SS440 AUTOMATIC VOLTAGE REGULATOR (AVR)

SPECIFICATION, INSTALLATION AND ADJUSTMENTS

GENERAL DESCRIPTION

The SS440 is a half-wave phase-controlled thyristor type Automatic Voltage Regulator (AVR) and forms part of the excitation system for a brushless generator.

In addition to regulating the generator voltage, the AVR circuitry includes underspeed and sensing loss protection to ensure safe, reliable control of the generator. Excitation power is derived directly from the generator terminals.

Positive voltage build up from residual levels is ensured by the use of efficient semiconductors in the power circuitry of the AVR.

The AVR is linked with the main stator windings and the exciter field windings to provide closed loop control of the output voltage with load regulation of +/- 1%.

In addition to being powered from the main stator, the AVR also derives a sample voltage from the output windings for voltage control purposes. In response to this sample voltage, the AVR controls the power fed to the exciter field, and hence the main field, to maintain the machine output voltage within the specified limits, compensating for load, speed, temperature and power factor of the generator.

A frequency measuring circuit continually monitors the generator output and provides output underspeed protection of the excitation system, by reducing the output voltage proportionally with speed below a presettable threshold. A manual adjustment is provided for factory setting of the under frequency roll off point, (UFRO). This can easily be changed to 50 or 60 Hz in the field by push-on wire link selection.

Overvoltages caused by open circuit sensing terminals are avoided by sensing loss detection circuitry which reduces the generator terminal voltage to a safe fixed level.

Provision is made for the connection of a remote voltage trimmer, allowing the user fine control of the generator?s output.

Accessories are available for this AVR. Please refer to factory for further details.

TECHNICAL SPECIFICATION

INPUT

Voltage	170-250 V ac max
Frequency	50-60 Hz nominal
Phase	1
Wire	2

OUTPUT

Voltage	max 90 V dc at 207 V ac input
Current	Continuous 4 A dc
	Transient 6 A for 10 seconds
Field Resistance	15 W minimum

REGULATION (See Note 1) +/- 1%

THERMAL DRIFT

(after 10 min)
1% for 40°C change in AVR ambient

TYPICAL SYSTEM RESPONSE

Field current to 90%	80ms
Machine Volts to 97%	300ms

EXTERNAL VOLTAGE ADJUSTMENT (see note 2)

+/- 8% with 1 K W trimmer

UNDER FREQUENCY PROTECTION

Set Point (See Note 3)	95% Hz
Slope	170% down to 30 Hz

UNIT POWER DISSIPATION

12 watts maximum

BUILD UP VOLTAGE

3.5 Vac @ AVR terminals

ACCESSORY INPUT

+/- 1V = +/- 13% change in output volts

QUADRATURE DROOP SENSITIVITY

Maximum sensitivity	(10 W Burden)
	0.07A for 5% droop @ 0p.f.

