

Due to the vibration (particularly when the diesel engine is started up) of the flexibly mounted generating set, it is recommended that the power cables from the generator conduit box to the switchgear have flexing capability.

3. Ensure that the excitation connections F1,F2 have been made in item 9 above.

4. Generator and switchgear connections, overload protection and grounding should be done in accordance with local electrical codes.

INSPECTION PRIOR TO INITIAL START

This check-list procedure should also be followed after any lengthy shutdown.

1. Ground connections are in place to the stator frame.

2. Rotor has been rotated by manual means.

3. Generator and driving equipment have been aligned.

4. Generator and exciter magnet frame feet, pedestal and exciter support have been dowelled.

5. Generator and exciter magnet frame mounting bolts are torqued.

6. Instrumentation connections are made.

7. All covers are in place and secured.

8. Oil level in the pedestal is correct.

9. Stator winding insulation resistance is greater than 1.6 megohms when corrected to 40°C.

10. Space heaters are connected:
    (a) Power switch is OFF.
    (b) Insulation resistance is higher than 1 megohm.

11. Water flow is correct in both coolers.

12. Pedestal insulation resistance is higher than 20,000 ohms.

13. Generator field insulation resistance is higher than 1.4 megohms when corrected to 40°C.

14. Exciter field insulation resistance is higher than 1.1 megohms when corrected to 40°C.

15. Excitation connections F1,F2 are made.

16. The make up air system is operating.

17. The lighting system is operational.

18. The water leak detector is operational.

19. Condensation drains are in place.

20. Connections are insulated in accordance with applicable electrical codes.

21. To serve as a reference for bearing wear-down, measure and record the initial condition as follows:
    - (a) Refer to drawing 4004D1025HT. Open up the sight hole by removing parts 15, 16, 17 and 104. Lift out the oil scraper (part 11).
    - (b) Refer to group 2 of drawing 499C696PP. Select and mount in the depth gauge (part 2) the rod that is appropriate to reach from the sight cover flat to the top edge of the oil disc. Use the guide lines on the bar (part 3) to position the gauge on the flat.
    - (c) Record the rod used and the distance to the top of the oil disc.
    - (d) If possible, rotate the rotor 180° by manual means and make a second measurement.

LIQUID DOWEL INSTRUCTIONS

153A7629

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

LIQUID DOWEL INSTRUCTIONS

DOWELLING:

(1) ALIGN COMPONENTS ON BASE USING THE CHISEL MARKS PROVIDED ON SIDE OF FEET AT DOWEL HOLE LOCATIONS.

(2) CHECK ALIGNMENT PER INSTRUCTION BOOK.

(3) WIPE ANY EXCESS DIRT FROM DOWEL HOLES IN FEET.

(4) SEAL GAP BETWEEN FOOT AND BASE WITH THE SEALER PROVIDED, AS SHOWN.

(5) APPLY A RELEASING AGENT TO DOWEL. USE A VERY THIN FILM OF WAX, OIL, OR GREASE, AND WIPE WITH A CLOTH AFTER APPLYING.

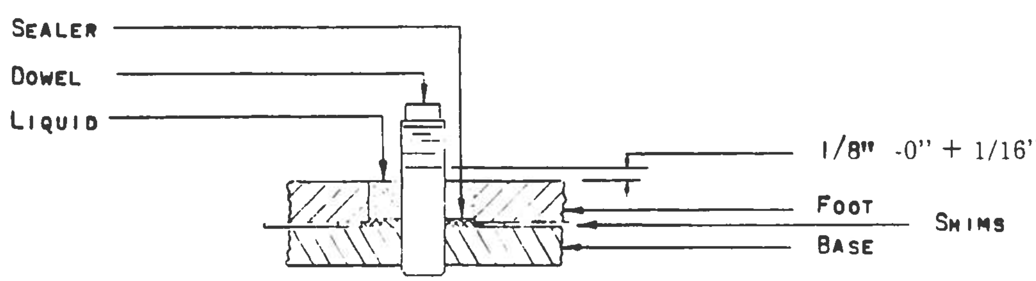
(6) INSERT DOWEL INTO HOLE. THREADS OF DOWEL MUST EXTEND ABOVE FOOT, AS SHOWN. (IT MAY BE DESIRABLE TO TAMP SEALER AFTER INSERTING DOWEL SO AS TO PROVIDE A FLAT BED FOR THE LIQUID).

(7) CUT ABOUT 1/4" FROM TOP OF PLASTIC BOTTLE TO PROVIDE POURING SPOUT.

(8) PREPARE LIQUID. POUR CONTENTS OF GLASS BOTTLE (HARDENER) INTO CONTENTS OF PLASTIC BOTTLE (RESIN MIX) AND STIR, THOROUGHLY.

(9) POUR LIQUID INTO ANNULAR SPACE BETWEEN DOWEL AND FOOT, AS SHOWN. LIQUID SHOULD BE POURED IMMEDIATELY AFTER MIXING AS IT WILL HARDEN IN 15 TO 20 MINUTES. IN CONTAINER.

(10) DO NOT DISTURB DOWEL FOR AT LEAST 8 HOURS.



REDOWELLING:

TO CORRECT A MISALIGNMENT OR TO INSTALL A SPARE MACHINE, THE SAME DOWELS AND REAMED HOLES CAN BE USED. THE PLASTIC IS EASILY CHIPPED FROM THE HOLE OF A FOOT AND THE DOWEL REPOURED.

SAFETY PRECAUTIONS:

SKIN CONTACT WITH LIQUID AND INHALATION OF FUMES SHOULD BE AVOIDED. IF CONTACT OCCURS WASH AFFECTED AREAS THOROUGHLY WITH SOAP AND WATER.

" **ATTENTION:** THIS PROCESS HAS BEEN PATENTED. IT IS NOT TO BE EMPLOYED WITH REFERENCE TO OR APPLIED TO ANY MACHINERY, EQUIPMENT, OR APPARATUS OTHER THAN THAT SUPPLIED BY CANADIAN GENERAL ELECTRIC COMPANY, LIMITED".

PAT. NO. 713,254

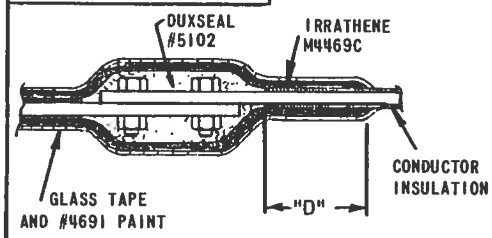
4002B1070AA

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

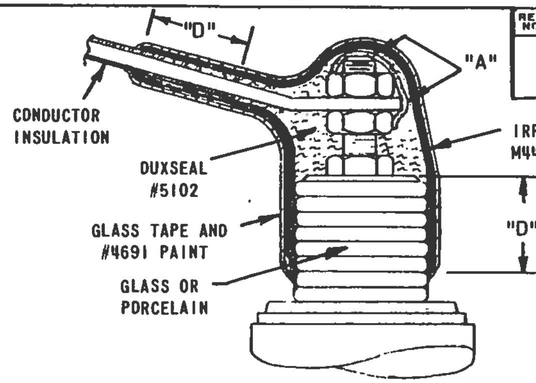
4 0 0 2 B 1 0 7 0 A A

TITLE: INSULATION - CONNECTIONS

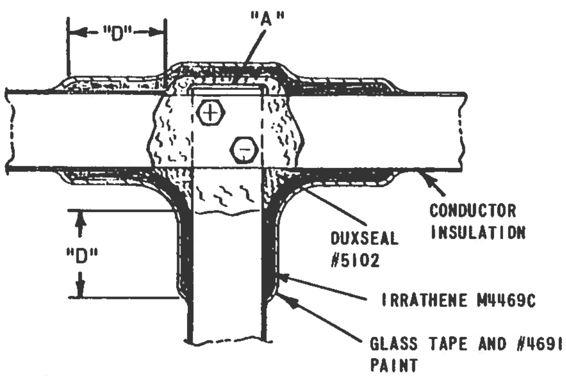
FIRST MADE FOR AC MACHINES (STANDARD)



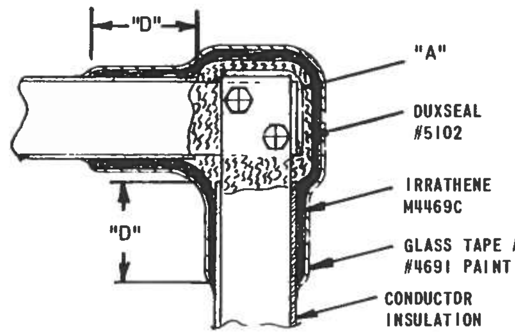
STRAIGHT BUS BAR JOINT
(STRAIGHT CABLE JOINTS INSULATED SIMILARLY)



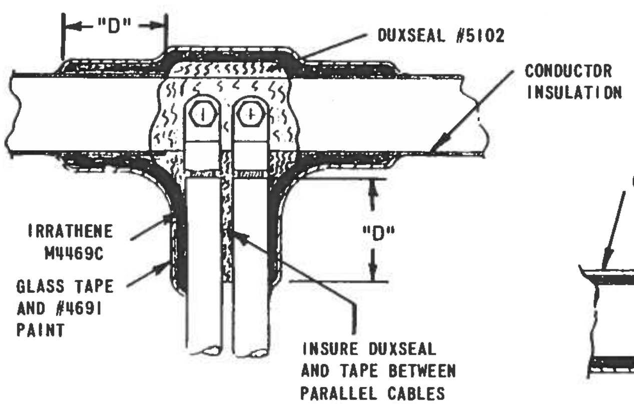
CONNECTIONS TO BUSHINGS



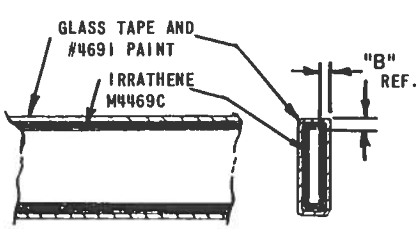
BUS BAR-TEE JOINT



BUS BAR TO BUS BAR 90° JOINT



CABLE TO BUS BAR JOINT



BUS BAR WITHOUT JOINT

NOTES

1. FILL IN AROUND NUTS, BOLTS AND BARE CONDUCTORS WITH DUXSEAL #5102 PUTTY TO GIVE A SMOOTH SURFACE FOR TAPING AND TO EXCLUDE ANY AIR DO NOT USE AN EXCESS.
   KEEP ADJACENT INSULATION SURFACES FREE OF DIRT AND DUXSEAL.
   THE DUXSEAL IS EASIER TO WORK WITH IF WARMED TO APPROXIMATELY 150°F.
2. STRIP GLASS TAPE OFF CONDUCTOR INSULATION FOR DISTANCE "D".
3. APPLY IRRATHENE TAPE PER "TABLE I" OVERLAPPING ADJACENT INSULATION BY AT LEASED DISTANCE "D" THE AREA'S MARKED "A" ARE TO BE COVERED BY A PAD OF IRRATHENE IF NORMAL TAPING WILL NOT COVER THESE SPOTS. HOLD PAD IN PLACE WITH THE FIRST LAYER OF IRRATHENE TAPE.
4. APPLY 1-1/2 LAP LAYER OF GLASS TAPE TO FINISH JOINT. PAINT GLASS WITH BROWN FIRE RETARDANT PAINT #4691.
5.

MATERIAL REQUIRED PER JOINT	5000V	10000V	15000V
IRR.M4469C .010X1 1/2 WD	40 FT.	60 FT.	80 FT.
GLASS #4389 .004 X 1" WD	20 FT.	20 FT.	20 FT.
PAINT #4691	1/2 PT.	1/2 PT.	1/2 PT.
DUXSEAL #5102	1/4 LB.	1/3 LB.	1/2 LB.
IRR.M4469C .010X3" SQ.	2	3	4

TABLE I

MAXIMUM INSULATION LEVEL-VOLTS	LAYERS OF TAPE		INCHES	
	IRR 2/3 LAP	GLASS 1/2 LAP	"D"	"B"
5000	2	1	2	.068
10000	3	1	2.5	.098
15000	4	1	3	.128

CONTROLLED DRAWING - DO NOT REVISE WITHOUT AUTHORIZATION

REVISIONS			PRINTS TO
3	DEC 71	N.C.D. 11032 KC	E10
4	MAR. 16-73	REDRAWN NO CHANGES. K.C.	745
5	JAN 24-75	ADDED TH'K TO GLASS TAPE K.C.	746
			758

REF.

DRAWN BY: S. COOK — 21 Mar 73

CHECKED BY: KARL CULLEN K.C. MAR 16 1973 — Mar 20/73

MOTOR & GENERATOR — PETERBOROUGH WORKS

4 0 0 2 B 1 0 7 0 A A

4

OPERATION

GENERAL

For a description of cycloconverter variable speed drive systems, see separate instruction manual PGEI-11514. Refer to instructions PGEI-5174 and PGEI-11480 in Part 7 of this manual for data on the exciter and the automatic voltage regulator.

STARTING

1. With the load breaker open, open the field circuit and bring the generator up to speed. Observe whether the oil scraper is directing oil to the bearing. If not, shut the generator down immediately and correct the problem.

2. With the generator at rated speed, increase the field current until the terminal voltage is approximately equal to the bus voltage.

3. Use the voltage regulator to control the generator voltage.

4. Adjust the terminal voltage until it is equal to the bus voltage.

5. Vary the speed of the generator until the generator voltage and the bus voltage are in phase.

6. With the generator and bus voltages equal and in phase, close the circuit breaker that connects the generator to the bus.

7. To increase the power (kW) output of the generator, increase the power output of the prime mover.

8. To increase the reactive (kVAR) output of the generator, increase the field current by increasing the voltage setting of the regulator.

RUNNING ACCEPTANCE CRITERIA

Deviations from these nominal or rated values should be recorded for future reference, but are not detrimental as long as they are below alarm values.

1. Operating temperatures (ambient plus rise) for all three generator stator phases are to be below the alarm value of 120°C by RTD. Shutdown is recommended at 130°C.

2. The insulation resistance of the generator stator winding (measured by a 500 or 1000 volt megger) is to be a minimum of 1.6 megohms when corrected to 40°C.

3. The insulation resistance of the generator rotor (field) winding (measured by a 500 or 1000 volt megger) is to be a minimum of 1.4 megohms when corrected to 40°C.

4. Measure the pedestal and frame vibration and compare them to the vibration values in instruction TPP-7515 in Part 5 of this manual, when measured relative to the base. The limit for absolute vibration is 0.010 inches (0.25 mm).

5. Operating temperature (ambient plus rise) for the bearing is to be below the alarm value of 80°C. Shutdown is recommended at 90°C.

6. Proper oil level is centered on the sight gauge, -0 +0.4 inches (10 mm).

7. The cooling water requirements for the air cooler are given in note 5 on the outline drawing.

8. The cooling water requirements for the bearing cooler are given in note 6 on the outline drawing.

9. The water leak detector switch should be set to actuate at 2 inches (50.8 mm) of water column.

10. The air circuit temperature detector should be instrumented to alarm at 78°C and trip at 85°C.

11. The permissable bearing wear (before re-babbitting or replacement) is recommended at 0.007 to 0.010 inches (0.18 to 0.25 mm).

STOPPING

1. Reduce the prime mover output until the kilowatt output of the generator is almost zero. This will require a simultaneous reduction of the field current to prevent overvoltage.

2. Continue to reduce the field current until the stator current is almost zero.

3. Trip the stator circuit breaker.

4. Reduce the prime mover output to minimum.

5. Reduce the field excitation to zero.

GENERATOR PERFORMANCE DATA

Additional data on generator performance will be found in the test data in Part 10 of this manual as well as in figures 4-1 through 4-4, which follow.

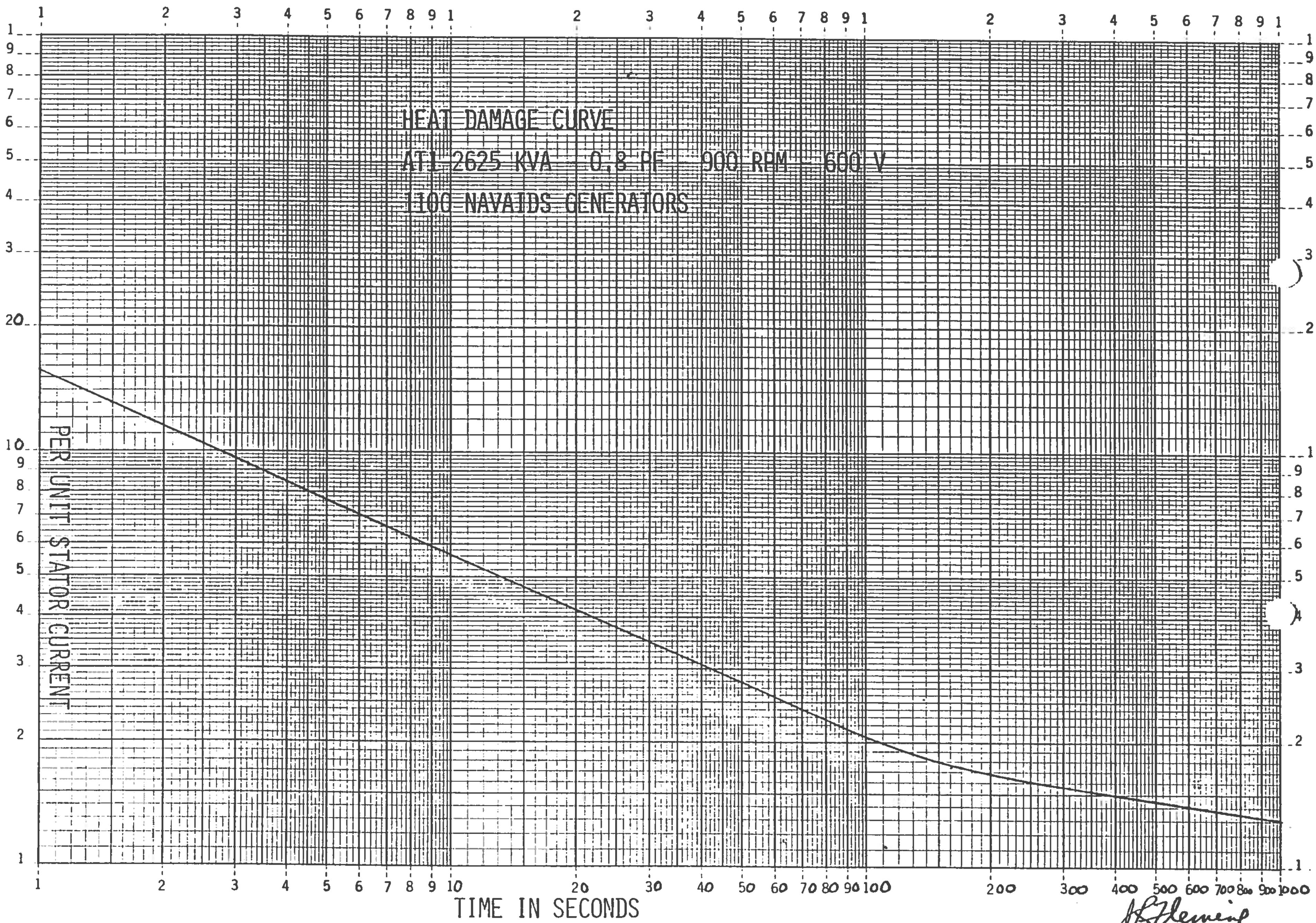
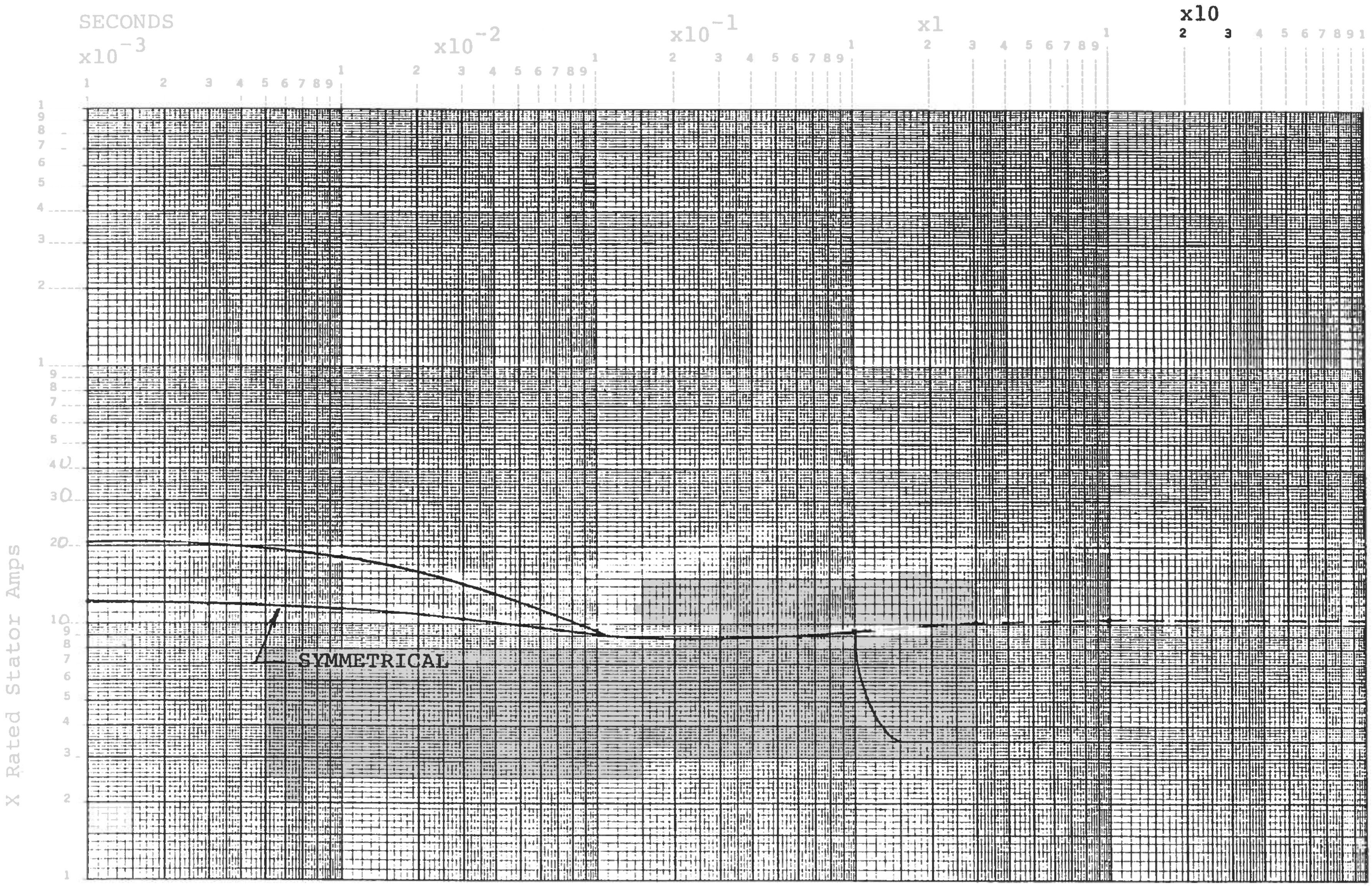

HEAT DAMAGE CURVE
ATI 2625 KVA - 0.8 PF - 900 RPM - 600 V
1100 NAVAIDS GENERATORS
PER UNIT STATOR CURRENT
TIME IN SECONDS
840712.

FIGURE 4-1

SHORT-CIRCUIT DECREMENT CURVE

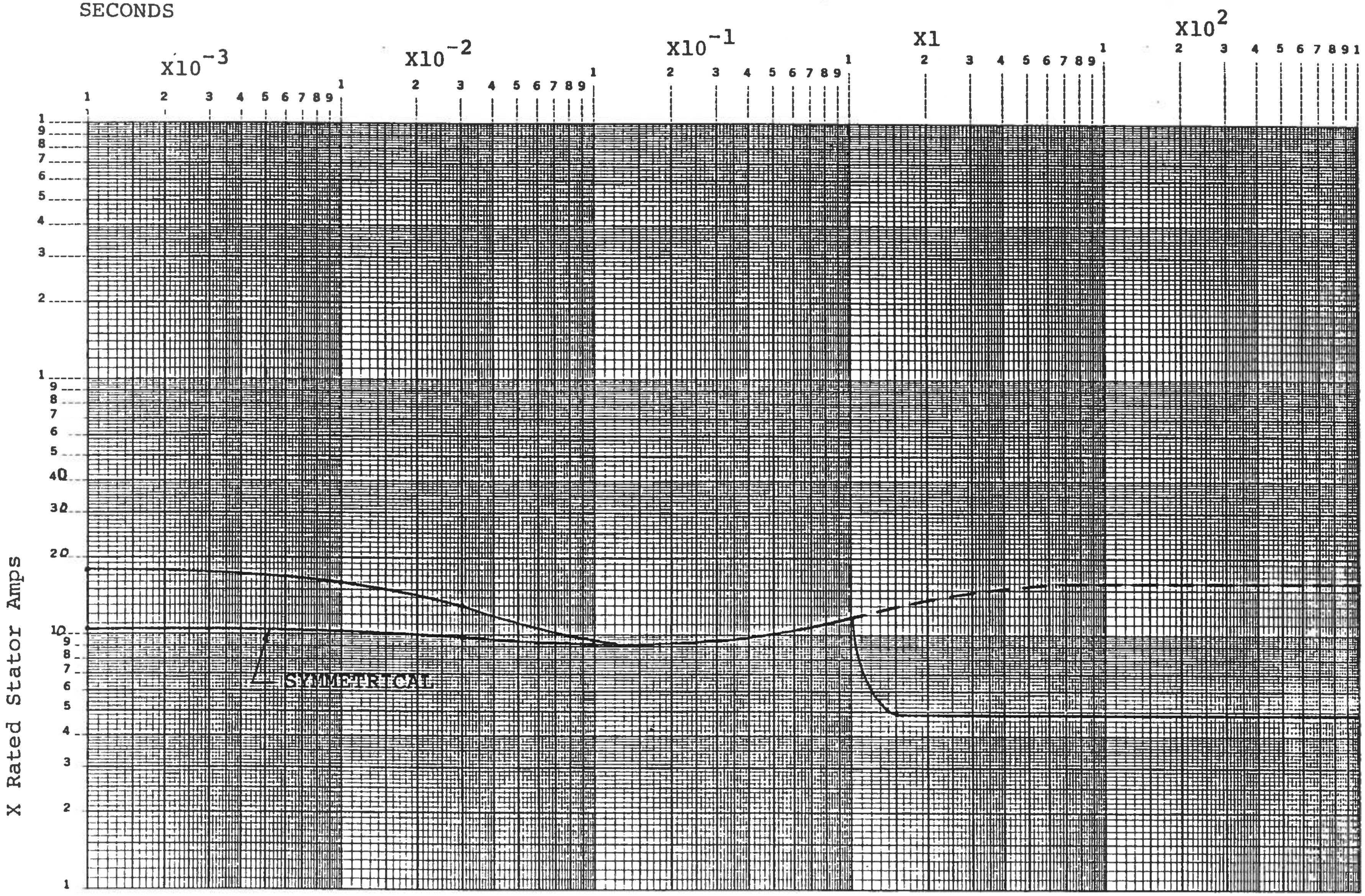


Three-phase short circuit with voltage regulator, gen. field 25°C
1100 Navaids generator-AT1-8Pole-2625KVA-2100KW-0.8PF-900RPM-600V

84 04 03

FIGURE 4-2

SHORT CIRCUIT DECREMENT CURVE

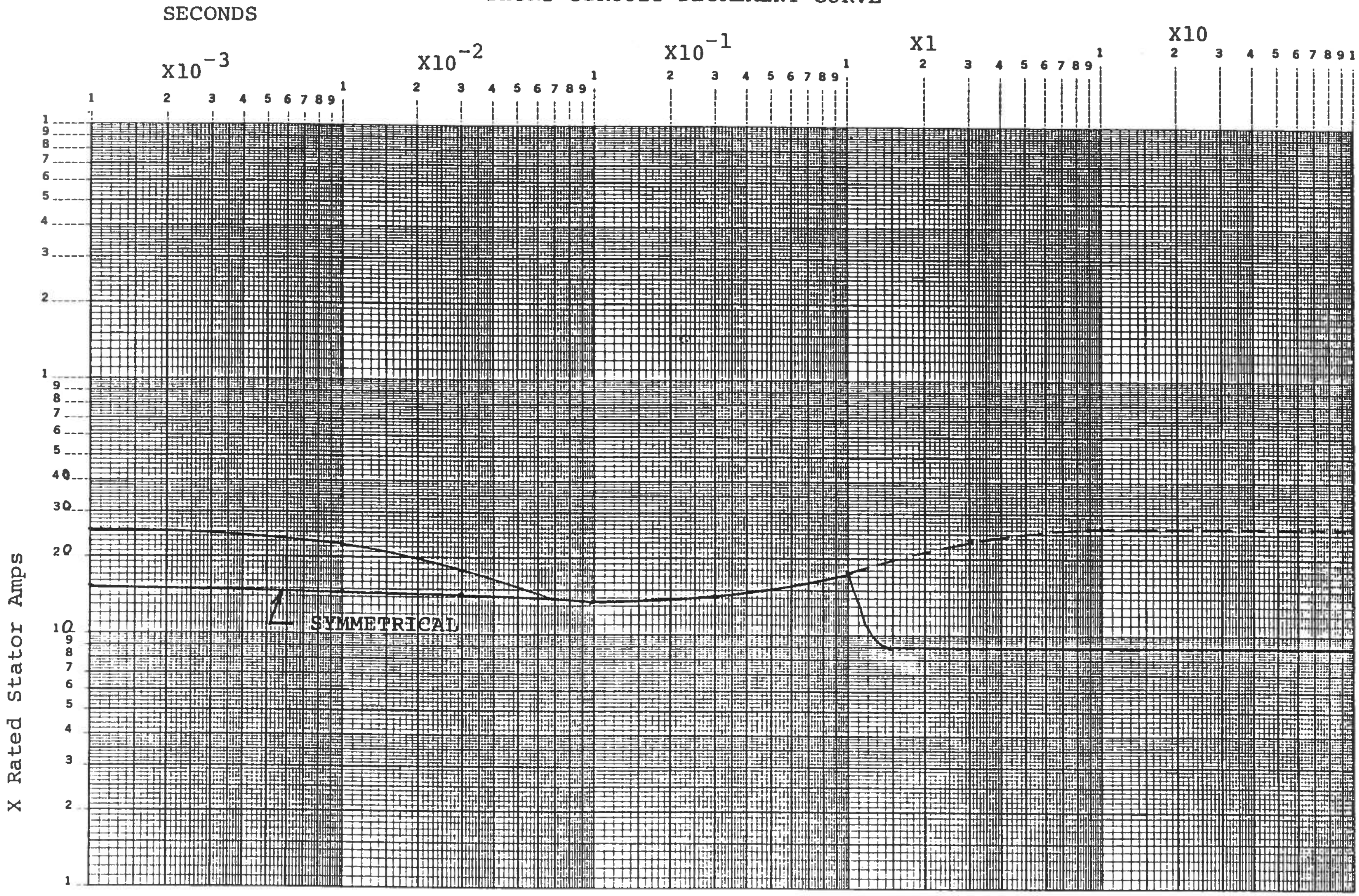


Line-to-line short circuit with voltage regulator, gen. field 25°C
1100 Navaids Generator-AT1-8Pole-2625KVA-2100KW-0.8PF-900RPM-600V

84 04 03

FIGURE 4-3

SHORT CIRCUIT DECREMENT CURVE



Line-to-neutral with regulator, gen. field 25°C
1100 Navaids Generator-AT1-8Pole-2625KVA -2100KW-0.8PF-900RPM-600V 84 04 03

FIGURE 4-4

5

TROUBLESHOOTING

Frequent careful inspection of machines during operation is essential to detect any improper operation that may in time result in a serious failure. Some operating difficulties that may occur (and their causes) are given below and should be corrected as soon as discovered.

EXCESSIVE VIBRATION

An unusual amount of vibration or an increase in generator vibration should be investigated immediately.

If the vibration occurs without the excitation, check for evidence of misalignment or parts rubbing on the rotating element before shifting any balance weights. If the unbalance occurs only when the excitation is applied, check for grounds and for short-circuited turns in the field winding. Refer to ROUTINE MAINTENANCE (instruction TPP-7515) in Part 5 of this manual.

OVERHEATING

The temperature rise of the windings is given on the nameplate. If there is any doubt about the safe operating temperature, take the temperature and confer with the nearest office of Canadian General Electric Company Limited. Give full details, including all nameplate information.

Stator windings will overheat from excessive current, which may be from an overload, an unbalanced voltage that creates unbalanced phase currents, shorted field coil turns or from a wrong polarity pole. Other reasons for over-temperature may be excessive ambient, restricted ventilation, excessive dirt on the winding, clogged ventilation ducts and excessive water temperature. The sleeve bearing may overheat from improper fitting, end thrust, improper oil grade, insufficient oil in the pedestal reservoir, sticking scraper, excessive vibration, misalignment, excessively worn bearing or from shaft currents.

OIL LEAKS

Oil leaks may be caused by too much oil in the pedestal reservoir or excessive air velocity over the pedestal from a disturbed end shield or shaft seal.

LOW INSULATION RESISTANCE

The most likely cause for low insulation resistance (if the surge capacitors have been disconnected) is excessive moisture or moisture with dirt on the winding.

BEARING WEAR

A periodic check should be made to determine the amount of bearing wear. To do this, proceed as in item 21 on page 3-5.

For a new bearing with a nominal journal diameter of 7 inches (178 mm), the diametric clearance should be from 0.010 to 0.013 inches (0.25 to 0.33 mm).

The bearing is considered to be worn out (in need of replacement or re-babbitting) when the clearance reaches 0.020 inches (0.51 mm). Since the bearing wear is all concentrated in the downward direction, the wear is directly expressed as an increase in the dimension from the sight cover flat to the top of the oil disc. Thus, the bearing is worn out when the increase in that dimension is from 0.007 to 0.010 inches (0.18 to 0.25 mm).

ROUTINE MAINTENANCE

Inspect the unit regularly, carefully and in an orderly way to detect unusual conditions which may in time result in a breakdown. Inspections should be carried out as often as operating conditions require and permit. It is beneficial to keep a log of this work so that problem areas can be detected quickly.

Measurements of vibration should be taken regularly. Acceptable levels are given in the following section. Observations on bearings, lubrication and collectors are also given in following sections.

The air gap and alignment should be checked at frequent intervals initially after installation and then during regular maintenance schedules.

Examine the rotating parts for looseness and check the tightness of bolts on fans, poles and cable covers according to table 1. Visual inspection of bolts locked with a locking plate is usually adequate, except for amortisseur joints.

Inspect the amortisseur bolted joints for evidence of overheating, sparking and for bolt tightness after 6 months to a year of operation, and then periodically.

Pole pieces with dovetails have tapered keys in the dovetail slots. These should be checked for tightness with a 3 lb. hammer. Avoid hitting the rotor coil. If any looseness is observed, inspect for damage and worn parts.

Whenever parts are dismantled from a rotor, mark them so that they can be replaced in the same position. This particularly applies to high speed units with dovetailed poles and co-operating spider covers with integral fans. Furthermore, the axial position of poles affects the dynamic balance. Before a dovetailed pole is removed, record the position of the center line of the pole punching iron. If all poles are removed record the position of the pole center lines with respect to the shaft or spider.

Check the bolt tightness on stationary parts also.

VIBRATION CAUSES AND LIMITS

VIBRATION CAUSES

Excessive vibration may be caused by one or more of the following:

(1) Misalignment;

(2) Unbalance in the electrical machine, its coupling and/or in the driven or driving machine;

(3) Transmitted vibration from the driven or driving unit;

BOLT DIA.	PEDESTAL & STATOR FEET	ROTOR POLES	AMORTISSEUR JOINTS	COIL BRACKETS
3/8	—	—	25	25
1/2	—	—	60	60
5/8	—	—	120	120
3/4	200	200	200	200
1	500	500	—	500
1-1/4	700	900	—	1000
1-1/2	1200	1500	—	—

Table 1 Torques for Unlubricated Bolts

(4) An electrical fault in the electrical machine rotor coils.

(5) Support structure inadequate.

Refer to the rotor coil diagnostic instructions if the rotor is suspected to be faulty.

VIBRATION LIMITS

Usual vibration limits for uncoupled units run at rated voltage and excitation are given in table 2. These limits are for the pedestal vibration measured in the horizontal direction, perpendicular to the shaft.

Coupled units under load, depending upon the characteristics of the driven or driving equipment, may exceed the above values by 50%.

CAUTION

Rebalancing which requires the addition of weights must be approved by the factory to ensure adequate attachment.

CLEANING INSTRUCTIONS

Excessive accumulation of dirt, oil and other contamination on the core and windings will decrease the air flow through the unit and increase the temperature rise, thereby tending to decrease the winding life. The windings and core may be cleaned by vacuuming or by blowing with dry air. Suction is preferred because it avoids the danger of moist air and the possibility of blowing dirt into insulation crevices or areas where it becomes more difficult to remove. If dry air is used observe safety practices, and regulate the pressure so as not to damage the insulation.

Remaining oil or dust should then be removed by wiping with a clean cloth. Do not scrape the insulation with sharp edged metal tools or other devices which could cause cuts or abrasions. If necessary, cloths dampened with a suitable cleaning fluid may be used. The cleaning fluid should be used sparingly to avoid saturation of windings. Extremely dirty windings may be cleaned with a low pressure steam jet and then dried out as described later.

Chlorothene (Inhibited 1, 1, 1-Trichloroethane) manufactured by Dow Chemical Co., Midland, Michigan, is recommended for cleaning as it is relatively non-toxic, non-flammable and does not leave an oil film.

Although the safety hazard involved in the use of the above cleaning fluid has been minimized by the vendor, the following practices are recommended:

1. Use the smallest quantity of cleaning fluid as practical, and clean one small area at a time. The use of excess quantities of the fluid increases the fume concentrations and results in a greater hazard.

2. Good ventilation is essential. Be sure that all existing ventilating equipment is operating properly.

3. Because high concentration of fumes is hazardous, respiratory equipment must be used to protect the health of the employees performing the cleaning. The type of respiratory equipment selected for use will depend upon the concentration of the fumes expected to be encountered.

4. However small the exposure may be to cleaning solvents, it is considered good practice to rotate the workmen.

5. Smoking on the job should be prohibited to lessen the fire hazard, and other sources of ignition must be avoided.

6. At least two twenty-pound carbon dioxide fire extinguishers should be part of the equipment of every cleaning crew.

Speed Range RPM	Pedestal Horizontal Vibration Limit Double Amplitude Peak-to-Peak, Mils
100 - 425	2.5
426 - 760	2.0
761 -1250	1.3
1251 -1850	1.0

Table 2

After the windings have been thoroughly cleaned and dried, a finish coat of varnish may be applied, if necessary. The varnish may be sprayed while observing every precaution to minimize the fire hazard. Spray a small test area first to be sure that the cleaned area provides a good bonding surface for the varnish. All insulating varnishes have a low flashpoint and ignition may be caused by a spark, flame or excessive heat. Possible causes of ignition include a short circuit, switching, or electrostatic discharge. The hazard from these sources may be minimized by grounding all metal parts to a common point, including those to be sprayed and the spraying apparatus.

A recommended room temperature cured varnish is GE Cat. No. 74004.

DRYING OUT WINDINGS

New machines should not require drying out unless they have become wet during transportation, storage, or installation. However, all windings should be meggered before connecting to the power system as indicated earlier in the operation section.

To remove moisture, windings must not be heated above 90°C, measured by resistance or by embedded temperature detector or 75°C by externally mounted thermometer. The heating rate should be controlled so that this temperature is not reached in less than two hours. This procedure allows entrapped moisture to be removed slowly without damaging the insulation.

The short circuit method of drying out is applicable only on generators or other units which can be mechanically driven. Operate the machine at rated speed with all phases of the armature winding short circuited. Excite the field to give the short circuit armature current necessary to heat the winding as noted above (usually between 60 to 100 percent of rated armature current).

The drying out should be continued at this temperature until the insulation resistance attains a satisfactory value as described in the section on insulation resistance measurements.

Direct current method of drying out is applicable to all types of AC machines and is done with the machine stationary. A low voltage, high current source of DC power (such as a welding generator) is necessary for drying out armature windings. The armature terminals may be connected in series or multiple to best suit the source of power. It is best to have balanced current in each phase but on Y-connected machines with only three leads out it is necessary to connect two phases in parallel and in series with the third phase. In any case, the maximum current in any phase should be limited to that necessary to give the temperature time relation noted above, and since the machine is stationary this current will usually be between 25 and 50 percent of rated value.

Field windings can be dried out by applying a separate source of DC power to the windings. Do not use brushes to carry the field current, but connect the leads to the terminals on the collector.

The external heat method employs calrod elements, heat lamps or space heaters to heat the unit or part of the unit in a temporary enclosure. This enclosure must be ventilated to allow the moisture to escape with the heated air.

For drying out brushless exciters refer to the appropriate section in the exciter instruction.

GROUND INSULATION RESISTANCE TESTING INSTRUCTIONS

GENERAL

The insulation resistance of a winding is a function of the type and assembly of insulating material and of machine size and voltage. In general, it varies directly with the thickness of the insulation and inversely with conductor surface area.

METHOD

To determine insulation resistance, a DC voltage (usually 500 volts) is applied to the winding for a period of one minute, during which time the current is monitored. The insulation resistance is the quotient of the applied voltage divided by the current. If the polarization index is to be determined, the DC voltage is applied for a second period of ten minutes and the two sets of readings compared (see figure 5).

The insulation resistance of a given winding varies, depending upon the temperature, moisture in or on the winding, cleanliness, age, value and duration of test voltage. Properly interpreted insulation resistance readings, while not a definite measure of insulation dielectric strength, afford a useful indication of the suitability of a winding for operation or over-potential testing. To correlate periodic readings, it is necessary that they be taken at a definite temperature, voltage and length of time.

For specific details on methods and procedures, refer to IEEE Publication 43: 'Recommended Guide for Testing Insulation Resistance of Rotating Machinery'.

WARNING

FOR SAFETY OF PERSONNEL CONDUCTING THE TEST, THE MACHINE MUST BE AT STANDSTILL, ALL WINDINGS DE-ENERGIZED, AND THE WINDING TO BE TESTED GROUNDED FOR SUFFICIENT TIME TO REMOVE ALL RESIDUAL CHARGE PRIOR TO TESTING.

CAUTION

To avoid damage to the windings, note that the voltage used constitutes a voltage test and the value should be selected accordingly, particularly for low voltage, dirty or wet machines.

INTERPRETATION
The standard value of insulation resistance of a rotating machine winding is the least value which a winding should have after cleaning and drying out, or before an appropriate overpotential test is to be applied to the winding. The standard value is not necessarily the minimum value for operation of machinery since a dry winding, as it becomes dirty in operation, will have a lower value of insulation resistance. It is recognized that it is possible to operate machines with insulation resistance approximately 1/10 the standard value.

Insulation resistance varies inversely with the amount of moisture in the insulation and the amount of solvent left in the bonding varnish of the connections if thermoplastic end connection materials are used. From this standpoint, the insulation resistance should increase gradually with age if the machine is operated in a clean dry place. Where thermoset or fully reactive-cured binders are employed (epoxy, polyesters, etc), the resistance of the stator winding should be of a higher value and less change will be experienced in dryout.

Insulation resistance varies with the length of time of voltage application; usually it increases during the first 10 minutes. This variation (dielectric absorption) makes the measurement of a very high insulation resistance somewhat difficult.

Duplicate machines may have widely different insulation resistance. This should not necessarily be considered cause for concern.

A high value of insulation resistance does not necessarily give assurance that the insulation is in good condition and free from defects which eventually may result in a failure. A winding that has failed on the end portion, although clean and dry, may have a relatively high insulation resistance. A machine that has a relatively low insulation resistance may have sufficient dielectric strength to operate satisfactorily for a long period of time.

The current that flows through the insulation and the leakage current that flows along the surface of the end winding and connections determine the insulation resistance. A low value of resistance, therefore, does not indicate whether the insulation itself has deteriorated or whether the surface leakage is excessive. A decrease over a long period of time, however, may be significant.

A winding requires considerable time to absorb moisture; a low insulation resistance is the result of several months of moisture accumulation. A machine that operates continuously will have higher insulation resistance than a machine that operates intermittently.

Measurement of insulation resistance of a winding, where the end winding and connections are encased with dirt, will give a false impression of the insulation. In this case, the insulation may be in good condition, but excessive end leakage may condemn the winding.

A coil may show a high resistance when checked by itself. The insulation resistance may then drop off when it is put into the circuit and the whole circuit checked as a unit. This is due to paralled connection of the coils.

STATOR WINDINGS
The standard values of insulation resistance (Ri) for stator windings of AC machines are:

1 - 999 KVA inclusive:

$$Ri = \left(\frac{\text{Rated Voltage}}{1000} + 1\right) \text{ megohms}$$

1000 KVA and Up
The standard value varies with rating, and winding temperature, see figure 4.

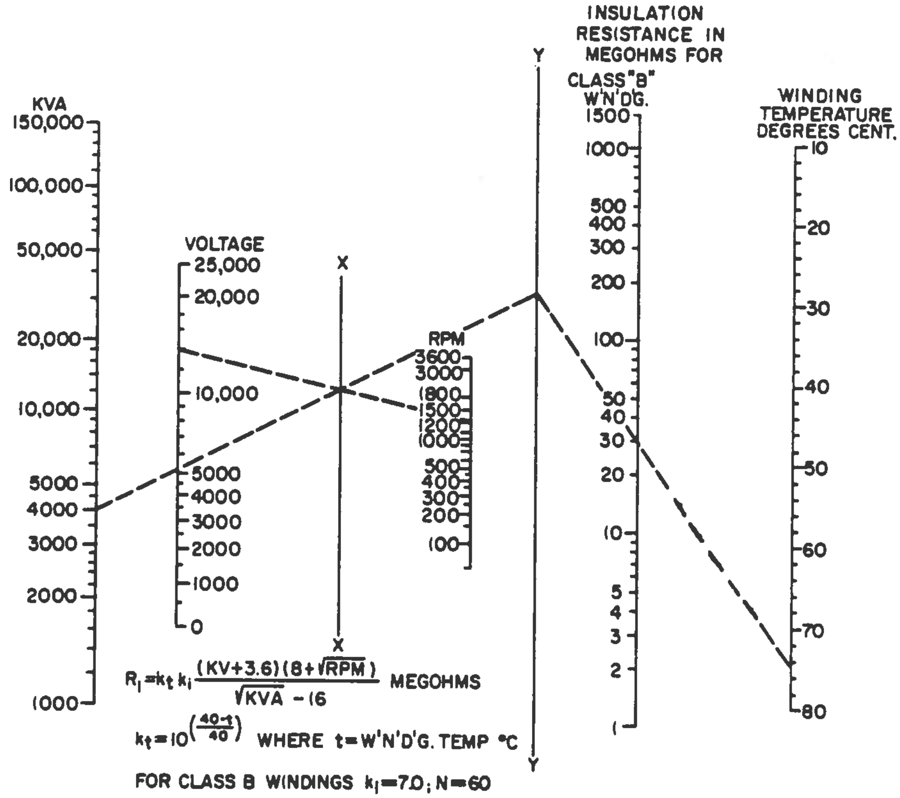
POLARIZATION INDEX
The ratio of insulation resistance values obtained by a ten minute and one minute application of voltage is the polarization index (P.I.). This is useful in determining when the drying process may be terminated or in determining the condition of windings on which no previous data is available. For specific details on methods and procedures, refer to IEEE Publication 43: 'Recommended Guide for Testing Insulation Resistance of Rotating Machinery'. Figure 5 shows how the polarization index can vary with insulation condition.

