



Compatible with Leroy Somer voltage regulator.

Specialist in AVR

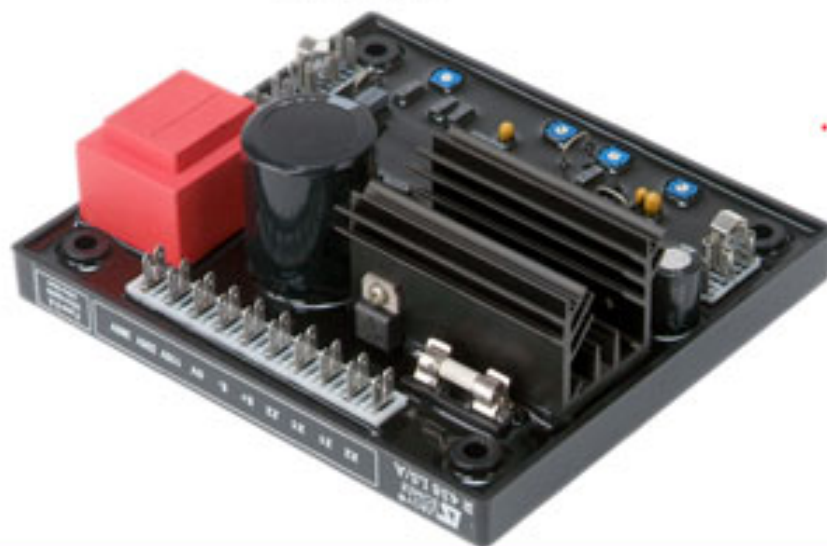
R230



SSAYEC432



R438



R448



R449



# R230 A.V.R.

## 1 - SUPPLY

### 1.1 - SHUNT excitation system

The alternator with Shunt excitation is self-excited with an R 230 voltage regulator.

## 2 - R230 A.V.R.

### 2.1 - Characteristics

- Voltage regulation: around  $\pm 0.5\%$ .
- Voltage supply/sensing range 85 to 139 V (50/60 Hz)
- Rapid response time (500 ms) for a transient voltage variation amplitude of  $\pm 20\%$
- Voltage setting **P1**
- Stability setting **P2**.

## 3 - INSTALLATION - COMMISSIONING

### 3.1 - Electrical checks on the AVR

- Check that all connections have been made properly as shown in the attached wiring diagram.
- Check that the ST3 frequency selection jumper is on the correct frequency setting.
- Check whether the ST4 jumper or the remote adjustment potentiometer have been connected.

### 3.2 - Settings



The machine is tested and set at the factory. When first used with no load, make sure that the drive speed is correct and stable (see the nameplate). After operational testing, replace all access panels or covers.

The only possible adjustments to the machine should be made on the AVR.

#### 3.2.1 - R 230 settings (shunt system)

Initial potentiometer settings

- **P1** potentiometer (AVR voltage adjustment): fully anti-clockwise.
  - Remote voltage adjustment potentiometer: centre position.
- Run the alternator at its rated speed. If the voltage does not increase, the magnetic circuit should be remagnetized (see section 2.3).
- Turn the AVR voltage adjustment potentiometer **P1** slowly until the output voltage rated value is obtained.
  - Adjust the stability setting using **P2**.
  - Sealed potentiometer **P3** is factory set at 48 Hz for 50 Hz and 58 Hz for 60 Hz

#### 3.2.2 - Special type of use

**WARNING**

Excitation circuit E+, E- must not be left open when the machine is running : AVR damage will occur.

The regulator monitors the exciter excitation current as a function of the alternator output voltage. Very simple in design, the alternator with shunt excitation has no sustaining short-circuit capacity.

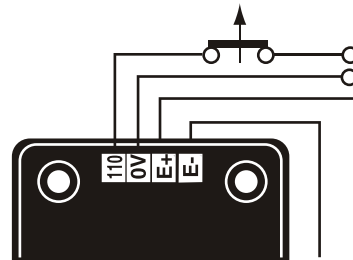
- Power supply protected by 8 A fuse, slow-blow action (tolerates 10 A for 10 s)
- Frequency: 50 Hz with **ST3** jumper - 60 Hz without **ST3** jumper
- Factory-set underspeed protection **P3**.

### 2.2 - R230 AVR option

Potentiometer for remote voltage adjustment, 1000  $\Omega$  / 0.5 W min: adjustment range  $\pm 5\%$ .

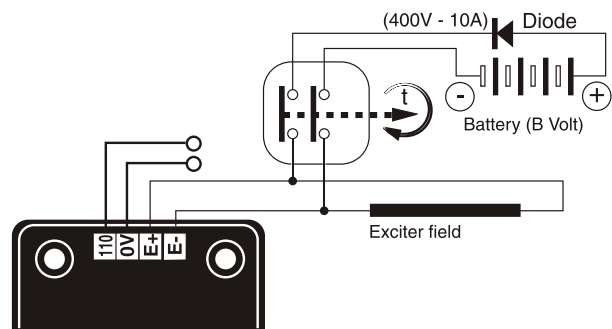
- Remove the **ST4** jumper.

#### 3.2.2.1 - R230 field weakening (SHUNT)



The exciter is switched off by disconnecting the AVR power supply (1 wire - 0 or 110V).  
Contact rating : 16A - 250V alt.

