THE POWER OF SYNERGY

CAT AVR

Voltage regulator for generators

Instruction Manual V2.3.1

Product version V2.3

EMRI ELECTRONICS POWER IN CONTROL

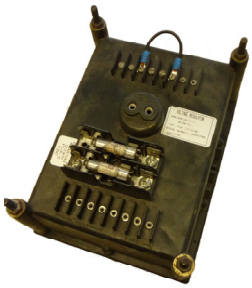
MANAGEMENTSYSTEEM CERTIFICATIE DNV·GL ISO 9001 = VCA*

EXPERTS IN ROTATING ENERGY

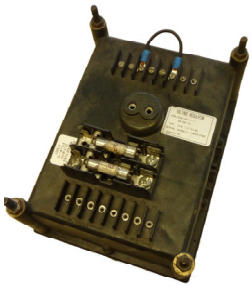
CAT AVR V2.3

One AVR replaces
All VR3 types

200-240V PM



400-480V PM

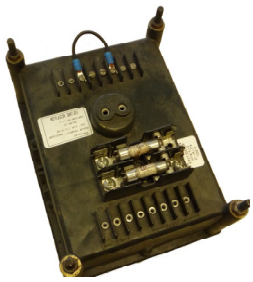


200-240V SE

CATAVR 2.3 replaces all VR3 avr's.
Easy to configurate (dipswitches)
Identical adjustments as VR3.
Identical connections.
Similar operation.
PMG and SE compatible.
Similar input terminals for PF controller.
Replacement of VR6, CDVR or DVR is possible.
Droop CT circuit may be subject for modification.

Series Boost

Universal Series Boost Unit
In Caterpillar shape



WWW.EMRI.NL
INFO@EMRI.NL

Warnings

WARNING

The system should not be installed, operated, serviced or modified except by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

.

WARNING

Never work on a LIVE generator. Unless there is another person present who can switch of the power supply or stop the engine

WARNING

Dangerous voltages are present at the voltage regulator board. Accidental contact with live conductors could result in serious electrical shock or electrocution.
Disconnect the power source before making repairs, connecting test instruments, or removing or making connections to the voltage regulator or generator.

WARNING

Due to liability reasons, EMRI products may not be used, applied or commissioned in equipment residing under law of the United States of America or Canada. Neither may EMRI products be applied or commissioned by any person residing under law of the United States of America or Canada.

ELECTRICAL HAZARDOUS VOLTAGES DANGEROUS DO NOT OPERATE WHEN NOT FAMILIAR WITH GENERATORS

The manual does not cover all technical details of the product. Specifications may be modified by the manufacturer without notice. For further information, the manufacturer should be contacted.

Introduction

This manual contains instructions for installing, operating and maintaining the EMRI CAT automatic voltage regulator (AVR).

The CAT AVR replaces the following AVR's:

- 240VSE-6130
- 240VPM-3820
- 480VPM-3819
- VR6

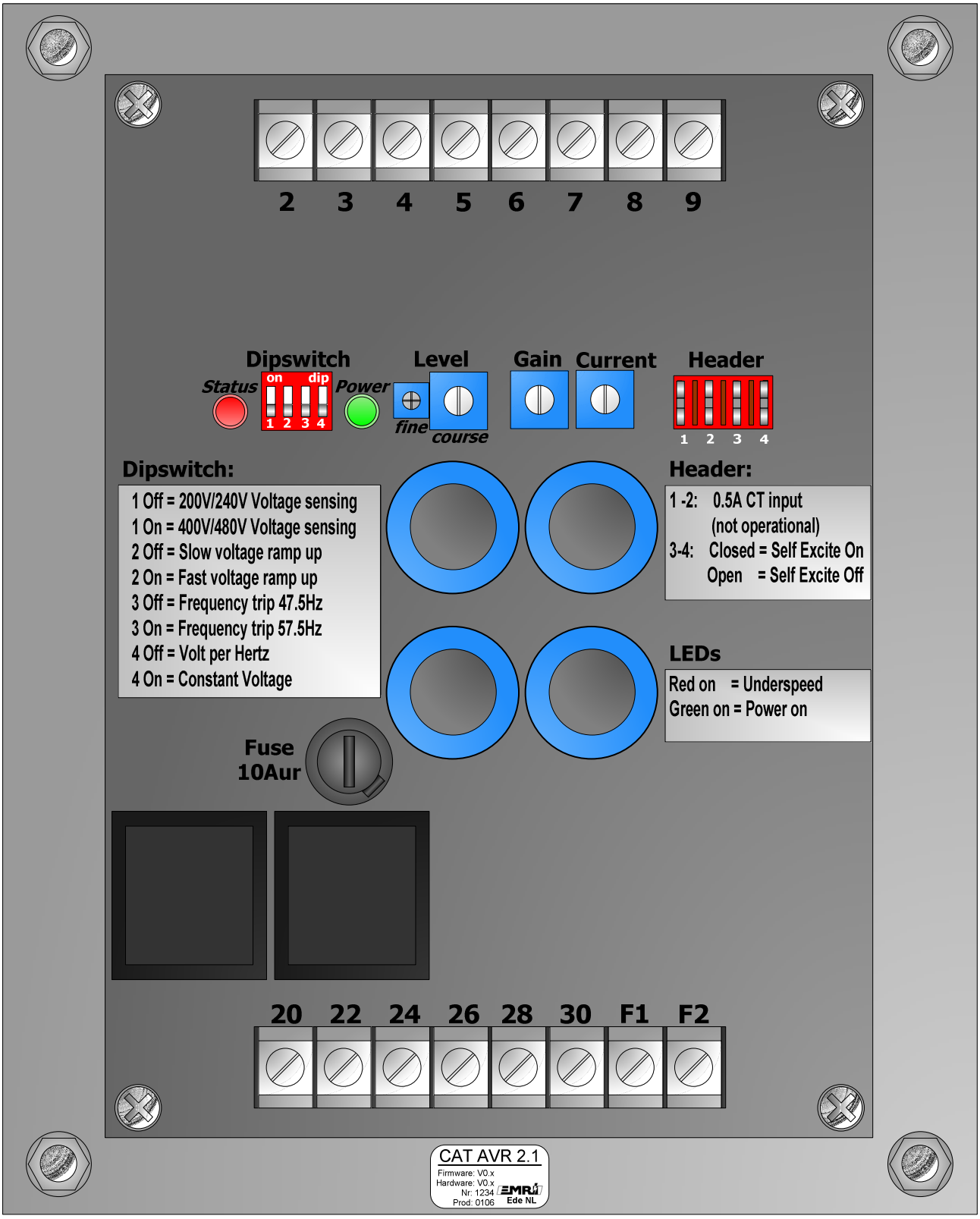
It is not possible to use an original booster kit in combination with an EMRI CAT AVR. Contact EMRI for further information and solutions.

Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U_U, U_V, U_W	Voltage sensing input	< 30 s.	-	500	V_{AC}
I_{F1+}, I_{F2-}	AVR field current			10	A_{DC}
U_{28} U_{29} U_{30}	Supply input	2 phases connected 3 phases connected	20 20	270 240	V V
R_{field}	Field resistance	@ 150 V_{uh} (rms) @ 230 V_{uh}, (rms)	4 7	- -	Ω Ω
T_{AMB}	Operating ambient temperature	non condensing	0	+70	ºC
T_{STG}	Storage temperature	non condensing	-20	+105	ºC
FUSE	Fuse rating	Ultra rapid		10	A

AVR Layout

The AVR is protected from environmental influences by a PUR coating. A prefabricated link is provided for header terminals 3-4.



Commissioning information

The system should not be installed, operated, serviced or modified except by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions.

Defects in the generator or AVR may cause consequential loss. Precautions must be taken to prevent this from occurring.

Never work on a LIVE generator. Unless there is another person present who can switch of the power supply or stop the prime mover.

Dangerous voltages are present at the voltage regulator board. Accidental contact with live conductors could result in serious electrical shock or electrocution.
Disconnect the power source before making repairs, connecting test instruments, or removing or making connections to the voltage regulator.

