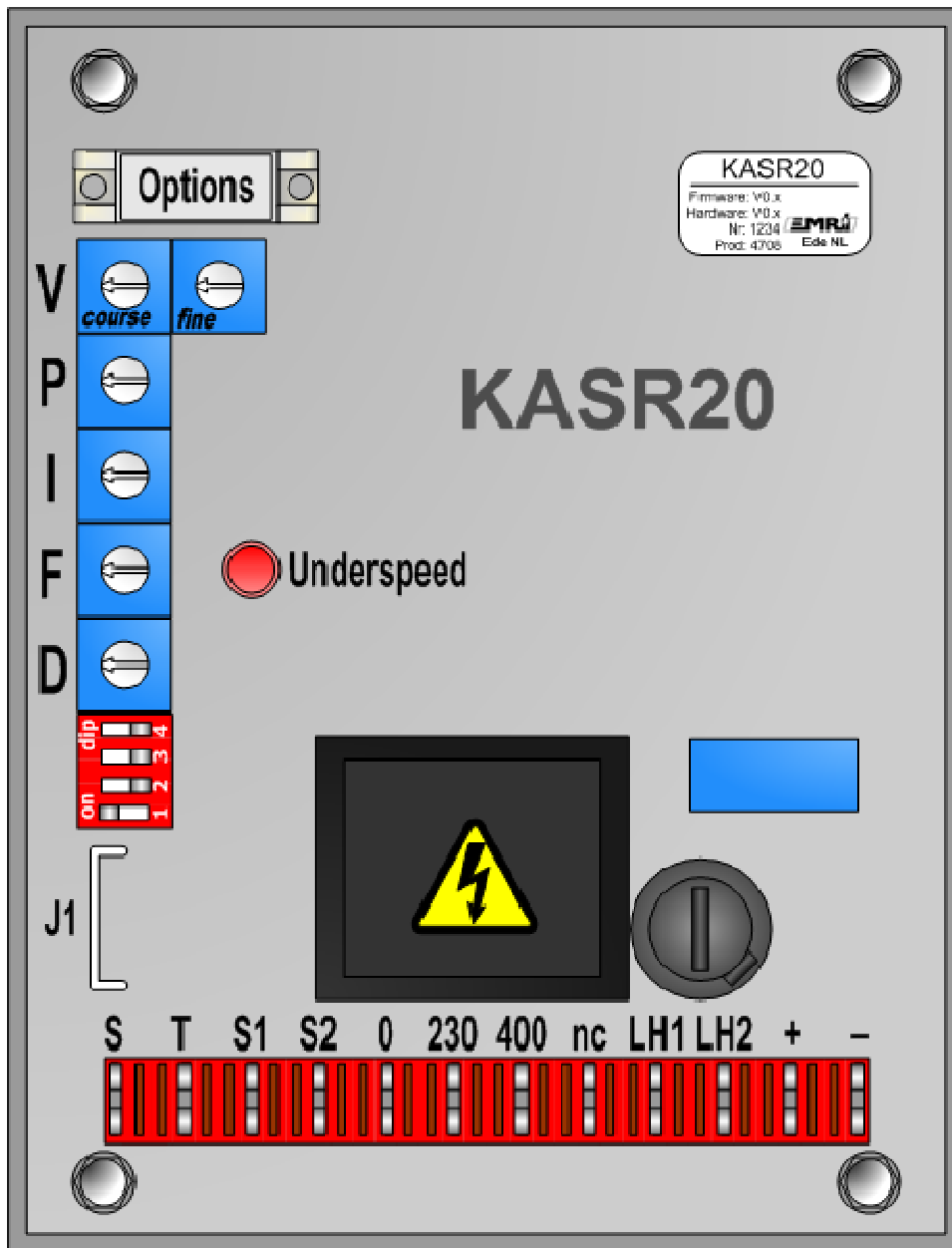


KASR20 v2.0

Voltage regulator for generators



March 2012

Instruction Manual



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**



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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

1.1 General description

This manual contains instructions for installing, operating and maintaining the KASR20 automatic voltage regulator (AVR).

The KASR20 is an easy to use automatic voltage regulator, suitable for single and three phase applications.

1.2 AVR Layout

The AVR is protected from the environment by a PUR coating.

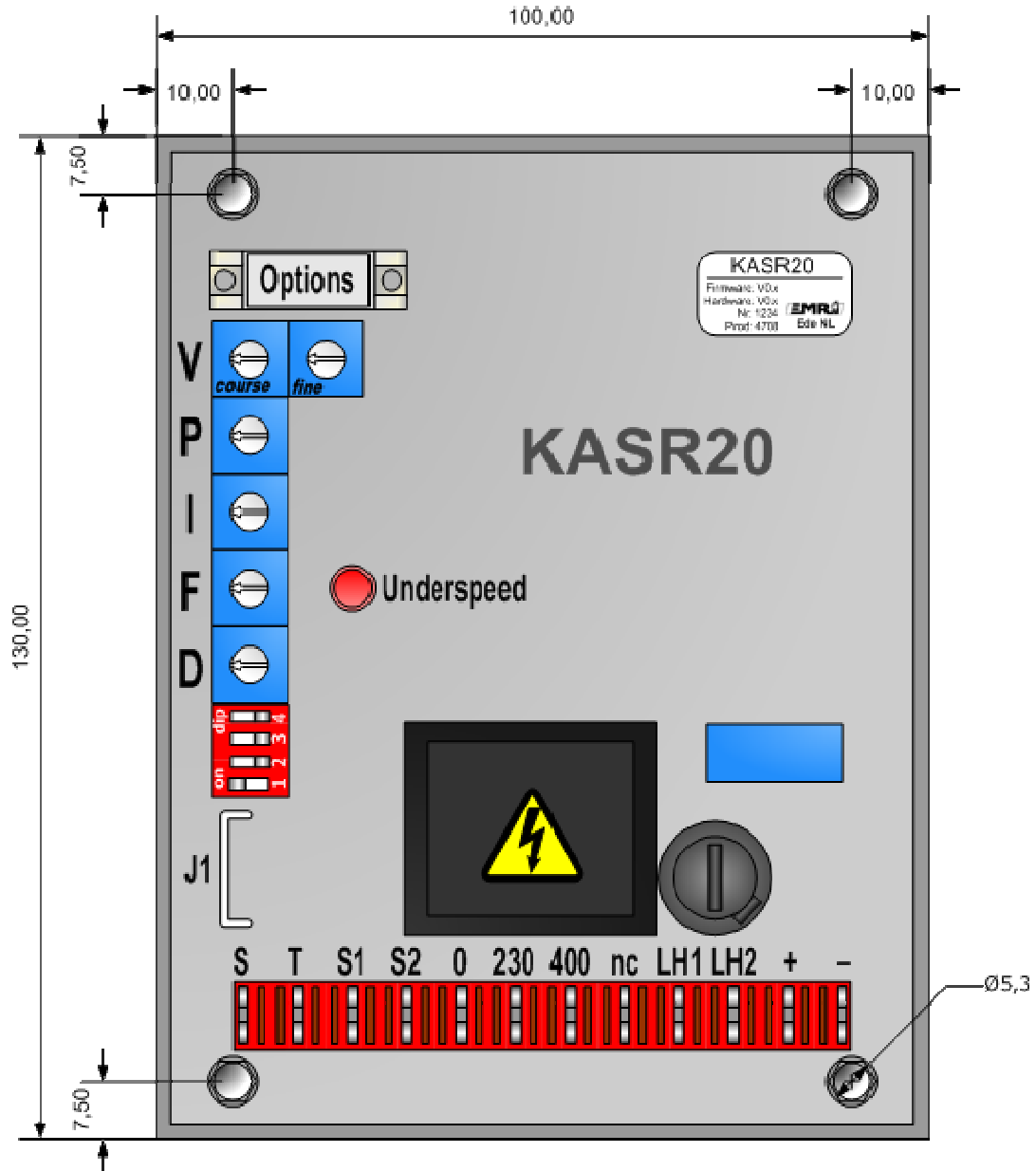


Fig 1. AVR layout

- Measurements in mm
- Height ± 75 mm
- All four mounting points must be used to insure the mechanical integrity

