LX20 V1.1

Voltage regulator for generators

November 2010

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

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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.

Table of contents

1. Introduction

1.0 General description

This manual contains instructions for installing, operating and maintaining the LX20 automatic voltage regulator (AVR).

The LX20 is designed for use in brushless generators and can be used as a cost effective universal replacement for a great variety original manufacturers AVR's.

In conjunction with the optional EMRI droopkit the LX20 can be used for parallel operation with other generators that also control voltage droop by means of quadrature voltage droop (QVD).

Available replacement diagrams include the following manufacturers:

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AEG®	DELCO®	Marathon®
AEM®	ECC®	Markon®
ABB®	ELIN®	Marelli®
Alconza®	Hitzinger®	Mecc Alte SpA®
Ansaldo®	Hyundai®	Reliance®
AvK®	INDAR®	Stamford®
Brion Leroux®	Jeumont Schneider®	Siemens®
BKB®	Koncar®	Uljanik®
Caterpillar®	Leroy Somer®	Unelec®
Contrology®	MagnaMax®	VEM®

1.1 AVR Layout

The AVR is protected against harmful environmental impact by a protective coating. A prefabricated termination header is provided for the options connector as well as a prefabricated link fitted between terminals EX-EX.

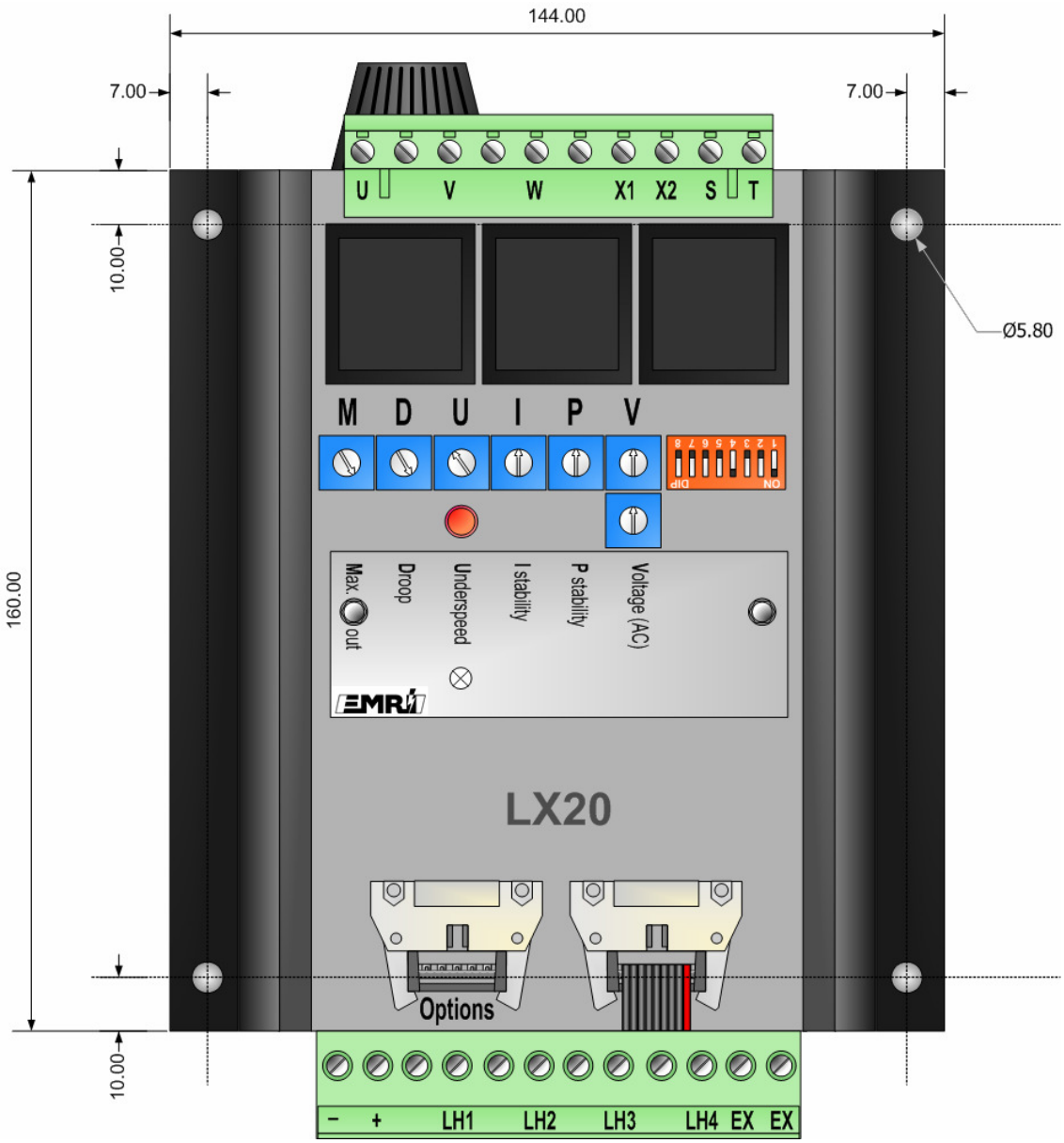


Fig 1. AVR layout

- Measurements in mm
- Height ± 110 mm

1.2 Electrical characteristics

Symbol	Parameter	Condition	Min	Max.	Unit
U-V-W	Voltage sensing input	50-60 Hz	170	480	V_{AC}
LH1-LH2 LH3-LH4	Supply input	1 phase connected (DC-400Hz) 3 phase connected (DC-400Hz) *No DC at terminal LH1*	22 15	140 115	V_{Ac} V_{Ac}
R_{FLD}	Exciter field resitance	at 230 V_{Ac} supply input at 115 V_{Ac} supply input	20 10	- -	Ω Ω
I_{EXC}	Excitation current	continuous <1s		15 20	A_{DC} A_{DC}
T_{AMB}	Operating temperature	95 % RHD non condensing	0	+55	℃
T_{STG}	Storage temperature	95 % RHD non condensing	-20	+85	℃
	Accuracy			1	%
X1-X2	Droop CT	isolated CT	-	0.5	A_{AC}
S-T	External Volt adjust	10kΩ potentiometer	-	10	kΩ
FUSE	AVR supply fuse	ultra rapid type required	-	20	A

Table 1. Electrical characteristics

1.3 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U-V-W	Voltage sensing input	<30 s	-	500	V_{AC}
LH1-LH2 LH3-LH4	Supply input	1 phase connected (DC-400Hz) 3 phase connected (DC-400Hz) *No DC at terminal LH1*	22 15	146 120	V_{Ac} V_{Ac}
R_{FLD}	Exciter field resitance	at 230 V_{Ac} supply input at 115 V_{Ac} supply input	20 10	- -	Ω Ω
I_{EXC}	Excitation current	< 1s		20	A
T_{AMB}	Operating temperature	95 % RHD non condensing	0	+55	℃
T_{STG}	Storage temperature	95 % RHD non condensing	-20	+85	℃
X1-X2	Droop CT	< 1s	-	1	A_{AC}
FUSE	AVR supply fuse	ultra rapid type required	-	20	A

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.