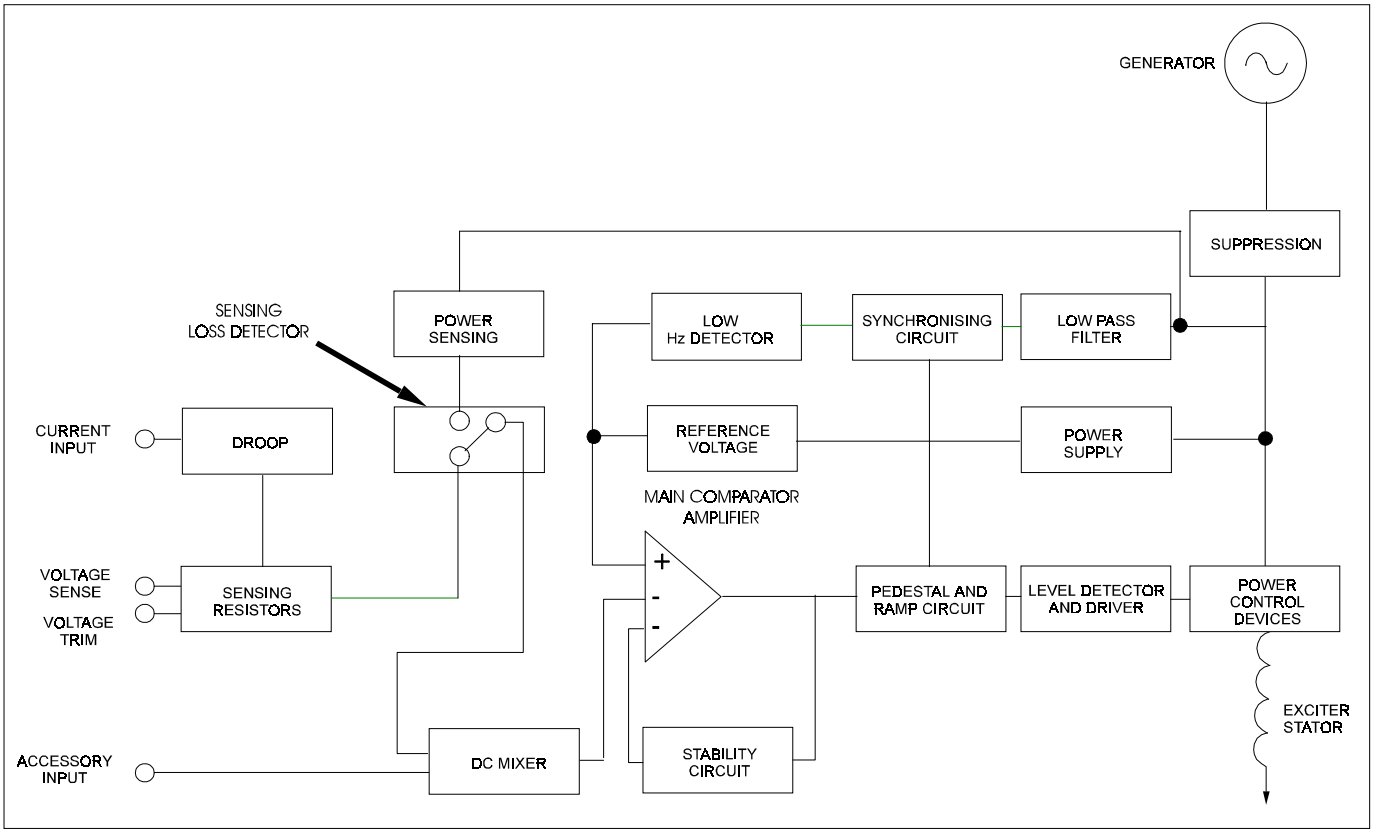
ENVIRONMENTAL

Vibration	20-100 Hz	50mm/sec
	100 Hz-2 kHz	3.3g
Relative Humidity	0-60°C	95%
Operating Temperature		-40°C to + 70°C
Storage Temperature		-55°C + 80°C

NOTES

1. With 4% engine governing
2. External trim range is reduced to +/- 5% with 1 K W trimmer when 3 phase sensing is fitted.
3. Factory set, semi-sealed, jumper selectable.

DESIGN DETAILS



The main functions of the AVR are:

Sensing Resistors take a proportion of the generator output voltage and attenuate it. This input chain of resistors includes the range potentiometer and hand trimmer which adjust the generator voltage. An isolating transformer allows connection to windings of different polarity and phase. An operational precision rectifier converts the ac sensing voltage into dc for further processing.

Quadrature droop circuit converts the current input into a voltage, which is phase mixed with the sensing voltage. The result is a net increase in the output from the sensing network as the power factor lags, causing the reduction in excitation needed for reactive load sharing of parallelled generators.

A trimmer allows control over the amount of droop signal.

Sensing loss detector is an electronic changeover switch which normally connects the main comparator/amplifier to the "input sensing" network, and automatically changes over to the "power sensing" network when the normal sensing voltage is lost.

DC Mixer provides an interface between the AVR and accessories and allows the generators excitation to be controlled by adding or subtracting the accessory dc output voltage to the AVR rectifier sensing voltage.

Main Comparator/Amplifier compares the sensing voltage to the "**reference voltage**" and amplifies the difference (error) to provide a controlling signal for power devices. The "**pedestal and ramp**" circuit and "**level detector and driver**" provide the means to infinitely control the conduction period of the output device over each half cycle (phase control), and provide the exciter with the required power to maintain the generator voltage within the specified limits. The "**Stability circuit**" provides adjustable negative ac feedback to ensure good steady state and transient performance of the control system.