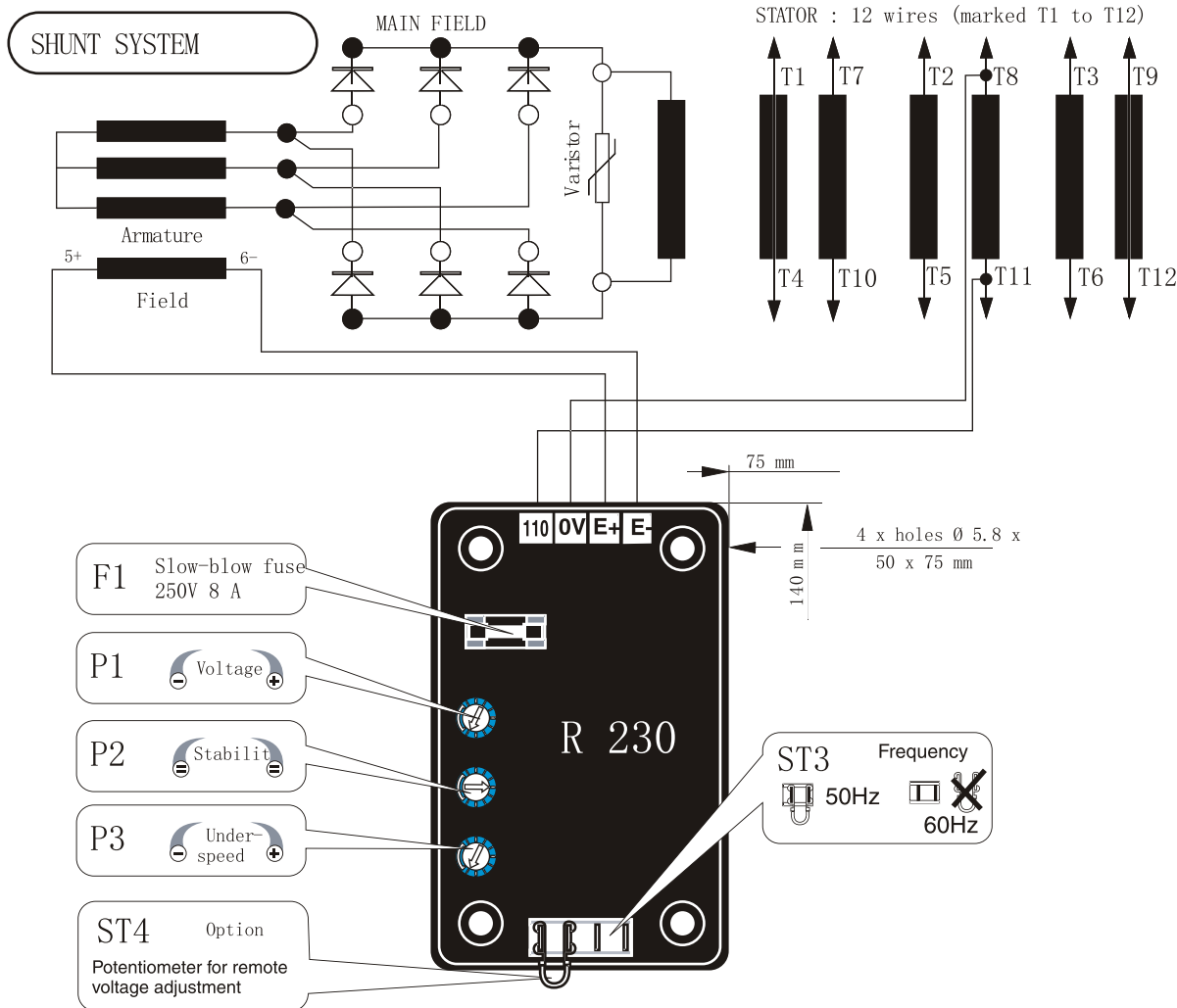
#### 3.2.2.2 - R230 field forcing



Battery must be isolated from the earth.



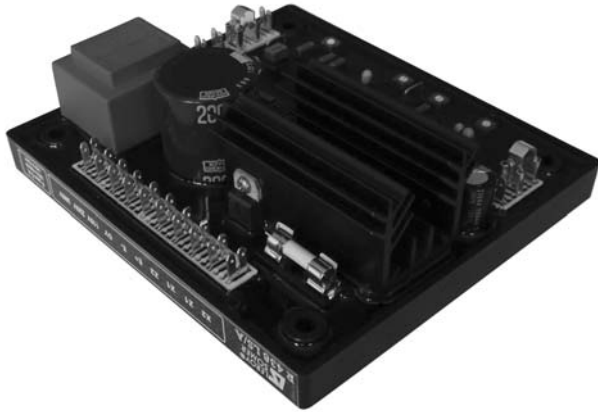
Exciter field may be at line potential.



### 3.3 - Electrical faults

Fault	Action	Effect	Check/Cause
No voltage at no load on start-up	Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity, for 2 to 3 seconds	The alternator builds up and its voltage is still correct when the battery is removed.	- Lack of residual magnetism
		The alternator builds up but its voltage does not reach the rated value when the battery is removed.	- Check the connection of the voltage reference to the AVR - Faulty diodes - Armature short-circuit
		The alternator builds up but its voltage disappears when the battery is removed	- Faulty AVR - Field windings disconnected - Main field winding open circuit - check the resistance
Voltage too low	Check the drive speed	Correct speed	Check the AVR connections (AVR may be faulty) - Field windings short-circuited - Rotating diodes burnt out - Main field winding short-circuited - Check the resistance
		Speed too low	Increase the drive speed (Do not touch the AVR voltage pot. (P2) before running at the correct speed.)
Voltage too high	Adjust AVR voltage potentiometer	Adjustment ineffective	Faulty AVR
Voltage oscillations	Adjust AVR stability potentiometer	If no effect : try normal / fast recovery modes (ST2)	- Check the speed : possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or U/F bend set too high)
Voltage correct at no load and too low when on load (*)	Run at no load and check the voltage between E+ and E- on the AVR		- Check the speed (or U/F bend set too high)
			- Faulty rotating diodes - Short-circuit in the main field. Check the resistance - Faulty exciter armature.
<b>(*) Caution :</b> For single-phase operation, check that the sensing wires coming from the AVR are correctly connected to the operating terminals			
Voltage disappears during operation	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components	The voltage does not return to the rated value.	- Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Main field open circuit or short-circuited

# AUTOMATIC VOLTAGE REGULATOR - R438



The circuitry of the R438 Automatic Voltage Regulator (AVR) provides closed loop control of the generator output voltage by regulating the exciter field current. The R438 can be powered by AREP or PMG field excitation system and is fitted as an option on:

- 1000 Series Generators\*
- 2000 Series Generators
- 3000 Series Generators

With the AREP excitation system the R438 AVR is powered by two auxilliary windings which are independent of the voltage detection circuit. With the PMG option the R438 AVR is powered by the PMG which is fitted at the rear end of the generator.