The unit should be installed with respect to the environmental specifications as well as the rules mentioned in the General installation information.
For safety reasons the voltage LEVEL potentiometers and the GAIN potentiometer are best turned completely counter clockwise in order to start at the lowest possible voltage.

As a reference the chart below shows generator voltages for different configurations.

Settings / Frequency	Volt per hertz control		Constant voltage control	
	400/480V sensing	200/240V sensing	400/480V sensing	200/240V sensing
50 Hz	400V	200V	400V	200V
60 Hz	480V	240V	400V	200V

The stated voltages can be adjusted by approximately +/-15% with the voltage LEVEL potentiometers.

All information drawn up in this manual is valid under the condition that the stator rotary field is clockwise; U→V→W.

Application hints

In case of poor exciter stator insulation a supply isolation transformer is recommended. Refer to the application diagrams for the required parts and connection diagrams.

In case the voltage of a SE generator remains somewhat unstable at no load conditions it is possible to improve control by decreasing the AVR supply voltage. This is achieved by supplying the AVR from generators tap T0-T8 instead of 20-22. Refer to the application diagrams for the connection diagram.

AVR dipswitch settings

The AVR is equipped with four dipswitches which provide a means of setting different operation specific parameters. These dipswitch settings may not be changed during operation but must be set beforehand. Changes to the settings may only be made when the generator is stopped and the green power led is off.

Sensing voltage: dipswitch 1

The AVR is able to control 400/480V or 200/240V at terminals 20, 22, 24. The correct sensing voltage selection is made with dipswitch 1.
If dipswitch 1 is ON, the AVR is set to 400/480V sensing.
If dipswitch 1 is OFF, the AVR is set to 200/240V sensing.

Carefully determine the correct way of connecting the sensing leads to the AVR by looking up the corresponding application diagram. Incorrect installation could lead to hazardous situations and damage to generator and AVR.

Ramp up speed: dipswitch 2

The AVR can be set to slow or fast voltage ramp up, selectable with dipswitch 2.
If dipswitch 2 is ON, fast voltage ramp up is selected. The generator voltage is ramped to the nominal generator voltage in 5s.
If dipswitch 2 is OFF, slow voltage ramp up is selected. The generator voltage is ramped to the nominal generator voltage in 10s.

The ramp up speed setting only applies to voltage build up situations, for instance during initial power up situations or after the recovery from a frequency trip.

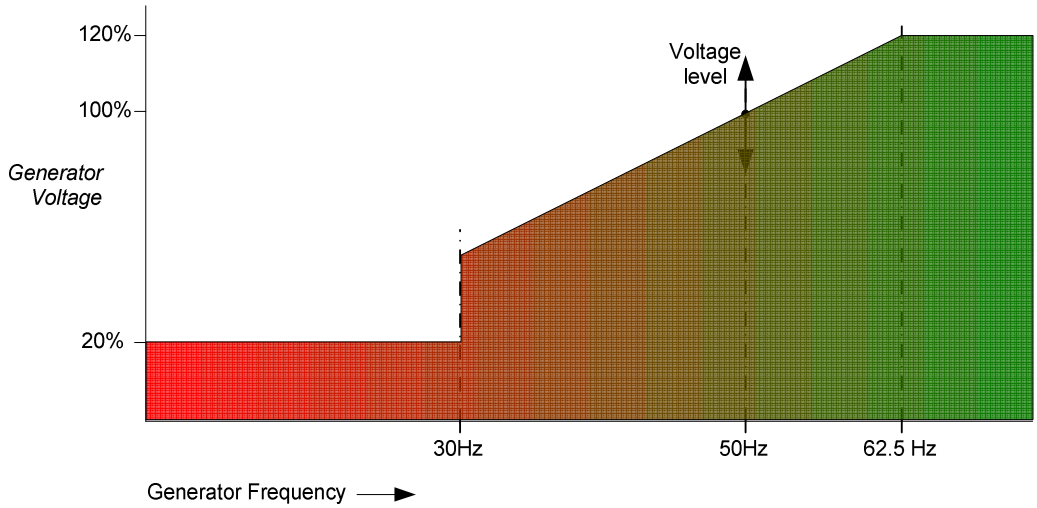
Frequency trip: dipswitch 3

To prevent over excitation situations due to underspeed conditions the AVR provides in a frequency trip protection selectable with dipswitch 3.
If dipswitch 3 is ON, the frequency trip is 57,5 Hz. (Only Constant Voltage)
If dipswitch 3 is OFF, the frequency trip is 47,5 Hz. (Only Constant Voltage)
When the frequency drops below selected underspeed frequency trip for a period longer than 500 mS, the generator voltage will be lowered to 20% of the nominal voltage and the status led will signal continuous red.

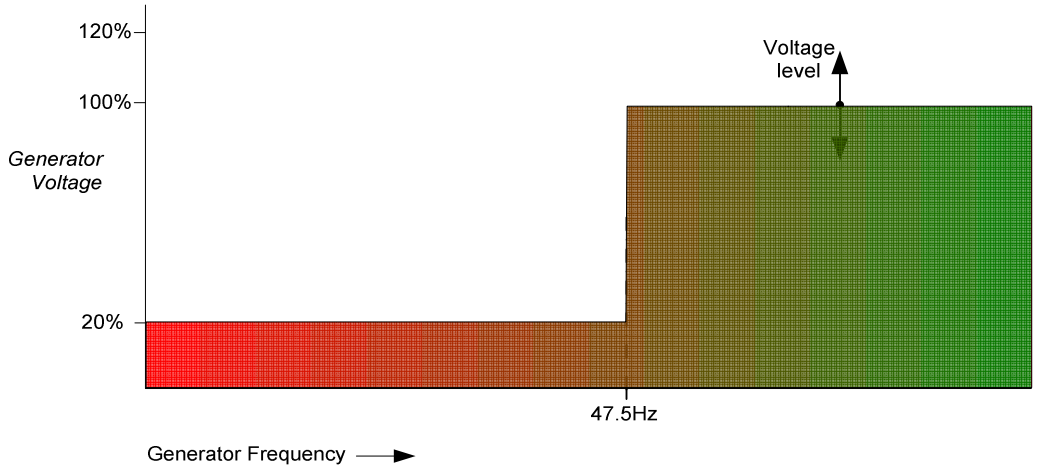
When Volt per Hertz is selected and the frequency drops below 30Hz, the generator voltage will be decreased to 20% of the nominal voltage and the status led will signal continuous red.

The voltage-frequency characteristics for the different control modes are depicted in the following diagrams.

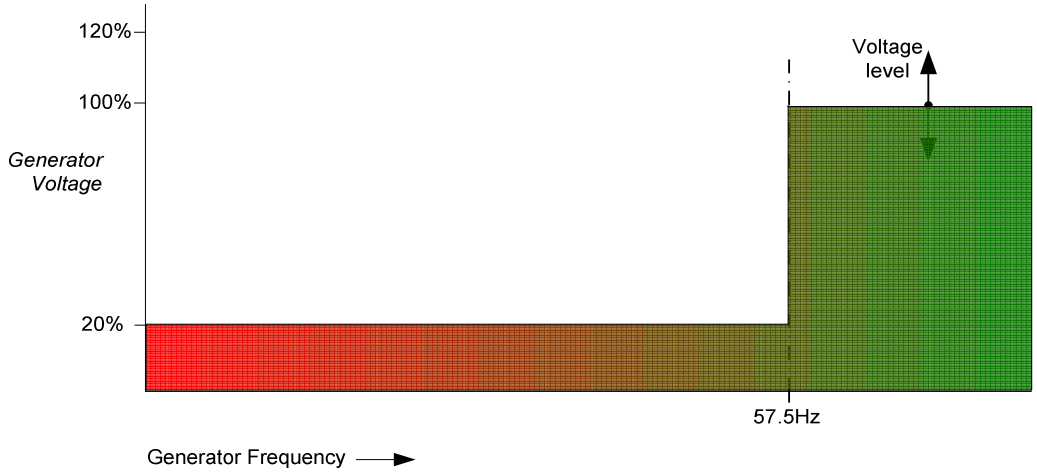
Volt Per Hertz (VPH) control



Constant Voltage control



47.5Hz underspeed trip



57.5Hz underspeed trip

AVR control mode: dipswitch 4

The AVR can be set to two different control modes: Volt per hertz (VPH) or Constant voltage control.

