



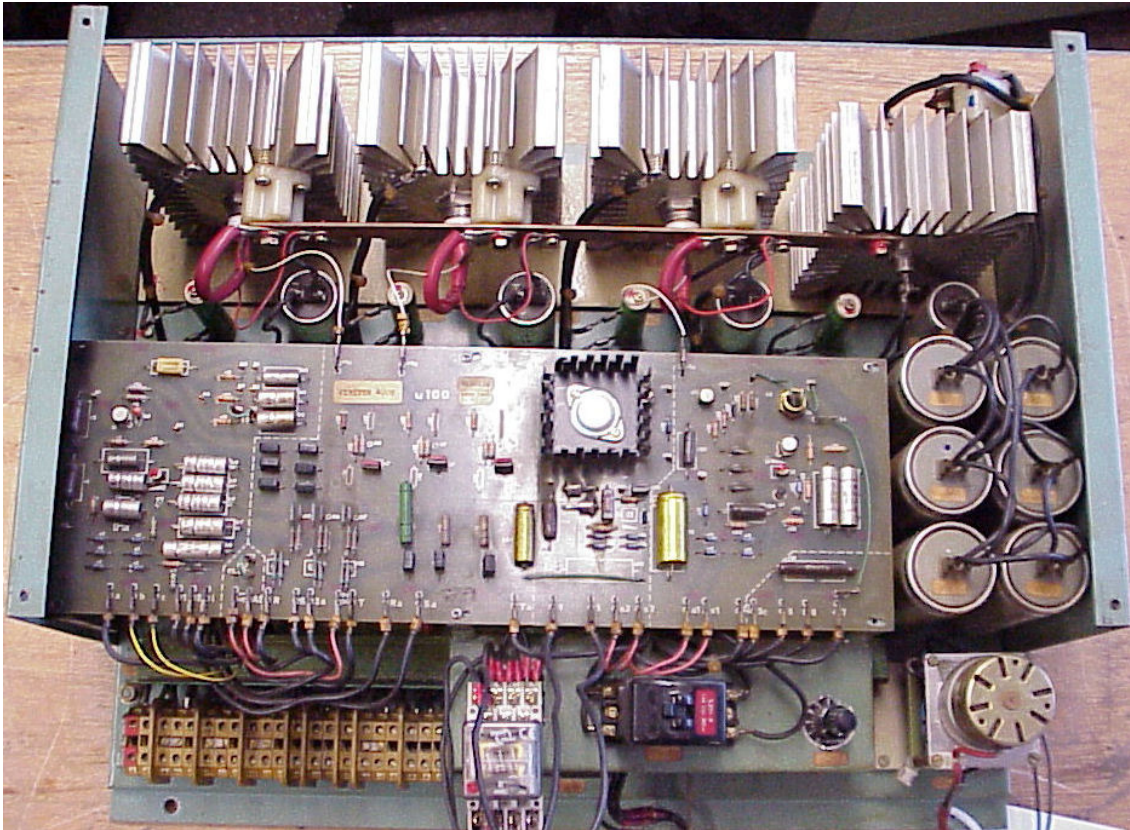
# SMUJ

*Voltage regulator for generators*

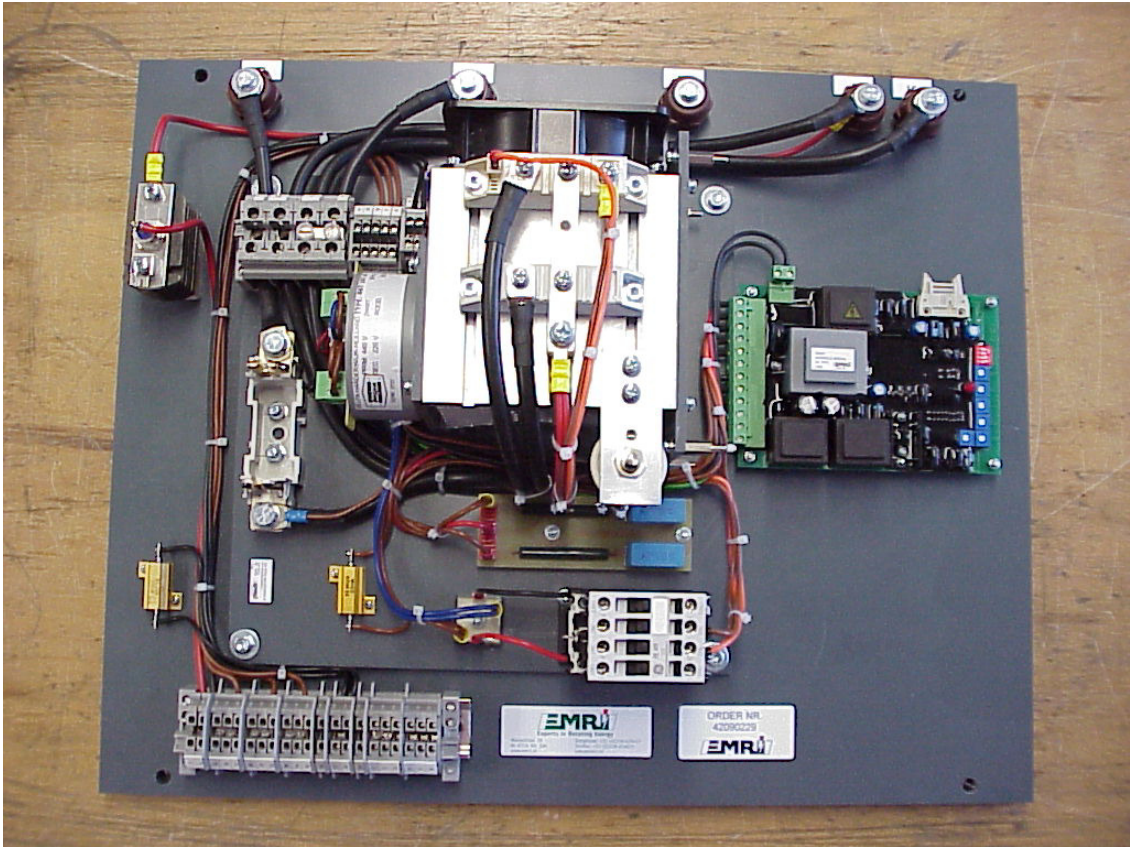
**Instruction Manual V1.1**

Product version V1.1

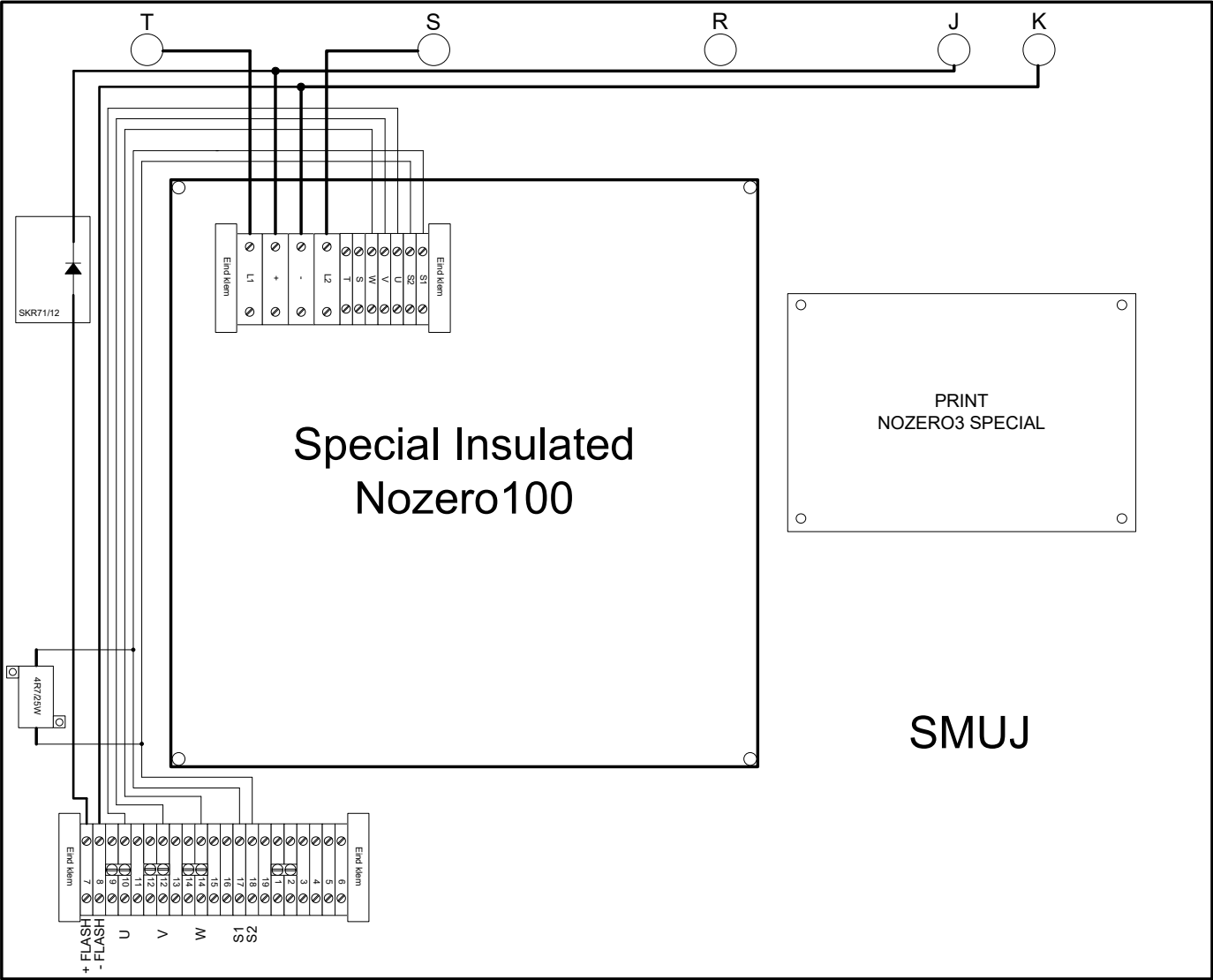
# STRÖMBERG SMUJ75K3



# EMRI SMUJ

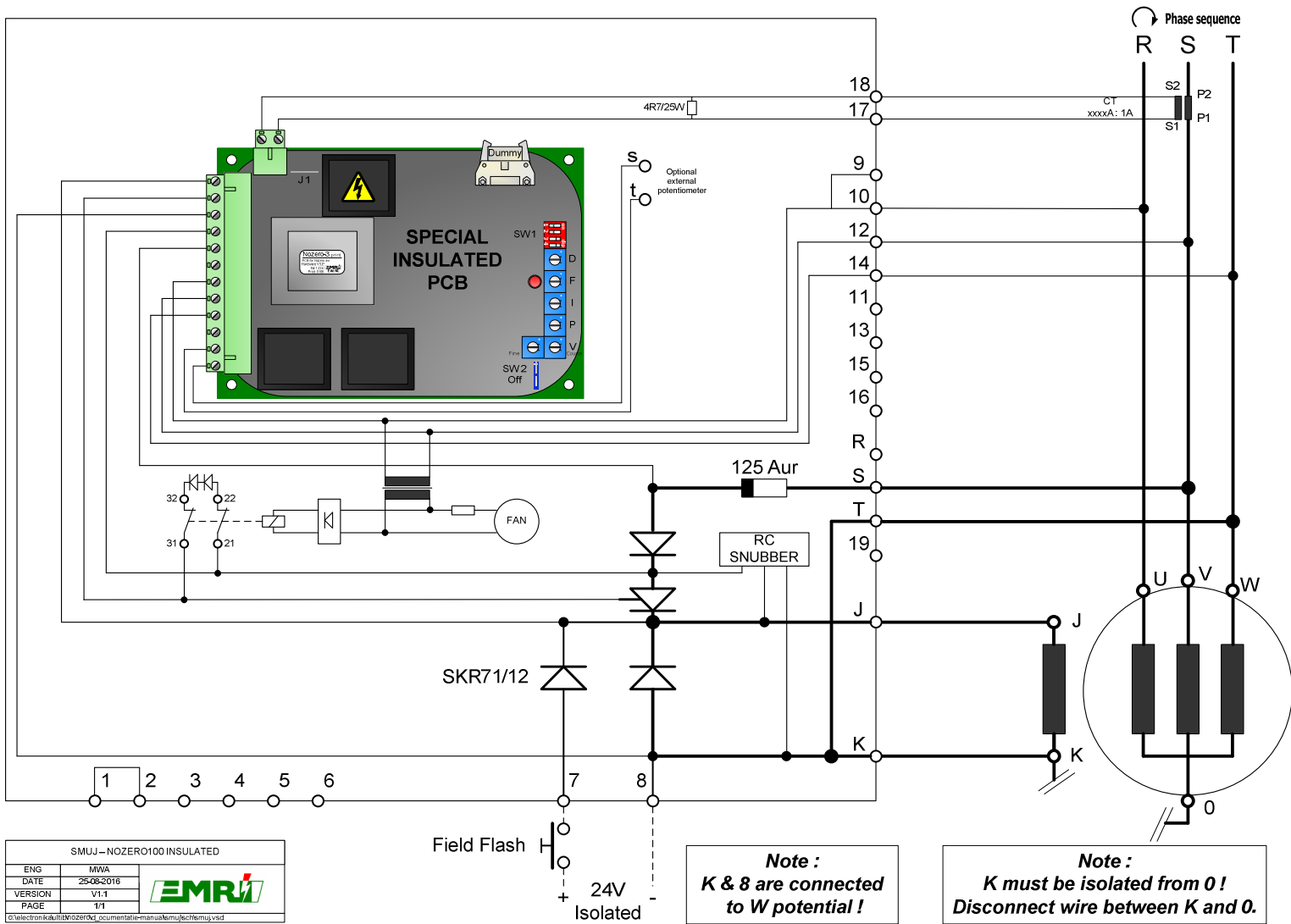


# EMRI SMUJ



# EMRI SMUJ

WIRING DIAGRAM : IMPORTANT, SEE NOTE'S



SMUJ-NOZERO100 INSULATED	
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VERSION	V1.1
PAGE	1/1



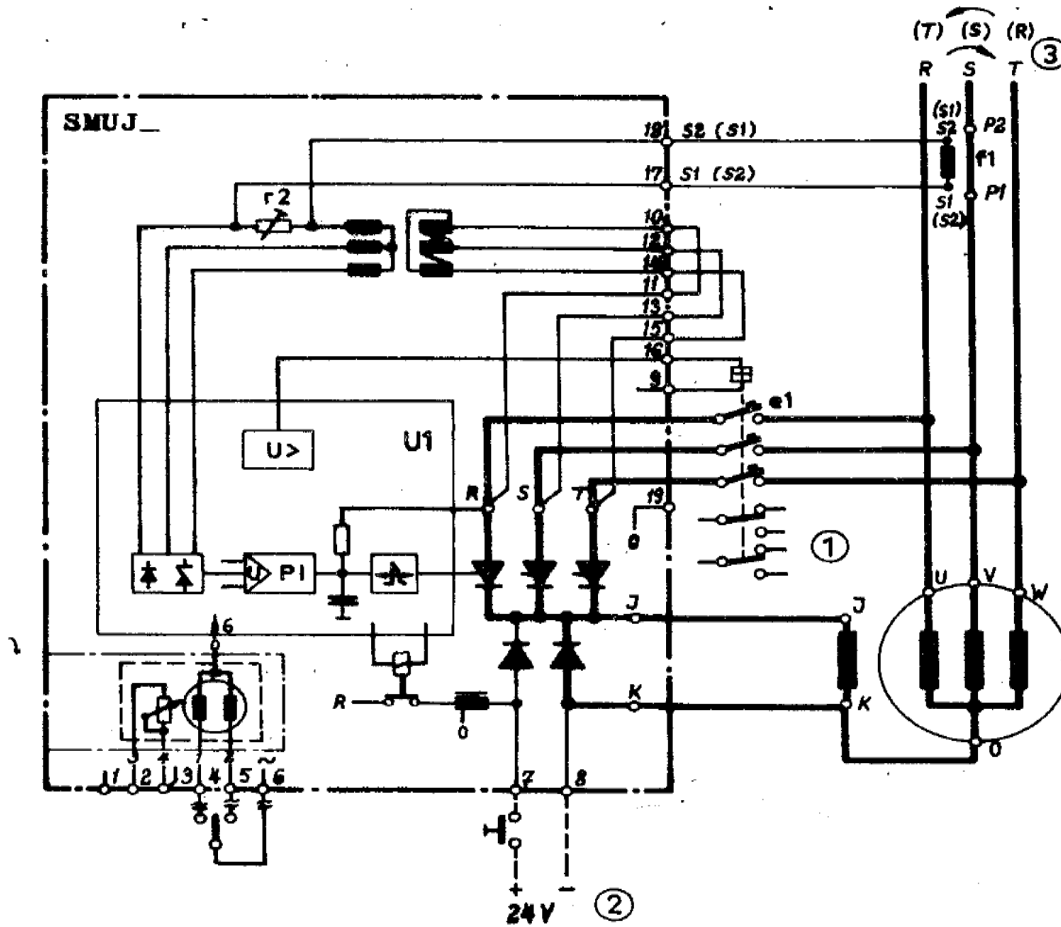
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# STRÖMBERG SMUJ

Synkronigeneraattoreiden elektroniset jännitteensäätäjät  
 SMUJ 75 K 3  
 SMUJ 200 K 1

## LIITÄNTÄKAAVIO

Jännitteensäätäjän liitännät generaattoriin, jossa ei tarvita sovituselimiä eikä oikosulkumagnetointilaitteita.



- ① Generaattorin pääkatkaisijan aukiohjaus.
- ② Käytetään vain, jos remanenssijännitettä ei ole.
- ③ Vaihejärjestys vaihtuu pyörimissuunnan kääntyessä.

**Oy Strömberg Ab**

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Sivu 21.0111  
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Jakelu  
 Fördeln.

Korvaa  
 Ersätter

Pvm. 010471  
 Dat.