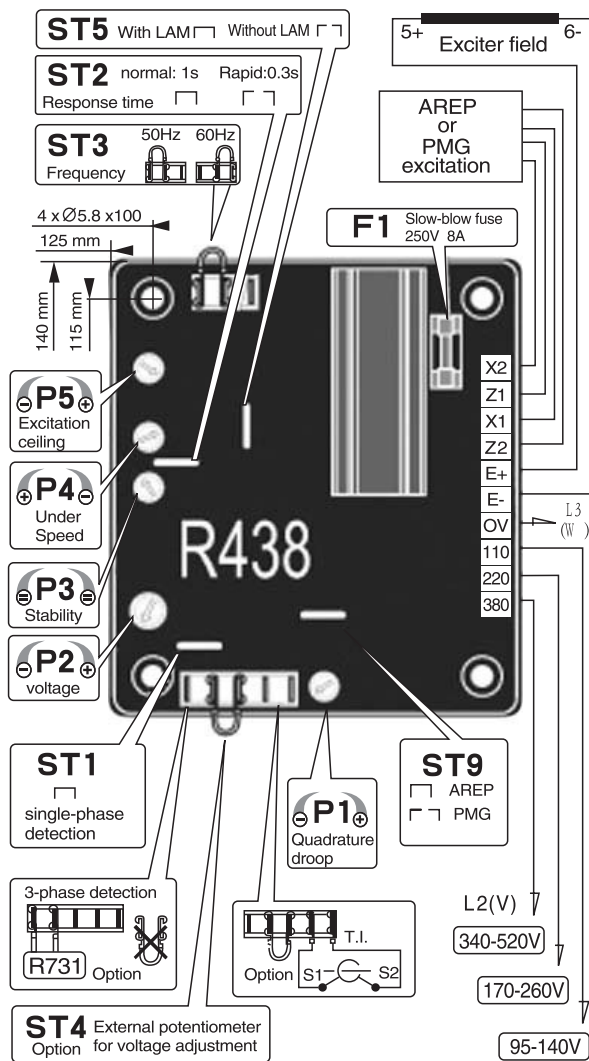
## SPECIFICATION:

- Voltage regulation  $\pm 0.5\%$
- Short circuit capability: 3 x Irated for 10 seconds (AREP or PMG excitation)
- Voltage sensing:  
95 to 140 volts (50/60 Hz) or  
170 to 260 volts (50/60 Hz) or  
340 to 520 volts (50/60 Hz)
- Response time:  
Normal (1 sec) for  $\pm 20\%$  voltage variation  
or Rapid (0.3 sec) for  $\pm 20\%$  voltage variation
- Remote voltage adjustment range of:  $\pm 5\%$

## LOAD ADJUSTMENT MODULE (LAM):

On load impact, the rotation speed of the generator set decreases. When it passes below the preset frequency threshold, the LAM causes the voltage to drop by approximately 15% and consequently the amount of active load applied is reduced by approximately 25% until the speed reaches it's rated value again.

\*1000 Series alternators do not have PMG option



**ADJUSTMENT CAPABILITY:**

The R438 AVR features the following adjustment capabilities (please note that no adjustments should be made prior to careful consultation of the generator installation and maintenance manual):

- Quadrature droop adjustment
- Generator output voltage adjustment
- Stability adjustment
- LAM threshold (underspeed) adjustment
- Excitation ceiling adjustment



# R448 AUTOMATIC VOLTAGE REGULATOR (AVR)

## SPECIFICATION, INSTALLATION AND ADJUSTMENTS

### SPECIFICATIONS

Normal AVR supply power: 2 auxiliary windings (X1, X2, and Z, Z2)

Shunt supply : 150V - 50/60Hz

Rated overload current: 10A, 10s.

Electronic built-in (overload, short circuit, and loss of sensing) protection: If excitation current raises over 10 Amps for more than 10 seconds, excitation current will drop automatically to about 1A.

To reset AVR protection, generator must be stopped (or by cutting supply voltage to the AVR).

Protection of power inputs by fuses F1

Voltage sensing: 5VA insulated transformer with input voltage taps at:

Terminals 0-110V = 95 to 140V

Terminals 0-220 V = 170 to 260 V

Terminals 0-380 V = 340 to 520V

Output Voltage adjustment by using pot P2

Other sensing voltages by using an adapting other transformers

Current sensing (parallel operation) CT 2.5 VA class 1 secondary current xxx/1 (optional).

Adjustment of quadrature droop with pot P1

Under-speed (U/F) and LAM protection: for knee frequency adjustable use P4.

Excitation over current adjustment use P5: 4.5 to 10A

For 50/60 Hz (U/F) selection use jumper ST3.

### Load acceptance module

LAM is suppressed by cutting wire marked ST5

#### LAM (Load Acceptance Module) function.

When applying a step load to the generator, the rotational speed (frequency) of the genset drops. If the speed is below the preset frequency, the "LAM" circuits drops the voltage about 15% and this way reducing the effective step to about 25%, as long as the speed has not recovered to normal values.

