

**CUSTOM DESIGNED  
EXCITATION SYSTEMS  
MODEL SSE  
for Steam or Hydro Turbine  
Drive Generators**

**APPLICATION:**

Designed for steam, gas, diesel, or hydro turbine applications requiring a high efficiency, high-initial-response potential source excitation system. The equipment is customized to meet your application requirements using a family of interconnected standard modules. Basler's experienced Excitation System designers will interface the equipment needed to make your system perform.

**FEATURES:**

- Complete system; designed and tested at Basler for your application requirements
- Easy replacement for rotating exciters
- High Initial Response per IEEE 421.2
- High operating efficiency
- All equipment mounted and interconnected in an all-metal enclosure (NEMA 1 standard)
- All wires labeled and harnessed
- All equipment 100% tested
- Exciter power transformer mounted in separate enclosure
- Exciter response matched to generator requirements
- High Potential Cabinet Test IEEE 421B

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**B Basler Electric**

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## BASLER STATIC EXCITER SYSTEMS

Basler Electric will engineer an excitation system to meet the specific needs of your power plant. A description of the basic SSE equipment and optional control and protection devices

is offered as a guide for their application to facilitate selection of the devices that will meet your system requirements.

### BASIC STATIC EXCITER DESCRIPTION: Model SSE

The SSE consists of a control chassis, power rectifier chassis, and electrical power isolation transformer: all the elements required to maintain generator terminal voltage within  $\pm 1/2\%$  across the load range.

The SSE features field selectable single or three-phase sensing.

A frequency compensation circuit in the voltage regulator reduces the generator voltage at subsynchronous speeds below approximately 55 Hz on a 60 Hz system and 45 Hz on a 50 Hz system to avoid overfluxing the generator and transformer magnetics during startups. A jumper is provided to allow field selection of either a voltage limited volts-per-hertz or twice-volts-per-hertz characteristic, as shown in Figure 1. Threshold frequency is adjustable.

A reactive droop compensation circuit is provided to minimize circulating currents between generators operating in parallel.

A manual excitation control system provides backup to the automatic voltage regulator function.

Excitation may be shut down electronically by shutting off gating circuits to the SCRs for SSE systems less than 17kW. For larger kW SSE systems, an AC contactor is recommended to interrupt power to the rectifier bridge. Voltage build-up of the generator may be successful if a minimum of 5% residual voltage is available. Field flashing from a battery is an option.

For more detailed data, see product bulletin SNE.

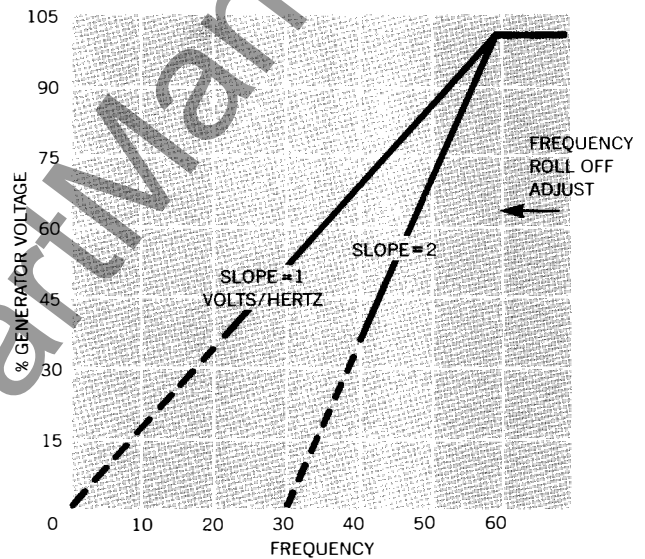


FIGURE 1 - FREQUENCY COMPENSATION

### STATIC EXCITER SPECIFICATION

#### SENSING:

60Hz: 120-139, 208-240, 416-480, 520-600,  $\pm 10\%$   
 50Hz: 100-119, 220-240, 380-415,  $\pm 10\%$

**SENSING BURDEN:** 10VA per phase

#### PARALLEL COMPENSATION:

Burden	Input Current	Droop	Power Factor
25VA	3-5 Amperes	0-5%	0.8

#### POWER RANGE TABLE:

Generator Voltage Ranges $\triangle 1$	Generator Field		Field Power
	Voltages	Amperes	
240V-15,500V	32-375vdc	Up to 1800	Up to 675kW

Transformer BIL: 10-110kV

$\triangle 1$  For higher voltages consult factory.

#### REGULATION:

Less than  $\pm 1/2\%$  for no-load to full-load.

#### EXCITER-REGULATOR RESPONSE:

Less than 50 milliseconds.

#### UNDERFREQUENCY COMPENSATION PARAMETERS:

Refer to Figure 1.

#### TEMPERATURE COEFFICIENT:

Better than 1% for a 50° C ambient temperature change.

#### STORAGE TEMPERATURE:

-65° C (-85° F) to +85° C (+185° F).