## 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 off 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.

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



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.



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.

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# 1. INTRODUCTION

## 1.0 General description

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

The Nozero type AVR's are suitable for most generators regardless of excitation power. The AVR consists of a control unit and power stage. Because of this modular construction it is possible to have AVR's with the same functionality but with various output power ratings. There are five different power stage ratings available. Ranging from 40 A to 350 A output current.

### Additional features

Modes of control:

- Single operation

- Parallel operation (droop kit available at EMRI)

Additional protections:

- Short circuit

- Phase loss

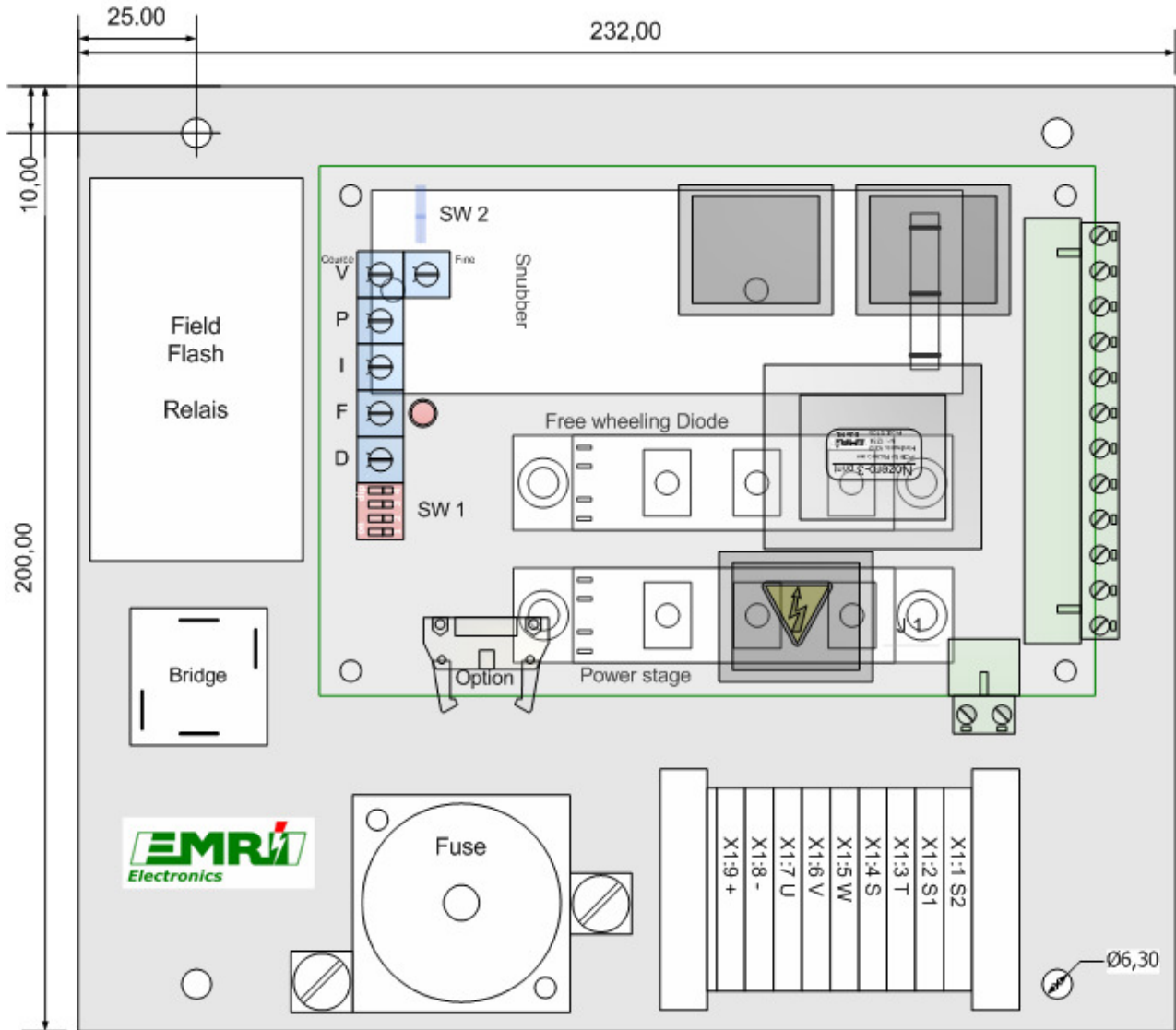
More flexible protections:

- User adjustable underspeed knee

## 1.1 AVR Layout

The AVR control unit is protected from the environment by a PUR coating. Prefabricated links are provided for S and T.

