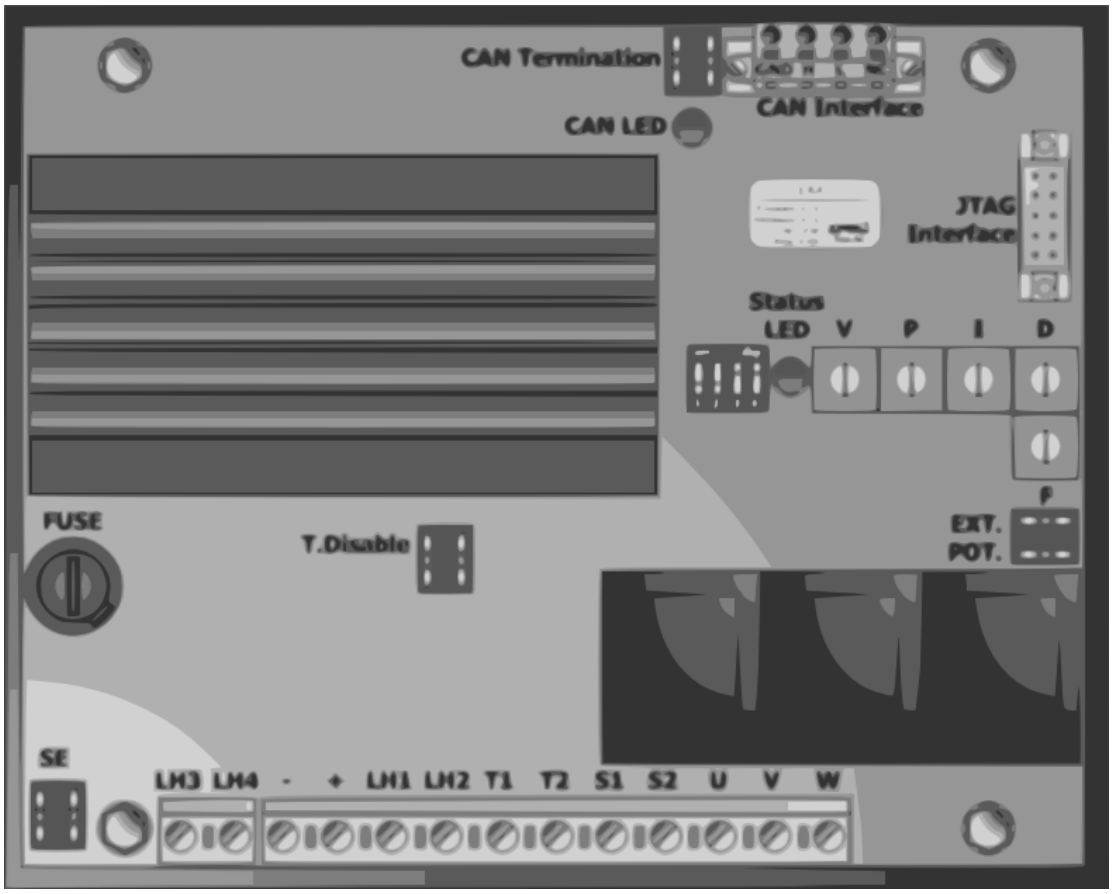
LX4 V3.0

Voltage regulator for generators



October 2008

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.

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.

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1. INTRODUCTION

1.0 General description

This manual contains instructions for installing, operating and maintaining the LX4 V3.0 Automatic Voltage Regulator (AVR).

1.1 AVR Layout

The AVR is protected against environmental influences by a PUR coating. Prefabricated links are provided for T.Disable, EXT.POT and CAN termination

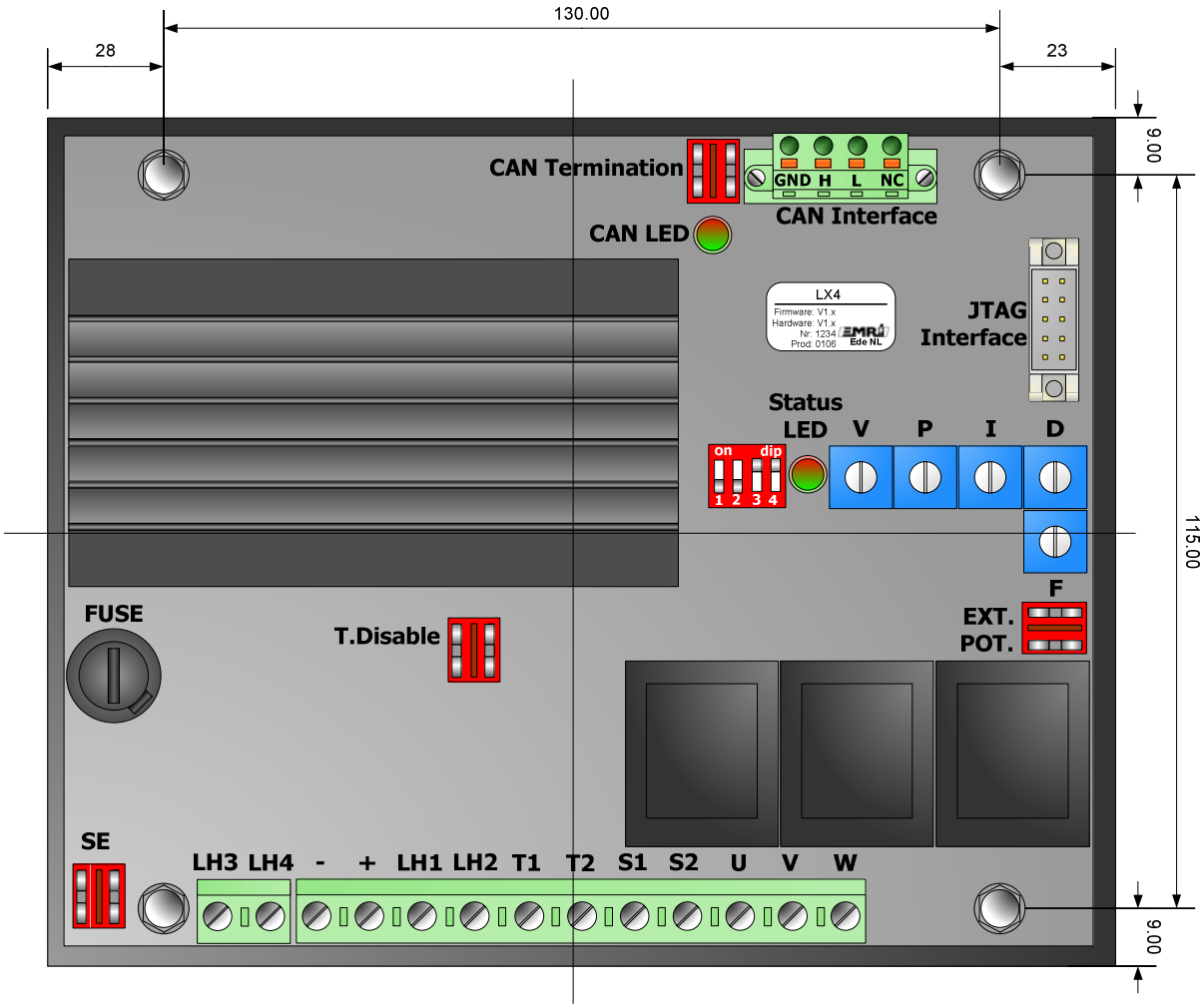


Fig 1. AVR layout

Max AVR height: 60 mm
Dimensions in mm

1.2 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U, V, W	Voltage sensing input	< 30 s.	-	500	V_{AC}
+, -	AVR field current	Continuous < 10 s.	- -	3 6	A_{DC} A_{DC}
LH1-LH2, LH3-LH4	Supply input	1 phase connected (dc-400Hz) 3 phases connected (dc-400Hz)	20 15	100 100	V V
R_{field}	Field resistance	@ 100 $V_{LH1-2\ LH3-4}$ (rms) @ 60 $V_{LH1-2\ LH3-4}$ (rms)	10 6	- -	Ω Ω
T_{AMB}	Operating temperature	95 % RHD non condensing	-20	+70	°C
T_{STG}	Storage temperature	95 % RHD non condensing	-20	+85	°C
S1,S2	Droop set current	Isolated CT - continuous Isolated CT - < 10 s	- -	0.25 0.75	A_{AC} A_{AC}
EXT. POT.	External Volt adjust		-	10	kΩ
FUSE	Fuse rating	Ceramic, Time delay		4	AT

Table 1. Absolute maximum ratings

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

2. INSTALLATION

For a complete wiring diagram refer to chapter 6: Wiring diagrams.