ROTOR WINDINGS
The standard value of insulation resistance for Class B field windings of a-c machines should be of the order of one megohm for winding temperatures up to 75°C.

DIELECTRIC TESTING INSTRUCTIONS FOR WINDING GROUND INSULATION

Units with complete windings which have not been in service do not require high potential dielectric tests.

No winding should be given dielectric tests before a complete visual inspection of the winding has been made and the insulation resistance indicates the winding to be clean and dry. Disconnect surge capacitors and/or lightning arrestors.



STANDARD INSULATION RESISTANCE OF A-C ARMATURE WINDINGS OF 1000 KVA OR MORE FOR ONE MINUTE APPLICATION OF 500 VOLTS D. C.

To Determine Standard Value of Insulation Resistance

1. Draw a straight line connecting rated speed and rated voltage. This line determines the point of intersection with the line X-X.
2. Draw a straight line connecting the rated KVA and the intersection with the X-X line determined in (1) above, and project this line to the line marked Y-Y. The intersection with Y-Y thus determined remains fixed for a given rating.
3. Draw a straight line connecting the winding temperature with the intersection on the Y-Y line determined in (2) above. The winding temperature to be used is the temperature of the winding at the time of the insulation resistance test.
4. Determine the insulation resistance from the intersection of the line determined in (3(with the proper insulation resistance scale.

Example:

The example shown is for a 4000 KVA, 1200 RPM, 13,800 volt machine. An insulation resistance test taken with winding temperature at 75 C should measure about 30 megohms if the winding is Class "B" insulated. In the same manner the insulation resistance for 25 C winding temperature can be found to be about 200 megohms for a Class "B" winding.

Figure 4 Standard Insulation Resistance of AC Armature Windings of 1000 KVA or more for One Minute Application of 500 Volts DC

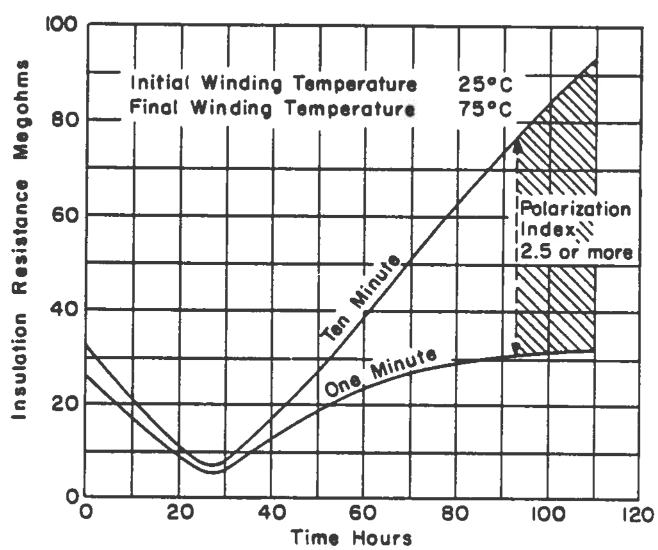


Figure 5 Typical Change in One-Minute and Ten-Minute Insulation Resistance During the Drying Process of a 13,800 Volt Class B Insulated AC Armature Winding

WARNING

PROPER PRECAUTIONS SHOULD BE TAKEN SO THAT NO ONE WILL COME IN CONTACT WITH ANY PART OF THE CIRCUIT OR APPARATUS WHILE THE HIGH POTENTIAL TEST IS BEING MADE.

FOLLOW THE INSTRUCTIONS FOR USE OF THE TEST EQUIPMENT. AFTER THE TEST, THE TESTED WINDING SHOULD BE DISCHARGED TO GROUND BEFORE IT IS TOUCHED BY PERSONNEL.

A-C DIELECTRIC TESTS

The test voltage to be applied should be an A-C voltage of the RMS value specified below. The test voltage should be relatively free from harmonics and subject to stable control over the entire range required. During the test, the voltage should be rapidly built up to the required level, held for one minute, and then rapidly reduced to zero. A sphere gap calibration is recommended with the gap opened 15% and left in the circuit to protect against overvoltage.

NOTE

A variable voltage supply should be used. Full voltage should not be applied or removed by closing or opening a line switch.

To apply high potential tests to a complete winding of any synchronous machine, connect all terminals of the same rated voltage together and apply the specified test voltage between these terminals and ground, with terminals of all other windings grounded. No leads are to be left unconnected during this test as this may cause an extremely severe strain at some point in the winding. Repeat this procedure with each winding of different voltage rating.

To apply a high potential test to a phase or to a section of any winding, both ends of that phase or section must be isolated and voltage applied between both ends and ground. All other phases, sections and windings are to be grounded.

For further information refer to publication IEEE #51 'Guiding Principles for Dielectric Tests'.

The following A-C high potential test voltages are the maximum test voltages recommended for the service condition specified and should not be exceeded, except for special cases where other values have been accepted by contract specifications. In the following, E is the rated voltage of the particular winding to be tested (equals rated line to line voltage for an A-C winding).

A complete new winding, which has not been in service and has not previously been tested should, after complete installation, receive the following:

Field Winding

Generator:	10E, but not less than 1500 volts
Motor:	10E, but not less than 2500 volts

Stator Winding: 2E + 1000 volts

Embedded detectors: 500 volt megger, resistance should be greater than one megohm.

Machines received with windings completely assembled will have successfully passed the above test before shipment. If further tests are required before putting the machine in service, it is recommended the test voltage be 75% of the above values.

A winding in service before repair or installation of a partial set of coils:

Synchronous machine field winding:

Generator, 125-volt field:	1000 volts
Generator, 250-volt field, or any motor:	1500 volts.
Stator winding:	160% E.

A winding in service after repair or installation of a partial set of coils:

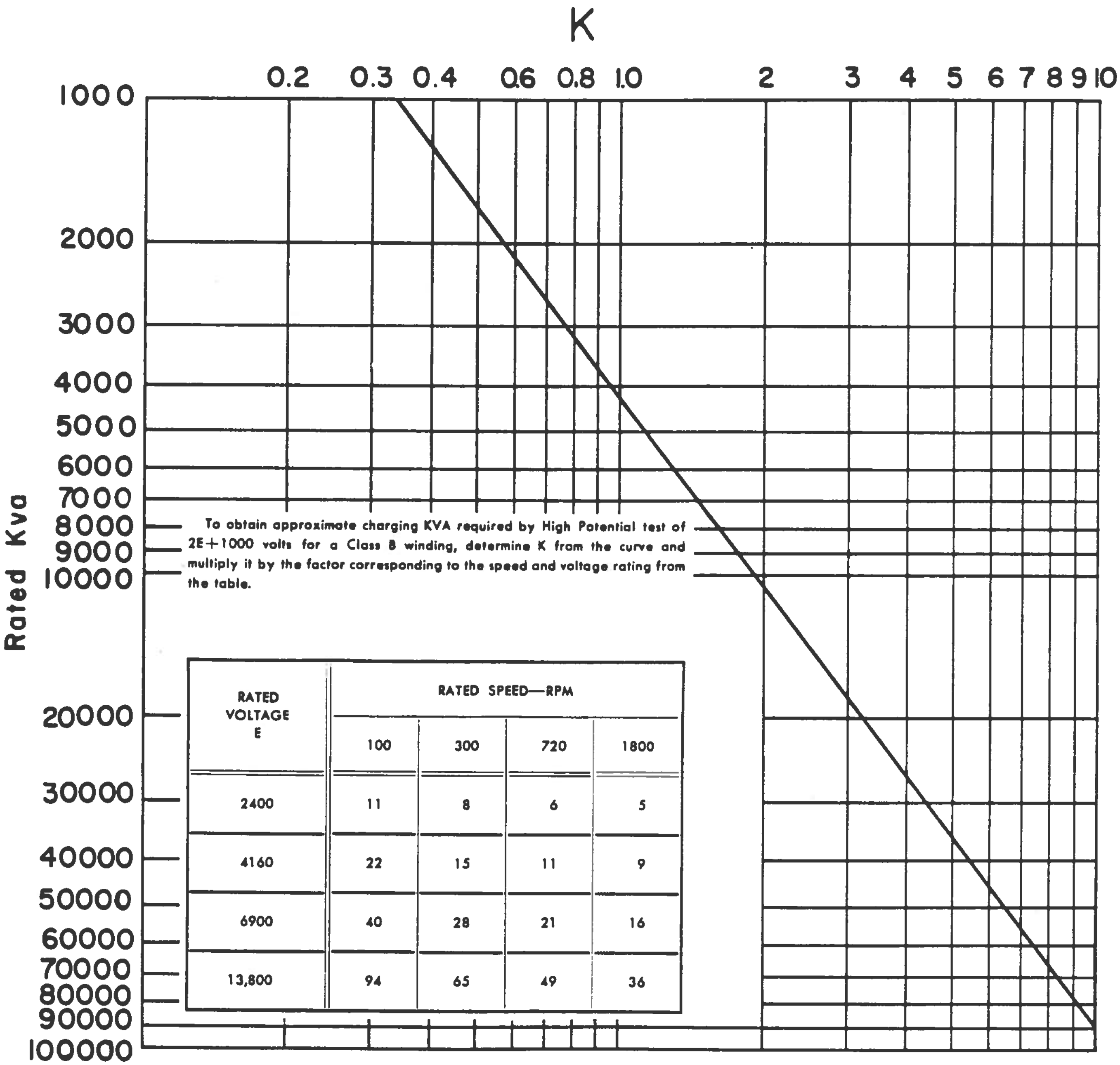
Synchronous machine field winding:

Generator, 125-volts field:	1000 volts
Generator, 250-volt field, or any motor:	1500 volts.
Wound new coils unconnected	2 E + 1000
Complete Stator winding:	150% E.
Embedded detectors	250 volt megger

It is essential that the power supply have ample capacity. The approximate charging Kva or size of testing transformer required when the entire armature winding is subjected to the new-winding test of 2E + 1000 volts is shown in figure 6.

If only one phase of a three-phase winding is tested, the charging Kva will be about 40 per cent of the value determined for the entire winding.

For a high potential test at a test voltage of less than 2E + 1000 volts, or for a test frequency (f)



To obtain approximate charging KVA required by High Potential test of 2E+1000 volts for a Class B winding, determine K from the curve and multiply it by the factor corresponding to the speed and voltage rating from the table.

RATED VOLTAGE E	RATED SPEED—RPM			
	100	300	720	1800
2400	11	8	6	5
4160	22	15	11	9
6900	40	28	21	16
13,800	94	65	49	36

Figure 6 Approximate Charging KVA Required for High Potential Test For An Entire AC Armature Winding

of other than 60 cps, the charging Kva will be the value as determined from the above, multiplied by:

$$\left(\frac{f}{60}\right)\left(\frac{\text{Voltage to be applied}}{2\,E + 1000}\right)^2$$

D-C VOLTAGE TESTING

The a-c voltage test is preferred and recommended for machines operating under AC voltage because this test more nearly duplicates service conditions. However, if AC test equipment of the required capacity cannot be made available, a DC test may be substituted. Follow the instructions for the equipment used. The recommended magnitude of the DC test voltage for AC stator windings is 1.7 times the corresponding RMS AC test voltage. For DC field windings a factor of 1.42 times the AC test voltage is recommended. Positive polarity is preferred for the ungrounded lead. The frame of the machine under test should be solidly grounded during the test and discharge of the winding. The high-potential terminal of the d-c tester should be connected to the winding using bare copper cable. Maintain a clearance between the high-voltage lead and ground and other equipment of four inches plus one inch per 10 KV of applied test voltage. In making the test, the voltage should be increased to full value as rapidly as is consistent with its value being correctly indicated by the meter, and the full voltage maintained for one minute. Reduce voltage to at least one-half test voltage in not less than 10 seconds and ground the winding through a resistor of from one to six ohms per volt of test voltage. The windings should then be solidly connected to the frame until it has been determined that there is no dangerous residual charge.

WARNING

THE D-C VOLTAGE TEST REQUIRES ADDITIONAL SAFETY PRECAUTIONS BECAUSE OF THE HIGH VOLTAGE CHARGE RETAINED BY THE INSULATION AFTER THE TEST. THIS ABSORBED CHARGE WILL DISCHARGE VERY SLOWLY. AFTER COMPLETION OF THE TEST, EACH PHASE OF THE WINDING SHOULD, THEREFORE, BE SOLIDLY CONNECTED TO THE FRAME FOR AT LEAST EIGHT HOURS. EVEN THEN IT SHOULD BE MOMENTARILY GROUNDED IMMEDIATELY PRIOR TO PHYSICAL CONTACT WITH THE WINDING.

Refer to Publication IEEE #95: 'Guide for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage'.

If a d-c volt-ampere curve is obtained on a new winding it may be used for comparison with future curves to estimate the condition or rate of deterioration of the insulation. When applying the d-c test for this purpose, the leakage current does not always indicate impending failure and failures do sometimes occur without warning. The wide variation in the many factors such as humidity, temperature, corona, cleanliness of the winding, etc., seriously affect leakage current readings and prevent precise interpretation of these d-c volt-ampere curves.

DIAGNOSTIC AND REPLACEMENT INSTRUCTIONS FOR ROTOR COILS

GENERAL

Clean the rotor before meggering, if this is practical. A low megger reading may be caused by dirt on the creepage paths, damage in the cable from the rotor coils to the exciter or collector, or damage to the insulation in the support structure between coils, if these are present. Attempt to locate the problem before embarking on the removal of one or more poles.

Shorted rotor coil turns usually create excessive vibration. The faulty coil may be detected by the application of 220 volts, 60 hertz, preferably across the whole set of coils. Comparison of volts across individual coils will likely be sufficient to identify faulty coils. Differences of 3% or less may not be significant. Shorted coils will affect the voltage drop on the two adjacent coils as well. If the rotor is removed from the stator, place it at least one foot from any iron floor beam or iron object when conducting the above test.

Before removing fans, covers, or poles, mark their position and the axial position of the pole centerlines with respect to the spider or shaft shoulder so that they can be replaced in the same position. The axial position of pole centrelines affects the dynamic balance.

Remove the rotor in a manner similar to that for assembly in the installation section.

BEARINGS - LUBRICATION AND MAINTENANCE

The minimum clearance between the journal and bearing is 1 mil per inch of journal diameter plus 3 mils. The bearing should be rebabbited if the clearance exceeds twice this value.

Ensure that the static oil level in the bearing pedestal is kept at the gauge level plus 0.4 inch minus 0 inch.

The choice of oil rests with the purchaser; however, experience indicates that oils having the characteristics given in table 5 should give satisfactory service.

The oil should be checked about every six months, or more often depending upon cleanliness conditions. It should be reconditioned or changed when the neutralization value approaches the value of 1.0 for dry oil (0.5 for wet oil). When the oil is changed, the complete system should be thoroughly cleaned and flushed.

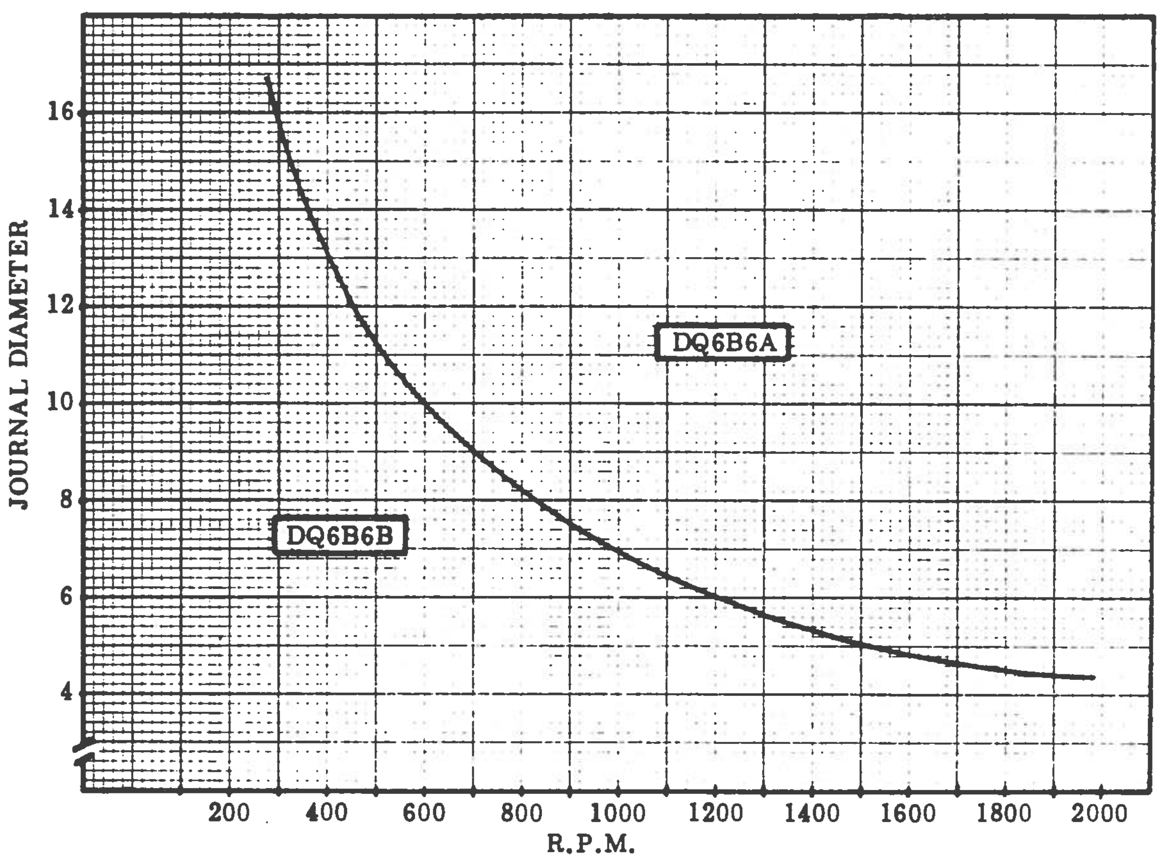
Darkened oil may be the result of shaft currents.

Check the insulated pedestal resistance to ground regularly. Keep the area around the pedestal feet clean of debris and dry on units supplied with insulation under the bearing pedestal.

The oil rings should be checked on start up to see that they revolve.

Ensure that the dust seals, if present, have clearance around the shaft.

Lubricating Oil Recommendations for Sleeve Bearings*



* For ambients of 5C to 40C.
For units with more than one bearing make the oil selection for the largest bearing.
For other conditions refer to the factory.

CGE DESIG-NATION	FLASH POINT, DEG C MIN	FIRE POINT, DEG C MIN	VISCOSITY, SAYBOLT SECONDS AT 40 C MIN	VISCOSITY, SAYBOLT SECONDS AT 40 C MAX	VISCOSITY, SAYBOLT SECONDS AT 100 C MIN	POUR POINT, DEG C MAX	NEUTRAL-IZATION VALUE, mgKOH, MAX	OXID'N TEST, OIL LIFE, HRS, MIN (1)
DQ6B6A	166	188	140	170	43	-7	0.20	1000
DQ6B6B	177	199	270	325	47	-4	0.20	1000

(1) The life of an oil in the oxidation test is the number of hours required to reach a neutralization value of 2.0 mgKOH/g.

Rust-preventing characteristics - A cylindrical steel specimen shows no rusting after being stirred for 24 hours in a mixture of 300 ml of the oil under test both with 30 ml of distilled water and 30 ml of synthetic sea water at a temperature of 60C.

Table 5 Recommended Oil Characteristics

MACHINES OUT OF SERVICE

Site conditions vary considerably so these instructions are given as a guide to minimize the detrimental effect on the rotating electrical machine during a shutdown. For all shutdowns, prevent sweating by energizing heaters and/or by controlling the room temperature. For a shutdown of more than 3 to 4 weeks, lift brushes from collector rings (if supplied) and reoil the shaft journals by flooding with lubricating oil. For extended shutdown, slush shaft journals and collector rings, as described in the receiving and inspection section.

Also, drain water coolers, if present.

CLEANING FLUIDS AND SAFETY

All cleaning fluids are hazardous to a greater or lesser degree to other materials as well as to health and should be considered carefully from four points of view:

1. The fluid selected should not attack the insulation, varnishes or paints involved in the equipment concerned.
2. The fluid should exhibit a minimum health hazard in any of its phases and the health hazard should be understood.
3. The fluid should not represent a significant fire or explosion hazard in any of its phases under normal conditions of use.
4. The fluid should not represent a corrosion hazard to metals.

The following cleaning fluids are suggested and are considered at this time to be the most suitably applicable and least hazardous. As a guide, they are listed in order of preference together with a tabulation of the respective toxic Threshold Level Values (TLV) * in parts per million toxic levels:

CLEANING FLUID	TLV - P.P.M.
(1) Freon - TF (Trichlorotrifluoroethane) Manufactured by E.I. Dupont De Nemours and Co. Wilmington 98, Delaware, U.S.A.	1000
(2) Inhibited 1,1,1 - Trichloroethane Available from the chemical industry	350
(3) A solution of 70% Stoddard Solvent	100
20% Trichloroethylene	100
10% Perchloroethylene (Skin)	100
Available from the chemical industry.	

Freon - TF is preferred because it is a relatively mild solvent which may be used on insulation or on finish varnish coats.

There are other more common cleaning fluids available which have not been listed for reasons involving things such as fire hazard, explosion hazard, toxicity etc.

Since there is a health safety hazard with all solvents, it is good practice to observe at least the following safety precautions:

1. Use as small quantities of solvent as practicable and plan to clean a small area at a time. A large quantity of solvent tends to increase the fume concentration, resulting in a greater hazard.
2. Good ventilation is essential. All existing ventilation facilities should be operating and in good condition.
3. Because the higher concentration of fumes of any solvent is hazardous, respiratory equipment must be used to protect the health of employees involved in cleaning operations. However, the need for and the type of equipment used will depend, of course, upon the nature and the concentration of the toxic fumes that may be encountered.
4. In extreme solvent exposure situations, it is considered to be good safety practice to rotate the people concerned.
5. Solvents tend to migrate through the human skin. It is important, therefore, to wear solvent-proof gloves at all times.
6. Smoking in the vicinity of the work area should be prohibited to reduce the fire or explosion hazard. Other sources of ignition such as welding activities should also be prohibited for the same reason.
7. Carbon dioxide (CO_2) fire extinguishers should always be present and ready for use.

(TLV)* Reg'd Trademark of American Conference of Governmental Industrial Hygienists - 1976.

6

RENEWAL PARTS

SUPPLY PARTS

When ordering supply parts, always include the following information:

a) name of purchaser;

b) complete address to which shipment of parts is to be made;

c) model number and serial number of unit or exciter as given on the appropriate nameplate;

d) rating of the machine;

e) complete description and use of the part being ordered;

f) whether the part is for immediate installation or for stocking as a renewal part.

NOTE
If for immediate use, state if part is being replaced because of normal wear or because of failure.

If the above information is not available, furnish any stamped data that may appear on the original part or, if drawings are available, refer to the drawing and part number.

Should any uncertainty exist as to exactly what is required, or if the part is not clearly shown in the instruction book, a sketch of the part required, giving all necessary dimensions, should accompany the order.

VENDOR PARTS

New parts for equipment that is not made by Canadian General Electric should be ordered direct from the manufacturer. Always supply complete nameplate data for the part, the number of the instruction book or bulletin covering the part, and the figure and part numbers illustrating the part.

REPAIRS AND REPLACEMENTS

When shipping parts to the factory for repair or replacement, observe the following instructions.

1. Contact the Canadian General Electric District Representative. If circumstances permit, he will obtain a return tag and advise the factory of the shipment.

2. Complete the return tag and attach it to the part being shipped. If circumstances are such that immediate shipment is to be made without a tag, ensure that identification tags are securely attached to the part. Ship the part in accordance with instructions from the District Representative.

3. Paint or stencil the customer's name on each part or large piece, as tags may be destroyed during handling.

RECOMMENDED RENEWAL PARTS LIST

The renewal parts recommended below are those most subject to wear in normal operation, or most subject to damage or breakdown due to abnormal operating conditions. Whether or not a supply of spare parts should be maintained depends entirely upon the evaluation of loss that can be sustained during the time required to procure such parts after an unexpected failure.

The quantities recommended below are given only as a guide, but are believed to offer reasonable security against normal operating hazards. Where continuous operation is of paramount importance, consideration should be given to increasing the quantities shown depending on the severity of service conditions and the time required to obtain replacements.

RECOMMENDED MINIMUM STOCK OF RENEWAL PARTS

Item	Description of Part	No. of Units in Operation	
		1 to 4	5 to 9
	Synchronous Motors, Generators & Condensers		
1.	Complete machine*	0	0
2.	Complete stator	1	1
3.	Complete rotor	0	1
4.	Complete pole piece	1	2
5.	Brushholders & springs**	1	2
6.	Brushholder stud insulation**	1 set	2 sets
7.	Brushes**	2 sets	4 sets
8.	Bearings ##	1 set	2 sets
9.	Oil rings	1 set	1 set
10.	Brushless exciter armature**	0	1
11.	Brushless exciter magnet frame**	0	1
12.	Converter spares**	1 set	1 set

* Less base or soleplates.

** If supplied.

One bearing of each size used.

RECEIVING INSPECTION

Each shipment should be visually inspected upon arrival. Any evidence of damage should be reported promptly to the carrier and to the nearest office of Canadian General Electric Company Limited.

STORAGE OF RENEWAL PARTS

Store supply parts in a clean, dry, ventilated place, protected from rodents and termites, to prevent damage or loss. Slush all finished iron or steel surfaces with heavy oil or compound to protect them from corrosion. The parts should be inspected regularly.

G

NOT COMPLETE

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED

PARTS LIST EN - 139530 | CONT ON SHEET 2.2 | SH NO 2.1

SYNCHRONOUS

PSO 505-02 50

TITLE: LIST OF MACHINE COMPONENTS

TYPE	POLES	KW/KVA	PF	RPM	VOLTAGE	O.S.	O.D.	I.D.	STACK
ATI	8	2100	0.8	900	600	25%	60.00	43.40	23.60

FIRST MADE FOR CLASS 1100 NAVAIDS — REQ. 9280-250-0W3

COMP. No	DESCRIPTION	DRAWING NO	A/O	GR. & QTY. 1	GR. & QTY. 2	MATERIAL SPECIFICATION	DATE ADDED	
2500 3 00	WOUND STATOR	4004D1044CK GR 1		1	–	VPI STATOR	APR 23-84	
9901 2 00	RELAY (MOTOR MAKE UP)			1	–	GESCAN CAT. PG 292 CR120B011	FEB 17-84	
2521 2 00	STATOR ASSEMBLY	4006L1086CL GR 1		1	–		JUNE 29-84	
2511 3 00	STATOR COILS	4002B1163BR GR 1	1	1	1	72 COILS	FEB 17-84	
2403 9 00	UNWOUND STATOR	4006L1022AT GR 1		1	–		MAR 13-84	
9902 2 00	ENCL FAB. CE	4004D1028DA GR 1		1	–	} STL	MAY 16-84	
9903 2 00	ENCL FAB OCE	4004D1028DA GR 2		1	–	}	"	
2404 2 00	STATOR FRAME DET.	4006L1022AT GR 3		X	–		MAR 13-84	
9910 2 00	TOP HAT FAB FRONT	4004D1062AL GR 1		1	–	STL	MAY 16-84	
2407 2 00	STATOR SHIELDS D.E.	4004D1069AR GR 1		1	–	O.C.E. } FIBRE	APR 30-84	
2408 2 00	STATOR SHIELDS O.D.E.	4004D1069AP GR 1		1	–	C.E. } GLASS	"	
2409 2 00	CONDUIT BOX ASM. (DIFF. PROT.)	4005E1200EA GR 1		1	–	PART OF TOP HAT	JUNE 29-84	
2410 3 00	SPACE BLOCKS			X	–	SEE COMP 2411		
2411 2 00	STATOR PUNCHINGS	4006L1022AT GR 2	1	X	–	COMPOUND DIE	MAR 13-84	
2412 2 00	STATOR COIL SUPPORTS	4006L1022AT GR 4		X	–		"	
9909 2 00	FR. FOOT HOLE REAM			–	–	GEN'R. ASM.		(1)
2414 2 00	ENCLOSURE DE	4005E1200DW GR 2		X	–	OCE } SHT STL FR.	JUNE 11-84	
2415 2 00	ENCLOSURE O.D.E.	4005E1200DW GR 2		X	–	CE } FIBREGLASS PN'LS	"	
9905 2 00	AIR PRESS SW			–	–			(1)
2417 2 00	MACHINE ACCESS.	4006L1096PG GR 1		X	–	SEE SHT 2.3	JUNE 20-84	
2418 2 00	SPACE HEATERS	4003C1109AE GR 1		1	3	← GR.2 HEATERS ONLY	JUNE 29-84	
9906 2 00	TOP HAT ASM	4005E1200DW GR 3		X	–	1/2 STL & 1/2 FIBREGLASS	JUNE 11-84	
9907 2 00	ENCLOSURE & TOP HAT ASM TO ST FR.	4005E1200DW GR 1		1	–		"	
2517 2 00	CURRENT TRANSFORMER	266A5960 PT 1	1	3	–	50/5A	FEB 17-84	
2495 3 00	STATOR RTD	152A2117AF PT 4	1	6	–	(BUY IN) TW = .310	"	
9908 2 00	TOP HAT BACK	4004D1001NJ GR 1		1	–	FIBRE GLASS	MAY 16-84	
1180 2 00	PAINT FINISH (EXT)	4001A1170BG PT 1		1	–	STD. (ANSI #61 LIGHT GREY)	MAY 11-84	
1191 2 00	PAINT FINISH (INT)	4001A1170BG PT 2		1	–	SPL. (4001A1693AW PT.5)	"	

DESCRIPTION OF GROUPS

STATOR LB.
ROTOR LB.
TOTAL LB.

REVISIONS

NOTE
GR.1 PER GEN
GR.2 SPARES PER SHIP

1 | MAY 11-84 | DELETE COMP 9905 & 9909 | SC

DESIGN REVIEW WILL BE HELD: YES / ~~NO~~

PRINTS TO

F 745
B

REF.

DRAWN BY - J. RAY

CHECKED BY - Steve Cook June 29-84

I A D PETERBOROUGH WORKS

PARTS LIST EN - 139530 | CONT ON SHEET 2.2 | SH NO 2.1

~~NOT~~ COMPLETE FEB 8/84

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED

PARTS LIST EN-139530
CONT ON SHEET 2.3 SH NO 2.2

TITLE LIST OF MACHINE COMPONENTS

TYPE	POLES	KW	PF	RPM	VOLTAGE	O.S.	O.D	I.D	STACK
ATI	8	2100	0.8	900	600	25%	60.00	43.40	23.60

PSO 505-0250

FIRST MADE FOR CLASS 1100 NAVAIDS REQ. 9280-250-0W3

COMP. No			DESCRIPTION	DRAWING NO	A/O	GR. & QTY. 1	2	MATERIAL SPECIFICATION	DATE ADDED
~~2419~~			~~ROTOR ASSEMBLY~~	————		—			
~~2420~~			~~ROTOR ASSEMBLY~~	————		—			
2420	4	00	ROTOR ASSEMBLY	4004D1009DA.GR1		1			
2421	3	00	FAN O.C.E.	499C539GH.GR2		1			
2422	3	00	FAN C.E.	499C539GH.GR1		1			
2423	3	00	COIL BRACKET	4001A1173GA.GR1		16			
~~2424~~	—	—	~~COUPLING (HALF)~~	————					
~~2425~~	—	—	~~COLLECTOR~~	————					
~~2426~~	—	—	~~BALLAST RING~~	————					
2427	4	00	WOUND POLE	4003C1042LH.GR1		8			
2430	4	00	POLE PIECE	4002B1155CH.GR1		8			
2431	3	00	AMORTISSEUR DETAILS	SEE COMP 2430		X			
2432	4	00	POLE PUNCHINGS	4002B1155CHGR.2	1	8			
2433	3	00	SHAFT SPIDER ASM.	4002B1125BF.GR1		1			
2434	2	00	SHAFT	4004D1000DG.GR1	1	1			
~~2435~~			~~ROTOR SPIDER ASM.~~	————		—			
2437	2	00	SPIDER PUNCHINGS	4002B1124BEPT-1.	1	154			

DESCRIPTION OF GROUPS

REVISIONS

DESIGN REVIEW WILL BE HELD: YES ~~NO~~

PRINTS TO: B2, 607, 614

REF.

DRAWN BY: J.RAY
CHECKED BY: W.D. Wright Feb 8/84

IAD
PETERBOROUGH WORKS

PARTS LIST EN-139530
CONT ON SHEET 2.3 SH NO 2.2

~~NEW~~ COMPLETE

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED

PARTS LIST **EN-139530**
CONT ON SHEET – SH NO 2.3

SYNCHRONOUS

PSO 505-0250

TITLE LIST OF MACHINE COMPONENTS

TYPE	POLES	KW ~~KVA~~	PF	RPM	VOLTAGE	O.S.	O.D.	I.D.	STACK
ATI	8	2100	0.8	900	600	25%	60.00	43.40	23.60

FIRST MADE FOR CLASS 1100 NAVAIDS REQ. 9280-250-0W3

COMP. No			DESCRIPTION	DRAWING NO	A O	GR. & QTY. 1	GR. & QTY. 2	MATERIAL SPECIFICATION	DATE ADDED
2460	2	00	OUTLINE ASSEMBLY	4005E1203CR-P.1		1			MAY 9 84-JR
2444	2	00	SHAFT GRD. BRUSH	4002B1114BG-G.1	1	1			MAY 17 84-JR
~~2523~~	~~—~~		~~ROTECTOR ASM. PRIMARY~~	—					
~~2522~~			~~ROTECTOR~~	—					
~~2464~~			~~BRUSH RIGGING~~	—					
~~2470~~			~~PEDESTAL INSULATION~~	—					
2471	3	00	BEARING & PEDESTAL ASM	4006L1104AP-G.1		1			MAY 4 84-JR
2472	2	00	BEARING	4004D1025JH-G.1	1	1	1	7" DIA	APR. 23 84-JR
2473	3	00	BEARING PEDESTAL	SEE COMP. 2471		1			
~~2466~~	—	—	~~BEARING & PEDESTAL ASM~~	—					
7968	2	00	SCHEMATIC DIAG.	4004D1001NW		1			JUNE 28 84-JR
9948	2	00	OIL HEAT EXCHANGER	4004D1025JJ-G.1	1	1			MAY 17 84-JR
~~2476~~			~~BEARING PEDESTAL~~	—					
				—					
~~9931~~			~~EXTRA DRILLING (2464)~~	—					
				—					
~~9932~~			~~EXTRA DRILLING (2445)~~						
9933	2	00	BEARING WEAR GAUGE	499C696PP-G.1		–	1	OMIT PT. 4	MAY 17 84-JR
~~2479~~			~~SOLE PLATES~~	—					
~~2480~~	~~2~~	~~00~~	~~BASE~~	—					
2481	2	00	MACHINE ACCESSORIES	4006L1096PG-G.1		1			JUNE 28 84-JR
9971	2	00	TREATMENT OF INDIC. THERMOMETER BULB	196A5814		1		SUPPLIED WITH COMP. 2493	MAY 4 84-JR
9972	2	00	TREATMENT OF BRG. TEMP. DET. PROBE	196A5806-P.1		1		SUPPLIED WITH COMP. 9940	"
~~992~~			~~BASE COVERS~~	—		—			
9920 ~~2487~~	2	00	BRUSHLESS EXCITER ~~COLLECTOR COVER~~	EN-139482-G.1		1			MAY 9 84-JR
2493	2	00	BRG. TEMP THERMOMETER	4002B1142PH-P.1	1	1			MAY 4 84-JR
9940	2	00	BRG. TEMP R.T.D.	4001A1176BS-P.1	1	1			"
8900	2	00	SHIPPING SKIDS			1			
2498	3	00	TEST AND INSPECT			1			
2499	5	00	PACK AND SHIP			1			

DESCRIPTION OF GROUPS

GR.2 - SPARES PER SHIP

REVISIONS

1	OCT. 15-84	COMP. 9933 WAS 499C696PP-GR.2	JR

PRINTS TO

B2
~~X3~~

REF.

DESIGN REVIEW WILL BE HELD — YES ~~NO~~

DRAWN BY: J. RAY
CHECKED BY: J. Ray JUNE 28/84

IAD
PETERBOROUGH WORKS

PARTS LIST **EN-139530**
CONT ON SHEET – SH NO 2.3

[redacted] COMPLETE

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

PARTS LIST EN-139530 CONT ON SHEET — SH NO 2.4

SYNCHRONOUS

PSO 505-0250

TITLE LIST OF MACHINE COMPONENTS

TYPE	POLES	KW	PF	RPM	VOLTAGE	O.S.	O.D.	I.D.	STACK
ATI	8	2100	0.8	900	600	25%	60.00	43.40	23.60

FIRST MADE FOR CLASS 1100 NAVAIDS REQ. 9280-250-0W3

COMP. No			DESCRIPTION	DRAWING NO	A/O	GR & QTY 1	GR & QTY 2	MATERIAL SPECIFICATION	DATE ADDED
2441	3	00	COOLER	4003C1119LD-P.1	1	1			MAY 4 84-JR
9934	2	00	EXCITER SUPPORT	4003C1117AR-G.1		1			MAY 4 84-JR
9939	2	00	LEAK DETECTOR	4005E1200EA-G.5		X			JUNE 28 84-JR
~~9935~~	~~2~~	~~00~~	~~GEN'R. HOUSING FAB.~~	—		1			
9936	2	00	ASSEMBLY OF INTERNAL LIGHTING	SEE COMP. 9947		1			
~~9937~~	~~2~~	~~00~~	~~GEN'R. HOUSING ASM.~~	—		1			
2518	2	00	AIR CIRCUIT THERM.	4002B1142PM-P.1	1	1		AIR IN	MAY 4 84-JR
9945	2	00	AIR CIRCUIT THERM.	4002B1142PL-G.2	1	1		AIR OUT	"
9904	2	00	AIR CIRCUIT R.T.D.	4002B1154AD-P.6	1	1		AIR IN	"
9941	2	00	MAKE-UP AIR BLOWER & MOTOR	4001A1128GF-P.3	1	1			MAY 4 84-JR
9943	2	00	MAKE-UP AIR BLOWER & MOTOR & FILTER ASM.	4005E1200EA-G.7	1	X			JUNE 28 84-JR
9947	2	00	WIRING ASSEMBLY	4005E1200EA-G.1	1	X		SEE COMP. 9907 SHT. 2.1	JUNE 28 84-JR
~~9949~~	~~2~~	~~00~~	~~SHIPPING CLAMP~~	—				NOT REQ'D.	
9961	2	00	SHIPPING ASM.	—		1		SHIPPED DISASSEMBLED	MAY 24 84-JR
9967	2	00	LIFTING SHIM	197A7255-P.29		1			JUNE 7 84-JR
9962	2	00	ASM. OF AIR COOLER	4005E1200DW-G.5		X			JUNE 11 84-JR
9964	2	00	CONDENSATION DRAIN ASSEMBLY	4003C1119LW-G.1		/			JUNE 20 84-JR
~~9965~~	~~2~~	~~00~~	~~BEARING PACKING~~	~~197A7295-P.3~~		1		~~FOR SHIPMENT~~	MAY 11 84-JR
9966	2	00	MACHINE ASS'Y.	4003C1119MC		1		{DRAWING & ASSOC. PARTS TO BE SENT TO CUSTOMER.	JUNE 12 84-JR
9973	2	00	FLEX. CONNECTION	4002B1142RH-G.1	1	2		} TO BE SHIPPED SEPARATELY.	
9974	2	00	FLEX. CONNECTION	4002B1142RH-G.2	1	2			

DESCRIPTION OF GROUPS

REVISIONS

1	MAY 24-84	DELETE COMP. 9965	JR
2	AUG. 20-84	ADD 9973 & 9974	JR

PRINTS TO: B2, ~~X3~~

REF.

DESIGN REVIEW WILL BE HELD — YES ~~NO~~

DRAWN BY - J. RAY

CHECKED BY - J. Ray JUNE 28/84

IAD PETERBOROUGH WORKS

PARTS LIST EN-139530 CONT ON SHEET — SH NO 2.4

Canadian General Electric

4001A1158NH
CONT ON SHEET — SH. NO. —

REV. NO.

CONT ON SHEET SH. NO.

TITLE
CONVERTER SPARES (AF1000/2000 STD.)

FIRST MADE FOR

GROUP NO. AND QUANTITY 6	5	4	3	2	1	PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
3	3	3	4	4	4	1	DIODE	4001A1158JA PT.1 FORWARD
3	3	3	2	2	2	2	DIODE	4001A1158JB PT.1 REVERSE
2	2	2	2	2	2	3	SCR	I.R. 151RA80
		1			1	4	M-1 FIR. CIR.	4006L1099AM GR.4 250V
	1			1		5	M-1 FIR. CIR.	4006L1099AM GR.5 500V
1			1			6	M-1 FIR. CIR.	4006L1099AM GR.6 750V
1	1	1	1	1	1	7	VARNISH KIT	4001A1158HC GR.1
6	6	6	6	6	6	8	BELLVILLE WASHER	B0750-056 640S
8	8	8	8	8	8	9	KEPS NUTS	#534-750200-52-0242B-0542B 3/4-16
8	8	8	8	8	8	10	NYLOCK BOLT	M4DS616-32Z N22BP25032B 3/8-16x2.0
1	1	1	1	1	1	11	INSUL. GREASE	G322L 690S
1	1	1	1	1	1	12	LOCTITE	CAT. 222-21 THREADLOCKER 10ml.
6	6	6	6	6	6	13	NUT	HEX. STL. JAM 3/8-24 N213P24B

DESCRIPTION OF GROUPS

GR.1 250V MODULE
GR.2 500V MODULE
GR.3 750V MODULE
} 1000 NAVAIDS TYPE

GR.4 250V MODULE
GR.5 500V MODULE
GR.6 750V MODULE
} STD AF2000

REVISIONS

1 SEPT. 10-84 PT. 8 WAS ~~3/8-24 KEP NUT. ADD~~ PT. 13. ADD GR. 4,5,6. QTY PT. 8 WAS 8, PT. 9 WAS 6. PT. 11 WAS G622L T.M.

PRINTS

C
607B

REF. 4006L1103DL

DRAWN BY

CHECKED BY T. D. McCALL MAY 1-84

IND. APP. DIV.
PETERBOROUGH PLANT

4001A1158NH
CONT ON SHEET — SH. NO. —

PW 2351F 4/81

7

BRUSHLESS EXCITER DATA

TYPE:	AF-1030 (See instruction PGEI-5174, drawing 4004D1041BH and group 2 of drawing 4004D1039AE).
	NOTE Drawings 4004D1041BH and 4004D1039AE state that after re-assembly, the converter is to be varnished. The recommended treatment is detailed as group 2 on drawing 4001A1158HC. It is recommended that the two components be included in the stock of renewal parts.
MODEL NO:	EN-139482
SERIAL NO:	1044814, 1044815 and 1044816
KW:	17
SPEED:	900 RPM
EXCITATION VOLTS:	125
EXCITATION AMPS:	3.3
TEMPERATURE RISE:	80°C
DRIVE:	Direct, shaft-mounted (inboard of opposite-to-driven-end bearing).
ENCLOSURE:	Dripproof, self-ventilated (inside generator enclosure).
EXCITATION SOURCE:	Basler voltage regulator (see instruction PGEI-11480).

PGEI-5174

CGE

SYNCHRONOUS GENERATOR BRUSHLESS EXCITER

M-1 RECTIFIER ASSEMBLY AND SERIES AF1000 EXCITER

This instruction describes the general installation, operation and maintenance procedures for a direct-connected brushless exciter.

DESCRIPTION

GENERAL

The brushless exciter consists of a stationary magnet frame, with a dc salient-pole field winding, mounted on a base; a rotating armature with a three-phase ac winding; and a rotating ac-to-dc converter assembly. A schematic diagram is shown in figure 1.

MAGNET FRAME

The magnet frame consists of random-wound field coils, supported on solid pole pieces with conformable felt blocking, and vacuum-pressure-processed with epoxy resin. The coils are vented along the end-head section to provide ample ventilation and temperature-rise margins.

ARMATURE

The armature consists of a laminated core supported by a spider, with a three-phase winding. Provision is made on the spider for mounting the armature onto the motor shaft and for mounting the converter onto the armature.

The laminated core is made up of high-grade magnetic-steel punchings, enameled with compatible inorganic filler in resin.

The armature winding consists of random-wound coils that are vacuum-pressure-processed with epoxy resin. The coils are sufficiently bonded to the slot sides, and the end heads braced with conformable banding, to withstand the centrifugal forces during normal operation.

CONVERTER

The converter consists of six rectifiers (D's), two silicon controlled rectifiers (SCR's) and a control module containing the firing circuit for the SCR's and the commutation filters. Heatsinks, which are attached to, but electrically isolated from, the armature, provide the necessary cooling for the semiconductors as well as the physical support required to withstand centrifugal forces at the rated speed.

CIRCUIT OPERATION

The M-1 rectifier consists of a three-phase full-wave diode bridge with a crowbar circuit comprising SCR1 and SCR2, and a control module containing the firing circuit and commutation filters.

The generator must be rotating, for power to be supplied to the generator field windings from the brushless exciter. The level of field current generated is a function of speed and brushless-exciter field current input. Once the generator is rotating, excitation of the exciter field windings induces three-phase ac power into the armature, which is rectified by the diode bridge.

The dc power applied to the generator field initiates the build-up and establishes the operating level of the generator-stator output voltage.

If the generator pulls out of synchronization, the equipment is protected from induced field voltages by the free-wheeling action of the diode bridge and the crowbar firing of SCR1 and SCR2.