#### APPLICABLE SPECIFICATIONS:

- ANSI C57.12.01 - General Requirements for Dry Type Distribution & Power Transformer
- ANSI Z55.1 - Gray Finishes for Industrial Equipment
- NEMA - Part ICS6-110.10.02, Type I, NEMA 1 Ventilated
- NEMA - Part ICS1-111 Electrical Spacings
- IEEE 421.1 - IEEE Std. Definitions for Excitation Systems
- IEEE 421.2 - Identification, Testing & Evaluation of the Dynamics of Excitation Control System
- IEEE 421.3 - High Potential Test Requirement for Excitation System for Synchronous Machines
- IEEE 421.4 - Guide for the Preparation of Excitation System Specifications Transformer NEMA Specification ST-20
- ANSI C37.20 Section 4.2 - High Voltage Transformer BIL Ratings

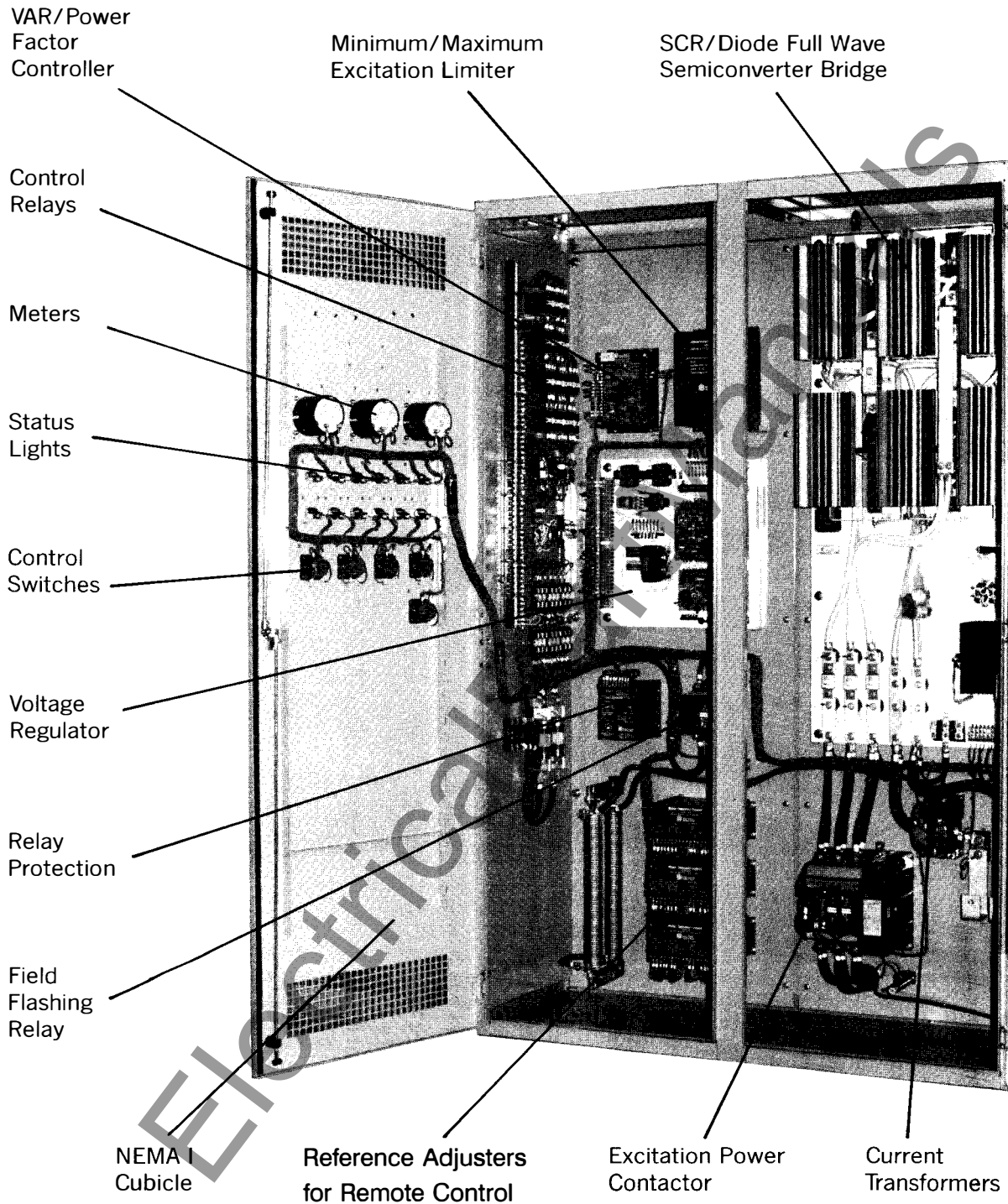


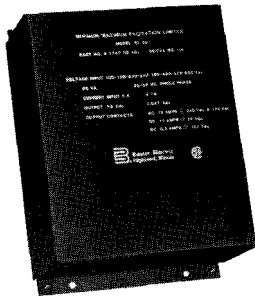
FIGURE 2 - TYPICAL GENERATOR EXCITATION SYSTEM IN CUBICLE

## SSE STATIC EXCITER ACCESSORIES

### I. INTRODUCTION

Static exciter accessories provide control or protection beyond the functions provided by the basic SSE exciter-regulator, expanding the capability of the SSE exciter, and maximizing utilization of the machine over its entire operating range. These devices and their applications are described below.