2.0 Interfaces overview

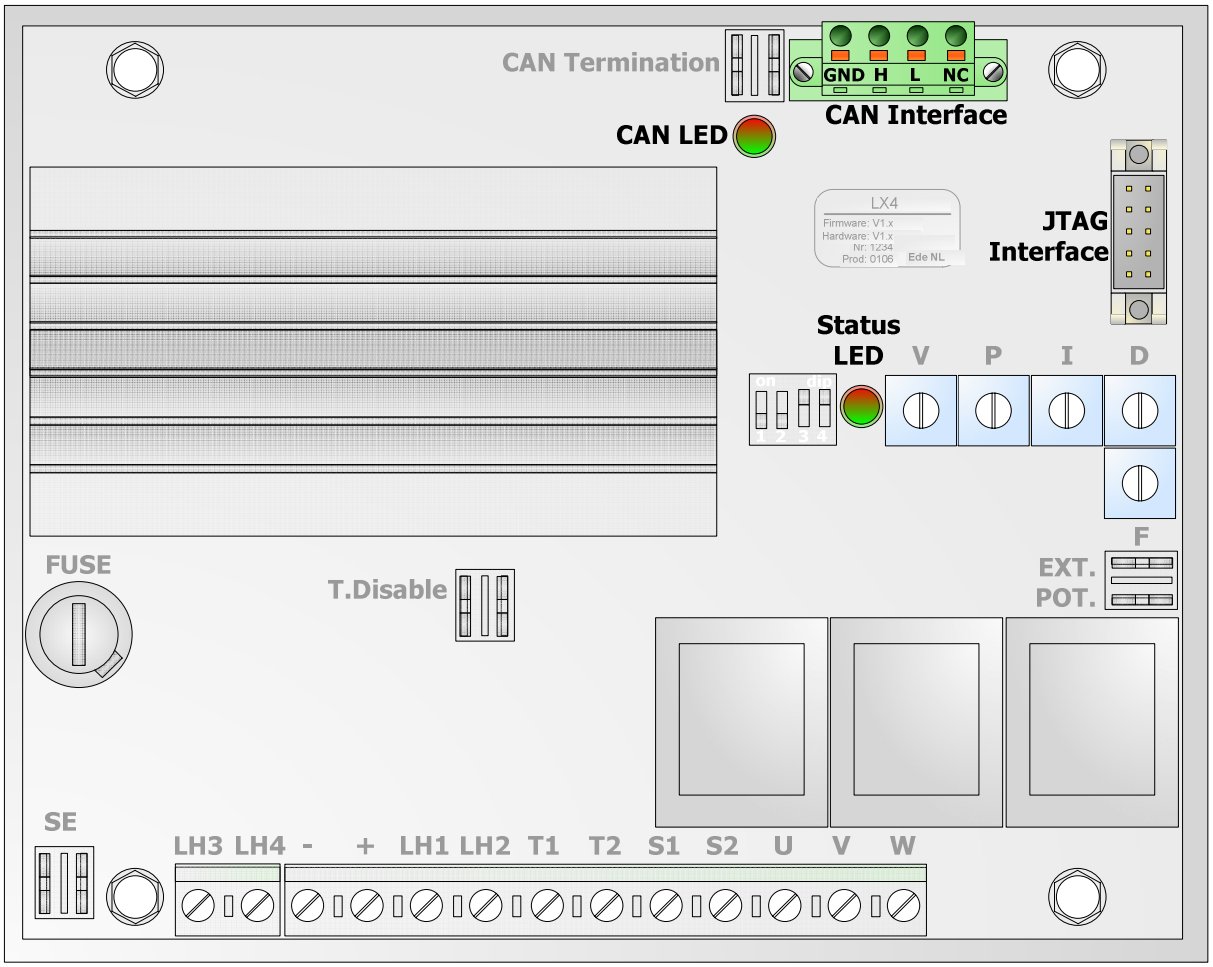


Fig 2. Interfaces overview

Symbol	Description	Notes
Status LED	AVR control mode & Error diagnostics	See Table 6 and 11
CAN LED	CAN bus control mode & Error diagnostics	See Table 7
CAN Interface.L	CAN bus low wire	
CAN Interface.H	CAN bus high wire	
CAN Interface.GND	CAN bus ground	
CAN Interface.NC	Not connected	
JTAG Interface	Maintenance port	

Table 2. Interfaces

2.1 Adjustments overview

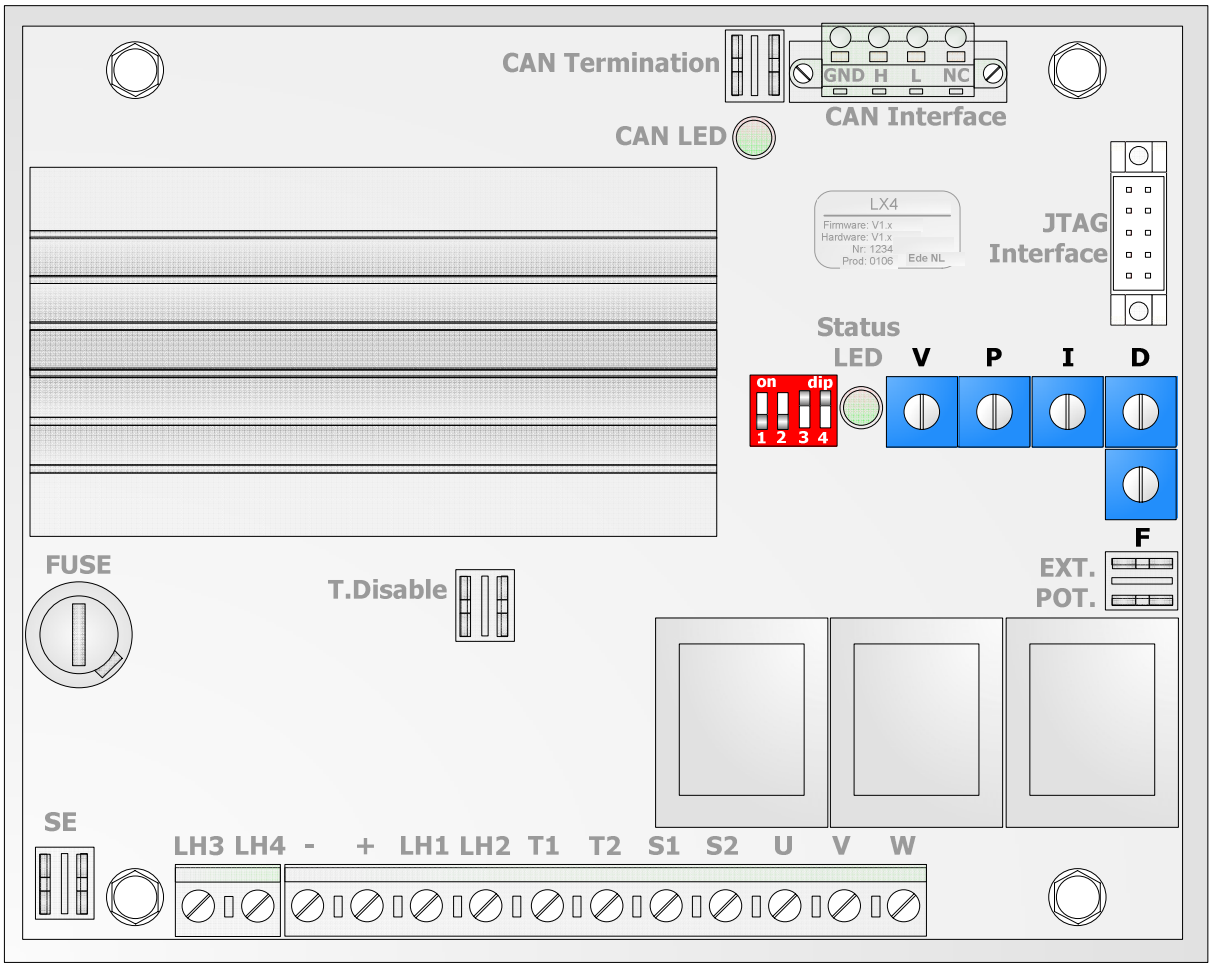


Fig 3. Adjustments overview

DO NOT CHANGE DIPSWITCH SETTINGS DURING OPERATION

Symbol	Description	Notes	
V	Generator voltage setpoint		
P	Proportional gain setpoint		
I	Integral time setpoint		
D	Voltage droop setpoint	For parallel operation	
F	Underspeed setpoint		
Dipswitch 1	Sensing voltage selection	Off = 400V_{ac}	On = 230V_{ac}
Dipswitch 2	Phaseloss protection	Off = disabled	On = enabled
Dipswitch 3	Control mode selection	Off = Constant voltage	On = VPH
Dipswitch 4	Overexcitation threshold	Off = 2A	On = 4A