When set to VPH control, the AVR adjusts the voltage setpoint proportional to a change in frequency. The increase of the voltage setpoint is limited at 125%, corresponding with a frequency of ≥62,5Hz.

When set to Constant voltage control, the AVR will keep the voltage setpoint at 100% of Unom, irrespective of the frequency. The only exception is during an underspeed condition.

Overview dipswitch settings

Dipswitch / Setting	1 Sensing voltage	2 Ramp up speed	3 Frequency trip	4 AVR control mode
On	400/480V	Fast (5s.)	57,5Hz	Constant voltage
Off	200/240V	Slow (10s.)	47,5Hz	VPH

Green Power LED

When the power LED signals green, a supply voltage is present at terminals 26/28/30 and the AVR is operating.

Red Status LED

The status LED signals red, an underspeed condition is detected.

Level potentiometers

The AVR is equipped with a course and a fine level adjustment potentiometer.
Turning a potentiometer clockwise increases the generator voltage setpoint, turning counter clockwise decreases the generator voltage setpoint. The course potentiometer adjustment range is ±15%, the fine potentiometer adjustment range is ±1%.

Gain potentiometer

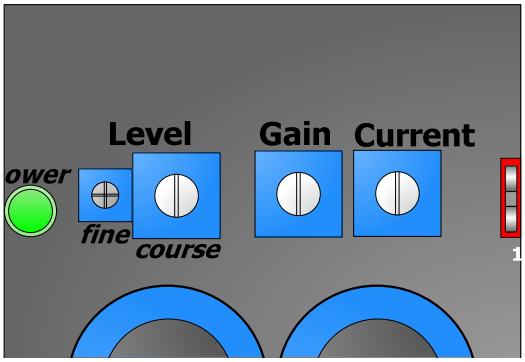
The gain potentiometer provides a means of compensation for engine RPM droop and/or voltage droop under load. The gain can be used to maintain the same voltage under no load and full load conditions when there is a small change in frequency or voltage setpoint as a result of the load.
The gain function increases the voltage set point as a function of the of the AVR excitation output. Too high gain settings may lead to instability during parallel operation or excessive voltage levels.

Current potentiometer

The current potentiometer is for future implementation and not functional. The setpoint has no influence on the AVR's behavior.

Overview potentiometers

Potentiometer	Function
Level course	Generator voltage level (±15%)
Level fine	Generator voltage level (±1%)
Gain	Excitation dependant voltage setpoint influence
Current	not functional



Potentiometers

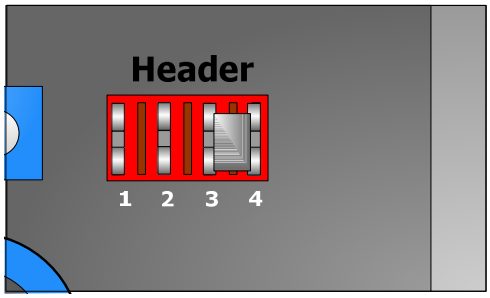
Current input header

The current input header is for future implementation and not functional. Header terminals 1 & 2 should be left open.

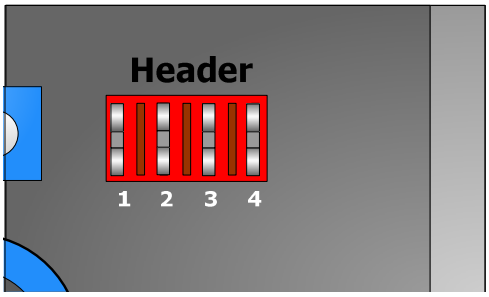
Self Excite / PMG header

In case the AVR is used to control a self excited generator, header terminals 3 & 4 should be linked. This way, if the supply voltage at terminals 26/28/30 is too low, the AVR uses the generator's residual voltage to flash the exciter field in order to create a sufficient enough supply.
During this field flash a small voltage peak occurs at startup, before the AVR starts actual voltage control.

When a PMG is used, header terminals 3 & 4 should be left open.



SE Generator

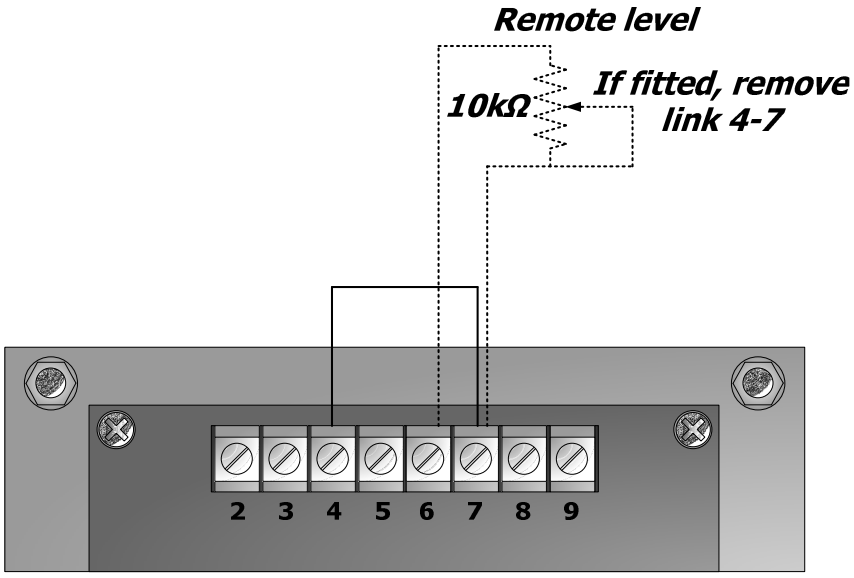


PMG Generator

External voltage adjustment

By potentiometer

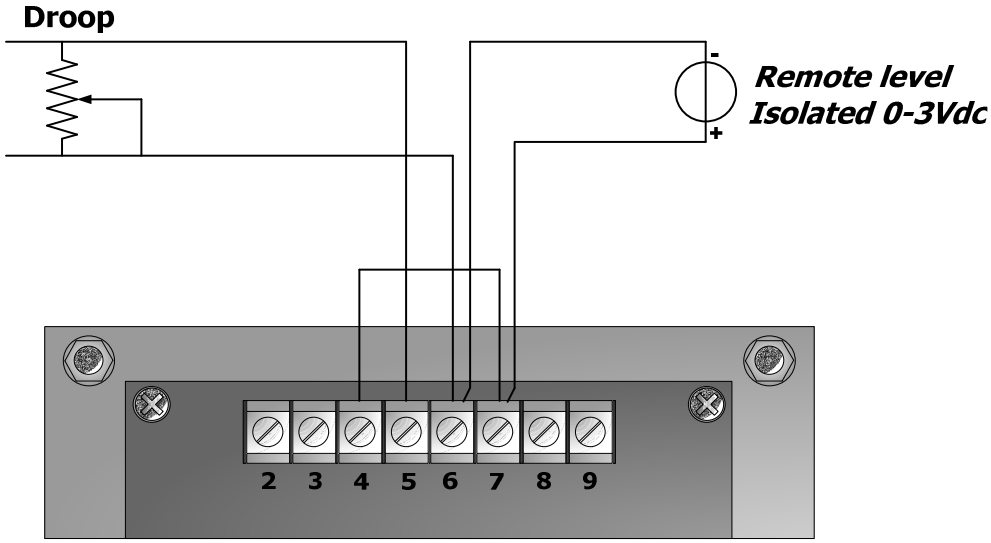
When desirable, the generator voltage setpoint can be adjusted from a remote location by means of a 10 kΩ remote level potentiometer, which must be connected between terminals 6 & 7. In case a remote level potentiometer is fitted, the link between terminals 4 & 7 must be removed.