### II. MINIMUM/MAXIMUM EXCITATION LIMITER



#### a. Minimum Excitation Limiter

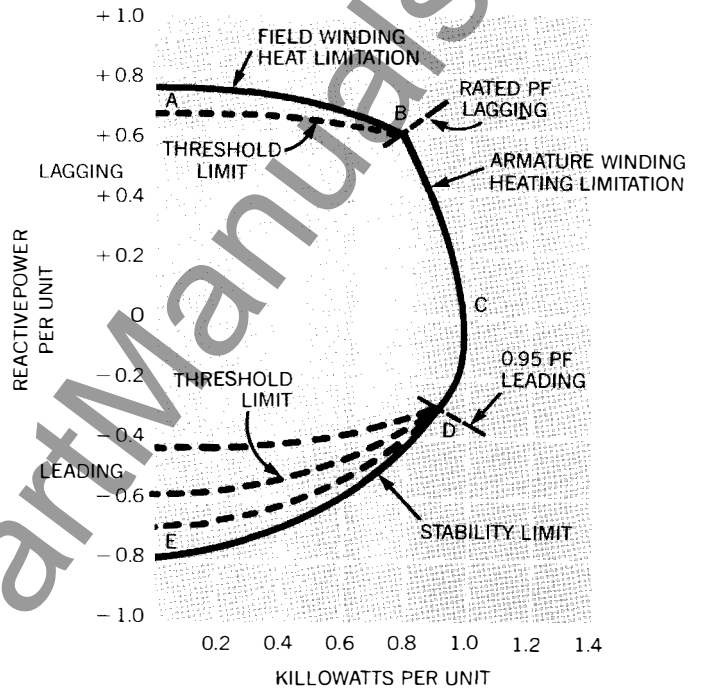
The capability curve of a generator defines the minimum excitation required to maintain generator synchronism. Figure 3 shows a typical capability curve. Curve ED represents the generator underexcited stability limit. The dotted line just above Curve ED is a minimum excitation level to maintain safe generator operation.

For further information, request Minimum/Maximum Excitation Limiter (EL200) product bulletin.

#### b. Maximum Excitation Limiting

In the capability curve of Figure 3, Curve AB represents the field winding heating limitation. If the excitation system exceeds this limit for an excessive time period, the generator field can overheat. The maximum excitation limiter prevents operation in this region by automatically reducing the excitation.

The maximum excitation limiter is provided with time delays to allow the voltage regulator to provide short time field

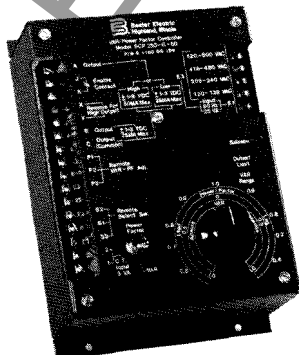


**FIGURE 3 - GENERATOR REACTIVE CAPABILITY CURVE**

forcing and is equipped with inverse and definite time delay characteristics. Definite time is useful in establishing the maximum time limits for solid-state devices; the inverse time function is more closely related to the thermal heating limits of the generator field winding.

For further information, request the Minimum/Maximum Excitation Limiter (EL200) product bulletin.

### III. VAR AND POWER FACTOR REGULATION



Many small generators are controlled to maintain constant power factor or VAR output, requiring constant operator attention. A Var/Power Factor controller can be added to the voltage regulator/exciter system to automate this control function. The Var/PF controller can be operated in either the VAR or PF control mode, and provides a means for adjusting the Var or PF setpoint locally or from a remote location.

For further information, request the VAR/Power Factor Controller (SCP250) product bulletin.

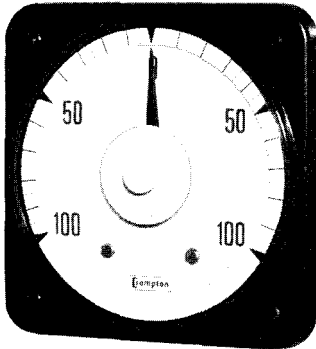
## SSE STATIC EXCITER ACCESSORIES, continued

### IV. BUMPLESS TRANSFER

Bumpless transfer assures matched levels of excitation output to the field of the generator during transfer from auto to manual or manual to auto control. A substantial variation in field output levels between auto and manual can result in

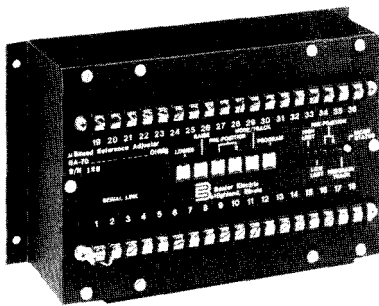
sudden changes of generator VAR output and a possible loss of generator synchronization. Bumpless transfer can be performed either manually or automatically.

#### a. Manual Nulling



Manually, a nullmeter with a "zero" reading at mid-scale is used to facilitate a smooth transfer from automatic to manual control or vice versa. The operator physically adjusts the voltage setpoints for the auto/manual control modes until the nullmeter reaches zero.

#### b. Automatic Nulling



An autotracking manual follower can be added to the system to constantly match the manual system setpoint with the automatic setpoint. The autotracking feature drives a DC signal into the manual setpoint to cause the null meter to move toward zero. Refer to Figure 4.

For further information, request RA-70 product bulletin.

#### c. Automatic Transfer to Manual

If the power plant is unattended or if operators are not constantly available to respond to changing conditions, protective functions may be included in the exciter/regulator system to automatically initiate transfer from Auto to Manual control under various abnormal conditions. Protection may be provided for loss of voltage regulator sensing, generator overvoltage, and field overexcitation or underexcitation. The transfer to manual control enables the generator to stay on line when a disturbance has occurred affecting the automatic voltage regulator's ability to respond to system conditions.