INSTALLATION

GENERAL

Exciter parts must be handled carefully. Slings or blocking should never be used around or against the windings or the rectifier assembly, as these parts are easily damaged. Spreaders should be used, if necessary, to avoid damage to these parts. The windings and the rectifier assembly

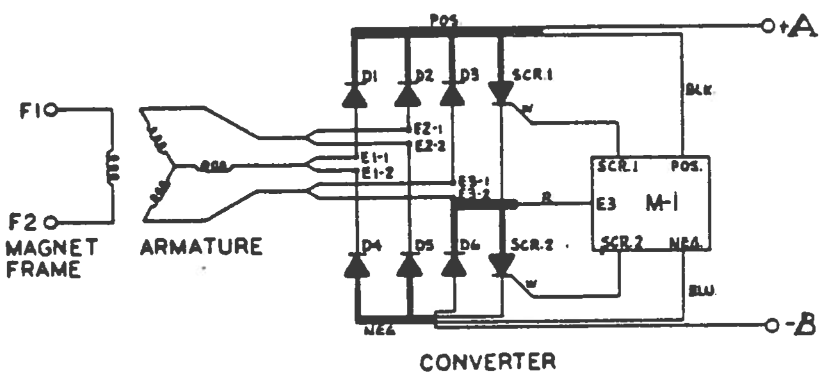


Figure 1 Schematic Diagram

should also be shielded to prevent them from picking up foreign material, in particular, metal chips and filings, weld splatter, etc.

MAGNET FRAME

The magnet frame has been constructed with a vertical split for ease in assembly of the exciter unit. Each half of the frame is self-supporting and should only be lifted by the eye provided. See the exciter assembly drawing for recommended torquing values for the split-assembly bolts. In most cases the magnet frame has been assembled and properly located on the main machine at the factory. Install the magnet frame and line up to the match-marks provided for this purpose. The field poles and armature punchings are to be aligned when the rotor is on the magnetic centre. With a feeler gauge, measure the air gap between the centre of a pole and an armature tooth at both ends of the core, and at several locations around the periphery. Equalize the air gap, using adjustment shims beneath the magnet frame feet. The maximum difference of diametrical readings from the average should not exceed 10% when the hold-down bolts have been tightened. Dowels, which are provided, must be in place before running the unit on load. Refer to instruction TPP-7529 (or to drawing 153A7629) for liquid dowels.

Connect and insulate the dc field supply leads inside the condulet box. Connect and insulate the field-pole leads at the split, for a split magnet frame.

ARMATURE

The armature may be lifted with a padded sling around the armature punchings, and by the tapped holes at the end of the armature spider.

For inboard exciters, the armature must be bolted to or shrunk on the shaft before assembling it into the magnet frame. If a shrink fit is specified, jacking provisions are provided. See the exciter assembly drawing for details.

For outboard exciters, the armature is assembled to the shaft and bolted to the specified torque, as shown on the exciter assembly drawing. Lock all bolts with the means provided. Both the exciter assembly and converter assembly drawings are included in the motor instruction manual for reference. These drawings should be reviewed prior to assembling or disassembling components of the exciter.

COVER

The type of cover construction depends on the ventilation scheme requested to cool the exciter. See the exciter assembly drawing for cover-mounting details. Care must be exercised when installing the cover, to prevent damage to the exciter windings and converter parts. Checks should be made after the cover is installed to ensure that there is adequate clearance between the rotating components of the exciter and the cover.

OPERATION

Prior to start-up of the exciter, check that the external connections have been made according to the drawings and ensure that the clearance between rotating and stationary parts is adequate.

For generator applications, build-up of generator stator voltage should occur with excitation current applied to the exciter magnet frame and with the generator operating at a reasonable speed. Failure to build up voltage could be due to faulty converter or regulator components.

After synchronization, check the synchronous machine line voltage, current, power factor, and exciter field current against the factory data. Some discrepancies due to different winding temperatures and air-gap variations are normal, but should not differ by more than 10%. If excessive exciter field current is required to maintain rated stator voltage and current, the probable cause is shorted rectifiers or SCR's. Locate and replace the defective components.

Adjust the exciter field current to the rated value stamped on the nameplate. This value must not be exceeded, in order for the temperature rise of the machine to stay within allowable limits.

Any abrupt change in stator voltage or current observed on the machine, without a corresponding change in load or exciter field current, suggests a possible failure in an excitation component and should be investigated.

Excessive exciter vibration should be checked. This may be indicative of exciter malfunction such as cell failures or winding failures.

MAINTENANCE

CLEANLINESS

Insulated windings will give satisfactory long-lived operation if kept reasonably clean and free from dirt, oil metal dust, contaminants, etc. Dirt decreases the heat-dissipation ability which, in turn increases the temperature rise of the exciter, thereby reducing the operating capacity.

A similar reduction in heat-dissipating ability is caused by dirt on heat sinks. In addition to reducing capacity, electrically-conductive dirt may lead to sparking and flashovers of components that have bare conductors.

Cleanliness will be promoted by keeping the ventilating air as clean as possible, and through periodic inspection and cleaning. Cleaning should consist of blowing out the machine with dry compressed air, and brushing and wiping with lint-free cloths. Do not use waste. If the windings are extremely dirty, it may be necessary to clean with a suitable liquid solvent designed for the purpose. Normal cleaning and drying procedures for the type of solvent used may be followed. Liquid solvents should not be used on rectifier assemblies.

VIBRATION

The machine should be checked frequently to ensure that there is no evidence of increase in vibration.

WINDINGS

Insulation resistance to ground should be checked periodically to determine the condition of the windings and to detect any failure to ground that may have occurred. Either armature or field windings, being normally ungrounded, may work with one ground on the winding. Any subsequent ground in the winding or on the system, however, can cause considerable damage. Therefore, if a ground is detected in any winding, it should be isolated and repaired immediately.

CAUTION

Before making any insulation or dielectric tests, protect the rectifier assembly from test voltages, by connnecting all heat sinks together with clip leads. Also disconnect the exciter field input.

Test values are as follows:

Field:	Megger	500 volts
	Hipot	2000 volts for 1 minute
Armature:	Megger	500 volts
	Hipot	2500 volts for 1 minute

TROUBLESHOOTING THE RECTIFIER ASSEMBLY

In many cases, an ohmmeter is a satisfactory instrument for checking the condition of diodes and controlled rectifiers. Diodes should show a low resistance in the forward direction and a very high resistance in the reverse direction. Diodes usually fail by shorting and the ohmmeter reads almost zero ohms in both directions. Open-circuited diodes are sometimes found.

When tested with an ohmmeter, controlled rectifiers show a very high resistance in both directions. Defective cells usually read almost zero ohms in both directions.

Rectifiers can often be tested in the circuit, provided there are no low-resistance parallel paths. If there are parallel paths, the rectifier must be disconnected from the circuit for testing, by isolating one lead of the device. In the case of silicon controlled rectifiers, the gate lead should be disconnected at the control module to prevent damage to the cell.

The control module (firing circuit) consists of a metal-oxide varistor trigger circuit. Disconnect all leads to the module before checking the unit with an ohmmeter. A high resistance should be observed between any of the following terminals:

(a) Positive to negative.

(b) Positive to SCR1(G) or SCR1(C) or SCR2(G) or E3.

(c) Negative to SCR1(G) or SCR1(C) or E3.

SCR1(G) to SCR1(C) and SCR2(G) to SCR2(C) should show 100 ohms resistance. Negative to SCR2(G) will show low resistance. SCR1(C) to E3 and SCR2(C) to negative will show zero resistance. See figure 2 for module schematic.

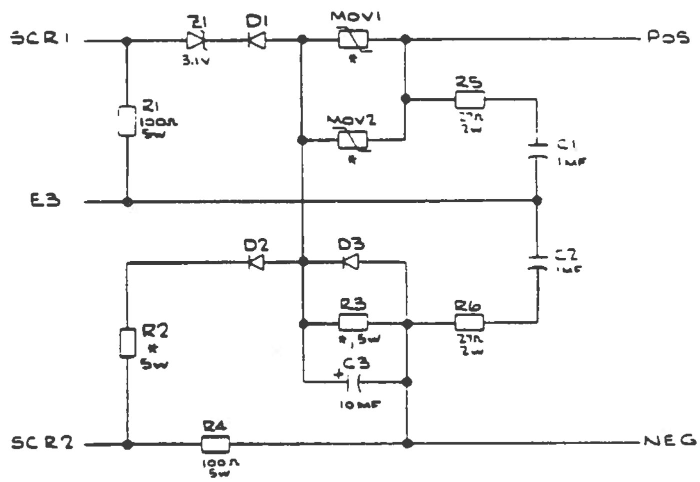


Figure 2. Control Module Schematic.

The Troubleshooting Chart (Table 1) shows a number of possible malfunctions and probable causes and corrections.

TROUBLESHOOTING CHART

TROUBLE	CAUSE	CORRECTION
Excessive exciter field current required to maintain rated stator current	Shorted rectifier or SCR	Locate and replace defective component
Excessive exciter vibration	As above	As above
	Failed winding	Check and rewind
No generator output	Shorted or open rectifiers, or shorted SCR's	Check all cells, replace defective components
	Faulty connections	Locate and repair
	Open exciter field	Locate and repair or replace
	Faulty external control equipment	See manufacturers' equipment manuals

Table 1

REPLACEMENT OF SEMICONDUCTORS

GENERAL INFORMATION

Prior to reassembly, all mating surfaces should be thoroughly cleaned. Check that the surfaces are bare, smooth and without burrs or gouges.

Mating surfaces should then be coated with a thin film of General Electric G322L Silicone Dielectric Grease (or equivalent). Remove excess grease from edges of mating surfaces after assembly (proper application of grease should not have excess grease).

After reassembly, all new or disturbed components should be brush-coated with CGE compound 5197 (two-part mix) available in a kit (see CGE drawing 4001A1158HC, Group 1).

DIODES

The diodes have been secured with kep-nuts, which are locked by applying a small mount of Loctite 222-21.

Replacement diodes are to have the kep-nuts torqued to the value specified on the converter assembly drawing. Table 2 indicates the maximum torque to be applied for most semiconductor stud sizes.

STUD SIZE	MAXIMUM STUD TORQUE
10 - 32	15 inch-pounds
1/4 - 28	30 inch-pounds
3/8 - 24	125 inch-pounds
1/2 - 20	150 inch-pounds
3/4 - 16	300 inch-pounds

Table 2

Avoid straining the stud connection on the diode when making the armature connections to the diodes. Always use two wrenches, one to hold the diode terminal-stud while tightening the connection nut. See the exciter converter assembly drawing for recommended torque values.

SCR's

The SCR should be positioned so that the flexible lead can be connected without strain on the cell.

Mounting details are similar to those detailed for diodes. See the converter assembly drawing for recommended mounting torques.

CONVERTER RENEWAL PARTS

The converter has been designed to use the maximum number of standard parts practical for the application. Listed in table 3 are the manufacturer's recommended spare components for the converter.

Qty per Converter	Qty of Spares Recommended	Description of Part	Part Number
4	4	Diode, Forward Polarity	4001A1158JA P001
2	2	Diode, Reverse Polarity	4001A1158JB P001
2	2	SCR	I.R. 151RA80
1	1	Firing Module	Consult Part Sales
6	6	Belleville Washer	B0750-056
8	8	Keps Nuts	534-750200-52-0242B -0542B 3/4-16
8	8	Nylock Bolt	M4DS616-32Z (N22BP25032B)
6	6	Nut	Hex. Stl. Jam. 3/8-24 N213P24B
1	1	Varnish Kit	4001A1158HC G001
1	1	Insul. Grease	G322L
1	1	Loctite	Cat. 222-21 Thread Locker

Table 3

INSTRUCTIONS

AUTOMATIC VOLTAGE REGULATING SYSTEM

for

AF-1000 SYNCHRONOUS GENERATOR BRUSHLESS EXCITER

LIST OF COMPONENTS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION
01	Basler Electric	9 1256 00 103	Voltage Regulator
02	Basler Electric	9 1747 00 103	Excitation Limiter
03	Basler Electric	9 1096 00 104	Current Boost Module
04	Basler Electric	9 1051 00 105	UFOV Module
05	Basler Electric	11001	Circuit Breaker
06	Basler Electric	BE 11976 001	Paralleling C/T
07	Basler Electric	BE 14032 001	Power C/T
08	Ohmite	2623	Resistor; 16 ohm, 300 watt
09	Hammond	126565	Power Transformer
10	CGE	CR205 PXBAA02A	Contactor
11	Potter Brumfield	PM17AY120	Relay
12	CGE	0177A1372, part 1	Fuse (2 amp, 250 volt)
13	CGE	0177A1379, part 7	Fuse Block

MANUAL AND DRAWING REFERENCE LIST

DESCRIPTION AND PART NO.	INSTRUCTION BOOK REFERENCE	OUTLINE DRAWING NO.
Voltage Regulator 9 1256 00 103	9 1256 00 990	X9125600920 Rev.
Rheostat 03456	--	03456 Rev. B
Excitation Limiter 9 1747 00 103	9 1747 00 990	9 1747 00 920
Current Boost Module 9 1096 00 104	9 1096 00 994	9109600920 Rev. C
UFOV Module 9 105100 105	9 1051 00 99X	9105100920
Circuit Breaker 11011	--	209 E-Frame 2P
Paralleling C/T BE11976 001	--	BE 11976 001
Power C/T BE 14032 001	--	BE 14032 001
Resistor 2623	--	2623
Power Transformer 126565	--	B126565
Contactor CR205PXBAA02A	--	0252A4542AA
Interconnection Drawing	This manual	4002B1166AT (2 sheets)
Relay PM17AY120	--	Data Page 77
Fuse Holder	--	0177A1379, part 7

GENERAL CIRCUIT DESCRIPTION

The circuit arrangement as detailed on the interconnection drawing 4002B1166AT (sheets 1 and 2) utilizes Basler Electric voltage regulator system components to provide field power to the generator brushless exciter field windings.

The system is designed to provide a constant generator output voltage within the manufacturer's published ratings and circuit tolerances. A brief description of the circuit element functions is given below. However, detailed operating instructions of the system components can be obtained from the manufacturer's manuals.

Brushless exciter field power is controlled by the Basler SR250H3 regulator. Feed-back to the regulator is obtained by direct connection to the three generator output lines. Control of the generator output voltage is obtained by adjusting the remote-mounted 500 ohm rheostat. Power to the regulator is obtained from the 600 volt generator lines via the 600/480 volt 3kVA power transformer under normal operating conditions. The current boost CBS377X module has been included to provide short-circuit fault clearing capability for the generator. Under these conditions, the current boost module provides field power to the exciter independently of the regulator. This power is derived from the generator line currents flowing through the BE 11976 001 power current transformers. The underfrequency/overvoltage module UFOV260A and associated circuit breaker provide protection against generator overvoltage and prime mover speed variations.

On overvoltage conditions, the circuit breaker in the regulator power supply lines will trip, removing field power to the generator. If underfrequency conditions exist, the module will adjust the exciter field current to a safe operating level for the frequency generated. Since the system has a high level of forcing capability to minimize the voltage recovery time on load application, a field current limiter module has been provided. This module insures that the field current is kept to a safe operating level, but also allows for maximum forcing for a pre-set interval of time. A contactor has been provided to shut down the regulator system when the generator is not in use. Contacts should be connected into the regulator power source as shown. Paralleling provisions for the generator are also included with the system. Sheet 2 of the interconnection drawing details the recommended wiring for cross-current compensation between generator sets. See the regulator instruction for a complete description of this aspect of the system. Provision for automatic field flashing of the voltage regulator is included. For this purpose, a 24 volt DC power supply is required.

INSTALLATION AND SET-UP

Refer to the manufacturer's instructions for a comprehensive description of the regulator components, including installation and set-up instructions. Paralleling and power current transformer polarity and phase relationships are critical for correct circuit operation. See the interconnection diagram for the recommended connection of these components.

Based on factory tests on the regulator system, the following adjustments and set points are recommended. It is also recommended that these settings be checked and re-adjusted, if necessary, during the commissioning of the generator systems at the time of installation.

Regulator
The reference is part number 9 1256 00 103; instruction 9 1256 00 990.

- Set the generator link on MSO.
- Set the exciter link on SLO.
- Set the range-adjust potentiometer (R14) to obtain rated generator output voltage with the external voltage-adjust potentiometer at the mid-position.
- Set the stability-adjust potentiometer (R11) 90% counter-clockwise for the first trial. Fine tune to obtain the fastest system response with minimal voltage overshoot on load application.

Underfrequency/Overvoltage Module
The reference is part number 9 1051 00 105; instruction 9 1051 00 99X.

- Set the voltage trip to minimum setting without nuisance tripping with the generator system initially energized on open circuit.

Current Boost System

The reference is part number 9 1096 00 104; instruction 9 1096 00 994.

- See instruction section 5.0 for the recommended operational test procedure.
- Set the module to actuate at 80% of rated generator output volts.

Minimum/Maximum Excitation Limiter

The reference is part number 9 1747 00 03; instruction 9 1747 00 990.

- The system does not incorporate a minimum-excitation circuit.
- Leave the potentiometer (R1) as factory set.
- Set the potentiometer (R33) fully clockwise.
- Set the potentiometer (R36) fully counter-clockwise.
- Adjust the potentiometer (R32) to limit the DC field current at 3.9 amperes.
- Adjust the potentiometer (R40) to delay the limit circuit for 2 seconds.

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED
TE-DC
PETERBOROUGH PLANT

16 LEVEL 17 | 63 STOCK 67 | 68 ORIGIN 72 | 77 | 78 STD/SPC

PROD 79 80: 206

PARTS LIST FOR

CONT. ON SHT. 2 SHT. NO. 1

DRAWING: 4006L127IMT

19 TITLE: GEARBOX ASSEMBLY PARTS

FIRST MADE FOR: 9280-248 TO 9280-253

F.C.F. EN 139246

4	3	2	1	PT	DRAWING	P/G	NO	LEV	NAME AND DESCRIPTION	STK	ORIG
			1	1	SEE MAIN EN				GEARBOX MACHINING		
			1	2	4001A1328PA	P	006		V-RING OIL SEAL (V-80S)		
			1	3	4002B1429MM	P	001		COVER (INPUT INBOARD)		
			1	4	0252A6198	P	354		"O" RING (INPUT INBOARD)		
		✓	1	5	SEE MAIN EN				6015NR BEARING (INPUT INBOARD)		
			1	6	THIS DWG	P	006		RETAINING RING (WALDES TRUARC N5100-293)		
				7							
		✓	1	8	SEE MAIN EN				6005NR BEARING (IDLER HELD)		
			3	9	THIS DWG	P	009		RETAINING RING (WALDES TRUARC N5100-98)		
			2	10	0252A6198	P	331		"O"RING (IDLER FLOATING AND HELD)		
			1	11	4002B1429MN	P	001		COVER (IDLER HELD)		
				12							
			1	13	4002B1429MP	P	001		IDLER SHAFT		
		✓	1	14	SEE MAIN EN				IDLER GEAR		
			2	15	THIS DWG	P	015		RETAINING RING (WALDES TRUARC N5100-125)		
			2	16	0169A7013BC	P	005		IDLER/OUTPUT GEAR KEY (1/4 X 1/4 X .50)		
		✓	1	17	SEE MAIN EN				INPUT GEAR		
			1	18	0169A7013BC	P	005		INPUT GEAR KEY (5/8 X 5/8 X .50)		
			1	19	THIS DWG	P	019		RETAINING RING (WALDES TRUARC N5100-250)		
				20							
			1	21	4003C1305LR	G	001		INPUT SHAFT		
				22							
			1	23	4002B1429PK	P	001		SHAFT EXTENSION (INPUT)		
				24							
			1	25	0252A6198	P	346		"O"RING (INPUT OUTBOARD)		
		✓	1	26	SEE MAIN EN				6210RS1 BEARING (INPUT OUTBOARD)		
			1	27	4001A1328PA	P	005		V-RING OIL SEAL (V-50A)		
			1	28	THIS DWG	P	028		RETAINING RING (WALDES TRUARC N5100-196)		

GROUP DESCRIPTION

GROUP EN 139246 GR1

REVISION

PRINTS TO: C

REF. 4006L127I05

16 LEVEL 17 | 63 STOCK 67 | 68 ORIGIN 72 | 77 | 78 STD/SPC

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED
TE-DC
PETERBOROUGH PLANT

PROD 79 80: 206

PARTS LIST FOR

CONT.ON SHT. 3 SHT.NO. 2

DRAWING: 4006L1271MT

19 TITLE GEARBOX ASSEMBLY PARTS

FIRST MADE FOR: 9280-248 TO 9280-253

F.C.F. EN 139246

GROUP QUANTITY 4	3	2	1	PT	DRAWING	P/G	NO	LEV	NAME AND DESCRIPTION	STK	ORIG
			1	29	4002B1429PL	P	001		CARTRIDGE (INPUT OUTBOARD)		
				30							
		✓	2	31	SEE MAIN EN				6005RS1 BEARING (IDLER & OUTPUT FLOATING)		
			1	32	4002B1429MT	P	001		COVER (IDLER FLOATING)		
				33							
				34							
				35							
			1	36	0252A6198	P	346		"O"RING (OUTPUT HELD)		
			1	37	THIS DWG	P	037		RETAINING RING (WALDES TRUARC N5000-281)		
		✓	1	38	SEE MAIN EN				6207RS1 BEARING (OUTPUT HELD)		
			2	39	THIS DWG	P	039		RETAINING RING (WALDES TRUARC N5100-137)		
			1	40	4001A1328PA	P	002		V-RING OIL SEAL (V-32A)		
			1	41	4002B1429MW	P	001		CARTRIDGE (OUTPUT HELD)		
				42							
		✓	1	43	4002B1429NA	P	001		SHAFT EXTENSION (OUTPUT)		
		✓	1	44	4002B1429NB	P	001		SHAFT (OUTPUT)		
				45							
				46							
			1	47	0252A6198	P	328		"O"RING (OUTPUT FLOATING)		
			1	48	4001A1328PA	P	001		V-RING OIL SEAL (V-20A)		
		✓	1	49	4002B1429NC	P	001		COVER (OUTPUT FLOATING)		
				50							
				51							
		✓	1	52	SEE MAIN EN				OUTPUT GEAR		
				53							
			1	54	THIS DWG	P	054		BREATHER (DOWTY #UC-SAB-1563-15)		
			2	55	THIS DWG	P	055		PIPE PLUG (1" IRON CODE#971119)		
			1	56	NP275755	P	001		NAMEPLATE		

GROUP DESCRIPTION

R[illegible]N 139246 GR1

REVISION

1 20JUN84 JLT QTY OF PT 31 WAS 1

PRINTS TO: C

REF. 4006L1271GF

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CHECKED BY: JLT

JAN17 1981

4006L1271MT

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED
TE-DC
PETERBOROUGH PLANT

16 LEVEL 17 | 63 STOCK 67 | 68 ORIGIN 72 | 77 | 78 STD/SPC

PROD 79 80: 206

PARTS LIST FOR

CONT.ON SHT. - SHT.NO. 3

DRAWING: 4006L1271MT

19 TITLE: GEARBOX ASSEMBLY PARTS

FIRST MADE FOR: 9280-248 TO 9280-253

F.C.F. EN 139246

QTY 4	QTY 3	QTY 2	QTY 1	PT	DRAWING	P/G	NO	LEV	NAME AND DESCRIPTION	STK	ORIG
			1	57	THIS DWG	P	057		VIEW GAUGE (GITS BROS MFG #04040)		
			1	58	THIS DWG	P	058		BUSHING (3/4X1/4) MAL IRON CODE# 971162)		
			1	59	THIS DWG	P	059		BUSHING (1"X3/4) MAL IRON CODE# 971168)		
			2	105	N509P1324				DOWEL PIN (STL 1/8 X 1.50)		
			4	104	N530P404C				DRIVE SCREW (STL #4 X .26)		
			16	103	N22P21012B				SCREW (HEX HD STL 1/4-20X.76)		
			26	102	N405P41C				LOCKWASHER (1/4 SPRING NON-TANGLING)		
			10	101	N22P21016B				SCREW (HEX HD STL 1/4-20X1.00)		

GROUP DESCRIPTION: 1 EN 139246 GRI

REVISION: 1 22AU084 ADDED PT59 JLT

PRINTS TO: C

REF. 4006L1271GF

DRAWN BY: JIM THOMPSON

CHECKED BY: ...17.1984

4006L1271MT

Sale Contacts - Nova Scotia

Choose your market segment for contact information on your sales representative.

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Dartmouth, Nova Scotia
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You can also contact Basler Electric directly at +1 618.654.2341 or fax us at +1 618.654.2351 or email us at info@basler.com.

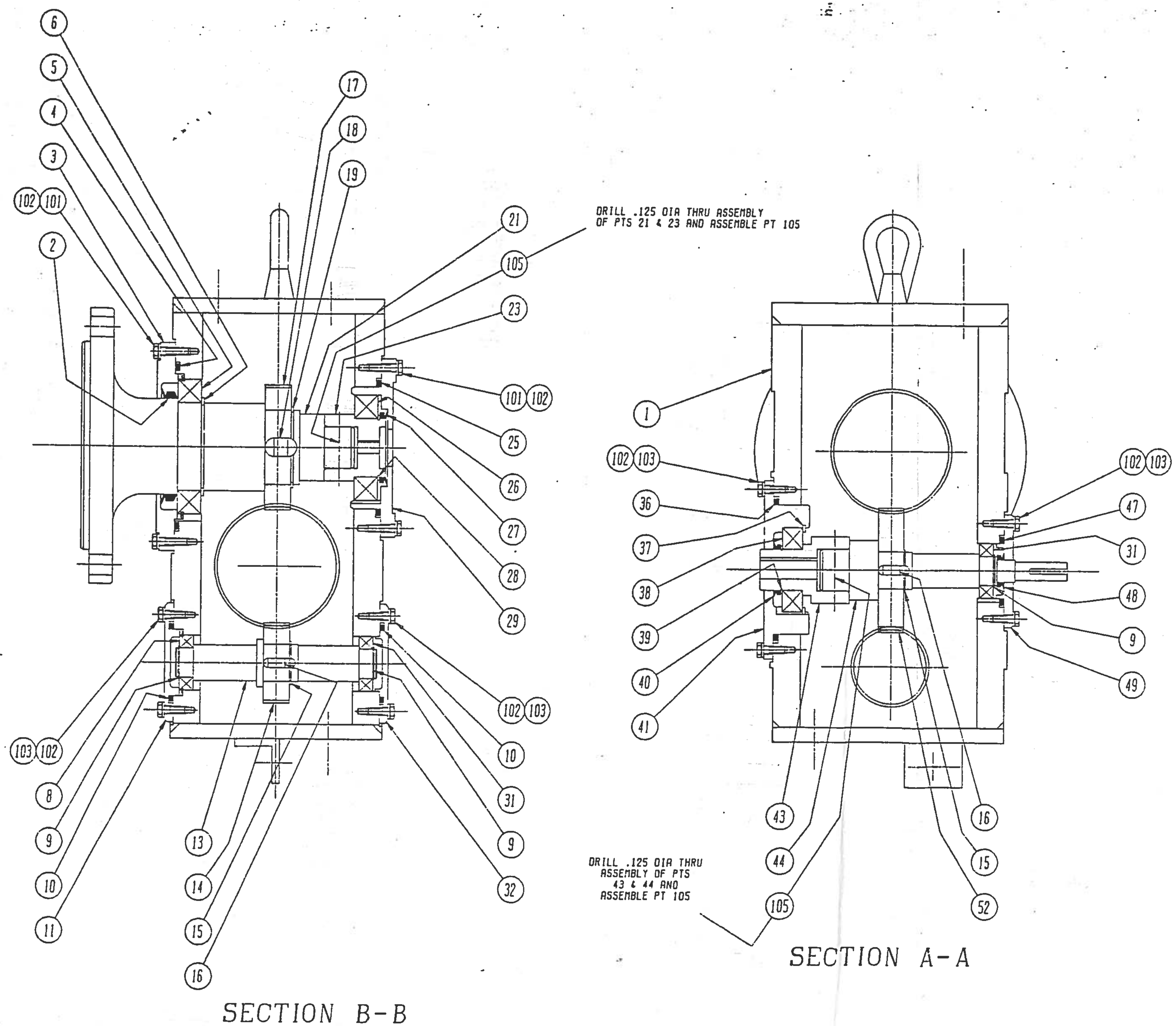
CANADIAN GENERAL ELECTRIC COMPANY LIMITED

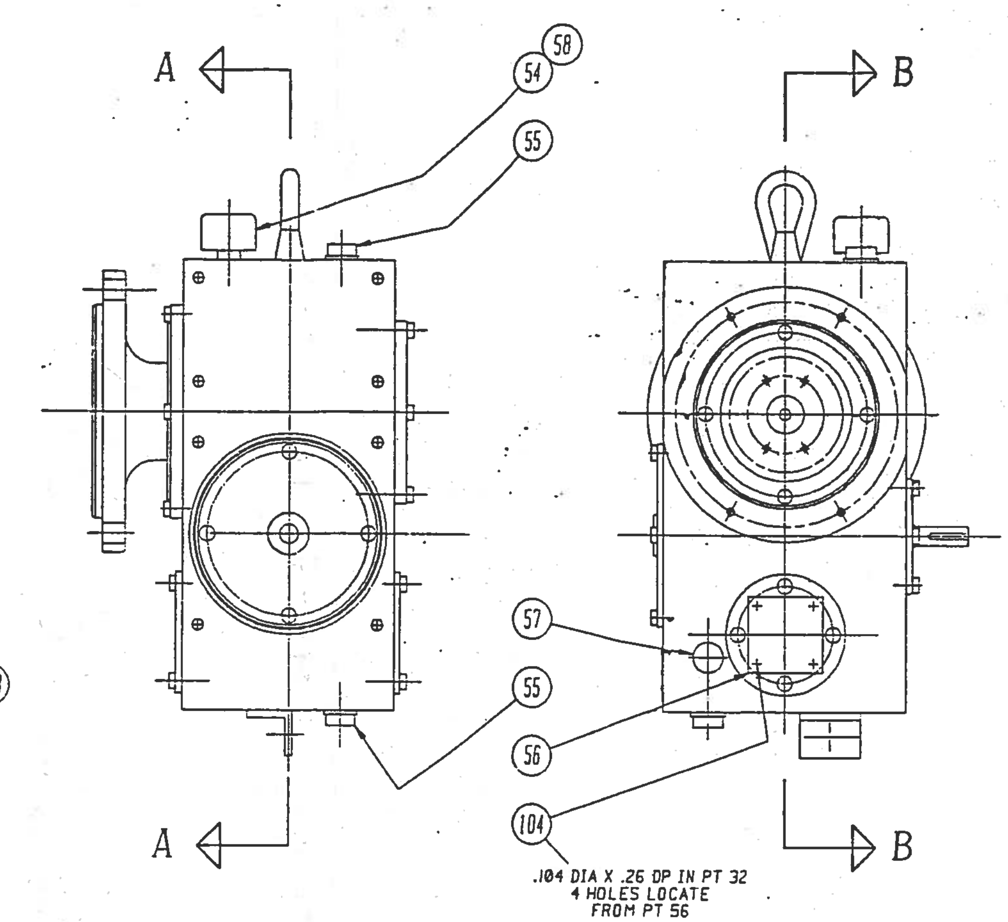
TITLE GEARBOX ASSEMBLY

FIRST MADE FOR 9288-248 TO 9288-253

EN139246

4004D1142JR





99

NOTES:

1) FOR PART NUMBERS IN SMALL CIRCLES REFER TO GEARBOX ASSEMBLY PARTS DWG 4006L1271MT G001

2) FILL CASING WITH #-4254B OIL TO CENTRE OF SIGHT GAUGE (APPROX 1 LITRE)

3) INSIDE OF GEARBOX TO BE PAINTED WITH #4277 OIL PROOF GREY PAINT

4) INSURE THAT PTS 11,29 & 41 ARE ASSEMBLED WITH OIL DRAIN GROOVES AT 6:00 O'CLOCK

Rec'd 11-05-89

REVISIONS | PRINTS TO C

DRAWN BY	CHECKED BY		
JL THOMPSON	JLT JAN17-84	IAD-DC PETERBOROUGH PLANT	4004D1142JR

INSTRUCTION
MANUAL

Basler Electric
Highland, Illinois

VOLTAGE REGULATOR
Models: SR32H/E, SR63H/E,
SR125H/E, SR250/E
Part Numbers: 9 1256 00 100-103 (SR-H
9 1256 00 104-107 (SR-E

Publication:
Number: 9 1256 00 990
Date: August 29, 1978
Revision 5: January, 1984

WARNING

TO PREVENT POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED TECHNICIANS/OPERATORS SHOULD PERFORM THE OPERATION PROCEDURES, MAINTENANCE AND TROUBLE SHOOTING PRESENTED IN THIS MANUAL.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

SECTION 1.0

GENERAL INFORMATION

1.1 PURPOSE

The regulators precisely control the output voltage of an AC power generating system by controlling the amount of current supplied to the exciter or generator field. This includes brush type rotary exciters, brushless rotary exciters or direct excitation into the generator field.

The Basler SRH/E regulator is available in eight different models: SR32H, SR32E, SR63H, SR63E, SR125H, SR125E, SR250H and SR250E. These units are used with exciters and generator field of 32, 63, 125 and 250 VDC, and have a continuous DC output current rating of twenty (20) amperes (SR-H) or 36 amperes (SR-E) at their respective voltage ratings with a field forcing capability of 40% above nominal. All regulators are field connectable for single or three phase sensing and 5VA or 25VA maximum burden for the parallel compensation circuit.

1.2 DESCRIPTION

The regulators consist of an integrated circuit, silicon transistors, transformers, silicon diodes, resistors and non-electrolytic capacitors.

All components are mounted on a formed sheet metal chassis with a metal cover (open-end perforated grill) mounted to the chassis.

1.3 SPECIFICATIONS (See also Table 1-1)

Regulation	±0.5 of 1% of no load to full load.
Regulation Drift	Less than ±0.5% for 50°C temperature change (including warm-up).
Regulation Response	Less than 0.017 second.
Voltage Build-Up	Provides generator voltage build-up with a residual voltage of 10%.
Voltage Adjust Range	±10% of nominal.
Overvoltage Protection	Provides built-in overvoltage protection that limits generator output of 135% of nominal.
Ambient Operating Temperature	-40°C to +70°C (-40°F to +158°F).

Specifications (Continued)

Storage Temperature	-40°C to +100°C (-40°F to +212°F) with no degradation of components.
Vibration	Withstand 1.3 G's from 5 to 26 Hz, .036 double amplitude from 26 to 52 Hz, and 5 G's from 52 to 260 Hz.
Shock	Withstands 15 G's in each of three mutually perpendicular axes.
Finish	Dark brown, lusterless, textured baked enamel.
Weight	50 pounds net
Dimensions	18.19" X 13.38" X 6.75"

1.4 ACCESSORIES

The following accessories are available for use with SR-H, SR-E voltage regulator.

a. Power Isolation Transformers
b. Motor Operated Controls
c. Underfrequency-Overvoltage Protection
d. Current Transformers Parallel Reactive Load Divisions

Information regarding these accessories may be obtained by consulting the applicable operation manual/product bulletin or by contacting your nearest Basler Electric Sales Representative or Basler Electric Company, Highland, Illinois.

TABLE 1-1

SPECIFICATIONS

Model	Part No.	Power Input ⚠2			Output Rating (Max.)				Sensing ⚠1		Parallel Comp.		Field Res. Ohms	
		A.C. Volts	Freq. (Hz)	KVA ⚠3	D.C. Cont. Volts	D.C. Cont. Amps	D.C. Forc. Volts	D.C. Forc. Amps	A.C. Volts (50/60 Hz)	V.A. Burden Max. per Ø	Input Amps	V.A. Burden	Min.	Max.
SR32E	9 1256 00 104	60	50/60	2	32	36	45	52	NEMA STD: 120/208, 240/416, 480/600	10	5	5/25	0.89	200
SR63E	9 1256 00 105	120	50/60	3.5	63	36	90	52		10	5	5/25	1.75	200
SR125E	9 1256 00 106	240	50/60	7.0	125	36	180	52		10	5	5/25	3.50	200
SR250E	9 1256 00 107	480	50/60	13.5	250	36	360	52		10	5	5/25	7.00	200
SR32H	9 1256 00 100	60	50/60	1	32	20	45	28		10	5	5/25	1.60	200
SR63H	9 1256 00 101	120	50/60	2	63	20	90	28		10	5	5/25	3.20	200
SR125H	9 1256 00 102	240	50/60	4	125	20	180	28		10	5	5/25	6.20	200
SR250H	9 1256 00 103	480	50/60	8	250	20	360	28		10	5	5/25	12.50	200

NOTES:

⚠1 Field connectable single or three phase sensing.

⚠2 If correct voltage is not available for power input, a suitable power transfomer must be selected. Transformer KVA rating is determined by output DC power required.

⚠3 When regulator is opened at less than maximum output, power isolation transformer rating can be determined by multiplying input volts by DC continuous output current.

4. The maximum burden value of the regulator parallel compensation circuit is 5 V.A. (terminals 1 and 2) or 25 V.A. (terminals 1 and 2H).

Basler Electric
Highland, Illinois

SECTION 2.0

THEORY OF OPERATION
(Refer to Figure 2-1)

2.1 INPUT POWER

Power input is applied to terminals 3 and 4 and then to the SCR Power Stage.

2.2 SCR POWER STAGE

The conduction angle of the SCR Power Stage determines the amount of output current to the generator exciter field. Conduction angle in turn, is controlled by the timing of gating pulses from the Sensing and Gating Circuitry. The greater the angle of conduction of the SCR's the greater the output current.

2.3 GENERATOR SENSING

On single phase sensing voltage regulators, the sensing voltage is connected to terminals E1 and E3. Three phase sensing voltage is connected at E1, E2 and E3. The regulator is customer connectable for single or three phase sensing. When generators are operated in parallel, it is important that "A" phase supply E1 and "C" phase supply E3. The tap selection on the primary winding of the transformer (s) is dependent upon the application (120, 208, 240, 416, 480, or 600 volts). The output voltage from the transformer secondary winding is rectified as a representative sample, taken from a voltage divider network, is applied to the Sensing and Gating Circuitry.

2.4 SENSING AND GATING CIRCUITRY

The Sensing and Gating Circuitry is comprised of electronic components which sense any change in generator output voltage and translate such changes into phase control of the gating pulses. The gating pulse is sent to the SCR Power Stage to permit it to conduct and provide the correct exciter field current to maintain a constant generator voltage. When the Sensing and Gating Circuitry determines that generator output is low, the gating pulse is applied to the SCR's earlier in the cycle causing a greater output current to flow. When the generator output voltage is high, the gating pulse is applied later in the cycle causing less current to flow to the exciter field.

2.5 VOLTAGE BUILD-UP

The Sensing and Gating Circuitry provides voltage build-up without the use of a relay. It supplies gate pulses to the SCR's when the voltage at the power input terminals is 5 to 10% of nominal. These gate pulses cause the SCR's to conduct, exciting the field and raising generator voltage to nominal.

2.6 STABILIZATION ADJUST

A feedback signal taken from the regulator output is applied to the Sensing and Gating Circuitry. This signal, controlled by the Stability Control Adjust rheostat R11 prevents sytem voltage from hunting or oscillating.

2.7 VOLTAGE ADJUST

The external voltage adjust rheostat connected across terminals 6 and 7 allows adjustment of generator voltage ±10% of nominal.

2.8 PARALLEL COMPENSATION

If generators are operated in parallel, a current input from the B phase of the generator is applied to terminals 1 and 2L or 2H. This current is proportional in amplitude and phase to the line current. A portion of this current is applied to the primary winding of the paralleling transformer. The secondary of this transformer is connected in series with the secondary of the sensing transformer(s) and the rectifier bridge. The AC applied to the rectifier bridge, therefore, is the vector sum of sensing voltage and the parallel CT signal. The result is that if two generators are operating in parallel and the field excitation of one becomes excessive, the parallel compensation circuit will adjust field excitation between the generators so that circulating currents are minimized and each supplies a proportional amount of inductive load current.

The action and circuitry just described is called parallel droop compensation (reactive droop compensation). Although it reduces circulating current flow, it allows the system voltage to droop with increasing inductive reactive load.

Parallel cross-current compensation (reactive differential compensation) allows two or more paralleled generators to share inductive reactive loads with no decrease or droop in the generator system voltage. These regulators provide the necessary circuit isolation so that parallel cross-current compensation can be used. This is accomplished by the action and the circuitry described previously for parallel droop compensation, and the addition of cross connecting leads between the parallel CT secondaries as shown in Figure 7-5. By connecting the finish of one parallel CT to the start of another, a closed series loop is formed which interconnects CT's of all generators to be paralleled. The signals from the interconnected CT's cancel each other when the line currents are proportional and in phase. If this type compensation is used, it is <u>mandatory</u> that all regulators used in the paralleling network have the <u>same type</u> paralleling circuit. It is also necessary that all generators supplying power to that bus be included in the interconnection circuit.

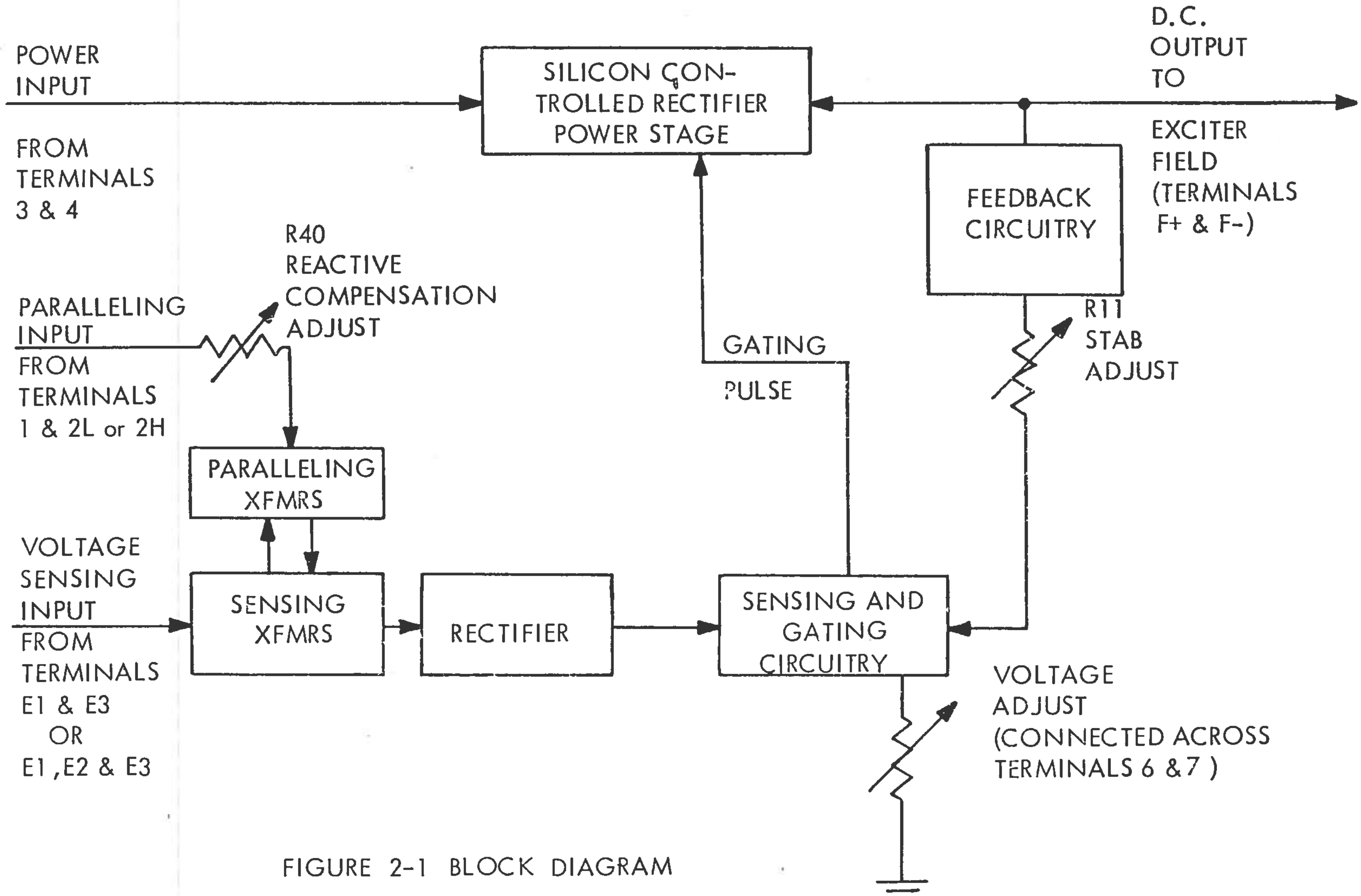


FIGURE 2-1 BLOCK DIAGRAM

SECTION 3.0

CONTROLS, TERMINAL SELECTIONS AND OTHER ADJUSTMENTS

3.1 CONTROLS (Refer to Figure 3-1)

3.1.1 Voltage Adjust Rheostat R49

This rheostat is supplied as a separate item for panel mounting. It provides adjustment of the regulated generator voltage. When the jumper is connected as shown in the interconnection diagrams, adjusting it to its maximum resistance position (CCW), minimum generator voltage is obtained. Maximum generator voltage is obtained with minimum resistance (CW).

3.1.2 Stability Control Adjust R11

Potentiometer R11 is located on the printed circuit board. It provides stable operation by controlling the amount of feedback that is applied to the Sensing and Gating Circuitry. Normally it is factory set near the extreme clockwise (CW) position. This setting normally assures good stability, but tends to slow the response time of the generator. If rotated counterclockwise (CCW), the system response time becomes faster. However, if rotated too far CCW, the generator voltage may oscillate (hunt). It should then be rotated CW well above the point where oscillating occured. The system voltage stability is most critical at no load. If a setting is desired that provides the fastest possible voltage response with good generator stability, an oscilloscope or some voltage recording device should be used. R11 operates in conjunction with the stability selection jumper (paragraph 3.2.2)

3.1.2 Voltage Range Adjust R14

Potentiometer R14 is located on the printed circuit board. It provides a means of varying the limits of the external voltage adjust rheostat. Normally, the external voltage adjust rheostat is set to midrange and R14 is adjusted for rated generator voltage. This allows an external voltage adjust range of $\pm$10%.

3.2 TERMINAL SELECTIONS (Refer to Figure 3-1).

3.2.1 Sensing Connections

The regulator single phase sensing terminals are E1 and E3. Three phase sensing terminals are E1, E2 and E3. The PH wire is connected to the 1PH terminal (TB2) for single phase sensing and to the 3PH terminal (TB2) for three phase sensing. The regulator is factory connected for single phase 120 Vac sensing. Internal sensing transformers have provisions for sensing 120,208,240,416,480 and 600 VAC. The transformers are factory connected to the 120 volt tap and must be reconnected to another tap before operation if other than 120 volt sensing is employed. On generating systems with voltages above 600 VAC, instrument type potential transformers must be used to step down the voltage to match one of the regulator sensing voltages. Figure 3-1 shows the sensing terminal board (TB2) location and the voltage tap identification.