**The "LAM" is used either to reduce the speed drop of the engine, during the step load, or to increase the applicable step load for the same speed variation (turbo charged engines) so the engine can recover normal speed quickly.**

To prevent voltage oscillations, the frequency threshold must be adjusted about 2 Hz below the lowest frequency in normal operation.

### Optional items for use with the AVR

CT for parallel operation with other generators

Remote voltage adjusting potentiometer 470 ohm .3W (\*) giving an adjustment range of +/- 5% (centering of the range by using internal P2 potentiometer). Remove wire ST4 to connect external potentiometer.

Three phase sensing available by using additional modulo Model R 730:200 to 500V. Cut ST1 to connect this module.

Generator output voltage is adjusted by using the voltage adjustment potentiometer on the AVR

Power factor regulator (2nd function) and voltage equalization before paralleling with the mains (3rd function)

CT xxx/1 A. 5VA CL1

Module R 724: 2 functions.

Module R 725 A: 3 functions.

EMI suppression

(\*)Note: For a wider voltage adjustment range and 1 k ohm/3W pot may be used.

The R 730 module is not compatible with paralleling.

### Special applications

Field de-energizing

Cutting excitation current is accomplished by switching off the supply power to AVR (1 lead on each auxiliary winding)

Contacts capacity: 10A. 250V AC

This is the same connection used to reset internal protection of AVR.

### Static test AVR

\* Testing the A.V.R. by using a static test does not necessarily mean it can operate properly.

\* But inversely, if the A.V.R. does not test properly during static tests, it is obviously defective

Setup the test (see drawing).

Supply voltage must be 100 to 140V and the light bulb must be rated for 220v use you can also use 2 x 110v bulbs in series.

Total lamp load must not exceed 100 Watt

1) - Adjust AVR voltage by moving screw P2 to

maximum CCW position

2) - Apply power to the AVR the lamp should flash momentarily and turn off.

3) - Slowly rotate the AVR voltage screw clockwise:

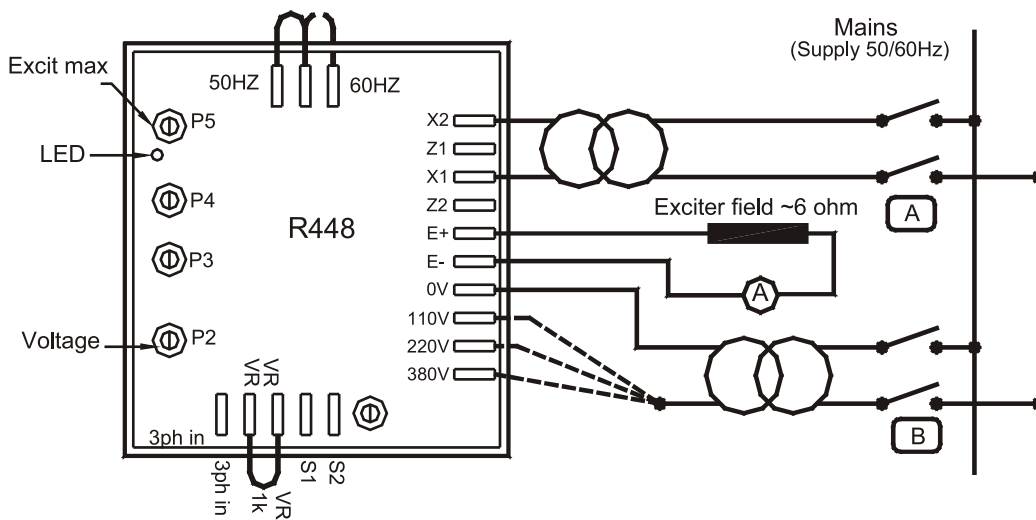
The bulb will slowly light up and reach full brilliance before P2 is moved completely clockwise, at the regulating point a small movement back and forth with P2 will turn the bulb on and off. If the lamp remains constantly on/off the AVR is defective.

Repeat the test supplying AVR power through terminals XI, X2, and then test again by supplying power through terminals Z1, Z2.