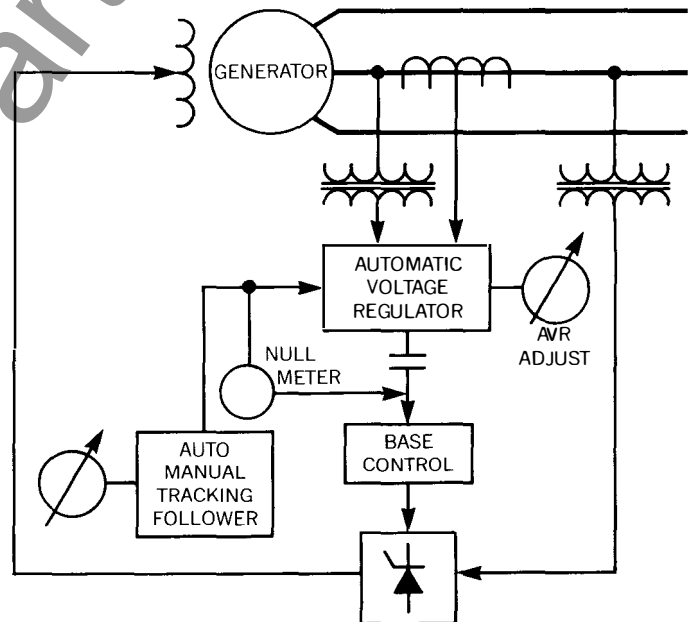
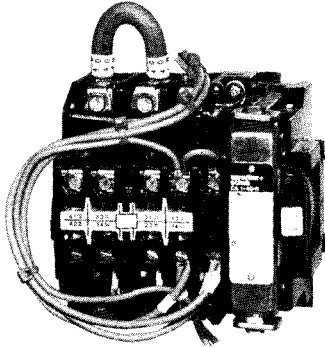


FIGURE 4 - BUMPLESS TRANSFER

The auto follower function includes a time lag to prevent immediate movement of the manual setpoint, preventing the manual setpoint from immediately tracking the malfunctioning voltage regulator and allowing time for the protective relays to sense the problem and initiate a transfer.

## SSE STATIC EXCITER ACCESSORIES, continued

### V. FIELD FLASH SYSTEM



For positive voltage buildup, a field flashing contactor provides fast, positive voltage build-up from a battery. The field flashing circuit also includes an overflash protection circuit to automatically interrupt the source when the generator terminal voltage has not built up within 25 seconds. The field flashing system also includes a resistor sized to limit current demand from the station DC system during field flashing.

### VI. AC FIELD INTERRUPT

Various devices are used to interrupt AC power to the rectifier to shut down the excitation system.

#### a. AC Field contactor

An AC contactor is used for exciter systems rated 400 amps and less. It is designed to interrupt the AC input to the power rectifier bridge. The device is designed for repetitive switching for long life. Fuses on the power rectifier bridge provide high interrupting capability.

#### b. AC Field Breaker

For systems rated above 400 amps, a molded case breaker with a motor operator is utilized. Unlike the AC contactor, the interrupting capability is designed into the breaker which can be equipped with thermal overload and a shunt trip.

#### c. AC Drawout Breaker

Large static exciters (1200 amperes and above) may require extremely high interrupting capability. A drawout breaker equipped with large arc chutes for suppression is used for these application.

#### d. DC Field Contactor/Discharge Resistor

Solid-state static exciter-regulators eliminate the need for dc field contactor and discharge resistors, since the excitation equipment provide a path for field discharge. DC field contactors and discharge resistors are used primarily for:

- (1) Total electrical isolation between the static exciter and generator field.
- (2) Providing a more rapid decay of field energy in the event of a major fault, to minimize possible damage to large generators.

### VII. PROTECTIVE RELAYING

Protective relays are used to detect abnormal operating conditions that could cause equipment damage. A number of relays may be used to monitor machine activity, and to alarm or trip if problems occur. Some of the abnormalities are listed below with protective relaying suggestions to detect and initiate an alarm or trip.

#### a. Insulation Failure or Flashover in Field Circuit

A field ground relay, device 64, can be used on brush type generators to detect a ground in the generator field circuit. Although one ground will not cause any damaging effects, two grounds will. Therefore, early detection is very useful.

#### b. DC Overexcitation

(1) If the exciter goes to ceiling output unexpectedly, the safe heating limits of the generator field can be exceeded. A field overcurrent relay, device 51F, will alarm if a preset level is exceeded. Two DC overcurrent relays are used in some systems, one to monitor field current when the generator is off line, the other to monitor the field current when the generator is on line. This scheme provides more sensitive protection during off-line operation.

(2) Generator overvoltage may result if excessive power from the static exciter is applied to the generator field. A generator overvoltage relay, device 59, can be used to trip or to initiate a transfer to manual if the machine voltage exceeds preset levels.

(3) A volts-per-Hertz relay, device 24, can be used to protect the generator against overexcitation at any speed. A volts-per-Hertz relay monitors the ratio of generator voltage and frequency. If a preset V/Hz ratio is exceeded, the relay will initiate a trip. A 1.05 per unit ratio is generally recognized as the acceptable limit for full generator load and a 1.1 per unit ratio is a typical generator no-load limit.