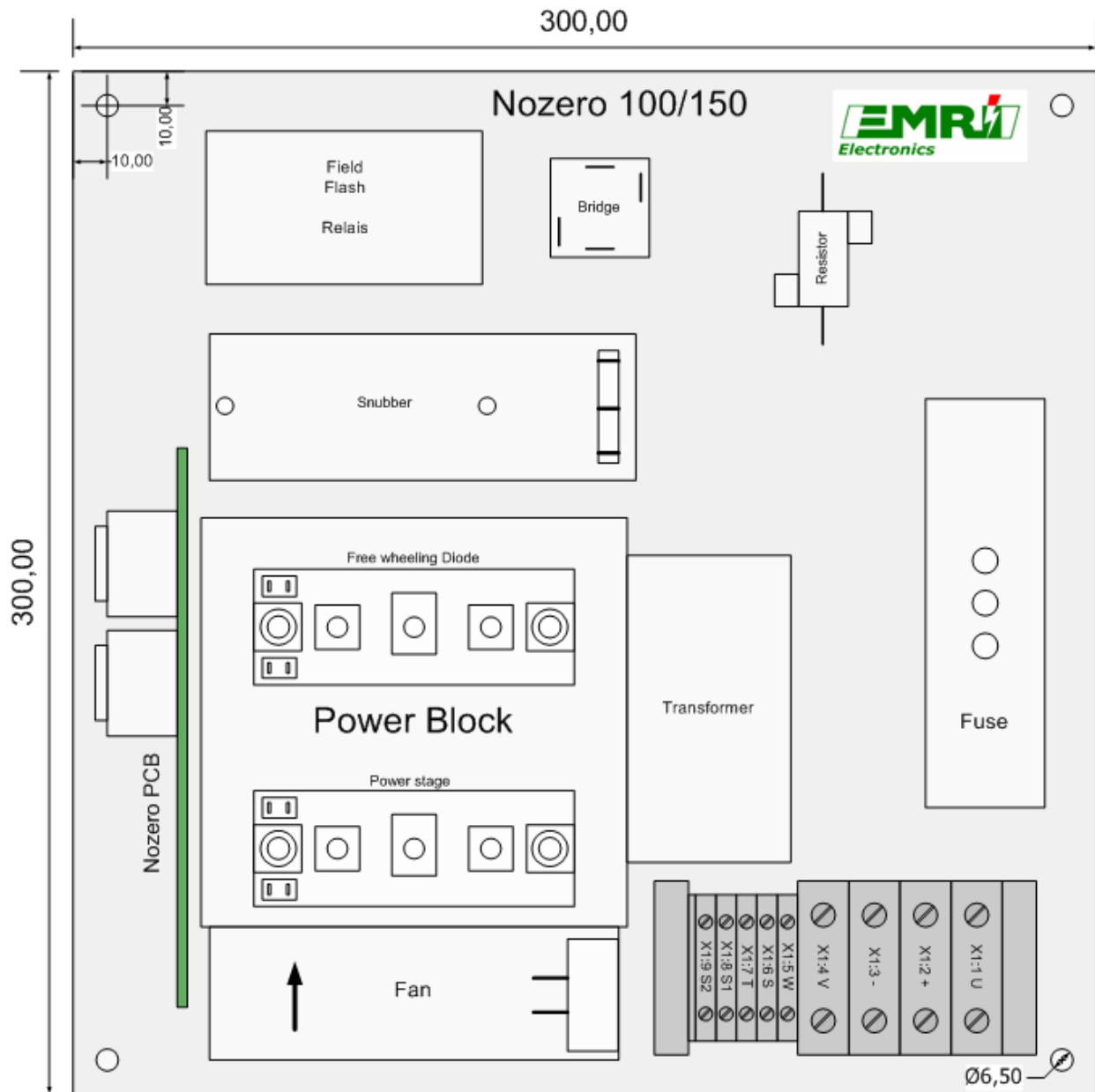
### 1.1.1 Layout Nozero 35



**Fig 1. layout Nozero 35**

- Measurements in mm
- Height  $\pm 150$  mm
- International protection rating: IP00

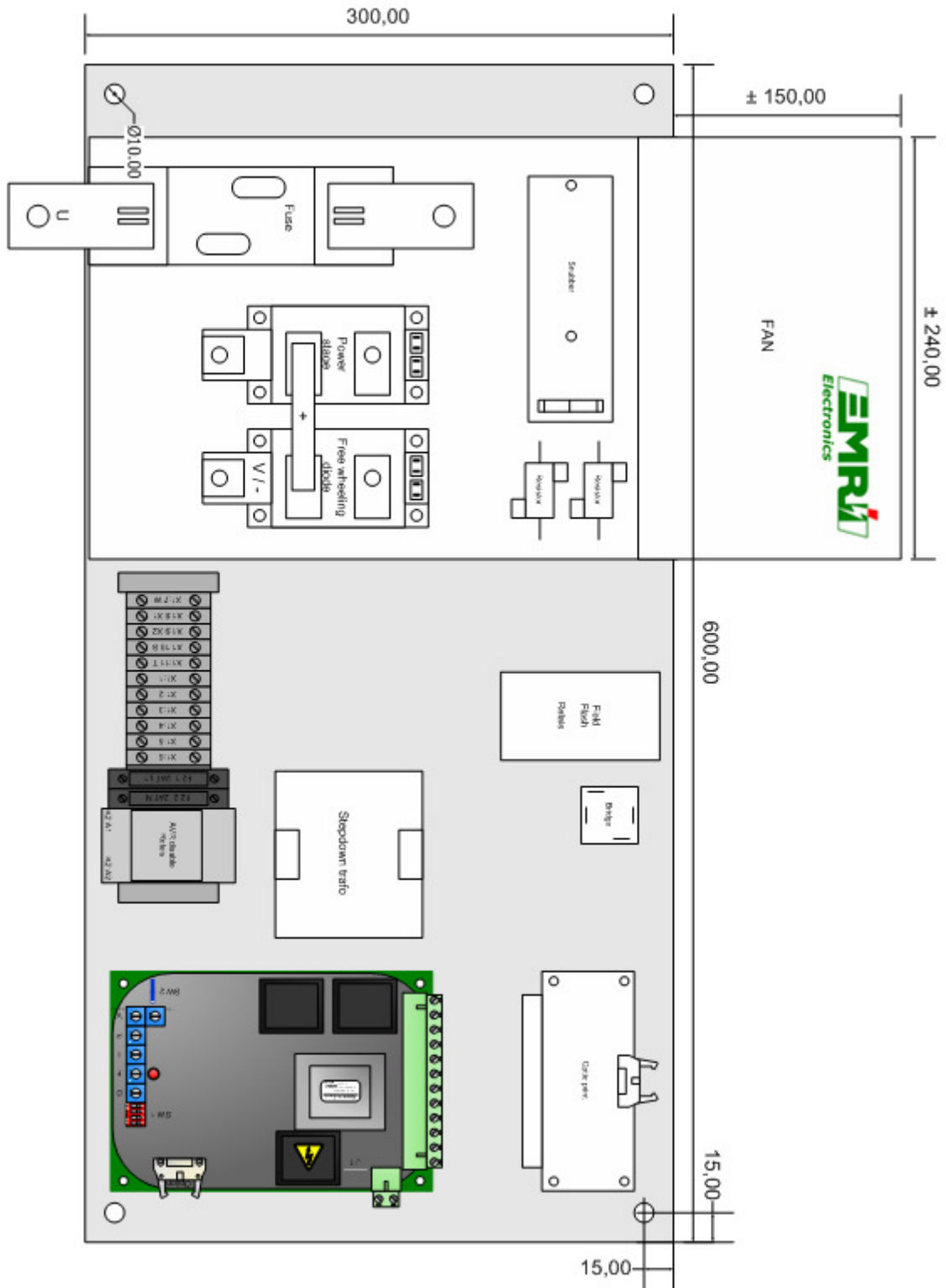
## 1.1.2 Layout Nozero 100/150



**Fig 2. layout Nozero 100/150**

- Measurements in mm
- Height  $\pm$  210 mm
- International protection rating: IP00

### 1.1.3 Layout Nozero 250/350



**Fig 3. layout Nozero 250/350**

- Measurements in mm
- Height  $\pm 300$  mm
- International protection rating: IP00

## 1.2 Electrical characteristics

Symbol	Parameter	Condition	Min	Max.	Unit
U,V,W	Voltage sensing input	50-60 Hz	250	500	V <sub>AC</sub>
+, -	AVR field current Nozero 35 Nozero 100 Nozero 150 Nozero 250 Nozero 350		-	40 100 150 250 350	A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub>
T <sub>AMB</sub>	Operating temperature	95 % RHD non condensing	0	+45	°C
	Accuracy	sinusoidal waveform		1	%
S1,S2	Droop	Isolated CT	-	0.5	A <sub>AC</sub>
S,T	External Volt adjust		-	10	kΩ

**Table 1. Electrical characteristics**

## 1.3 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U,V,W	Supply / Voltage sensing input	< 30 s.	- 40	500 65	V <sub>AC</sub> Hz
+, -	AVR field voltage AVR field current Nozero 35 Nozero 100 Nozero 150 Nozero 250 Nozero 350	DC % of supply voltage(RMS) < 10 s.	-	170 60 150 225 375 525	V <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub> A <sub>DC</sub>
Fuse	Fuse rating Nozero 35 Nozero 100 Nozero 150 Nozero 250 Nozero 350	Type: Ultra Rapid (UR)		50 125 160 400 400	A <sub>UR</sub> A <sub>UR</sub> A <sub>UR</sub> A <sub>UR</sub> A <sub>UR</sub>
Fuse 2.1 Fuse 2.2	Fan fuse	Type: Time Delay Nozero 250/350 only		2	A <sub>t</sub>
T <sub>AMB</sub>	Operating temperature	95 % RHD non condensing	0	+50	°C
S1,S2	Droop set current	Isolated CT < 30 s	-	1	A <sub>AC</sub>
S,T	External Volt adjust		-	10	kΩ

**Table 2. Absolute maximum ratings**

Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability and lifetime.