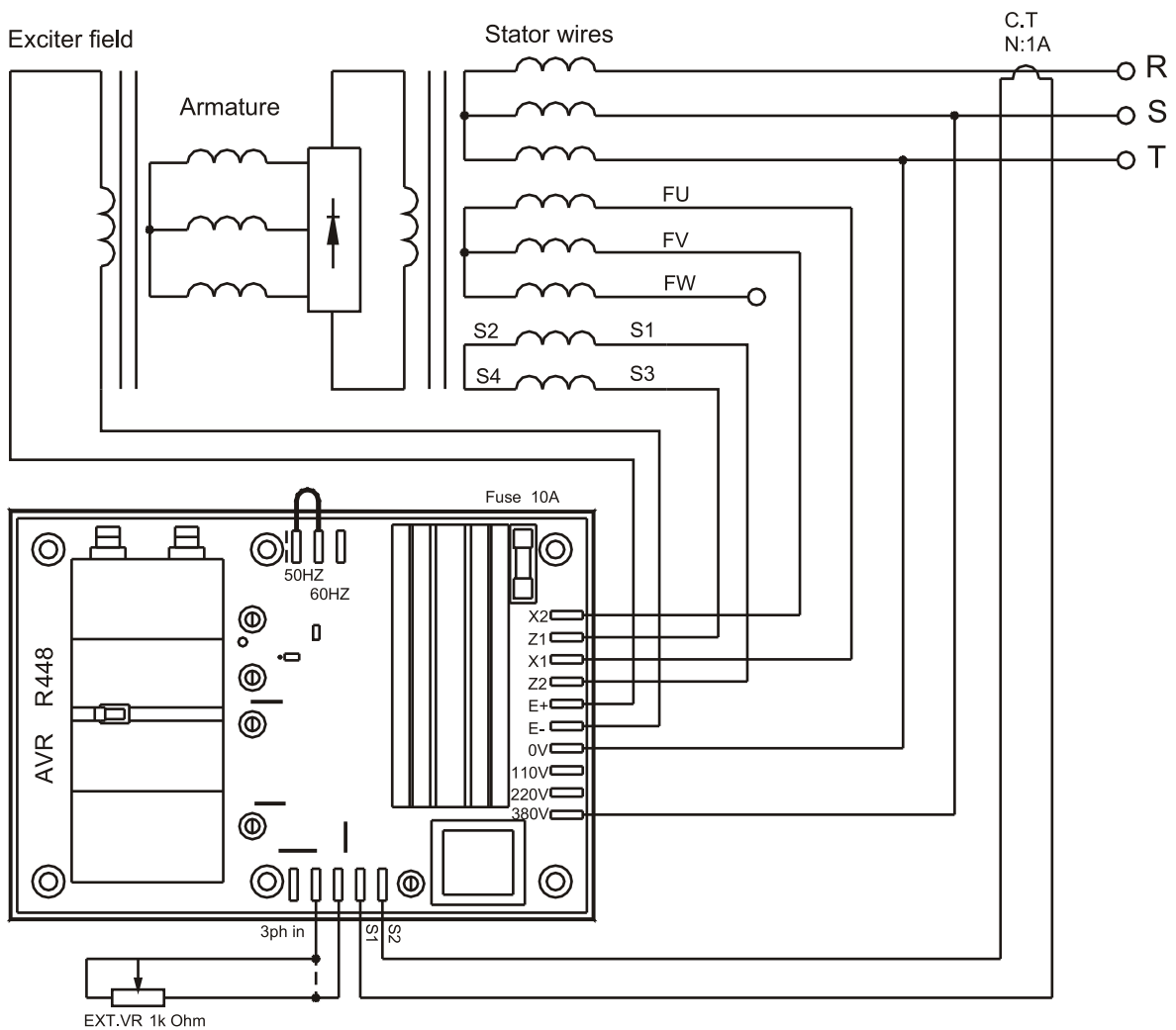
### Static test LAM

#### (under-speed protection)

Voltage adjustment Pot P2 should be set in its normal position just when the lamp just begins to glow. Turn P4 slowly CCW the brightness should decrease suddenly the voltage at AVR's output terminals E+, E- must fall about 15%. Then resetting P4 to initial position : the lamp should glow normally as before



### Adjustment of maximum excitation current



## Adjustment procedure

a) Initial setting of potentiometers

- P2 VOLTAGE: lowest fully CCW.
- P3 STABILITY: middle position.
- PI QUADRATURE VOLTAGE DROP : fully CCW
- P5 EXCITATION CURRENT LIMIT: to be adjusted only if necessary maximum fully CW.
- Remote voltage trimmer Rhe - 470 OHM (jumper ST4 removed): middle position.

b) Connect one analog (needle type) voltmeter cal. 50V D.C. across E+, E-terminals and another (300V-500V or 1000V) A.C. across the alternator output terminals.

c) Make sure that the 50/60 Hz link is correctly connected

d) (P2) potentiometer must be set maximum anti-clockwise

e) (P4) (V/Hz) must be set maximum clockwise

f) (P3) (Stability) has to be adjusted maximum clockwise -1/3.

g) Start and adjust the engine speed corresponding to 48Hz for 50 Hz (nominal) or 58 for 60 Hz.

h) Adjust output voltage with (P2) to the required value

- rated voltage UN if generator operates alone

(for example 400V)

-or UN+2 to 4% for parallel operation with CT

(i.e. 410V - see below)

If voltage is unstable, adjust (P3) (try in both directions), noting voltage across E+, E- (approx.10V dc) The fastest recovery time may be achieved when (P3) is set close to the limit of instability. If there is no stable position try adjustment again after having cut or reconnecting link ST2 (normal / fast).

i) Turn (P4) anticlockwise until the voltage drops about 15%

j) Modify engine speed around 48 or 58 Hz in order to check the LAM voltage drop (~ 15%).

k) Readjust speed of genset to its normal no-load level

## ADJUSTMENTS IN PARALLEL OPERATION

Note: Preliminary to any adjustment on the AVR, make sure that engine speeds are similar.

l) Presetting for parallel operation (with CT connected to terminals S1 ,S2 of terminal strip J2)

- Potentiometer P1 (Voltage droop) in middle position. Switch on the rated load (P.F. 0.8 inductive). The output voltage should drop 2% to 3%. If voltage rises, reverse the 2 leads from the CT.

m) No load voltages must be identical on all gensets working together and in parallel.

- Synchronize and parallel the gensets together.

- By adjusting engine speed, reduce power exchange, to 0 KW

- By adjusting voltage pot (P2 or Rhe) on one of the machines try to cancel (or minimize) circulating currents.

- Do not change voltage adjustments.

n) Switch on the load (adjustments cannot be made if there is no reactive load).

- By adjusting speed, balance the KW (proportionally to the rated powers of each genset).

- By adjusting voltage droop with pot. P1, balance the output currents.

## Adjustment of maximum excitation current (Excitation ceiling)

- Static adjustment of excitation current limitation, potentiometer P5 (factory adjustment: 10 A, fuse caliber: 10A-10seconds).

The factory adjustment corresponds to the excitation current for a sustained 3 phase short circuit, of about 3 times the rated current, unless otherwise specified(\*)

It is possible to reduce the maximum excitation level by a static method which is safer for the alternators and the network.