#### c. Transformer Overtemperature Detection

A voltage imbalance at the power isolation transformer can cause excessive heating in either the power isolation transformer or the power semiconductor bridge. Various methods are used for detecting transformer overheating:

##### (1) Temperature Switch

A simple but effective scheme is to wind a bimetal element into each coil of the three-phase transformer. If excessive

## SSE STATIC EXCITER ACCESSORIES, continued

temperatures are sensed, a contact closure provides user annunciation.

### (2) RTD with Temperature Relay

An RTD sensor may be wound into each coil of the three-phase transformer to provide a millivolt signal to a device 49 temperature relay, which will alarm and provide user annunciation on transformer overtemperature.

### d. Loss of Voltage Sensing/Voltage Balance

Fuses in the instrument potential transformer circuit can fail and cause a false feedback signal to be applied to the input of the automatic voltage regulator. A voltage imbalance in the sensing circuit requires immediate detection to prevent generator overvoltage. A device 47N is typically used for the application. Should all fuses fail or should a disconnect switch be opened between the PT and AVR, a low voltage will be sensed by the voltage regulator, which will act to drive the generator to an overvoltage condition. Hence, the device 47N is often combined with a device 27 undervoltage function to sense either condition, and to alarm or to initiate transfer to manual.

### e. Failed Rectifier

A failed rectifier relay, device 47, is used to monitor the fuses protecting the power rectifier bridge. If a fuse fails due to a failed power semiconductor, the relay will alarm to indicate a failure has occurred which reduces the capacity of the rectifier bridge until the unit is taken offline and the bridge repaired.

### f. Field Underexcitation

Low field current can result in loss of generator synchronism. A field underexcitation relay, device 40, monitors field current and provides indication when the current drops below the preset threshold level.

### g. Transformer/Rectifier Short Circuit/Overload Protection

For systems with PPT primary currents over 20 Amperes, overcurrent relays, device 51, may be used to monitor the line current at the primary and/or secondary of the power isolation transformer. Current transformers installed in each of the transformer phases are connected to AC overcurrent relays to alarm or trip when currents exceed preset values.

## SSE SAMPLE SPECIFICATION AND SELECTION GUIDE

### I. SCOPE

This specification describes the static excitation system for use on a slip-ring type synchronous generator whose rating is:

Generator Rating \_\_\_ KVA, \_\_\_ VAC, \_\_\_ Hz, \_\_\_ PF, \_\_\_ RPM.  
 Generator field requirements at no load of \_\_\_ Amps, \_\_\_ Volts.  
 Generator field requirements of \_\_\_ Amps, \_\_\_ VDC at \_\_\_ %  
 rated voltage and rated KVA.  
 Generator Prime Mover \_\_\_\_\_.

### II. GENERAL

The static regulator will be provided to supply the volt ampere requirements of the main field of the synchronous generator. The excitation system shall be a high initial response design as defined by IEEE 421.2.

#### a. Applicable Specifications

See page 2 of this product bulletin.

### III. BASIC STATIC EXCITATION SYSTEM-CONTROL CUBICLE

#### a. Voltage Regulator Control

The static exciter voltage regulator will provide  $\pm 1/2\%$  voltage regulation on the generator from no load to full load. The control range of the automatic voltage regulator will be -10% to +10% of the nominal generator terminal voltage. The temperature drift shall not exceed .5% for slow changes in ambient temperatures from 15° C to 40° C. The voltage regulator will be equipped with an underfrequency compensation circuit to reduce the generator terminal voltage as the

prime mover speed is reduced to prevent rotor heating during subsynchronous operation. The threshold frequency shall be adjustable. Voltage shall be 120 Volts to accommodate standard instrument potential transformers.

Paralleling provisions will be included to allow reactive load sharing between multiple generators. The droop setting will be adjustable from 0 to 5% at rated power factor, rated load.

The automatic voltage regulator shall have a wide range adjustable stability control. A potentiometer shall be used to eliminate machine instability as well as providing adjustable voltage response.

Manual voltage control will be integral to the static exciter. The control range of the device will be 25% to 115% of the nominal generator terminal voltage when in parallel with the infinite bus.

#### b. Power Stepdown Transformer

A three-phase dry type power isolation transformer shall be supplied to step down the exciter system supply voltage to voltage levels acceptable for the power rectifier bridge. The transformer shall be designed with a 185°C insulation system, 115°C rise at a 40°C ambient for operation at altitudes to 1000m.

Transformer will be convection cooled, Type AA, having open frame construction with one hot spot temperature switch contact per coil, contact to close on rising temperature. (optional)

## SSE SAMPLE SPECIFICATION AND SELECTION GUIDE, continued

High voltage fusing will be provided at the input of the power potential transformer. (optional)

### c. SCR Power Rectifier Bridge

A three-phase semiconverter rectifier bridge rectifier will be provided. It will consist of three power SCRs and three power diodes to phase control the DC power to the main field of the generator. A permanent diode will be connected at the output of the rectifier bridge to provide a commutating path for the power SCRs during switching. This device is to eliminate the mechanical operations otherwise occurring when utilizing a field breaker at shutdown. The power semiconductors will have a PIV rating of not less than three times the maximum root-mean-square voltage of the voltage input to the rectifier bridge. Three fast acting current limiting fuses will be provided at the AC input to the three phase rectifier bridge. RC snubber circuits will be provided for the AC input and DC output. DC output transients will be clamped by surge suppressors. The static exciter regulator shall be capable of providing a minimum of 145% field forcing for one minute from the nominal full load voltage rating. Additionally, it shall have a response ratio of not less than 1.76 for 145% maximum exciter ceiling voltage.