1.4 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 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 measuring equipment, 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.

To prevent damage due to excessive shock and vibration mount the AVR on anti vibration mounts.

When the AVR is mounted in a closed cabinet proper ventilation must be guaranteed for cooling. Cooling can be improved by mounting the AVR vertically, allowing for natural convection, and by mounting the AVR on a low thermal resistance surface.

Never apply de-excitation switches in the field excitation output (+, -) of the AVR. If a de-excitation switch is required place at the supply inputs (LH1, LH2, LH3, LH4).

Do not connect a DC level supply to terminal LH1. This will cause an unrecoverable overvoltage situation when self-excitation is enabled.

2. Installation

For a complete wiring diagram see chapter 7.

2.0 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	If no extensions are connected the dummy termination header must be connected.

Table 3. Interfaces

2.1 Adjustments overview

Fig 3. Adjustments overview

Symbol	Description	Notes
V_{course}	Generator voltage course adjustment	Top potentiometer
V_{fine}	Generator voltage fine adjustment	Bottom potentiometer
P	Control loop proportional gain	
I	Control loop integral action	
U	Underspeed frequency	
D	Voltage droop	For parallel operation
M	Maximum output limiting	Limits the excitation current.
DIP	AVR Dipswitch settings	Refer to 5.6 for individual dipswitch settings

Table 4. Adjustments

2.2 Terminals overview

Fig 4. Terminals overview

Symbol	Description	Notes
U, V, W	Voltage sensing input	phase sequence U→V→W
X1, X2	CT input for voltage droop	CT in V-phase
S, T	External voltage adjust input	10 kΩ potentiometer
LH1, LH2, LH3, LH4	AVR and excitation supply input.	Do not connect DC supply to terminal LH1. This will cause an overvoltage situation with enabled self-excitation.
+, -	Field excitation output	
EX, EX	Self Excitation link (Caution: High voltage)	Never fit or remove link while generator is in operation Refer to 3.1 for more information

Table 5. Terminals

3. Operation and maintenance

3.0 General operating principle

The LX20 is designed for use in brushless generators and precisely controls the generator voltage by controlling the current supplied to the exciter field.

In basic operation, when no protections are triggered and no voltage droop is set, the AVR controls the generator voltage according a constant voltage characteristic irrespective of load and frequency.

3.1 Self excitation

When the AVR supply voltage, at terminals LH1 to LH4, is insufficient to supply the AVR, the generator voltage will not build up. If the AVR supply voltage is referenced from the generator voltage, self excitation can be used to start generator voltage build-up. For self-excitation to function LH1 must be connected. Self excitation is enabled by shorting terminals EX.

When enabled, the self excitation circuit redirects the AVR supply voltage to the generator's exciter field uncontrolled, bypassing the internal controller. This field flashing causes the generators flux to increase, amplifying the supply voltage.
When the supply voltage has increased to a level sufficient to supply the AVR, the self excitation circuitry is disabled again. Hereafter the AVR's internal controller builds up the generator voltage. Diagram 1 shows a sequence of events with enabled self excitation, for diagnosis purposes.

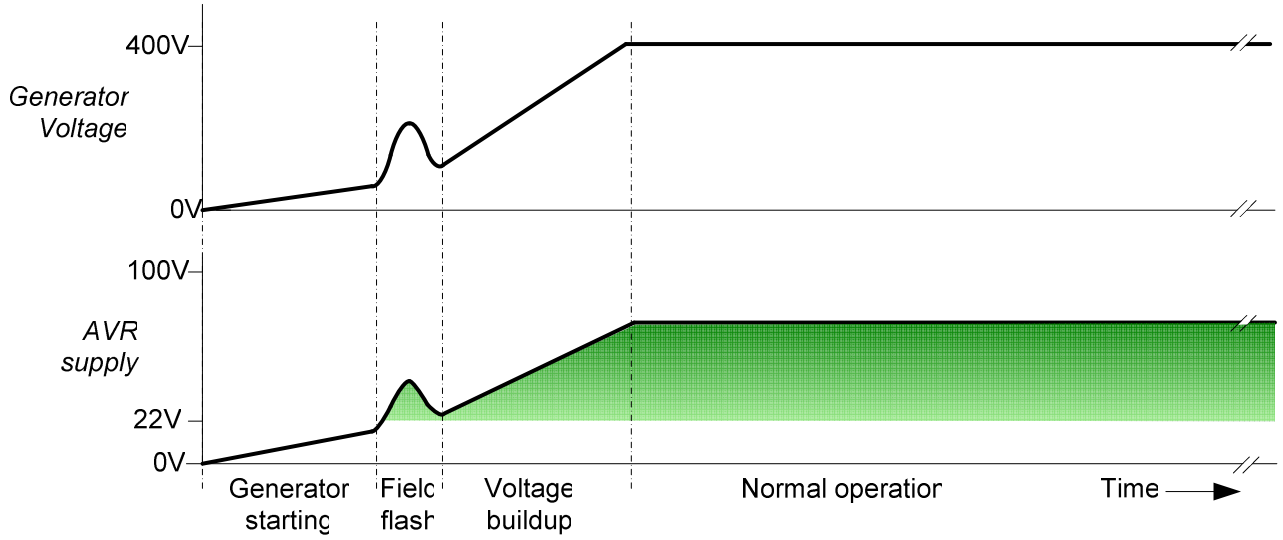


Diagram 1. Self-excitation

Never fit or remove the EX link when the generator is operation, this could result in serious electrical shock.
Do not connect a DC level supply to terminal LH1, this will cause an unrecoverable overvoltage situation with enabled self-excitation.

3.2 Parallel operation

If the generator operates in parallel operation with one or more generators, reactive load sharing can be accomplished by means of Quadrature Droop Compensation (QDC). Parallel operation requires an EMRI droopkit. The droopkit must be rated to match the generator nominal current.
In order to obtain a proper load distribution the no-load voltages and the amount of voltage droop during load must be set equal for all generators. The adjustments must be made very precise and under equal conditions for each generator (frequency, current, power factor)

The influence of the voltage droop on the generator voltage is depicted in diagram 2.

