SA465-2 AUTOMATIC VOLTAGE REGULATOR (AVR)

SPECIFICATION, INSTALLATION AND ADJUSTMENTS

GENERAL DESCRIPTION

The SA465 is a half wave phase controlled thyristor type Automatic Voltage Regulator (AVR) and forms part of the excitation system for brushless generators. The design employs Surface Mount Technology (SMT) to reduce component count, yielding a host of features in a small footprint AVR.

Positive voltage build up from residual levels is ensured by the use of efficient semiconductors in the power circuitry of the AVR. Excitation power is derived directly from an auxiliary winding within the generator stator when sustained short circuit current is required, or alternatively, it can be derived from the main stator winding.

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

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 in such a way as 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 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 60Hz in the field by jumper link selection.

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

Accessories are available for this AVR.

TECHNICAL SPECIFICATION

SENSING INPUT

Voltage	100 - 130 } Jumper
	170 - 250 } Selectable
Frequency	50 - 60Hz nominal
Phase	2
Wire	2

POWER INPUT

Voltage	100 - 250 Vac
Frequency	50 - 60Hz
Phase	1
Wire	2

OUTPUT

Voltage	75dc @ 170 Vac input
	105 dc @ 240 Vac input
Current	Continuous 4A dc
	Transient 7.5A for 10 seconds
Field resistance	10 Ω minimum up to 170Vac input
	15 Ω minimum up to 250Vac input

REGULATION (See Note 1) +/- 1.0% Average

THERMAL DRIFT

0.05% per °C

TYPICAL SYSTEM RESPONSE

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

EXTERNAL VOLTAGE ADJUSTMENT

+/- 10% with 1 K Ω trimmer

UNDER FREQUENCY PROTECTION

Set Point (See Note 2)	95% Hz
Slope	170% down to 30 Hz

UNIT POWER DISSIPATION

12 watts maximum

BUILD UP VOLTAGE

3.5 V ac (@ AVR terminals)

ACCESSORY INPUT

+/- 1V input = +/- 10% change in output volts @ 415V nominal

QUADRATURE DROOP

Maximum sensitivity (10 Ω Burden)