1.3 Electrical characteristics

Symbol	Parameter	Condition	Min	Max.	Unit
0-230	Voltage sensing input	50 Hz	-	250	V _{AC}
		60 Hz	-	275	V _{AC}
0-400	Voltage sensing input	50 Hz	-	440	V _{AC}
		60 Hz	-	480	V _{AC}
+/-	AVR field current		-	12.5	A _{DC}
LH1-LH2	Supply input* ¹	50-60 Hz	100	295	V _{AC}
		Minimum supply input required for self excitation.	3.5	-	V _{AC}
T _{AMB}	Operating temperature	95 % RHD non condensing	0	+40	°C
T _{STG}	Storage temperature	95 % RHD non condensing	-20	+85	°C
U _{DRIFT}	Voltage drift with T	T _{RISE} 30 °C, THD < 5%		0.5	%
S1-S2	Droop CT	Isolated CT (J1 closed)	-	1	A _{AC}
		(J1 open)	-	0.5	A _{AC}
S-T	External Volt adjust	10kΩ potentiometer	-	10	kΩ

Table 1. Electrical characteristics

*¹ : LH1-LH2 must be supplied by the generator e.g. phase-neutral, PMG or auxiliary windings

1.4 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
0-230	Voltage sensing input	50 Hz	-	265	V _{AC}
		60 Hz	-	290	V _{AC}
0-400	Voltage sensing input	50 Hz	-	460	V _{AC}
		60 Hz	-	500	V _{AC}
+/-	AVR field current	Continuous	-	12.5	A _{DC}
	AVR field voltage	< 1 Sec DC % of supply voltage (RMS)		20 35	A _{DC} % _{DC}
LH1-LH2	Supply input	Single phase	80	300	V _{AC}
R _{field}	Field resistance		2	-	Ω
T _{AMB}	Operating temperature	95 % RHD non condensing	0	+40	°C
T _{STG}	Storage temperature	95 % RHD non condensing	-20	+85	°C
S1-S2	Droop CT	Isolated CT < 30 s (J1 closed)	-	2	A _{AC}
		(J1 open)	-	1	A _{AC}
S-T	External Volt adjust		-	10	kΩ
Fuse	Fuse rating	Time delay		10	AT

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.

1.5 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 chapter 7.

2.1 Interfaces overview

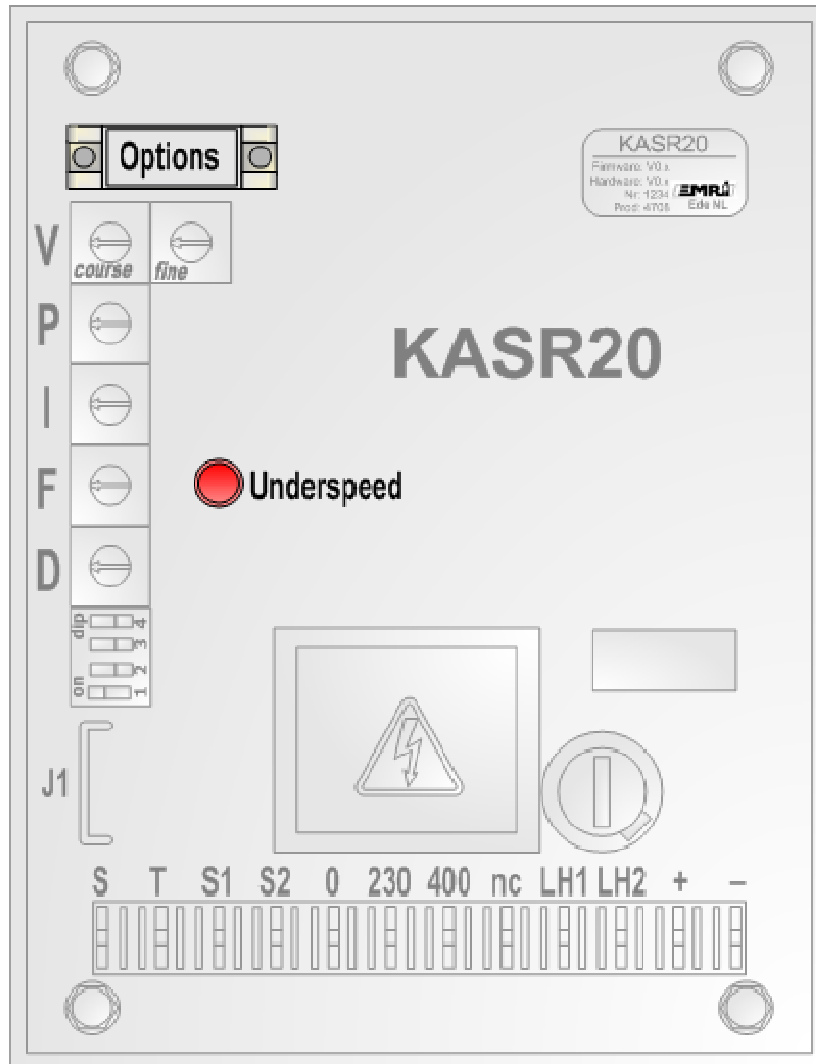


Fig 2. Interfaces overview

Symbol	Description	Notes
Underspeed	Underspeed active LED	When the LED is on, underspeed limiting is active.
Options	Connector for optional extensions. Refer to 6.1.	If no extensions are connected the dummy termination header must be connected.