3.2.2 Stability Selection

Stability selection is accomplished on terminal strip TS2 located on the printed circuit board. With these connections, the regulator's two basic stability time constants can be changed. These are "exciter" time constant and "generator" time constant. The "exciter" time constant can be changed to 'fast' or 'slow'. The "generator time constant can be changed to 'fast' 'medium', or 'slow'. Each time constant operates in conjunction with the stability adjust potentiometer R11 to provide a wide range of stability adjustment. The stability time constants provided allows operation on applications consisting of brush type rotary exciters, brushless rotary exciters or static exciters operating directly into a generator field. These circuits are designed to provide system voltage stability for power generator systems ranging from 10KW to 10,000KW. The following chart is provided as a guide to proper connection for various generator systems. Variance from these recommended connections is acceptable and desireable if optimum system voltage stability results. Refer to Figure 3-1 for location of jumpers.

STABILITY SELECT GUIDE

In this type of application,	These jumper selections are selected.	
	Exciter Link	Generator Link
Brush	slo	med or slo
Brushless rotary exciter or generators rated above 150KW	slo	med or slo
Brushless rotary exciter or generators rated below 150KW	slo	fast or med
Static exciter operating directly into generator field	fast	fast or med

3.3 OTHER ADJUSTMENTS (Refer to Figure 3-1)

3.3.1 Parallel Compensation Adjust R40

3.3.1.1 This wire wound resistor provides a method of adjusting the amount of reactive droop compensation when generators are operated in parallel. For maximum droop, move the slider up towards the chassis, for minimum droop, move the slider down away from the chassis.

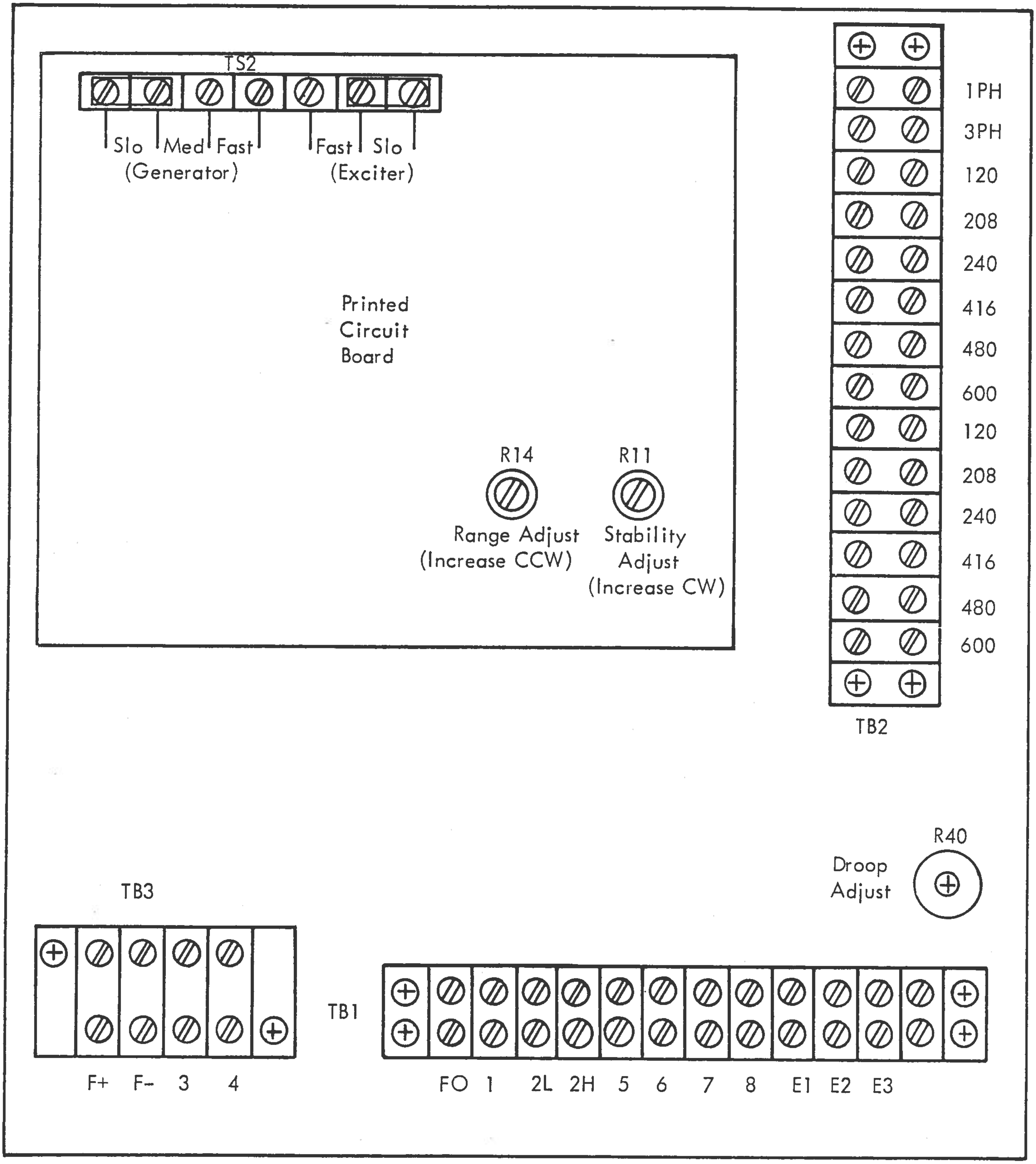


Figure 3-1 Location of Controls, Terminals and Adjustments

SECTION 4.0

INSTALLATION AND OPERATION

4.1 INSTALLATION

4.1.1 Mounting

This unit is convection cooled and should not be mounted near heat generating equipment or inside totally enclosed switchgear where the temperature rise could exceed its operating limit. Vertical mounting is recommended to obtain optimum convection cooling.

4.1.2 Interconnection

<u>CAUTION</u>

MEGGERS AND HIGH POTENTIAL TEST EQUIPMENT MUST NOT BE USED. INCORRECT USE OF SUCH EQUIPMENT WILL DESTROY THE REGULATOR SEMICONDUCTORS.

The regulator must be connected to the generator system as shown in the Interconnection Diagrams Figure 7-2, 7-3, or 7-4. Even momentary operation with an incorrect connection can damage the control equipment. Number 12 gauge (SR-H) or number 8 gauge (SR-E) wire or larger should be used for connections to terminals 3, 4, F+ and F-. Number 16 gauge wire is satisfactory for all other connections.

4.1.3 Input Power

The regulator operates on a power input voltage applied to terminals 3 and 4. Nominal input voltages for each model regulator are listed in Table 1-1. The input power may be taken from any generator lines that provide the required voltage (line to line or line to neutral). If the available generator voltage is different from the required voltage, a power transformer must be used to match the generator voltage to the regulator power input. If the field or field flashing circuit is grounded, a power isolation transformer must be used to isolate the regulator input from ground. Failure to use an isolation transformer may result in blown fuses (The input fuses for the SR-H are mounted inside the regulator. The SR-E fuses are mounted external to the regulator and are supplied as loose items). On single phase sensing model regulator, it is recommended that the input power be taken from a phase other than the one used for regulator sensing to insure optimum voltage stability.

The permanent installation of a voltage shutdown switch as shown in Figures 7-2, 7-3 or 7-4 is recommended. It permits immediate removal of field excitation if necessary. In any case, its use is suggested during initial checkout.

CAUTION

THE VOLTAGE REGULATOR DC OUTPUT (TERMINALS F+ AND F-) MUST NEVER BE OPENED DURING OPERATION. TO DO SO WILL PRODUCE INDUCTIVE ARCING THAT CAN POSSIBLY DAMAGE THE EXCITER FIELD AND/OR THE VOLTAGE REGULATOR. THEREFORE, NEVER PLACE THE VOLTAGE SHUTDOWN SWITCH IN THE EXCITER FIELD CIRCUIT.

4.1.4 Modified Voltage Regulator Input (Terminals 5 and 8)

The terminals are used only on special modified versions such as UFOV applications, or special sensing inputs. Terminal 5 is used for UFOV applications and Terminal 8 is used for the special sensing input (consult factory for additional information regarding Terminal 8).

4.1.5 Voltage Regulator Sensing

The regulator has internal sensing transformers with taps for sensing voltages of 120, 208, 240, 416, 480 and 600 VAC. They are shipped connected to the 120 volt taps. If voltage other than 120 volts is required, make the necessary tap connections. On generating systems with voltages above 600 VAC, instrument type potential transformers must be used to step the voltage down to match one of the regulator sensing voltages. For single phase sensing, the sensing leads are connected to terminals E1 and E3. For three phase sensing leads are connected to terminals E1, E2 and E3. E1 is connected to the "A" phase, E2 is connected to the "B" phase (only if three phase sensing is required) and E3 is connected the the "C" phase. If single phase sensing is used, the PH wire must be connected to the 1PH terminal. For three phase sensing, connect the PH wire to 3PH terminal. It should be noted that the type of sensing bears no relationship to the type of generator used. Although most generators employing an SR-H/SR-E regulator are three phase, in most applications single phase sensing is entirely adequate.

For precise regulation, the sensing leads should be connected as close as possible to the point where regulation is desired. Of course, the leads must remain on the generator side of the breaker. The regulator regulates the voltage applied to its sensing terminals and cannot correct for cable or bus voltage drop that may occur at points other than where the sensing leads are connected. The sensing leads should not be used to supply any other equipment.

4.1.6 Field Power

The maximum continuous output current of these regulators (terminals F+ and F-) is 20 ADC for the SR-H regulators or 36 ADC for the SR-E regulators. The DC resistance of the field into which the regulator operates must be as specified in Table 1-1.

When making connections to the rotary exciter, polarities must be observed. The regulator F+ terminal connects to the field positive terminal and the F- terminal to the negative terminal. With brush type rotary exciter applications, it is important to observe polarities between generator field, exciter output and exciter field. If the polarities are not known and the system has manual voltage control, polarities can be determined by operating the system on manual voltage control before connecting the regulator.

4.1.7 Voltage Adjust Rheostat

The external rheosat is rated at 500 ohms, 25 watts. It connects across terminals 6 and 7. The jumper should be connected as shown in the interconnection diagrams so that clockwise rotation results in decreased resistance and increased generator voltage.

4.1.8 Parallel Compensation

Use of terminals 1 and 2L or 1 and 2H is required only if generators are operated in parallel. If parallel operation is not anticipated, terminal 1 should be connected to terminal 2L with a jumper.

If paralleling is required, a current transformer (CT) with a 5 amp secondary rating is installed in the generator phase B line. This current transformer should deliver from 3 to 5 amps secondary current at rated generator load. The maximum burden of the regulator parallel compensation circuit is 5 VA (terminals 1 and 2L) or 25 VA (terminals 1 and 2H). A Unit-Parallel switch can be used to short the paralleling CT when the system is operated as a single unit. Shorting the CT secondary prevents a droop signal from being injected into the voltage regulator.

The phase relationship between the paralleling current transformer signal applied to voltage regulator terminals 1 and 2L or 1 and 2H and the voltage sensing signal applied to regulator terminals E1, E2 and E3 is very important. It is equally important that the paralleling current transformer secondary polarity be correct for the existing generator phase sequence (A-B-C or A-C-B). These connections must be made as described in the interconnection diagrams, Figure 7-2, 7-3 or 7-4. (Regulator terminal E2 is not used for single phase sensing).

If it cannot be determined which generator lines are Phase A, B and C, follow this procedure:

a). With a three phase sensing voltage regulator, always place the paralleling current transformer in the generator phase that <u>does</u> supply sensing voltage to regulator terminal E2. When a single phase sensing regulator is used, place the current transformer in the generator phase that <u>does not</u> supply sensing voltage to the regulator.

b). When step a. is observed, the only unknown remaining is the correct polarity of the paralleling current transformer secondary signal. If an inductive reactive load is available, this can be determined by the test as outlined in paragraph 4.2.3.1.

c). If the generator load outlined in step b. is not available and it becomes necessary to parallel the generator without knowing the correct paralleling current transformer secondary polarity, extreme caution must be observed or equipment damage may result. If abnormally high generator current results after closing the breaker, immediately reopen the breaker, shut down the generating system and reverse the secondary connections of the paralleling current transformer (the leads to regulator terminals 1 and 2L or 1 and 2H).

NOTE

The parallel compensation circuit of all interconnected voltage regulators must have the same ampere and voltage-ampere ratings.

If parallel cross-current compensation (reactive differential compensation) is desired, make the same installation connections as previously described and illustrated in Figure 7-2, 7-3 or 7-4. Then interconnect with the cross-current loop as shown in Figure 7-5 and as described in paragraph 2.8.3.

It is recommended that the cross-current connecting loop be left open at one point until proper parallel operation is achieved with the parallel droop compensation circuit only.

On applications utilizing cross-current compensation, an auxiliary breaker contact should be used to short out the current transformer secondary if that generator is not on the load bus. If such a contact is not used, a voltage droop will be introduced into the system because the unloaded generator paralleling CT is not supplying the compensating signal and a voltage drop occurs across it. This drop will also cause the voltage of the incoming generator to fluctuate prior to paralleling. The solution is to connect an auxiliary contact on the main generator must be closed when the main generator circuit breaker across the paralleling current transformer secondary. This auxiliary contact must be closed when the main breaker is open, and open when the main generator breaker is closed.

4.2 OPERATION

4.2.1 Field Flashing

The regulator contains an internal circuit for automatic voltage build-up. Usually there is sufficient residual voltge to allow the generator voltage to build up without an additional flashing circuit. However, if field flashing is required, apply a 12 VDC flashing source, with the prime mover at rest, across terminals FO and F- on the regulator. The positive of the flashing source must be connected to FO and the negative of F-. This action remagnetizes the field poles and allows build-up when the system is restarted. A diode in the regulator allows the flashing source to be removed from the field without danger of inductive arcing.

If the generator field is flashed during system startup, the field flashing source must be removed after nominal generator voltage is obtained. This can be accomplished with a push button or switch on manual field flash applications, and with a relay on automatic field flash applications. If a relay is used, it should sense the generator voltage and open the flashing circuit at approximately 70% of rated voltage. On automatic field flashing applications, provisions (such as a speed switch) must be made to open the circuit when the generator is secured (not rotating). For proper connection instructions, refer to the interconnection diagrams.

4.2.2 Unit (Single or Non-Parallel) Operation

4.2.2.1 Operation (No Load)

a). Set the external voltage rheostat to approximately midrange.

b). Start the prime mover and bring up to rated speed. If a voltage shutdown switch is used (see paragraph 4.1.3), close switch. When this switch is not used, generator voltage should build up automatically. (If field flashing is necessary, see paragraph 4.2.1).

c). Verify that generator voltage is within ±10% of rated. Slight voltage corrections can be made with the voltage adjust rheostat. If the voltage is not at rated but within ± 10%, leave the voltage adjust pot at mid-range and re-adjust the voltage range adjust pot. R14 located on etched circuit board (see paragraph 3.1.3).

Overvoltage, Undervoltage or Unstable Voltage Condition

If an overvoltage, undervoltage or unstable voltage condition results, review the following.

a.) Overvoltge Condition (+15% or more above rated) If an overvoltage condition occurs, open the shutdown switch immediately and/or stop the prime mover. The regulator's internal overvoltage limit circuitry should prevent an overvoltage condition from exceeding approximately 135% above rated. An overvoltage condition may result because the regulator sensing leads are not connected. If the cause of over voltage cannot be determined, refer to the troubleshooting section of this manual.

b). Undervoltage Condition (-15% or less of rated) If an undervoltage condtion exists, stop the prime mover and determine the cause. If necessary, refer to the troubleshooting section of this manual.

c). Unstable Generator Voltage If the system voltage oscillates or hunts, adjust the voltage stability potentiometer R11 located on the etched circuit board. If necessary refer to the troubleshooting section.

4.2.2.2 Operation (With Load)

a). Apply rated load to the generator.

b). Verify that no load to full load regulation is less than ±1/2%. If the generating system has paralleling CT, make certain that the CT secondary is shorted before starting the test. If acceptable regulation is not obtained, refer to the troubleshooting section.

c). Alternately remove and apply load to determine the generator voltage remains stable. If the generator voltage becomes unstable, readjust R11.

NOTE

Unstable governors are frequently the cause of generator voltage instability. If a stability problem still exists after performing the procedures described in the manual, a thorough check of the governor should be made.

4.2.3 Parallel Operation

To parallel generators and to check for proper parallel operation, generators should be equipped with the following instrumentation:

AC Voltmeter
Frequency Meter
Synchroscope or a set of lights, etc.
AC Ammeter

It is also desirable to have KVAR or Power Factor Meter and a Generator or Exciter Field Current Ammeter.

4.2.3.1 Preliminary Tests Prior to Paralleling

It is recommended that correct operation of the regulator and generator be verified for unit operation (paragraph 4.2.2) prior to attempting paralleling. Then the following preliminary steps should be accomplished.

a). Adjust parallel compensation rheosat R40 to its nearly full resistance position (refer to paragraph 3.3.1.1). This adjustment provides maximum droop signal and should be set nearly identically on all regulators to be paralleled.

b). Make certain that the paralleling CT secondary is not shorted (Unit-Parallel switch is in the Parallel position).

c). With generating set operating at rated voltage and frequency, apply from 25 to 100% unity power factor load. Generator voltage should not change more than ± 1/2%. (The frequency should decrease if the governor is set for droop operation).

d). Apply a 25 to 100% 0.8 power factor load to the generator. The voltage should droop from 4 to 6% (with full load and with parallel compensation rheostat R40 set nearly full resistance). If the voltage rises instead of drooping, reverse the parallel current transformer secondary leads.

e). Repeat this test on all generators to be operated in parallel. After satisfactorily completing these tests, the generators should parallel properly.

4.2.3.2 Paralleling Procedure

CAUTION

THE INCOMING GENERATOR VOLTAGE PHASE SEQUENCE (PHASE ROTATION) MUST BE THE SAME AS THAT OF THE BUS TO WHICH IT IS TO BE PARALLELED.

a). Adjust the voltage of the incoming generator (the generator to be paralleled with the bus) to match the bus voltage.

b). Adjust the incoming prime mover speed so that its frequency is slightly faster than the load bus.

c). Observing the synchroscope (or synchronizing lights) close the incoming generator circuit breaker when in phase with the bus.

d). Immediately after closing the breaker, observe the generator line current ammeter. It should read well within the rating of the generator. If not, immediately reopen the circuit breaker and completely review paragraph 4.1.2 or refer to Section 5.0.

e). If operation after paralleling is normal, adjust the prime mover speed control so that the generator takes on KW load, thereby avoiding the possibility of the reverse power relay tripping the generator off line.

f). Adjust voltage so that the generator just placed on the bus assumes its share of KVAR load.

g). If two or more generators using the same type voltage regulators are on a common bus, vary the bus load and make voltage, speed and parallel compensation R40 adjustments as necessary to obtain the optimum load sharing.

4.2.3.3 Paralleling Problems

If, upon paralleling with the bus, improper operation results, try to determine which control system is at fault, the voltage control or the speed control. A high ammeter reading, or circuit breaker opening may occur in either case. Immediately after closing the incoming generator circuit breaker, observe the KVAR and KW meters.

a). A large KVAR reading (incoming or outgoing) indicates a faulty voltage regulating system.

b). A large KW reading would indicate a faulty speed regulating system.

Another method of determining which control system is at fault is to operate the system on manual voltage control (or systems having manual control). If proper parallel operation is obtained on manual voltage control, the voltage regulating system is probably at fault. If proper operation is not obtained, the speed regulating system is probably at fault.

If the trouble is isolated to the voltage regulating system, recheck the interconnection diagrams, Figure 7-2, 7-3 or 7-4. Almost all paralleling problems encountered with these voltage regulators are caused by incorrect system interconnections.

SECTION 5.0

MAINTENANCE AND TROUBLESHOOTING

5.1 PREVENTIVE MAINTENANCE

This unit should be cleaned and inspected periodically to insure that the air flow is not restricted.

5.2 TROUBLESHOOTING

If trouble is to avoided during initial operation, the importance of eliminating wiring errors cannot be over-emphasized. The voltage regulator cannot operate properly until it is connected correctly and may be damaged or fail if operated while incorrectly connected. An effective test, used to determine if the regulator is basically operational, is described in Figure 5-1.

Some of the possible malfunctions that could occur during operation of the voltage regulator and the corrective action are listed in Table 5-1.

It is recommended that the regulator be returned to Basler Electric Company for repair if the problem cannot be resolved using Table 5-1. In such instances, insure that the regulator is adequately packed to prevent damage in transit.

NOTES

(1). If, when troubleshooting a generating system, a defective voltage regulator is found, do not install a replacement regulator without first measuring DC resistance of the exciter field winding to insure that the resistance is above the minimum specified in Table 1-1 for that regulator model.

(2). On generating systems not using a power isolation transformer, or using a power isolation transformer with a grounded secondary, insure that the exciter field winding or circuitry is not grounded before installing a new voltage regulator.

Bench Test Procedure:

1. Select single phase and adjust taps on sensing transformers as follows:

   SR63: position to 120 volt taps
   SR32: position on taps which correspond to transformer primary voltage
   SR125: position to 240 volt taps
   SR250: position to 480 volt taps

2. Connect as shown. Identical 120 volt light bulbs should be used. (any wattage below 200 watt is satisfactory).

3. Adust Voltge Rheostat for maximum resistance.

4. Apply Power. (Light may flash on momentarily when power is applied).

5. Slowly adjust Voltage Adjust Rheostat toward minimum resistance. Before reaching minimum resistance, light bulb should come to near full brilliance. (Brilliance will be less when testing the SR32).

6. At the regulating point, a small change in the Voltage Adjust Rheostat should turn the light bulb on or off.

7. This test may not reveal a voltage stability problem.

8. Before installing back in system, connect regulator sensing transformer to original tap.

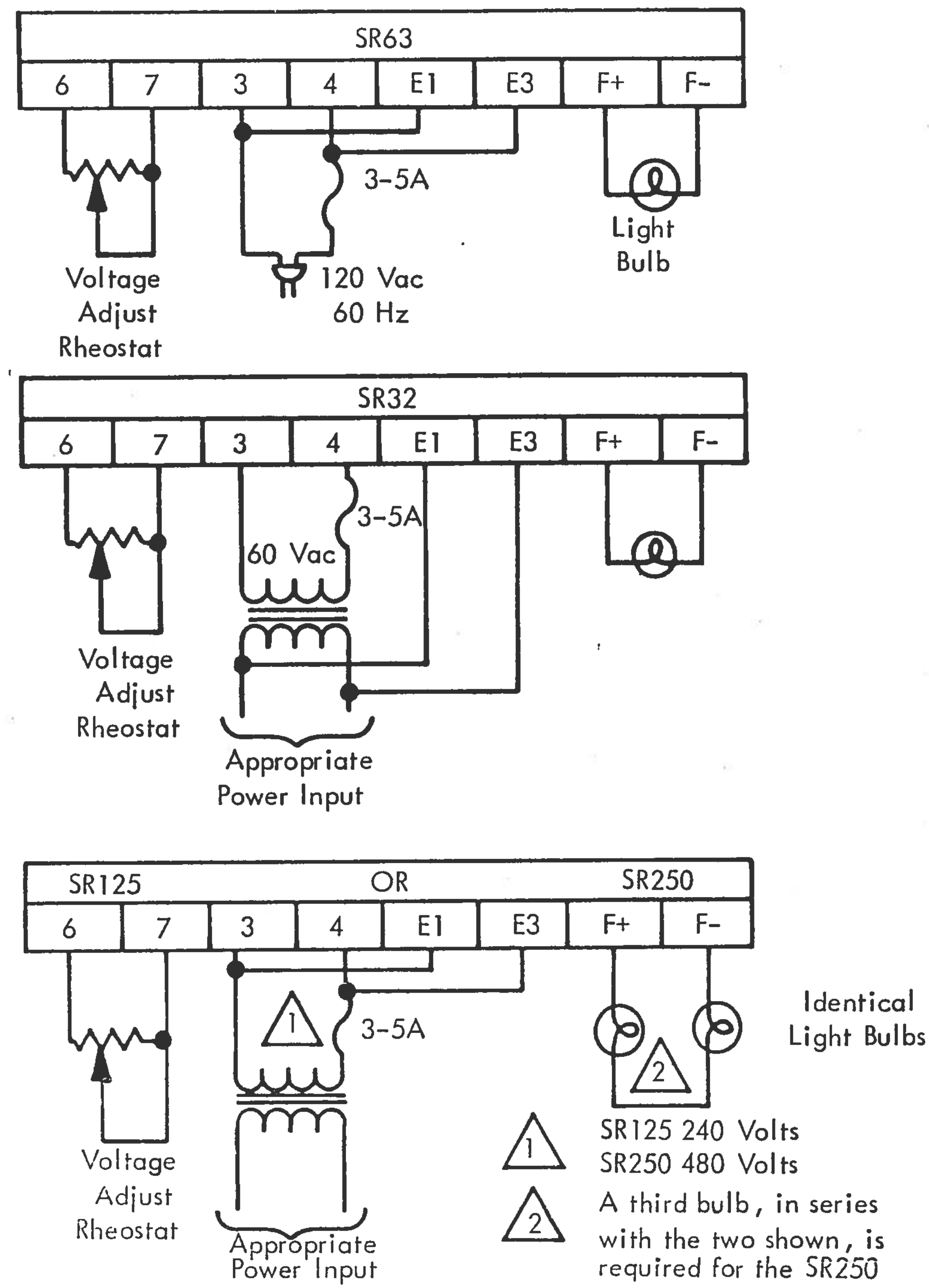


Figure 5-1 Operational Test (SR-H-SR-E)

TABLE 5-1 TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSE	REMEDY
Voltage does not build up to rated value.	Low residual or incorrect polarity relationship between exciter output and generator field.	Field flashing is required.
	Voltage shutdown switch open, or Manual-Off-Auto switch is Off position.	Close switch.
	Prime mover not up to rated speed.	Adjust speed to rated.
	No voltage or improper voltage to input terminal 3 and 4.	Verify wiring.
	No connections to F+ and F-.	Verify wiring.
	Generator output shorted or heavily loaded.	Remove load or short.
	Defective or improperly wired exciter.	Verify exciter operation or connections.
Voltage High, uncontrollable with voltage adjust rheostat.	No sensing voltage, terminals E1, E3 (and E2 if three phase sensing is used).	Verify wiring.
	Sensing connections set to wrong voltage tap.	connect to correct tap.
	Faulty PC board.	Replace
	SCR's faulty.	Replace SCR's or regulator.

TABLE 5-1 TROUBLESHOOTING CHART (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Voltage high, controllable with voltage adjust rheostat.	Sensing connections set to wrong voltage tap.	Connect to correct tap.
	Voltage range adjust (R14) set too high.	Adjust.
	Voltage adjust rheostat resistance too low.	Increase resistance.
	Improper connection of sensing leads to generator.	Verify wiring.
	Voltmeter inaccurate.	Verify operation or replace.
	Defective PC board.	Replace.
	Defective voltage Regulator.	Replace.
Voltage low, controllable with voltage adjust rheostat.	R14 set too low.	Adjust.
	Prime mover not up to rated speed.	Increase speed.
	Improper connections of sensing leads to generator.	Verify wiring.
	Voltmeter inaccurate.	Verify operation or replace.
Poor regulation.	Voltage at terminals 3 and 4 of regulator is too low at nominal generator voltage.	Refer to table 1-1 for proper input voltages.

TABLE 5-1 TROUBLESHOOTING CHART (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Poor regulation (Continued)	Output voltmeter at different location than regulator sensing (voltage drop in leads or wrong phase).	Connect voltmeter at same point as regulator sensing.
	Waveform distortion due to harmonic content in generator voltage. (Regulator senses average voltage; meter may be indicating RMS values.	Consult generator manufacturer.
	Unit-Parallel switch in parallel position.	Place switch in Unit position, (terminals 1 and 2L or 1 or 2H. shorted) except during parallel operation.
	Unit-Parallel switch faulty.	Replace
	Unbalanced load with three phase sensing.	Unit averages all three phase voltages.
	Prime mover not up to rated speed.	Bring up to rated.
	Fault in exciter or generator.	Verify operation.
	Faulty PC board.	Replace
	Faulty SCR's or diodes	Replace
Poor voltage stability.	Stability adjust R11 misadjusted.	Adjust to proper setting.

TABLE 5-1 TROUBLESHOOTING CHART (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Poor voltage stability (Continued)	Stability selection not correct.	Make proper selection. (Refer to paragraph 3.2.2).
	Defective etched circuit board.	Replace
	Fault in exciter or generator.	Verify exciter and generator operation.
Voltage recovery slow with load change.	R11 misadjusted.	Adjust to faster setting.
	stability selection too slow.	Reset as instructed in paragraph 3.2.2
	Insufficient regulator forcing capability.	Improper application of regulator.
	Slow prime mover response.	Consult governor manual.
Parallel generators do not divide real (KW) load equally.	Improper setting of power sensing of governor.	Consult governor manual.
No droop compensation can be obtained for parallel generators.	R40 set to minimum droop position.	Adjust R40 to obtain required droop.
	Parallel CT does not supply the required 3 to 5 amps secondary current.	See paragraph 4.1.8.

TABLE 5-1 TROUBLESHOOTING CHART (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Parallel generators do not divide reactive KVAR load equally. (Circulating reactive current between generators.)	Terminals 1 or 2L or 1 and 2H of regulator shorted by Unit-Parallel switch.	Place switch in parallel position.
	Voltage adjust rheostat not set correctly.	Readjust.
	R40 set too low droop position.	Adjust for increase.
	Parallel CT does not supply the required 3 to 5 amps secondary current.	Replace with proper CT (see paragraph 4.1.8).
	Paralleling CT's polarity reversed.	Interchange CT secondary leads.
	Paralleling CT not in correct generator line.	Verify wiring. Figure 7-2, 7-3, or 7-4)

SECTION 6.0

REPLACEMENT PARTS

6.1 SR-H SERIES REGULATORS

The following table contains parts and assemblies which are maintenance significant. When ordering replacement parts, always specify the complete model number and part number of the voltage regulator.

QTY.	DESCRIPTION	REFERENCE DESIGNATOR	BASLER PART NO.	EFFECTIVITY
1	Circuit Board Assembly	----	90 59701 102	SR32H
1	Circuit Board Assembly	----	90 59701 100	SR63H, SR125H
1	Circuit Board Assembly	----	90 59701 101	SR250H
2	Sensing Transformer	T1, T2	BE 17290 001	All units
1	Transformer	T5	BE 10365 001	SR63H, SR125H
1	Transformer	T5	BE 12374 001	SR250H
1	Transformer	T5	BE 13069 001	SR32H
1	Transformer	T3	BE 10351 002	All units
1	Reactor	L1	BE 08794 003	All units
2	SCR	CR32, CR33	90 95000 015	SR63H, SR125H, SR32H
2	SCR	CR32, CR33	11853	SR250H
3	Diode 70 H80A	CR35, CR37, CR38	08608	SR63H, SR125H, SR32H
2	Diode 70 HR80A	CR34, CR36	08609	SR63H, SR125H, SR32H
3	Diode S36160	CR35, CR37, CR38	11851	SR250H
2	Diode R36160	CR34, CR36	11852	SR250H
1	Resistor Adj. 0.2 ohm 25W	R40	13468	All units
1	Resistor Variable 500 ohm 25W	R49	06874	All units
2	Fuse	F1, F2	08614	All units
2	Resistor 15 ohm, WW, 25W, 5%	R46, R48	03343	SR32H
1	Resistor 4700 ohm, WW, 10W, 5%	R42	03603	All units
1	Resistor 100 ohm, WW, 25W, 5%	R47	06648	SR32H
1	Resistor 2700 ohm, WW, 10W, 5%	R43	07291	All units
3	Resistor 50 ohm, WW, 25W, 5%	R46, R47, R48	03993	SR63H, SR125H
2	Resistor 25 ohm, WW, 25W, 5%	R46, R51	03224	SR250H
2	Resistor 100 ohm, WW 25W, 5%	R47, R48	06648	SR250H
1	Resistor 0.75 ohm, 100W, 10%	R50	13318	All units

QTY.	DESCRIPTION	REFERENCE DESIGNATOR	BASLER PART NO.	EFFECTIVITY
1	Capacitor 2 microfarad, 100V	C23	11788	SR32H, SR63H, SR125H
2	Capacitor 0.5 microfarad, 1500V	C23, C25	11790	SR250H
1	Capacitor 10 microfarad, 200V	C25	11792	SR32H
1	Capacitor 3 microfarad, 1000V	C25	11791	SR63H, SR125H

6.2 SR-E SERIES REGULATORS

The following table contains parts and assemblies which are maintenance significant. When ordering replacement parts, always specify the complete model number and part number of the voltage regulator.

QTY.	DESCRIPTION	REFERENCE DESIGNATOR	BASLER PART NO.	EFFECTIVITY
1	Circuit Board Assembly.	----	90 59701 102	SR32E
1	Circuit Board Assembly	----	90 59701 100	SR63E, SR125E
1	Circuit Board Assembly	----	90 59701 101	SR250E
2	Sensing Transformer	T1, T2	BE 17290 001	All units
1	Transformer	T5	BE 10365 001	SR63E, SR125E
1	Transformer	T5	BE 12374 001	SR250E
1	Transformer	T5	BE 13069 001	SR32E
1	Transformer	T3	BE 10351 002	All units
1	Reactor	L1	BE 08794 003	All units
2	SCR	CR32, CR33,	90 95000 015	SR63E, SR125E, SR32E
2	SCR	CR32, CR33	11853	SR250E
3	Diode 70 H80A	CR35, CR37, CR38	08608	SR63E, SR125E, SR32E
2	Diode 70 HR80A	CR34, CR36	08609	SR63E, SR125E, SR32E
3	Diode S36160	CR35, CR37, CR38	11851	SR250E
2	Diode R36160	CR34, CR36	11852	SR250E
1	Resistor Adj. 0.2 ohm, 25W	R40	13468	All units
1	Resistor Variable 500 ohm, 25W	R49	06874	All units
2	Fuse	F1, F2	11913	All units

QTY.	DESCRIPTION	REFERENCE DESIGNATOR	BASLER PART NO.	EFFECTIVITY
2	Resistor 15 ohm, WW 25W, 5%	R46, R48	03343	SR32E
1	Resistor 4700 ohm, WW 10W, 5%	R42	03603	All units
1	Resistor 100 ohm, WW 25W, 5%	R47	06648	SR32E
1	Resistor 2700 ohm, WW 10W, 5%	R43	07291	All units
3	Resistor 50 ohm, WW, 25W, 5%	R46, R47, R48	03993	SR63E, SR125E
2	Resistor 25 ohm, WW, 25W, 5%	R46, R51	03224	SR250E
2	Resistor 100 ohm, WW, 25W, 5%	R47, R48	06648	SR250E
1	Resistor 0.75 ohm, 100W 10%	R50	13318	All units
1	Capacitor 2 microfarad, 1000V	C23	11788	SR32E, SR63E, SR125E
2	Capacitor 0.5 microfarad, 1500V	C23, C25	11790	SR250E
1	Capacitor 10 microfarad, 200V	C25	11792	SR32E
1	Capacitor 3 microfarad, 1000V	C25	11791	SR63E, SR125E

SECTION 7.0

DRAWINGS

7.1 GENERAL

This section contains drawings and diagrams to facilitate the installation, operation and maintenance of the voltage regulator.