### 1.3 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 off the power supply or stop the prime mover.

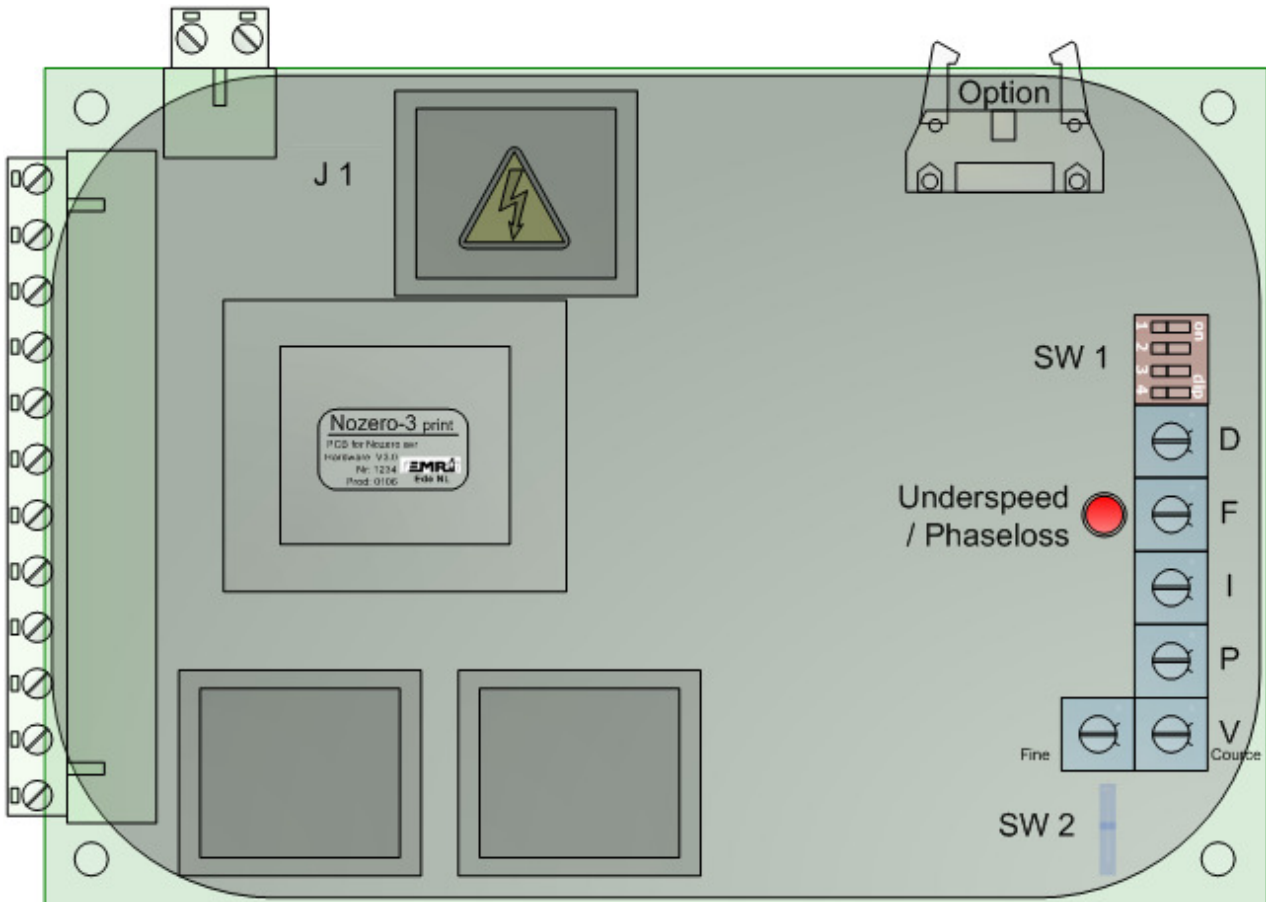
Dangerous voltages are present at the voltage regulator board. Accidental contact with live conductors could result in serious electrical shock or electrocution. Disconnect the power source before making repairs, connecting test instruments, or removing or making connections to the voltage regulator.

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 are best turned completely counter clockwise in order to start at the lowest possible voltage.

## 2. INSTALLATION

For a complete wiring diagram see pages 31 and 32.

### 2.0 Interfaces overview

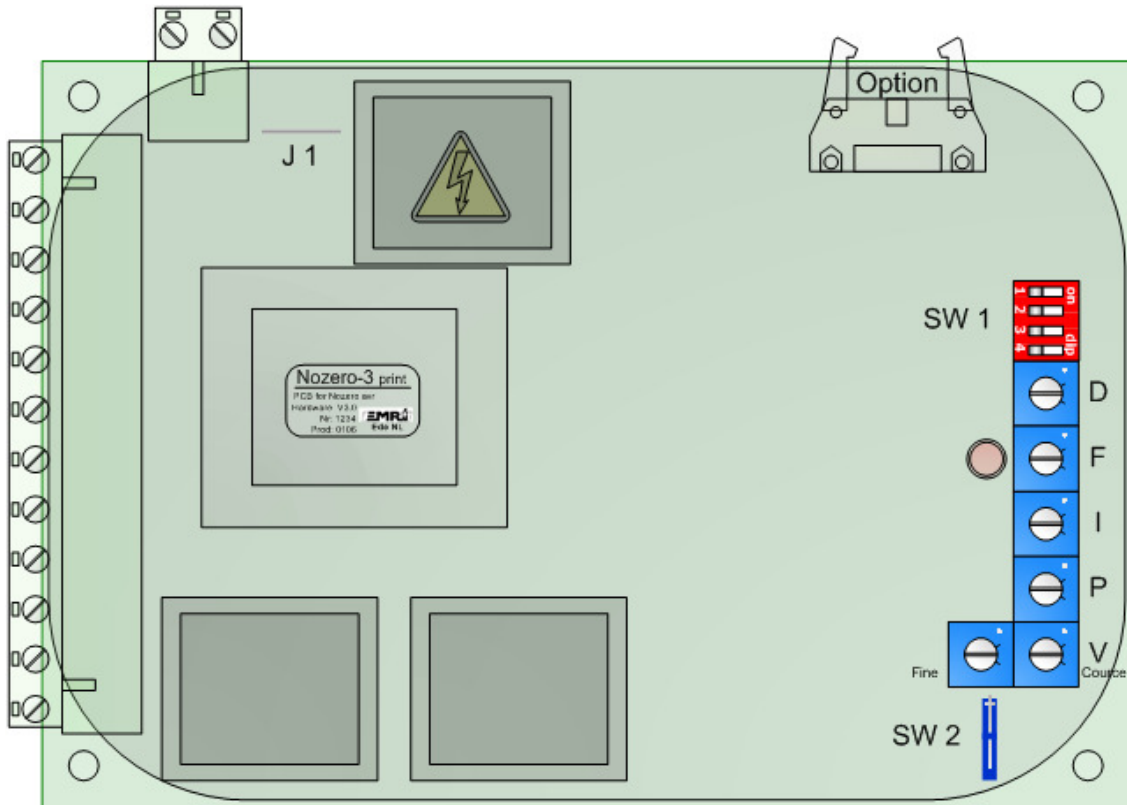


**Fig 4. Interfaces overview**

Symbol	Description	Notes
Underspeed / Phaseless Led	Underspeed / Phaseless indication	ON: Underspeed active / Phaseless detected

**Table 3. Interfaces**

## 2.1 Adjustments overview



**Fig 5. Adjustments overview**

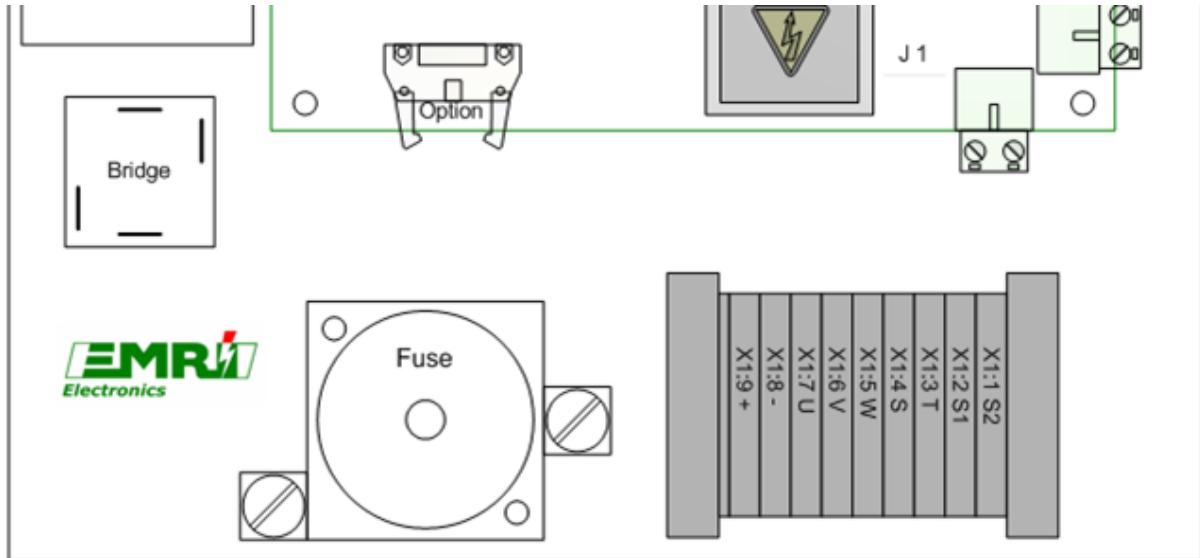
Symbol	Description	Notes
V <i>course</i>	Course generator voltage setpoint	$\pm 35\%$
V <i>fine</i>	Fine generator voltage setpoint	$\pm 2\%$
P	Proportional gain setpoint	
I	Integral time setpoint	
F	Underspeed setpoint	32 – 86 Hz
D	Voltage droop setpoint	For parallel operation. $U_{nom} \pm 18\%$
SW1.1	Soft underspeed trip Enable *	ON: Enabled
SW1.2	Slow / fast Voltage buildup	ON: Slow buildup
SW1.3	Sharp underspeed trip Enable *	ON: Enabled
SW1.4	Disable external potentiometer	ON: ext. pot. Disabled
SW2	Additional integrator capacity	Shorted: Add. Integrator Enabled
J1	Extended droop range	Link cut: Extended range Enabled

**Table 4. Adjustments**

\* NOTE When SW1.1 & SW1.3 are both off there is no underspeed trip. SW1.1 & SW1.3 should never be enabled at the same time.