Low Hz detector measures the period of each electrical cycle and causes the reference voltage to be reduced approximately linearly with speed below a presettable threshold. A light emitting diode gives indication of underspeed running.

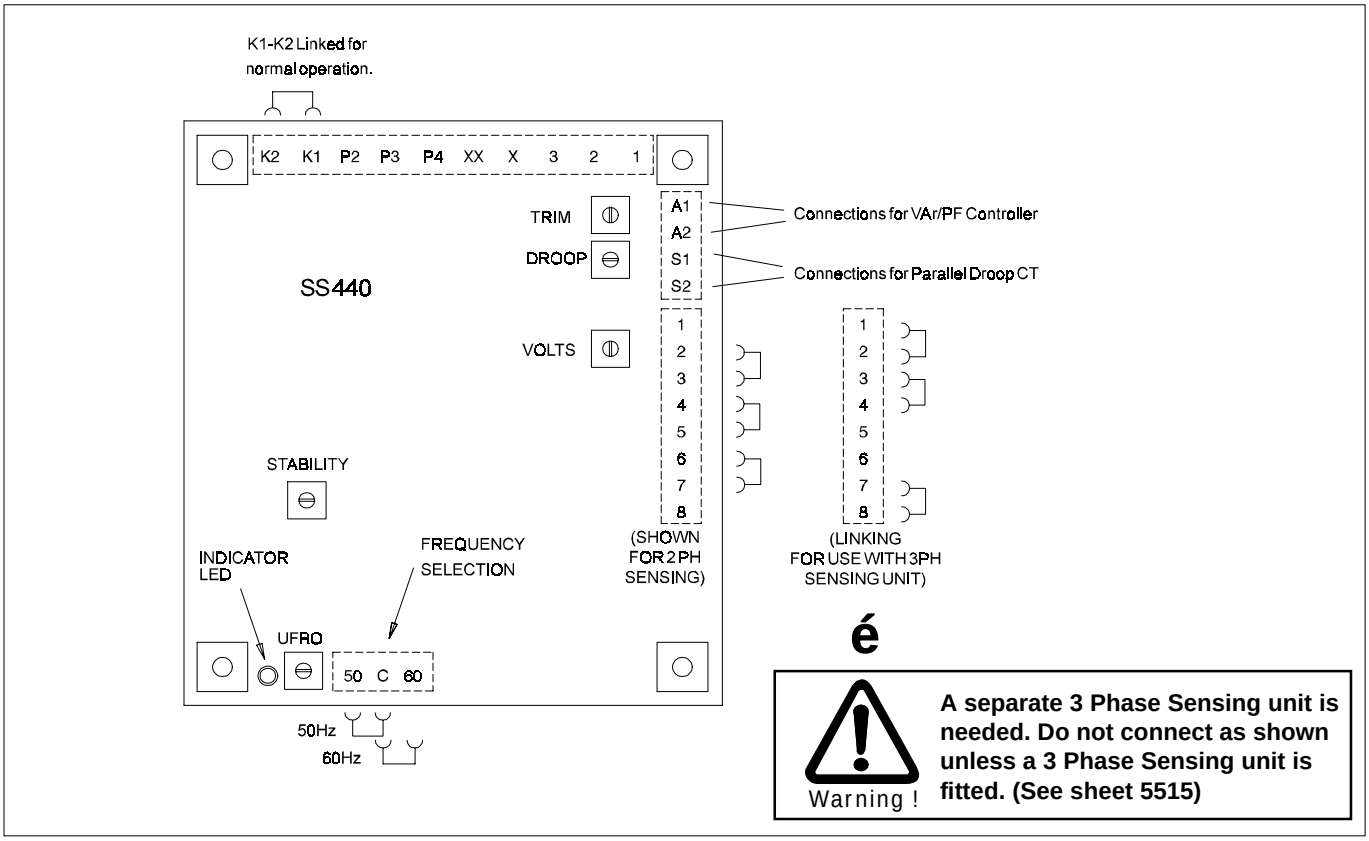
Synchronising circuit provides a short pulse at the zero crossing of each cycle and is used to synchronise the underspeed and pedestal and ramp circuit to the generator waveform. The circuit is preceded by a "low pass filter" to prevent false zero crossing pulses caused by severely distorted waveforms.