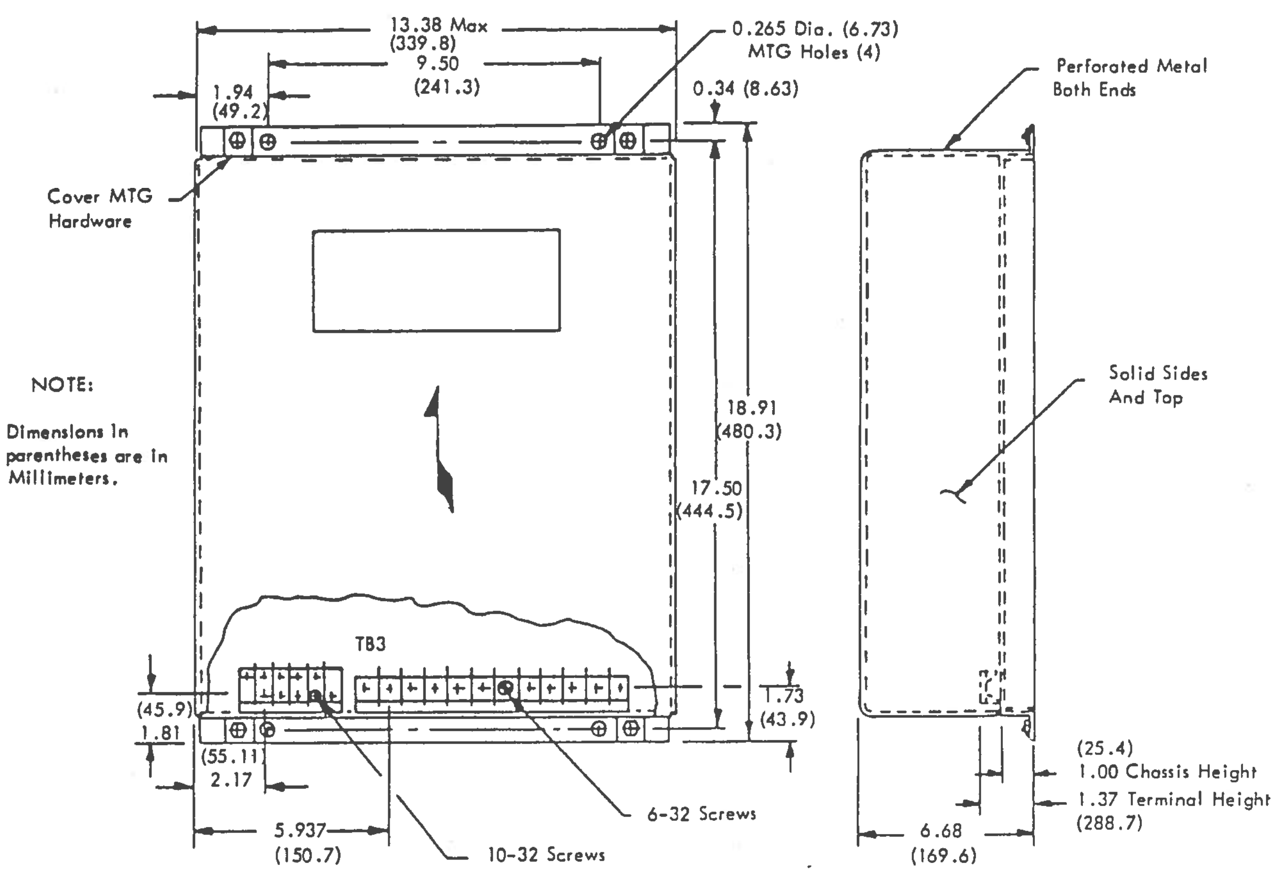


Figure 7-1 Outline Drawing

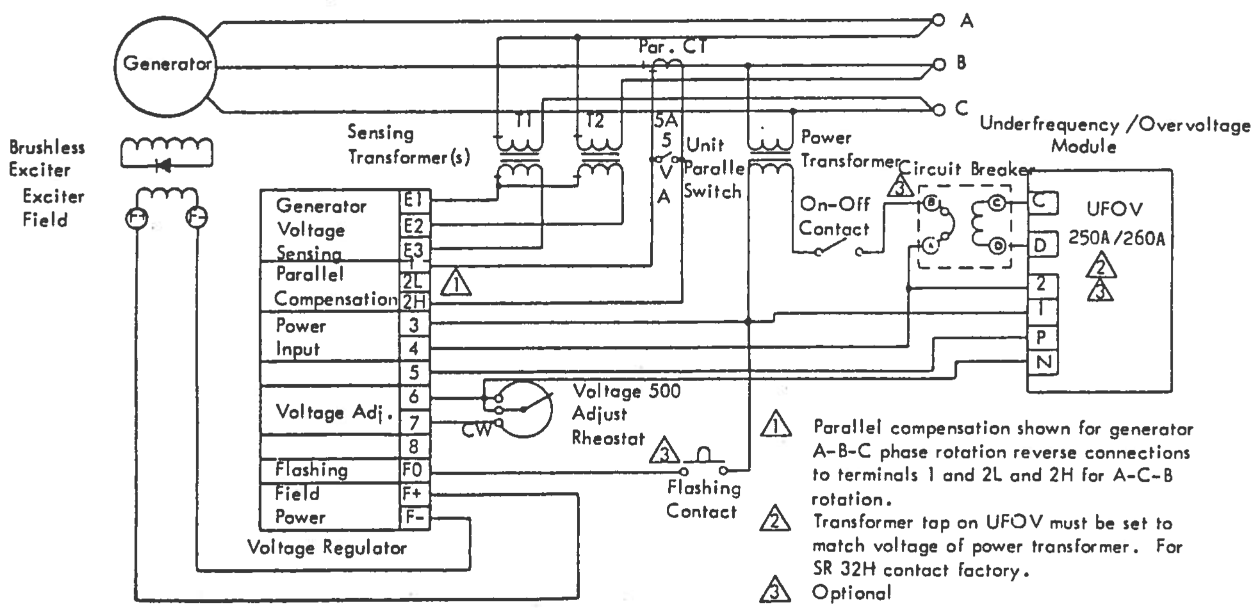


Figure 7-2 SR-H Interconnection Diagram - Brushless Exciter Applications

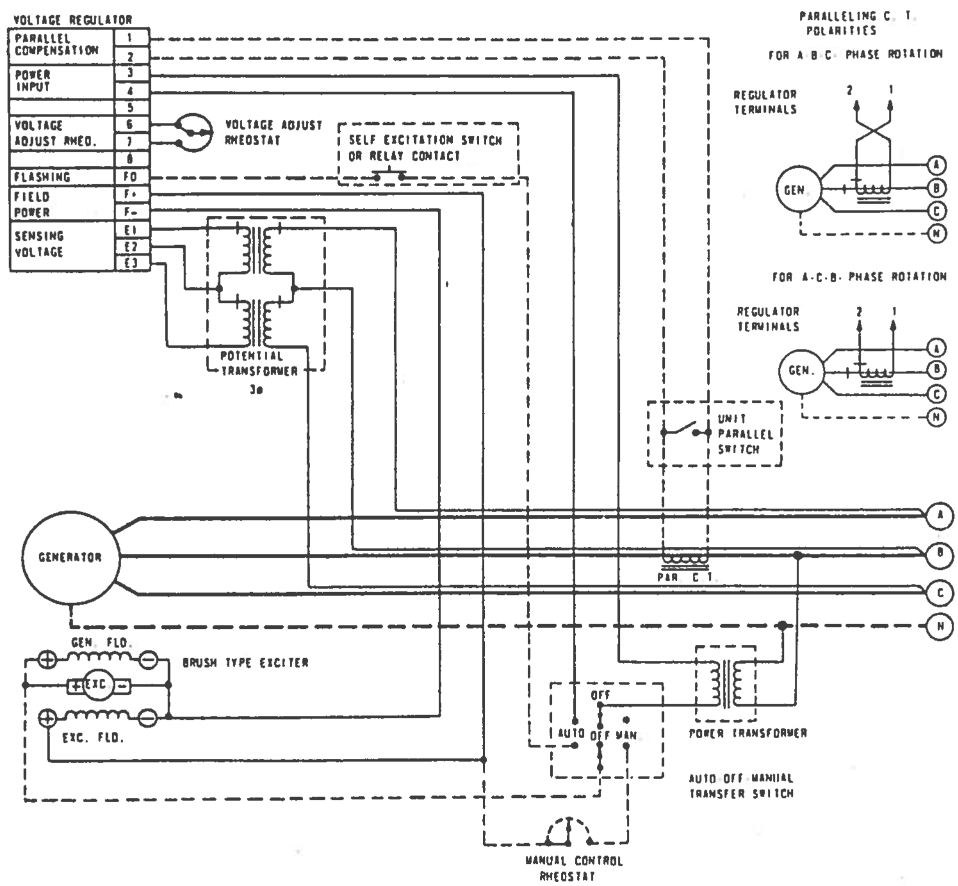


FIGURE 7-3 INTERCONNECT DIAGRAM - BRUSH TYPE ROTARY EXCITER APPLICATION

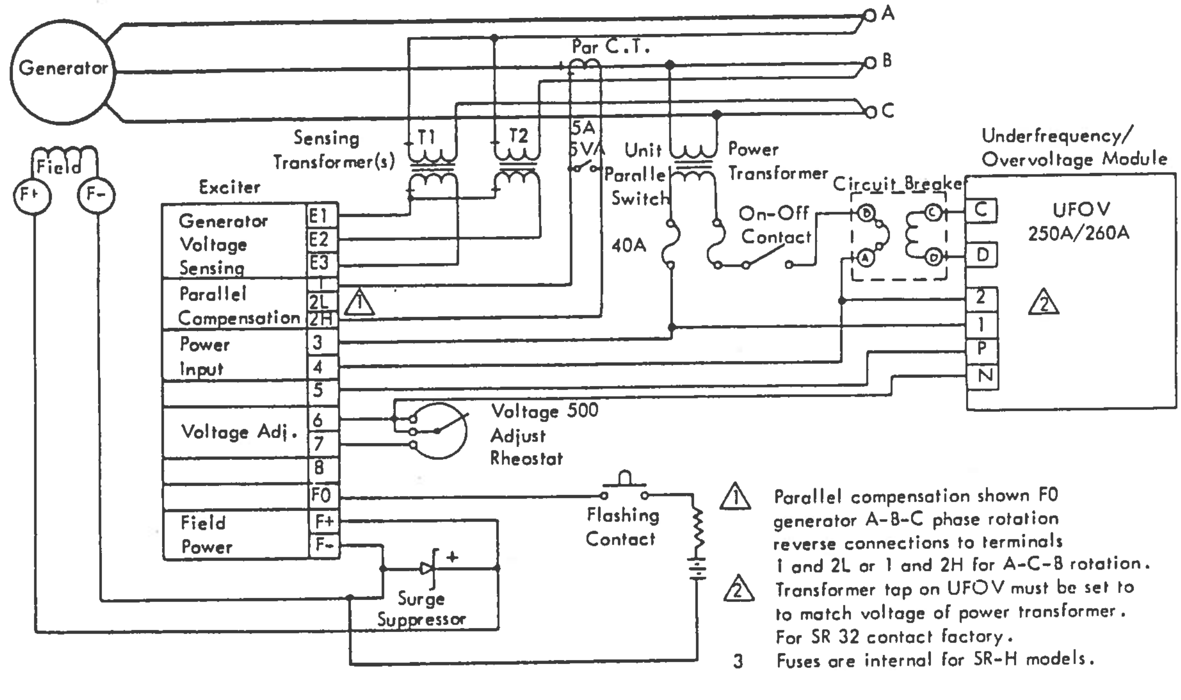


Figure 7-4 SR-E/SR-H Interconnection Diagram - Static Exciter Applications

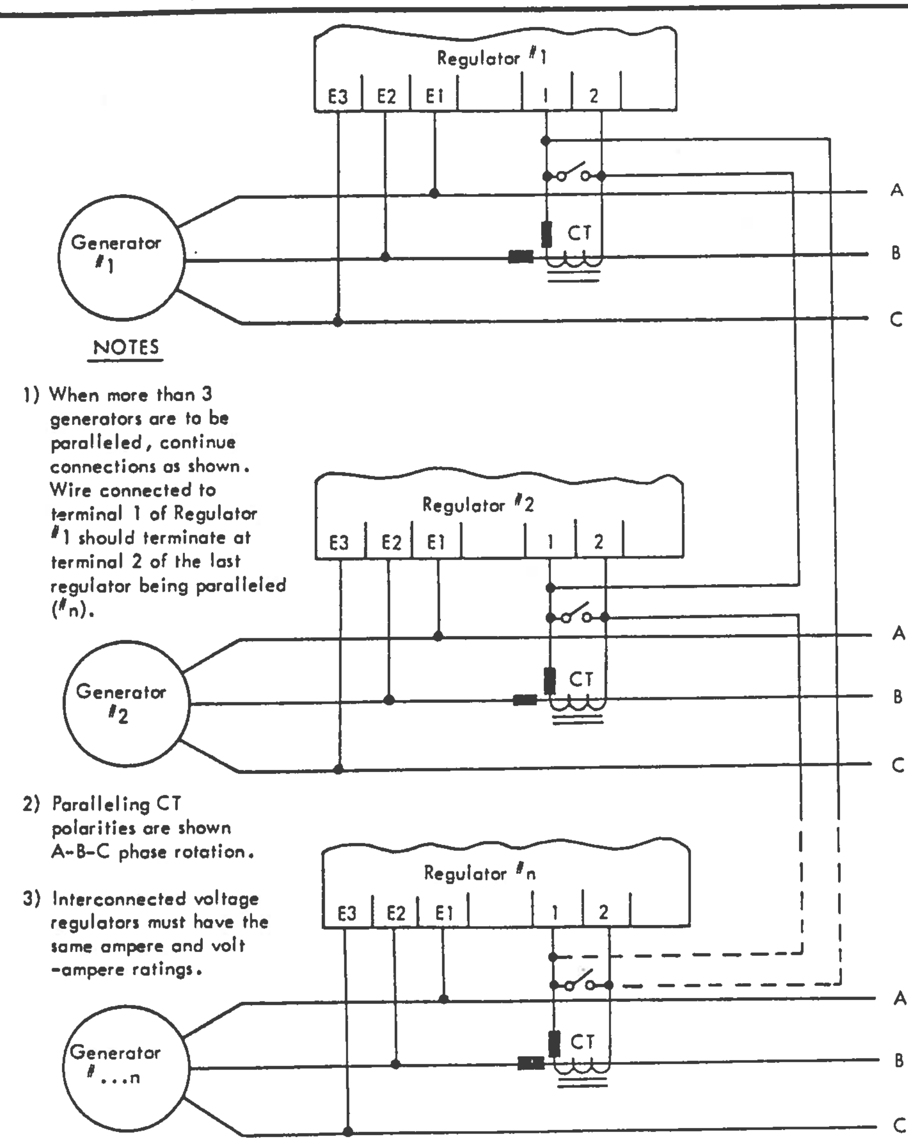


Figure 7-5 Cross-Current Compensation CT Interconnection

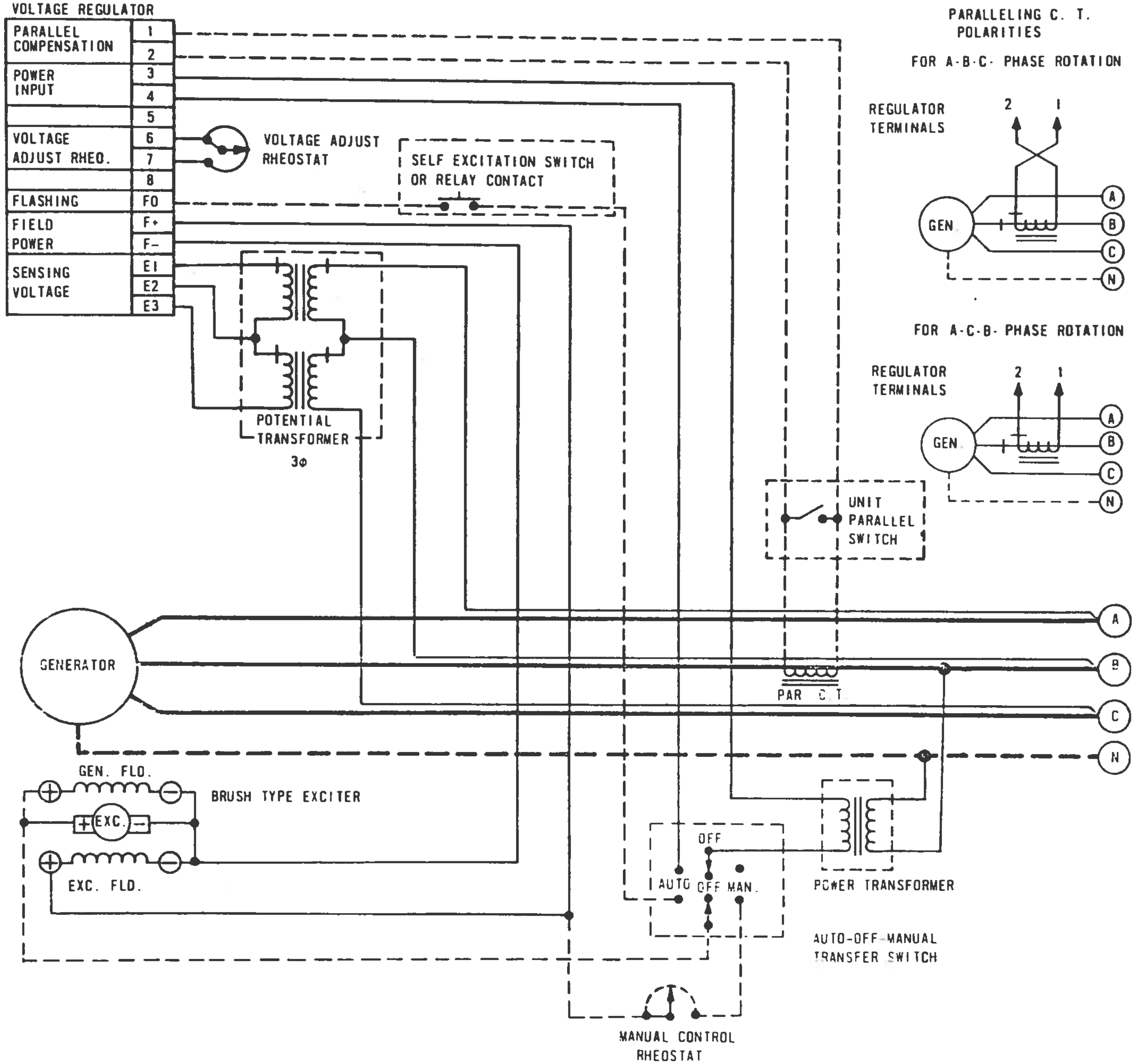
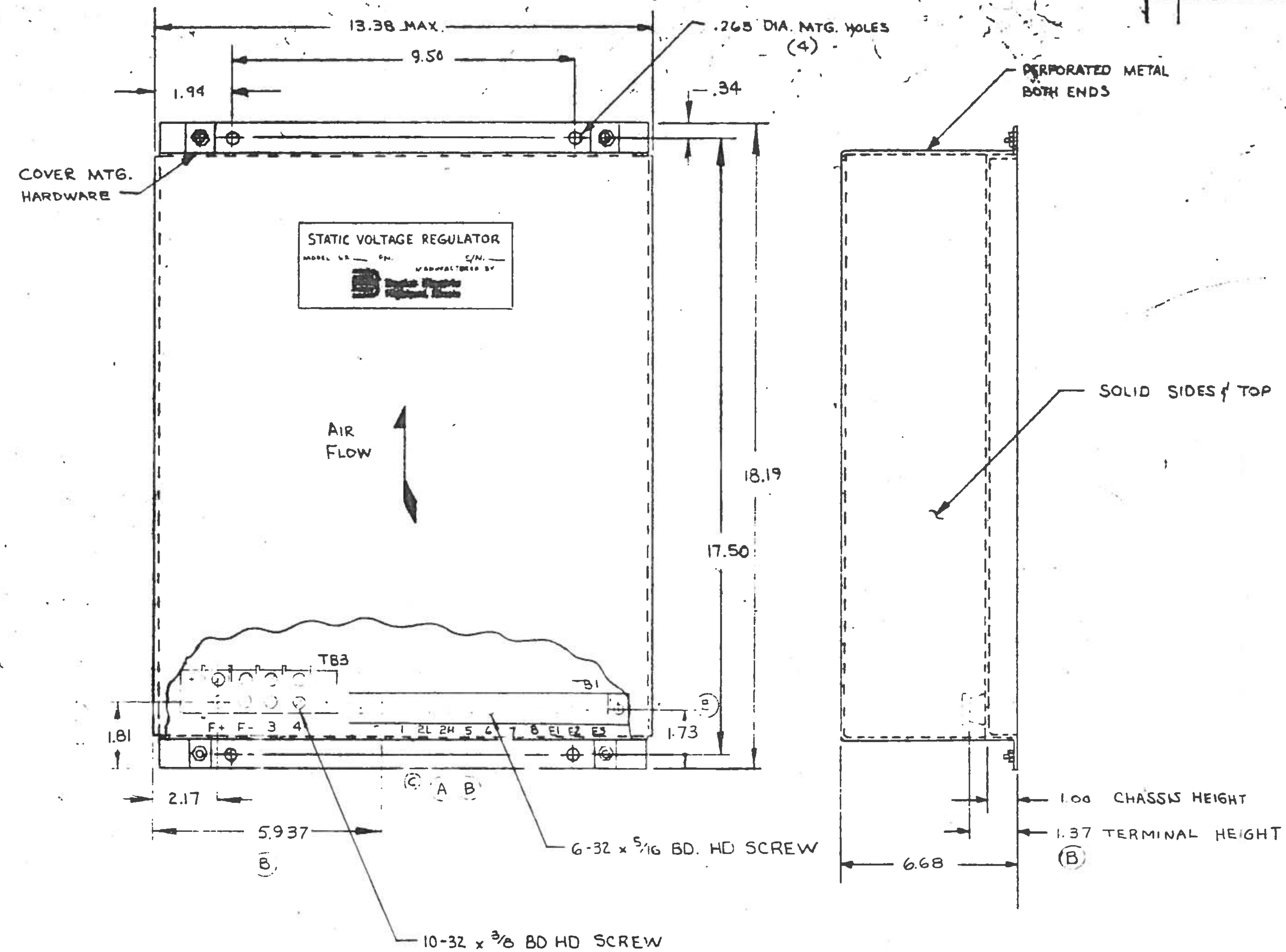


FIGURE 7-3 INTERCONNECT DIAGRAM - BRUSH TYPE ROTARY EXCITER APPLICATION



FINISH: DARK FAWN

LETTER	REVISION	DATE	BY
C	Revised Term. Des. of TB1 - R.Hagins 6-12-79		
B	Revised Term. & Revised Term. Loc.		

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMALS ± .031 FRACTIONS ± ANGLES ±

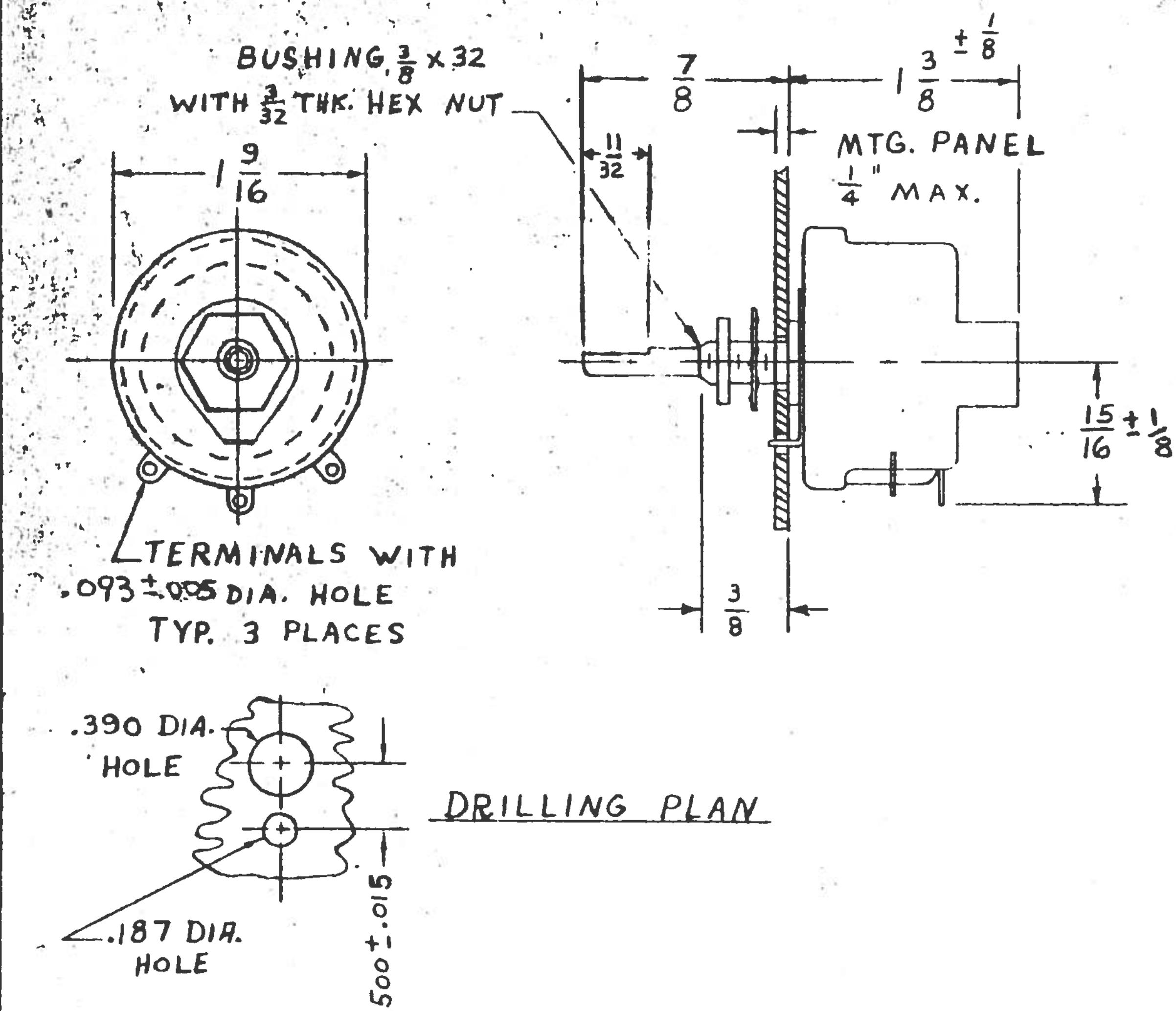
TITLE: OUTLINE DRAWING - VOLTAGE REG.

SR---E/H

BASLER ELECTRIC CO.
HIGHLAND, ILLINOIS

C X 9125600920 C

A	03456	B



NOTES:

1) RATING: 175 OHM ±10%, 25 WATT.
2) ROTATIONAL TORQUE: 4-12 IN/OZ.
3) CONTACT PRESSURE: 400 TO 920 GRAMS

LETTER	REVISION	DATE	BY
B	REVISED PER ECA 5708	9/7/83	L
A	REDRAWN WITHOUT CHANGE 1-13-76 J.G.	1/13/76	J.G.

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMALS ±.010 FRACTIONS ±1/16. ANGLES ± —

TITLE: RESISTOR, VARIABLE, 25 WATT

MATERIAL

DRAWN BY	DATE	CHKD. BY	DATE	APPR. BY	DATE	SCALE
J.G.	3/20/67	J.G.	3/30/67	J.G.	3/30/67	NONE

BASLER ELECTRIC CO.
HIGHLAND, ILLINOIS

DRAWING NO. A 03456 B

INSTRUCTION MANUAL
FOR
MINIMUM/MAXIMUM EXCITATION LIMITER

MODEL: EL200

Part Number: 9 1747 00 100

Basler Electric
Highland, Illinois

Publication Number: 9 1747 00 990
Date: June, 1984

WARNING

To prevent personal injury or equipment damage, only qualified technicians/operators should install, operate or service this device.

CAUTION

Meggers and high potential test equipment should not be used. Incorrect use of such equipment could damage components contained in the regulator.

SECTION 1.0

GENERAL INFORMATION

1.1 DESCRIPTION

The excitation limiter performs two functions. As a maximum excitation limiter, it senses the field current output of the voltage regulator or exciter and limits the field current to prevent overheating of the field. As a minimum excitation limiter, it senses the leading volt ampere reactive output (VAR) of the generator and increases the excitation as necessary to prevent loss of synchronization and armature core overheating during parallel operation.

The excitation limiter has a circular characteristic that is compatable with typical generator reactive capabilities as shown by Figure 1-1.

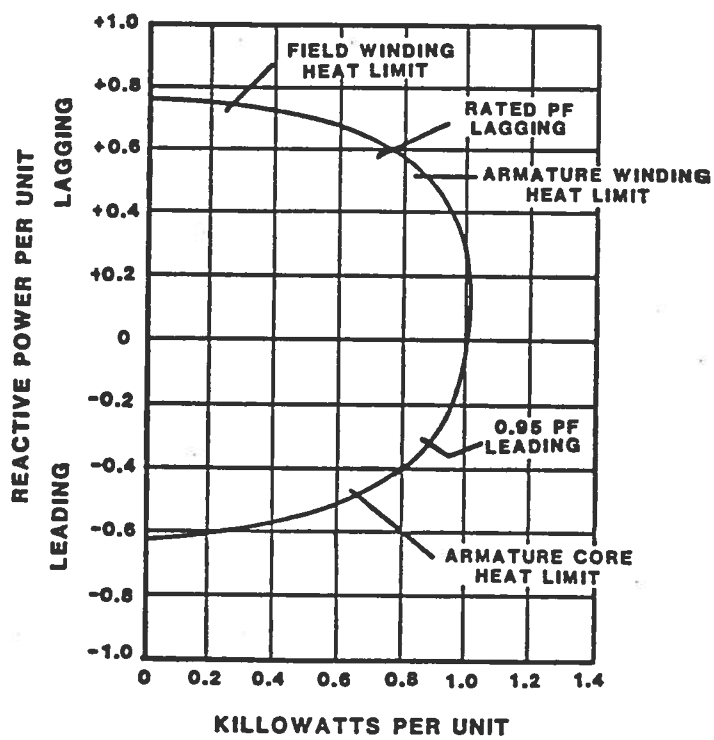


Figure 1-1. Typical Generator Reactive Capability.

1.2 SPECIFICATIONS

1.2.1 Physical Specifications

a.	Overall dimensions:	8.203" X 11.500" X 4.203" (20.84 cm X 29.21 cm X 10.68 cm)
b.	Weight:	50 lbs. (22.73 kg)
c.	Storage temperature range:	-65°C (-85°F) to +85°C (+185°F)
d.	Operating temperature range:	-40°C (-40°F) to +70°C (+158°F)
e.	Vibration:	Withstands 1.3 G's at 2 to 27 Hz; 0.036" double amplitude at 27 to 52 Hz; and 5 G's at 52 to 1000 Hz.
f.	Shock:	Withstands up to 15 G's

1.2.2 Electrical Specifications

a.	Input voltage:	90-139, 180-264, 342-528, 540-660 Vac; 50 or 60 Hz.
b.	Burden:	50 VA maximum.
c.	Current transformer input:	2.5 to 5 amperes at full load rated 0.8 p.f.; 0.5 VA burden
d.	Output:	±8Vdc
e.	Drift:	Less than 5% of nominal per 50°C change.

1.3 APPLICATION

The excitation limiter can be used with following Basler voltage regulator, and excitation systems: XR2001, XR2002, XR2003, SR-A series, SR-E series, SR-H series, KR-F series, SSE, and SER-CB.

SECTION 2.0

THEORY OF OPERATION

(Refer to Figure 2-1)

2.1 POWER SUPPLY

a. The limiter senses the generator voltage through transformer T2. This transformer has taps for use with the following input voltages: 90-130 Vac, 180-264 Vac, 342-528 Vac, and 450-660 Vac.

b. A portion of the transformer output feeds the regulated power supply to produce a +14 Vdc and a -14 Vdc output for operating the limiter circuitry.

c. Transformer T2 also provides reference signals to the VAR detector, the watt detector, and power for the dc transducer (transformer T3).

2.2 VAR LIMITING CIRCUIT

a. Transformer T1 receives a 0-5 ampere signal from an external current transformer (CT) that senses the generator output current. The output of transformer T1 is passed to the VAR and watt detectors.

b. The VAR and watt detectors convert the ac inputs to dc outputs which represent (by polarity and amplitude) the VAR and watt components of the generator output current,

c. The output of the VAR detector passed through a tapped resistor network (curve selector) to the VAR comparator. The VAR comparator makes a comparison of the curve selector output with a d c reference voltage. If the leading VAR component (generator current) is higher than the reference, the comparator outputs a signal through the voltage regulator/exciter that will cause in excitation increase and thus prevent operation outside the limit.

d. The VAR limiting action described in paragraph 2.2. a would produce a limiting threshold (refer to Figure 1-1) that would be a horizontal line at the -0.4 to -0.6 per unit level. To produce the output curve required, a watt signal is passed through the forward watt amplifier (non-linear) to the VAR comparator. To assure proper operation, a calibration circuit is provided to set up the proper levels of operation for a wide range of input current levels.

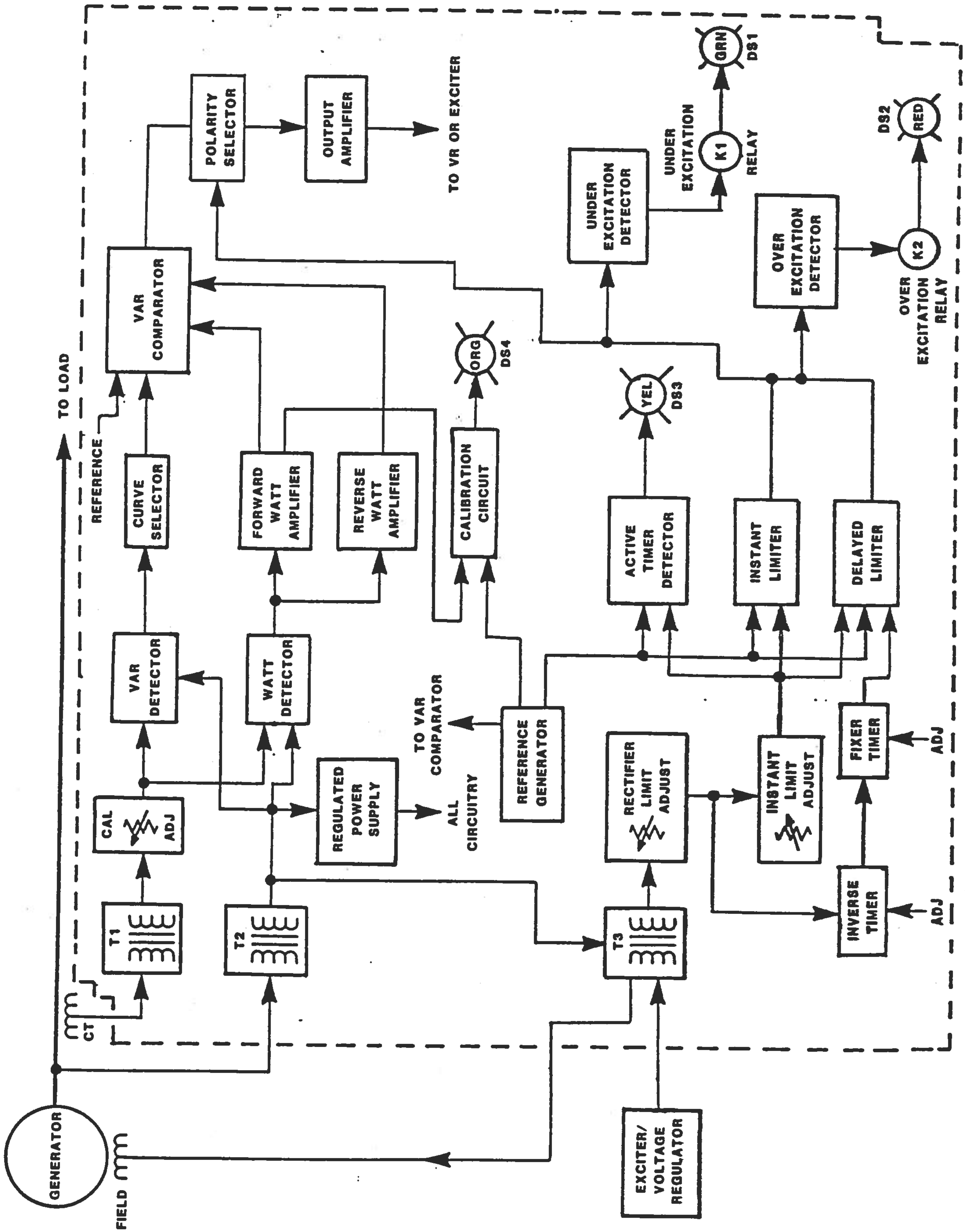


Figure 2-1. Excitation Limiter Block Diagram.

2.3 OUTPUT AMPLIFIER

The output amplifier produces either positive or negative signals to drive the regulator or exciter. The polarity of this signal is determined by the jumpering of a terminal strip.

2.4 OVER-EXCITATION LIMITING

a. Overexcitation limiting provides a fast acting limit of the field current at a selected high level initially (allowing for motorstarting, fault clearing, etc.) and for a set period of time after which the limit drops to a lower level to prevent field overheating.

b. The dc output current of the exciter or regulator passes through the a winding of the dc transducer (T3). The ac output of T3 is proportional to the input. The output is rectified, adjusted and applied to the inverse timer.

c. The output of the inverse timer is passed to the fixed timer. If the field current is above the threshold of the inverse timer and both the inverse and fixed timer time out, the delayed limiter is actuated. This reduces the current to the delayed threshold level.

2.5 RELAYS AND INDICATIONS

a. When the underexcitation portion is functioning, the underexcitation detector will illuminate a green LED on the printed circuit board and energize relay K1, whose form C contacts are connected to terminals 10, 11, and 12.

b. When the overexcitation portion is functioning, the overexcitation detector will illuminate a red LED on the printed circuit board. Relay K2 will be energized and its form C contacts are connected to terminals 20, 21 and 22.

SECTION 3.0

CONTROLS AND INDICATORS

3.1 CONTROLS

For the controls and their functions, refer to Figure 3-1 and Table 3-1.

Table 3-1. Controls

Control	Function
Potentiometer R1	This potentiometer calibrates the current signal.
Potentiometer R32	This potentiometer adjusts the delayed limiter threshold current.
Potentiometer R33	This potentiometer adjusts the instant limiter threshold current.
Potentiometer R36	This potentiometer adjusts the inverse timer.
Potentiometer R40	This potentiometer adjusts the fized timer.

3.2 INDICATORS

For the indicators and their functions, refer to Figure 3-1 and Table 3-2.

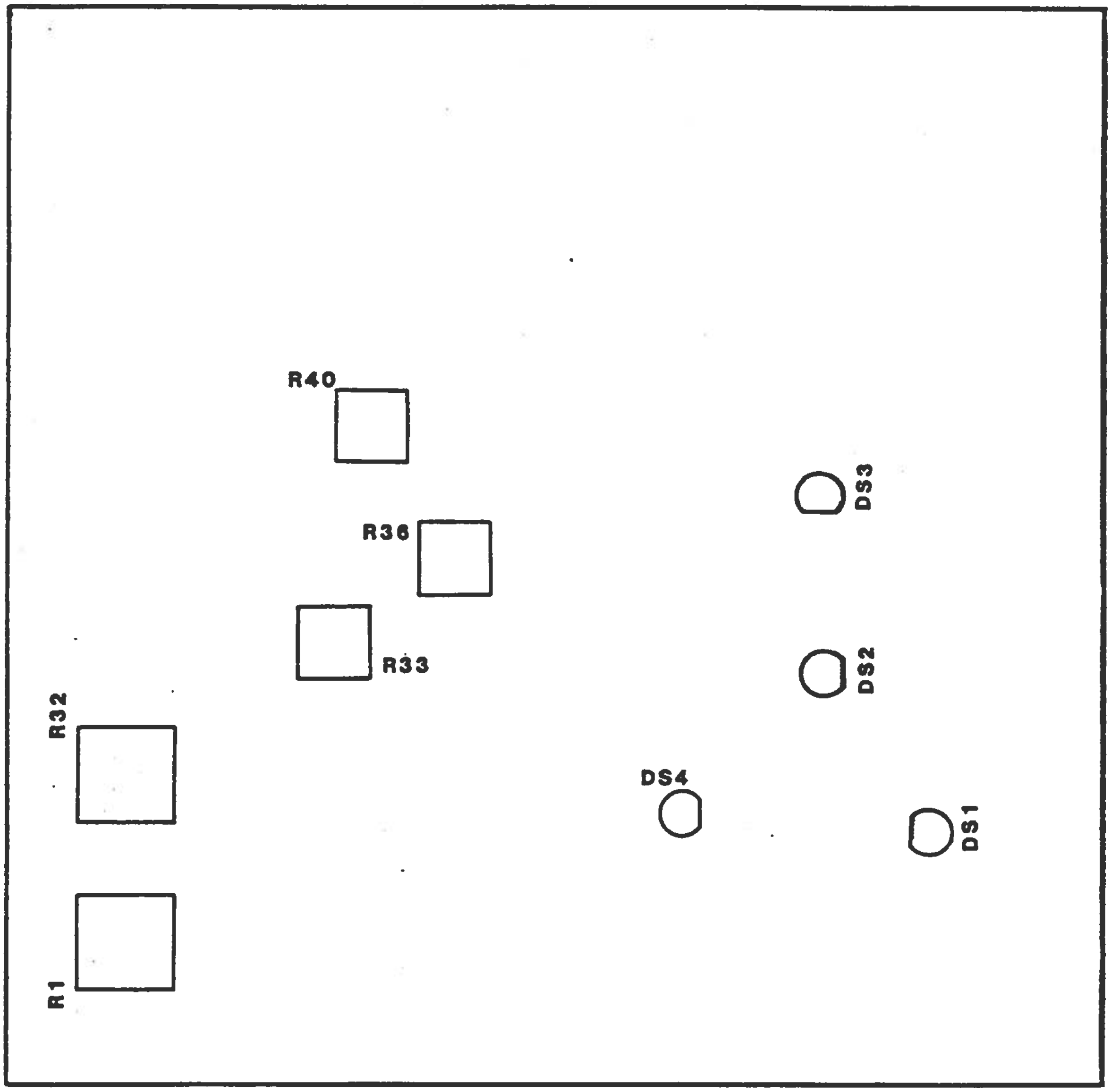


Figure 3-1. Controls & Indicators

Table 3-2. Indicators

Indicator	Function
LED DS 1	Illuminates to indicate an under excitation condition.
LED DS 2	Illuminates to indicate an over excitation condition.
LED DS 3	Illuminates to indicate that the active timer detector is activated.
LED DS 4	Illuminates to indicate that the calibration circuit is calibrated.

SECTION 4.0

INSTALLATION AND CALIBRATION

4.1 MOUNTING

The excitation limiter should be mounted in a vertical position for maximum convection cooling. Refer to Figure 4-1 for mounting holes and dimensions.

4.2 INTERCONNECTION

Connect the excitation limiter and other equipment in accordance with either Figure 4-2, 4-3, or 4-4, as applicable.

4.3 PRELIMINARY SET-UP

a. Set potentiometer R1 fully clockwise.

b. Set potentiometer R32 fully clockwise.

c. Set potentiometer R33 fully clockwise.

d. Set potentiometer R3G fully counterclockwise.

e. Set potentiometer R41 fully counterclockwise.

f. Connect the curve selecting jumper from terminal 4 to terminal 1, 2, or 3 depending on the leading kVAR curve. (Refer to Figure 4-5).

g. Place the polarity fanning strip in either the A or B position depending on the polarity required. (Refer to Table 4-1).

NOTE

If a runaway event occurs during the following test, it is probably caused by a reversed polarity of the A-B fanning strip, or reversed connections at terminals L and C, 1 and 2, or E1 and E3.

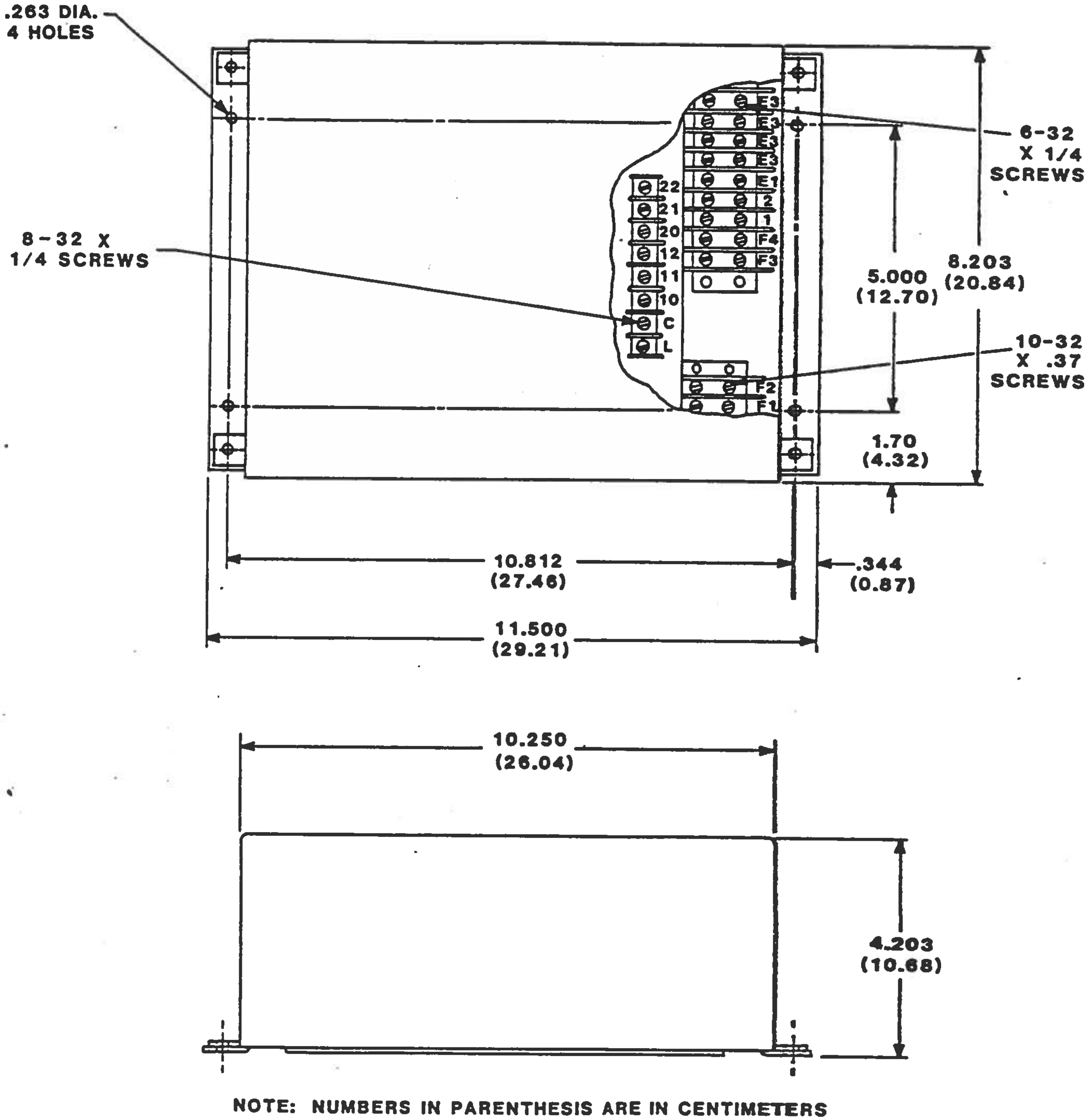


Figure 4-1. Outline Drawing.

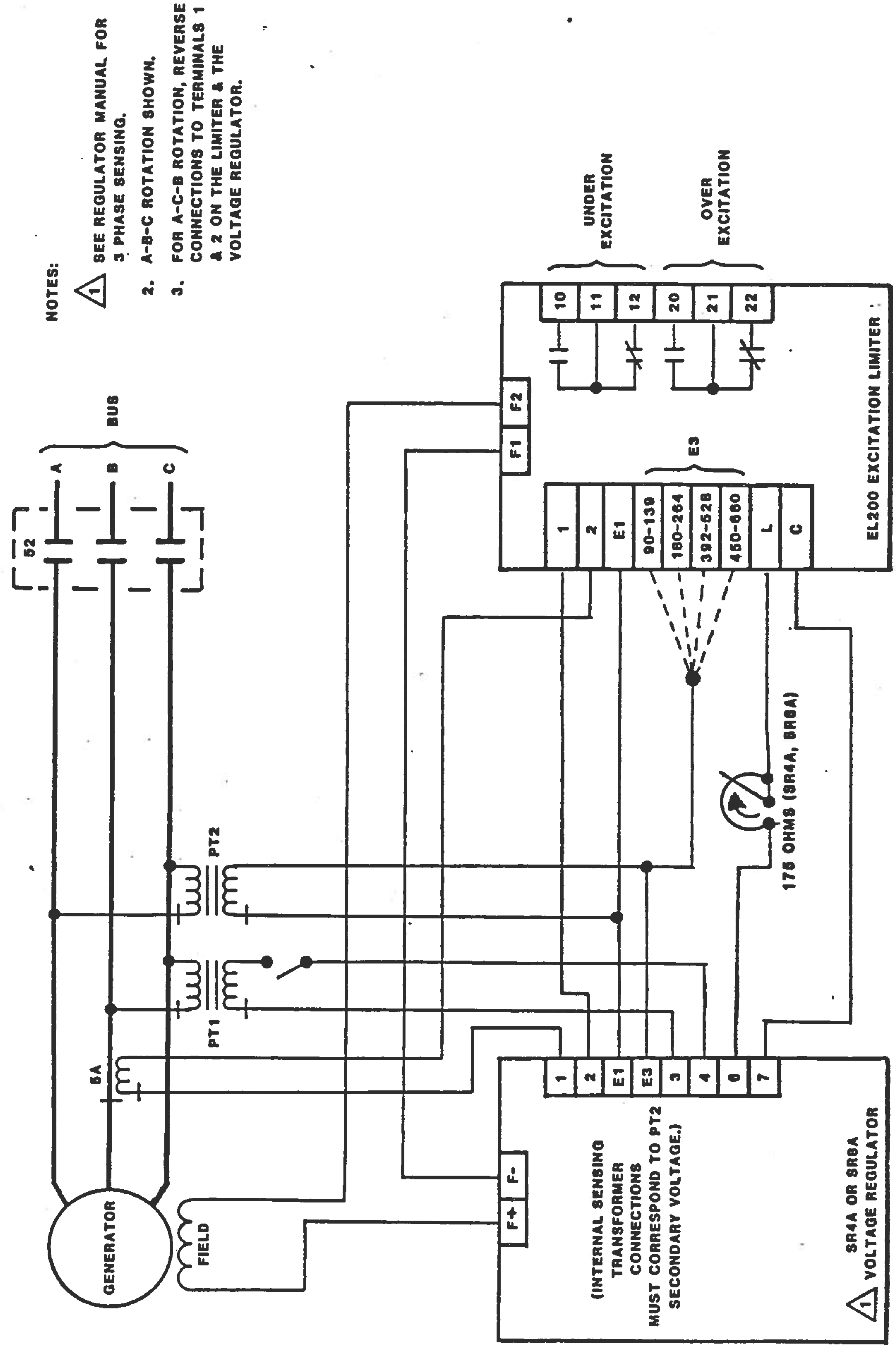


Figure 4-2. SR Voltage Regulator Interconnection Diagram

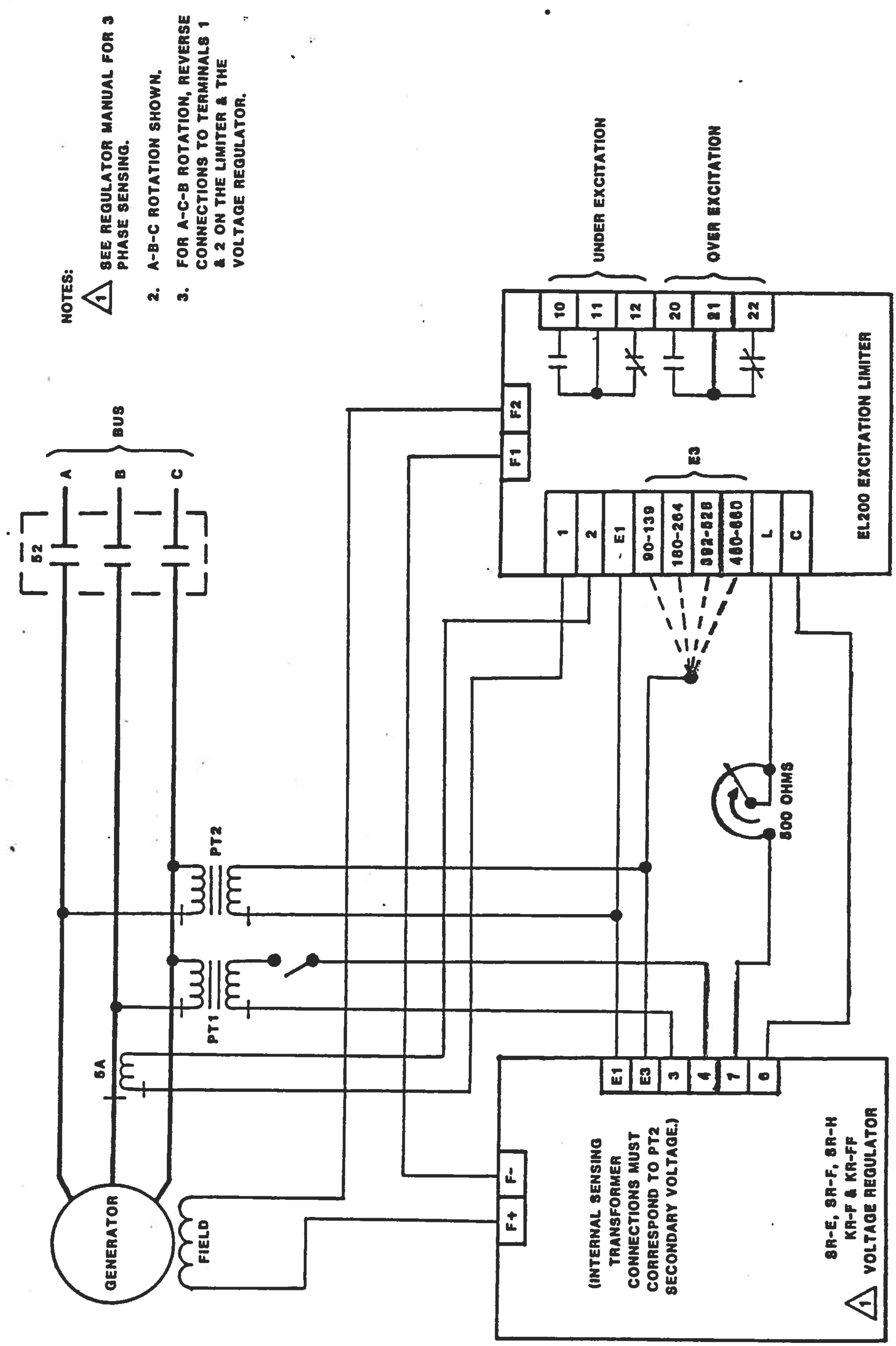


Figure 4-3. KR Voltage Regulator Interconnection Diagram

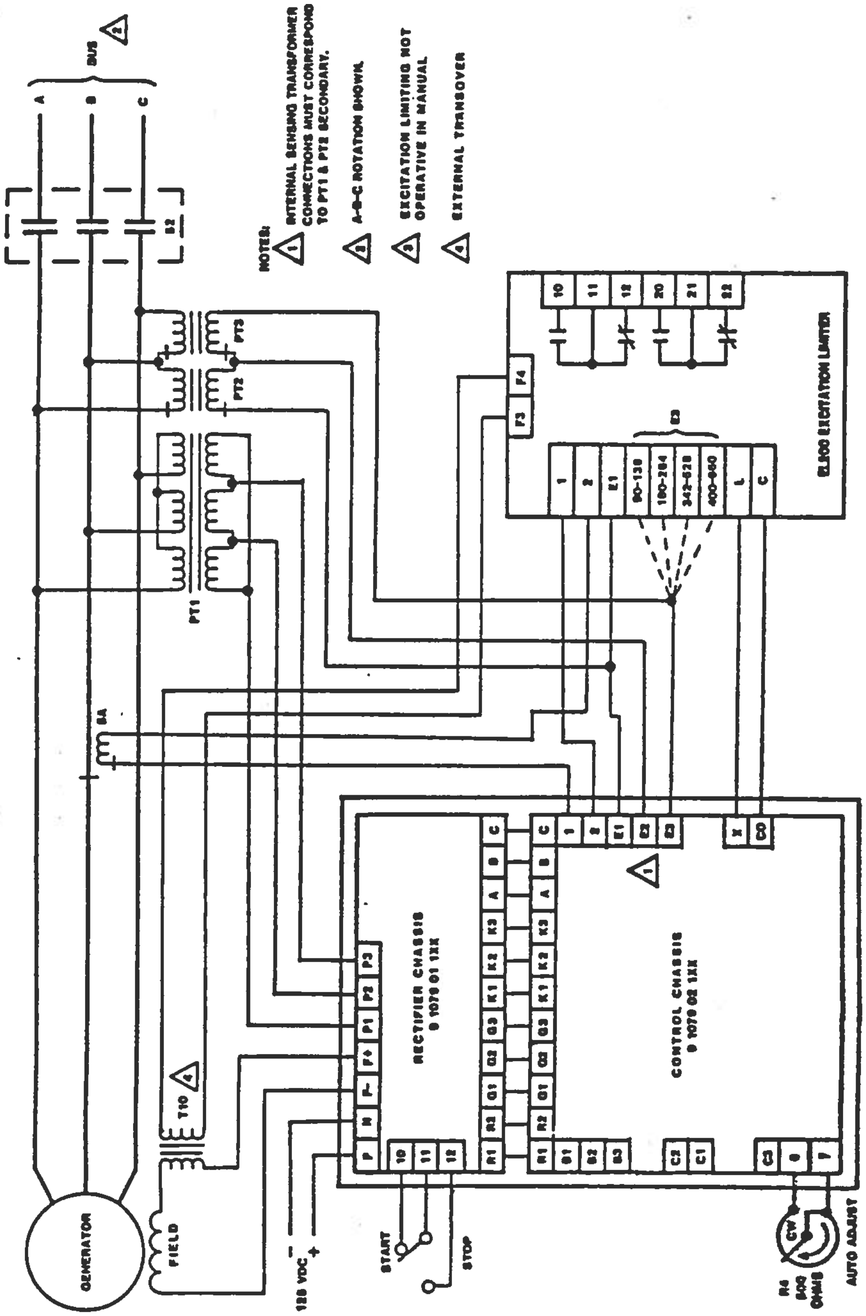


Figure 4-4. Shunt Static Exciter Interconnection Diagram

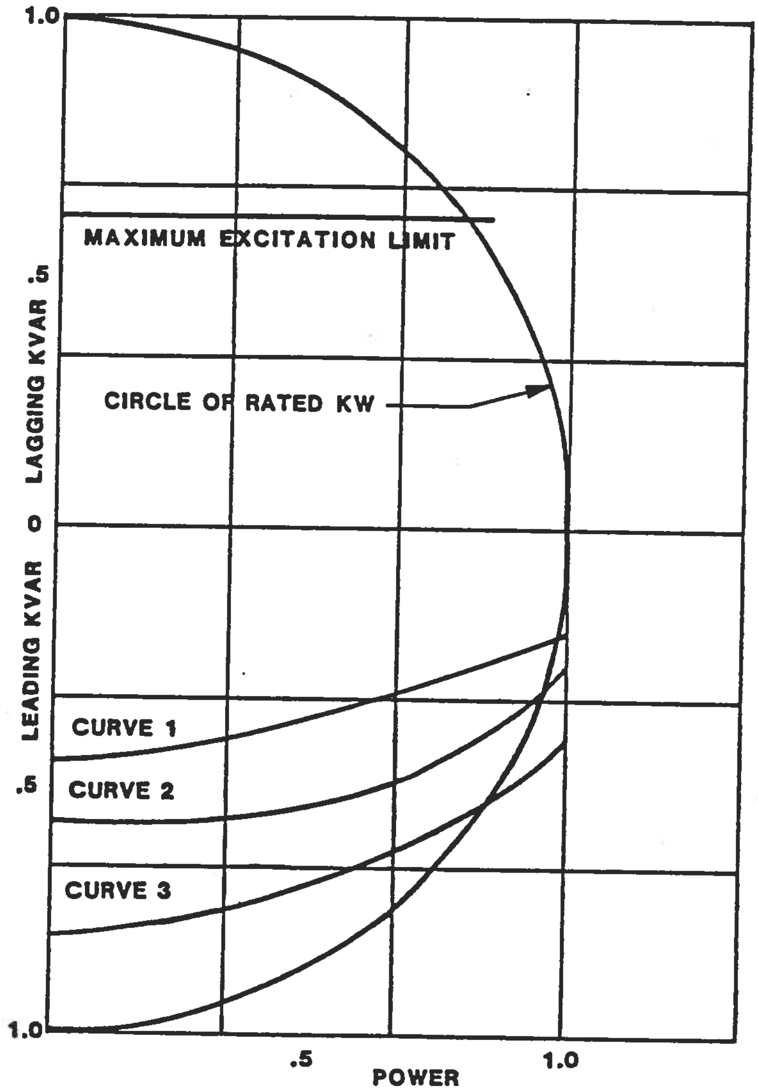


Figure 4-5. Leading KVAR Curves

Table 4-1. Fanning Strip Selection

A Position	B Position
SBSRN SR-A XR2001 XR2002 XR2003	SER-CB SR-E SR-H SSE KR-F

h. Tag and disconnect the leads from terminals L and C.

i. Tie the leads together.

j. Start the generator and parallel to the bus in the normal manner. Test for normal operation.

k. Rotate the voltage regulator/exciter voltage adjust rheostat to increase voltage.