Table 3. Adjustments

2.2 Terminals overview

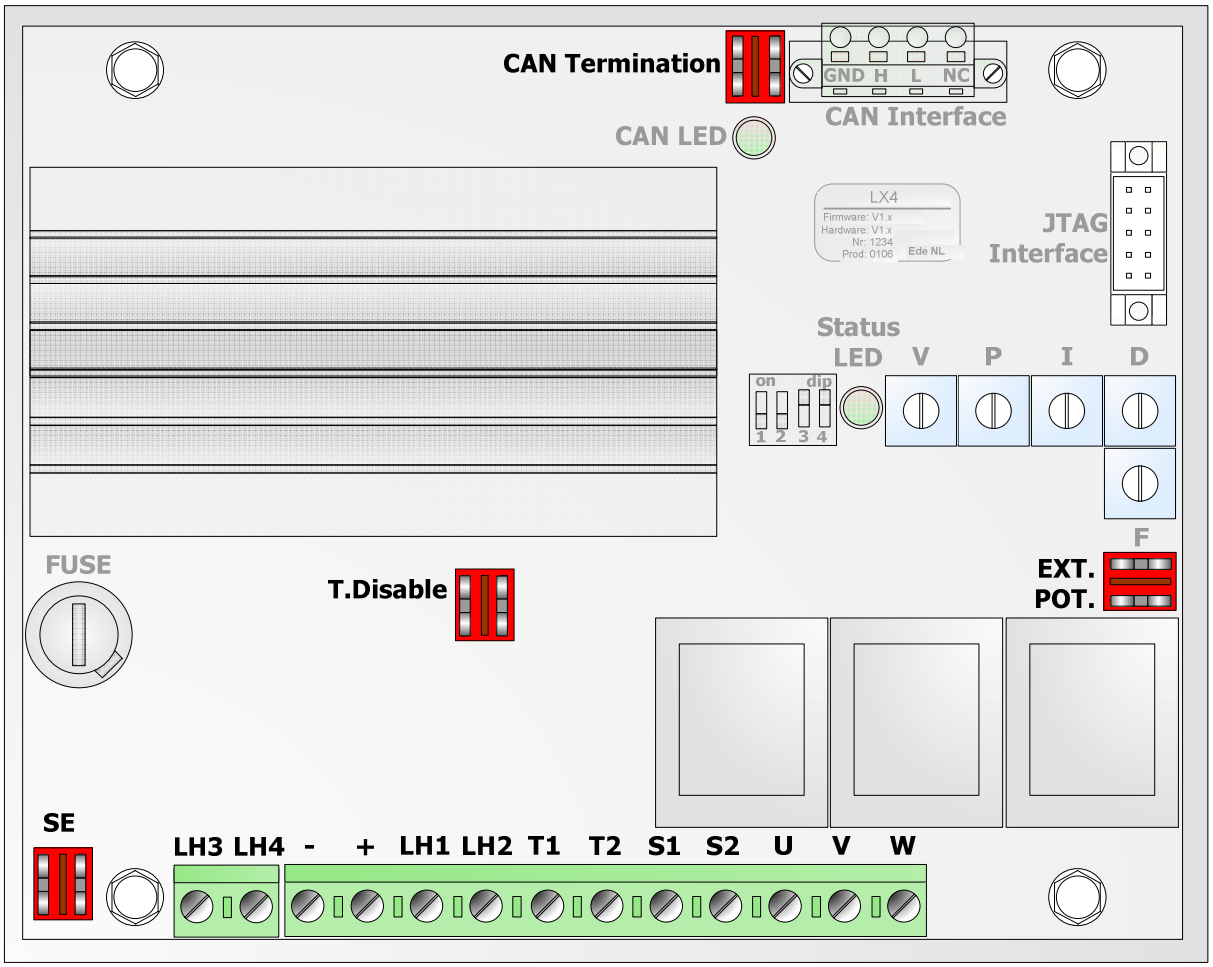


Fig 4. Terminals overview

Symbol	Description	Notes
U, V, W	Voltage sensing input	phase sequence U→V→W
S1, S2	CT input for voltage droop	CT in V-phase
T1, T2	Temperature sensor input	KTY84-130, PTC or Clixon sensor
LH1, LH2 LH3, LH4	Supply inputs	For self excitation, the auxiliary supply winding must be connected to LH3-LH4
+, -	Field excitation output	
SE	Self Excitation link (Caution: High voltage)	Never fit or remove link while generator is in operation Shorting SE enables self excitation.
EXT. POT.	External voltage adjust input	10 kΩ potentiometer
T.Disable	Disables T1 – T2 sensing	Shorting T.Disable disables temperature protection
CAN Termination	CAN bus termination link	Shorting enables 120 Ohm bus termination

Table 4. Terminals

2.3 Electrical characteristics

Symbol	Parameter	Condition	Min.	Max.	Unit
U, V, W	Voltage sensing input	50-60 Hz	20	480	V_{AC}
+, -	AVR field current		-	3	A_{DC}
LH1 – LH2, LH3 – LH4	Supply input	dc - 400 Hertz	20	100	V_{AC}
R_{field}	Field resistance		10	-	Ω
T_{AMB}	Operating temperature	95 % RHD non condensing	0	+70	°C
T_{STG}	Storage temperature	95 % RHD non condensing	-20	+85	°C
S1 – S2	Droop CT	Isolated CT	-	0.25	A_{AC}
EXT. POT.	External Volt adjust	10kΩ potentiometer	0	10	kΩ
FUSE	Fuse rating	Ceramic, Time delay		4	AT

Table 5. Electrical characteristics

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.

3. Operation and maintenance

3.0 AVR Status LED

The AVR's mode of control is indicated by the status LED. The options are depicted in table 6.

LED Color / Blinks	AVR status	Colour code
	Idle	Green blink
	Setpoint ramp / buildup	Orange blink
	Voltage control	Continuous Green
	Voltage / Excitation limiting	Continuous Orange
	Error condition	Red / Green blink

Table 6. AVR status

3.1 Modes of control

3.2.0 Idle

When a supply is connected to the AVR but the generator frequency is below 25Hz, the AVR enters idle mode. During idle mode field excitation is inhibited however all protections remain functional.

3.1.1 Build-up

When the generator frequency rises above 25Hz, the AVR enters the build up mode. The generator voltage is ramped up to the voltage setpoint. When the generator voltage is close to the desired nominal value, the status led signals continuous green. Diagram 1 shows the sequence of events.

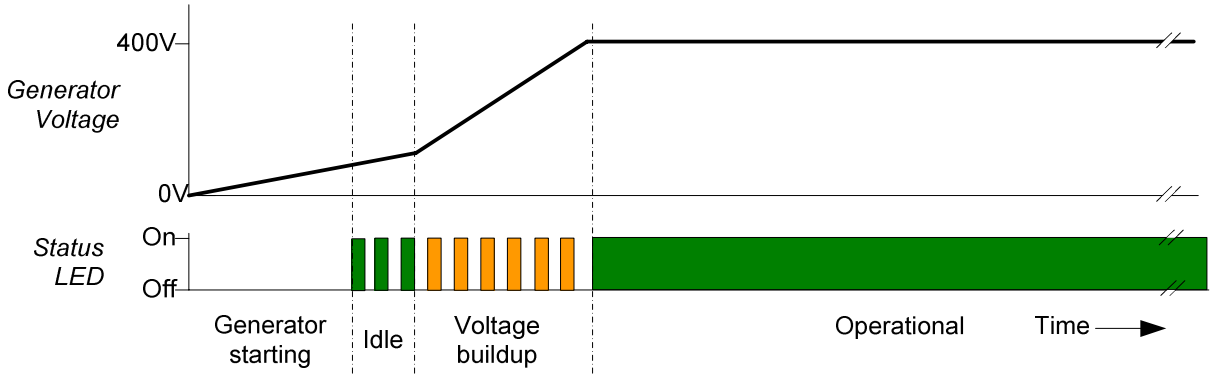


Diagram 1. Build up

3.1.2 Voltage control

When dipswitch 3 is in off position, the AVR performs constant voltage control after finishing the build up mode. The voltage/ frequency characteristic is depicted in diagram 2.