## 2.2 Terminals overview

### 2.2.1 Terminals overview Nozero 35

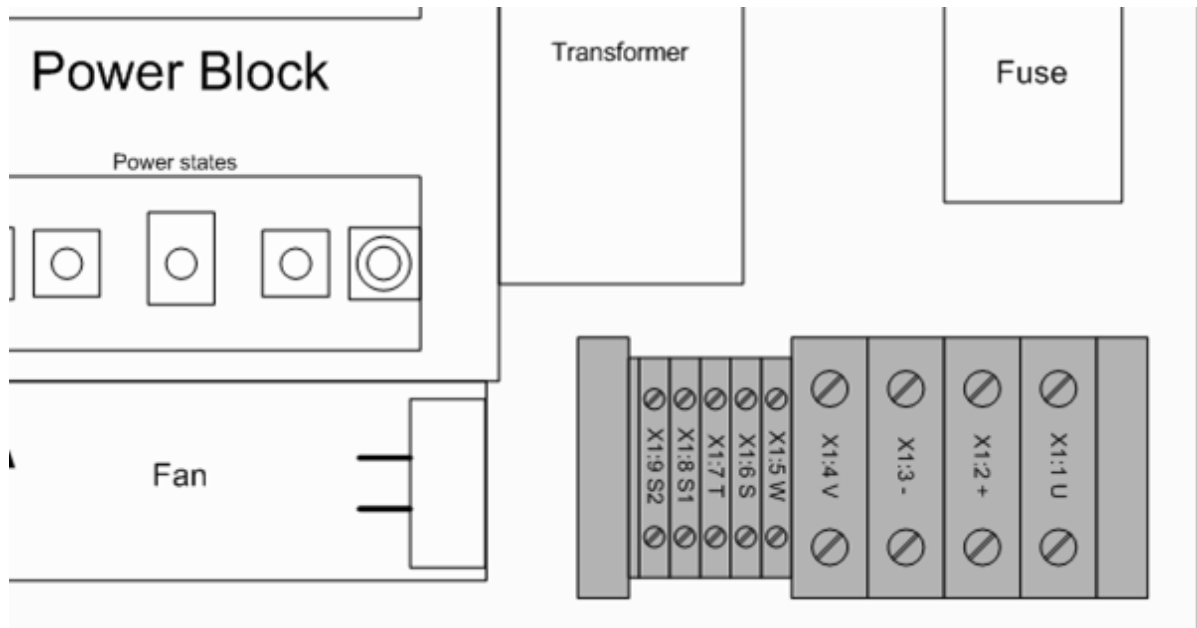


**Fig 6. Terminals overview Nozero 35**

Symbol	Description	Notes
X1:1 S2	CT input for droop	0.5A input
X1:2 S1	CT input for droop	0.5A input
X1:3 T	External voltage adjust input	10 kOhm potentiometer
X1:4 S	External voltage adjust input	10 kOhm potentiometer
X1:5 W	W phase sensing input	phase sequence U → V → W
X1:6 V	Field supply input / V phase sensing input	phase sequence U → V → W
X1:7 U	Field supply input / U phase sensing input	phase sequence U → V → W
X1:8 -	Field excitation output (Negative)	
X1:9 +	Field excitation output (positive)	

**Table 5. Terminals Nozero 35**

## 2.2.2 Terminals overview Nozero 100/150

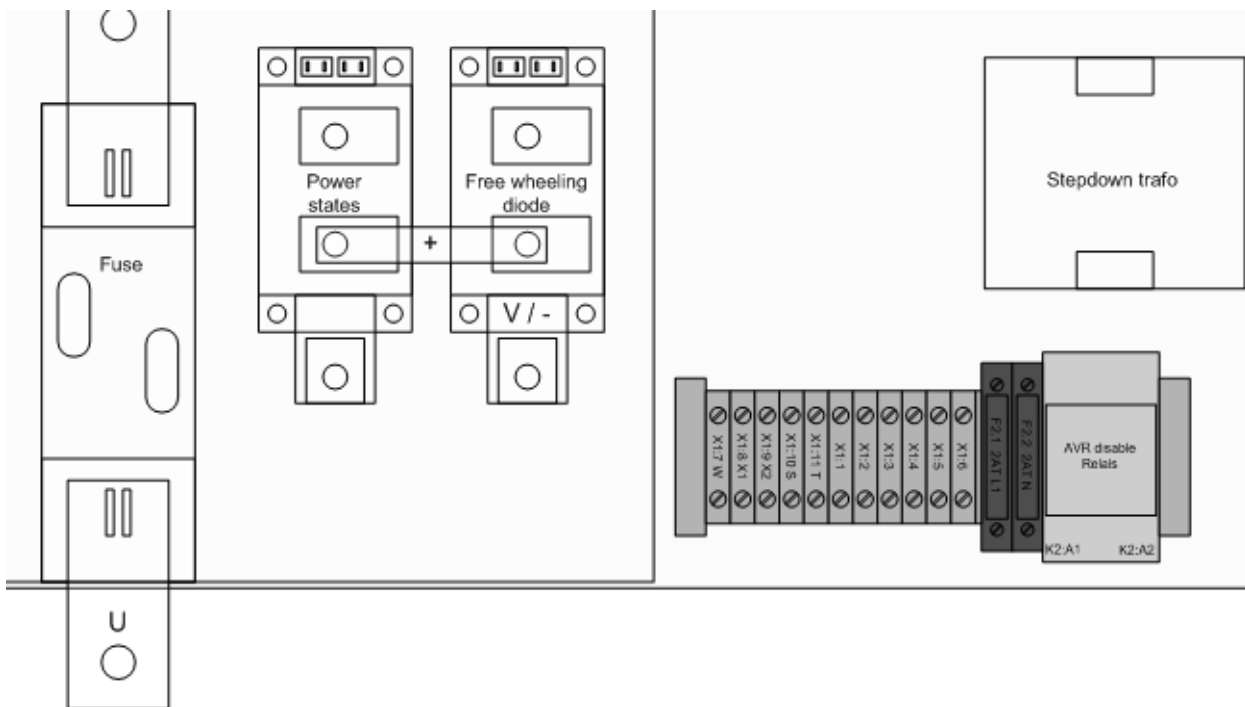


**Fig 7. Terminals overview Nozero 100/150**

Symbol	Description	Notes
X1:1 U	Field supply input / U phase sensing input	phase sequence U → V → W
X1:2 +	Field excitation output (positive)	
X1:3 -	Field excitation output (Negative)	
X1:4 V	Field supply input / V phase sensing input	
X1:5 W	W phase sensing input	
X1:6 S	External voltage adjust input	10 kOhm potentiometer
X1:7 T	External voltage adjust input	10 kOhm potentiometer
X1:8 S1	CT input for droop	0.5A input
X1:9 S2	CT input for droop	0.5A input

**Table 6. Terminals Nozero 100/150**

## 2.2.3 Terminals overview Nozero 250

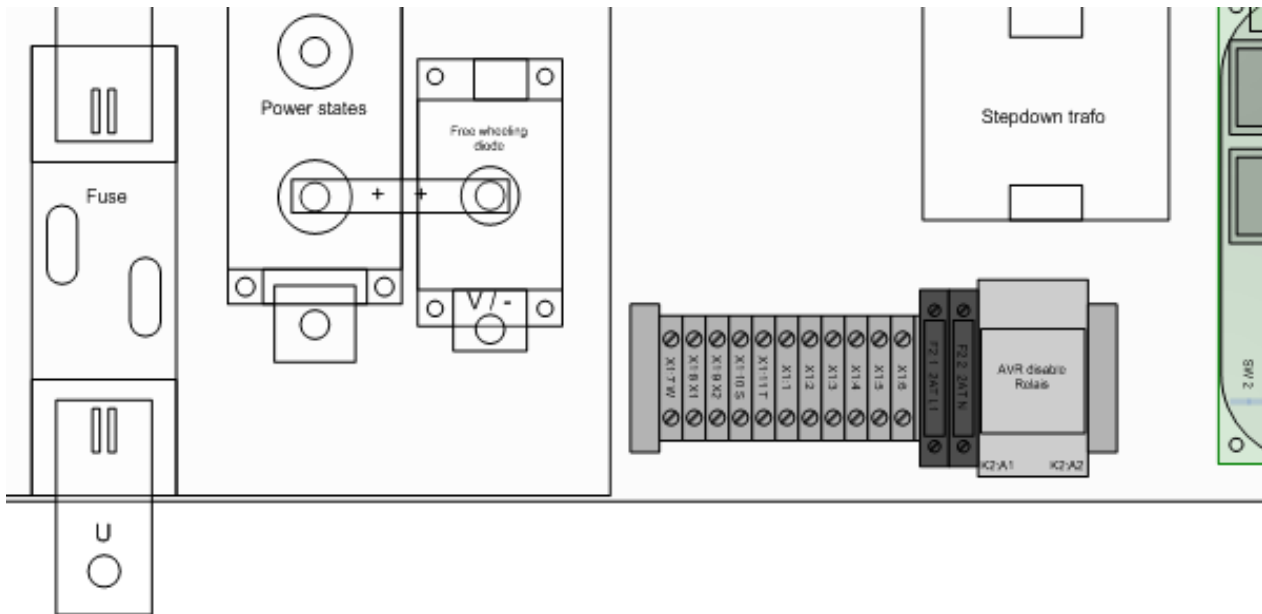


**Fig 8. Terminals overview Nozero 250**

Symbol	Description	Notes
U	Field supply input / U phase sensing input	phase sequence U → V → W
V/-	Field supply input, V phase sensing input Field excitation output (Negative)	phase sequence U → V → W
+	Field excitation output (positive)	
X1:1	Disable control unit	Open: control unit Enabled
X1:2	Disable control unit	Shorted: control unit Disabled
X1:3	Disable field flash	Open: field flash Disabled
X1:4	Disable field flash	Shorted: field flash Enabled
X1:5	Fan supply output	
X1:6	Fan supply output	
X1:7 W	W phase sensing input	phase sequence U → V → W
X1:8 X1	CT input for droop	0.5A input
X1:9 X2	CT input for droop	0.5A input
X1:10 S	External voltage adjust input	10 kOhm potentiometer
X1:11 T	External voltage adjust input	10 kOhm potentiometer
F2.1 L1	Fan supply input	
F2.2 N	Fan supply input	
K2:A1	AVR Disable input (Positive)	24Vdc relay coil
K2:A2	AVR Disable input (Negative)	24Vdc relay coil