Table 3. Interfaces

2.2 Adjustments overview

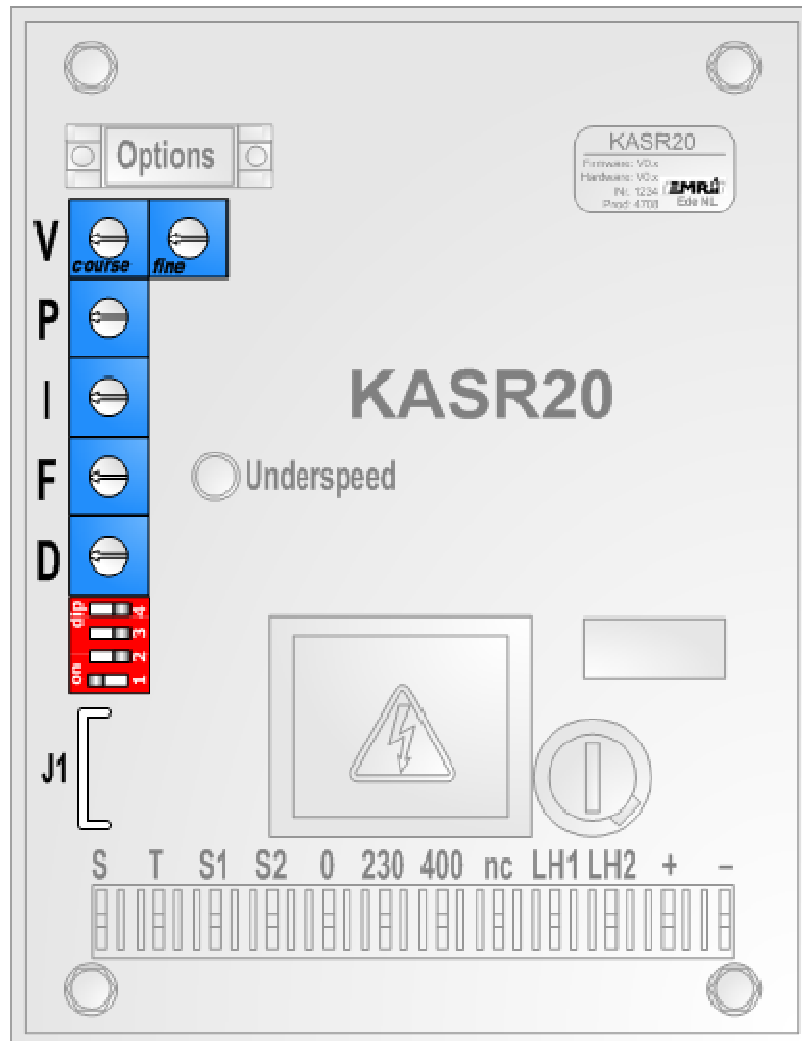


Fig 3. Adjustments overview

Symbol	Description	Notes
V_{course}	Generator voltage course adjustment	
V_{fine}	Generator voltage fine adjustment	
P	Control loop proportional gain	
I	Control loop integral action	
F	Underspeed frequency setpoint	
D	Voltage droop setpoint	For parallel operation. $U_{nom} \pm 10\%$
Dipswitch.1	Disable extern voltage adjust	On = short terminals S & T
Dipswitch.2	1/2 phase sensing	On = 1/2 phase sensing.
Dipswitch.3	Stability range selection	Off = Normal I-time
Dipswitch.4	Underspeed trip	Off = enabled
J1	Droop CT selection	Closed = 1 A, Open = 0.5 A

Table 4. Adjustments

2.3 Terminals overview

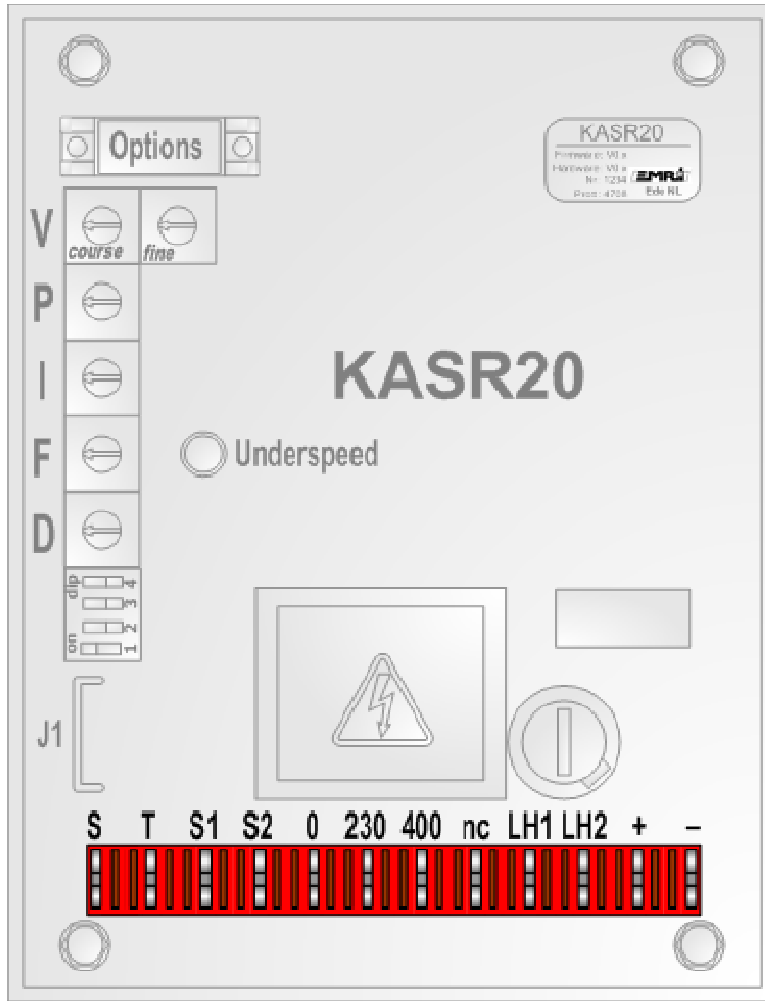


Fig 4. Terminals overview

Symbol	Description	Notes
S/T	External voltage adjust input	If not used set Dipswitch.1 ON
S1/S2	CT input for droop	
0	Neutral voltage sensing input	
230	230V sensing input	
400	400V sensing input	
nc	Not connected	Leave unconnected
LH1/LH2	Supply input	
+/-	Field excitation output	

Table 5. Terminals

3. Operation and maintenance

3.1 Modes of control

3.1.0 Underspeed

The KASR20 has a build in frequency trip function. This function drops the generator voltage relative to drop of the generator frequency. For further information see chapter 5.3 Underspeed.

3.2 Special Applications

3.2.0 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).

When parallel operation with QDC is required, voltage sensing of U and W must be used.

The amount of voltage droop must be precisely set to be equal for all generators under equal load conditions. The influence of the voltage droop on the generator voltage is depicted in diagram 1. For further information see chapter 5.4 Droop.

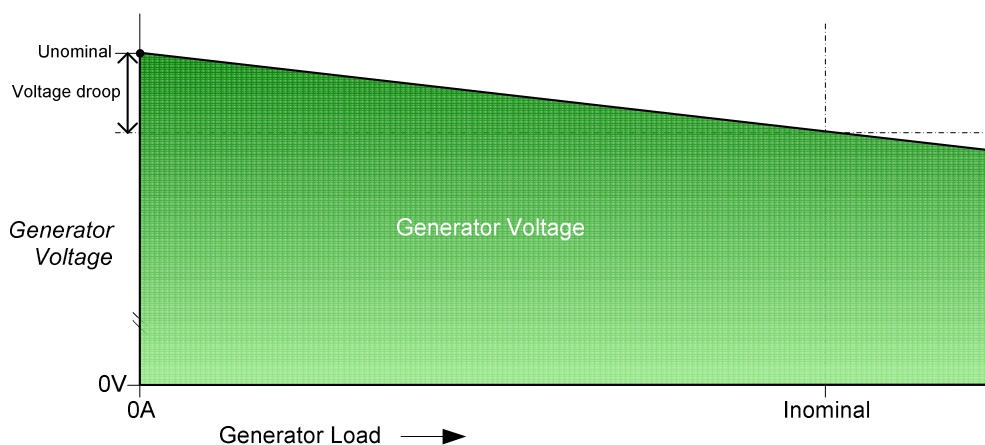


Diagram 1. Voltage droop

4. Protections

4.1 Over current

The AVR is protected by a 10A time delay fuse in the AVR supply line. This fuse also protects the generator exciter field against damage caused by over-excitation.

