

# STAMFORD®

## AS480 AUTOMATIC VOLTAGE REGULATOR (AVR)

### SPECIFICATION INSTALLATION AND ADJUSTMENTS

#### General description

The AS480 is a half wave phase controlled AVR which forms part of the excitation system of the brushless generator. The design employs Surface Mount Technology (SMT), custom mouldings and heatsinks to produce a compact AVR assembly. The AVR also incorporates an interface to the optional Excitation Boost System (EBS) for use where short-circuit current maintenance is required.

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 +/- 1.0%. The AVR voltage sensing terminals continuously sample 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.

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

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

A wide range of stability settings are available to compensate for machine sizes and applications. A 'slow' setting is available for applications involving single/twin cylinder engines and where lamp-flicker could be a problem.

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

Operation with 110Vac sensing is possible, replace the hand trimmer link with fixed resistor. The hand trimmer option cannot be used in this configuration. The generator overload capability is reduced in 110V operation.

The AVR has the facility for droop CT connection, to allow parallel running with other similarly equipped generators.

Over excitation conditions are limited to a safe period by a protection circuit within the AVR. Once activated by a sustained over-excitation condition, the generator voltage is reduced to a low level until reset. Stopping the generator or removing power from the AVR will perform the necessary reset.

Connections are provided to interface to the optional Excitation Boost System. This incorporates a small externally mounted rotary power supply which provides excitation power in the event of heavy overloads or short circuits. The EBS is short term rated and responds to signals from the AVR to deliver excitation power when required. A separate overload protection system within the EBS electronic module protects the generator against sustained overloads.

#### Technical specification

##### SENSING and POWER INPUT

Voltage	100-264 V ac 1 phase
Frequency	50-60 Hz nominal

##### OUTPUT

Voltage	82 V d.c. @ 200 Va.c power input.
Voltage	45 V d.c. @ 110 Va.c power input.
Current	continuous 5A (see note 1). transient 7.5A for 10 secs.
Resistance	15 ohms min

##### REGULATION

+/- 1.0% (see note 2)

##### THERMAL DRIFT

0.03% per deg. C change in AVR ambient (see note 3)

##### TYPICAL SYSTEM RESPONSE

AVR response	20ms
Field current to 90%	80 ms
Machine Volts to 97%	300ms

##### EXTERNAL VOLTAGE ADJUSTMENT

+/-10% with 1 k ohm 1 watt trimmer (see note 4)  
Increasing resistance lowers voltage.  
Fixed 15kOhm resistor enables 110V sensing

##### UNDER FREQUENCY PROTECTION

Set point 94 -98% Hz (see note 5)

##### UNIT POWER DISSIPATION

12 watts maximum

##### BUILD UP VOLTAGE

4 Volts @ AVR terminals

##### QUADRATURE DROOP INPUT

10 ohms burden  
Max. sensitivity: 0.07 A for 5% droop 0PF  
Max. input: 0.33 A

##### OVER EXCITATION PROTECTION

Set point	67 Vdc +/-3% (fixed)
Time delay	10-15 seconds (fixed)