Below the underspeed frequency, set by potentiometer F, the generator voltage is controlled according a Volt per Hertz ramp. Below 25Hz the AVR control mode returns to idle and excitation is stopped. As a consequence the generator voltage will then drop to the residual voltage level. For a detailed description of potentiometer F see chapter 5.4.

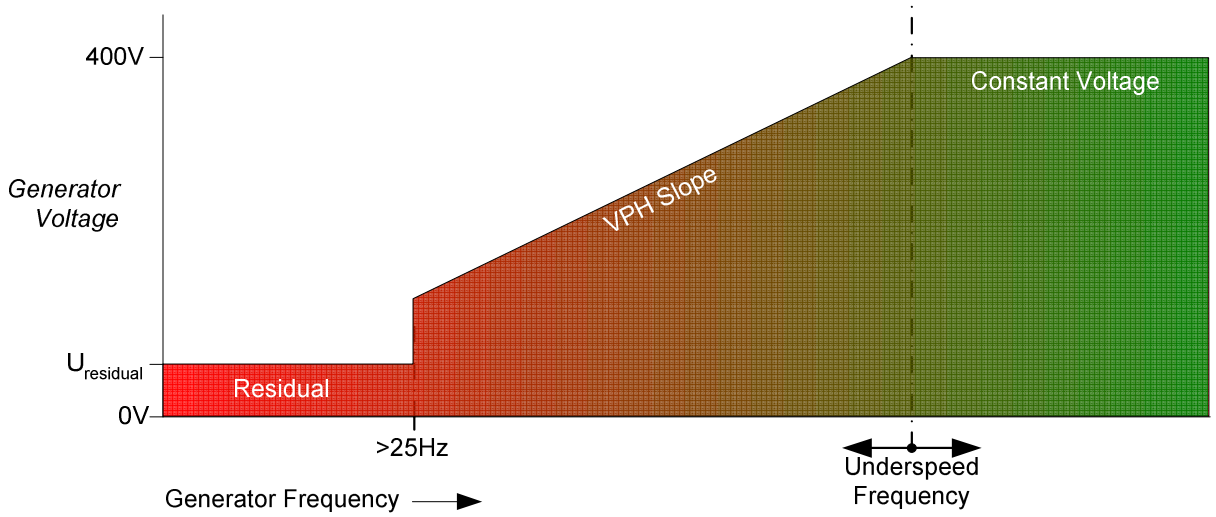


Diagram 2. Constant Voltage control

When dipswitch 3 is in on position, the AVR performs Volt per Hertz control after finishing the build up mode. The voltage/ frequency characteristic is depicted in diagram 3.

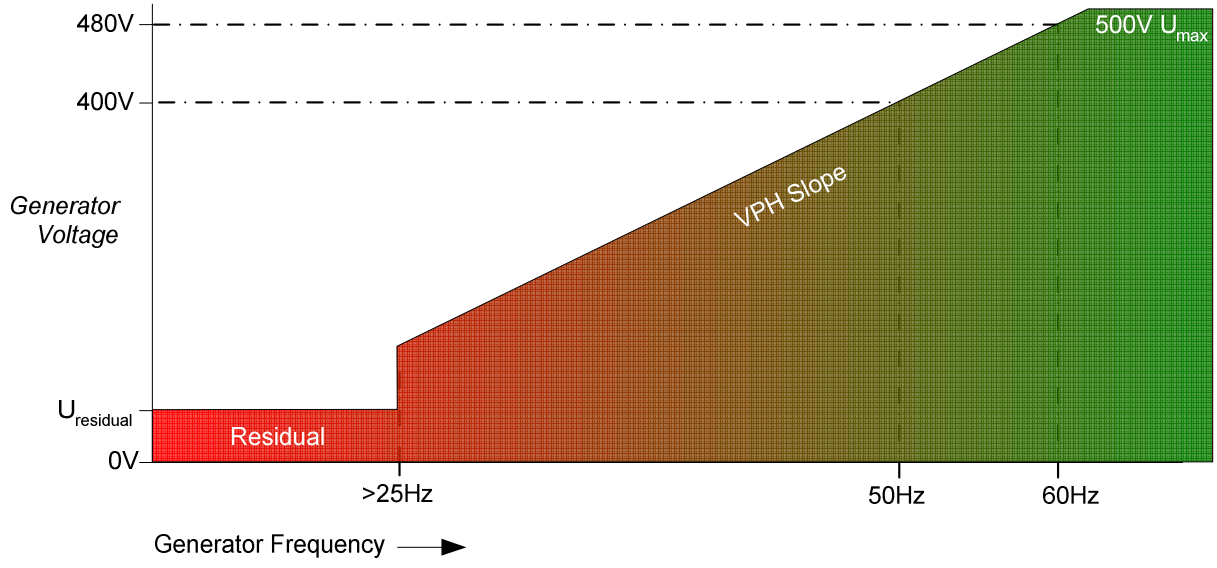


Diagram 3. Volt per Hertz Control

3.2 Setpoint limiting

3.2.0 Introduction

The AVR is equipped with both limiting functions and protections.

The limiting functionality lowers the voltage- or excitation setpoint if a certain threshold is exceeded. When the measured quantity no longer exceeds the threshold, the setpoint is increased again. This enables the AVR to recover from the situation.

The protections also lower the voltage setpoint, upon exceeding a certain threshold. However Recovery is only possible by resetting the AVR. This is accomplished by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this may be accomplished by stopping the generator.

When a protection is triggered the voltage setpoint is decreased to a fixed level of 95V.
Keep in mind that the actual generator voltage may larger than 95V due to the generator's residual magnetism.

For a detailed description of all protections refer to chapter 4.

3.2.1 Generator current limiting

When the generator current exceeds the level, corresponding with 0.25A at terminals S1-S2, for longer than 10 seconds, generator current limiting is activated. The AVR controls the generator current down to the selected level.

0.25A at terminals S1-S2 usually corresponds with the nominal generator current when the recommended CT ratio of I_{nom}:0.25A is used.

Generator current control is visualized by the status LED signalling continuous orange.

When the generator current decreases below the threshold again, for more than 10 seconds, voltage control is resumed. The AVR ramps back to the voltage setpoint, while signalling a orange blinking status LED. When the generator voltage is close to the desired nominal value, the status led becomes continuous green.

Diagrams 4 shows a sequence of events for diagnosis purposes in case of generator current limiting.

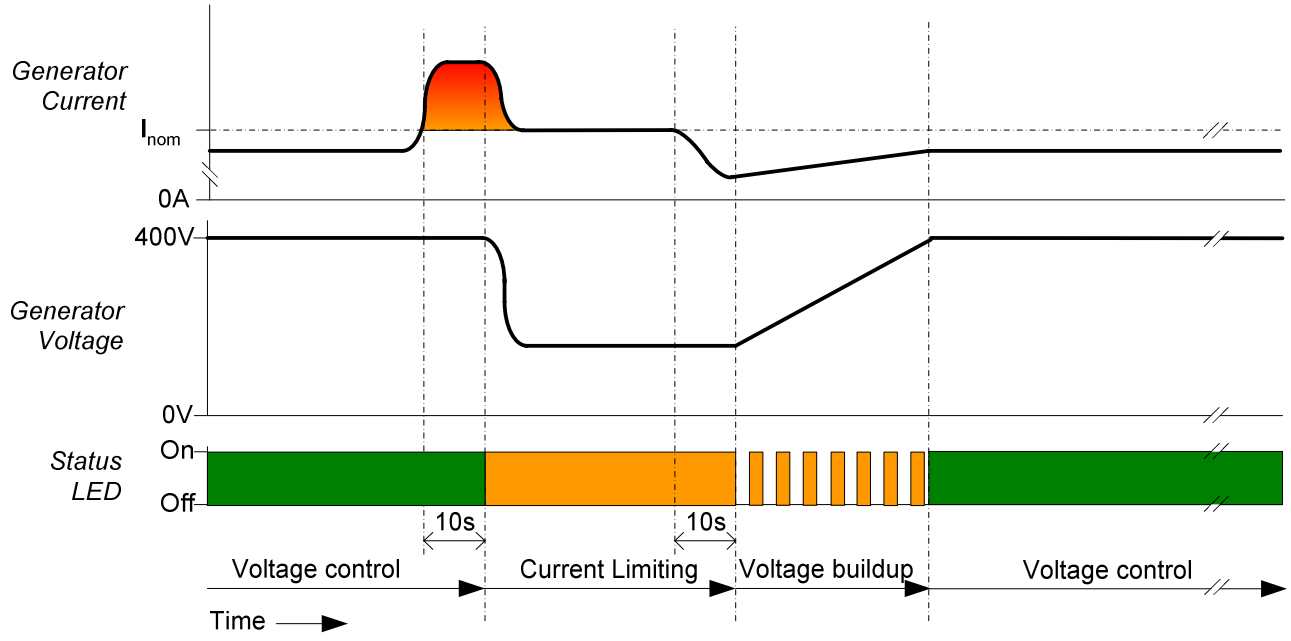


Diagram 4. Generator current limiting

3.2.2 Excitation current limiting

When the excitation current level, selected by dipswitch 4, is exceeded for more than 5 second, the AVR controls the excitation current to the selected level.