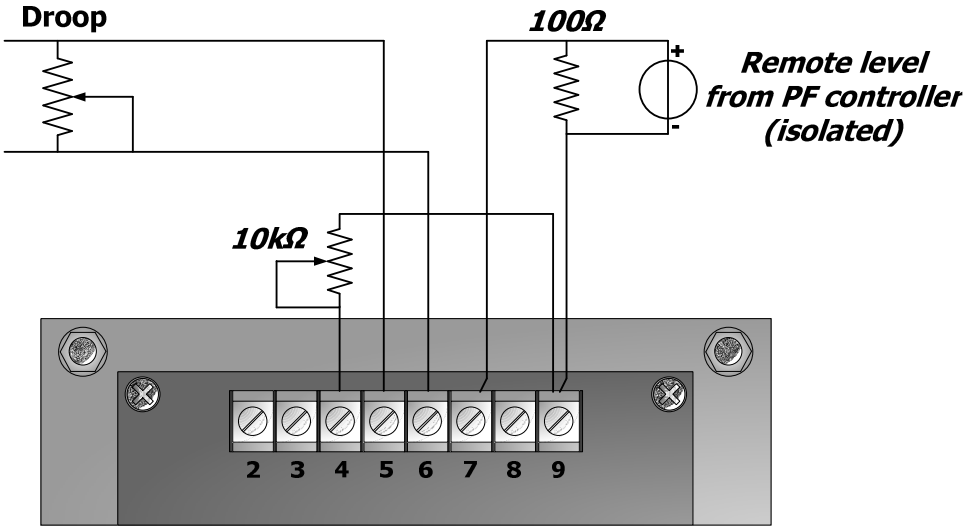
If no remote level potentiometer is fitted, the link between 4 & 7 must be present for normal operation.

By external voltage source

The voltage source must be isolated and not exceed 3Vdc.



Another configuration used in combination with an external voltage source (e.g. PF controllers) as well is shown in diagram below.



Terminal 9 is not connected to the AVR internal electronics and can be used to connect several wires together more easily.

Terminal designation

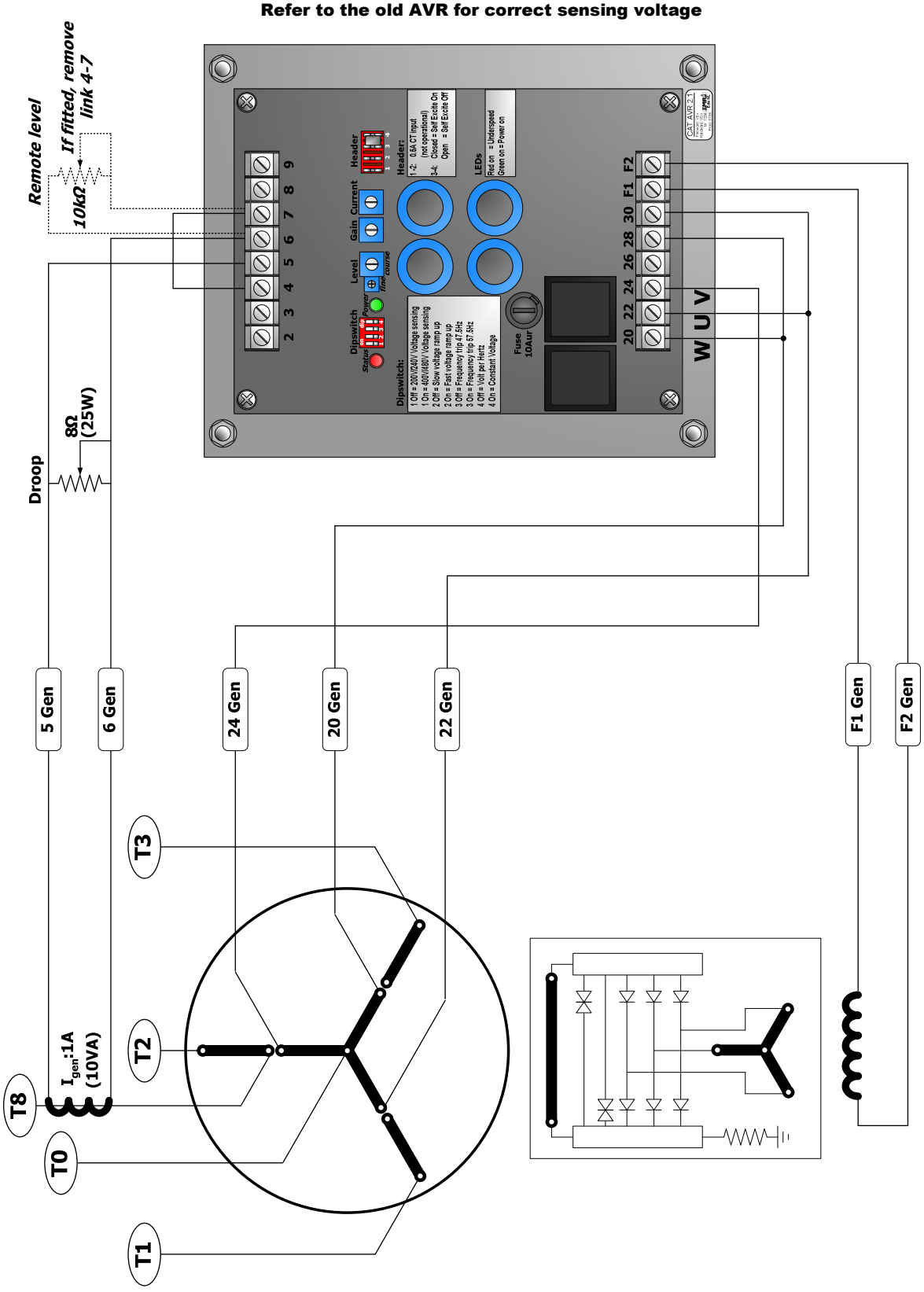
Terminals	Designation
2, 3,9	Not connected
8	Not to be used
4,7	Open if an external voltage adjustment potentiometer is installed at terminals 6 & 7 (See application diagrams). Shortened if no external voltage adjustment potentiometer is installed.
5,6	Droopkit input (For paralleling operation only)
22,24,20	Sensing terminals (U, V, W)
26,28,30	Supply terminals. Terminal 28 must always be connected for self excited generators.
F1, F2	Field excitation output
Header 1 & 2	Not functional, leave open
Header 3 & 4	Shortened for self excited generators, open for PMG excited generators.