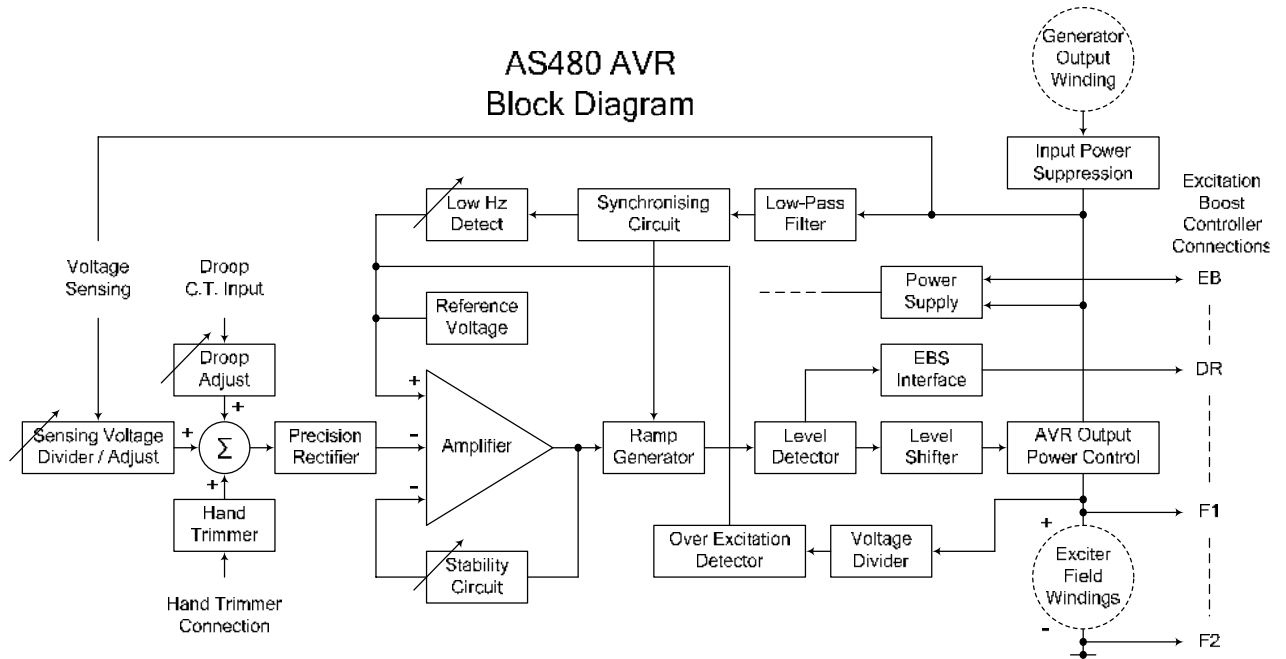
##### ENVIRONMENTAL

Vibration	20-100 Hz	50mm/sec
	100Hz – 2kHz	3.3g
Operating temperature	-40 to +70C (note 6)	
Relative Humidity 0-70C	95% (note 7)	
Storage temperature	-55 to +80C	

##### NOTES

1. De-rate by 20% if mounted external to generator.
2. Inclusive of 4% engine governing.
3. After 2 minutes warm-up.
4. Generator de-rate may apply. Check with factory.
5. Factory set, semi-sealed, jumper selectable.
6. De-rate output current by 5% per deg. C above 60C.
7. Non condensing.

## AS480 AVR Block Diagram



### The AVR Circuit Description

The main functions of the AVR are:

The Sensing Voltage Divider / Adjust takes a proportion of the generator output voltage and attenuates it. The potential divider is adjustable by the AVR Volts potentiometer and external hand trimmer (when fitted). The output from the droop CT is also added to this signal. A Precision Rectifier converts the a.c. input signal into d.c. for further processing.

The Amplifier compares the sensed voltage to the Reference Voltage and amplifies the difference (error) to provide a controlling signal for the power devices. The Ramp Generator and Level Detector and Level Shifter infinitely control the conduction period of the AVR Output Power Control devices. This provides the exciter field windings with the variable power necessary to maintain the generator voltage within specified limits.

The Stability Circuit provides adjustable feedback to ensure good steady state and transient performance of the control system.

The Low Hz Detector measures the period of each electrical cycle and causes the reference voltage to be reduced approximately linearly with speed below a pre-settable threshold. A Light Emitting Diode gives indication that the circuit is activated by the low-speed running condition.

The Synchronising circuit is used to keep the Ramp Generator and Low Hz Detector locked to the generator waveform period. The Low Pass Filter prevents distorted waveforms affecting the operation of the AVR control circuit.

AVR Output Power Control devices vary the amount of exciter field current in response to the error signal produced by the Amplifier.

Input Power Suppression components are included to prevent load generated voltage transients from damaging the AVR components and also to reduce the amount of conducted radio-frequency noise on the generator terminals.

The Over Excitation Detector continuously monitors the exciter field voltage and provides the signal required to collapse the output voltage. This protection circuit triggers only if an over excitation condition persists for a specific amount of time.