Excitation current control is visualized by the status LED signalling continuous orange.

When the excitation current decreases below the selected threshold again, for more than 5 second, voltage control is resumed. The AVR ramps back to the voltage setpoint, while signalling a orange blinking status LED. When the generator voltage is close to the desired nominal value, the status led becomes continuous green.

Diagrams 5 shows a sequence of events for diagnosis purposes in case of excitation limiting.

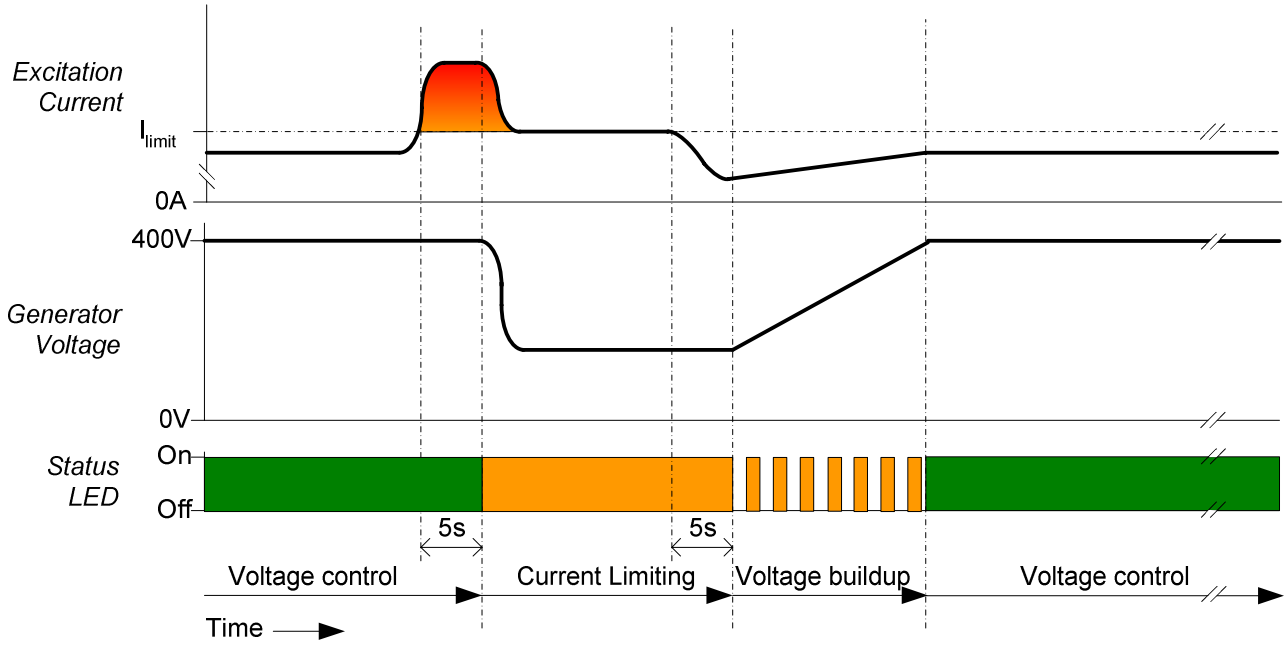


Diagram 5. Excitation limiting

3.2.3 Generator over temperature limiting

The generator temperature may be sensed either by a clixon, PTC or KTY84-130 sensor connected to terminals T1-T2. The over temperature limiting and protection can be disabled by omitting the temperature sensor and shorting link T.Disable

If a clixon or PTC is connected no absolute temperature can be measured, only the exceeding of a threshold. In this case the generator over temperature protection is triggered simultaneously with the over temperature limiting function. This causes the AVR to decrease the voltage setpoint to 95V. The generator over temperature protection is described in 4.2.1.

If a KTY84-130 sensor is connected and the generator temperature exceeds 160ºC for more than 5 seconds, the AVR decreases the voltage level. The voltage level is decreased linear, inverse proportional to the temperature transgression by 1.5V/ºC.

Active voltage limiting is visualized by the status LED signalling continuous orange.

When the generator temperature decreases, voltage is increased again until the nominal voltage. When the generator voltage is close to the desired nominal voltage, the status led becomes continuous green again.

Diagram 6 shows a sequence of events for diagnosis purposes in case of generator over temperature limiting.

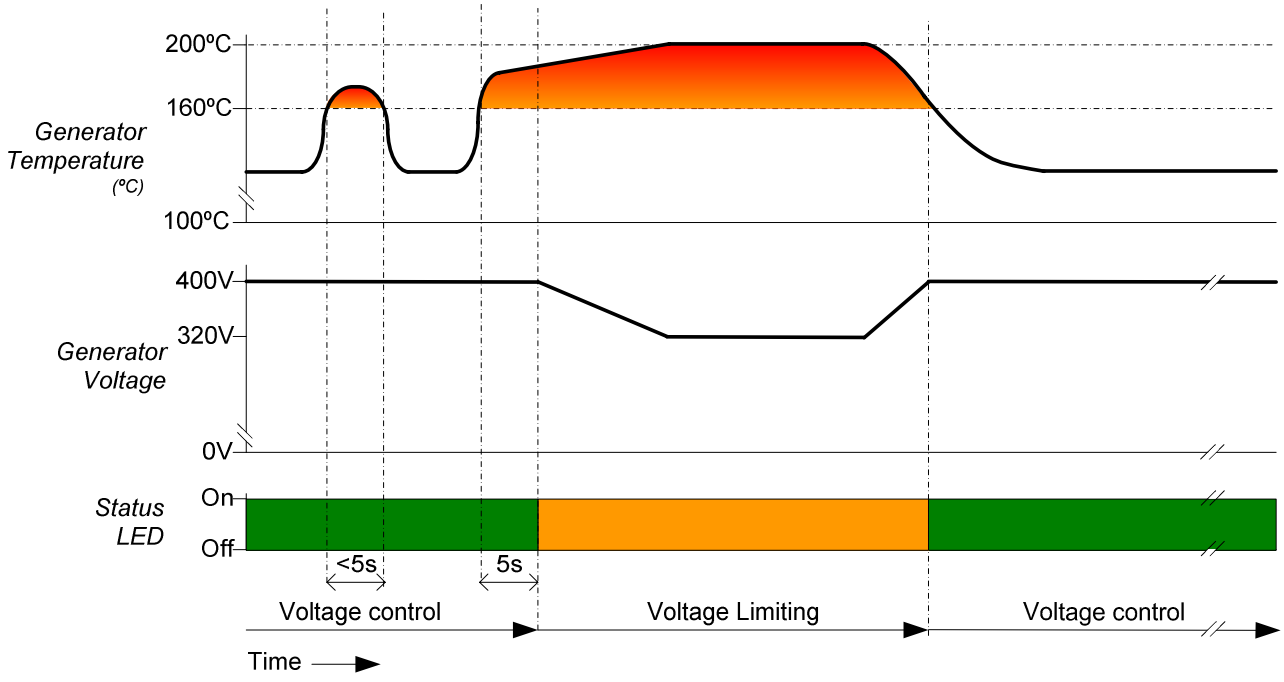


Diagram 6. Over temperature limiting

3.2.4 Underspeed limiting

The goal of the underspeed limiting is to prevent damage to the generator caused by overexcitation. When the generator frequency drops below the underspeed setpoint, $F_{underspeed}$, the generator voltage is decreased linear, proportional to the generator frequency.

The underspeed setpoint is set by potentiometer F, as is described in 5.4.

Active underspeed limiting is visualized by the status LED signalling continuous orange, however only when the constant voltage control mode is selected (dipswitch 3 = ‘ on’).