**Table 7. Terminals Nozero 250**

## 2.2.4 Terminals overview Nozero 350



**Fig 9. Terminals overview Nozero 350**

Symbol	Description	Notes
U	Field supply input / U phase sensing input	phase sequence U → V → W
V/-	Field supply input, V phase sensing input Field excitation output (Negative)	phase sequence U → V → W
+	Field excitation output (positive)	
X1:1	Disable control unit	Open: control unit Enabled
X1:2	Disable control unit	Shorted: control unit Disabled
X1:3	Disable field flash	Open: field flash Disabled
X1:4	Disable field flash	Shorted: field flash Enabled
X1:5	Fan supply output	
X1:6	Fan supply output	
X1:7 W	W phase sensing input	phase sequence U → V → W
X1:8 X1	CT input for droop	0.5A input
X1:9 X2	CT input for droop	0.5A input
X1:10 S	External voltage adjust input	10 kOhm potentiometer
X1:11 T	External voltage adjust input	10 kOhm potentiometer
F2.1 L1	Fan supply input	
F2.2 N	Fan supply input	
K2:A1	AVR Disable input (Positive)	24Vdc relay coil
K2:A2	AVR Disable input (Negative)	24Vdc relay coil

**Table 8. Terminals Nozero 350**

## 3. Operation and maintenance

### 3.1 Modes of control

#### 3.1.1 Underspeed

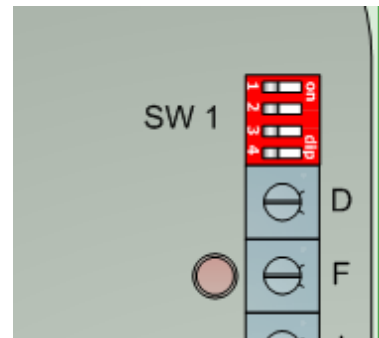
The Nozero has a build in underspeed function which acts when the generator frequency drops below the user-adjustable level. Depending on the dipswitch selection, a drop in generator frequency below the underspeed setpoint will either decrease the generator voltage proportional to the drop in frequency, or decrease the voltage setpoint by 50%. For further information see chapter 5.3 Underspeed.

#### 3.1.2 Buildup

To prevent overexcitation and overshoot. The buildup speed of the generator voltage is selectable. The buildup speed can be set by dipswitch 1.2 to 3 or 5 Seconds to best match the generator physical characteristics.

SW1.2	Seconds
ON	$\pm 5$
OFF	$\pm 3$

**Table 9. Buildup**



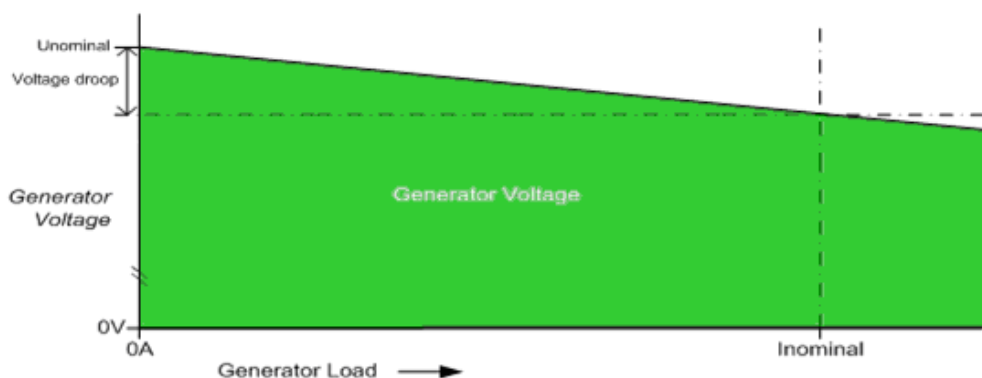
**Fig 10. Buildup**

### 3.2 Special Applications

#### 3.2.1 Parallel operation

If the generator is in parallel operation with one or more generators, load sharing can be accomplished by means of Quadrature Droop Compensation (QDC). The amount of voltage droop must be precisely set to be equal for all generators under equal load conditions.

The of the droop on generator depicted in



influence voltage the voltage is diagram 1.

**Diagram 1. Voltage droop**

## 4. Protections

### 4.1 Over current

The AVR is protected by an Ultra Rapid (UR) fuse in the AVR U phase. This fuse also protects the generator exciter field against damage caused by over-excitation. The fuse rating may be decreased when the standard fuse exceeds the generator maximum excitation current. For fuse ratings see Table 1. Absolute maximum ratings.

## 5. Settings and adjustments

### 5.1 Generator Voltage

The generator voltage setpoint is user adjustable by means of two voltage potentiometers. The course voltage potentiometer range is  $U_{nom} \pm 35\%$ . The fine voltage potentiometer range is  $U_{nom} \pm 2\%$ . Turning the potentiometers clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage.

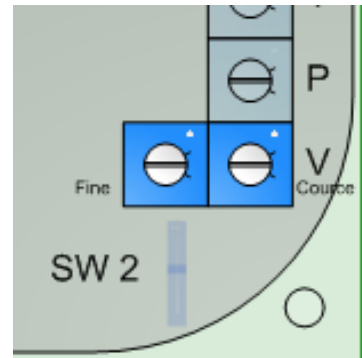


Fig 11. Voltage adjustments

### 5.2 Stability

The generator stability and control response are adjustable by means of the proportional and integral action potentiometers. Turning the proportional action potentiometer clockwise increases the proportional gain, turning counter clockwise decreases the proportional gain.

Turning the integral action potentiometer clockwise increases integral time, turning counter clockwise decreases the integral time.

Tuning the PI-controller must be performed by a control specialist to prevent damage to the AVR and generator. If no

sable operation can be established an additional capacitor be added by closing switch 2.

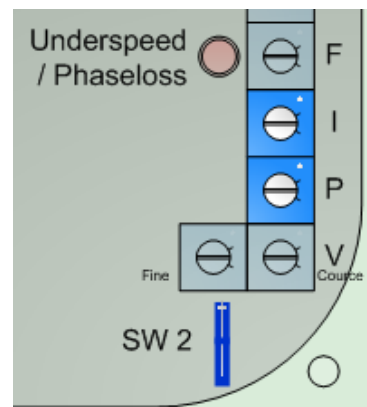


Fig 12. Stability adjustments

the

can

### 5.3 Underspeed

The underspeed trip frequency is adjustable by means of potentiometer F. Turning the potentiometer clockwise decreases the trip frequency to 32Hz, turning potentiometer F counter clockwise increases the trip frequency to 86Hz.

Setting the underspeed trip frequency is done by running the generator at normal frequency and turning potentiometer F counter clockwise until the red LED lights, then turning the potentiometer clockwise until the LED is off again(\*) and the generator voltage switches back to normal.

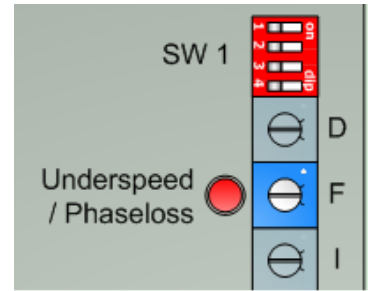


Fig 13. Underspeed adjustments

The underspeed behaviour is selectable by means of dipswitches 1.1 & 1.3. Setting dipswitch 1.1 to ON causes the generator voltage to drop relative to drop of the generator frequency. When dipswitch 1.3 is set to ON the generator voltage is lowered to  $\pm 50\%$  if the generator frequency falls below the underspeed setpoint. Dipswitch 1.1 & 1.3 should never be ON at the same time.

\* NOTE It is recommended to turn the potentiometer a little further counter clockwise to allow for short frequency dips.

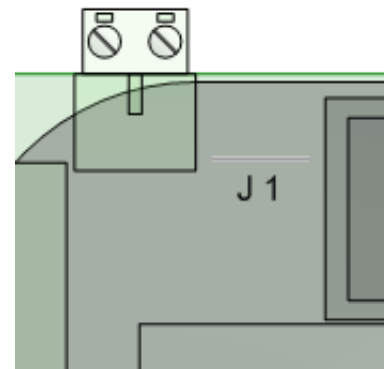
### 5.4 Droop

When the generator is in parallel operation with one or more generators, Quadrature Droop Compensation is used to enable load sharing. The amount of voltage droop can be adjusted by means of the droop potentiometer.

The droop potentiometer range is  $U_{nom} \pm 18\%$ . Turning the potentiometer clockwise increases the voltage droop, turning counter clockwise decreases the voltage droop.

If the generator is not operating in parallel, turn the droop potentiometer completely counter clockwise to disable voltage droop. When the normal droop range is not enough jumper J1 can be cut to extend the range.

For a more detailed description of voltage droop see chapter 3.2.0.