The Power Supply provides the required voltages for the AVR circuitry.

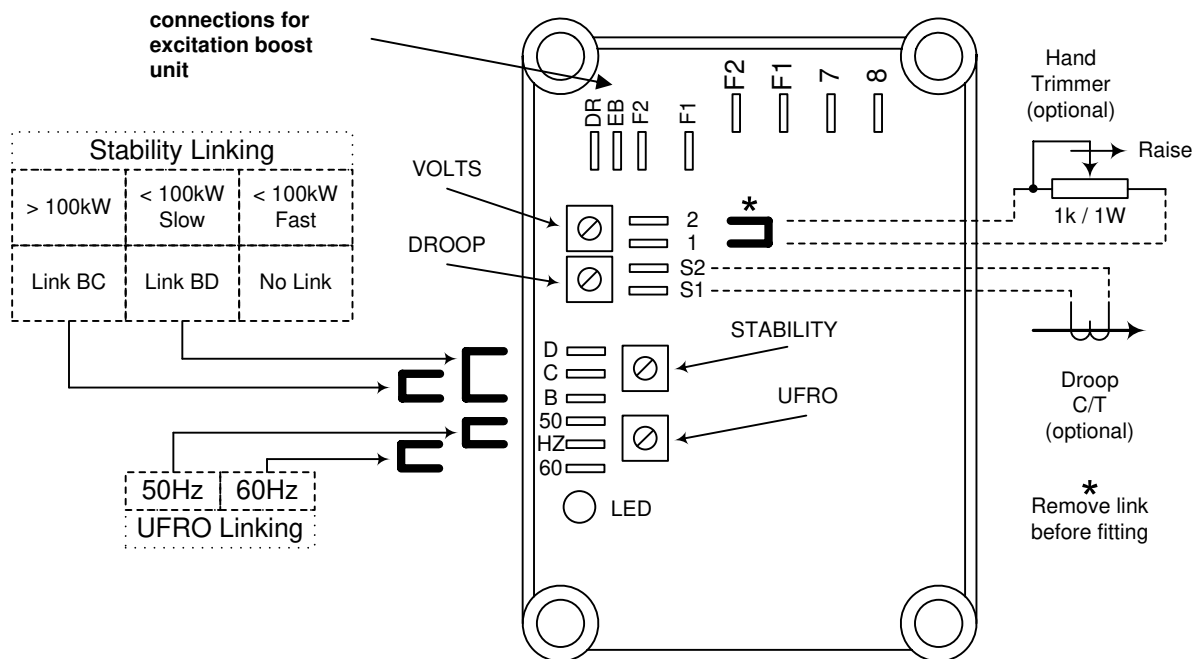
The EBS Interface provides the signals necessary to control the excitation boost generator (EBG). The EBG responds to the level of excitation provided by the AVR and supplies additional power as it is needed to support the overload.

# AS480 AVR – Links and Adjustments

refer to the generator wiring diagram for all connection details

### Operation at 110Vac (optional)

- remove link(\*) before fitting
- connect the 15k/1W sensing link
- the hand trimmer cannot be used in this mode
- Overload performance is limited in this mode.



Control	Function	Direction
VOLTS	Generator output voltage setting	Clockwise raises voltage
STABILITY	Output voltage stability	Clockwise increases stabilisation effect
DROOP	Voltage droop for paralleling	Clockwise increases drooping effect
UFRO	Under-frequency 'Knee' point	Clockwise decreases 'Knee' point

Refer to the Generator Wiring Diagrams for all Connection detail

## ADJUSTMENT OF AVR CONTROLS

### VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory but can be altered by adjustment of the VOLTS control on the AVR board or by the external hand trimmer if fitted. Before adjusting the generator output voltage, note the following warnings.