In case the generator frequency drops below 25Hz excitation is stopped completely and the AVR control mode becomes idle. This is visualized by a green blinking status LED.

Diagrams 7 shows a sequence of events for diagnosis purposes in case of underspeed limiting during constant voltage control.

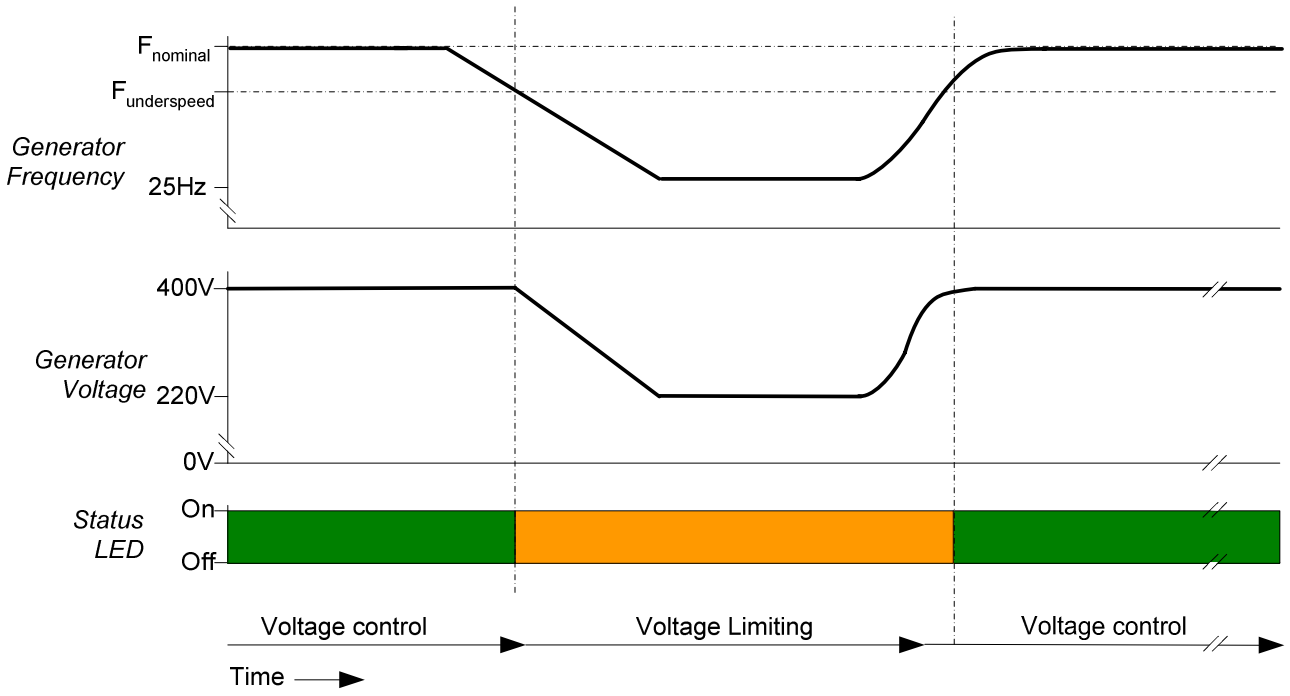


Diagram 7. VPH underspeed limiting

3.3 Special functions

3.3.0 Self Excitation

When the AVR supply voltage, connected to LH1-2 and LH3-4, is insufficient to supply the AVR, self excitation can be used. Self excitation is enabled by shorting the SE terminal.
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 circuit is disabled again. Hereafter, the AVR's internal controller builds up the generator voltage.

Diagram 8 shows a sequence of events with enabled self excitation, for diagnosis purposes.

Caution:
Never fit or remove the SE link when the generator is operation.
This is a live conductor, contact can result in serious electrical shock.

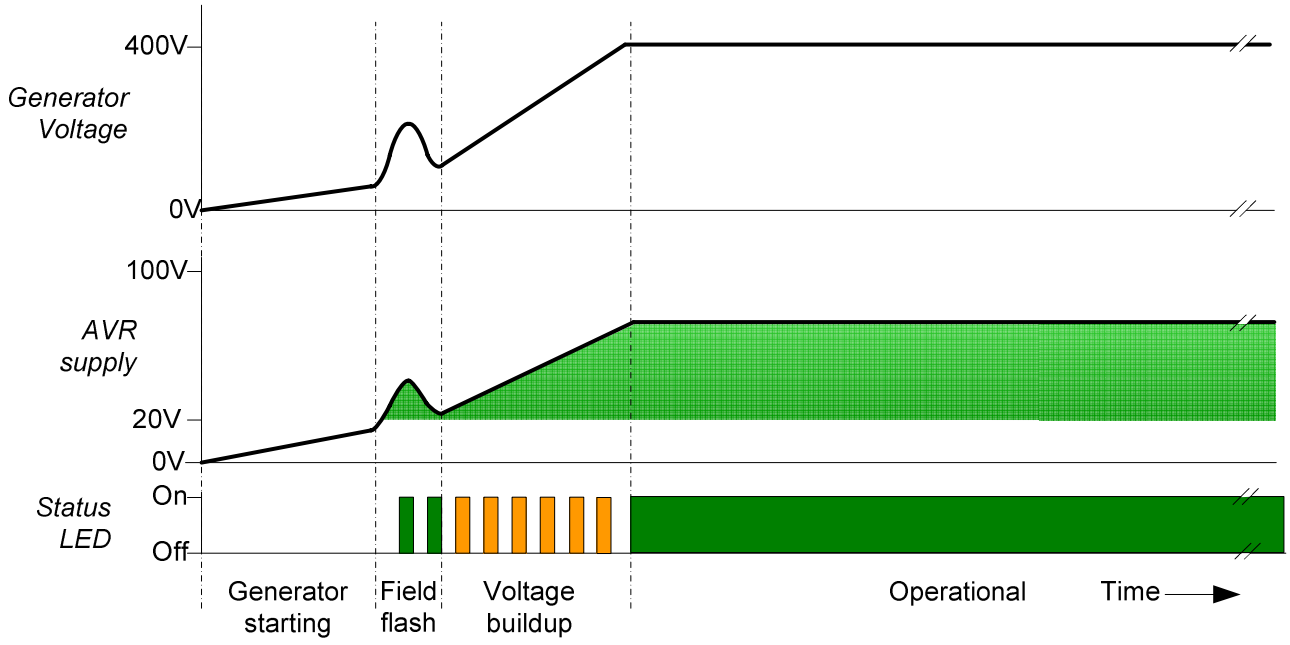


Diagram 8. Self Excitation

3.3.1 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 influence of the voltage droop on the generator voltage is depicted in diagram 9.

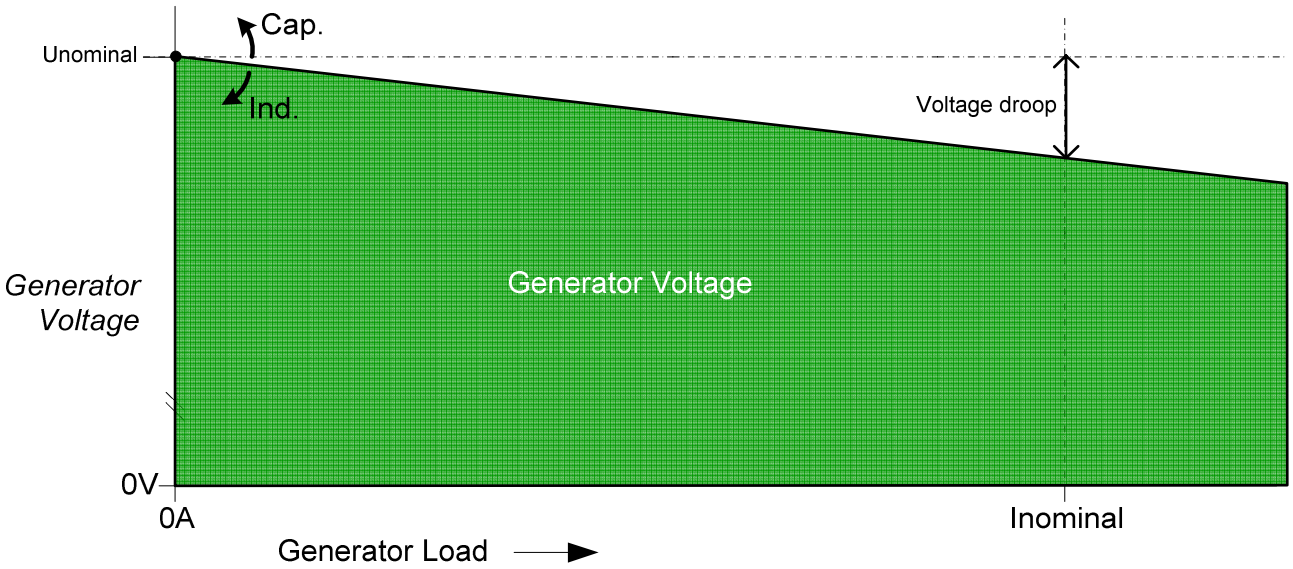


Diagram 9. Voltage droop

3.4 CAN-bus

3.4.1 Introduction

The AVR is equipped with a CAN bus interface. The CAN interface enables the user to obtain detailed information about the AVR status, measured quantities and to adjust AVR control setpoints.