### d. Field Flashing Relay (optional)

A field flash relay will be supplied to provide directional positive voltage into the field for generator startup. An overflash preventive circuit shall be included to de-energize the field flash source if the generator voltage has not built up within 25 seconds. Flashing shall be automatically disconnected at 50% of generator terminal voltage. A fail to field flash contact shall be provided to alarm upon failure of the generator to build voltage.

A dropping resistor shall be supplied to minimize battery power drain required for flashing, while allowing adequate flashing to get the exciter into operating range.

Flashing voltage will be \_\_\_ Volt DC source.

### e. AC Power Switching (optional)

Means shall be provided to interrupt AC power to the three-phase rectifier bridge.

## IV. RECOMMENDED/PERFORMANCE FEATURES

### a. Minimum/Maximum Excitation Limiter (Optional)

Minimum Excitation Limiter - Shall be provided. To prevent a loss of generator synchronism due to underexcitation, the minimum excitation limiter shall utilize a circular characteristic that approximately matches the generator's underexcited capability curve. The device shall be equipped with green indicator light and relay for external contact annunciation when the system is in the limiting mode.

Maximum Excitation Limiter - Shall be provided. To prevent rotor field heating due to excessive current in the generator

field, a two-stage current limiter shall first instantaneously limit the maximum field current, then, after a time delay, limit the field current to a further reduced operating level. Time delay will be inverse or definite time, field selectable. The device shall be equipped with red indicator light and relay for external contact annunciation when the system is in the limiting mode.

### b. Var/Power Factor Controller (Optional)

Var/Power Factor Controller - Shall be provided. To compensate for large voltage changes occurring on the infinite bus that may otherwise cause the automatic voltage regulator to over or underexcite the generator, a Var/Power Factor Controller is used. The Var/Power Factor Controller regulates at a programmed quantity of vars or power factor that is field selectable. The controller shall automatically adjust field excitation in accordance with the programmed Var or Power Factor adjusted on the unit. The controller will maintain the setting for system voltages ranging from an adjustable value of 10-30%.

### c. Nulling System for Bumpless Transfer from Automatic Voltage Regulator to Manual Voltage Control (Optional)

#### Nulling Meter

To prevent exchanges of generator vars and change of generator voltage during transfer from automatic voltage regulator to manual voltage control mode, a nulling meter is used. It will indicate a match level of output excitation between the automatic voltage regulator and manual voltage control.

#### Autotracking Manual Followers

For manual voltage control to automatically track the output of the automatic voltage regulator, an autotracking function shall be provided. Autotracking will enable a bumpless transfer between the automatic voltage regulator and manual voltage control without the use of operator intervention. The autotracker will be enabled any time the system is in automatic voltage regulation.

### d. Automatic Transfer from Automatic Voltage Regulator to Manual Voltage Control

Automatic transfer to manual will take place when an abnormal condition occurs in the system. The condition of transfer is as follows:

1. Loss of Voltage Regulator Sensing
2. Overexcitation
3. Extended overexcitation alarm contact

### e. Shaft Voltage Suppression for Steam or Gas Turbine

Shaft voltage suppression shall be supplied across the generator field for all steam and gas turbine applications. A resistor and capacitor network shall be provided to prevent bearing deterioration caused by capacitive coupling resulting from switching noise by power rectifiers and radio interference.



## SSE SAMPLE SPECIFICATION AND SELECTION GUIDE, continued

### V. SYSTEM CONTROL PROVISIONS - OPTIONS

#### a. Local Control

The excitation system shall be equipped with the ability to provide local control of the generator at the excitation cubicle. Switches to include (as applicable):

1. Auto/Manual Transfer
2. Static Exciter ON/OFF
3. Raise/Lower for Automatic Voltage Regulator
4. Raise/Lower for Manual Voltage Control
5. Raise/Lower Var/Power Factor Control
6. Var/Power Factor Control ON/OFF
7. Var/Power Factor Transfer
8. Local/Remote Transfer Switch

#### b. Remote Control

Provisions for remote control of the excitation at a remote switchboard or other supervisory station shall be provided.

#### Reference Adjuster

Reference adjusters shall be provided with changeable traverse rates for remote control of the generator output quantities. Reference adjusters shall have a pre-position setpoint, adjustable between the entire upper and lower limit range. The following adjusters shall be provided (as applicable):

1. For automatic voltage regulators
2. For manual voltage control
3. For Var/Power Factor Control

#### A Position Signal Output

Each reference adjuster shall provide a 0-1mA signal for use with an analog position meter.

The following remote control provisions will be provided (as required):

1. Auto/Manual Transfer
2. Static Exciter ON/OFF
3. Automatic voltage regulator setpoint adjust
4. Manual voltage regulator setpoint adjust
5. Var/Power Factor Control setpoint adjust
6. Var/Power Factor ON/OFF
7. Var/Power Factor Transfer

### VI. EXCITATION CUBICLE

All components of the excitation system shall be mounted in a formed 11 gauge sheet steel NEMA 1 enclosure built in accordance with ICS6-110.10.02 for ventilated enclosures. The cubicle shall be rigid and self-supporting with enclosed panels on rear.

A full-length door, equipped with a 3-point latch assembly and locking handle, shall be provided for access to inside mounted equipment. Openings will be provided as necessary for adequate ventilation while preventing the entrance of rodents. The power isolation transformer will be shipped in a separate NEMA 1 enclosure.