**WARNING! Do not increase the voltage above the rated generator voltage shown on the rating plate mounted on the generator case.**

**WARNING! Do not ground any of the external hand trimmer terminals. Failure to observe this could cause equipment damage.**

To adjust the generator output voltage, proceed as follows:

1. Before running the generator set, turn the [VOLTS] control fully anti-clockwise. Turn the [STABILITY] control to its midway position and the external hand trimmer (if fitted) to its midway position.
2. Connect a suitable voltmeter (0-300Vac) across Line and Neutral of the generator.
3. Start the generator set, and run on no load at nominal frequency e.g. 50Hz (or 60Hz).
4. If the red Light Emitting Diode (LED) is illuminated, refer to the section on Under-Frequency-Roll-Off adjustment.
5. Carefully turn the [VOLTS] control clockwise until the required voltage is reached.
6. If instability is present at rated voltage, refer to the section on Stability adjustment.
7. Voltage adjustment is now completed.

### STABILITY ADJUSTMENT

The AVR includes an optimised stability circuit to provide good steady state and transient performance of the generator. Links are provided to change the response of the stability circuit to suit different frame size generators and applications. A slow response setting is more appropriate on small generator sets and will prove helpful in reducing lamp flicker.

The correct setting of the Stability adjustment 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 position for the control is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

### UNDER-FREQUENCY-ROLL-OFF ADJUSTMENT: (UFRO)

The AVR incorporates an under-speed protection circuit which produces a volts/Hz characteristic when the generator frequency falls below a preset threshold - known as the "knee" point. The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating in the low frequency region.

The UFRO adjustment is preset and sealed and only requires the selection of 50Hz or 60Hz operation using the jumper link.

For normal operation, the LED should illuminate as the frequency falls just below 95% of nominal. i.e. 47Hz on 50Hz systems or 57Hz on 60Hz systems.

### DROOP ADJUSTMENT

Generators intended for parallel operation should be fitted with a quadrature droop C.T. The C.T. is connected to S1, S2 on the AVR and provides a power factor dependent signal for the AVR voltage sensing circuit. This allows the control of generator reactive current when two or more generators are operated in parallel.

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

### OVER EXCITATION TRIP

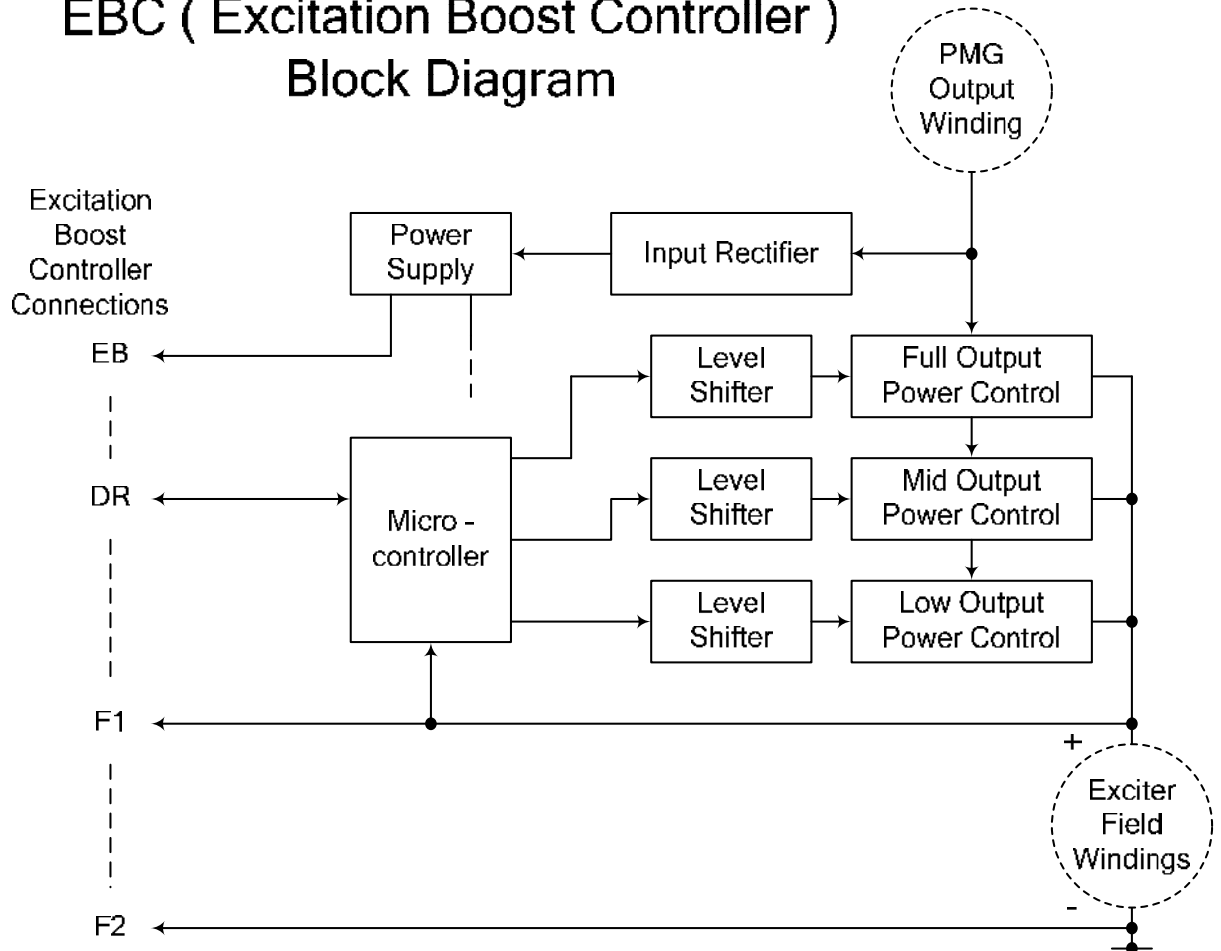
The over-excitation trip level is set at the works at 65Vdc and cannot be altered. An over excitation condition is indicated on the LED (which also indicates under speed running).