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 $U_{nom} \pm 25\%$. The fine voltage potentiometer range is $U_{nom} \pm 2.5\%$. Turning the potentiometers clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage.

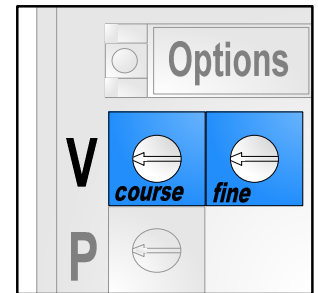


Fig 5. Voltage adjustments

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 decreases the integral time, turning counter clockwise increases the integral time.

Tuning the PI-controller must be performed by a control specialist to prevent damage to the AVR and generator.

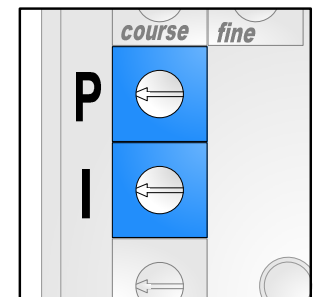


Fig 6. Stability adjustments

5.3 Underspeed

The underspeed trip frequency is adjustable by means of the potentiometer F. Turning the potentiometer clockwise decreases the trip frequency to 40Hz, turning potentiometer F counter clockwise increases the trip frequency to 59Hz.

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*¹ and the generator voltage is build up again.

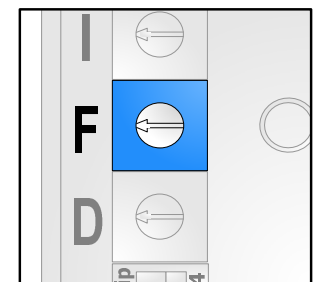


Fig 7. Underspeed adjustment

*1: 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.

When parallel operation with voltage droop is required, voltage sensing of phases U and W must be used.

The droop potentiometer range is $U_{nom} \pm 10\%$. 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 (D) completely counter clockwise to disable voltage droop.

J1 is used to select the droop CT. By default J1 is linked (closed) and set to 1 A_{ac}. When J1 is cut (open) the droop CT is set to 0.5 A_{ac}.

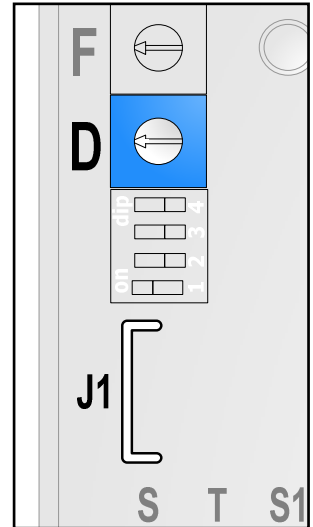


Fig 8. Droop adjustments

For a more detailed description of voltage droop see 3.2.0.

5.5 External potentiometer (S-T)

The generator voltage setpoint can be adjusted by means of an external 10kOhm potentiometer or by an isolated 0-10Vdc source. When this is desired, dipswitch 1 must be switched off.

When a 10kOhm potentiometer is used a value of 0 Ohm has no effect on the generator voltage setpoint. Increasing the potentiometer resistance decreases the generator voltage setpoint, upto +/- 15% at 10kOhm.

When a 0-10Vdc source is used, a resistive divider must be installed according Fig. 10. The 10kOhm to 100kOhm series connected potentiometer can be used to adjust the bandwidth and resolution. An increase in DC voltage will cause an increase in the generator voltage setpoint.

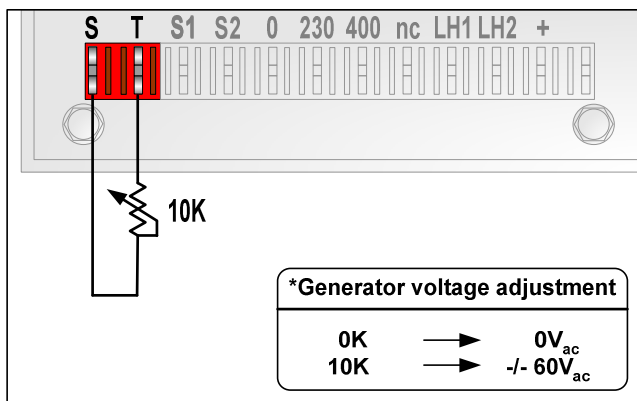


Fig 9. External potentiometer

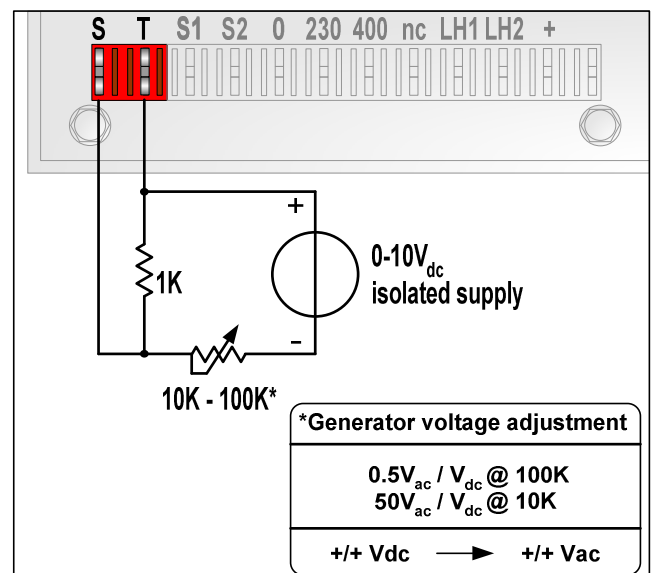


Fig 10. External voltage source

5.6 Dipswitch settings

Before any dipswitch settings are altered the generator must be stopped and the AVR power supply must be disconnected. A short description can be found in table 6; in the following paragraphs a more elaborate explanation of each individual switch is provided.

Factory default dipswitch settings can be found in paragraph 5.6.

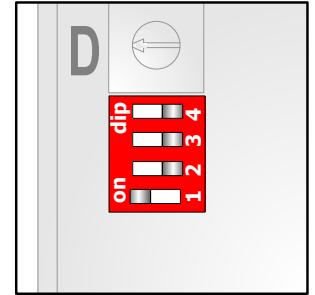


Fig 11. Dipswitch

Symbol	Description	Notes
Dipswitch 1	S-T link	Off = Ext. Pot. enabled On = S-T internally shorted
Dipswitch 2	½ phase sensing	Off = Full phase sensing On = ½ phase sensing
Dipswitch 3	Stability range selection	Off = Normal I-time On = Increased I-time
Dipswitch 4	Underspeed trip	Off = Enabled On = Disabled

Table 6. Dipswitch settings

5.6.1 Dipswitch 1: S-T link

When no external potentiometer is fitted on terminals S-T the dipswitch must be switched on, effectively shorting terminals S-T. When an external potentiometer is fitted the dipswitch must be switched off.

5.6.2 Dipswitch 2: ½ phase sensing

Switching dipswitch 2 on enables ½ phase sensing. In this case the AVR controls the voltage measured at its sensing terminals down to ½ of the nominal value; 200V when the 0-400V terminals are used, 115V when the 0-115V terminals are used.

