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SS321 AUTOMATIC VOLTAGE REGULATOR (AVR)

SPECIFICATION, INSTALLATION AND ADJUSTMENTS

GENERAL DESCRIPTION

The SS321 is a three phase, 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 protective features to ensure safe reliable control of the generator. Excitation power is derived from a permanent magnet generator (PMG) to guarantee low Radio Frequency Interference (RFI) and immunity from thyristor type loads.

The AVR is linked with the main stator windings and controls the power fed to the exciter stator and hence the main rotor to maintain the machine output voltage within the specified limits, compensating for load, speed, temperature and power factor of the generator.

Soft start circuitry is included to provide a smooth controlled build up of generator output voltage.

Sustained overvoltage caused by open circuit sensing terminals is avoided by overvoltage detection circuitry which provides internal shutdown of the AVR output device.

A frequency measuring circuit continually monitors the generator output and provides underspeed protection of the excitation system by reducing the generator output voltage proportionally with speed below a presettable threshold. A further enhancement of this feature is an adjustable volts/Hz slope to improve frequency recovery time on turbo charged engines.

Current limiting may be included to allow control over the amount of short circuit current flowing during three phase and single phase short circuits on the generator output.

Uncontrolled over excitation is limited to a safe period by internal shutdown of the AVR output device. This condition remains latched until the generator has been stopped.

For complete protection, a circuit breaker option is available providing circuit isolation in event of a short circuit power device.

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

TECHNICAL SPECIFICATION

SENSING INPUT

Voltage	170-250 V ac max
Frequency	50-60 Hz nominal
Phase	1 or 3
Wire	2 or 3

POWER INPUT (PMG)

Voltage	170-220Vac	
Current	3A/phase	
Frequency	100-120Hz	nominal
Phase	3	
Wire	3	

OUTPUT

Voltage	max 120 V dc
Current	continuous 3.7 A (See note 3) Transient 6 A for 10 seconds
Field Resistance	15 ? minimum

REGULATION (See Note 1) +/- 0.5% RMS*

THERMAL DRIFT

(after 10 min)
0.5% for 40°C change in AVR ambient

SOFT START RAMP TIME

0.4 - 4 seconds

TYPICAL SYSTEM RESPONSE

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

EXTERNAL VOLTAGE ADJUSTMENT

+/- 6% with 4.7 K ? trimmer

UNDER FREQUENCY PROTECTION

Set Point (see note 2)	95% Hz	
Slope		100-300% down to 30 Hz
Dwell (Recovery)		0.5-2.0 seconds

UNIT POWER DISSIPATION

18 watts maximum

ACCESSORY INPUT

+/- 1 V = +/- 5% change in output volts

QUADRATURE DROOP

Maximum sensitivity	(10 ? Burden) 0.22 A for 5% droop @ 0p.f.

CURRENT LIMIT

sensitivity range (10 ? Burden)	0.45 A - 1 A

OVER VOLTAGE PROTECTION

Set Point	300 V	
Time Delay (fixed)	1 second	
Circuit breaker	trip coil voltage	40-60 v dc
Circuit breaker	trip coil resistance	50-100 ohms