The interface complies with CAN specification 2.0B. The AVR communication operates at a transfer rate of 250kBit/s and uses standard frame (11-bit) message identifiers.

3.4.2 CAN status LED

The CAN bus status is indicated by the CAN status LED. The options are depicted in table 7.

LED Color / Blinks	CAN status	Colour code
	CAN bus disabled	Off
	CAN bus error	Continuous Red
	CAN bus OK	Continuous Green
	CAN bus OK + CAN control active	Continuous Orange

Table 7. CAN status

3.4.3 CAN heartbeat

The AVR sends a heartbeat signal when the AVR is powered. This signal may be used to assess the proper functioning of the CAN bus communication.
The heartbeat consists of a message with ID 0x70A and is sent every 500ms. The message content is 1 byte long and alternating 0x05 or 0x85 .

Heartbeat			***ID:0x70A***
Byte	**Description**	**Value**	**Remarks**
0	Alternating heartbeat	0x05 ~ 0x85	

Table 8. CAN heartbeat

3.4.4 CAN AVR measurements & status

When the AVR is powered a message containing AVR measurements and the present AVR status is sent. The message with ID 0x18A is sent every 500ms. The definition of the 8 byte content is described in table 9

AVR measurements & status				***ID:0x18A***
Byte	**Description**	**Value**	**Unit**	**Remarks**
0	Generator voltage	0-255	V	Phase - Neutral
1	Excitation current ratio	0-100	%	(Byte 5 / Byte 3) * 100%
2	Generator temperature	0-255	ºC	
3	Excitation current	0-255	0.01A	
4	Generator frequency	0-255	0.5Hz	
5	Excitation current setpoint	0-255	0.01A	
6	Status AVR			Bitwise AVR statusregister
bit 0	Generator current limiting	1 - 0	bit	1 = active
bit 1	Excitation current limiting	1 - 0	bit	1 = active
bit 2	Over temperature generator limiting	1 – 0	bit	1 = active
bit 3	Over temperature AVR limiting	1 – 0	bit	1 = active
bit 4	Underspeed limiting	1 – 0	bit	1 = active
bit 5	Overvoltage 440V protection	1 – 0	bit	1 = triggered
bit 6	Overvoltage 500V protection	1 – 0	bit	1 = triggered
bit 7	Phaseloss protection	1 – 0	bit	1 = triggered
7	AVR temperature	0-255	ºC	Measured at MCU

Table 9. CAN measurements & status

3.4.5 CAN control

When the AVR is powered it is possible to obtain remote control over the AVR voltage setpoint and excitation limit setpoint.

To realize CAN control a message with ID 0x20A must be sent at least every 1 seconds complying with the content definition described in table 10.
When CAN control is activated, but the AVR has not received a valid control message for the last 1 seconds, CAN control is automatically disabled and normal AVR control is resumed.

Active CAN control is visualized by the CAN status LED signalling continuous orange.

Be aware that when the user enables CAN control over the voltage and/or excitation setpoints, adjustments to the respective potentiometers on the AVR will have no immediate effect. The adjustments will only then be effective when CAN control is disabled and AVR control is resumed again.

CAN control				***ID:0x20A***
Byte	**Description**	**Value**	**Unit**	**Remarks**
0	Generator voltage setpoint	0-255	V	Phase - Neutral
1	Excitation current ratio setpoint	0-100	%	Derived from dipswitch 4 setting
2	-	-	-	not used
3	-	-	-	not used
4	CAN control			Bitwise CAN commandregister
bit 0	Activate CAN voltage setpoint	1 - 0	bit	1 = active
bit 1	-	0	bit	not used
bit 2	-	0	bit	not used
bit 3	-	0	bit	not used
bit 4	Activate CAN excitation ratio setpoint	1 – 0	bit	1 = active
bit 5	-	0	bit	not used
bit 6	-	0	bit	not used
bit 7	-	0	bit	not used
5	-	-	-	not used
6	-	-	-	not used
7	-	-		not used

Table 10. CAN control

4. Protections and Diagnose

4.1 Led error Codes

Every triggered protection is indicated by an error code signalled by the status LED.

Table 11 shows the relation between the number of red blinks and the error condition.

LED Color Number of red blinks		Error condition
	1	Short circuit
	2	Over excitation error
	3	Generator over temperature
	4	AVR over temperature
	5	Phaseloss / Phase sequence error
	6	Overvoltage 110%
	7	Overvoltage 125%

Table 11. Error codes

4.2 Protections

When an error condition triggers the AVR's protections, field excitation is limited, decreasing the voltage setpoint to 95V. Nevertheless, the generator voltage could be higher than 95V due to the generator's remanent voltage.

The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator. After a successful reset the AVR restarts from idle mode and any information concerning the previous error is lost.

4.2.0 Short circuit protection

The short circuit protection validates the generator current measured on terminals S1 and S2.

If the generator current exceeds the level corresponding with 0.5A at terminals S1-S2 for longer than 1s, the short circuit protection is triggered, decreasing the generator voltage setpoint to 95V.
0.5A at terminals S1-S2 usually corresponds with 2 times the nominal generator current when the recommended CT ratio of I_{nom}:0.25A is used.

An short circuit error is visualized by the status LED blinking red one time. The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagram 10 shows a sequence of events for diagnosis purposes in case of an short circuit error.

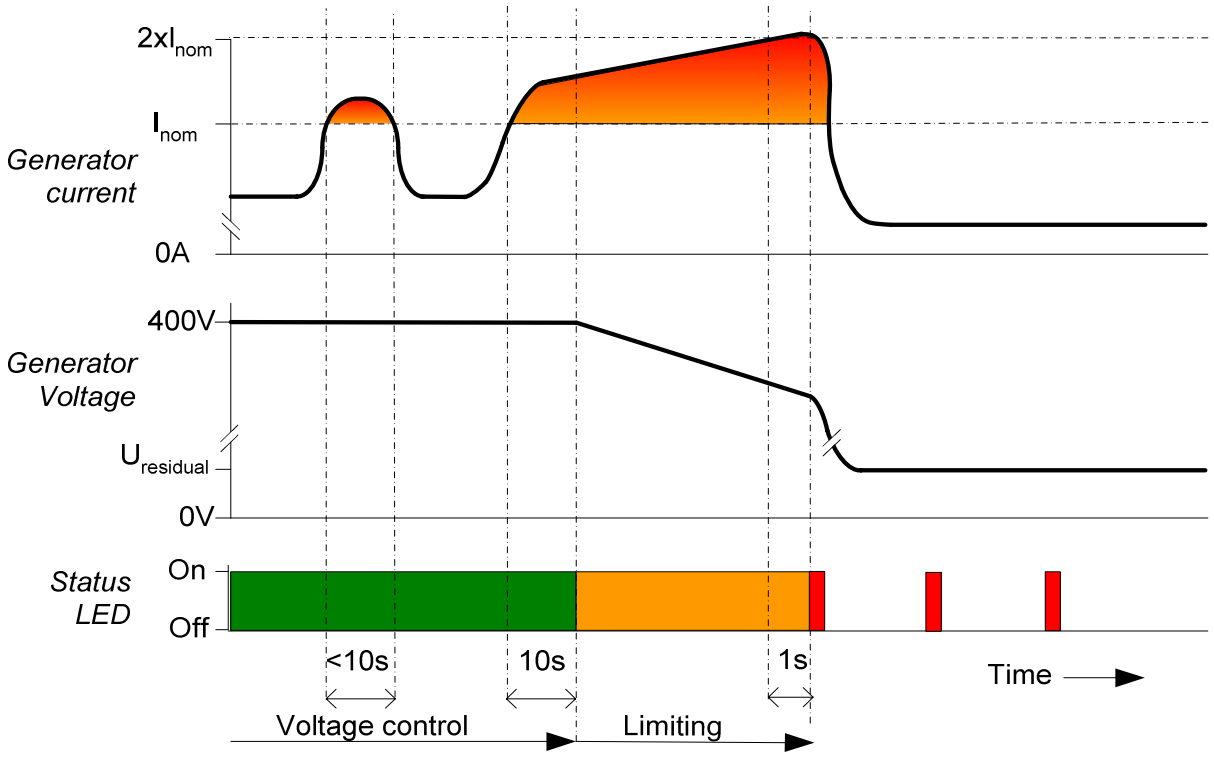


Diagram 10. Over excitation protection

4.2.1 Over excitation protection

The over excitation protection validates the generator field excitation measured on terminals + and -.