Power Devices are configured as half-wave thyristor and freewheel diode to vary the amount of exciter field current in response to the error signal produced by the main comparator.

Suppression components are included to prevent sub cycle voltage spikes damaging the AVR components and also to reduce the amount of AVR thyristor noise on the main terminals of the generator.

Power Supply components consist of zener diodes with dropper resistor and smoothing to provide the required voltages for the integrated circuits and reference voltage.

The AVR is fully encapsulated to ensure long trouble-free operation. It is usually fitted on a panel of the terminal box. It can also be separately fitted in a switchboard.



SUMMARY OF AVR CONTROLS		
CONTROL	**FUNCTION**	**DIRECTION**
VOLTS	TO ADJUST GENERATOR OUTPUT VOLTAGE	CLOCKWISE INCREASES OUTPUT VOLTAGE
STABILITY	TO PREVENT VOLTAGE HUNTING	CLOCKWISE INCREASES STABILITY OR DAMPING EFFECT
UFRO	TO SET UNDER FREQUENCY ROLL OFF KNEE POINT	CLOCKWISE REDUCES THE KNEE POINT FREQUENCY
DROOP	TO SET GENERATOR OR DROOP TO 5% AT FULL LOAD 0 PF	CLOCKWISE INCREASES THE DROOP
V/TRIM	TO MATCH AVR INPUT TO ACCESSORY OUTPUT	CLOCKWISE ALLOWS THE ACCESSORY MORE CONTROL OVER AVR

ADJUSTMENT OF AVR CONTROLS

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can be altered by careful adjustment of the volts control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 & 2 on the auxiliary terminal block inside the generator terminal box will be fitted with a shorting link if no hand trimmer is required.

Warning !

Do not increase the voltage above the rated generator voltage. If in doubt, refer to the rating plate mounted on the generator case.

If a replacement AVR has been fitted or re-setting of the VOLTS adjustment is required, proceed as follows:-

1) Before running generator, turn VOLTS control fully anti-clockwise.

2) Turn remote volts trimmer (if fitted) to midway position.

3) Turn STABILITY control to midway position.

4) Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.

5) Start generator set, and run on no load at nominal frequency e.g. 50-53Hz or 60-63Hz.

6) If the red Light Emitting Diode (LED) is illuminated, refer to the Under Frequency Roll Off (UFRO) adjustment.

7) Carefully turn VOLTS control clockwise until rated voltage is reached.

8) If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.

9) Voltage adjustment is now completed.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator.

The correct setting can be found by running the generator at no load and slowly turning the stability control anti-clockwise until the generator voltage starts to become unstable.

The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

OPTIMUM RESPONSE SELECTION

The "jumper" selector lead should be correctly linked (A,B,C at the bottom of the board) for the frame size of the generator (See diagram).

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an underspeed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a presettable threshold known as the "knee" point.

The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating.

The UFRO adjustment is preset and sealed at the works and only requires the selection of 50/60Hz using the jumper link.

For optimum setting, the LED should illuminate as the frequency falls just below nominal, i.e. 47Hz on a 50Hz system or 57Hz on a 60Hz system.

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a power factor dependent signal for the AVR. The C.T. is connected to S1, S2 on the AVR.

The DROOP adjustment is normally preset in the works to give 5% voltage droop at full load zero power factor.

Clockwise increases the amount of C.T. signal injected into the AVR and increases the droop with lagging power factor (cos Ø).

If a three phase sensing unit is fitted droop adjustment is made on this separate unit.

With the control fully anti-clockwise there is no droop.

TRIM ADJUSTMENT (V/TRIM)

An auxiliary input is provided to connect to the VAr/PF controller, (A1,A2). It is designed to accept dc signals up to +/- 5 volts.

The dc signal on this input adds to or subtracts from the AVR sensing circuit, depending on polarity.

The V/Trim control allows the user to adjust the sensitivity of the VPF controller.

With V/Trim fully anti-clockwise the VPF controller has no effect. Clockwise it has maximum effect. Normal setting is fully clockwise.