0.07 A for 5% droop @ 0p.f.

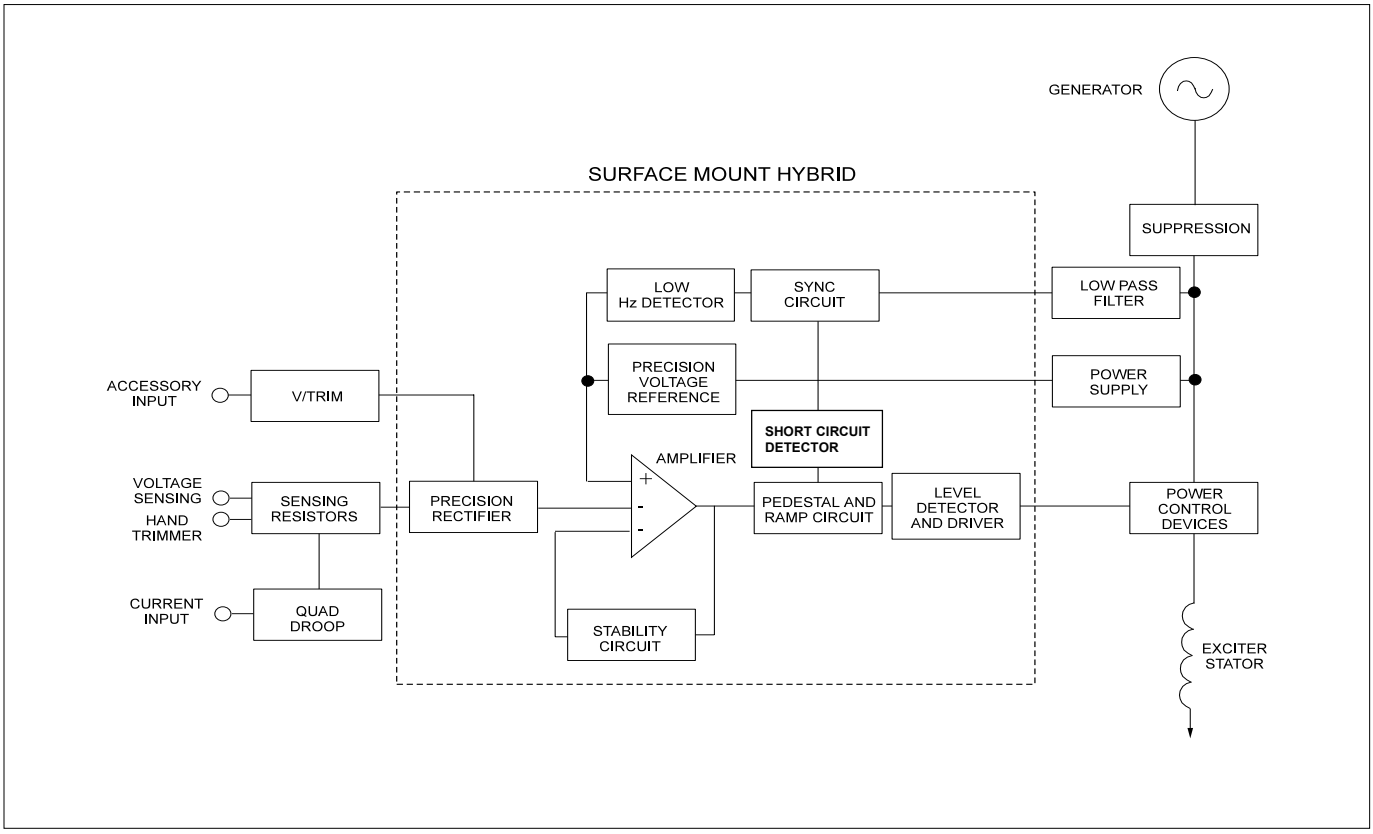
ENVIRONMENTAL

Vibration	20-100 Hz	50 mm/sec
	100 Hz-2 kHz	3.3g
Relative Humidity	0-60°C	95% RH
Operating Temperature		-40 to +70°C
Storage Temperature		-55 to +80°C
Weight		360 grams

NOTES

1. With 4% engine governing.
2. Factory set, semi sealed, selectable.

DESIGN DETAILS



The main functions of the AVR are:

Input sensing circuit takes a proportion of the generator output voltage and attenuates it to a suitable lower level. This input chain of resistors includes the means by which the generator voltage is adjusted (Range + Hand Trimmer).

Precision rectifier uses an operational precision rectifier to convert the a.c. sensing voltage into d.c. for further processing.

Quad. droop circuit converts the current input from a CT 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 a reduction in excitation. A trimmer allows control over the amount of droop signal.

V Trim 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 (from) the AVR rectified sensing voltage.

Main comparator/Amplifier compares the sensing voltage to the "**reference voltage**" and amplifies the difference (error) to provide a controlling signal for the 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 hence provide the exciter with the required power to maintain the generator voltage within specified limits. The stability circuit provides adjustable negative AC feedback to prevent voltage hunting and 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.

Sync. 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 waveforms. The sync circuit is preceded by a "**low pass filter**" to prevent false zero crossing pulses due to severely distorted waveforms.