Fuse

10 Ampere	Ultra rapid, 6.3 x 32 mm

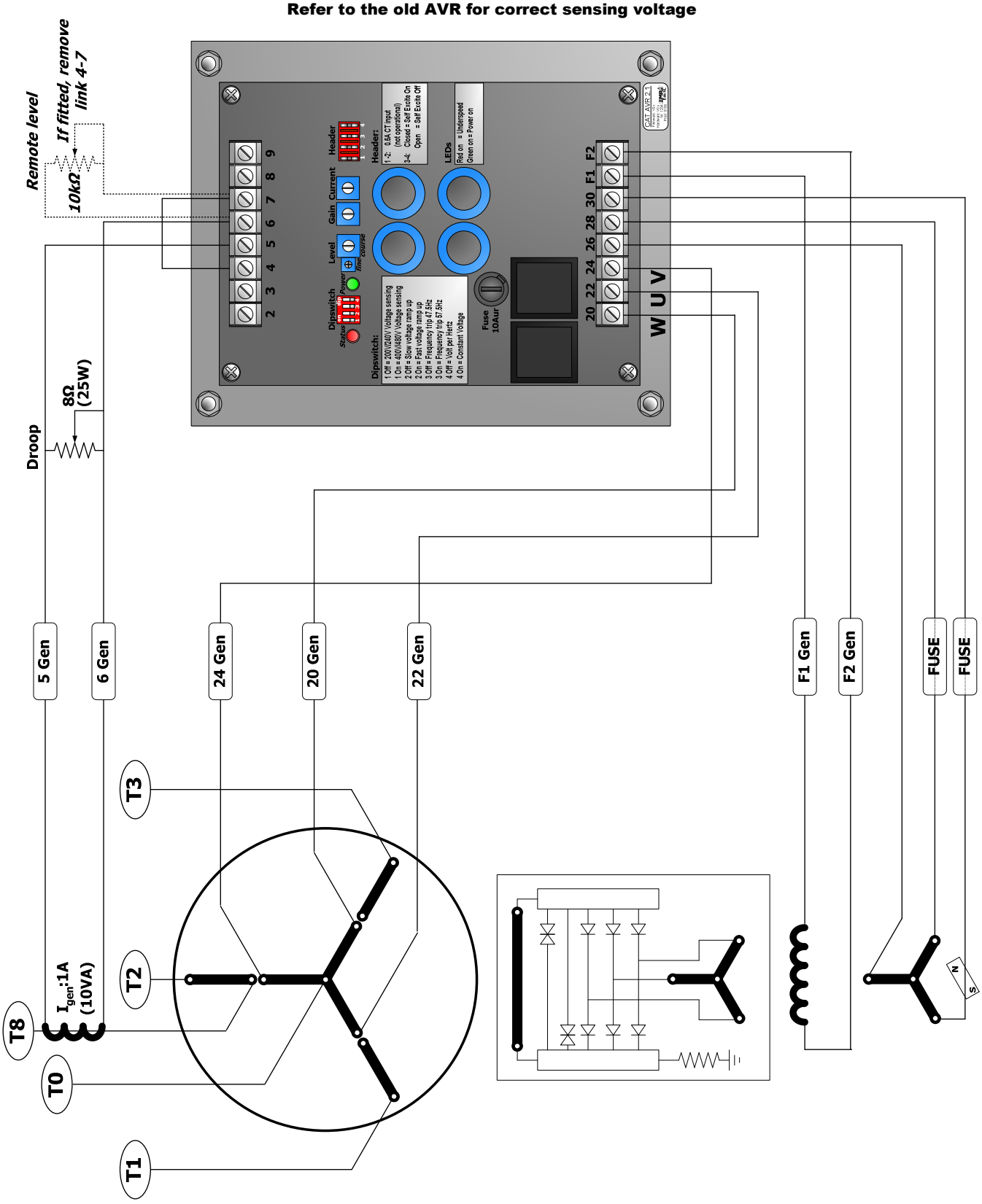
Most commonly used

Refer to the old AVR for correct sensing voltage



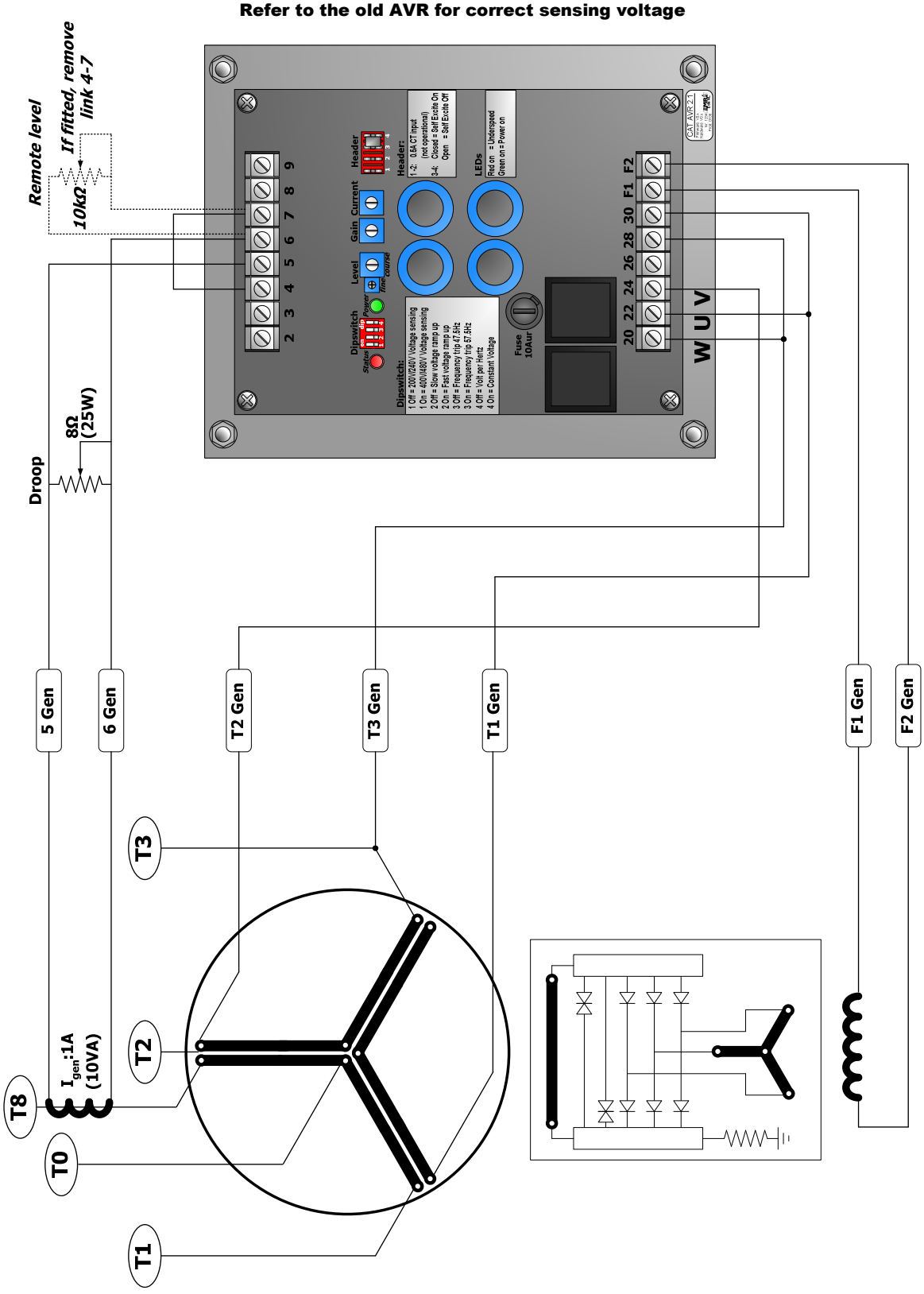
Most commonly used

Refer to the old AVR for correct sensing voltage



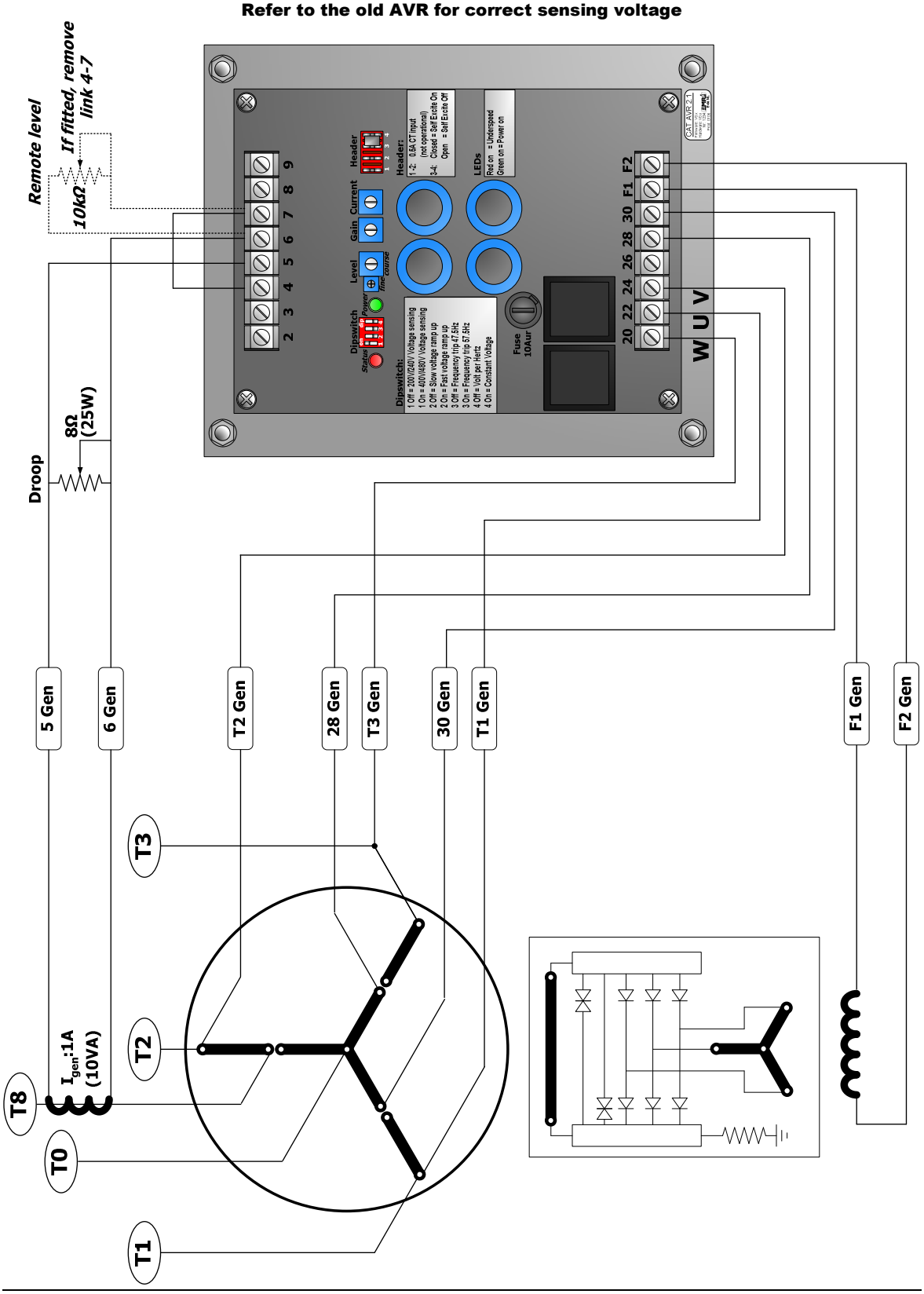
Rarely used