RESULT: Lagging kVAR should flow from the generator into the bus. Field current from F1 of the limiter or through the primary of the external transducer should increase.

l. Rotate the voltage regulator/exciter voltage adjust rheostat to decrease voltage.

RESULT: Leading kVAR should flow from the generator into the bus; field current from F1 of the limiter or through the primary of the external transducer should decrease.

m. Check that the governor can be adjusted to produce any amount of kW between zero and rated.

n. If operation is normal, unparallel and then shutdown the generator.

o. Reconnect the wires to terminals L and C per the tagged identification.

4.4 OVER-EXCITATION CALIBRATION

4.4.1 Delayed Current Limit Calibration

a. Start the generator and parallel to the bus.

b. Set the generator for 10% kW output.

c. Adjust the voltage adjust rheostat to obtain the level of field current selected for the delayed threshold.

CAUTION

Be sure to monitor the entire system continually to avoid overstress/overload.

d. Rotate potentiometer R32 clockwise until indicator DS3 illuminates. Continue rotating until indicator DS2 lights and the field current begins to decrease.

4.4.2 Instant Current Limit Calibration

a. Be sure field current is at a normal level.

b. Set potentiometer R40 fully clockwise.

NOTE

Perform the following steps quickly before the timing interval expires and the generator overheats.

c. Rotate the voltage adjust rheostat to the value selected for instant limiting.

d. Rotate potentiometer R33 counterclockwise until indicator DS2 illuminates and the field current begins to decrease.

e. Reduce field current using the voltage adjust rheostat to normal.

4.4.3 Final Timer Setting

a. If a fixed timer characteristic is desired, set potentiometer R36 counterclockwise and then set potentiometer R40 to the desired time indicated on the circuit board. Potentiometer R40 provides a selection of 0 to 60 seconds delay when rotated in a clockwise direction.

b. If an inverse time characteristic is desired, set potentiometer R40 fully counterclockwise and potentiometer R36 clockwise for increasing time delay.

4.5 UNDER-EXCITATION CALIBRATION

a. With the generator paralleled and the limiter calibratated for over excitation, adjust the voltage adjust rheostat for a low level of kVAR flow.

b. Adjust the governor for rated kW.

c. Adjust potentiometer R1 counterclockwise until indicator DS4 just illuminates.

d. Adjust the governor for about 10% kW.

e. Rotate the voltage adjust rheostat in the direction of leading kVAR output until indicator DS1 illuminates. Further movement of the voltage adjust rheostat should produce no further increase of leading kVAR flow.

SECTION 5.0

MAINTENANCE INSTRUCTIONS

5.1 PREVENTIVE MAINTENANCE

Periodic inspections of the excitation limiter should be made on a regular basis to ensure that the unit is clean and free from accumulations of dust and moisture. When inspecting the unit, check that all parts are securely mounted and that all electrical connections are clean and secure.

5.2 CORRECTIVE MAINTENANCE

If a malfunction is detected in the system, use the troubleshooting table in paragraph 5.3. Repair is limited to the replacement of those parts given in Section 6.0.

5.3 TROUBLESHOOTING

The more common malfunctions and their appropriate repair procedures are listed in Table 5-1.

Table 5-1. Troubleshooting Chart

Symptom	Probable Cause/Test	Corrective Action
Limiter does not operate.	1. No input voltage.	1. Repair wiring.
	2. Defective circuitry.	2. Replace printed circuit board.
Limiter does not operate properly.	1. Incorrect wiring.	1. Check wiring per paragraph 4.2.
	2. Limiter is out of calibration.	2. Recalibrate per paragraphs 4-3 through 4.5.

SECTION 6.0

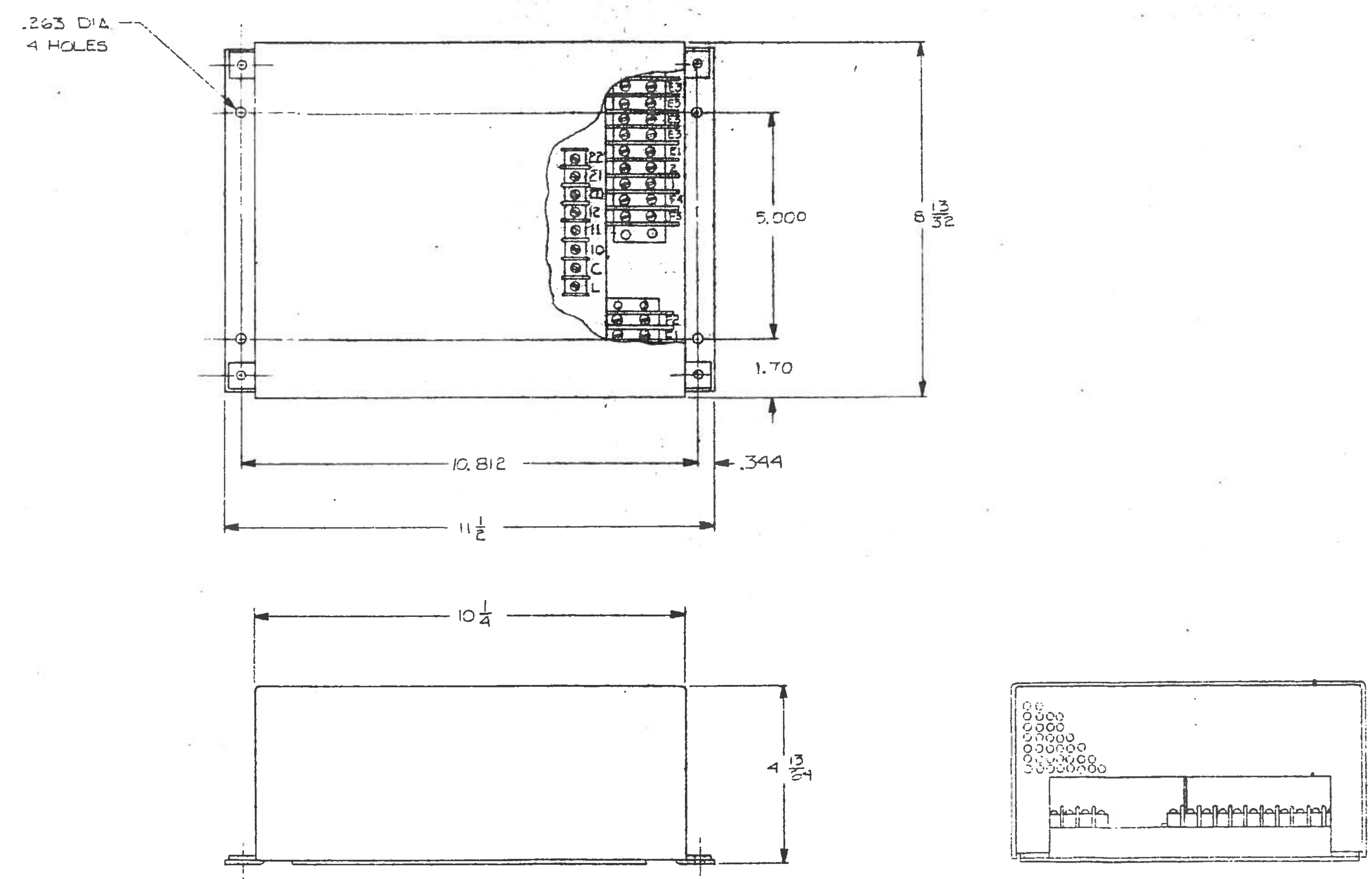
REPLACEMENT PARTS

6.1 GENERAL

The following list (Table 6-1) describes the assemblies and components that have maintenance significance. When ordering parts from Basler Electric, always specify the description of the item, part number, and quantity.

Table 6-1. Replacement Parts List

Reference Designation	Basler Part Number	Description
—	9 1747 01 001	Printed Circuit Board



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LETTER	REVISION	DATE	BY

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMALS ± .010 FRACTIONS ± 1/64 ANGLES ±

TITLE: OUTLINE DRAWING MIN/MAX EXCITATION LIMITER

MAT'L JOB NO: 5-8611

MATERIAL:

FINISH:

DRAWN BY	DATE	CHKD BY	DATE	APPR BY	DATE	SCALE
L. LIZOTTE	5/24/84		5-25-84	J. WEJ	5-29-84	NONE

BASLER ELECTRIC CO.
HIGHLAND, ILLINOIS

DWG SIZE: C

DRAWING NO.: 9 1747 00 900

INSTRUCTION
MANUAL

Basler Electric
Highland, Illinois

CURRENT BOOST SYSTEM
Model Number: CBS 377X
Part Number: 9 1096 00 104

Publication:
Number: 9 1096 00 994
Date: March 1, 1984

INTRODUCTION

This manual (Publication Number 9 1096 00 994) is a special version of Current Boost System, Model 377, Instruction Manual, Publication Number 9 1096 00 990.

This version of the manual is the result of a special modification to the CBS 377 Current Boost System to allow a 140-144 Vdc output.

To convert the standard CBS 377 to CBS 377X, proceed as follows:

a. Remove VR1, a 15V zener diode from the printed circuit board assembly.

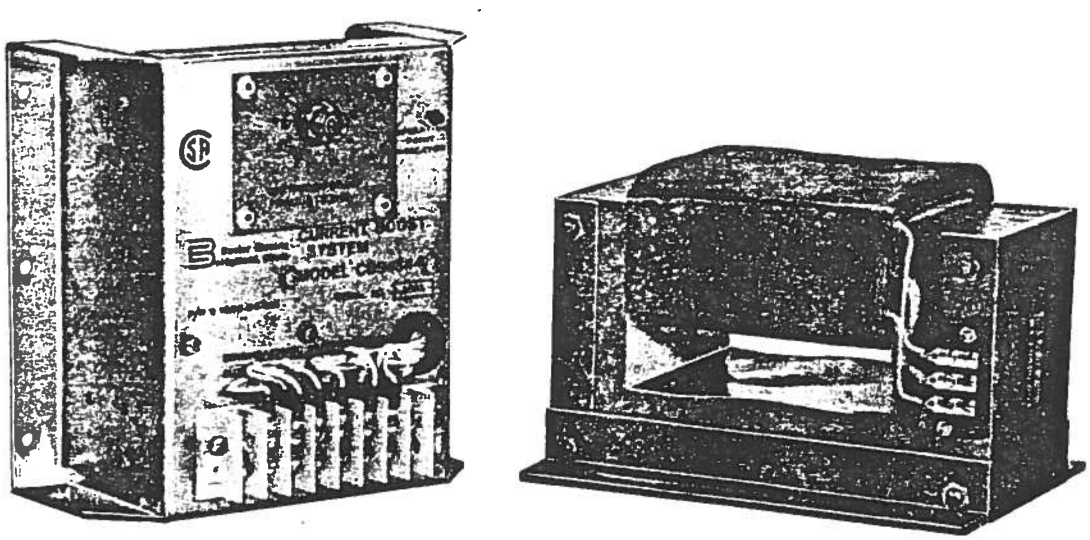
b. Install new zener diode (P/N 07615) into the VR1 location.

c. Re-identify unit as P/N 9 1096 00 104, CBS 377X.

d. Remove CSA logo from unit.

e. Note on schematic (9 1096 00 910) that VR1 is now 12V.

INSTRUCTION
MANUAL



Basler Electric
Highland, Illinois

CURRENT BOOST SYSTEM
Model Numbers: CBS 344
CBS 377
Part Numbers: 9 1096 00 102
9 1096 00 103

Publication:
Number: 9 1096 00 990
Date: July, 1983

WARNING

TO PREVENT PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED TECHNICIANS/OPERATORS SHOULD INSTALL, OPERATE OR SERVICE THIS DEVICE.

CAUTION

MEGGERS AND HIGH POTENTIAL TEST EQUIPMENT MUST NOT BE USED. INCORRECT USE OF SUCH EQUIPMENT COULD DAMAGE COMPONENTS CONTAINED IN THE CBS 344 AND CBS 377.

SECTION 1.0

GENERAL INFORMATION

1.1 DESCRIPTION

The purpose of the Current Boost System is to assist KR4 and KR7 series voltage regulators during generator overload conditions such as motor starting and to independently supply the generator exciter field current during generator short circuits. The CBS will permit 3-wire and 4-wire generators to support sustained single phase and multiple phase line-to-line faults. In addition, the CBS permits 4-wire generators to support phase A and phase B line-to-neutral faults (excluding phase C line-to-neutral faults). The CBS consists of a current boost module and a current transformer. An operation point adjustment and LED indicator are mounted on the front of the current boost module.

A special power current transformer is connected to two phases of the generator to provide current for the CBS. This CT provides several turns -ratios for tailoring the CBS to a variety of 3-wire generator systems. Refer to paragraph 4.3 for a chart showing the range of (three phase) short circuit line current/short circuit field current available using the CT, and the appropriate turns-ratios.

The CBS is available in two models:

a) CBS 344 - for KR4 series regulator
b) CBS 377 - for KR7 series regulator

The CT is available in two sizes (both have identical electrical ratings and turns-ratios):

a) P/N BE 15486-001 - standard size (see Figure 4-2A)
b) P/N BE 16866-001 - larger "window" (see Figure 4-2B)

1.2 SPECIFICATIONS

DC Output Power: (see Table 1-1)
AC Sensing Voltage: (see Table 1-1)

Table 1-1

MODEL	DC OUTPUT POWER		AC SENSING VOLTAGE	
	DC Volts (Max.)	DC Amps (Max.)	Adjustment Range	Burden
CBS 344 (Used with KR4 Series Regulator)	90 Vdc	3.5A	70 - 131 Vac	10VA
CBS 377 (Used with KR7 Series Regulator)	180 Vdc	5.0A	140 - 262 Vac	10VA

Power Dissipation:	Less than 50 watts at continuous rating.
Dropout Ratio - CBS 344:	Dropout @ 5V above pickup point.
- CBS 377:	Dropout @ 10V above pickup point.
Storage Temperature Range:	-85°F (-65°C) to +185°F (+85°C)
Operating Temperature Range:	-40°F (-40°C) to +140°F (+60°C)
Shock:	Withstand up to 15 G's in each of three mutually perpendicular planes.
Vibration:	Withstand 5 to 26 Hz. @ 1.2 G's; 26 to 52 Hz. @ 0.036 double amplitude; 52 to 260 Hz @ 5.0 G's.
Dimensions:	7.12 in. (180.97 mm) by 7.10 in. (180.34 mm) by 3.93 in. (99.99 mm)
Weight:	
CBS 344/CBS 377:	4.5 lbs. (2.03kg) net 5.0 lbs. (2.27 kg) shipping
(CT) BE 15486-001:	32.4 lbs. (14.69kg) net 35.0 lbs. (15.9 kg) shipping
(CT) BE 16866-001:	52.0 lbs. (23.59kg) net 53.0 lbs. (24.0 kg) shipping

SECTION 2.0

THEORY OF OPERATION

2.1 CURRENT TRANSFORMER (CT)

The current transformer(s) selected for use with the CBS 344 or CBS 377 system is placed in two phases of the generator output to provide a source of both operating power and current boost for the current boost module. See Figure 4-3A. Secondary coil taps are provided to select appropriate ampere turns. Two electrically identical transformers are available: P/N BE 15486-001 (standard, see Figure 4-2A) and P/N BE 16866-001 (larger cable "window", see Figure 4-2B).

Due to conductor size or location, some generator systems cannot provide more than one output line for one CT (window) - it then becomes necessary to use two identical CTs, one for each phase, and each having the same turns-ratio. See Figure 4-3B.

2.2 CURRENT BOOST MODULE

The current boost module rectifies the ac from the CT to provide dc current boost for the generator exciter field. During normal generator operation, power from the generator output provides sufficient exciter field power - the Current Boost System remains dormant and the OPERATION POINT indicator is illuminated. At this time, the input CT is effectively shorted by SCRs in the current boost module.

If the generator output voltage drops below the operation point selected on the OPERATION POINT adjustment (due to a short or during motor starting) the current boost module detects the voltage drop, extinguishing the OPERATION POINT indicator and removing the SCR "short" from the CT. The module then provides full current boost to the generator exciter until the voltage returns to a level just above the operation point, and illuminates the OPERATION POINT indicator. Refer to sections 3.0 and 4.0 for proper use of the OPERATION POINT adjustment.

A voltage limiting circuit prevents the output of the current boost module from exceeding the specified nominal output voltage of 90 Vdc (CBS 344) and 180 Vdc (CBS 377).

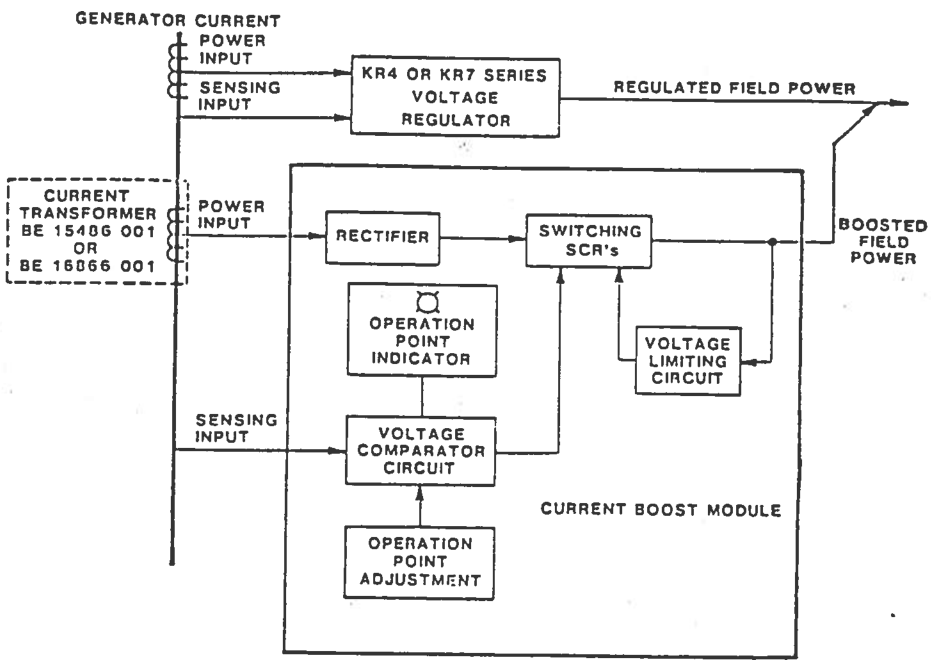


Figure 2-1. Current Boost System CBS 344 and CBS 377

SECTION 3.0

CONTROLS AND INDICATORS

Table 3-1 lists and describes the operator's controls and indicators of the Current Boost System.

Table 3-1 Controls and Indicators

Control or Indicator	Function or Indication
OPERATION POINT Adjustment	This front panel-mounted screwdriver adjustment on the current boost module establishes the lower limit (pickup point) of generator output voltage - if the sensed output voltage decreases below this limit, current boost will occur, continuing until the voltage increases to 5V (CBS 344) or 10V (CBS 377) above the limit (dropout point). NOTE Setting the OPERATION POINT adjustment too close to the nominal generator output voltage may cause oscillation of the output voltage. If this occurs, rotate the adjustment CCW until the oscillation stops.
OPERATION POINT Indicator	This front panel-mounted LED on the current boost module is normally illuminated, extinguishing during current boost, and illuminating again when generator output voltage exceeds the setting of the OPERATION POINT adjustment.

SECTION 4.0

INSTALLATION

4.1 CONSTRUCTION

See Figure 4-1. The current boost module consists of a fabricated steel chassis containing electrical components and a printed circuit board.

A single control, indicator, and terminal board for generator system interconnection, are mounted on the front of the unit.

See Figure 4-2A and 4-2B for the configuration of the two available CTs. (Both CTs have identical electrical characteristics - however, the CT shown in figure 4-2B has a larger "window" for accepting the generator cables).

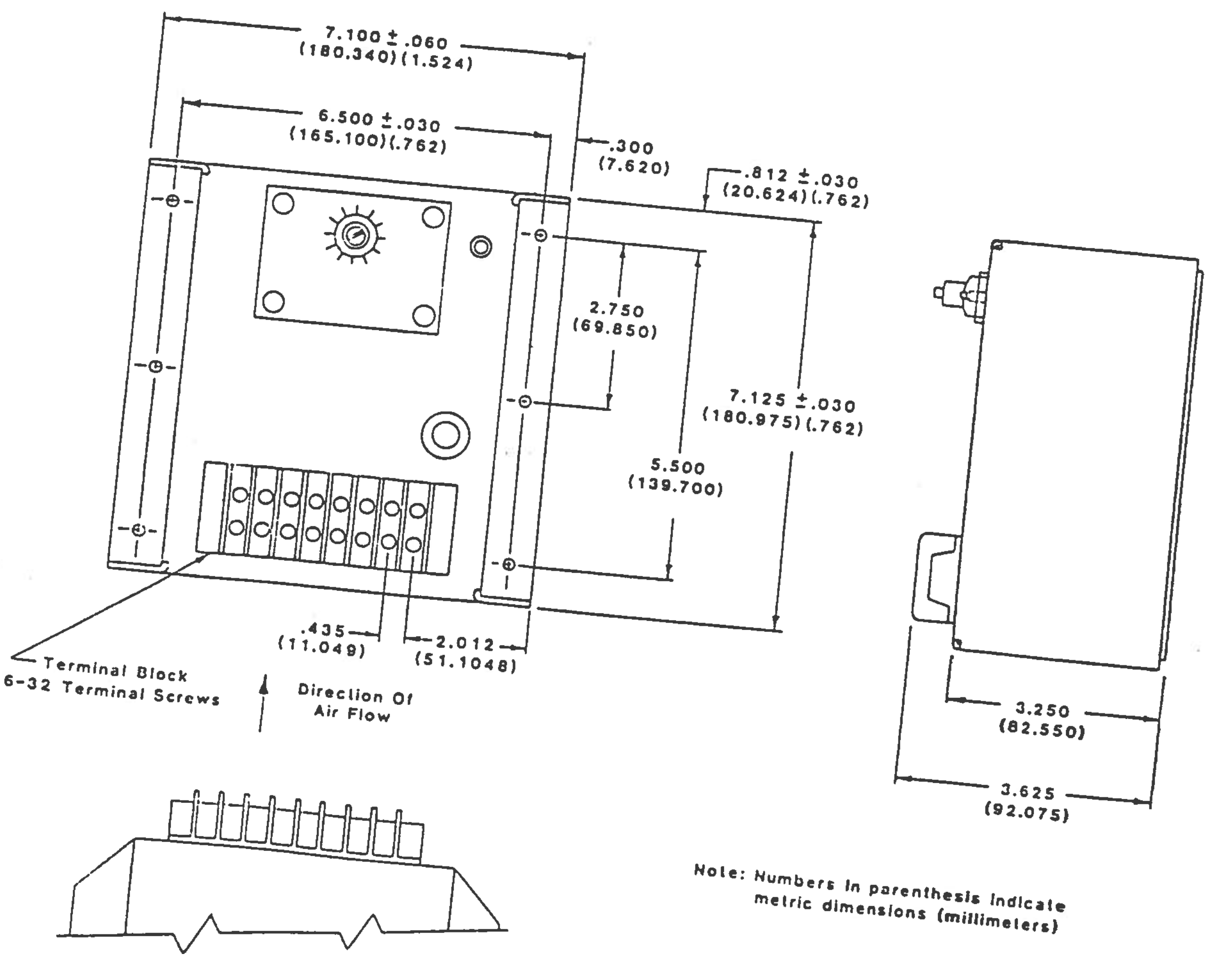


Figure 4-1. Outline Drawing - Current Boost Module

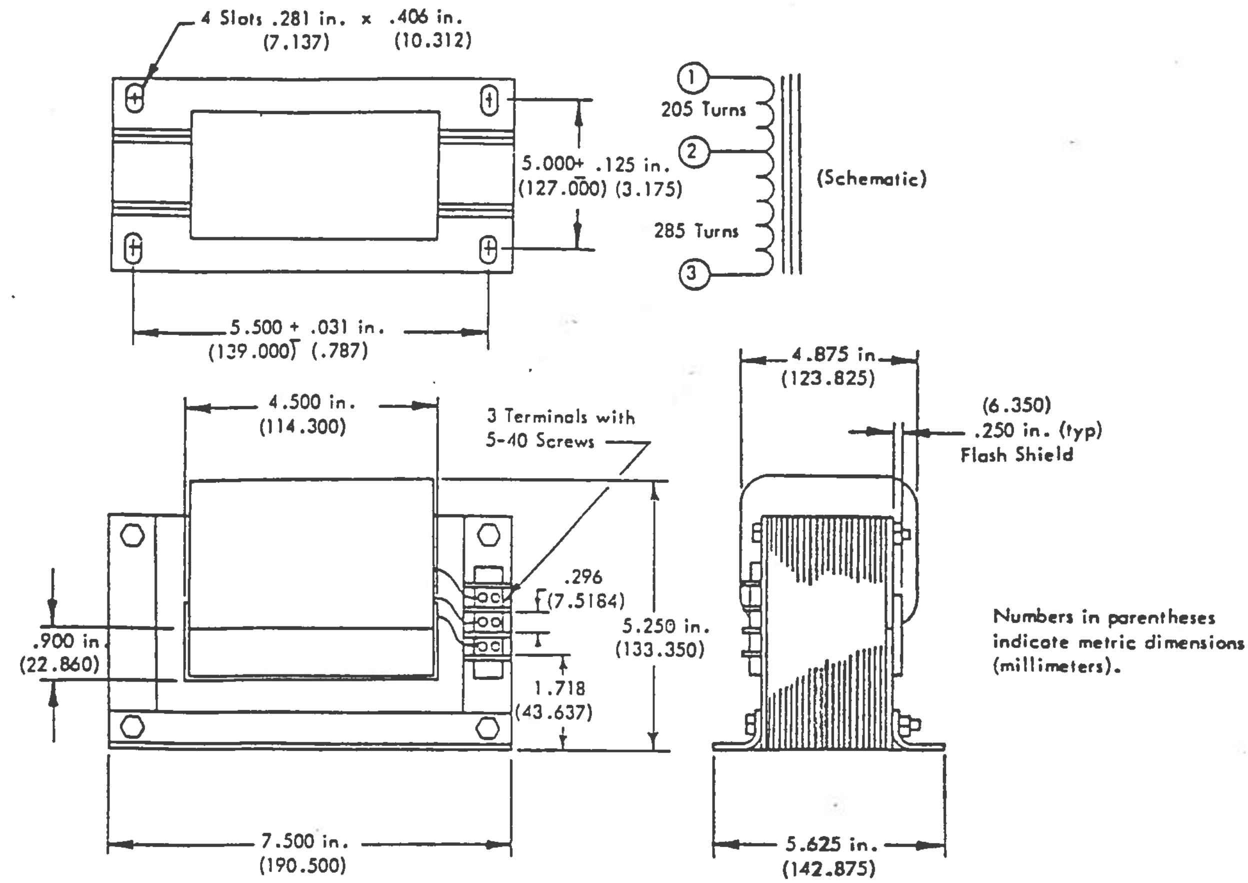


Figure 4-2A. Outline Drawing - Current Transformer Pt no. BE 15486-001

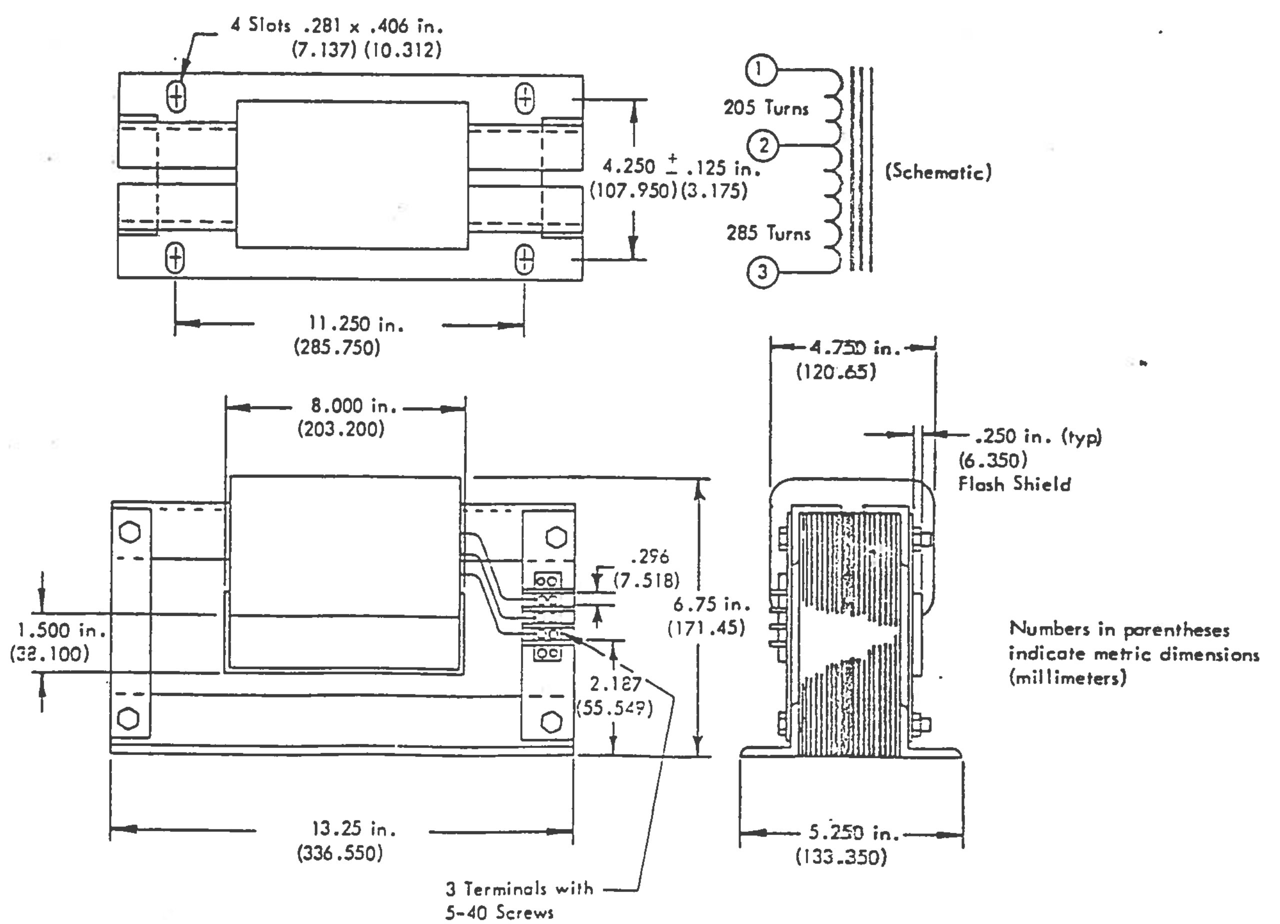


Figure 4-2B. Outline Drawing - Current Transformer Pt. no. BE 16866-001

4.2 INSTALLATION PROCEDURES

4.2.1 Mounting

The current boost module is convection cooled and should not be mounted near heat generating equipment nor inside totally enclosed switchgear where the temperature rise could exceed its operating limit. Vertical mounting is recommended to obtain optimum convection cooling.

4.2.2 Interconnections

External connections to the current boost module are made at the front of the unit.

4.2.2.1 Current Transformer

A typical external connection utilizing a single CT is shown in Figure 4-3A.

Two current transformers are recommended for generators rated above 600 volts or when their use simplifies wrapping the primary turns. Figure 4-3B shows a typical external connection for those situations requiring two CTs.

NOTE

For selection of the CT turns -ratio refer to paragraph 4.3.

Figures 4-3A and 4-3B show how the output leads of the generator pass through the window of the CT(s). NOTE THAT THE LEADS OF TWO PHASES PASS THROUGH THE WINDOW IN OPPOSITE DIRECTIONS.

With this configuration, energy is supplied to the CT to activiate the module during the following fault conditions:

a) Symmetrical Three Phase Short (Phase A to Phase B to Phase C)
b) Phase A to Phase B Short
c) Phase A to Phase C Short
d) Phase B to Phase C Short
e) Phase A to Neutral Short
f) Phase B to Neutral Short

If the generator has a neutral terminal, energy will be supplied to the CT during conditions e and f, but not for a phase C to Neutral short. In this case, if the voltage regulator is powered by phase A and phase B, the regulator may continue to supply power to the exciter field.

4.2.2.2 Exciter Field Current Boost Output Circuit (Terminals P and N).

Disconnect generator terminal F+ from the regulator F+ terminal. Reconnect generator terminal F+ to terminal P on the current boost module. Connect a new lead from terminal N on the current boost module to the F+ terminal on the voltage regulator.

4.2.2.3 Current Input Circuit (Terminals 1 and 2)

Connect terminals 1 and 2 to the CT secondary terminals. Refer to paragraph 4.3 for the correct turns-ratio for the CT.

4.2.2.4 Sensing Circuit (Terminals 3 and 4)

Generator voltage is applied between terminals 3 and 4 of the current boost module. The range of input voltage should not exceed 90 to 139 Vac for the CBS 344 Current Boost System or 180 to 277 Vac for the CBS 377 Current Boost System. If the appropriate input voltage is not available, a power isolation transformer should be installed as shown in Figure 4-3.

4.3 SELECTION OF CT TURNS-RATIO

4.3.1 Selection Procedure

Two phases of the generator output are applied to the CT. The following procedure is used to calculate the number of CT primary turns (generator output lines, wound through the CT window by the installer) for each phase, and secondary turns (Figure 4-2, terminals 1, 2, 3).

If dual CTs are used (for example, safety requirements will not allow generators with output voltage greater than 600V to pass two output cables through the "window" of the CT), two identical CTs are required, and identical turns-ratios applied.

Step 1. Calculate the exciter field current during a generator short circuit:

$$I_{Field} = \frac{E}{R}$$

where,

I_{Field} = Exciter Field Current at Short Circuit

R = Exciter Field Resistance

E = CBS Field Forcing Voltage*

* 90 Vdc Forcing Voltage for CBS 344
180 Vdc Forcing Voltage for CBS 377

Step 2. From short circuit saturation data (plot of exciter field current versus line amps with the output of the generator short circuited), available from the generator manufacturer, determine the generator three phase line current during a short circuit that would result from the exciter field current calculated in Step 1.

If (for your generator system)	Then
This results in excessive generator line current.	Proceed to step 3A
This results in acceptable generator line current.	Proceed to step 3B

Step 3A.

a. Determine the desired acceptable generator three phase line current at short circuit (typically 250 - 300% nominal). In Table 4-1 column 1, locate the value closest to this value.

b. Using short circuit saturation data (plot of exciter field current versus line amps with the output of the generator short circuited) from the generator manufacturer, determine the exciter field current at short circuit required to generate the acceptable generator line current*. In table 4-1 column 2, locate the current value closest to this value.

* To obtain this reduced current, place a current limiting resistor in series with the exciter field - the value of this resistance is calculated as follows:

$$R_S = \frac{E}{I_2} - R_f$$

where, R_S = value of series field resistance to be added (ohms). (This resistance must not be so great as to restrict normal forcing).

E = exciter field forcing voltage (from step 1).

I_2 = field current required to produce acceptable generator line current at short circuit.

R_f = exciter field resistance.

c. Proceed to step 4.

Step 3B

a. In Table 4-1 column 1, locate the value of generator three phase line current at short circuit, closest to the value determined in step 2.

Table 4-1 - Turns-Ratio Selection (1)

COLUMN 1	COLUMN 2						
3 Phase Line Current At Short Circuit (Amperes)	Exciter Field Current at Short Circuit (Amperes) - KR4 and KR7 Series Voltage Regulators						
	2.5	2.8	3.15	3.54	4.0*	4.45*	5.0*
141	3:205		4:205		5:205		6:205
158		3:205		4:205		5:205	
178	3:205		3:205		4:205		5:205
200		3:205		3:205		4:205	
225	2:205		3:205		3:205		4:205
253		2:205		3:205		3:205	
283	2:285		2:205		3:205		3:205
318		2:285		2:205		3:205	
357	2:285		2:285		2:205		3:205
401		2:285		2:285		2:205	
450	1:205		2:285		2:285		2:205
505		1:205		2:285		2:285	
567	1:285		1:205		2:285		2:285
636		1:285		1:205		2:285	
714	1:285		1:285		1:205		2:285
801		1:285		1:285		1:205	
900	1:285		1:285		1:285		1:205
1010		1:285		1:285		1:285	
1134	1:490		1:285		1:285		1:285
1273		1:490		1:285		1:285	
1428	1:490		1:490		1:285		1:285
1603		1:490		1:490		1:285	
† 1800	1:490		1:490		1:490		1:285
2020		1:490		1:490		1:490	
†† 2267	1:490		1:490		1:490		1:490
2547		1:490		1:490		1:490	
2857			1:490		1:490		1:490
3207				1:490		1:490	
3600					1:490		1:490 **
4040						1:490	**
4536							1:490 **

NOTE:

(1) First number - primary (generator cable) turns. Second number - secondary turns. If dual CTs are used, each CT receives the indicated primary turns from only one phase of the generator, and each CT is connected using the indicated secondary turns.

* KR7F only

** Only one phase connected to CT.

† Example (Paragraph 4.3.2) Step 3A

†† Example (Paragraph 4.3.2) Step 3B

b. In table 4-1 column 2, locate the value of exciter field current at short circuit, closest to the value determined in step 1.

c. Proceed to step 4.

Step 4. Find the turns-ratio at the point of intersection of the values found in step 3A or 3B - if there is not a ratio at this point, use the ratio directly above the intersection.

The first numeral of the turns-ratio indicates the number of turns of each generator line that passes through the CT window. The second numeral indicates the number of secondary turns to be used. See Figure 4-2 for appropriate CT terminals for secondary turns.

NOTE

Increased CT power will result if a smaller turns-ratio is selected (CT primary turns are increased or CT secondary turns are decreased).

Step 5. Verify that the CT "window" size is sufficient for the generator conductor, as follows. Multiply the first numeral of the turns-ratio by the number of conductors in each phase, then by the number of phases (2). Multiply this product by the diameter of the conductor to find the required minimum size of the CT window. The "window" of the CT specified for your CBS (Figure 4-2A or 4-2B) should exceed this minimum. Figures 4-2A and 4-2B also show the appropriate CT terminals for secondary turns.

NOTE

If dual CTs are used, each CT receives the indicated primary turns from only one phase of the generator and each CT is connected using the indicated secondary turns.

4.3.2 Example of CT Turns-Ratio Selection

This example shows the resulting turns-ratio of paragraph 4.3.1, Selection Procedure, for both excessive and acceptable generator short circuit current.

(Step 1) Determine the exciter field current that will be provided by a Basler KR4F voltage regulator during short circuit:

$$I_F = \frac{E}{R} = \frac{90\ \text{Vdc}}{30\ \text{ohms}} = 3.0\text{A}$$

where, I_F = Field current
E = Table 1-1, CBS 344/KR4 max. dc volts
R = Exciter field resistance

(Step 2) From generator manufacturer data, you determine that the exciter field current of 3.0A from the KR4F voltage regulator would result in a short circuit line current of 2258A.

If (for your generator system)	Then
This results in <u>excessive</u> generator line current.	Proceed to step 3A
This results in <u>acceptable</u> generator line current.	Proceed to step 3B

(Step 3A) (You determine that 1800A would constitute an acceptable generator line current at short circuit).

From generator manufacturer data, you determine that an exciter field current of 2.5A is required for the generator system to deliver an acceptable 1800A at short circuit.

Determine the necessary resistance to be added to the exciter field to achieve the 2.5A exciter field current.

$$R_S = \frac{E}{I_2} - R_f$$
$$= \frac{90\ Vdc}{2.5A} - 30\ ohms$$
$$= 36 - 30\ ohms$$
$$= 6\ ohms$$

NOTE

The series resistance must not be so great as to restrict normal forcing.

In table 4-1, column 1, the value of "1800A" corresponds with the required value of 1800A. Draw a horizontal line from this point across the chart.

In table 4-1, column 2, the value of 2.5A corresponds with the required value of 2.5A (from step 3A). Draw a vertical line from this point down the chart.

(Step 4) From table 4-1, the intersection of the two lines from step 3A is the turns-ratio, 1:490:

1 turn on primary (done by installer)
490 turns on secondary (terminals 1 and 3, Figure 4-2)

Step 5) The first numeral of the turns-ratio (1), the number of conductors per phase (2) and the number of phases (2) multiplied together results in: 4 conductors (through the CT window). From generator manufacturer data, 0.7 in. is the conductor diameter; therefore, for 4 conductors the CT window must be at least 0.7 in. X 2.8 in. Basler CT P/N BE 15486-001 (Figure 4-2A)) is 0.9 in. X 4.5 in. and meets the requirement.

NOTE

This ends the EXAMPLE for <u>excessive</u> line current.

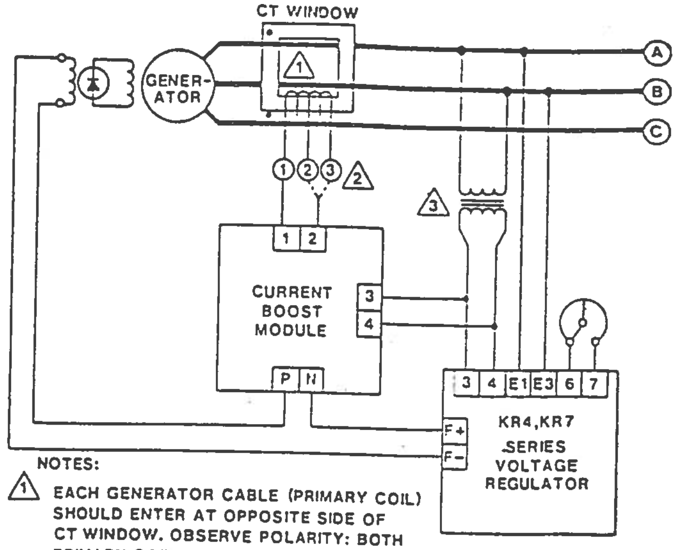
(Step 3B) In table 4-1, column 1, the closest value to 2258A (from step 2) is "2267A". Draw a horizontal line from this point across the chart.

In table 4-1, column 2, the closest value to 3.0A (from step 1) is "3.15A". Draw a vertical line from this point down the chart.