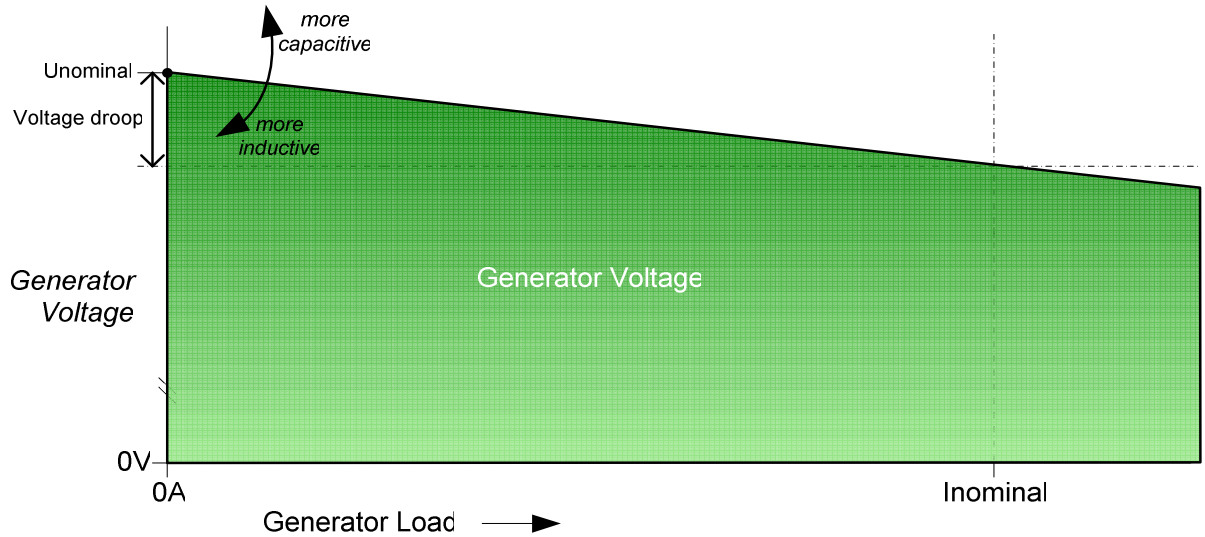


Diagram 2. Voltage droop

3.2 Options

The LX20 AVR can be functionally extended with the following options:

Type	Description	Interface
Droopkit	Required for parallel operation	AVR terminals X1-X2
LX_OVSC	Overvoltage protection	AVR terminals LH1-LH2-LH3-LH4
LX_VPH	Softstart and VPH control	AVR options connector
COSPHI3.2	Power factor control	AVR options connector
SETOPTION	Extended voltage setpoint range	AVR options connector
MULTIPOT	Contact selectable voltage setpoints	AVR options connector
LX_REVERSE	Inverts excitation output	AVR PCB
LX10_XFR	Extended frequency range	AVR PCB
DC_sensing	24Vdc sensing option	AVR PCB

Table 6. Options

Most options can be installed afterwards except for options with an AVR PCB interface. These are factory pre-installed.

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

4. Protections and diagnose

4.0 Underspeed protection

When the generator frequency drops below the underspeed frequency setpoint the generator voltage can be reduced to prevent over-excitation. The characteristic, by which the voltage is reduced, is user selectable.
One option is a VPH slope, which gradually reduces voltage proportional to the generator frequency. The second option is a trip slope, which reduces the voltage to a fixed level when the generator frequency drops below the underspeed threshold. The exact level to which the voltage is reduced for the trip option is user selectable to be either 100V or 50V.

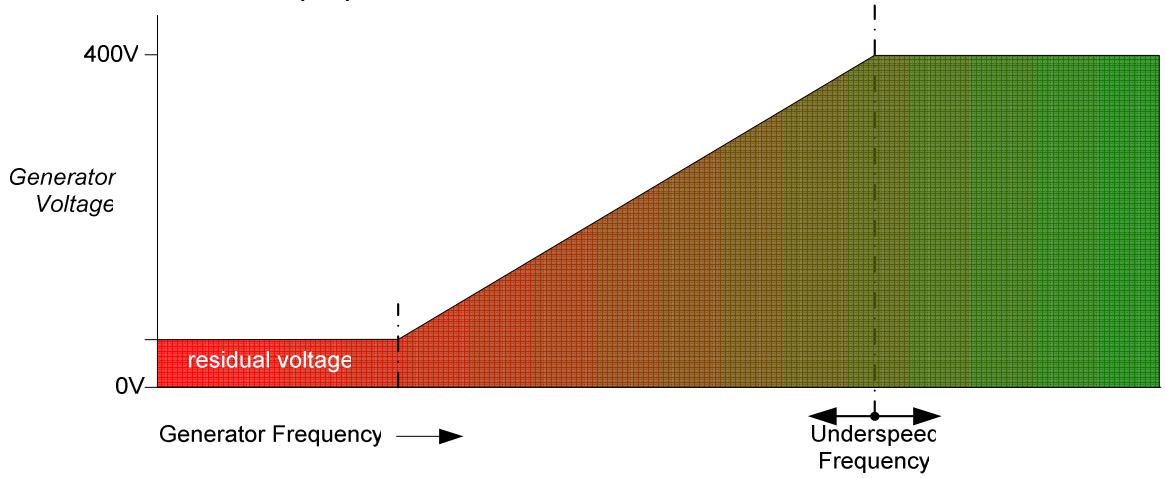


Diagram 3. VPH underspeed slope

The underspeed frequency setpoint must be chosen such that it prevents overexcitation during a prolonged period of underspeed, however allowing for a small incidental frequency dip without activating the underspeed protection.

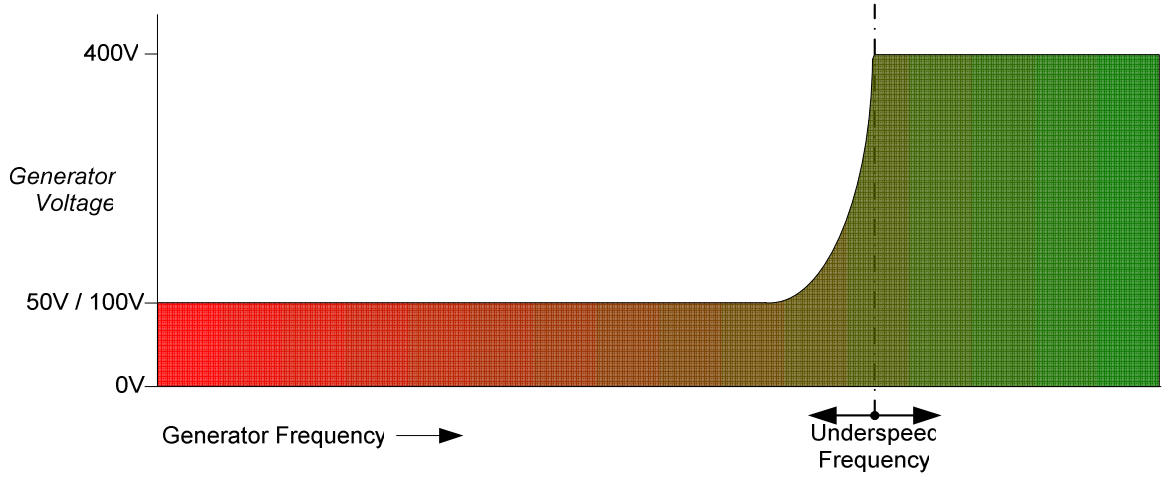


Diagram 4. Trip underspeed slope

The underspeed protection has a build-in recovery delay of approximately 2 seconds to prevent instability around the underspeed setpoint. For more information on how to select a specific slope refer to the dipswitch settings, paragraph 5.6. More information on setting the underspeed frequency setpoint see 5.2.