Refer to the old AVR for correct sensing voltage



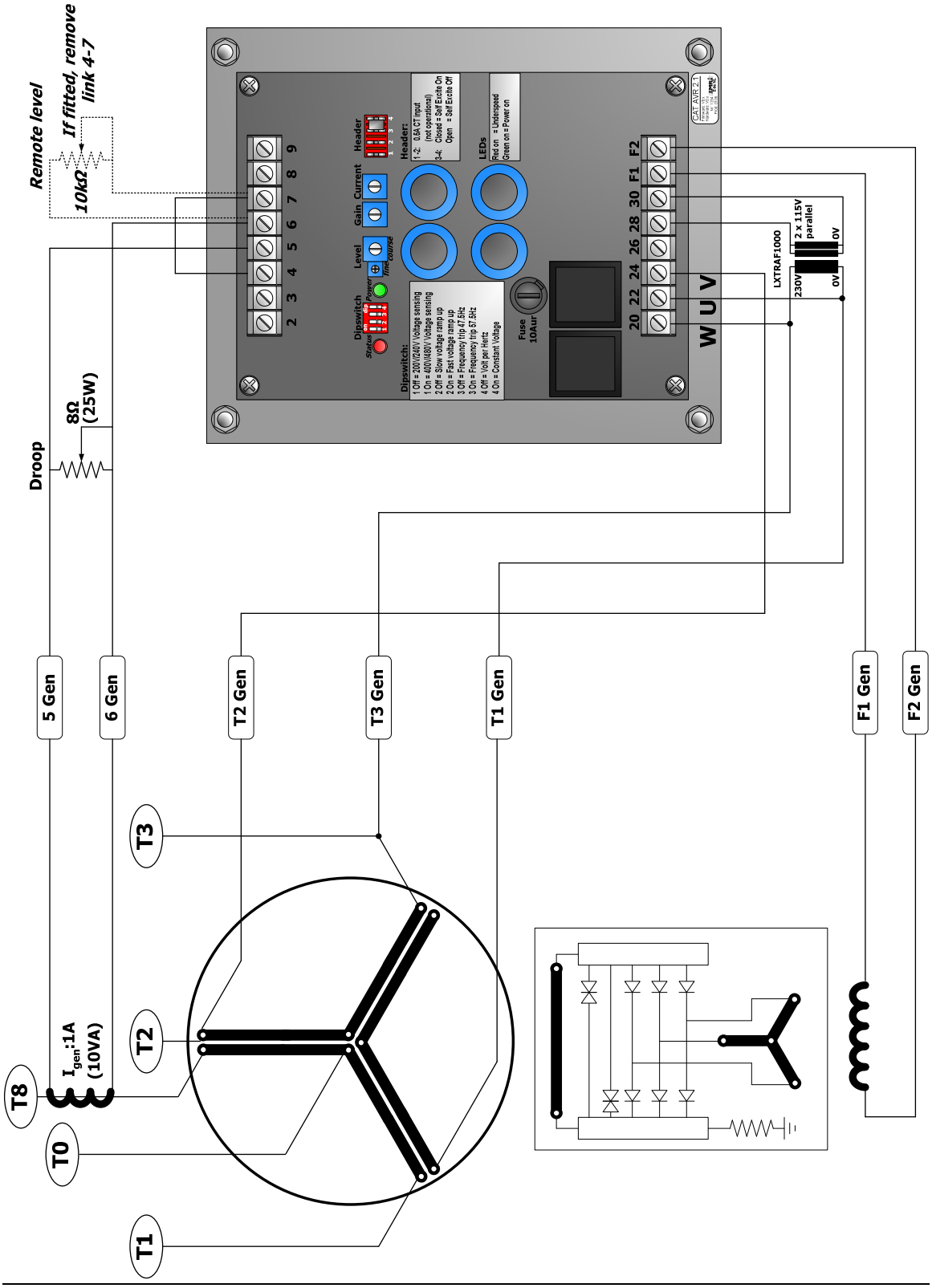
Rarely used

Refer to the old AVR for correct sensing voltage



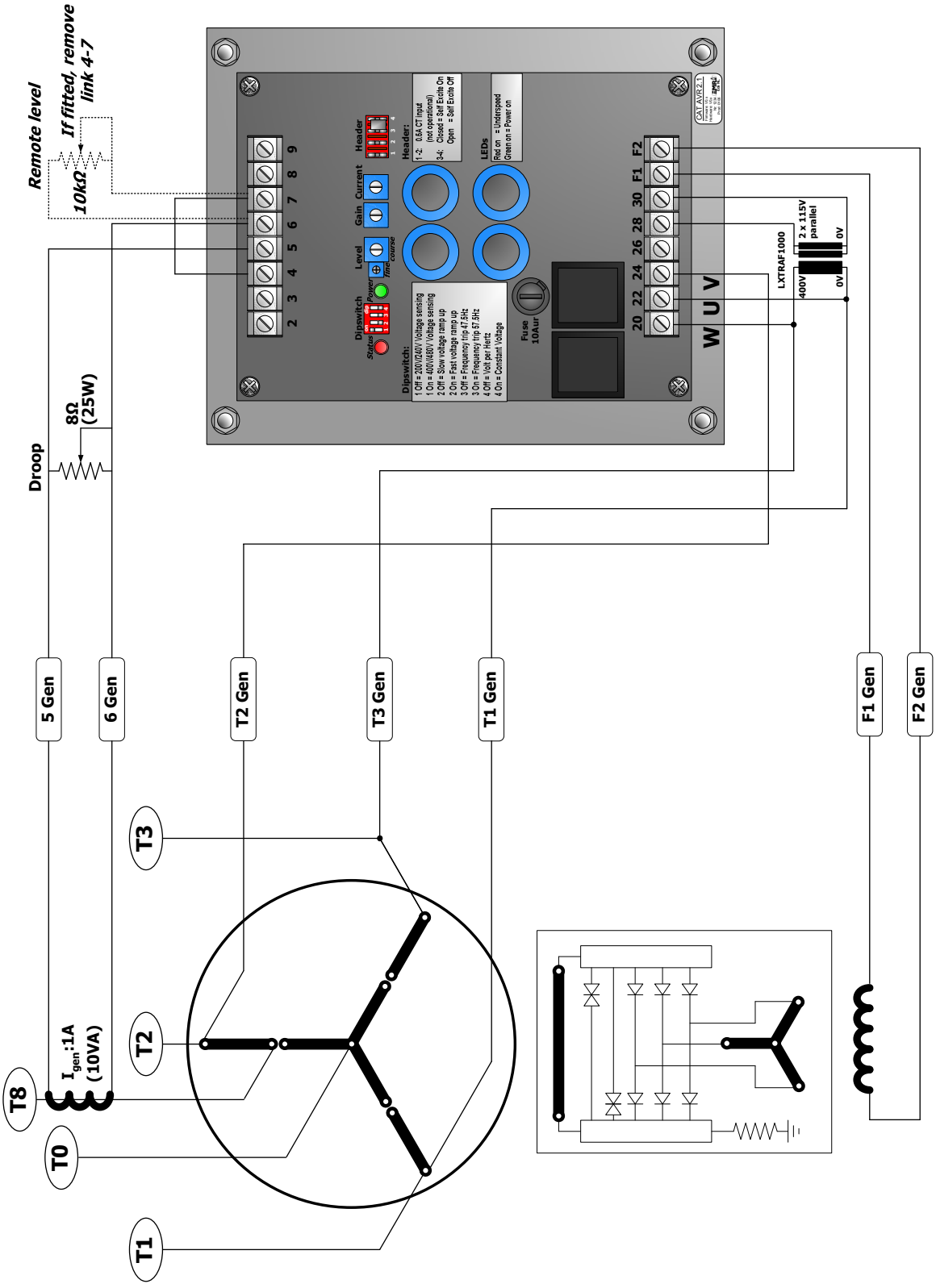
Use in case of poor exciter stator insulation

Refer to the old AVR for correct sensing voltage



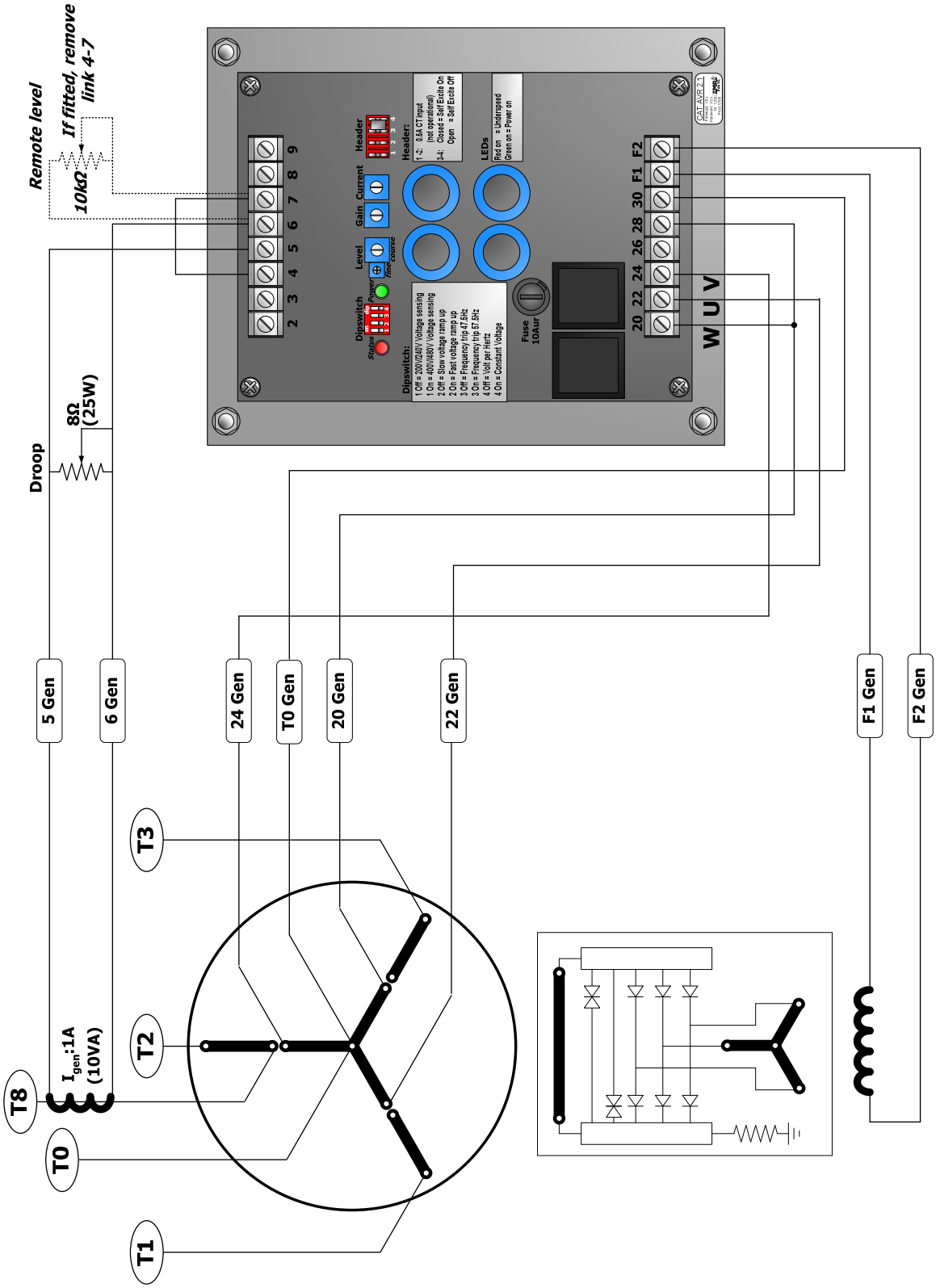