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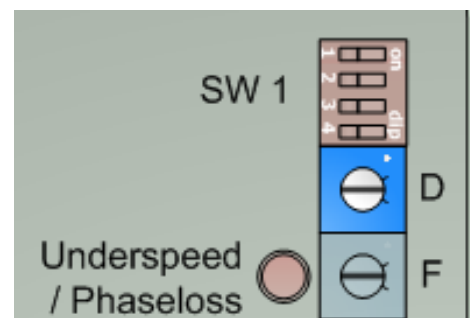
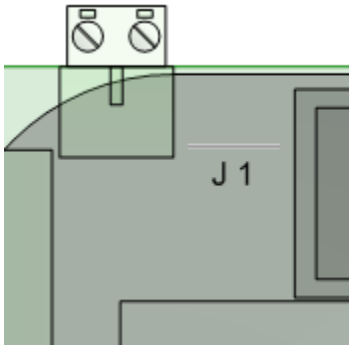


Fig 14. Droop adjustment

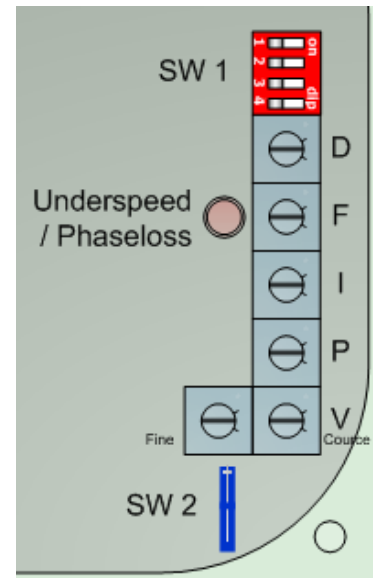
## 5.5 dipswitch settings



**Fig 15. Jumper**

Parameter	Description
Switch 1.1	Soft underspeed trip (see chapter 5.3)
Switch 1.2	Voltage buildup speed (see chapter 3.1.2)
Switch 1.3	Sharp underspeed trip (see chapter 5.3)
Switch 1.4	On: Disables the external potentiometer (S/T)
Switch 2	Additional integrator capacity(see chapter 5.2)
J1	Extended droop range (see chapter 5.4)

**Table 10. Dipswitch settings**



**Fig 16. Dipswitches**

## 5.6 Factory settings

All new or AVR's returned from service are supplied with factory settings as described in table 12. Adjusting the factory settings must only be performed by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

Parameter	Value	Unit/Note
Generator voltage setpoint	400	V <sub>AC</sub>
Proportional action	Middle	
Integral action	Middle	
Underspeed trip	47	Hz
Droop	0	V
Switch 1.1	Off	Sharp underspeed trip
Switch 1.2	Off	Fast buildup
Switch 1.3	On	Sharp underspeed trip
Switch 1.4	On	S,T shorted
Switch 2	Off	No additional Cap.
J1	Not cutted	

**Table 11. Factory settings**

## 6. Special features

### 6.1 Self excitation

All Nozero type AVR's feature self excitation capability. This will ensure voltage buildup when there is not enough residual voltage to supply the AVR itself.

In case of the Nozero 250 and 350 this feature should be disabled before the control unit is disabled. For further details about AVR Disable see chapter 6.2

### 6.2 AVR Disable inputs (250/350 Only)

The Nozero 250 and 350 can be disabled with contacts X1:1 to X1:6 and K2:A1, K2:A2. Making contact X1:1-X1:2 disables the AVR control unit. Breaking contact X1:3-X1:4 disables the self excitation function. Contact X1:1-X1:2 should never be closed before Contact X1:3-X1:4 is opened, doing so the AVR will start building up voltage again. Rapid consecutive enabling / disabling or enabling when there is still generator voltage present is not recommended.

Contacts X1:1-X1:2 and X1:3-X1:4 are pre wired to relay K2. This makes it possible to completely disable the AVR with a 24Vdc signal.

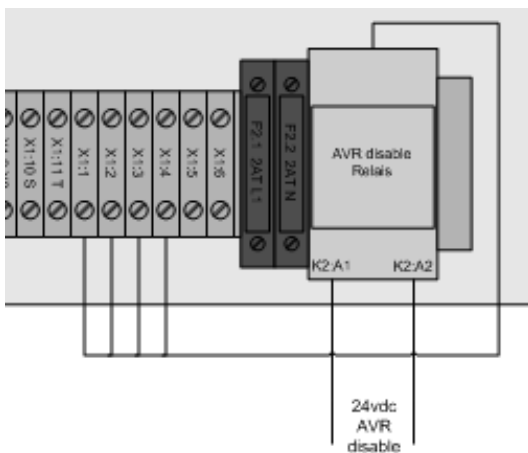


Fig 17. Pre wired AVR disable

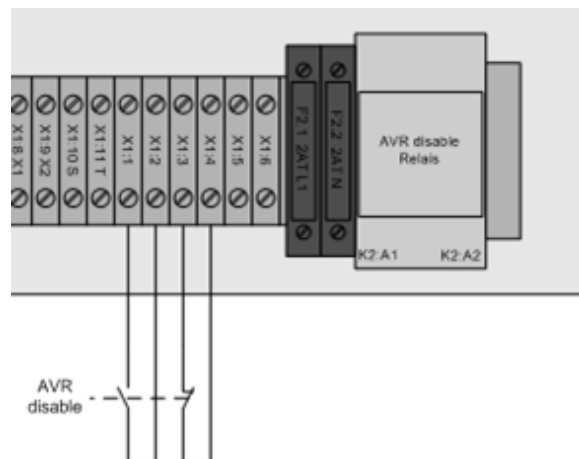


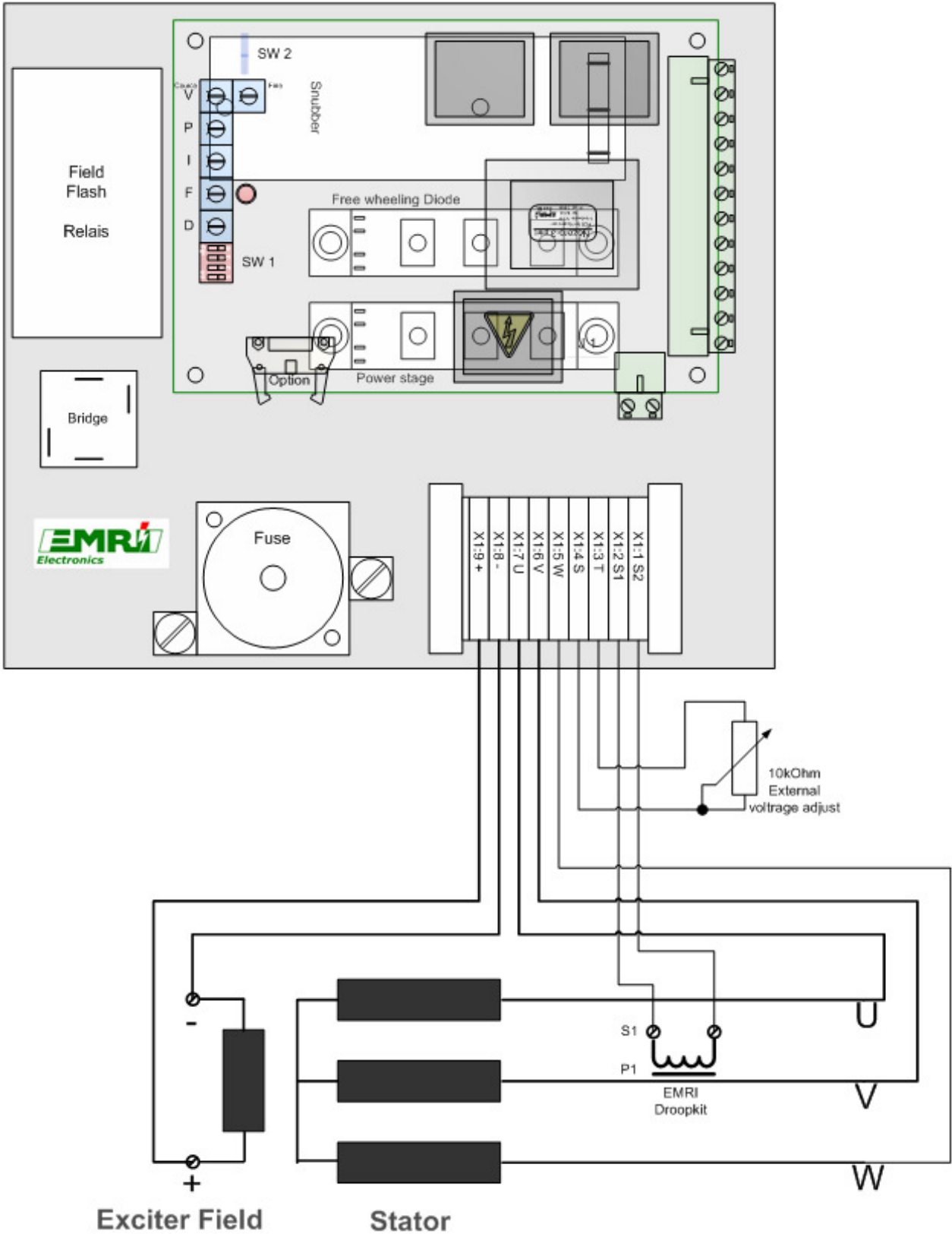
Fig 18. user specific AVR disable

### 6.3 External Fan supply (250/350 Only)

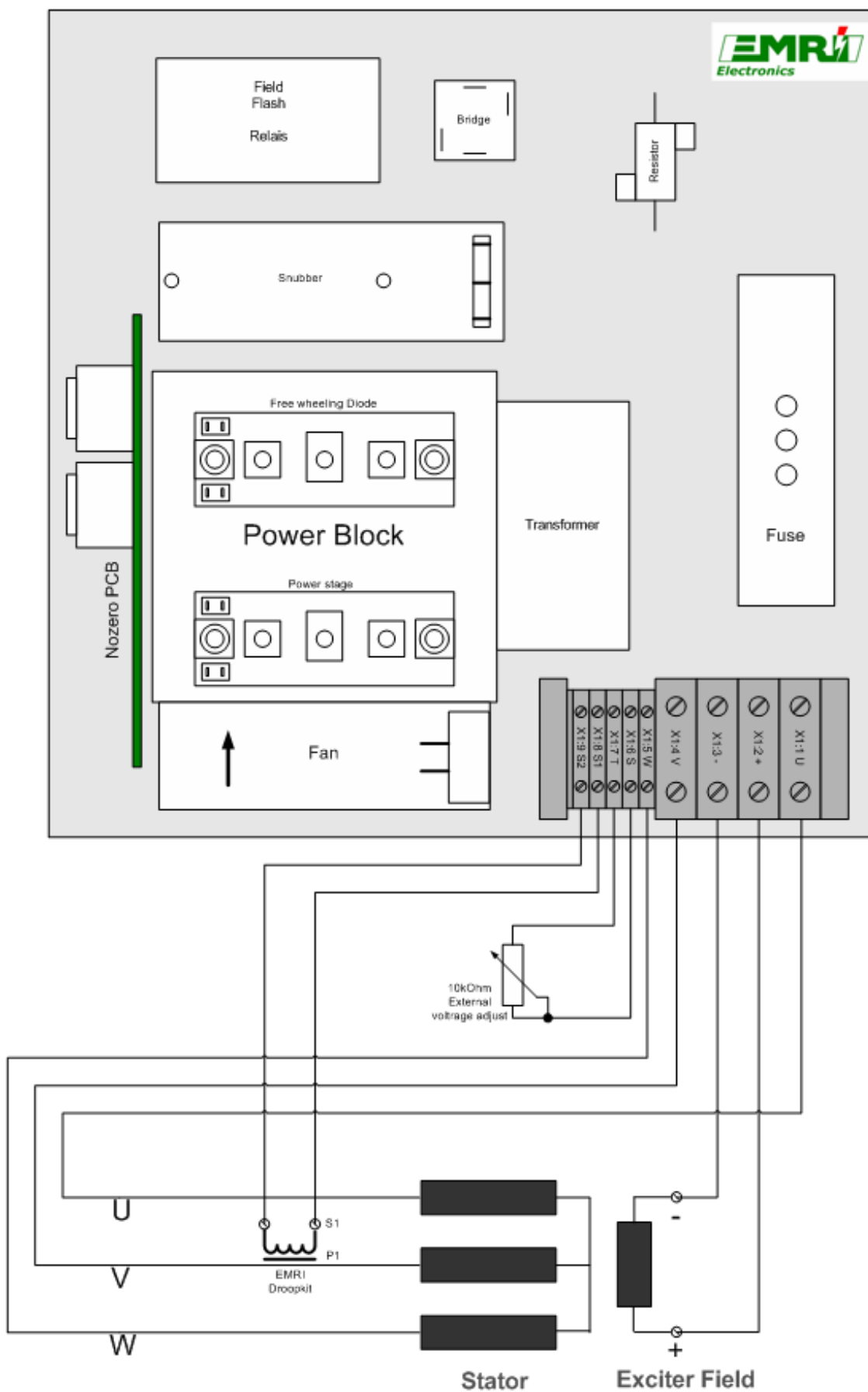
The AVR is cooled by a Fan. Default the cooling Fan is supplied by the AVR itself. However it is possible to supply the Fan externally. This can be achieved by removing the wires between X1:5-X1:6 and F2.1-F2.2 and connecting a 240Vac supply to F2.1-F2.2.