4.1 Phaseloss protection

The phaseloss protection validates the presence of all three generator phases on the sensing terminals U, V and W
When one of the three phases is not sensed anymore for more than 300ms the AVR decreases the generator voltage setpoint to +/-170V.
If the error condition is relieved, the generator voltage setpoint is ramped up again to nominal.

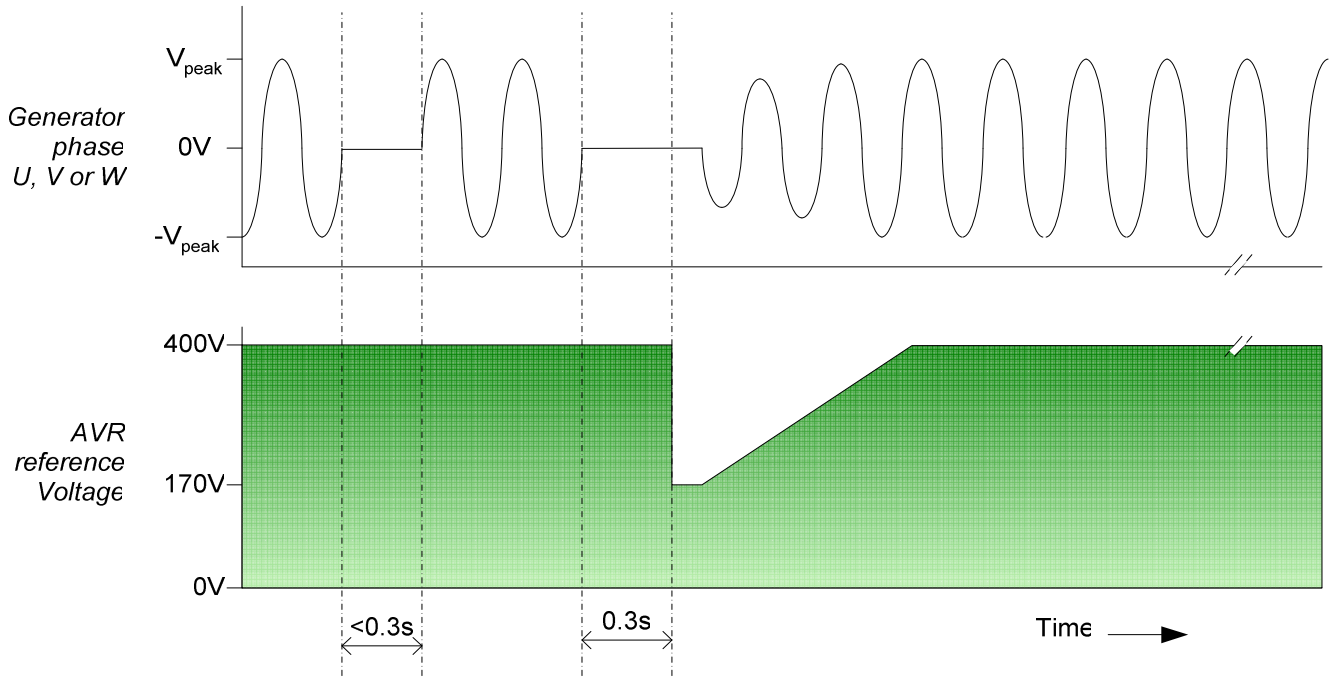


Diagram 5. Phaseloss protection

4.2 Fuse protection

To prevent consequential damage in case of an AVR or generator failure, the AVR supply is fused by a 20A fuse. Blowing the fuse will interrupt the field excitation output and cause the generator to de-excite. When replacing the fuse a 20A ultra rapid type fuse with dimensions 10.3 x 38.1mm must be used.

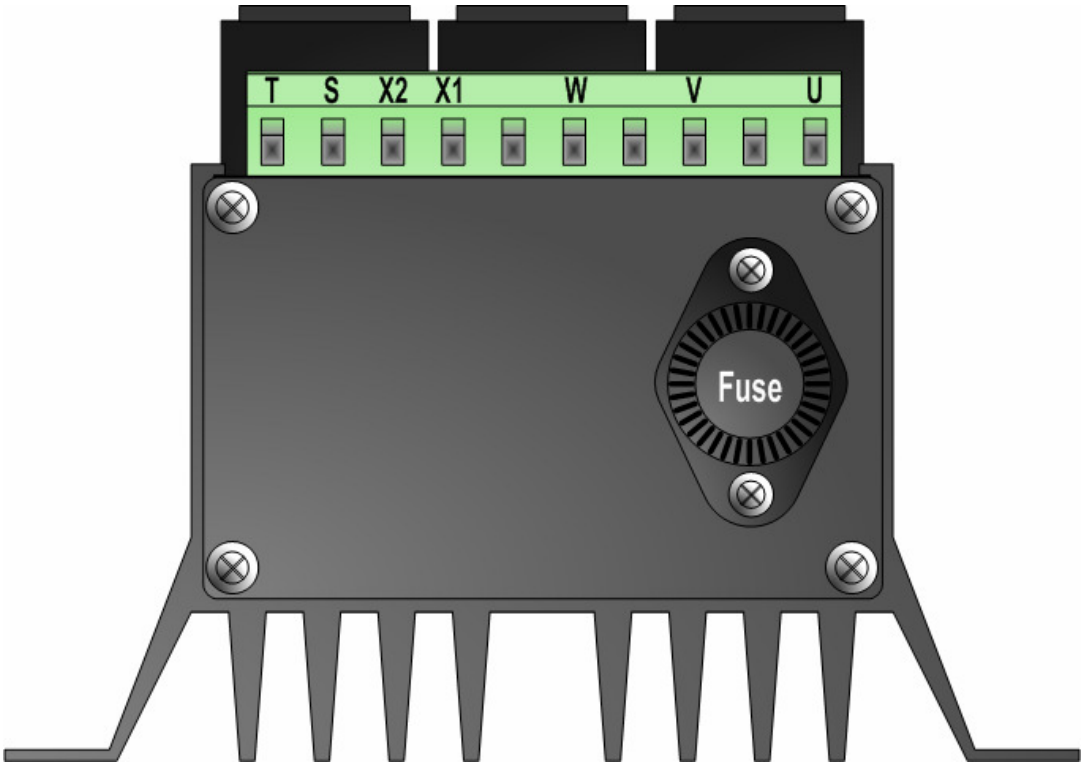


Fig 5. AVR Fuse

5. Settings and adjustments

5.0 Generator Voltage (V)

The generator voltage setpoint is user adjustable by means of two voltage potentiometers. The course voltage potentiometer range is U_{nom} ±17,5%. The fine voltage potentiometer range is U_{nom} ±3%. Turning the potentiometers clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage.

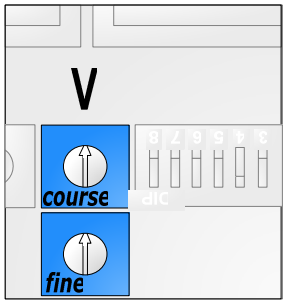


Fig 7. Voltage adjustments

5.1 Stability (P&I)

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, tuning counter clockwise decreases the proportional gain. Turning the integral action potentiometer clockwise increases the 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.