Disconnect the supply leads (XI X2, Z1, Z2) and sensing leads (0-110-220-380) on the AVR. Connect the supply as shown (XI, X2, 0,110V). Connect an ammeter (10A, dc) in series with the exciter field. Turn P5 fully CCW. Switch on the supply. If there is no output current from AVR, turn P2 (voltage) clockwise until ammeter indicates a stabilized current.

Switch the supply off, then on again. Turn P5 clockwise until the required current is obtained in the exciter field, (limit to 10A)

Checking internal protection:

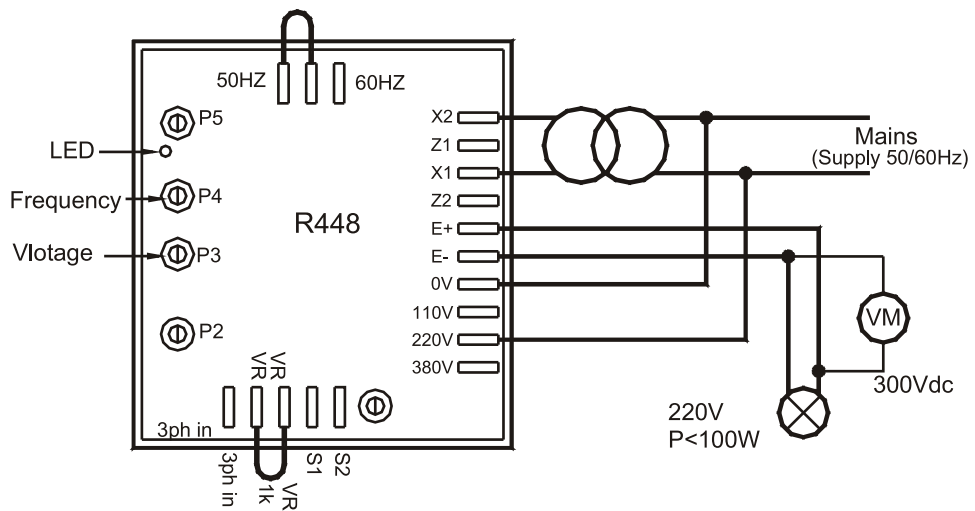
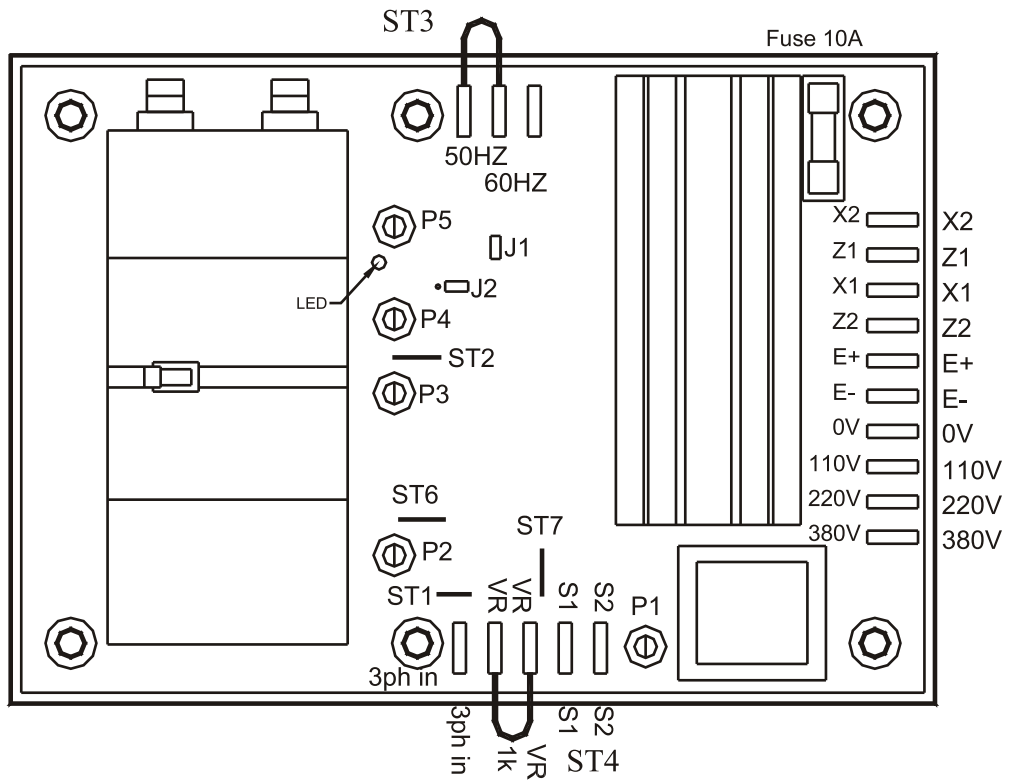
Switch off (B): the excitation current must rise to the pre-set high level, and remain at this level for a period of more than 10 seconds, than fall to less than 1A.

To reset, switch off the supply by opening switch (A).

Note: After having adjusted the excitation current limitation

(\*): In many countries short-circuit current equal to 3 times IN is obligatory in order to allow selective tripping of circuit breakers.





**Static test AVR**

# R449 AUTOMATIC VOLTAGE REGULATOR (AVR)

## SPECIFICATION, INSTALLATION AND ADJUSTMENTS

### SPECIFICATIONS

Normal AVR supply power: 2 auxiliary windings (X1, X2, and Z, Z2)

Shunt supply : 150V - 50/60Hz

Rated overload current: 15A, 10s.

Electronic built-in (overload, short circuit, and loss of sensing) protection: If excitation current raises over 10 Amps for more than 10 seconds, excitation current will drop automatically to about 1A.

To reset AVR protection, generator must be stopped (or by cutting supply voltage to the AVR).