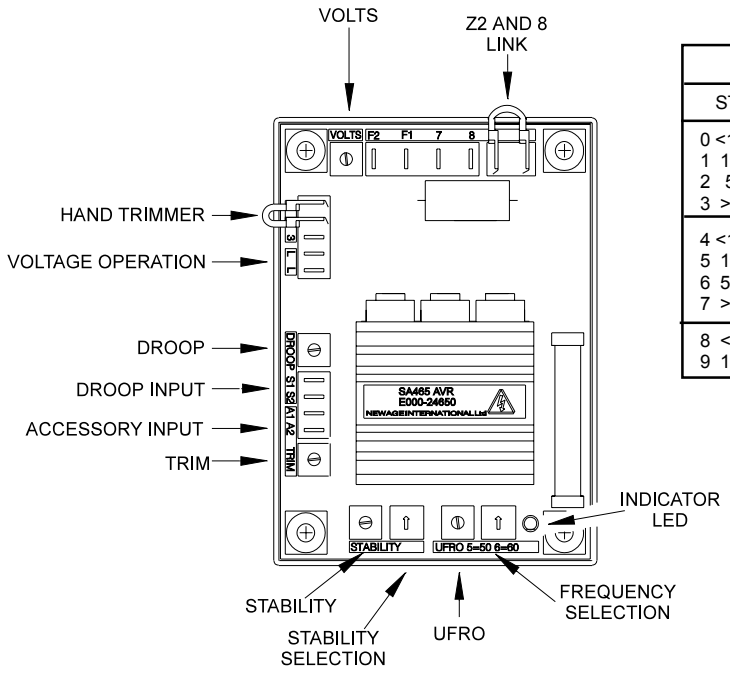
Power devices are configured as half wave thyristor and freewheel diode to vary the amount of exciter field current in response to the error signal produced by the main comparator.

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 a dropper resistor and smoothing to provide the required DC input for the Hybrid.

Short Circuit Detectorsenses the presence of a short circuit on the generator output and forces the power devices into full conduction. (This only occurs when the AVR is powered from an auxiliary winding).

FITTING AND OPERATING



SWITCH SELECTION	
STABILITY	RESPONSE
0 <100KW 1 100 - 500KW 2 500 - 1000KW 3 >1000KW	FAST
4 <100Kw 5 100 - 500KW 6 500 - 1000KW 7 >1000KW	MEDIUM
8 <100KW 9 100 - 500KW	SLOW

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
STABILITY SELECTION	T O OPTIMISE TRANSIENT PERFORMANCE	SEE TABLE
UFRO	TO SET UNDER FREQUENCY ROLL OFF KNEE POINT	CLOCKWISE REDUCES THE KNEE POINT FREQUENCY
FREQUENCY SELECTION	TO SELECT 'UFRO' CONTROL RANGE	SEE TABLE
DROOP	TO SET GENERATOR DROOP TO 5% AT FULL LOAD 0 PF	CLOCKWISE INCREASES THE DROOP
HAND TRIMMER	EXTERNAL HAND TRIMMER CONNECTION	REMOVE LINK ACROSS 1 AND 2 WHEN FITTING HAND TRIMMER
VOLTAGE OPERATION	110-120 V OPERATION	FOR 110-120 V AVR INPUT LINK L AND L
Z2 & 8 LINK	POWER ISOLATION	SEE WIRING DIAGRAM FOR DETAILS

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.

A switch is provided to change the response of the stability circuit to suit different frame size machines and applications.

The table below shows the options available:

RESPONSE	kVA RATING
Fast	0 < 100
	1 < 100-500
	2 < 500-1000
	3 < 1000
Medium	4 < 100
	5 < 100-500
	6 < 500-1000
	7 < 1000
Slow	8 < 100
	9 < 100-500

The correct setting of the stability control 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).

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. (i.e. Frequency is below knee point).

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

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a correction signal for 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.

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

TRIM ADJUSTMENT

An auxiliary input is provided to connect to accessories, (A1,A2). The input is designed to accept DC signals up to +/- 5 volts.

The D.C. signal presented to this input adds to or subtracts from the AVR sensing circuits depending on polarity, and allows the "Accessory" to have an influence on generator excitation.

The 'TRIM' adjustment allows the user to 'TRIM' how much control the 'Accessory' has over the AVR.

With the TRIM control fully anti-clockwise the Accessory has no control, clockwise maximum control.

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