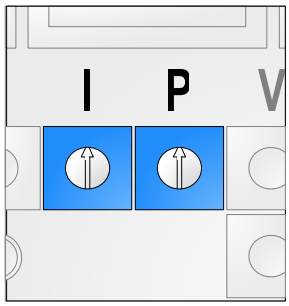


Fig 8. Stability adjustments

5.2 Underspeed (U)

The underspeed frequency at which the underspeed protection reduces voltage can be adjusted with the underspeed potentiometer. Turning the potentiometer clockwise decreases the underspeed frequency. Turning counter-clockwise increases underspeed frequency.
The underspeed protection has a build-in recovery delay of approximately 2 seconds to prevent instability around the underspeed setpoint. Therefore adjustments to the potentiometer position must be made slowly, allowing for the protection delay to settle.
When the underspeed protection is active, the underspeed LED is on.
For more information on the underspeed characteristics, see 4.0

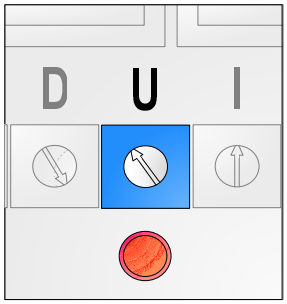


Fig 9. Underspeed adjustments

5.3 Droop (D)

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. 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.
For a more detailed description of voltage droop see 3.1

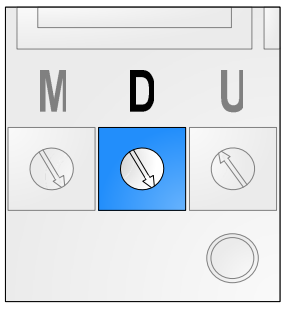


Fig 10. Droop adjustment

5.4 Maximum output (M)

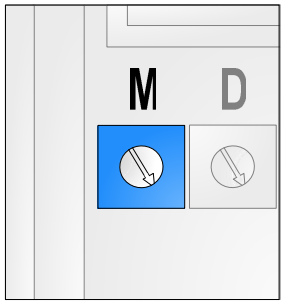


Fig 11. Max. out adjustment

The AVR excitation output can be limited with the maximum output potentiometer. Care should be taken when a limit is set, because this imposes a maximum dutycycle for the actuator which could lead to controller saturation.
Turning the potentiometer counter clockwise increases (activates) the limiting action, turning clockwise decreases the limiting action. When the potentiometer is turned completely clockwise, limiting is not active.

5.5 External setpoint (S-T)

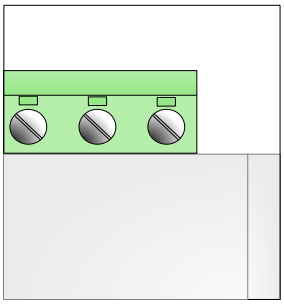


Fig 12. External setpoint

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 -/- 60V at 10kOhm.

When a 0-10Vdc source is used, a resistive divider must be installed according Fig. 14. 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.

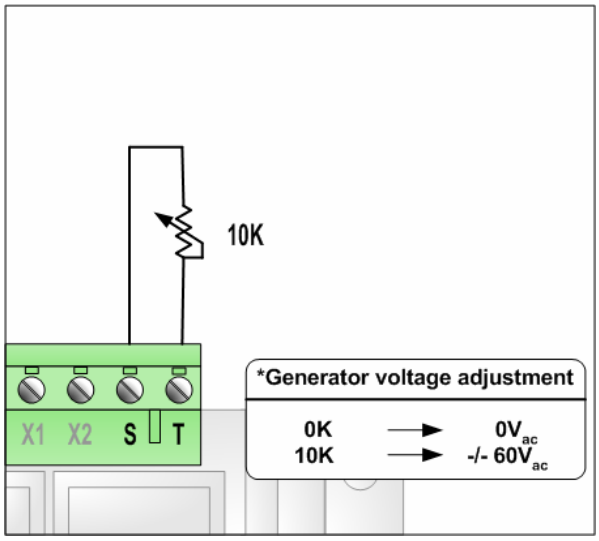


Fig 13. External potentiometer

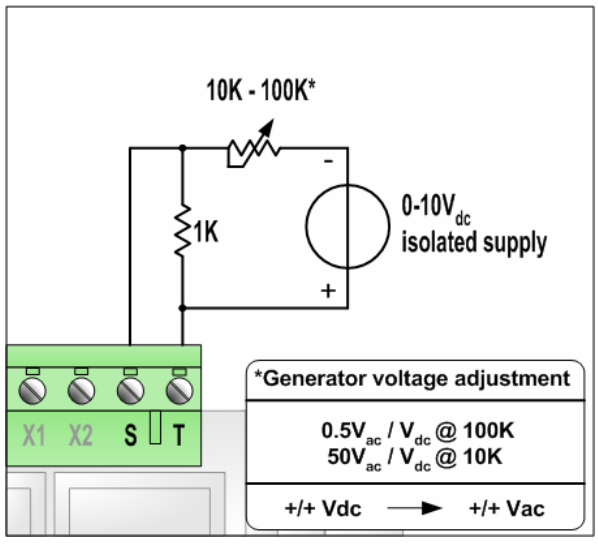


Fig 14. External voltage source

5.6 Dipswitches

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 7; in the following paragraphs a more elaborate explanation of each individual switch is provided.

Factory default dipswitch settings can be found in paragraph 5.7.

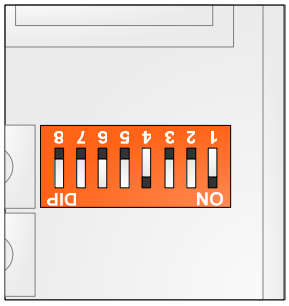


Fig 15. Dipswitch settings

Symbol	Description	Notes	
Dipswitch 1	S-T link	Off = Ext. Pot. enabled	On = S-T internally shorted
Dipswitch 2	Phaseloss protection	Off = Disabled	On = Enabled
Dipswitch 3	Sensing voltage selection	Off = 400V sensing	On = 230V sensing
Dipswitch 4	Underspeed trip slope	Off = Disabled	On = Enabled
Dipswitch 5	Underspeed VPH slope	Off = Disabled	On = Enabled
Dipswitch 6	Buildup speed selection	Off = 2 seconds	On = 5 seconds
Dipswitch 7	Stability range selection	Off = Normal I-time	On = Increased I-time
Dipswitch 8	Underspeed trip voltage	Off = 100 V setpoint	On = 50 V setpoint

Table 7. 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: Phaseloss protection

Switching dipswitch 2 on enables the phaseloss protection. When the dipswitch is switched off the phaseloss protection is disabled. For more information about the phaseloss protection refer to paragraph 4.1.

5.6.3 Dipswitch 3: Sensing voltage selection

If dipswitch 3 is switched off, the AVR controls the generator voltage, sensed at terminals U, V and W to 400V. When the switch is in on position, the AVR controls the voltage at its terminals to 230V. This can be used when a lower generator voltage is desired or a half winding tap is used for sensing.