(Step 4) From table 4-1, the intersection of the two lines from step 3B is the turns-ratio, 1:490:

1 turn on primary (done by installer)
490 turns on secondary (terminals 1 and 3, Figure 4-2)

(Step 5) The first numeral of the turns-ratio (1), the number of conductors per phase (2) and the number of phases (2) multiplied together, results in: 4 conductors (through the CT window). From generator manufacturer data, 0.7 in. is the conductor diameter; therefore, for 4 conductors the CT window must be at least 0.7 in. X 2.8 in. Basler CT P/N BE 15486-001 (Figure 4-2A) is 0.9 in. X 4.5 in. and meets the requirement.



NOTES:

⚠1 EACH GENERATOR CABLE (PRIMARY COIL) SHOULD ENTER AT OPPOSITE SIDE OF CT WINDOW. OBSERVE POLARITY: BOTH PRIMARY COILS SHOULD HAVE EQUAL TURNS. REFER TO SECTION 1 FOR SELECTION OF CT TURNS RATIO.

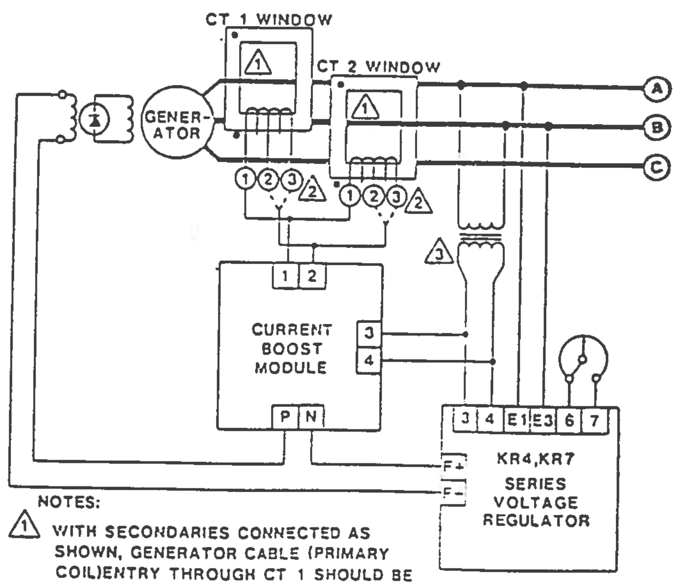
⚠2 SELECTABLE NUMBER OF SECONDARY COILS:

TERMINALS

① - ② 205 TURNS
② - ③ 285 TURNS
① - ③ 490 TURNS

⚠3 POWER ISOLATION TRANSFORMER IS REQUIRED IF APPROPRIATE INPUT POWER IS NOT AVAILABLE AT GENERATOR TERMINALS. CBS 344 REQUIRES 90-139V. CBS 377 REQUIRES 180-277V. FOR VOLTAGE REGULATOR INPUT POWER REQUIREMENT REFER TO VOLTAGE REGULATOR INSTRUCTION MANUAL

Figure 4-3A. Interconnection Diagram - Single CT



NOTES:

⚠1 WITH SECONDARIES CONNECTED AS SHOWN, GENERATOR CABLE (PRIMARY COIL)ENTRY THROUGH CT 1 SHOULD BE OPPOSITE OF CABLE ENTRY THROUGH CT 2. OBSERVE POLARITY: BOTH PRIMARY COILS SHOULD HAVE EQUAL TURNS; REFER TO SECTION 1 FOR SELECTION OF CT TURNS RATIO.

⚠2 SELECTABLE NUMBER OF SECONDARY COILS:

TERMINALS

① - ② 205 TURNS
② - ③ 285 TURNS
① - ③ 490 TURNS

⚠3 POWER ISOLATION TRANSFORMER IS REQUIRED IF APPROPRIATE INPUT POWER IS NOT AVAILABLE AT GENERATOR TERMINALS. CBS 344 REQUIRES 90-139V. CBS 377 REQUIRES 180-277V. FOR VOLTAGE REGULATOR INPUT POWER REQUIREMENT REFER TO VOLTAGE REGULATOR INSTRUCTION MANUAL

Figure 4-3B. Interconnection Diagram - Dual CTs

SECTION 5.0

OPERATIONAL TEST

5.1 GENERAL

CAUTION

MEGGERS AND HIGH POTENTIAL TEST EQUIPMENT MUST NOT BE USED. INCORRECT USE OF SUCH EQUIPMENT COULD DAMAGE THE SEMICONDUCTORS CONTAINED IN THE UNIT.

The procedures in this section are suggested for verifying proper installation, for adjusting and testing the operation point of the current Boost System, and for verifying boost current power.

The following procedures are performed with the unit installed in the generator system per section 4.0.

5.2 INSTALLATION INTERCONNECTION VERIFICATION

5.2.1 Preliminary

a. Ensure the prime mover is off.
b. Ensure Current Boost System CBS 344 or CBS 377 is connected per Section 4.0.
c. Install a 10A ammeter in the line leading to terminal 1 of the current boost module.
c. Set the OPERATION POINT adjustment CCW.

5.2.2 Test

a. With the generator at no-load, start the prime mover and bring up to rated speed.

RESULT: The CBS 344 or 377 OPERATION POINT indicator is illuminated.

b. Apply a load to the generator.

c. The measured input current (I_M) on the current boost module terminal 1 ammeter should be approximately equal to the calculated value of current at terminal 1 (I_C), which is based on a known value for generator line current and on the CT turns -ratio from table 4-1, as follows:

$$I_M = I_C$$

where, I_M = the measured input current at terminal 1
I_C* = the calculated input current at terminal 1

$$* \; I_C = I_L \times 1.73 \times P:S$$

where, I_L = generator line current
P:S = (primary:secondary) CT turns-ratio selected from table 1-2.

If $I_M \neq I_C$, check CT polarity, recheck generator data used for CT turns ratio selection, and check interconnection wiring.

5.3 OPERATIONAL TEST PROCEDURE

5.3.1 Preliminary

a. Ensure the prime mover is off.
b. Ensure Current Boost System CBS 344 or CBS 377 is connected per Section 4.0.
c. Set the OPERATION POINT adjustment CCW.

5.3.2 Test

a. With the generator at no-load, start the prime mover and bring up to rated speed.

RESULT: The CBS 344 or 377 OPERATION POINT indicator is illuminated.

b. Reduce the generator voltage to the desired operation point for current boost.

NOTE

Setting the OPERATION POINT adjustment too close to the nominal generator output voltage may cause oscillation of the output voltage. If this occurs, rotate the adjustment CCW until the oscillation stops.

c. To establish the pickup point for current boost operation, adjust the OPERATION POINT adjustment CW until the OPERATION POINT indicator extinguishes.

RESULT: Current boost operation occurs.

d. Return the generator voltage to nominal.

RESULT: The OPERATION POINT indicator illuminates and current boost ceases at a dropout point 5V (CBS-344) or 10V (CBS-377) above the pickup point.

NOTE

The CBS 344 or CBS 377 is now set to provide current boost at the selected operation point.

5.4 CURRENT BOOST POWER VERIFICATON

To verify that the Current Boost System will provide the specified boost current during shorting of the generator output, refer to the generator manufacturer's recommended procedures for generator testing under short circuit conditions.

SECTION 6.0

SPARE PARTS

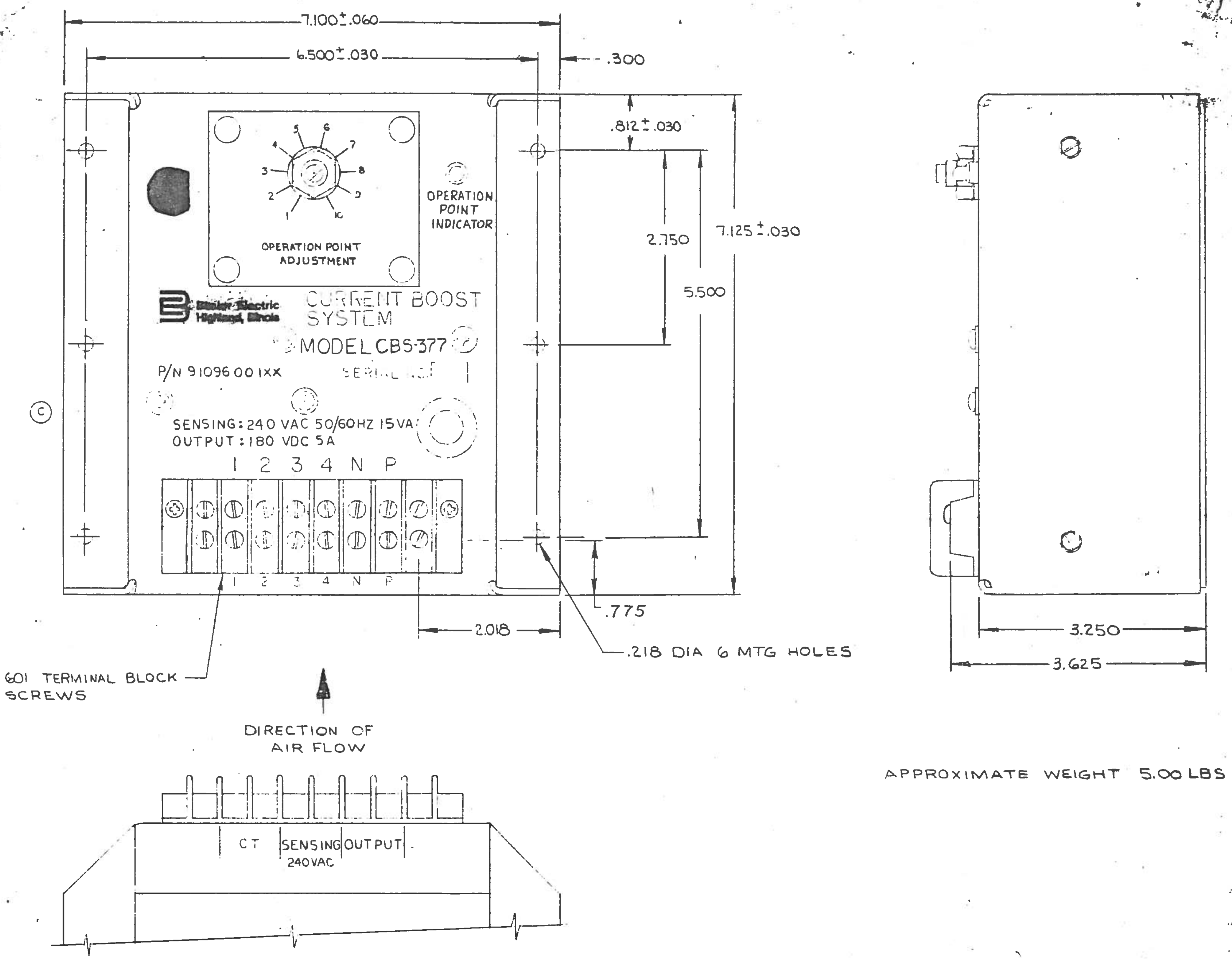
6.1 GENERAL

The following list describes the components that have maintenance significance. When ordering parts from Basler Electric, always specify the description of the item, part number and quantity.

Table 5-1. Replacement Parts

Reference Designation	Basler Part Number	Description
C1	04870	Capacitor
C2	10908	Capacitor
CR1, CR2	02677	Diode
CR3, CR4	06721	Diode
CR13	08590	LED
R13	11438	Resistor
SCR1, SCR2	06899	SCR
-	9 1096 02 100*	Circuit Board Assembly
-	9 1096 02 101**	Circuit Board Assembly
-	BE 15486-001	Current Transformer
-	BE 16866-001	Current Transformer

* Used with CBS 377
** Used with CBS 344



APPROXIMATE WEIGHT 5.00 LBS

CONFIDENTIAL INFORMATION

OF BASLER ELECTRIC COMPANY HIGHLAND ILL. IT IS LOANED FOR CONFIDENTIAL USE. SUBJECT TO RETURN ON REQUEST, AND WITH THE MUTUAL UNDERSTANDING THAT IT WILL NOT BE USED IN ANY MANNER DETRIMENTAL TO THE INTERESTS OF BASLER ELECTRIC COMPANY.

LETTER	REVISION	DATE	BY
—	[illegible] 2 JULY 91	7-2-91	[illegible]
C	REVISED PER ECA 3821	[illegible]	[illegible]
B	DWG NO. WAS 91096 00920, REV. PER ECA 3771	[illegible]	[illegible]
A	REVISED PER ECA 3722	[illegible]	[illegible]

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMALS ± [illegible] FRACTIONS ± [illegible] ANGLES ± [illegible]

TITLE: OUTLINE CURRENT BOOST SYSTEM

MATERIAL

DRAWN BY	DATE	CHKD BY	DATE	APPR. BY	DATE
[illegible]	24 FEB 77	[illegible]	[illegible]	[illegible]	[illegible]

BASLER ELECTRIC CO. HIGHLAND, ILLINOIS

9 1096 00920 C

INSTRUCTION
MANUAL

Basler Electric
Highland, Illinois

UNDERFREQUENCY OVERVOLTAGE MODULE

Model Numbers:
UFOV 250A, UFOV 260A

Part Numbers:
9 1051 00 106, 9 1051 00 105

Publication

Number: 9 1051 00 99X
Date: September, 1974
Change 8: June, 1982

WARNING

TO PREVENT PERSONAL INJURY OR EQUIPMENT DAMAGE ONLY QUALIFIED TECHNICIANS/OPERATORS SHOULD INSTALL AND OPERATE THIS DEVICE.

CAUTION

MEGGERS AND HIGH POTENTIAL TEST EQUIPMENT SHOULD NOT BE USED. INCORRECT USE OF SUCH EQUIPMENT COULD DAMAGE COMPONENTS CONTAINED IN THE MODULE.

SECTION 1.0

GENERAL INFORMATION

1.1 PURPOSE

The purpose of this unit is to reduce the generator terminal voltage in the event of a 4 to 7 hertz generator frequency reduction. This unit is available with a shunt trip breaker which removes the input power to the automatic regulator when the generator's terminal voltage exceeds a preset level.

1.2 SPECIFICATIONS

MODEL NUMBER	PART NUMBER	#INPUT (Vac)	FREQUENCY (Hz)	APPLICABLE REGULATORS
UFOV 250A	9 1051 00 106	120, 208, 240, 416, 480, 600	50	SR4A, SR8A SR32A, SR4F, SR8F, SR32H, SR63H, SR125H, SR250H
UFOV 260A	9 1051 00 105	120, 208, 240, 416, 480, 600	60	

NOTE: #These units are all factory connected for 120 Vac input, unless otherwise specified.

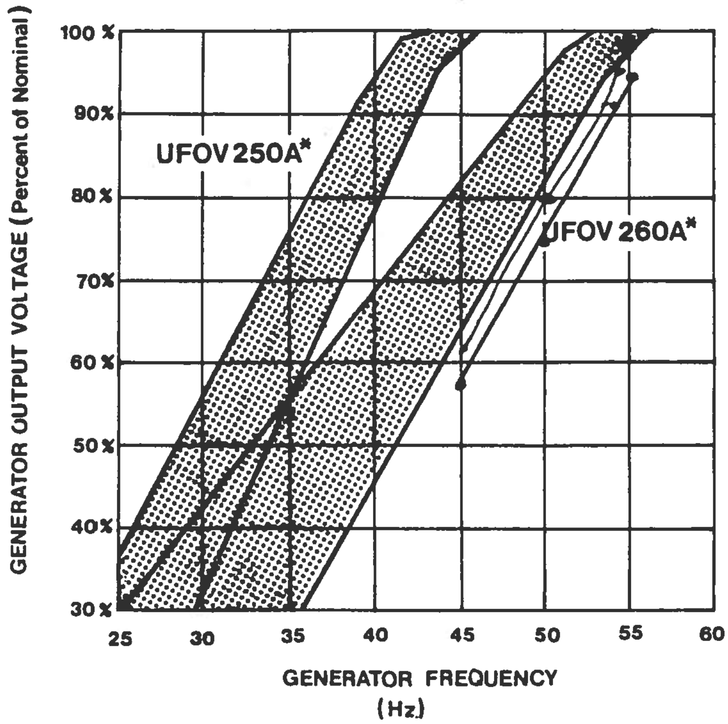
Underfrequency Threshold:	4-7 Hz below nominal
Underfrequency Operational Parameter:	See figure 1-1
Overvoltage Adjust Limits:	125 - 150% of nominal
Circuit Breaker Contact Rating:	P/N 05390, 50 Amp @ 480 Vac P/N 05391, 50 Amp @ 250 Vac
Vibration	Withstands 1.3 G's from 5 to 27 Hz, 0.036" displacement, from 27 to 52 Hz and 5 G's from 52 to 500 Hz.
Shock	15 G's in any plane
Ambient Operating Temperature	-55° to +70°C (-67° to +158°F)
Mounting	Designed for back-of-panel switchgear mounting.
Finish	Dark brown, lusterless, textured baked enamel.
Weight	10 lbs. net 12 lbs. shipping

SECTION 2.0

PRINCIPLES OF OPERATION

2.1 UNDERFREQUENCY CIRCUIT

If the generator frequency decreases approximately 4 to 7 Hz below nominal, the underfrequency circuit assumes control of the regulator and reduces generator output voltage.



98.7% at 54 HZ

96 % 53 HZ

Figure 1-1 Underfrequency Operational Parameters

The graph indicates the percentage of generator output voltage obtained for a specific reduction in frequency. As an example, if a 60 Hz generator is operating at 50 Hz, generator output voltage will be between 82% and 95% of nominal. The "spread" in the envelope (shaded area) is a function of operational temperature and normal tolerance in components.

*Data applies to Part Numbers 9 1051 00 105 (UFOV 260A) and 9 1051 00 106 (UFOV 250A). Similar units of earlier design (Part number 9 0400 00 100 and 9 0400 00 104), were also identified with Model Numbers UFOV 260/250. Those units have an underfrequency operational threshold of 10 Hz below nominal. For further information, contact the factory.

Once the speed of the generator is slow enough for the underfrequency circuit to function, a definite speed-voltage relationship will be present. In general, the voltage will drop at a slightly faster rate than the speed. For example, at 50% generator speed the generator output voltage will be less than 50%. The same relationship exists when the generator speed is increased (provided the field flashing relay in the regulator is energized). It should be noted that the field flashing relay overrides the function of the underspeed circuit on initial build-ups. For extended low speed operation, care must be taken to insure that the field flashing relay has been energized and the underfrequency circuit is in control of the generator output.

SECTION 1.0

GENERAL INFORMATION

1.1 PURPOSE

The purpose of this unit is to reduce the generator terminal voltage in the event of a 4 to 7 hertz generator frequency reduction. This unit is available with a shunt trip breaker which removes the input power to the automatic regulator when the generator's terminal voltage exceeds a preset level.

1.2 SPECIFICATIONS

MODEL NUMBER	PART NUMBER	#INPUT (Vac)	FREQUENCY (Hz)	APPLICABLE REGULATORS
UFOV 250A	9 1051 00 106	120, 208, 240, 416, 480, 600	50	SR4A, SR8A SR32A, SR4F, SR8F, SR32H, SR63H, SR125H, SR250H
UFOV 260A	9 1051 00 105	120, 208, 240, 416, 480, 600	60	

NOTE: #These units are all factory connected for 120 Vac input, unless otherwise specified.

Underfrequency Threshold:	4-7 Hz below nominal
Underfrequency Operational Parameter:	See figure 1-1
Overvoltage Adjust Limits:	125 - 150% of nominal
Circuit Breaker Contact Rating:	P/N 05390, 50 Amp @ 480 Vac P/N 05391, 50 Amp @ 250 Vac
Vibration	Withstands 1.3 G's from 5 to 27 Hz, 0.036" displacement, from 27 to 52 Hz and 5 G's from 52 to 500 Hz.
Shock	15 G's in any plane
Ambient Operating Temperature	-55° to +70°C (-67° to +158°F)
Mounting	Designed for back-of-panel switchgear mounting.
Finish	Dark brown, lusterless, textured baked enamel.
Weight	10 lbs. net 12 lbs. shipping

SECTION 2.0

PRINCIPLES OF OPERATION

2.1 UNDERFREQUENCY CIRCUIT

If the generator frequency decreases approximately 4 to 7 Hz below nominal, the underfrequency circuit assumes control of the regulator and reduces generator output voltage.

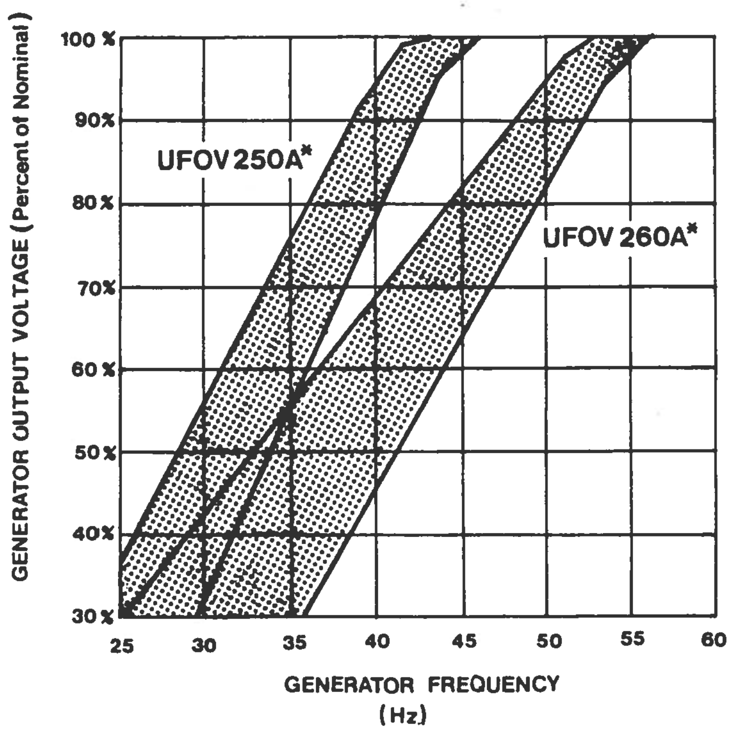


Figure 1-1 Underfrequency Operational Parameters

The graph indicates the percentage of generator output voltage obtained for a specific reduction in frequency. As an example, if a 60 Hz generator is operating at 50 Hz, generator output voltage will be between 82% and 95% of nominal. The "spread" in the envelope (shaded area) is a function of operational temperature and normal tolerance in components.

*Data applies to Part Numbers 9 1051 00 105 (UFOV 260A) and 9 1051 00 106 (UFOV 250A). Similar units of earlier design (Part number 9 0400 00 100 and 9 0400 00 104), were also identified with Model Numbers UFOV 260/250. Those units have an underfrequency operational threshold of 10 Hz below nominal. For further information, contact the factory.

Once the speed of the generator is slow enough for the underfrequency circuit to function, a definite speed-voltage relationship will be present. In general, the voltage will drop at a slightly faster rate than the speed. For example, at 50% generator speed the generator output voltage will be less than 50%. The same relationship exists when the generator speed is increased (provided the field flashing relay in the regulator is energized). It should be noted that the field flashing relay overrides the function of the underspeed circuit on initial build-ups. For extended low speed operation, care must be taken to insure that the field flashing relay has been energized and the underfrequency circuit is in control of the generator output.

2.2 OVERVOLTAGE CIRCUIT

This circuit prevents sustained high voltage excursions on the generator-regulator system. During overvoltage excursions exceeding the setting of this circuit, the regulator's input power is interrupted by the circuit breaker. The circuit breaker is manually reset. If the overvoltage circuit breaker repeatedly trips on load rejection, the overvoltage trip is adjusted too low for the system requirements.

2.3 Overvoltage Signal (Terminals C and D)

The tripping point for the breaker is preset at the factory at 130% of nominal generator voltage. If the overvoltage circuit is tripped at any time, the reason for the overvoltage should be determined before the breaker is reset. Continued trip during load rejection may indicate that the unit is tripped on the peak of the load rejection transient.

The overvoltage trip is adjustable from approximately 125% to 150% generator voltage. The unit should be set high enough to pass normal voltage transients. Circuit breaker P/N 05391 must be used if terminal A-is used on the SR-A series of regulators or if terminal FO is used on the SR-F or SR-H regulators.

SECTION 3.0

INSTALLATION AND OPERATION

3.1 GENERAL

These units can be mounted in any position without affecting their operating characteristics.

CAUTION

WHEN AN SBO (EXCITATION SUPPORT SYSTEM) IS USED, THE UFOV SENSING INPUT MUST BE TAKEN FROM THE SBO INPUT RATHER THAN THE REGULATOR POWER INPUT TO PROVIDE OVERVOLTAGE LIMITING. THE UFOV MODULE IS FACTORY CONNECTED FOR 120 VAC INPUT. IF OTHER VOLTAGES ARE REQUIRED, THE UNIT MUST BE MODIFIED PER PARAGRAPH 3.2.2

3.2 INTERCONNECTION

3.2.1 General

The unit is connected to the regulating system as shown in figures 5-3, 5-4. A check should be made before system operation is attempted.

3.2.2 Input Power (Terminals 1 and 2)

These modules have an internal transformer provided with taps for input voltages of 120, 208, 240, 416, 480 or 600 Vac. When shipped, the units are factory connected for 120V input (unless otherwise specified). To operate the unit on any of the other input voltages, remove the wire from its existing tap and connect it to the voltage tap desired. For operation on generators with voltages over 600 Vac, a potential transformer must be used. (See applicable Voltage Regulator Instruction Manual, or contact Basler Electric for further information).

3.2.3 Interconnection With an EMI Filter Pack

3.2.3.1 When the UFOV 250A/260A is used in conjunction with the EMI filter pack, the UFOV module terminal N must be connected directly to terminal F+ of the voltage regulator. Refer to figure 3-1.

3.2.3.2 EMI 248, 269 Filter Pack. Connect a 14 gauge wire from terminal N of the UFOV module and feed this wire through the grid (above the terminal strip) of the filter pack and connect it to terminal F+ of the voltage regulator. Insure that this connection is not grounded. Secure the connection and install the cover.

3.2.3.3 EMI 204, 206, 208, 209. The connection is similar to the previous procedure. In this case, the 14 gauge wire should be fed through the terminal strip of the filter pack, follow the existing wire harness and connect the wire to the F+ terminal of the voltage regulator. Insure that this connection is not grounded. The use of plastic tie-wraps is recommended. Secure the connection and install the cover.

CAUTION

This information is provided to alert users to the fact that UFOV 250A, Part Number 9 1051 00 106 and UFOV 260A, Part Number 9 1051 00 105, ARE INTERCONNECTED DIFFERENTLY than model UFOV 250, Part Number 90 40000 104 and UFOV 260, Part Number 90 40000 100, previously supplied. Portions of the interconnection diagrams are shown below to indicate the area in which wiring changes occur. REFER TO THE RESPECTIVE INSTRUCTION MANUALS FOR COMPLETE INTERCONNECTION DETAILS.

Table of Corresponding Terminals

UFOV 250A (P/N 9 1051 00 106) UFOV 260A (P/N 9 1051 00 105)	1	2	P	C	D	N
UFOV 250 (P/N 90 40000 104) UFOV 260 (P/N 90 40000 100)	1	2	3	4	6*	

*Note that of the two connections previously made at terminal 6 see figure 3-1, only one of them (terminal D of the breaker) is connected to terminal "D" of the UFOV 250A/260A. The second connection is made to a new terminal "N".

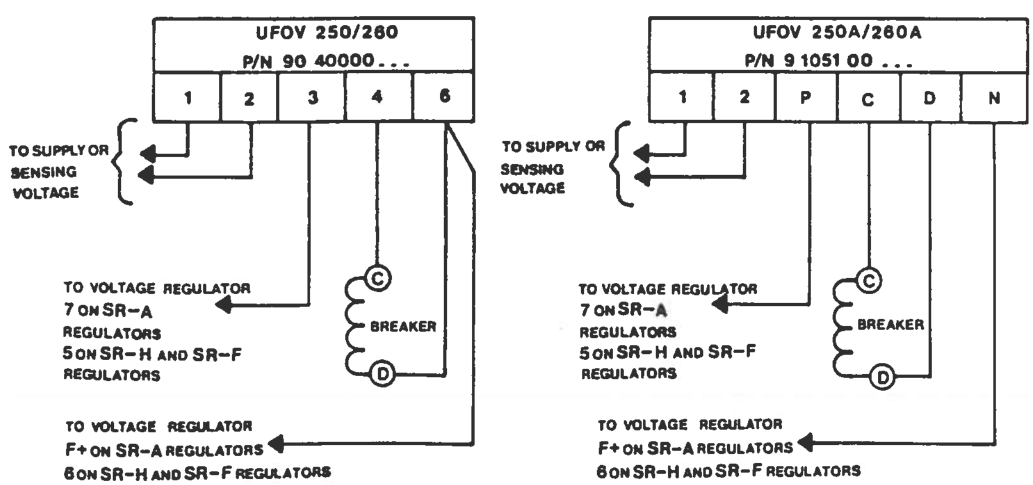


Figure 3-1

SECTION 4.0

TROUBLESHOOTING

4.1 General

Some possible malfunctions that could occur and the appropriate repair procedures are listed in Table 4-1.

TABLE 4-1 TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSE	SOLUTION
Underfrequency circuit affects generator voltage output at normal speeds.	Module Faulty	Remove and replace.
	Incorrect voltage applied to the underfrequency circuit.	Correct Voltage.
	Wrong module used on 50 Hz generator.	See paragraph 1.2
Underfrequency circuit fails to reduce generator voltage as frequency is reduced.	Frequency not low enough. Underfrequency threshold is 4-7 Hz below nominal.	Correct Frequency.
	Incorrect voltage applied to unit. Check voltage at terminals 1 and 2.	Correct voltage.
	Wrong model module.	See Paragraph 1.2.
	Module Faulty.	Remove and replace.
	Unit improperly connected.	See interconnection diagrams.
Units fail to open circuit breaker during overvoltage conditions.	Faulty wiring.	Check wiring.
	Module Faulty.	Remove and replace.
	Improperly adjusted.	Adjust.
	Circuit breaker coil defective.	Remove and replace.

SECTION 5.0
DRAWINGS

5.1 GENERAL

The following drawings are included to facilitate installation, operation and maintenance.

Figure 5-1	Outline Drawing -	UFOV 250A/260A
Figure 5-2	Outline Drawing -	Circuit Breakers
Figure 5-3	Interconnection:	UFOV-SR4A, SR8A and SR32A Voltage Regulators.
Figure 5-4	Interconnection:	UFOV-SR32H, SR63H, SR125H, SR250H, SR4F and SR8F.
Figure 5-5	Interconnection:	UFOV-EMI Filter Pack

SECTION 6.0
REPLACEMENT PARTS

6.1 GENERAL

Table 6-1 Lists components that have maintenance significance. When ordering parts from Basler Electric always specify the description of the item, part number and quantity.

TABLE 6-1
REPLACEMENT PARTS

DESCRIPTION	REFERENCE DESIGNATION	BASLER PART NUMBER
Power Transfomer	T1	BE 14101 002
Choke	L1	BE 13693 002
Choke	L2	BE 08794 010
Circuit Board (UFOV 260A)	---	9 1051 01 100
Circuit Board (UFOV 250A)	---	9 1051 01 101

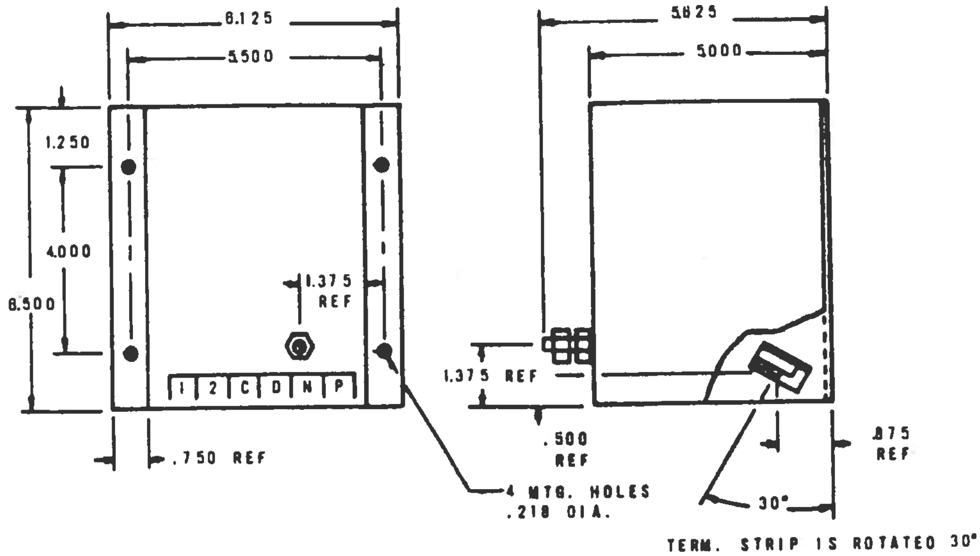
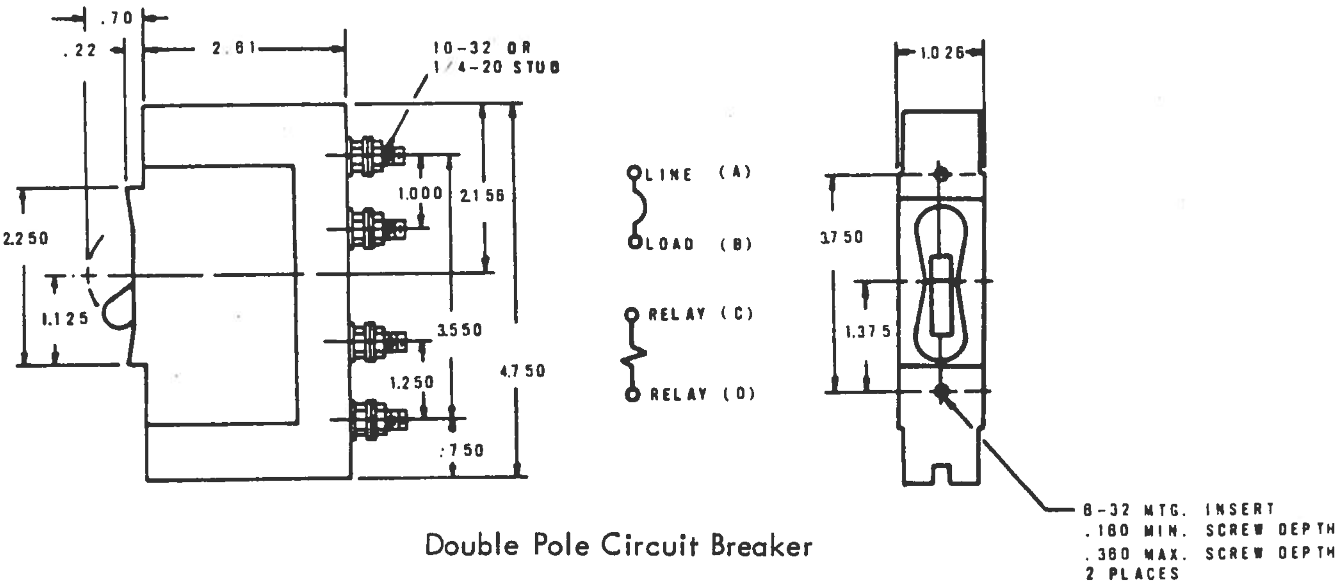


Figure 5-1. Outline Drawing - UFOV 250A/260A

Single Pole Circuit Breaker



Double Pole Circuit Breaker

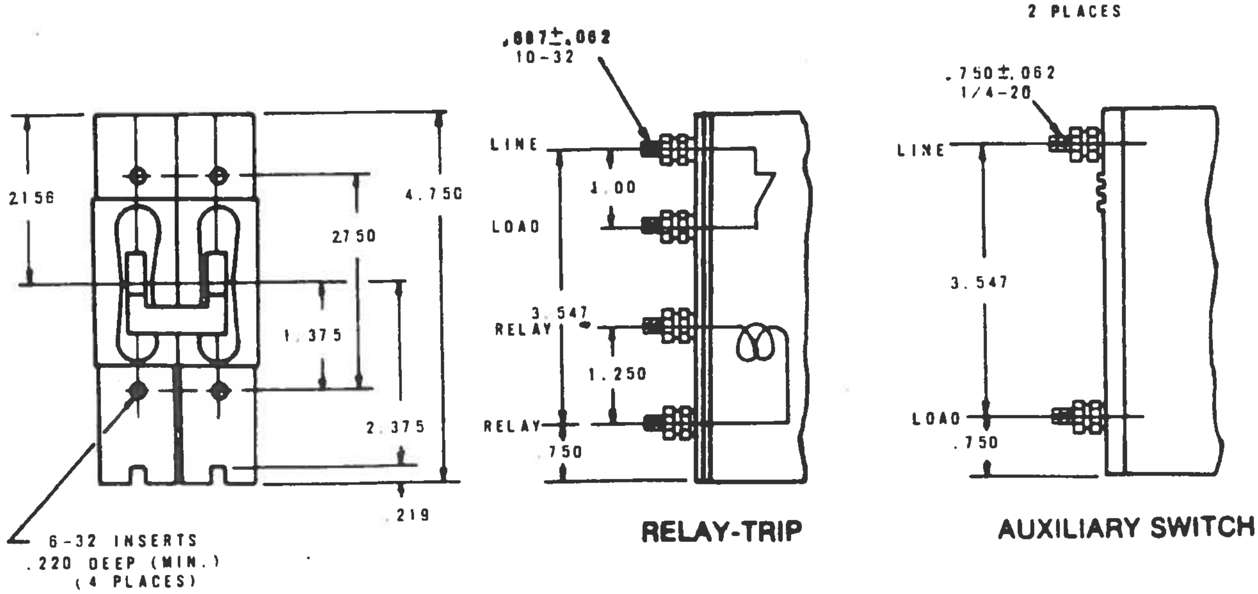


Figure 5-2. Outline Drawing-Circuit Breakers

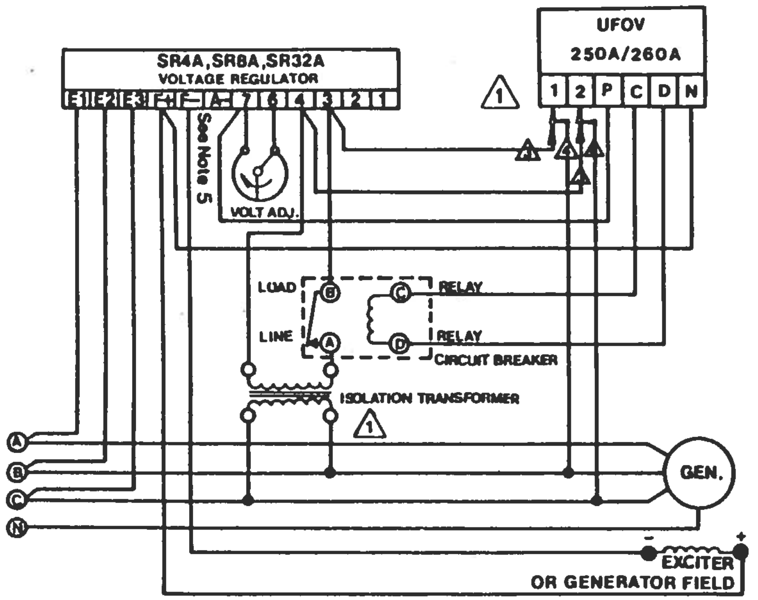


Figure 5-3 Interconnection: UFOV-SR4A,SR8A and SR32A voltage regulators.

NOTES

1. INPUT POWER (TERMINAL 1 & 2): This unit has an internal voltage and frequency sensing transformer (T1) with taps for 120, 208, 240, 416, 480 or 600 Vac. This transformer is factory connected for 120 Vac operation unless otherwise specified. See Paragraph 3.2.2
2. OVERVOLTAGE SIGNAL (TERMINALS C & D): These terminals provide an overvoltage trip signal to the external overvoltage current breaker.
3. This connection is used only with the SR4A and SR8A voltage regulators.
4. This connection is used only with the SR32A voltage regulators.
5. If terminal A- on the voltage regulator is used for field flashing, a circuit breaker should be used to disconnect the battery from the regulator.

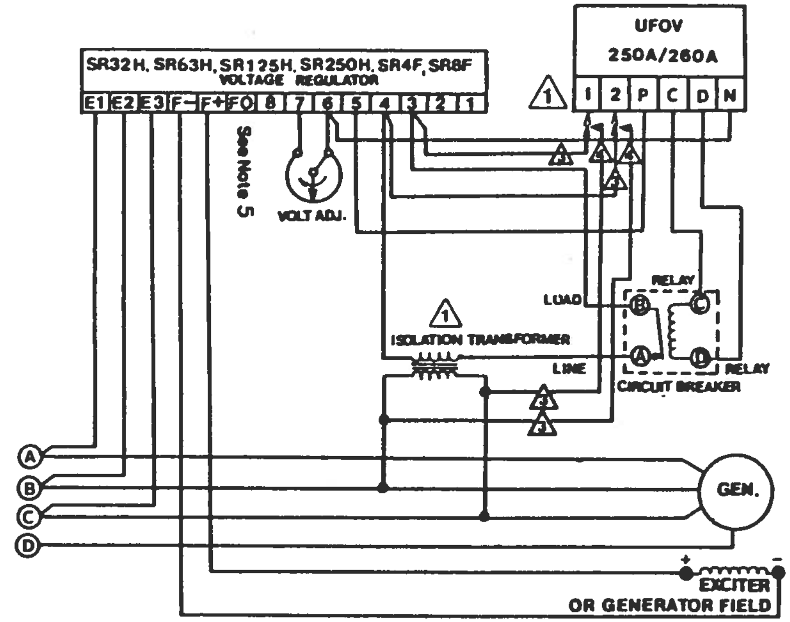
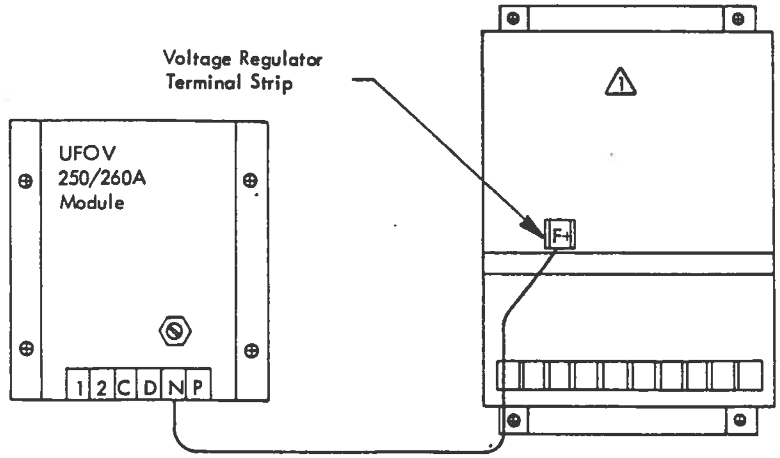


Figure 5-4 Interconnection: UFOV-SR32H, SR63H, SR125H, SR250H, SR4F and SR8F.

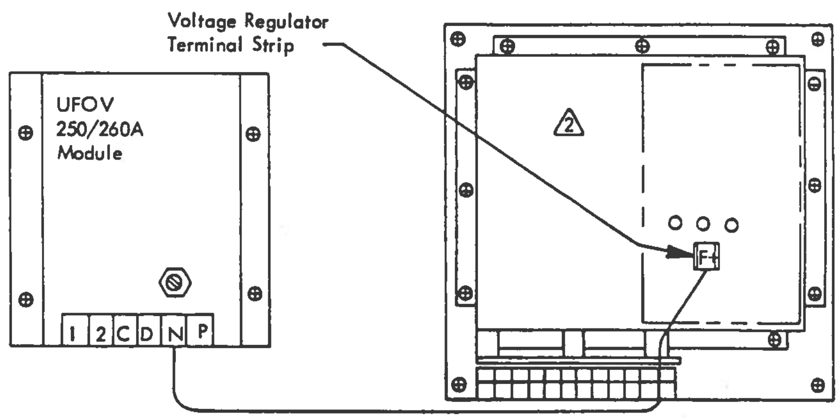
NOTES

1. INPUT POWER (TERMINAL 1 & 2): This unit has an internal voltage and frequency sensing transformer with taps for 120, 208, 240, 416, 480, or 600 Vac. This transformer is factory connected for 120 Vac operation unless otherwise specified. See paragraph 3.2.2
2. OVERVOLTAGE SIGNAL (TERMINALS C & D): These terminals provide an overvoltage trip signal to the external overvoltage current breaker.
3. This connection is used with all voltage regulators except the SR32H.
4. This connection is used only with the SR32A voltage regulators.
5. If terminal FO on the voltage regulator is used for field flashing, a circuit breaker should be used to disconnect the battery from the regulator.