Use in case of poor exciter stator insulation

Refer to the old AVR for correct sensing voltage

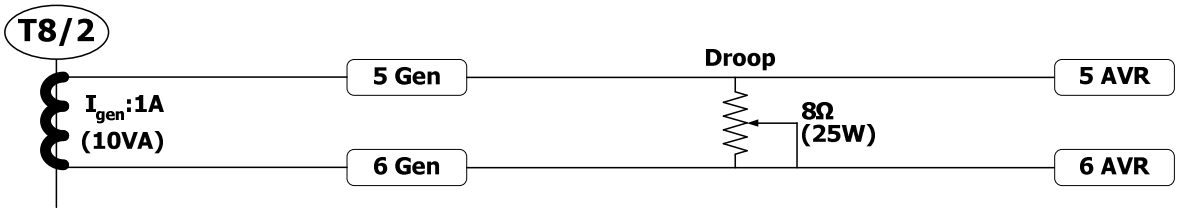


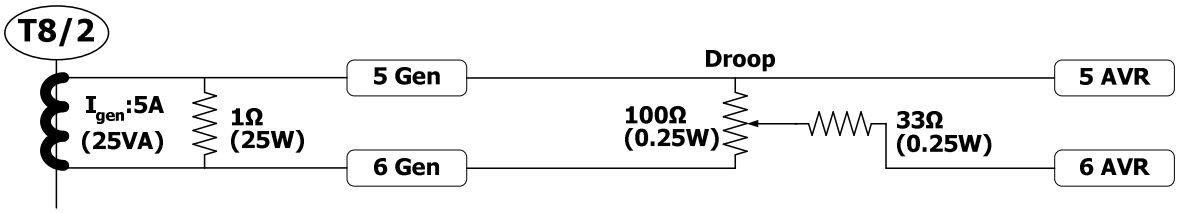
Use in case of instability at no load conditions

Refer to the old AVR for correct sensing voltage



Check the value of the droop CT before commissioning.