When the dipswitch is switched off the AVR controls the voltage measured at its sensing terminals to the nominal voltage

5.6.3 Dipswitch 3: Stability range selection

When dipswitch 3 is switched on additional Integral action for the AVR PI controller is added. This can add for improving stability for larger rated or slow rotating generators. In most normal operating conditions dipswitch 3 is left switched off.

5.6.4 Dipswitch 4: Frequency trip

When dipswitch 4 is switched off the trip slope is selected for the underspeed protection. This reduces the generator voltage to a fixed level when the generator frequency drops below the underspeed threshold (adjustable with potentiometer U).

If no underspeed protection at all is desired, dipswitch 4 must be switched on.

5.7 Factory settings

All new or AVR's returned from service are supplied with factory settings as described in table 7. 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
Output Voltage	400	Vac
Proportional action	50	%
Integral action	50	%
Underspeed trip	47	Hz
Droop	0	V
Dipswitch.1	On	
Dipswitch.2	Off	
Dipswitch.3	Off	
Dipswitch.4	Off	
J1	Closed	

Table 7. Factory settings

6. Tips & Suggestion

6.0 Instability

In application where there is a low excitation current, the stability could be improved by adding a resistor parallel to the exciter field.

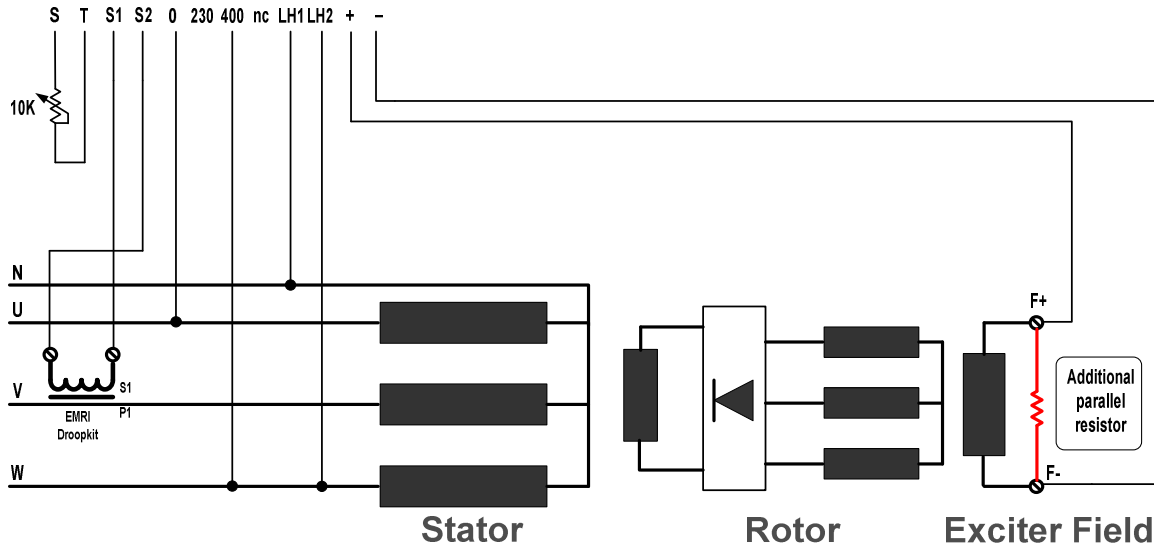


Fig 12. Addition field resistor

6.0.1 Example

Generator excitation field specifications:

- 40 Volt
- 20 Ohm

By adding a 33 Ohm parallel resistor the excitation current raises 1.2A. $(40 / 33)$ This will improve stability. When choosing a resistor the dissipation of the resistor should be taken in consideration. In this example the dissipation rating of the resistor should be 50 Watt. $(40^2 / 33)$

6.1 Options

The KASR20 AVR can be functionally extended with the following options:

Type	Description	Interface
Droopkit	Required for parallel operation	AVR terminals S1-S2
LX_VPH	Softstart and VPH control	AVR options connector
COSPFI3.2	Power factor control	AVR options connector
SETOPTION	Extended voltage setpoint range	AVR options connector
MULTIPOT	Contact selectable voltage setpoints	AVR options connector

Table 8. Options

When no options are installed, the pre-fabricated dummy connector must be fitted.

6.2 Generator insulation- / polarization index test

As a rule of thumb the testing voltage used during an insulation test is two times the nominal voltage of the winding under test. This exceeds the AVR ratings and may cause permanent damage to the AVR. Therefore the AVR must be disconnected completely from the generator. When performing an insulation test on the generator rotor disconnect the rotating rectifiers and any other components from the windings under test. This will prevent damage should the testing voltage exceed the rectifiers blocking voltage.

6.3 Field flashing

In case of a self excited generator it could be that the residual voltage level is too low for voltage to build up. Causes for a low residual voltage can be a prolonged period of stand still, excessive heating or mechanical shock and vibration.

6.3.1 Manual field flash

To restore the residual voltage the generator can be manual field flashed. In order to perform this safely the AVR must be completely disconnected from the generator. Next a potential free voltage (e.g. a 9V battery block) source is connected to the exciter field of the generator, while it's rotating. This will cause the generator voltage to rise and restore the residual voltage level.

6.3.2 Automatic field flash

If the residual voltage of the generator is permanently low, an automatic field flash unit can be used or a potential free voltage source which is automatically switched off when the generator voltage is within normal range. The generator voltage should not exceed nominal voltage when field flash is active, to prevent damage to the AVR. When using "Automatic field flash" there should always be a rectifier bridge in the output of the source/unit. For connection details see schematic below.