# 7. WIRING DIAGRAMS

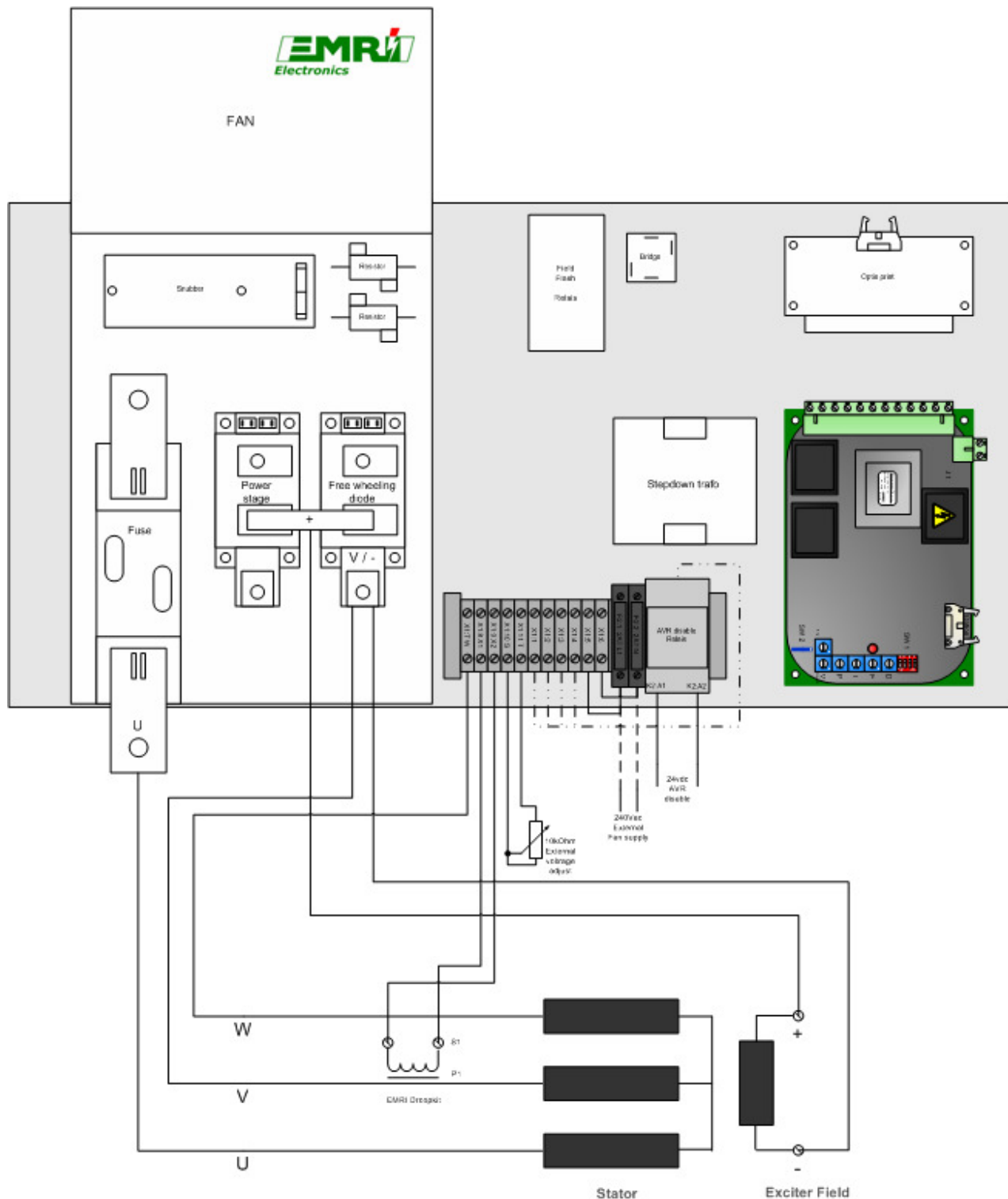
## 7.1 Wiring diagram Nozero 35



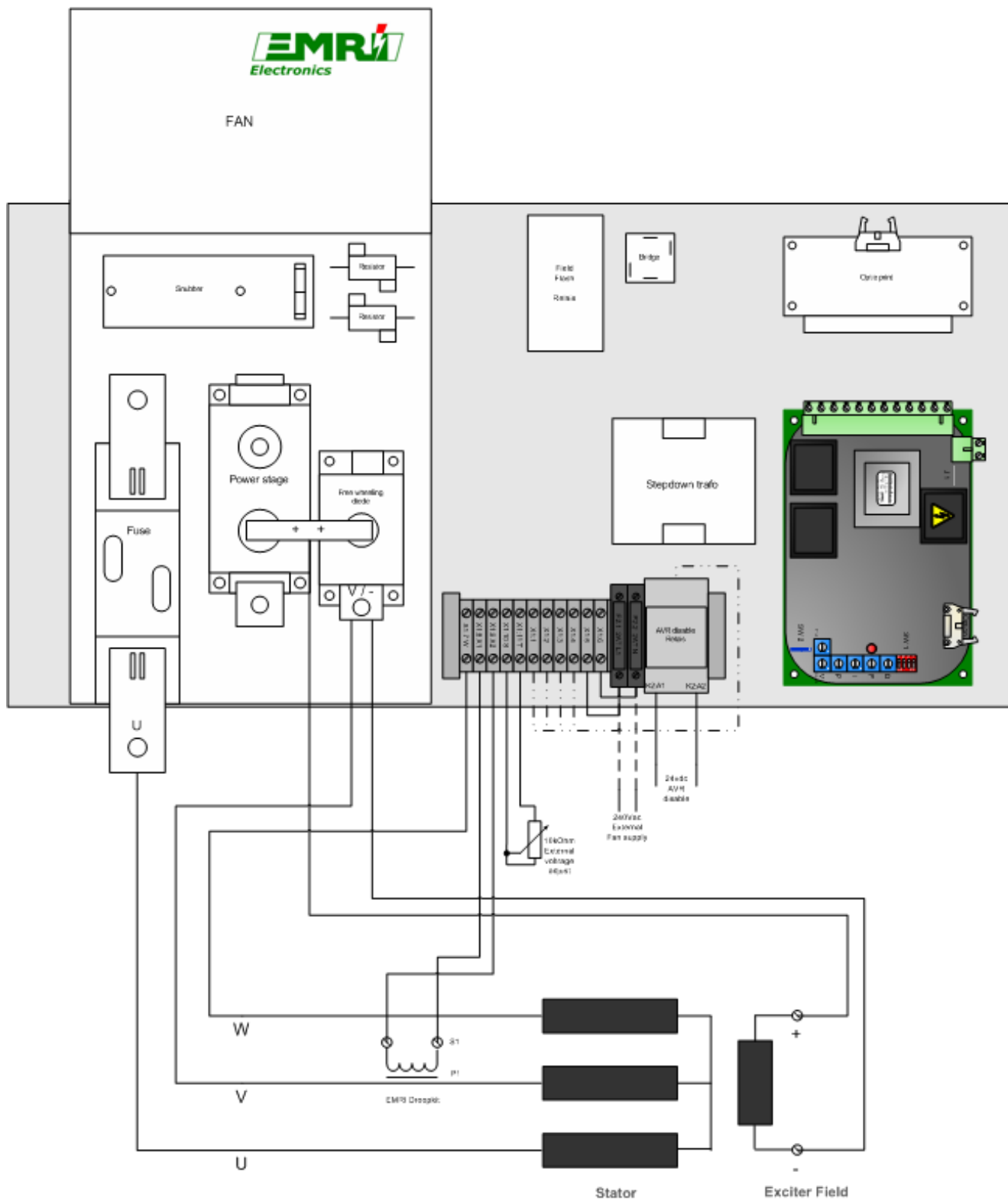
## 7.2 Wiring diagram Nozero 100/150



### 7.3 Wiring diagram Nozero 250



## 7.4 Wiring diagram Nozero 350



# Appendix

## A.1 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.
- Mounting of the product should be done in such a way that maximum cooling (direction of cooling ribs and direction of airflow) is achieved.
- Mounting of the product should be done in such a way that no humid air can flow through the product or condensation occurs.
- Mounting of the product should be done in such a way that dust or other materials or residue will not remain in or on the product.
- Mounting of the product should be done in such a way that the maximum vibration is not exceeded.
- Mounting of the product should be done in such a way that personal contact with persons is impossible.

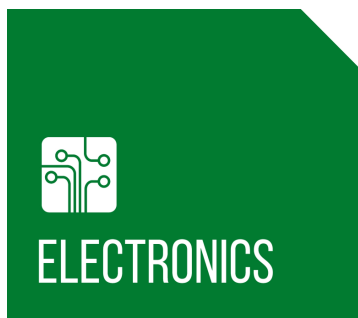
### Wiring

- 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 + and -, or Phase and neutral, X1 and X2, or S1 and S2.
- 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 + and - 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 sags and peaks 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.

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