OVER EXCITATION PROTECTION

Set Point	75 V dc
Time Delay (fixed)	8-15 seconds

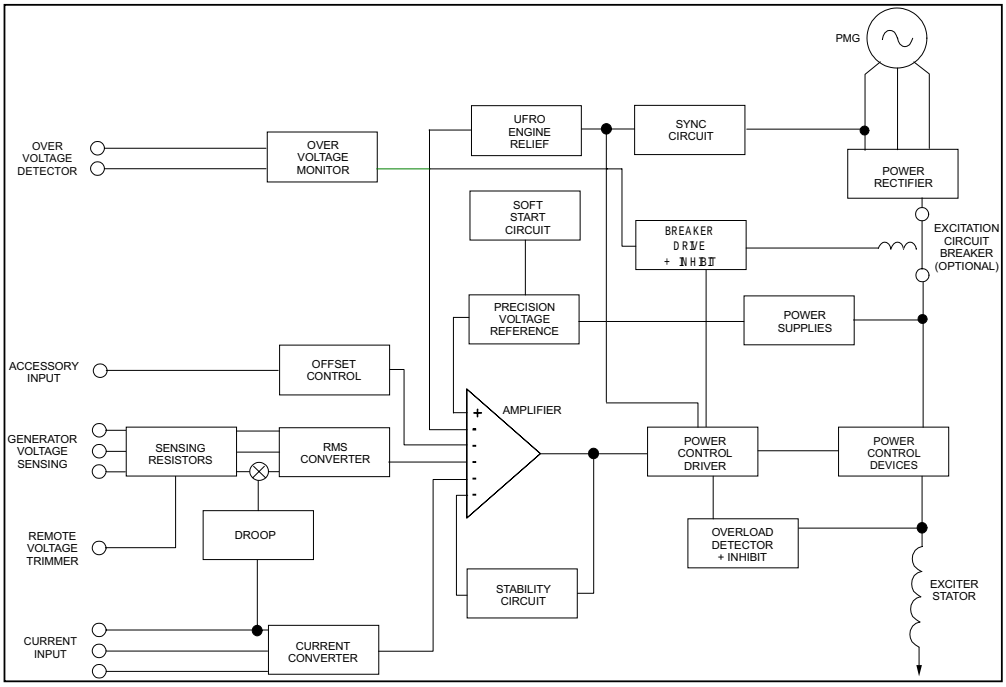
ENVIRONMENTAL

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

NOTES

1. With 4% engine governing.
2. Factory set, semi-sealed, jumper selectable.
3. Derate linearly from 3.7A at 50°C to 2.7A at 70°C operating temperature.

DESIGN DETAILS



The main functions of the AVR are:

Sensing Resistors take a portion of the generator output voltage and attenuate it. This input chain of resistors includes the hand trimmer adjustment.

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 paralleled generators.

RMS converter is a square law precision rectifier circuit that converts the ac signals from the sensing networks into a composite dc signal representing the mean squared value of the waveform.
The output of the RMS converter includes a variable potential divider which is the voltage range control for the AVR.

Current converter is a three phase precision rectifier and amplifier that converts the inputs from current transformers into a dc signal representing the mean value of the current waveform.

Offset control provides an interface between the AVR and accessories and allows the generator's excitation to be controlled by adding or subtracting the accessory dc output voltage to the AVR rectified sensing voltage.

Power supply components consist of zener diodes, dropper resistors and smoothing to provide the required voltages for the integrated circuits.

Precision voltage reference is a highly stable temperature compensated zener diode used for dc comparison.

Soft start circuit overrides the precision voltage reference during run up to provide a linear rising voltage.

Main Comparator/Amplifier compares the sensing voltages with the reference voltage and amplifies the difference (error) to provide a controlling signal for the power device to supply the exciter with the required amount of power to maintain the generator voltage within the specified limits.

Stability circuit provides adjustable negative ac feedback to ensure good steady state and transient performance of the control system.

Power control driver provides the means to infinitely control the conduction period of the output device. This is achieved by pedestal and ramp control followed by a level detector and driver stage.

Power control devices and rectifier vary the amount of exciter field current in response to the error signals produced by the main comparator.

Syncronising circuit provides a short pulse near the zero point of one of the phases on the PMG and is used to synchronise the Under Frequency Roll Off (UFRO) and power control circuits to the generator cycle period.

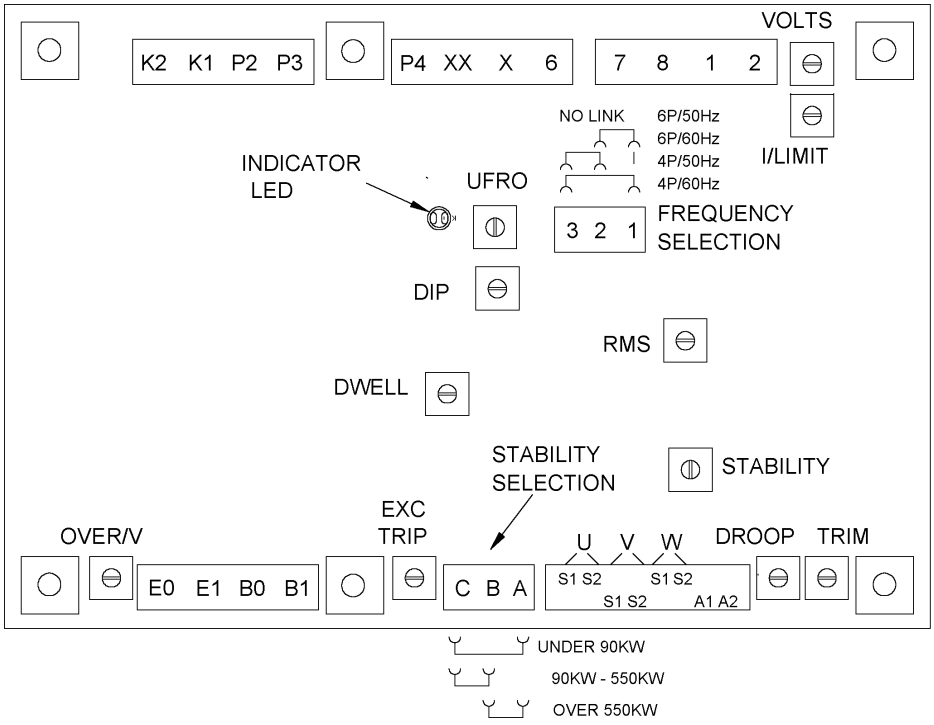
UFRO circuit measures the period of each electrical cycle and causes the reference voltage to be reduced linearly with speed below a presettable threshold. A light emitting diode (LED) gives indication of underspeed running.