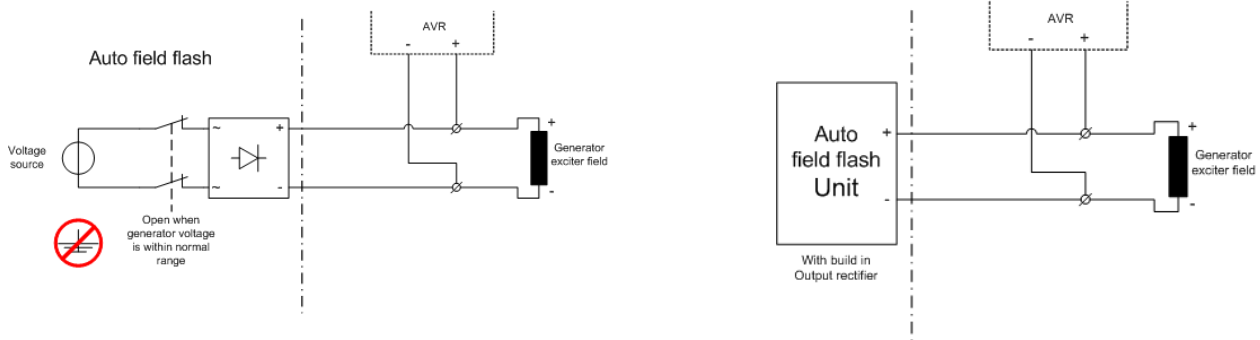
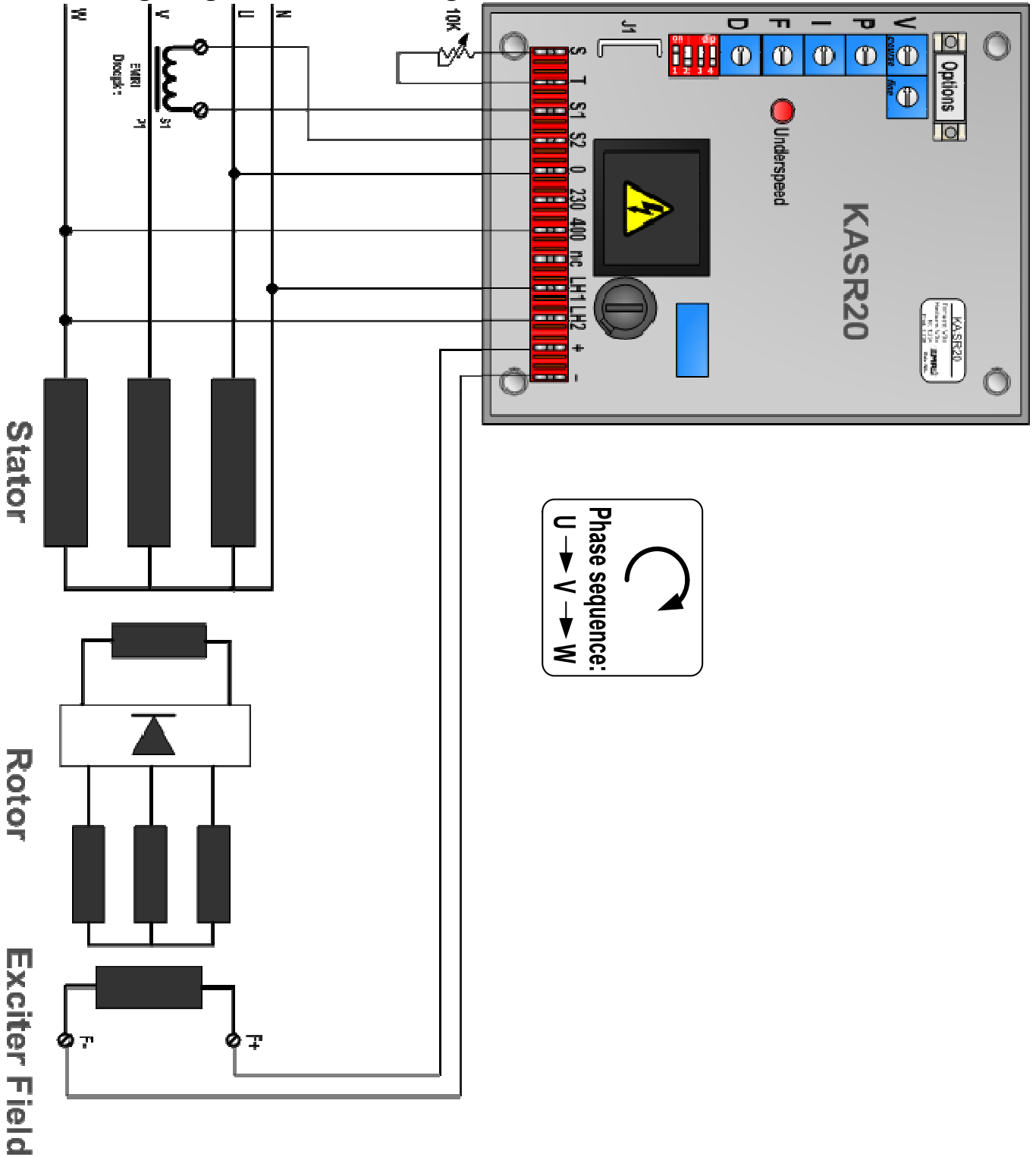