The over-excitation is allowed to exist for approximately eight seconds to prevent nuisance tripping and to support normal transients and short-term overloads. The generator voltage falls to low levels when the trip is activated. The generator must be stopped to reset an over-excitation shutdown condition.

### EXCITATION BOOST SYSTEM

There are no user adjustments on the EBS module just connect the unit and it is ready for use.

## EBC ( Excitation Boost Controller ) Block Diagram



### EBS - Circuit description:

The EBS comprises an add-on permanent magnet generator (EBG) with embedded control electronics (the EBC module).

### The main functions of the EBC are as follows:

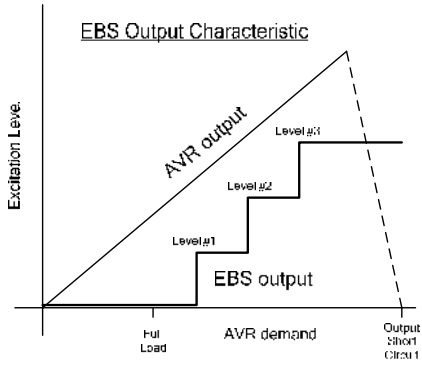
The **Input Rectifier** and Power-Supply provides supplies to the internal control parts of the EBC.

The **Micro-controller** measures the drive signal (DR) generated by the AVR and determines the

need for excitation power support. As this support is required it is delivered at low, medium or high levels to the exciter field. The AVR control function maintains generator voltage within broad limits until both AVR and EBS are fully conducting.

The micro processor contains three timer functions: to prevent activation on generator run up, operation below 30Hz and to disconnect the booster power after a period of boost operation i.e. preventing the generator from overheating. This function is designed to follow the approximate thermal state (temperature) of the machine windings.

The output characteristic of the EBS is as shown below. The high-speed interaction between the EBS output and AVR demand is effectively 'smoothed' by the connected generators excitation component time-constants.



**POWER INPUT**

Voltage 90-130 Vac 3 phase  
 Frequency 100-120 Hz nominal

**OUTPUT**

Voltage 120 Vd.c. @ 100 Va.c power input.  
 Current continuous 6A  
 Resistance 15 ohms min

**TYPICAL SYSTEM RESPONSE**

EBC response 20ms

**INTERNAL TIMERS**

Start-up timer 5sec nominal  
 Overload protection timer 5sec nominal

**UNIT POWER DISSIPATION**

12 watts maximum



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