Engine relief (load acceptance) circuit causes greater voltage roll off (makes the V/Hz slope steeper) to aid engine speed recovery after application of a "block" load.

Over voltage monitor continuously monitors the voltage at the generator terminals and provides signals to shut down the output device and trip an optional circuit breaker, to isolate power from the exciter and AVR if sustained overvoltage occurs.
A one second timer is included in the circuit to prevent operation during transient overvoltages, which are normal after load removal.

Overload detector continuously monitors the level of excitation and provides signals to shut down the output device if overloads last more than ten seconds. Both the overload and overvoltage conditions are latched faults requiring the generator to be stopped for reset.

FITTING AND OPERATING



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.

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 in the generator terminal box will be fitted with a shorting link if no hand trimmer is required.

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 SELECTION

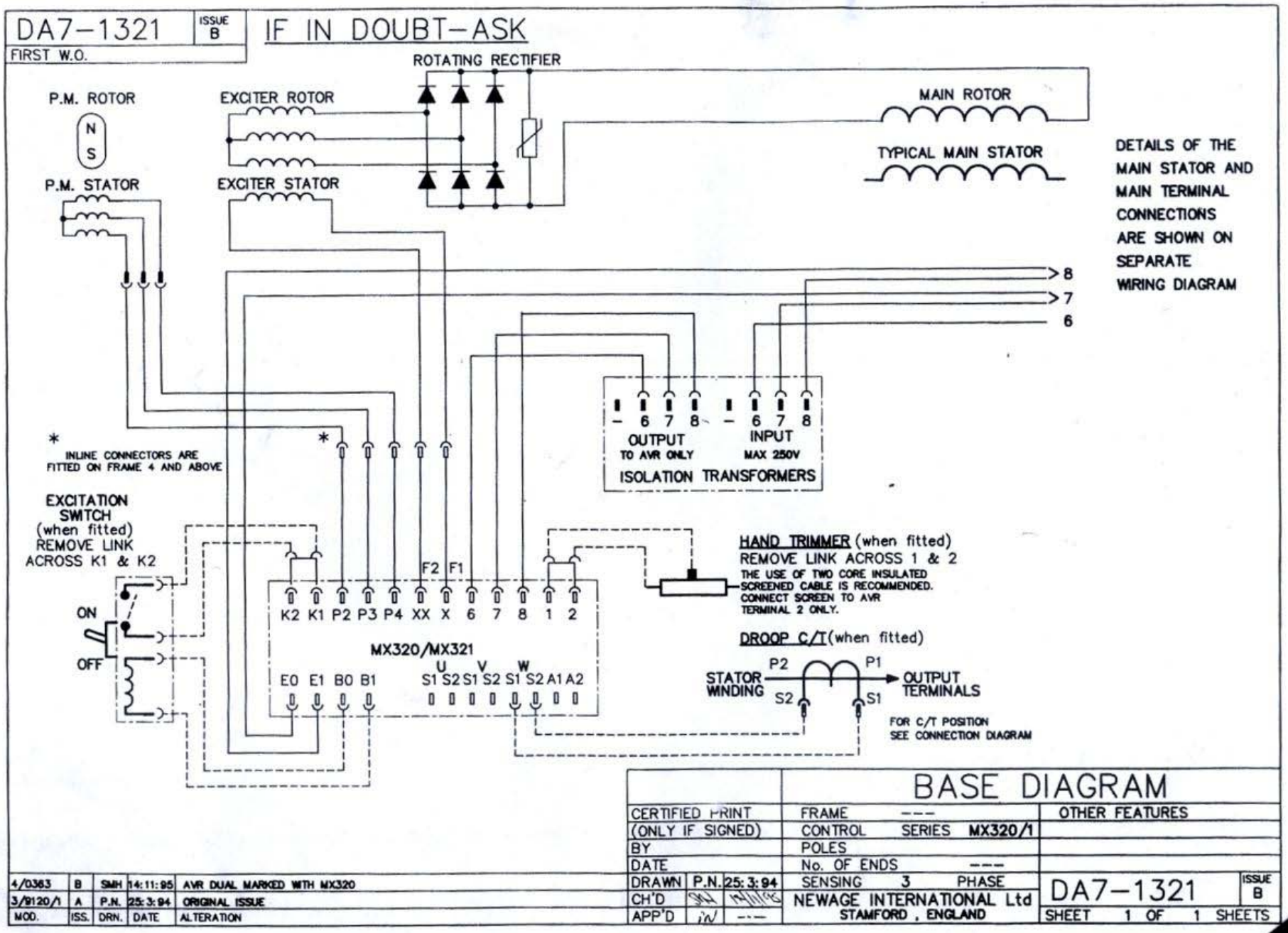
The "jumper" selector lead should be correctly linked (A,B,C at the bottom of the board) for the frame size of the generator (See diagram).

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).



MX321 Diagram