EMI Filter Pack 248/269

INTERCONNECTION: UFOV - EMI Filter Pack 248/269



EMI Filter Pack 204, 206, 208, 209

INTERCONNECTION: UFOV - EMI Filter Pack 204, 206, 208, 209

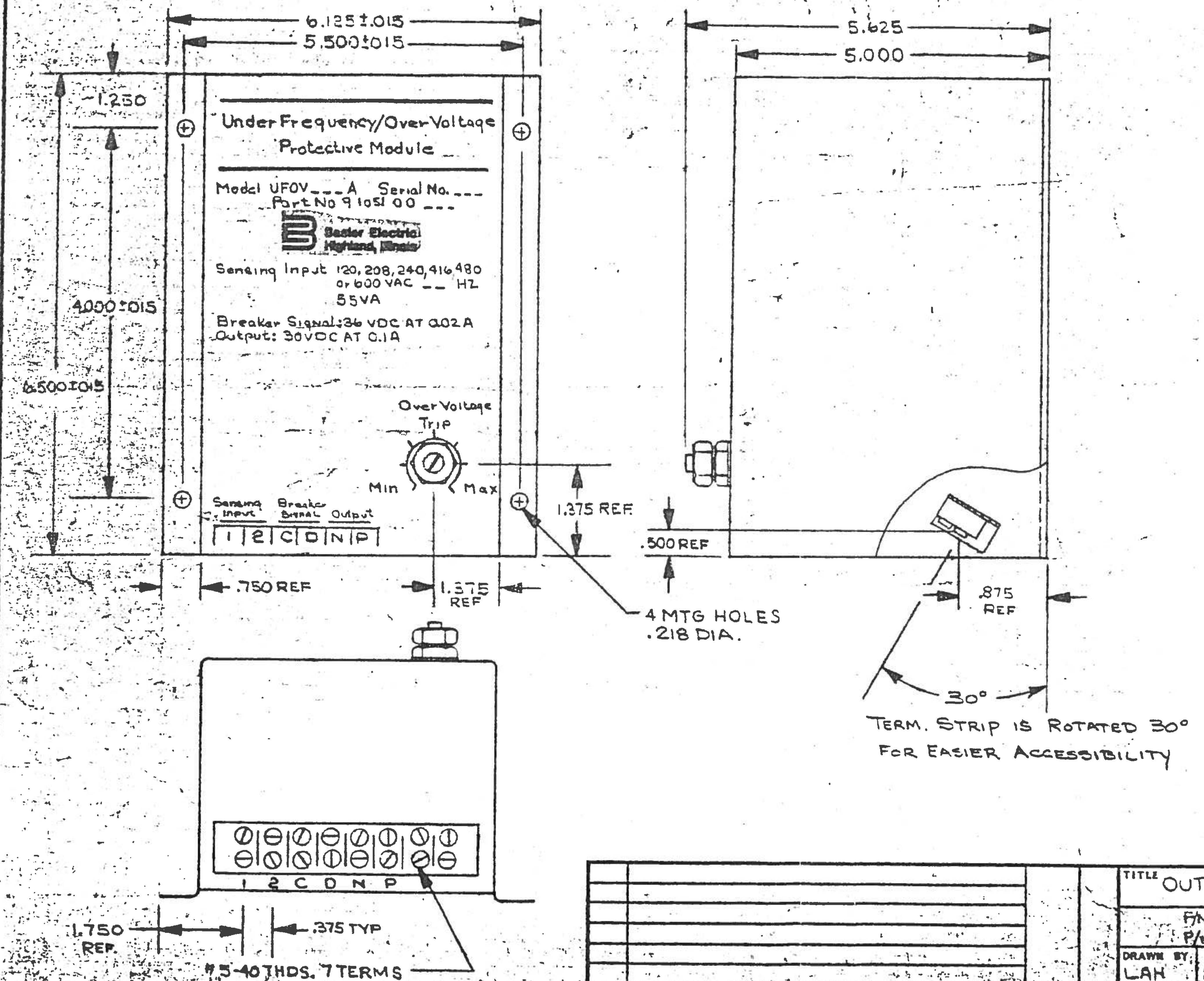
NOTE:

⚠1 Voltage Regulator SR4A, SR8A, SR6A or SR9A

⚠2 Voltage Regulator SR4, SR6, SR8 and SR9

3 EMI Filter Packs shown with cover removed

Figure 5-5 INTERCONNECTION: UFOV - EMI Filter Pack



FINISH: DARK FAWN.

SIZE B 9 1051 00 920 REV.

CONFIDENTIAL INFORMATION

OF BASLER ELECTRIC COMPANY, HIGHLAND, ILL. IT IS LOANED FOR CONFIDENTIAL USE, SUBJECT TO RETURN ON REQUEST, AND WITH THE MUTUAL UNDERSTANDING THAT IT WILL NOT BE USED IN ANY MANNER DETRIMENTAL TO THE INTERESTS OF BASLER ELECTRIC COMPANY.

LETTER	REVISION	DATE	BY

TITLE OUTLING DWG. - UNDER FREQ./OVER VOLT. MODULE

P/N 9 1051 00 100 UFOV 260 (For 60 Hz)
P/N 9 1051 00 101 UFOV 250 (For 50 Hz)

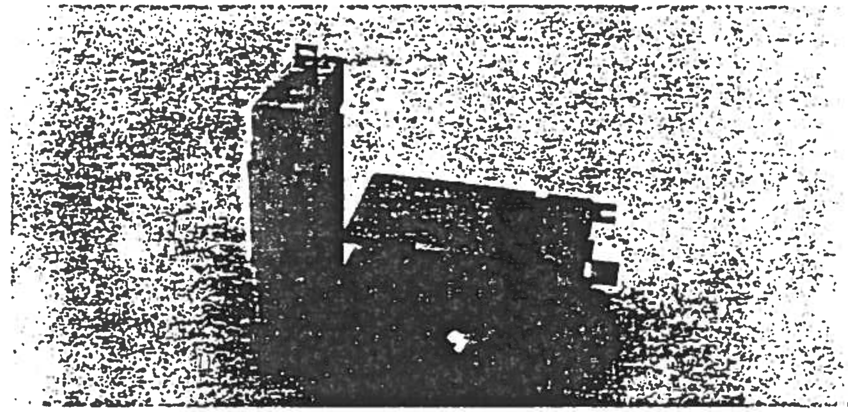
DRAWN BY	DATE	CHKD BY	DATE	APPR. BY	DATE	SCALE
LAH	8-19-74	RJD	8-21-74	RJO	8-21-74	NONE

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMAL ± .03 FRACTIONAL [illegible]

BASLER ELECTRIC CO. HIGHLAND, ILLINOIS

DWG. SIZE B DRAWING NO. 9 1051 00 920

209, E-Frame Master Drawings and Terminal Styles



Terminal Style

209 E-Frame circuit breakers may be specified with either screw terminals, stud or solderless connectors.

A choice of front or back connected terminal styles is available. The back connected terminal style is available with stud terminals only. Front terminal style is available with either screw terminals or solderless connectors.

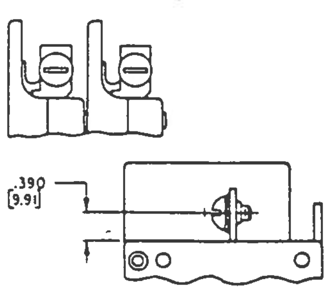
Width Dimensions

Width dimensions are as follows:

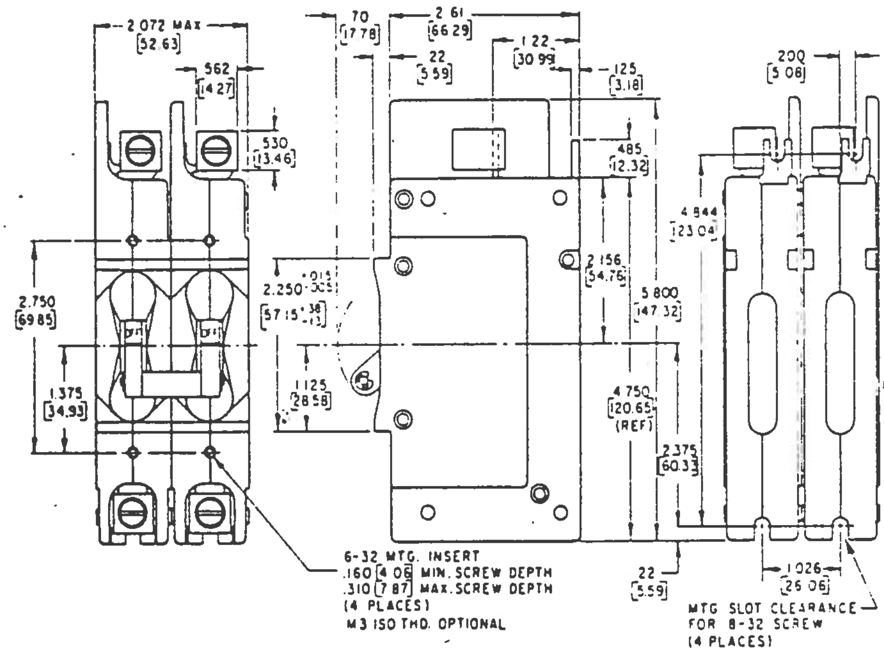
1 pole	1.026 [26.06] ±.010
2 pole	2.072 [52.63] Max
3 pole	3.108 [78.94] Max
4 pole	4.144 [105.26] Max
5 pole	5.180 [131.57] Max
6 pole	6.216 [157.89] Max

Barriers for back connected terminal styles are supplied on multi-pole units only. Line and load connections may be made to either terminal, and terminals will be identified as shown.

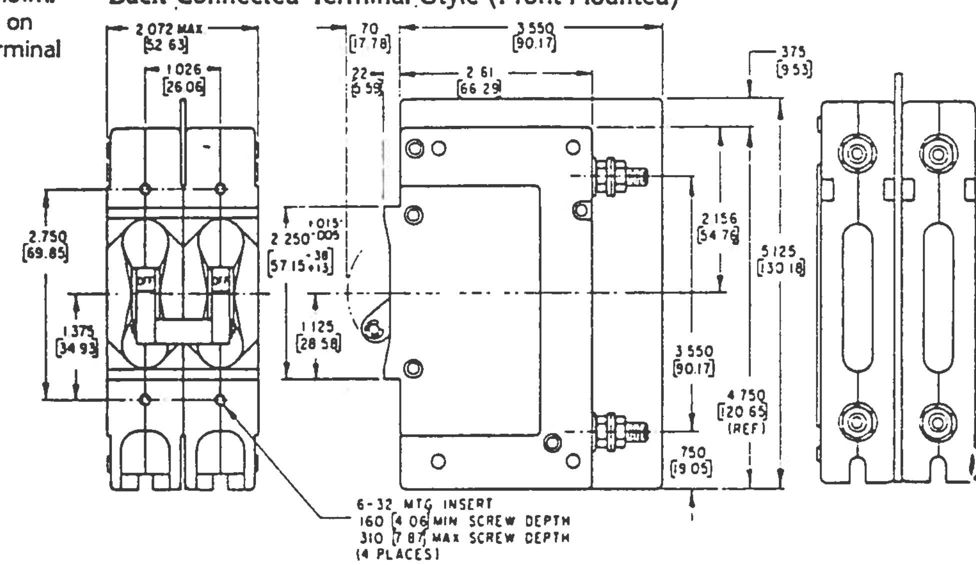
Refer to Sixth Decision Table on page 97 for front connected terminal information.



Front Connected Terminal Style (Back Mounted)

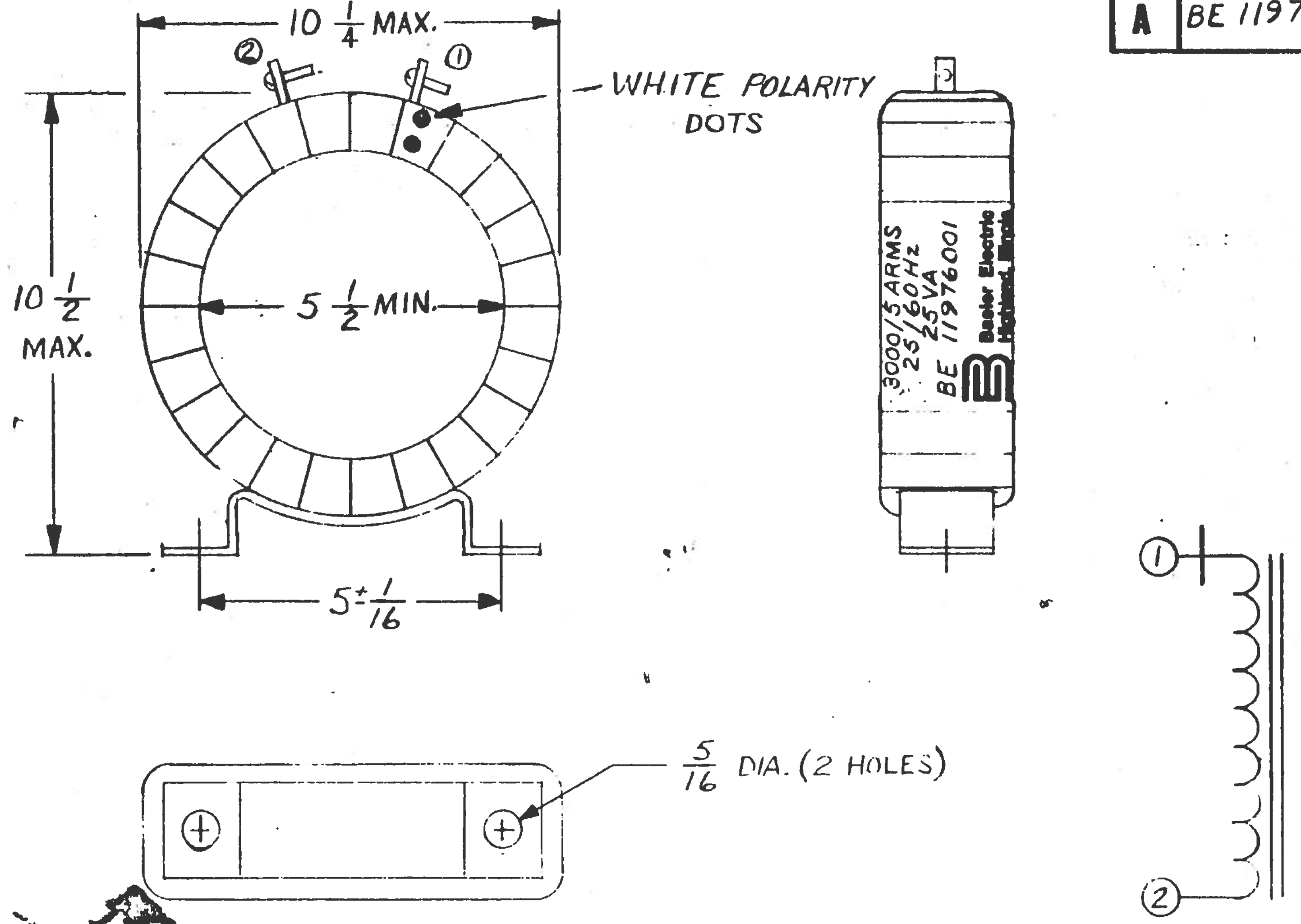


Back Connected Terminal Style (Front Mounted)



TOLERANCE ± .015 [.38] UNLESS NOTED   DIMENSIONS IN BRACKETS [ ] ARE MILLIMETERS

SIZE		REV.
A	BE 11976001	



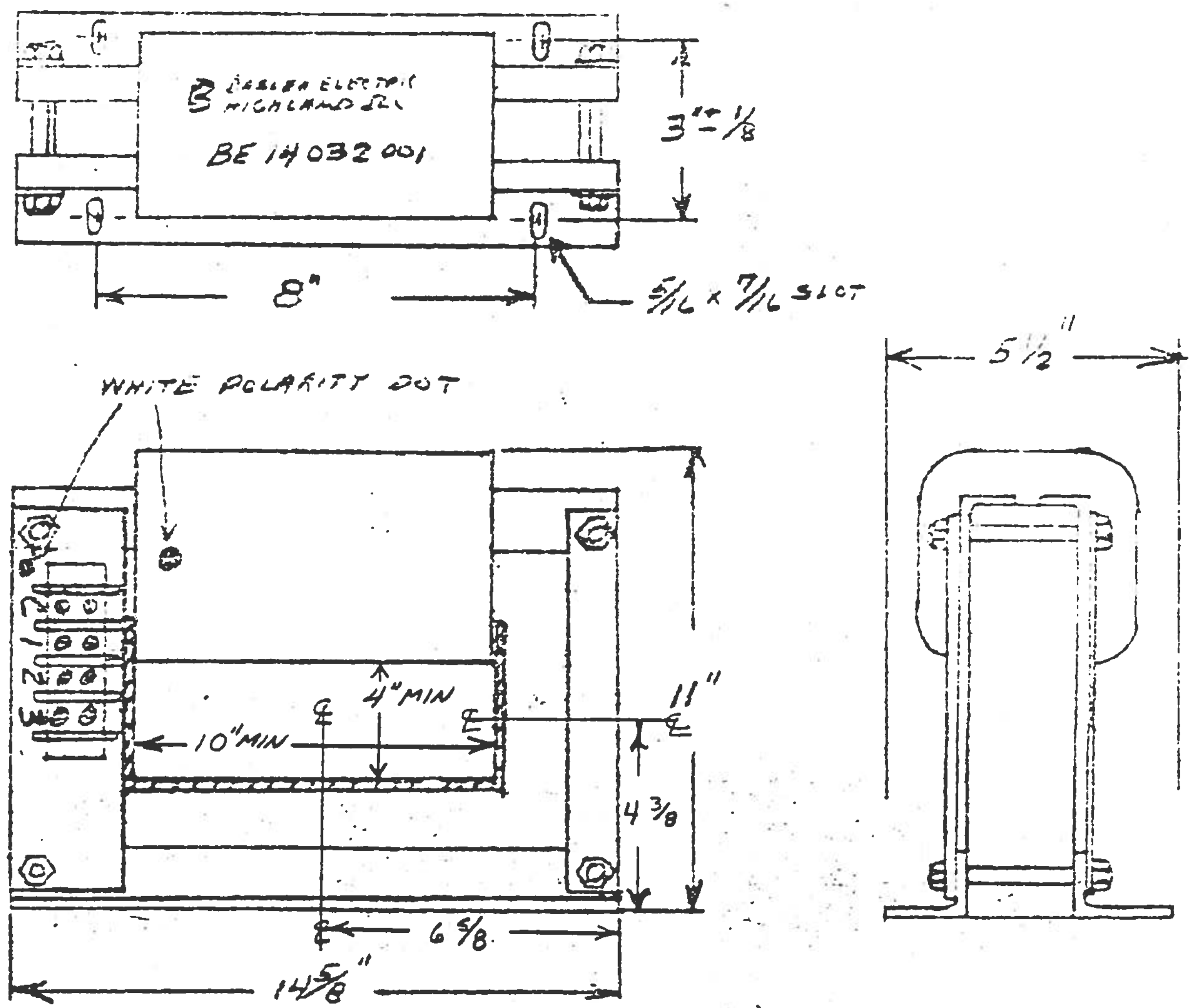
LETTER	REVISION	DATE	BY

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMALS ± FRACTIONS ± ANGLES ±

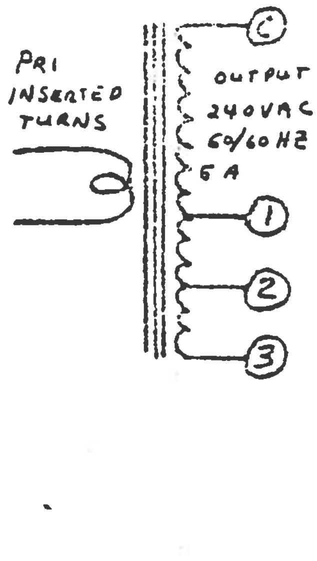
TITLE						
OUTLINE DRAWING-CURRENT XFMR						
DRAWN BY	DATE	CHKD BY	DATE	APPR. BY	DATE	SCALE
L. FREY	10-1-73			M. Schott	10-2-73	~

BASLER ELECTRIC CO.
HIGHLAND, ILLINOIS

DWG SIZE	DRAWING NO.	REV.
A	BE 11976001	



SCHEMATIC:



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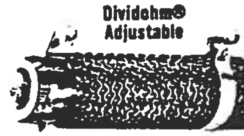
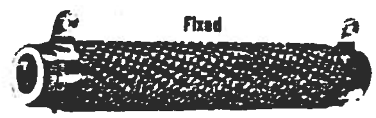
OUTLINE DRAWING	
DESIGNED BY: C Sievers	DATE 9/9/70
CHECKED BY:	DATE
SHEET 2 OF 5	REV
PART NO. BE 14032 001	

OHMITE corrib® HIGH CURRENT LOW OHMS resistors





High current, low resistance, heavy duty units used in motor starting, dynamic braking, etc. "Corrib" type units employ a corrugated ribbon of resistance alloy. This is space-wound edge-wise around a ceramic tube. Vitreous enamel is fused around the alloy ribbon to lock the turns securely in place. Heavy lug terminals. Resistance tolerance is ±10%.

Available in fixed or Dividohm® adjustable types. Dividohm® type is similar to fixed and includes one adjustable lug. Rating of Fixed or Dividohm® stock units—300 watts—reduce unit load for stack-mounted resistors; core size (bare) 8½" long x1⅛" diameter. Other sizes made to order.

STOCK CORRIBS — 300 WATT SIZE
Type 280 Fixed; 230 Dividohm

Core: 8½x1⅛" Fixed or Adjustable (DIVIDOHM)
Avg. Weight (Fixed) .61 lb.; (Dividohm) .64 lb.

* Indicates 15.00 per line minimum order charge

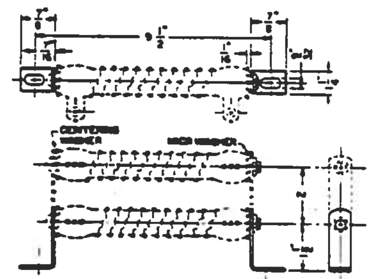
		Fixed		Adj.	
.10	54.7	2501	$10.75	2601	$12.25
.12	50.0	2502	10.75	2602*	12.25
.16	43.3	2503	10.00	2603	11.25
.20	38.7	2504	10.00	2604*	11.25
.25	34.6	2505	9.37	2605	9.37
.31	31.1	2506	9.37	2606	9.37
.40	27.4	2507*	7.40	2607	8.70
.50	24.5	2508	7.40	2608	8.70
.63	21.8	2509	7.40	2609	8.70
.80	19.3	2510	7.40	2610	8.70
1.0	17.3	2511	7.40	2611	8.70
1.2	15.8	2512	7.40	2612*	8.70
1.6	13.7	2513	7.40	2613	8.70
2.0	12.2	2514	6.30	2614	7.65
2.5	10.9	2515	6.30	2615	7.65
3.1	9.8	2516	6.30	2616	7.65
4.0	8.6	2517	6.30	2617	7.65
5.0	7.7	2518	6.30	2618	7.65
6.3	6.9	2519	6.30	2619	7.65
8.0	6.1	2520	5.75	2620	7.15
10.0	5.5	2521	5.75	2621	7.15
12.0	5.0	2522	5.35	2622	6.70
16.0	4.3	2523	5.35	2623	6.70
20.0	3.8	2524	5.35	2624	6.70

*Adjustable Lug-Stk. No. 1974 supplied with Dividohm.

THRU-BOLT MOUNTING BRACKETS FOR CORRIBS

Includes 2 brackets; bolt; centering, mica, and lock washers; nuts. Diagram below.

No. of Resistors	Catalog No.
1	6126P8½
2	6127P8½
3	6128P8½
4	6129P8½



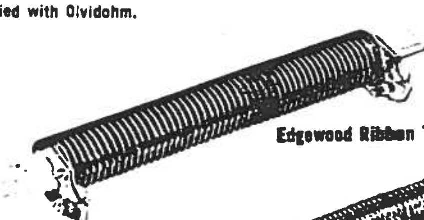
EXTRA ADJUSTABLE LUGS FOR CORRIBS

For Dividohm	Lug Catalog No.	
2601 to 2618	1974-B	$1.52 ea.
2619 to 2624	1974-A	1.52 ea.

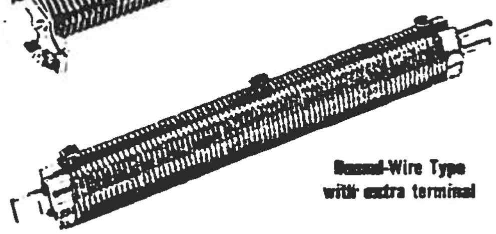
powr-rib® HIGH CURRENT LOW OHMS resistors

Even higher power handling capability—approximately 700 to 1000 watts—is available in stock, "Powr-Rib" resistors. These are UNCOATED types and are wound either edgewise with ribbon ("Edgewound" type) or with round wire (Round-Wire type).

The core of these units consists of ceramic segments on a metal bar which is slotted on both ends for rapid installation. Standard resistance tolerance is ±10%. Terminals clamp onto the resistor wire and may be moved in from the ends for intermediate resistance values. Extra terminals available for use as taps. See diagrams for terminals. Terminal Stk. No. 2172G (not shown) has screw connections.



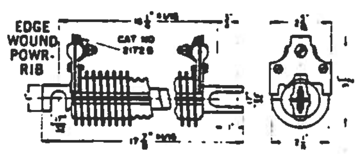
Edgewood Ribbon Type



Round-Wire Type with extra terminal

STYLE 080-5 EDGEWOUND POWR-RIBS

Ohms*	H ±⅛	D +⅛ —0
.10-.22	3 3/16	2⅛
.25-1.00	3⅛	1⅞
1.30-1.60	2 13/16	1⅞
2.2, 2.8, 4.5, 5.4	2½	1¾
3.5, 6.8, 8.5	2 3/16	1⅝



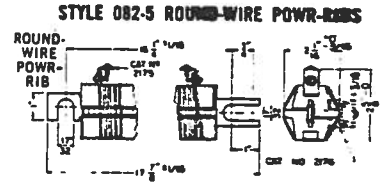
*.10 to 1.00 Ω with terminal No. 2172B
1.3 to 8.5 Ω with terminal No. 2172G

Avg. Weight .180 or less, 4 lbs.; .220 and up, 2 lbs.

Catalog No.[1]	Ohms	Max. Amps.	Net
2301	.10	100	$74.86
2302	.12	91	65.76
2303A	.14	89	56.11
2304A	.16	78	51.61
2305A	.18	75	48.12
2306A	.22	68	40.80
2306	.25	63	36.34
2308A	.30	57	36.33
2308	.33	54	31.74
2309A	.37	50	30.14
2310	.50	47	34.55
2317	.60	43	33.52

Catalog No.[1]	Ohms	Max. Amps.	Net
2318	.67	41	$31.79
2311	.75	39	38.27
2312	1.00	33	30.76
2319	1.30	29	23.44
2313	1.60	26	25.76
2331A	2.20	18.4	20.05
2332A	2.80	16.3	19.31
2333A	3.50	14.6	16.87
2334A	4.50	12.7	26.39
2335A	5.40	11.8	25.00
2336A	6.80	10.3	22.38
2337A	8.50	9.4	20.31

STYLE 082-5 ROUND-WIRE POWR-RIBS



Avg. Weight 3¼ lbs.

Catalog No.[1]	Ohms	Max. Amps.	Net
2338	11.0	8.3	$24.29
2339	13.0	7.6	23.91
2340	17.0	6.6	23.17
2341	20.0	5.9	23.17
2342	25.0	5.1	22.81

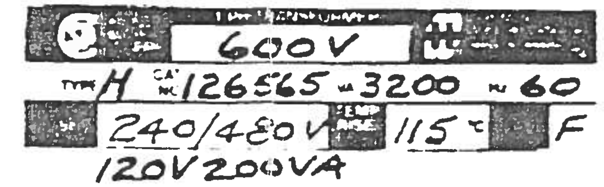
EXTRA TERMINALS

For Edgewound Powr-Rib

Descrip	Catalog No.	Net
30 Amps & more	2172B	$5.21
29 Amps & less	2172G	2.15

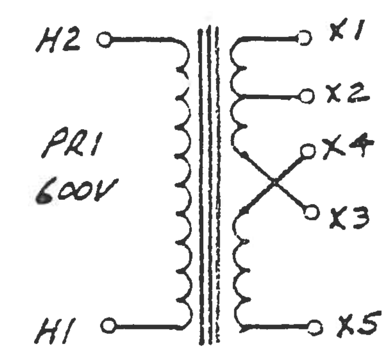
For Round Wire Powr-Rib

Descrip	Catalog No.	Net
In-Line Mtg.	2175	$3.04
90° Mtg.	(2176)	6.19



CATALOGUE: 126565
PRI: 600 Volts Phase 1 KVA 3.2
~~c/w~~ - ~~Taps~~ ~~FCAN~~ ~~FCBN~~
SEC: 240/480 Volts 120V TAP
Sound level: 40 Db Dimension no. 4651-R
Insulation class "F", 115 degrees C max. rise

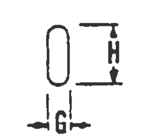
1/4-20 SCREW LUG TERMINALS (PRI & SEC)
COPPER WINDINGS
CSA CONSTRUCTION



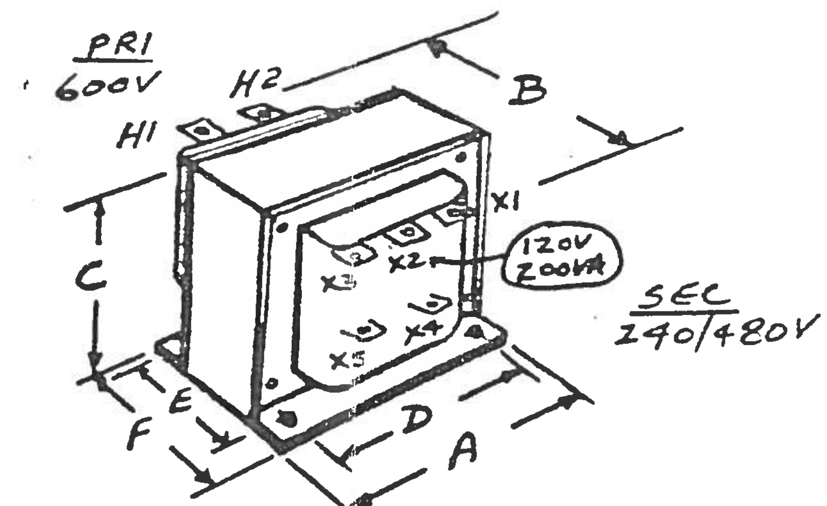
FOR	CONNECT
240V	X4 TO X1 & X3 TO X5
480V	X4 TO X3

Dimension Number	A	B*	C	D	E*	F†	G	H	J**	M=
4651-G	2 5/8		2 3/16	2			3/16	5/16	–	#8
4651-H	3		2 1/2	2 3/8			3/16	5/16	–	#8
4651-J	3 3/8		2 13/16	2 1/2			7/32	7/16	–	#10
4651-K	3 3/4		3 1/2	2 7/8			7/32	7/16	–	#10
4651-M	4 1/2		3 3/4	3 3/4			5/16	1/2	–	1/4
4651-N	5 1/4		4 3/8	4			5/16	1/2	–	1/4
4651-P	6		5	5			5/16	1/2	3 3/4	1/4
4651-Q	7 1/2		6 1/4	6			3/8	5/8	4 1/2	5/16
→ 4651-R	9	8.50	7 1/2	7	5.00	6.25	7/16	3/4	5 1/4	3/8
4651-S	12		10	9			9/16	7/8	6 3/4	1/2

* Dimension "B" is maximum over coil, or over terminals if used.
Dimensions "E" & "F" vary with the growth of lamination stack.
= M – suggested mounting bolt.
Tolerance: ± 1/16 except "B" which is normally given as maximum.
** Extra mounting holes on sizes P, Q, R and S



Mounting Hole Dimensions



H		
G		
F		
E		
D		
C		
B		
A		
	DATE	REVISIONS

HAMMOND MANUFACTURING CO., LTD.
GUELPH ONTARIO CANADA

TITLE:
HAMMOND TRANSFORMER 126565

DR. S	DATE 84-02-21	DWG. No. B126565	Sheet 1 of 1 Sheets
CK.			
APP.			

CANADIAN GENERAL ELECTRIC
COMPANY LIMITED

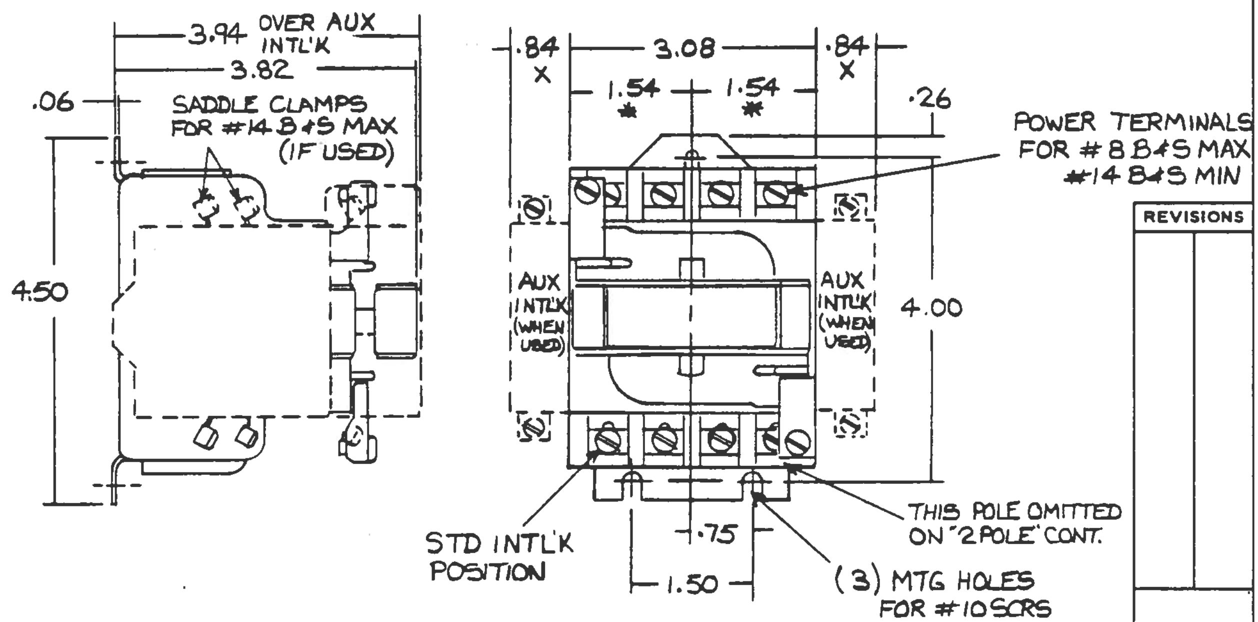
0252A4542AA
CONT. ON SHEET. — SH. NO. 1

REV. NO.

TITLE

OUTLINE (2 & 3 POLE)

FIRST MADE FOR CR205 SIZE 00,0 & 1 CONTACTORS
& CR160-20 & 30A LIGHTING CONTACTORS & CR205R1



NOTES:

1. FOR LOCATION & NUMBER OF AUX. INTERLOCKS THAT MAY BE USED SEE WIRING DIAG.
2. * ADD .50 FOR ELECTRICAL CLEARANCE IF AUX INTLK'S NOT USED.
3. X ADD .38 FOR ELECTRICAL CLEARANCE OVER AUX INTL'K

REVISIONS

3	MAR 1-77	ADDED "WHEN USED" TO DVM INTERLOCKS. REVISED ROUTE.
4	JUNE 29-84	REDRAWN. ORIGINAL LOST.

783/M

PRINTS TO

RE

DRAWN BY	CHECKED BY		
J. ROBERTS	J. Roberts June 29/84	LVC PETERBOROUGH PLANT	0252A4542AA CONT. ON SHEET. — SH. NO. 1

PW 2377F

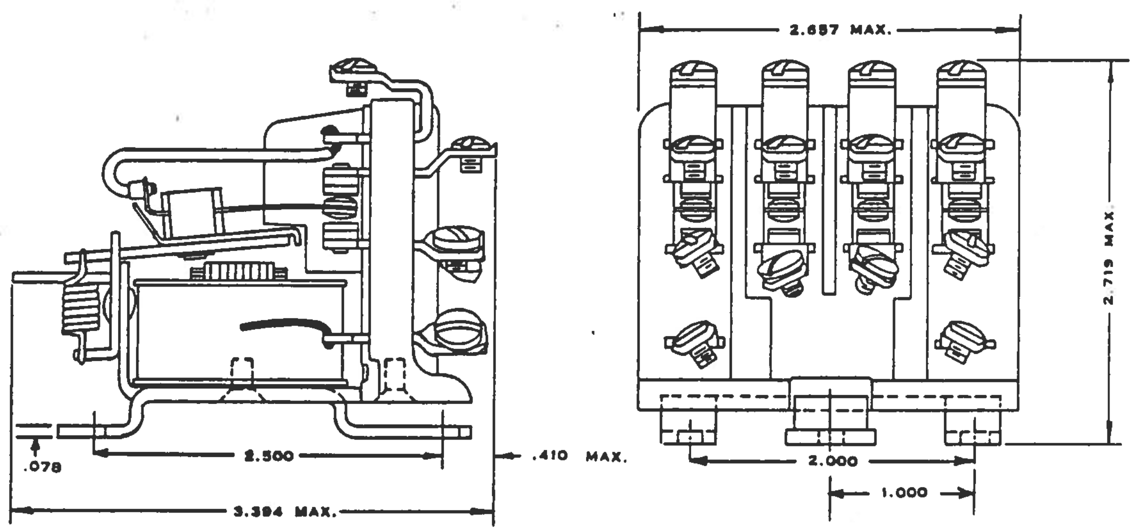
GENERAL
Initial Insulation Resistance: 100 megohms minimum.
Insulating Material: Molded diallyl phthalate.
Initial Breakdown Voltage: 2,000 volts rms minimum between all elements and ground.
Temperature Range: AC: −55 to +45°C. @ nominal coil power.
DC: −55 to +55°C. (+75°C. available on special order @ nominal coil power).
Terminals: PM & PMC: Heavy-duty screw type with No. 8-32 BH screw. PMT & PMF: .250″ quick-connect.
Weight: Approximately 14 ozs.

MOUNTINGS
Standard: Three holes; one front key-hole and two rear channel slots for No. 8-32 screws.
Special: Adaptor plate available for adapting these relays to a chassis predrilled for our PRD series relays.

COIL DATA FOR PM RELAYS

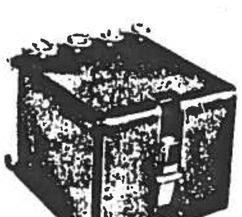
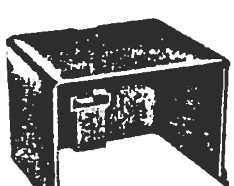
DC COILS			AC COILS (50/60 Hz)		
Nominal Voltage	DC Resis. In Ohms ±10% @ 25°C	Nominal Current In Milliamps	Nominal Voltage	DC Resis. In Ohms ±15% @ 25°C	Nominal Current In Milliamps
6	8.2	732	6	.37	2150
12	33	364	12	1.4	1070
24	132	182	24	5.0	540
48	526	91	120	120	128
110	2760	40	240	587	61
125	3570	35	480	1790	32
220	Use a 110 volt relay with 2700 to 3300 ohm 5 watt wire wound resistor in series.				

MOUNTING DIMENSIONS

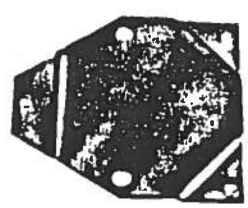


Tolerance: ±.010

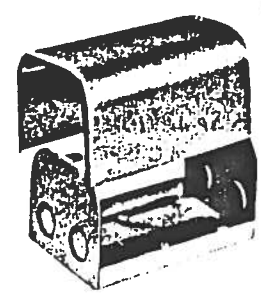
COVERS AND ADAPTOR PLATE

PM PLASTIC DUST COVER 35D203



PM ADAPTOR PLATE 37B370

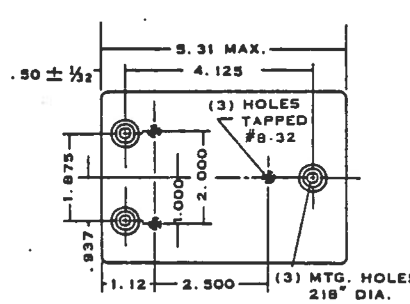


PM METAL COVER 35D227

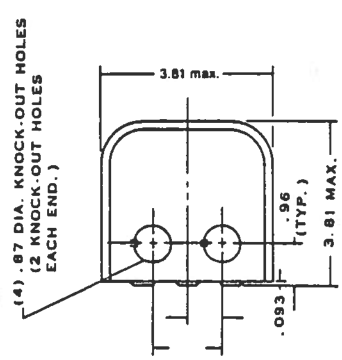
OVERALL DIMENSIONS IN INCHES

	Length	Width	Height
35D203	3.394*	2.657*	2.719*
35D227	5.313	3.813	3.813

*When mounted on relay.



35D227



TITLE FUSE BLOCK, FRONT CONNECTED

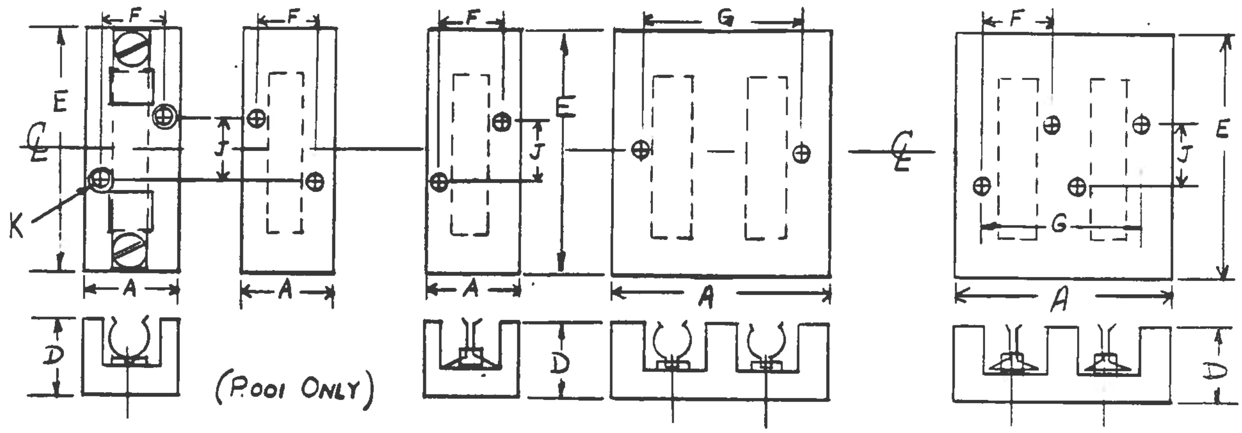


FIG. 1A FIG. 1B FIG. 2 FIG. 3 FIG. 4

NOTE: K= MOUNTING HOLE DIAMETER

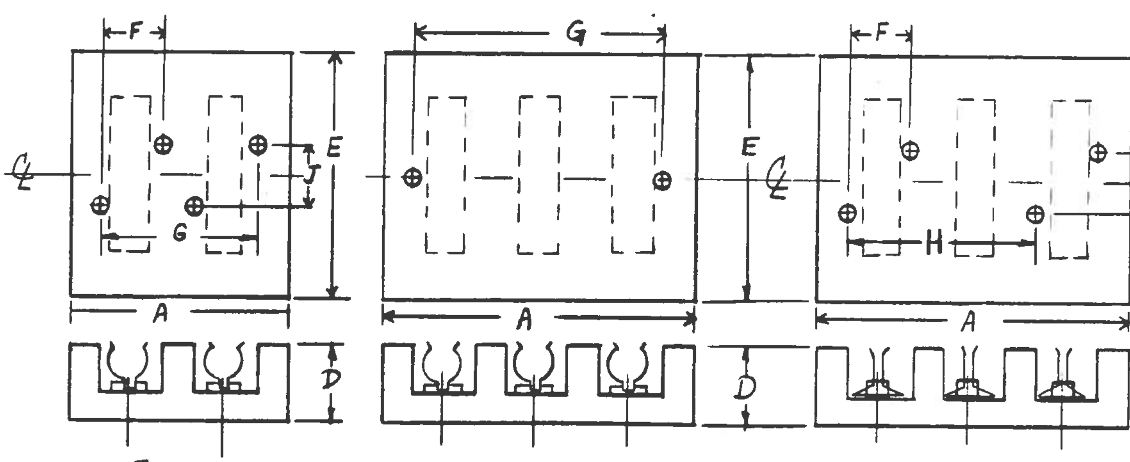


FIG. 5 FIG. 6 FIG. 7

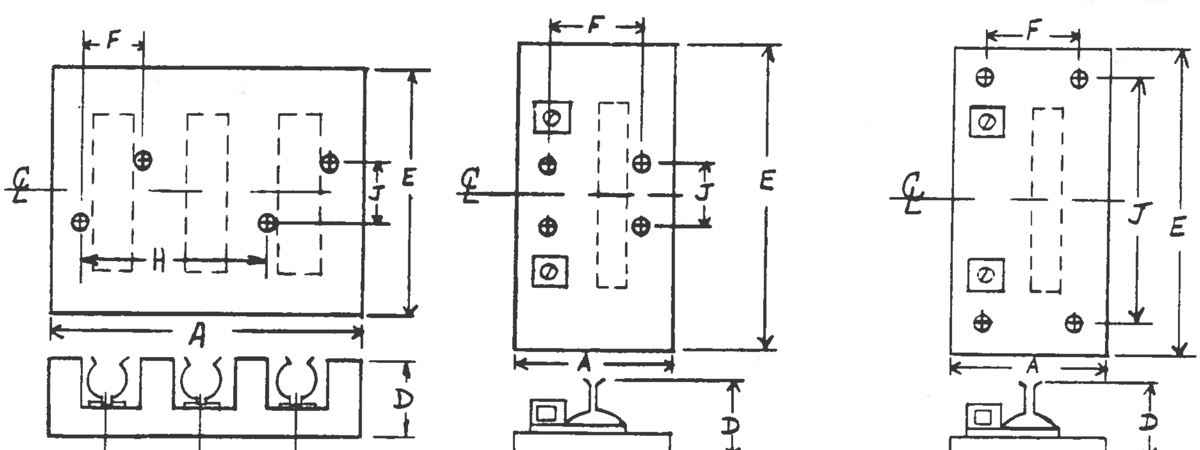


FIG. 8 FIG. 9 FIG. 10

REV						DRAWN D. DOLEMAN	177A1379
1		3		5			
2		4		6		APPD [signature] 24 Feb 75	SHT NO- 1 CONT ON- 2

SPECIFICATIONS

1. All fuse holders shall meet CSA standards for use in Industrial Control Equipments. Fuse clips shall be plated with tin or silver.

2. Refer to Parts Table for electrical ratings and dimensions.

PARTS TABLE

PART NO.	ORIGIN	NO. OF POLES	VOLTS MAX.	AMPS MAX.	OUTLINE DIMENSIONS (INCHES NOM.) FIGURE	A	D	E	F	G	H	J	K
001	P	1	250	30	1B	1.22	1.38	3	.75			.5	7/32
002	P	1	250	60	1A	1.70	2.12	4.8	.5			1.25	7/32
003	P	1	250	100	2	1.97	2.5	8.0	.625			2.38	9/32
004	P	1	250	200	9	3.0	2.81	8.0	2.0			3.0	9/32
005	P	1	250	400	10	4.25	3.12	11.	3			10	9/32
006													
007	P	2	250	30	3	2.12	1.38	3.0	-	1.25		CL	7/32
008	P	2	250	60	5	3.1	2.12	4.8	.5	1.81		1.25	7/32
009	P	2	250	100	4	3.53	2.5	8.0	.625	2.22		2.38	9/32
010	P	3	250	30	6	3.12	1.38	3.0	-	2.5		CL	7/32
011	P	3	250	60	8	4.33	2.12	4.8	.5		2.62	1.25	7/32
012	P	3	250	100	7	5.1	2.5	8.0	.625		3.12	2.38	9/32
013													
014	P	1	600	30	1A	1.95	2.12	6.75	.625			3.12	9/32
015	P	1	600	60	1A	1.95	2.12	6.75	.625			3.12	9/32
016	P	1	600	100	2	2.22	2.5	10	.88			4.25	9/32
017	P	1	600	200	2	3.0	2.81	10.5	2.			3.0	9/32

MARKING - Vendor shall mark all shipping cartons with CGE drawing numbers.

ORDERING - Order by Drawing Number and Part Number eg. 177A1379P001.