#### a. Door Mounted Equipment

These devices shall include the following (as required):

1. Local switches
2. Meters
  - DC voltmeter
  - DC ammeter
  - Nulling meter
  - AC voltmeter
3. Status Indication of Operating Mode/Limits/Alarms
4. One set of contacts wired for Remote (Normally Open)

#### b. Other Cubicle Accessories

1. Space heater with thermostat
2. Fluorescent light fixture assembly, with door-activated switch and convenience outlet(s)

### VII. INTERIOR MANUFACTURING STANDARDS

#### a. Identifying nameplates

Unit Identification Nameplate will be .02 inches thick aluminum, screw retained. Component Identification on Cubicle Doors will be .062 inches thick, lamocoid material, with black letters on white nameplate, screw retained.

#### b. Control Wiring

The equipment within the cubicle will be completely interconnected. All wiring for 250V systems and less shall be 14 awg minimum stranded copper, 600 Volt minimum, cross linked polyethylene insulation, 90° C, type "SIS", color gray. Each wire will be clearly identified by a wire number stamped on sleeve material located at each end. Electrical wiring associated with the paralleling current transformer circuit will be 10 awg minimum stranded copper, type "SIS".

#### c. Terminal Blocks

Customer termination of low voltage terminal blocks will be General Electric type CR151 rated 30 A, 600 Vac. All terminal blocks will be mounted a minimum of 4 inches above the floor. 20% additional terminals will be provided as spares. A safety shorting block shall be provided for the connection of the remote parallel current transformer.

#### d. Terminal Lugs

All connections to terminal screws will be made using insulated fork lock terminal lugs. Device connections utilizing compression terminals will use direct wire insert for termination.

#### e. Internal Component Identification

All devices inside the cubicle shall be identified by a printed adhesive label that provides device description. A protective coating shall be applied over the label.

#### f. Cubicle Grounding

A 1/4" x 2" x 3" copper ground bus pad will be provided near the bottom inside of the cubicle.

## SSE SAMPLE SPECIFICATION AND SELECTION GUIDE, continued

### g. Test Switches (Optional)

Switches shall be provided to allow testing of the current transformer and potential transformer sensing inputs.

### h. Protective Finishes

All fabricated metal parts shall have a protective finish. Cleaning, preparation, and paint methods will be as follows.

1. Metal preparation and cleaning will be by alkaline cleaning bath.
2. Paint pretreatment will be by ion phosphate bath.
3. Finish process will be one coat ANSI Z55.1 color number 61 gray for the cabinet enclosure. All subpanels will have a color white finish process. Paints will be in compliance with the 1990 U.S. Clean Air Act.

## VIII. OPERATING ENVIRONMENT

### a. Temperature

The cubicle and the installed components will be designed to function without degradation in performance for an outside cabinet ambient temperature of 40° C (104° F).

### b. Humidity

The cubicle will be designed for 95% humidity non-condensing.

### c. Electrical Spacings

Clearances and creepage spacings will be as specified in NEMA part ICS1-111.

## IX. DOCUMENTATION

The final system shall be supplied with the following information:

1. Enclosure outline dimensions: lifting eye locations and size of eye bolt, maximum weight, cabinet mounting hole sizes and location, and size and location for ventilation
2. Schematic/interconnect diagram with wiring number identification
3. Operational instruction manual
4. Cubicle assembly drawings
5. Wiring list
6. Outline and interconnect drawings in AutoCAD v.11 or DXF files on 3-1/2" disk can be provided at time of equipment shipment.

## X. EQUIPMENT TESTING

### a. Device Testing

Prior to mounting, all devices of Basler manufacture shall be individually tested in accordance with the acceptance test procedure for that device.

### b. Static Exciter Rectifier Test

1. Phase Control Range
2. Logic Circuits
3. 3-Phase Rectifier Unit at Reduced Load

### c. System Tests

The excitation system shall be thoroughly factory tested to determine compliance with the specification and the functional design of the system.

### d. Dielectric Cabinet Test

Electrical dielectric test shall be performed on the excitation cabinet in accordance with IEEE 421.3.

### e. Power Potential Transformer Test

1. No Load Core Loss
2. Exciting Current at Rated Voltage
3. Turns Ratio
4. Applied Dielectric Hipot
5. Open Circuit Voltage Test
6. Polarity Check

### f. Certification

Certification and test data will be provided if requested at time of order.

## ECONOMICS

Economics play an important role in the evaluation and selection of an excitation system. The static excitation system not only provides the volts and ampere requirements of the generator field, but can accomplish it more efficiently. Watts consumed in heat by the static excitation system is less than the rotating exciter.

Efficiency is measured by the power into the exciter versus the power out.

$$\text{Efficiency (\%)} = \frac{\text{Power Out}}{\text{Power In}}$$

The following example illustrates the annual cost savings resulting from replacing an existing rotary exciter system.

A generator is rated at 13800Vac, 96MW, 0.8pf, at 3600RPM. The rotary exciter is rated at 250Vdc at 250kW and has an operating efficiency of 77%.

The static exciter-regulator selected for this application is rated for 250Vdc at 250kW and has an operating efficiency of 95.5%.