Protection of power inputs by fuses F1

Voltage sensing: 5VA insulated transformer with input voltage taps at:

Terminals 0-110V = 95 to 140V

Terminals 0-220 V = 170 to 260 V

Terminals 0-380 V = 340 to 520V

Output Voltage adjustment by using pot P2

Other sensing voltages by using an adapting other transformers

Current sensing (parallel operation) CT 2.5 VA class 1 secondary current xxx/1 (optional).

Adjustment of quadrature droop with pot P1

Under-speed (U/F) and LAM protection: for knee frequency adjustable use P4.

Excitation over current adjustment use P5: 4.5 to 15A

For 50/60 Hz (U/F) selection use jumper ST3.

### Load acceptance module

LAM is suppressed by cutting wire marked ST5

#### LAM (Load Acceptance Module) function.

When applying a step load to the generator, the rotational speed (frequency) of the genset drops. If the speed is below the preset frequency, the "LAM" circuits drops the voltage about 15% and this way reducing the effective step to about 25%, as long as the speed has not recovered to normal values.

**The "LAM" is used either to reduce the speed drop of the engine, during the step load, or to increase the applicable step load for the same speed variation (turbo charged engines) so the engine can recover normal speed quickly.**

To prevent voltage oscillations, the frequency threshold must be adjusted about 2 Hz below the lowest frequency in normal operation.

### Optional items for use with the AVR

CT for parallel operation with other generators

Remote voltage adjusting potentiometer 470 ohm .3W (\*) giving an adjustment range of +/- 5% (centering of the range by using internal P2 potentiometer). Remove wire ST4 to connect external potentiometer.

Three phase sensing available by using additional modulo Model R 730:200 to 500V. Cut ST1 to connect this module.

Generator output voltage is adjusted by using the voltage adjustment potentiometer on the AVR

Power factor regulator (2nd function) and voltage equalization before paralleling with the mains (3rd function)

CT xxx/1 A. 5VA CL1

Module R 724: 2 functions.

Module R 725 A: 3 functions.

EMI suppression

(\*)Note: For a wider voltage adjustment range and 1 k ohm/3W pot may be used.

The R 730 module is not compatible with paralleling.

### Special applications

Field de-energizing

Cutting excitation current is accomplished by switching off the supply power to AVR (1 lead on each auxiliary winding)

Contacts capacity: 15A. 250V AC

This is the same connection used to reset internal protection of AVR.

### Static test AVR

\* Testing the A.V.R. by using a static test does not necessarily mean it can operate properly.

\* But inversely, if the A.V.R. does not test properly during static tests, it is obviously defective

Setup the test (see drawing).

Supply voltage must be 100 to 140V and the light bulb must be rated for 220v use you can also use 2 x 110v bulbs in series.

Total lamp load must not exceed 100 Watt

1) - Adjust AVR voltage by moving screw P2 to maximum CCW position

2) - Apply power to the AVR the lamp should flash momentarily and turn off.

3) - Slowly rotate the AVR voltage screw clockwise:

The bulb will slowly light up and reach full brilliance before P2 is moved completely clockwise, at the regulating point a small movement back and forth with P2 will turn the bulb on and off. If the lamp remains constantly on/off the AVR is defective.

Repeat the test supplying AVR power through terminals XI, X2, and then test again by supplying power through terminals Z1, Z2.

### Static test LAM

#### (under-speed protection)

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b) Connect one analog (needle type) voltmeter cal. 50V D.C. across E+, E-terminals and another (300V-500V or 1000V) A.C. across the alternator output terminals.

c) Make sure that the 50/60 Hz link is correctly connected

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g) Start and adjust the engine speed corresponding to 48Hz for 50 Hz (nominal) or 58 for 60 Hz.

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- rated voltage UN if generator operates alone

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-or UN+2 to 4% for parallel operation with CT

(i.e. 410V - see below)

If voltage is unstable, adjust (P3) (try in both directions), noting voltage across E+, E- (approx.10V dc) The fastest recovery time may be achieved when (P3) is set close to the limit of instability. If there is no stable position try adjustment again after having cut or reconnecting link ST2 (normal / fast).

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- By adjusting engine speed, reduce power exchange, to 0 KW

- By adjusting voltage pot (P2 or Rhe) on one of the machines try to cancel (or minimize) circulating currents.

- Do not change voltage adjustments.

n) Switch on the load (adjustments cannot be made if there is no reactive load).

- By adjusting speed, balance the KW (proportionally to the rated powers of each genset).

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## Adjustment of maximum excitation current (Excitation ceiling)

- Static adjustment of excitation current limitation, potentiometer P5 (factory adjustment: 15 A, fuse caliber: 15A-10seconds).

The factory adjustment corresponds to the excitation current for a sustained 3 phase short circuit, of about 3 times the rated current, unless otherwise specified(\*)

It is possible to reduce the maximum excitation level by a static method which is safer for the alternators and the network.

Disconnect the supply leads (XI X2, Z1, Z2) and sensing leads (0-110-220-380) on the AVR. Connect the supply as shown (XI, X2, 0,110V). Connect an ammeter (15A, dc) in series with the exciter field. Turn P5 fully CCW. Switch on the supply. If there is no output current from AVR, turn P2 (voltage) clockwise until ammeter indicates a stabilized current.