5.6.4 Dipswitch 4: Underspeed trip slope

When dipswitch 4 is switched on 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). The exact level to which the voltage is reduced is selectable with dipswitch 8 to be either 100V or 50V.
If the volt per hertz (VPH) underspeed slope is required, dipswitch 4 must be switched off.
If no underspeed protection at all is desired, both dipswitch 4 and 5 must be switched off.

5.6.5 Dipswitch 5: Underspeed VPH slope

When dipswitch 5 is switched on the Volt Per Hertz (VPH) slope is selected for the underspeed protection. This reduces the generator voltage gradually, proportional to the generator frequency, when the generator frequency drops below the underspeed threshold (adjustable with potentiometer U).
If the trip underspeed slope is required, dipswitch 5 must be switched off.
If no underspeed protection at all is desired, both dipswitch 4 and 5 must be switched off.

5.6.6 Dipswitch 6: Buildup speed selection

When dipswitch 6 is switched off, the generator voltage setpoint is ramped up from 0 to nominal voltage within 2 seconds following AVR startup. If the dipswitch is switched on, the generator voltage setpoint is ramped up within 5 seconds instead.

5.6.7 Dipswitch 7: Stability range selection

When dipswitch 7 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 7 is left switched off.

5.6.8 Dipswitch 8: Underspeed trip voltage

When dipswitch 8 is switched off and dipswitch 4 is switched on, the generator voltage is reduced to 100V when the generator frequency drops below the underspeed threshold (adjustable with potentiometer U). If dipswitch 8 is switched on, the generator voltage is reduced to 50V instead.
If dipswitch 4 is off, the setting of dipswitch 8 has no effect on the AVR behaviour.

5.7 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
Output Voltage	400	Vac
Proportional control action	50	%
Integral control action	50	%
Droop	100	%
Underspeed frequency	45	Hz
Maximum output	100	%
Dipswitch 1	On	
Dipswitch 2	Off	
Dipswitch 3	Off	
Dipswitch 4	On	
Dipswitch 5	Off	
Dipswitch 6	Off	
Dipswitch 7	Off	
Dipswitch 8	Off	

Table 8. Factory settings

6. Tips & Suggestion

6.0 Precautions for large, slow running generators

In general large (>1000kVA), slow running (<900RPM) generators tend to have more inductive exciter field windings. When the LX10.1 is used to control such a generator, the switched excitation current in combination with the increased inductivity can cause voltage spikes on the field excitation output. This can cause excessive AVR heating and damage to the AVR's output stage.
To reduce voltage spikes it is recommended to fit RC-snubber in parallel and as close as possible to the exciter field.

6.1 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.

6.2 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.

6.2.1 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.

6.2.2 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.

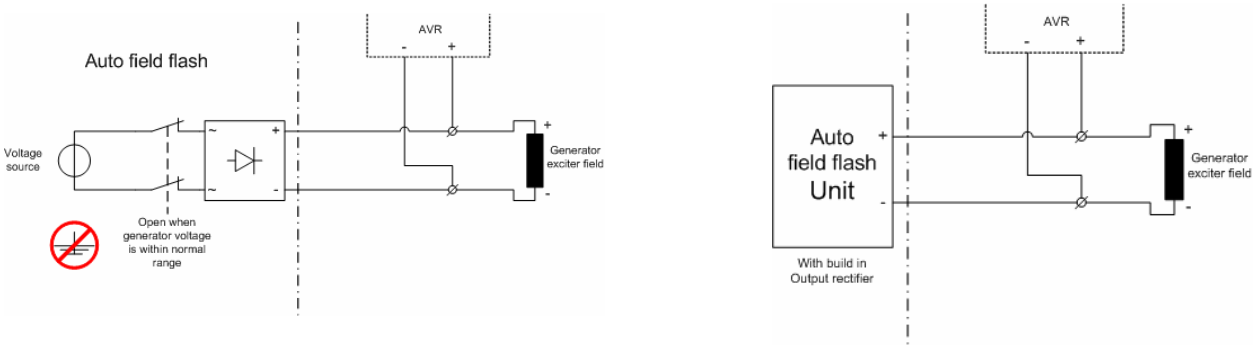
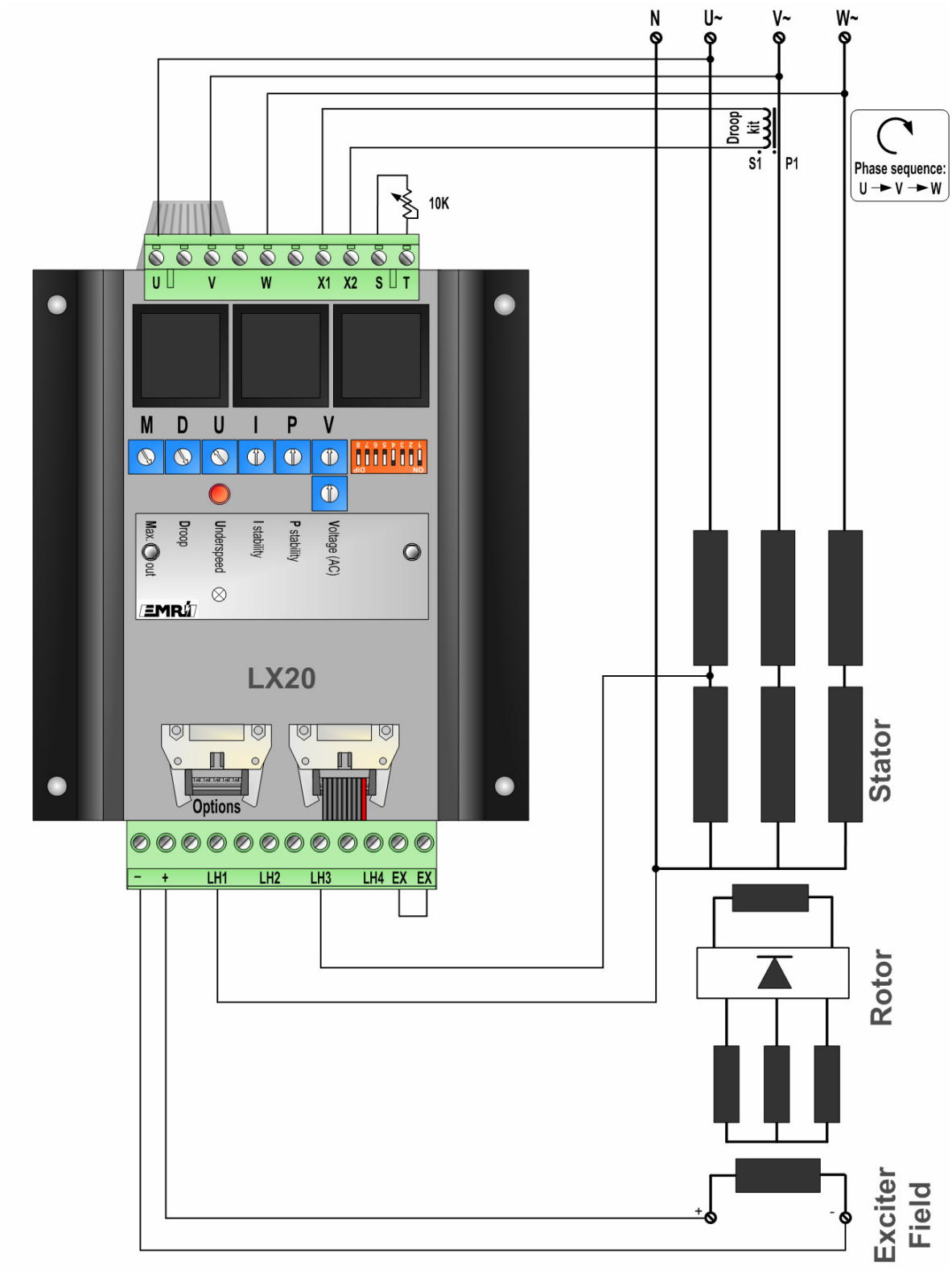