GENERAL INSTALLATION INFORMATION

Absolute Maximum Ratings

- The Absolute Maximum Ratings are those limits for the device that, if exceeded, will likely damage the device. Exceeding the absolute maximum ratings voids any warranty and/or guarantee.

Mounting

Mounting of the product should be done in such a way that:

- the absolute maximum ambient temperature rating of the product will never be exceeded.
- maximum cooling (direction of cooling ribs and direction of airflow) is achieved.
- Mounting no humid air can flow through the product or condensation occurs.
- dust or other materials or residue will not remain in or on the product.
- the maximum vibration is not exceeded.
- personal contact with persons is impossible.

Wiring

- Diameter size of the wiring should be enough to carry the expected current. Wire insulation should be enough to withstand the expected operating voltages and temperatures.
- To improve EMC emission and immunity, care should be taken for the lay out of the wiring. This in respect to all wiring in the installation.
- Keep current carrying wires as short as possible.
- Keep wires carrying a total sum of zero Ampere close to each other, or in one single cable, E.g. U, V, W, or J (+) and K (-),
  or Phase and neutral, or S and T.
- Avoid current carrying conductors next to sensing or control wiring. Especially current controlled by SCR's or PWM controlled transistors.
- If sensitive sensing signal cables need to be laid across distance along other cabling, shielded cable is preferred. Keep the shield as long as possible and the wiring outside the shield as short as possible. Do not solder or shrink the shield to a regular wire. Connect the original shield to ground at one side with an as large as possible contact surface.

Additional installation information

- When the product is supplied by means of a transformer, it should never be an auto-transformer. Auto-transformers react as voltage sweep up coil and may cause high voltage peaks.
- Standard fit capacitors or over-voltage suppressers across X (+) and XX (-), or exciter field terminals inside the generator should be removed.
- When the product is supplied by means of a transformer, it should be able to carry at least the maximum expected current. Advisable is, to have a transformer which can carry twice the maximum expected current. Inductive loads make voltage sacks and peeks into the secondary voltage of a transformer, from which the device may malfunction.
- It is not recommended to apply switches in dc outputs. It is preferred to use switches in the ac supply inputs of devices. In case it is unavoidable to have switches in the dc output of a device, action must be taken to avoid over voltage damage to the device due to contact arcing. Use a voltage suppressor across the output.
- It is not recommended to apply switches or fuses in the sensing lines. Defects can cause high voltage situations due to over-excitation.
- When using a step down transformer in medium or high voltage generators, the transformer should be three phase (if three phase sensing), and the transformer should be suitable for acting as a sensing transformer. If the transformer is unloaded, connect a resistor to avoid voltage waveform distortion.
- The phase relation from the generator to the AVR is important. Also when voltage transformers and/ or current transformers are installed.
- When using a step down or insulation transformer in the droop circuit, phase relation from the generator to the AVR is important.
- CT's wiring, connected to the AVR should never be grounded.
- Always disconnect electronic products, circuits and people before checking the insulation resistance (Megger check).
- Due to differences in generators impedance's, EMC behavior is not predictable. Therefore the commissioner / installer should be aware of proper and correct installation.
- Large, highly inductive, exciter stator windings can cause destructive high voltage peaks. Adding a resistor from 10 to 20 times the exciter stator field resistance reduces voltage spikes. If necessary filter can be fitted additionally. (e.g. snubber, RC-network)
- Upon problems during commissioning, faulty behavior or defects in the generator, consult the fault finding manual at our web site
- Some advises may be overdone or seem extraordinary, but since the electrical rules are the same everywhere, these advises are given.

CONTACT

EMRI Electronics B.V.
Morsestraat 10
6716 AH, Ede, Netherlands
Tel: +31 (0)318 620 427
Website: www.emri.nl
E-mail: info@emri.nl

Manufacturer

THE POWER OF SYNERGY

CANARY ISLANDS, Las Palmas
Zamakona Yards
Tel: +34 928467521
Fax: +34 928461233
Website: www.zamakonayards.com/
E-mail: jbetancor@zamakonayards.com

CHILE, Santiago
Lucio Vicencio y CIA.LTDA
Tel: +1-281-334-2904
Fax:: +1-832-221-5642
Website: www.luciovicencio.cl
E-mail: luciovincencioltda@gmail.com

GREECE, Piraeus
Stavros Kassidiaris S.A.
Tel: +30 210 4636000
Fax: +30 210 4624471
Website:www.kassidiaris.gr
E-mail: info@kassidiaris.gr

ICELAND, Hafnarfjordur
Rafeining ehf
Tel: +354 565 3049
Fax: +354 565 3048
Website: www.rafeining.is
E-mail: rafeining@rafeining.is

INDIA, Faridabad
Power Solutions
Tel: +91 9868907903
Fax:: +91 129 2431216
Website: www.psolindia.com
E-mail: ramesh.powersolutions@gmail.com

NORWAY, Bergen
Frydenbø Electric A/S
Tel: +47 55 34 91 00
Fax: +47 55 34 91 10
Website: www.frydenbo.no
E-mail: firma.fel@frydenboe.no

POLAND, Gdynia
An-Elec Sp. z o.o.
Tel: +48 58 668 44 00
Fax: +48 58 668 44 66
Website: http://an-elec.pl
E-mail: info@an-elec.pl

POLAND, Szczecin
MARCONTREL
Tel: +48 91 4 888 474
Fax: +48 91 4 888 475
Website: www.marcontrel.com
E-mail: emri@marcontrel.com

POLAND, Szczecin-Mierzyn
Marel Serwis
Tel: +48 91 48 58 388
Fax: +48 91 48 79 948
Website: www.marel.szczecin.pl
E-mail: handel@marel.szczecin.pl

REPUBLIC OF PANAMA, Panama
PASRAS S.A.
Tel: +507 3140095
Fax: +507 3140094
Website: www.pasras.com
E-mail: info@pasras.com

ROMANIA, Constanta
SAMTEC SRL
Tel: +40 241 517 047
Fax: +40 241 517 047
Website: www.samtec.ro
E-mail: samtec_srl@yahoo.com

SINGAPORE, Singapore
Cyclect Electrical Engineering
Tel: +65 6868 6013
Fax: +65 6863 6260
Website: www.cyclect.com.sg
E-mail: heng.p@cyclect.com.sg

SOUTH AFRICA, Roodepoort
Yneldo Electronics
Tel: +27(0)117637053
Fax: +27(0)117634212
Website: www.yneldo.com
E-mail: yneldo@yneldo.com

SWEDEN, Kungälv
Elektrisk Drivteknik EDT AB
Tel: +46-705-28 20 60
Tel: +46-709-50 47 90
Website: www.edtab.se
E-mail: info@edtab.se

THAILAND, Bang Lamung
Semtec Maritime/Genetech Co.Ltd
Tel: +66 38301262
Fax: +1-832-221-5642
Website: semtecmaritime.com/
Email: ron@northstarusa.co

TURKEY, Izmir
INTEGRAL
Tel: +90 (555) 211 55 75
Email: ozgur@integralguc.com

UNITED ARAB EMIRATES, Sharjah
KDU Technical Services
Tel: +971-6-5575480
Fax: +971-6-5575490
Website: www.kdutech.ae
E-mail: kdutech@kdutech.ae

UNITED KINGDOM, Stockton on Tees
MJR Controls
Tel: +44 1642 762 151
Fax: +44 1642 762 502
Website: www.mjrcontrols.com
Email: chris.milner@mjrcontrols.com

UNITED KINGDOM, Cheadle Hulme
TGS Total Generator Solutions Ltd
Tel: +44161 8188720
Fax: +447754677963
Website: http://totalgeneratorsolutions.com
Email: sales@totalgeneratorsolutions.com

UNITED STATES, Kemah - Texas
Ramtec Marine Systems LLC
Tel: +1-281-334-2904
Fax: +1-832-221-5642
Website: www.ramtec-marine.com
Email: waling@ramtec-marine.com