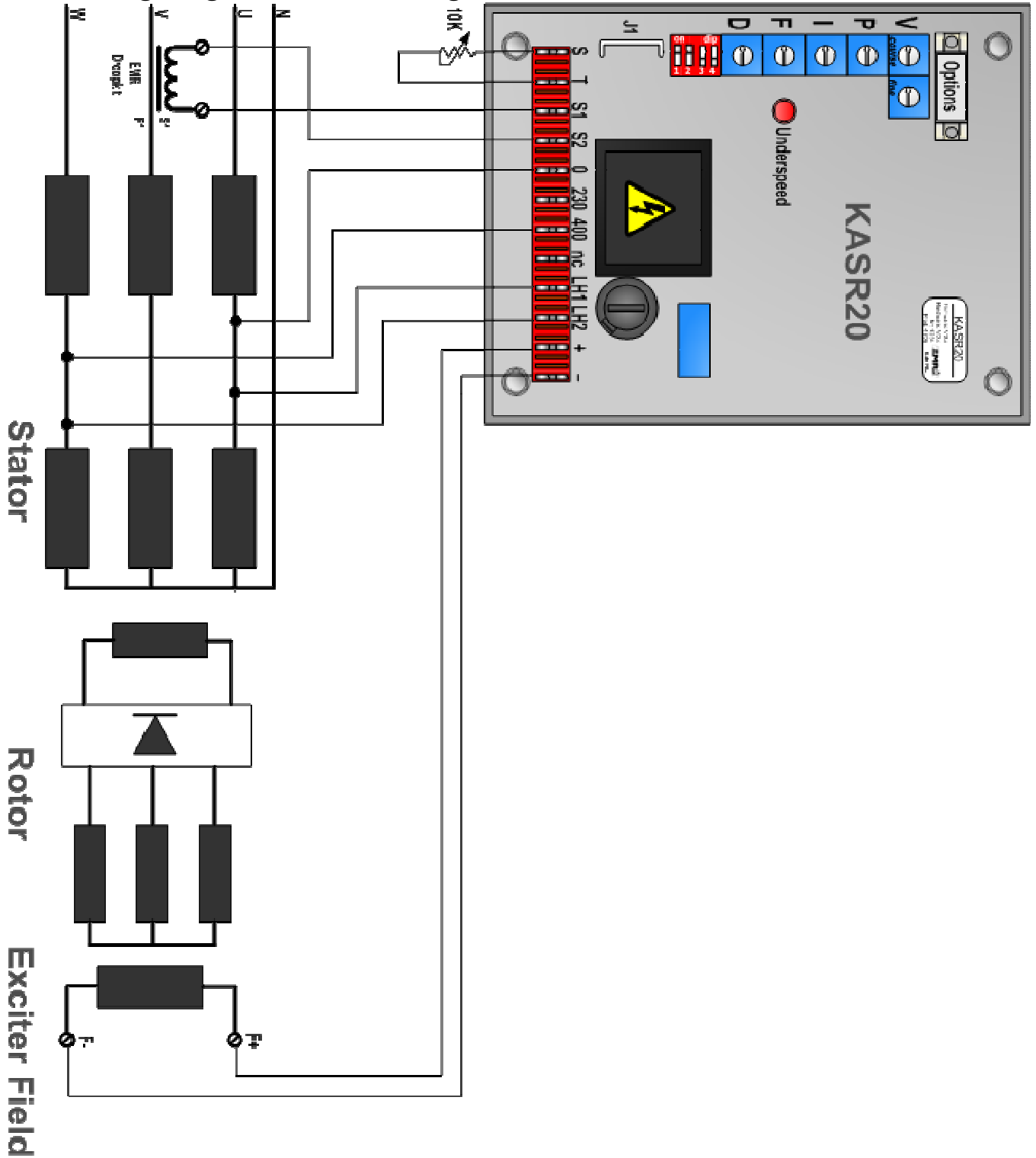
Fig 13. Auto field flash

7. Wiring Diagrams

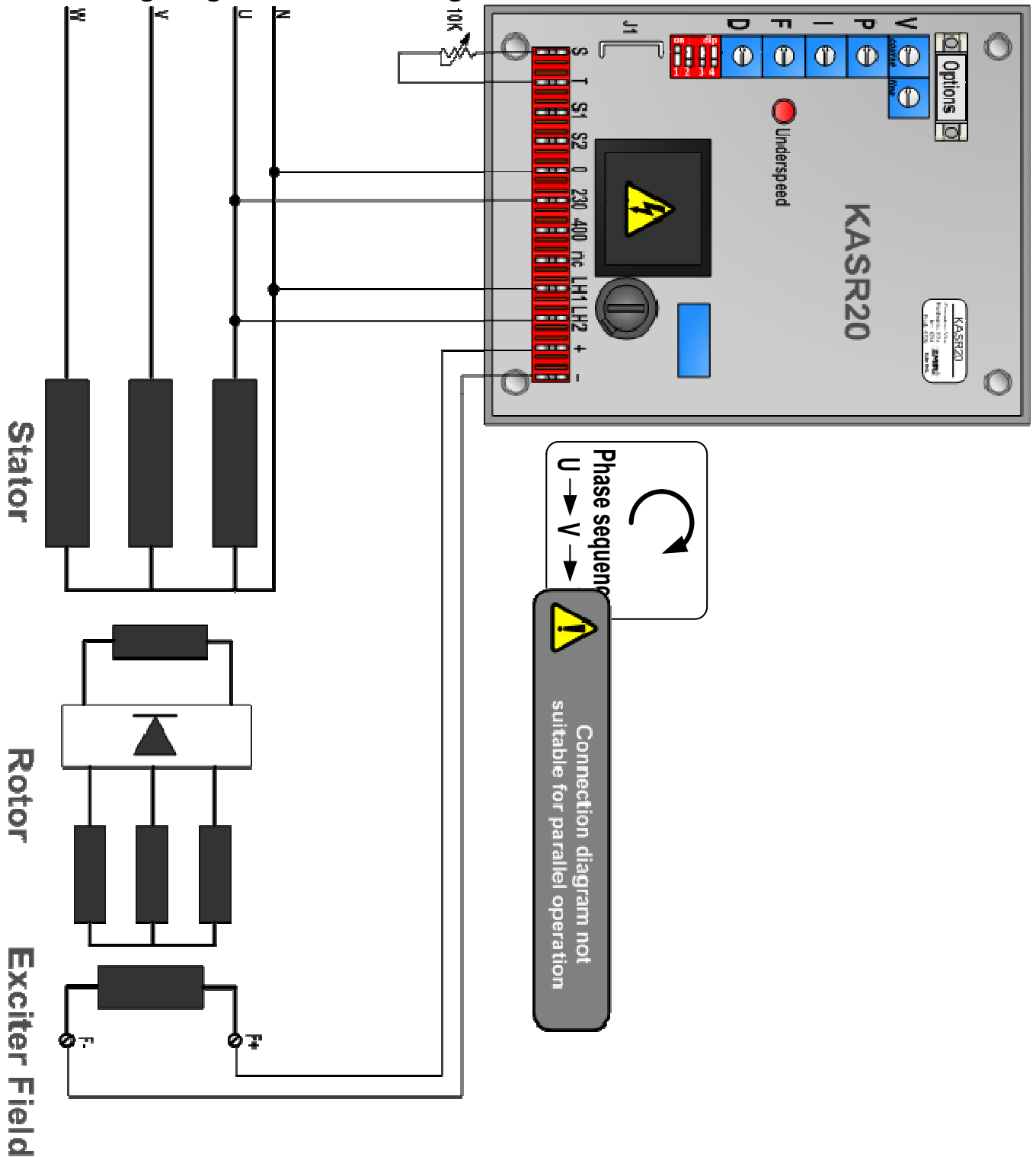
7.1 Wiring diagram 400V sensing



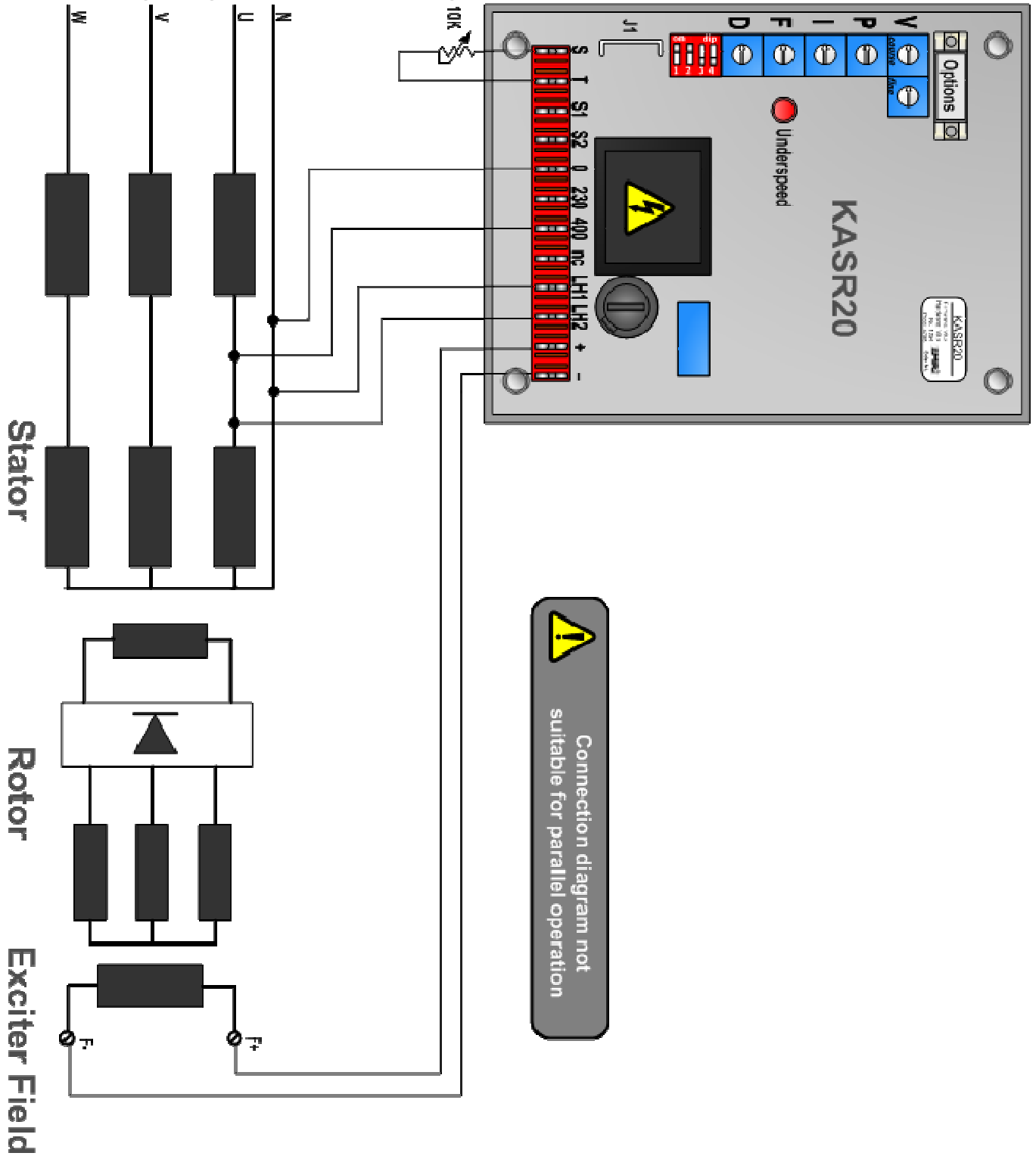
7.2 Wiring diagram 200V sensing



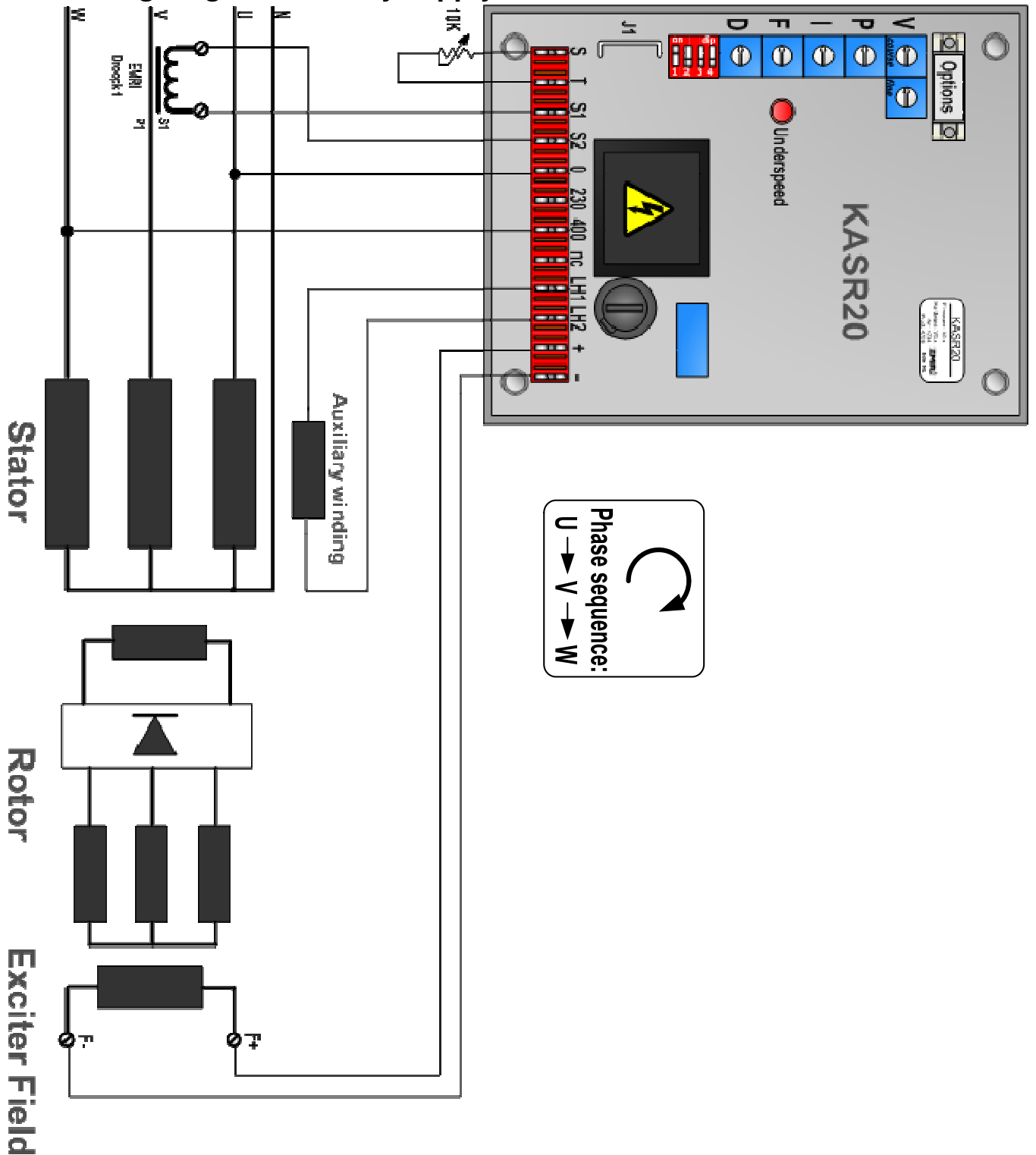
7.2 Wiring diagram 230V sensing



7.3 Wiring diagram 115V sensing



7.4 Wiring diagram auxiliary supply



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.
- Mounting of the product should be done in such a way that all mounting point are used

Wiring