Static exciter savings per year will include:

### STATIC EXCITER SAVINGS:

(% Eff. Improvement) (Rotor Load) (Operating Hours/Year) (Cost kW/Hour) = Operating Cost

(17.5%) (250kW) (8760 Hours/year, 100% duty factor) (\$0.06 per kW/Hr) = \$22,995.00

Wire wound rheostat losses - Estimated:

(5kW) (8760 Hours/year, 100% duty factor) (\$0.06 per kW/Hr) = \$ 2,628.00

Where: 17.5% represents the difference in operating efficiency between the rotary exciter and the static exciter-regulator

250kW equals the actual generator field loading

(1) Total operating savings for Static Exciter:

Static Exciter Efficiency Cost Savings = \$22,995.00

Wire Wound Rheostat Losses = \$ 2,628.00

(2) Typical Maintenance Savings (Annual and Unscheduled

Maintenance of Existing System:

Journeyman Electrician (175 hr/yr @ \$30.00/hr) = \$ 5,250.00

(3) Material:

Exciter Brushes = \$ 250.00

Total Savings/Year = \$31,123.00

\$31,123.00 represents the annual cost savings if the solid state excitation system is used, assuming \$0.06 per kW/Hr. Greater efficiency plus maintenance cost reduction over a period of time can result in a substantial dollar savings for a given generator system. For a computerized savings analysis for your application, contact the Basler Electric factory or your regional sales representative.

### STATIC EXCITER INFORMATION

If you would like more application information concerning static exciters, request the Basler Electric Excitation Systems Portfolio ("SSEPORT").

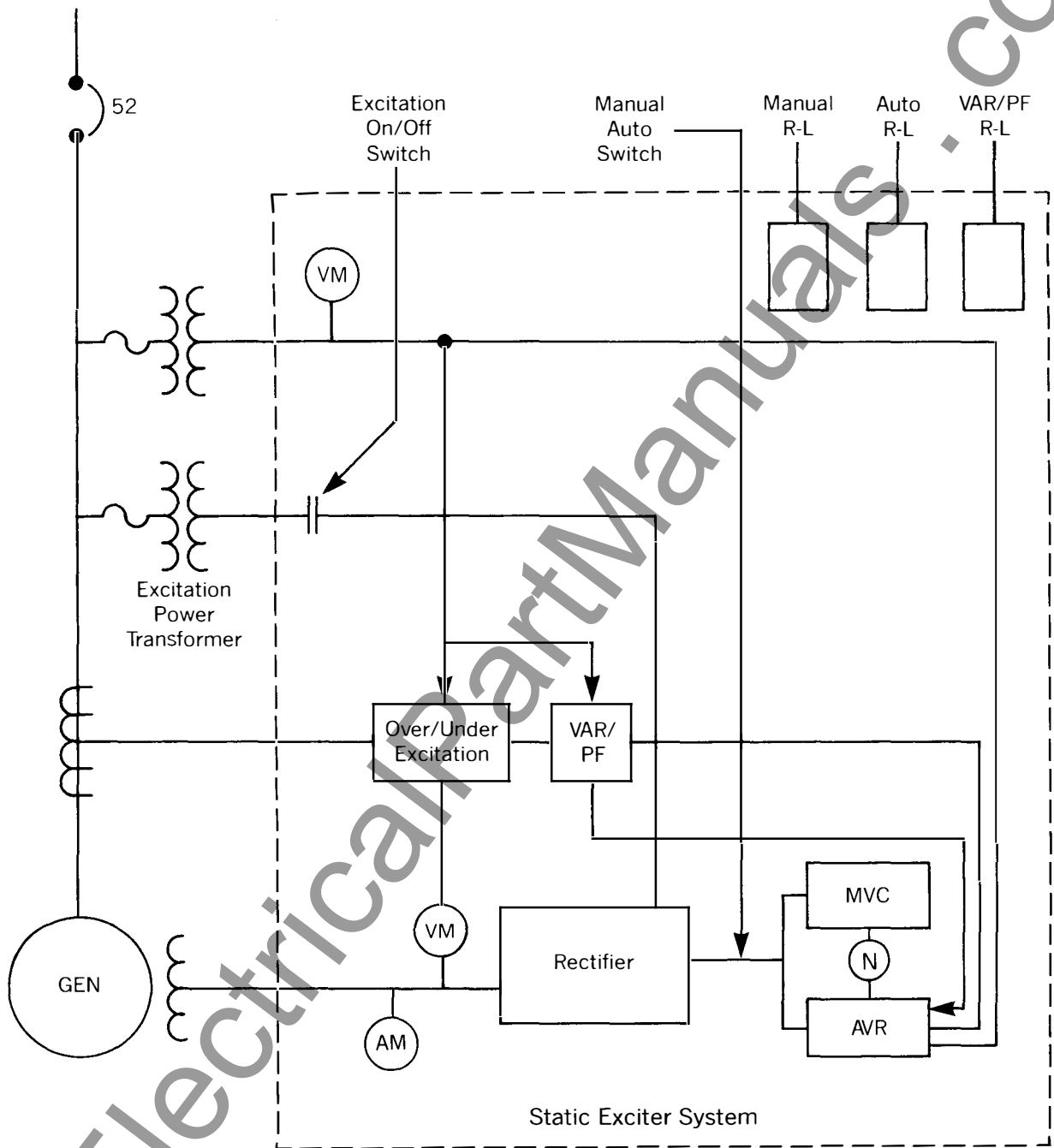


FIGURE 5 - FUNCTIONAL BLOCK DIAGRAM

**B Basler Electric**



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