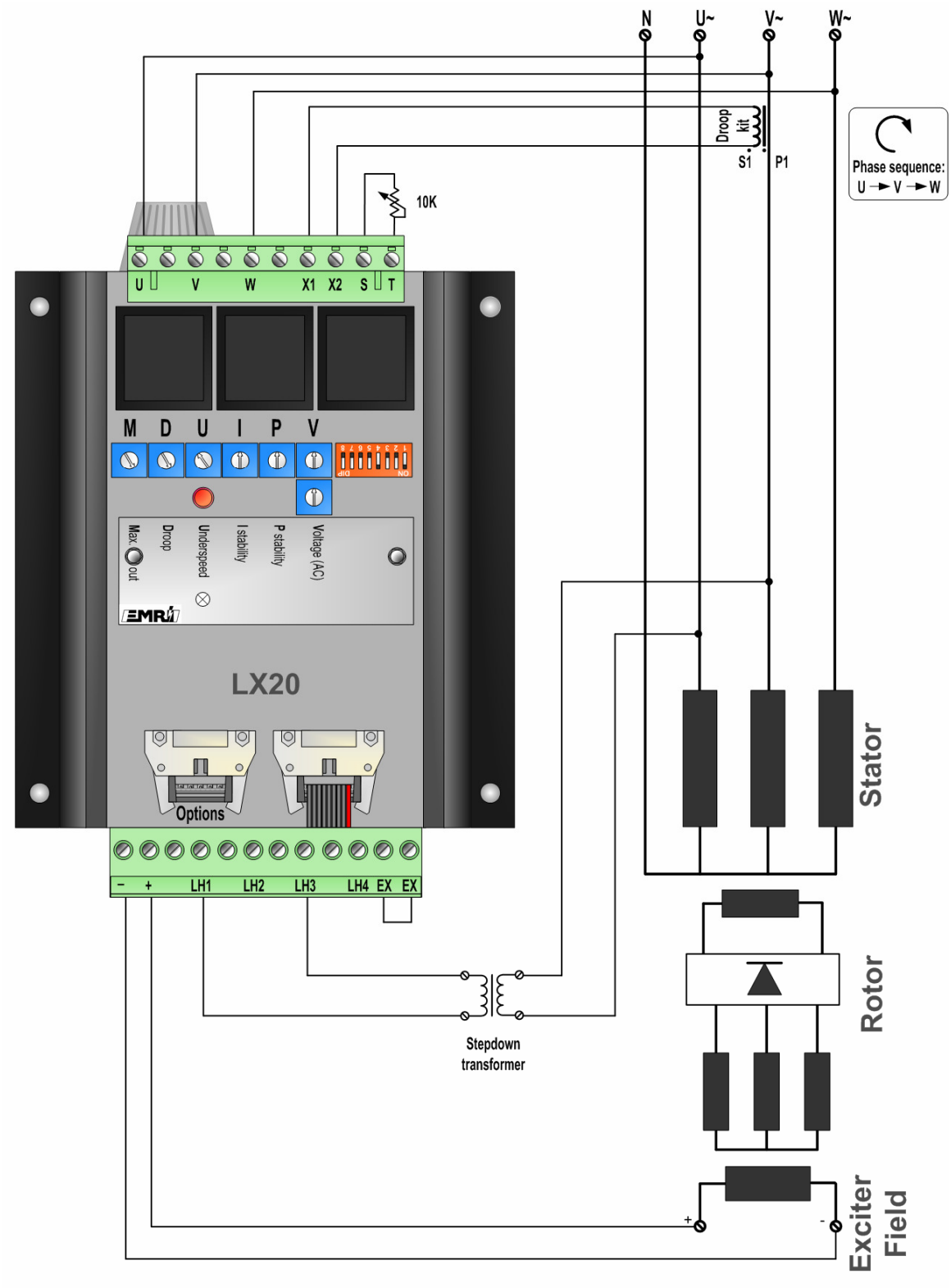
Fig 16. Auto field flash

7.0 General connection diagram – Generator ½phase - neutral supply



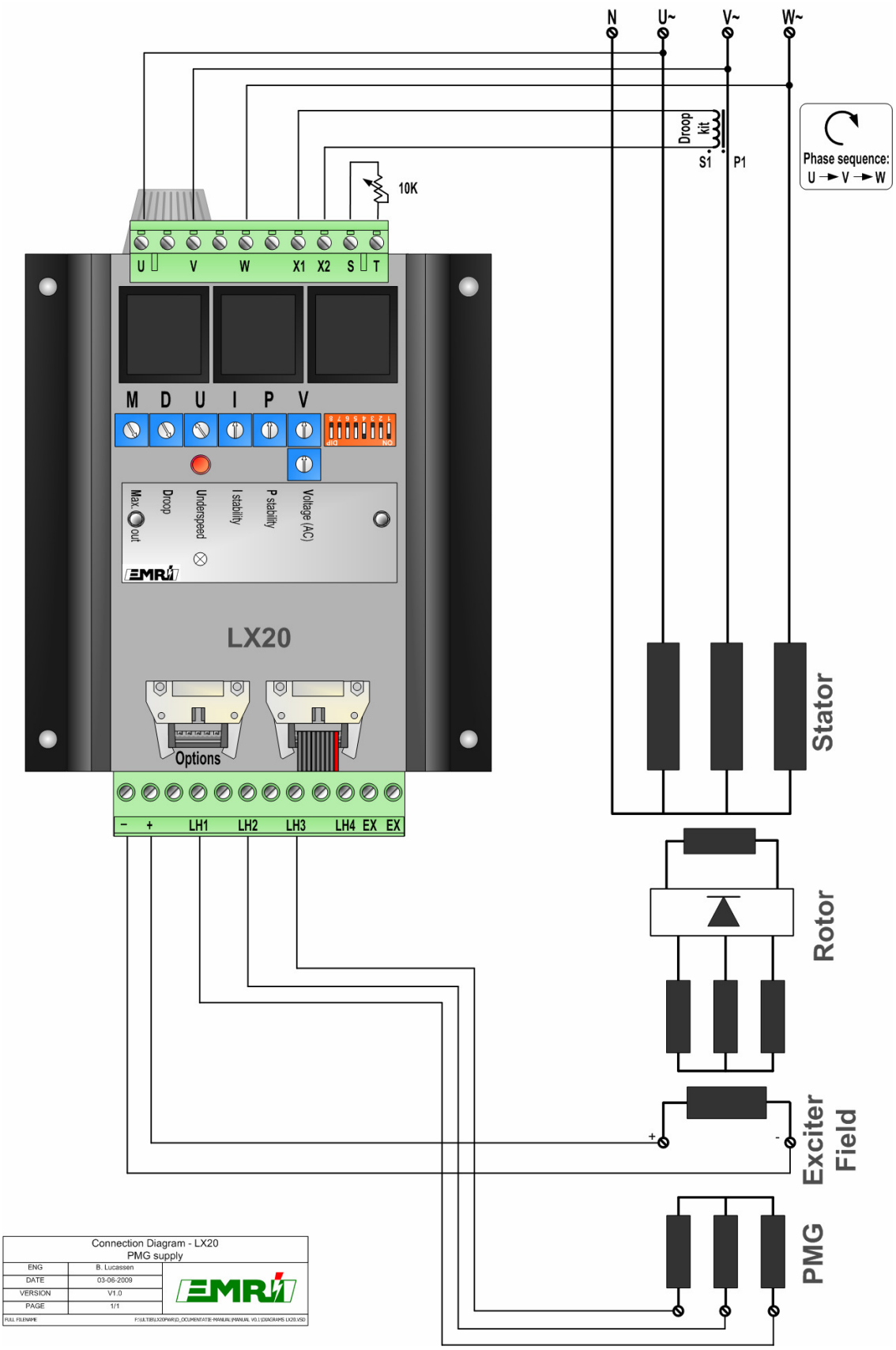
Connection Diagram - LX20 Generator half phase - neutral supply	
ENG	B. Lucassen
DATE	03-06-2009
VERSION	V1.0
PAGE	1/1
FULL FILENAME	F:\ULTIBUILD\PWR\D_DOCUMENTATIE-MANUAL\MANUAL V0.1\DIAGRAMS LX20.VSD

7.1 General connection diagram – Transformer / isolated supply

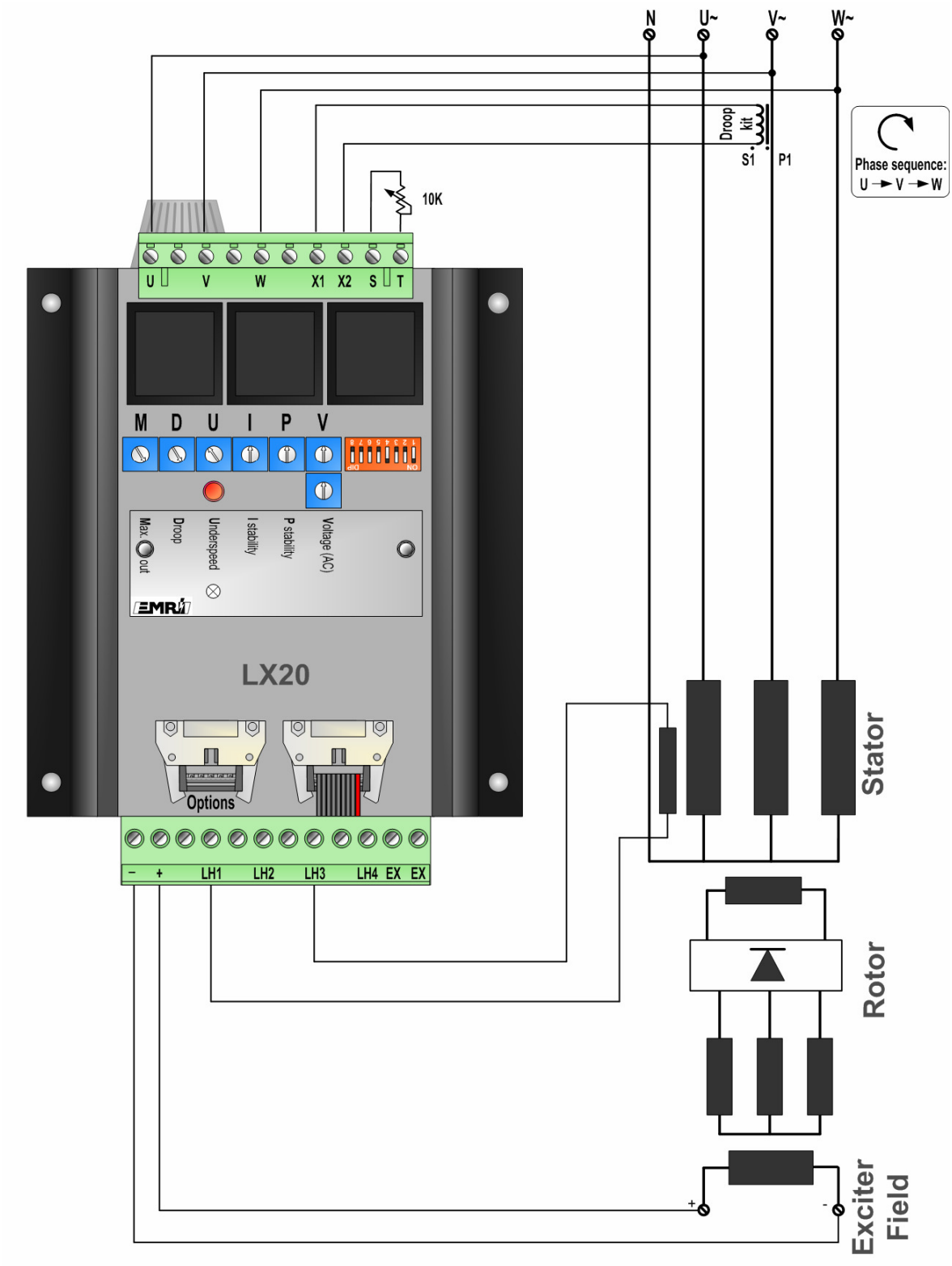


Connection Diagram - LX20 Generator isolated supply	
ENG	B. Lucassen
DATE	03-06-2009
VERSION	V1.0
PAGE	1/1
FULL FILENAME	P:\ULTIBYLX20\PWRD_DOCUMENTATIE-MANUAL\MANUAL V0.1\DIAGRAMS LX20.VSD

7.2 General connection diagram – PMG supply



7.3 General connection diagram – Auxiliary supply



Connection Diagram - LX20 Auxiliary winding supply	
ENG	B. Lucassen
DATE	03-06-2009
VERSION	V1.0
PAGE	1/1
FULL FILENAME	F:\ULTIEM\LX20PWR\D_DOCUMENTATIE-MANUAL\MANUAL V0.1\DIAGRAMS LX20.VSD

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 +, - or LH1, LH2, LH3, LH4 or X1 and X2.
- 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.
- 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 behaviour 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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See our website www.emri.nl for local suppliers