Switch the supply off, then on again. Turn P5 clockwise until the required current is obtained in the exciter field, (limit to 15A)

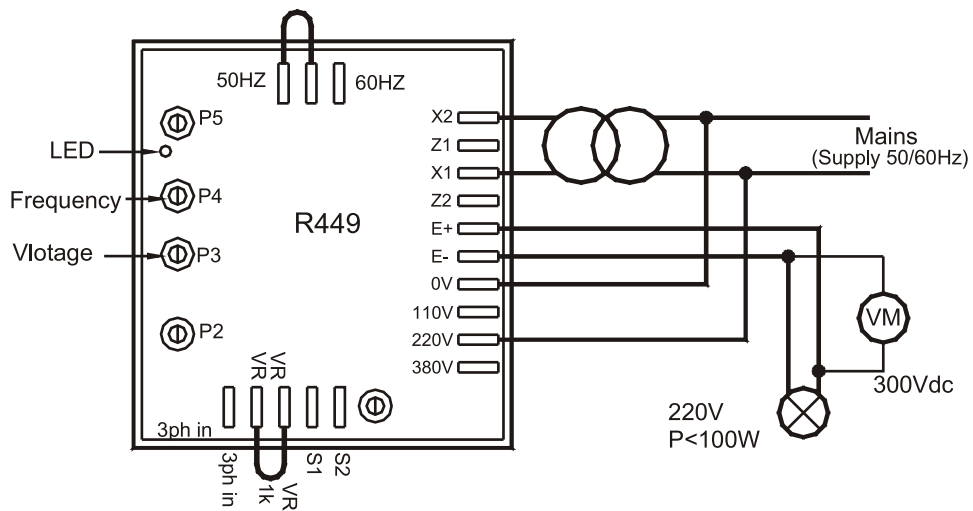
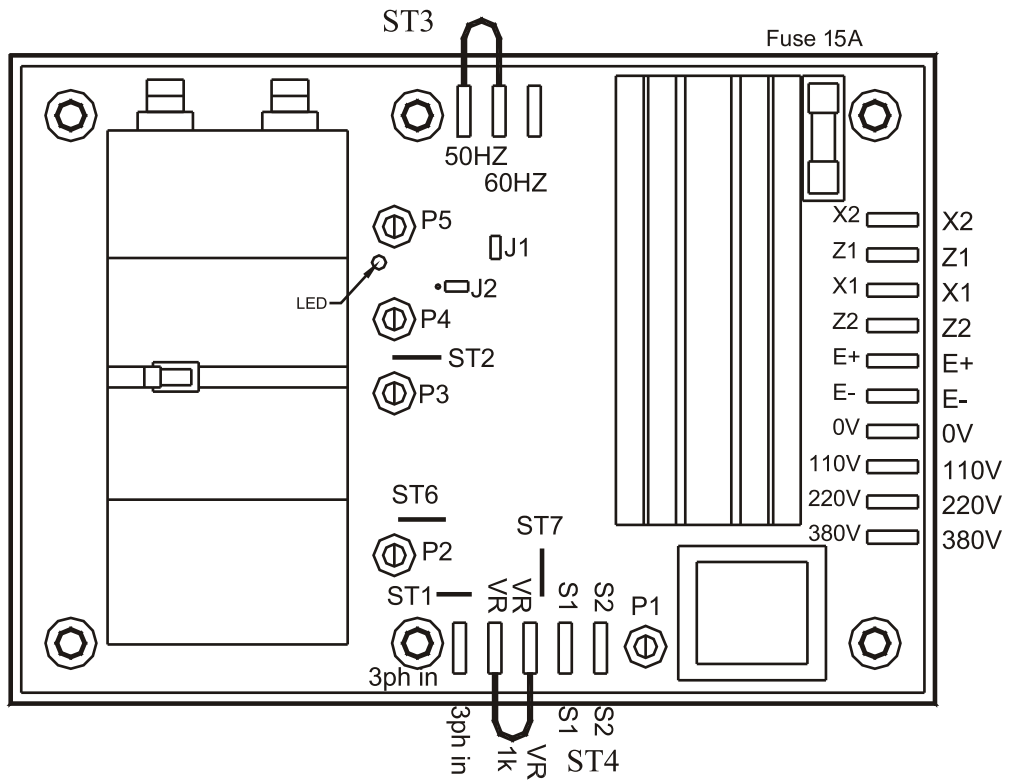
Checking internal protection:

Switch off (B): the excitation current must rise to the pre-set high level, and remain at this level for a period of more than 10 seconds, than fall to less than 1A.

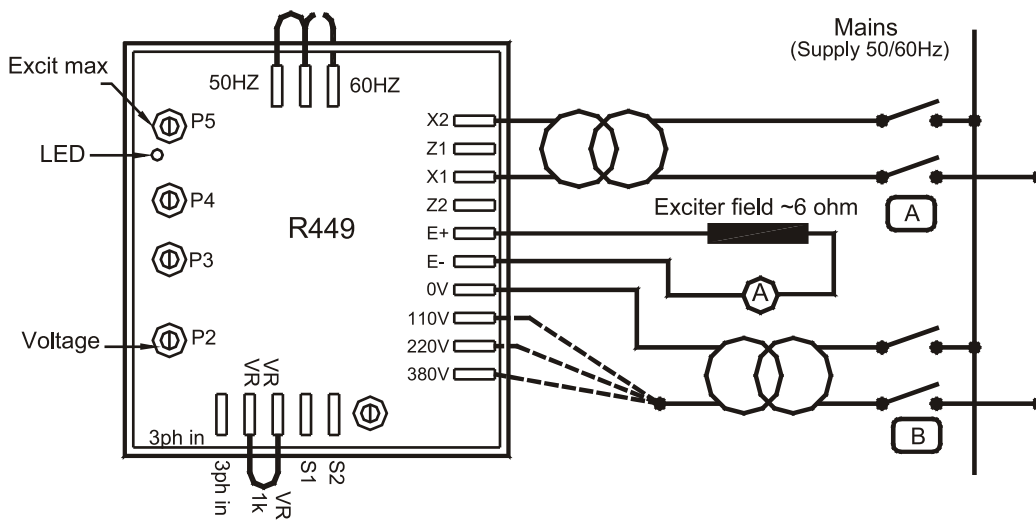
To reset, switch off the supply by opening switch (A).

Note: After having adjusted the excitation current limitation

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**Static test AVR**



### Adjustment of maximum excitation current