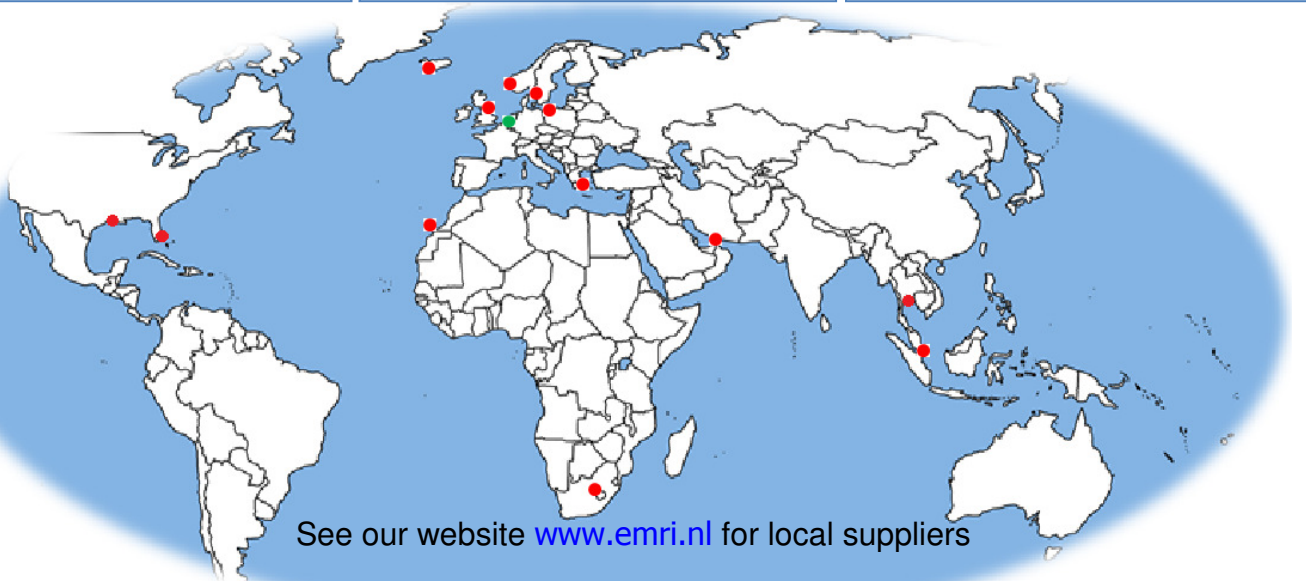
- Diameter size of the wiring should be enough to carry the expected current. Wire insulation should be enough to withstand the expected operating voltages and temperatures.
- To improve EMC emission and immunity, care should be taken for the lay out of the wiring. This in respect to all wiring in the 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, 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 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.

A.2 Contact

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