If the field excitation current exceeds the threshold of 6A for longer than 5s, the over excitation protection is triggered, decreasing the generator voltage setpoint to 95V.

An over excitation error is visualized by the status LED blinking red two times. The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagram 11 shows a sequence of events for diagnosis purposes in case of an over excitation error.

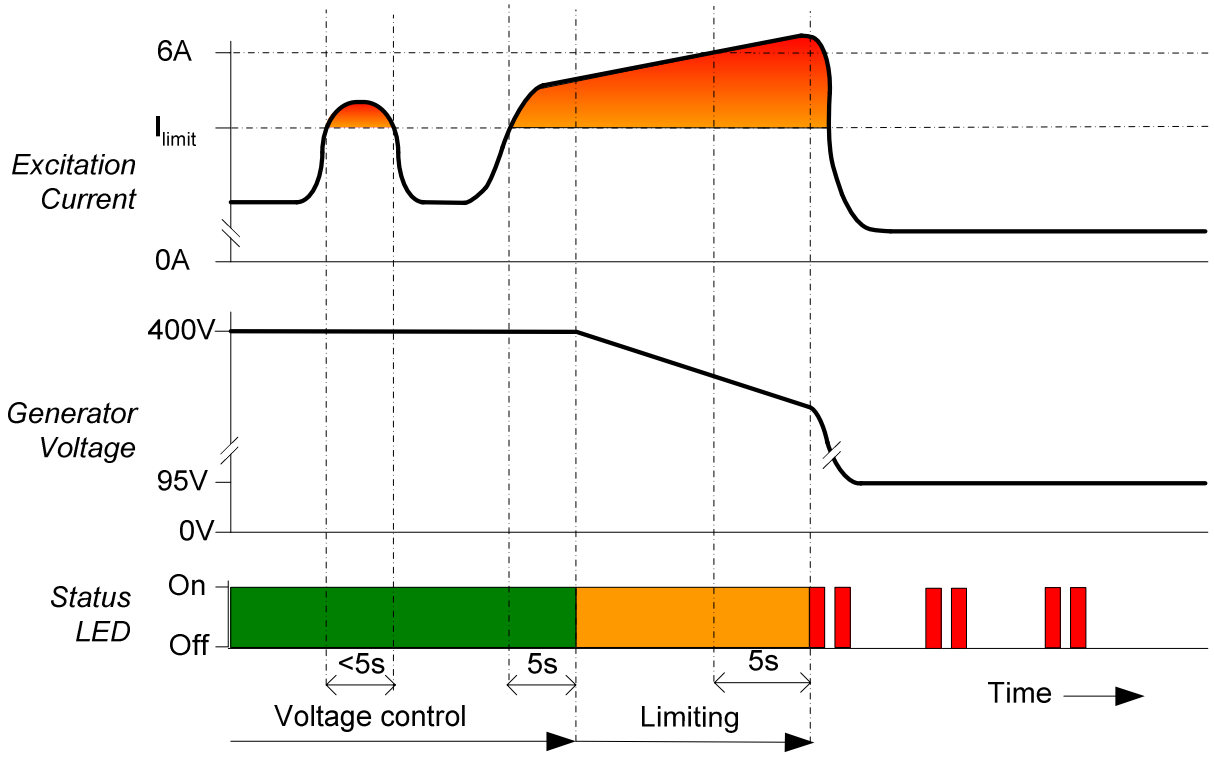


Diagram 11. Over excitation protection

4.2.2 Generator over temperature protection

The generator over temperature protection validates the generator temperature, sensed by either a clixon, PTC or KTY84-130 sensor, connected to terminals T1-T2. The over temperature limiting and protection can be disabled by omitting the temperature sensor and shorting terminals T.Disable.

In case a KTY84-130 sensor is connected, the over temperature protection is triggered upon exceeding a generator temperature of 200ºC for 2 seconds. In case a clixon or PTC is connected, the over temperature protection is triggered upon exceeding the specific sensor temperature threshold for 2 seconds. As is described in 3.2.2, fitting a clixon or PTC, instead of a KTY84-130 sensor, effectively disables the generator over temperature limiting.

If the generator over temperature protection is triggered, the generator voltage setpoint is decreased to 95V.

A generator over temperature error is visualized by the status LED blinking red three times. The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagram 12 shows a sequence of events for diagnosis purposes in case of a generator over temperature error.

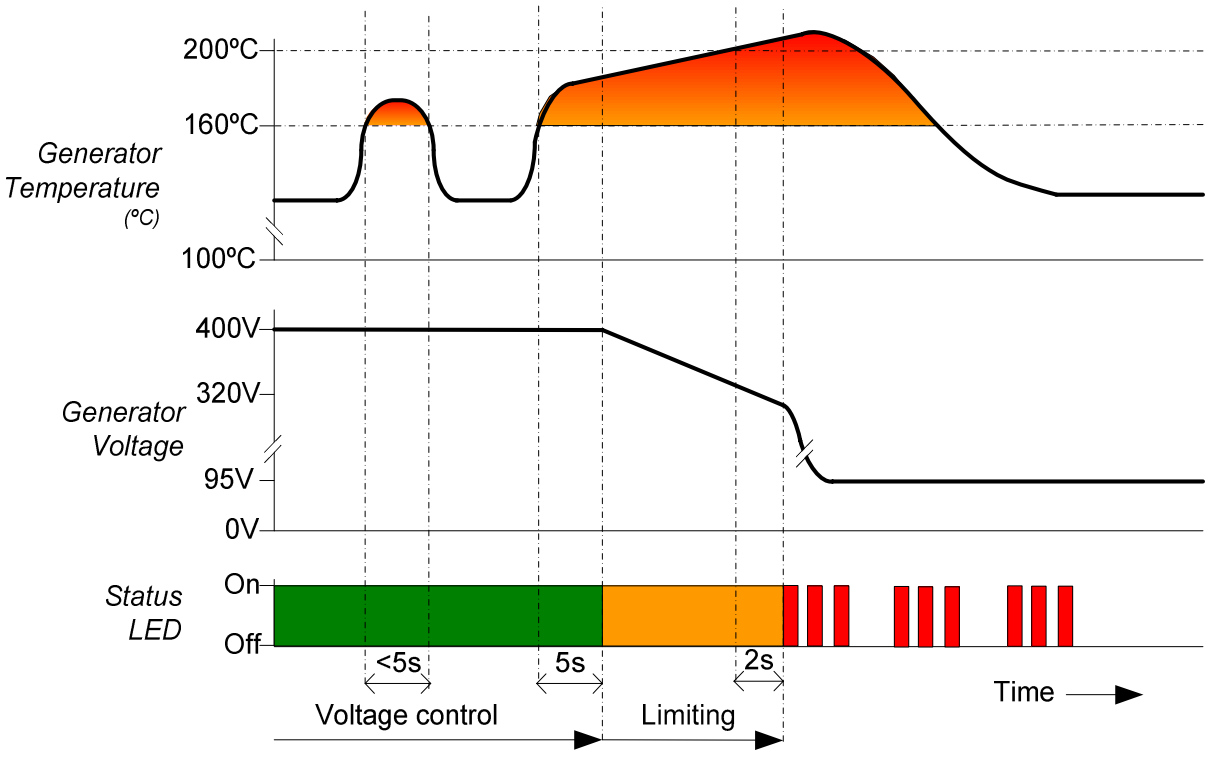


Diagram 12. Generator over temperature

4.2.3 AVR over temperature protection

The AVR over temperature protection validates the AVR temperature, measured by an internal sensor. If the over temperature limit of 85°C is exceeded for 20 seconds, the generator voltage setpoint is decreased to 95V.

An AVR over temperature error is visualized by the status LED blinking red four times.

The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagram 13 shows a sequence of events for diagnosis purposes in case of an AVR over temperature error.

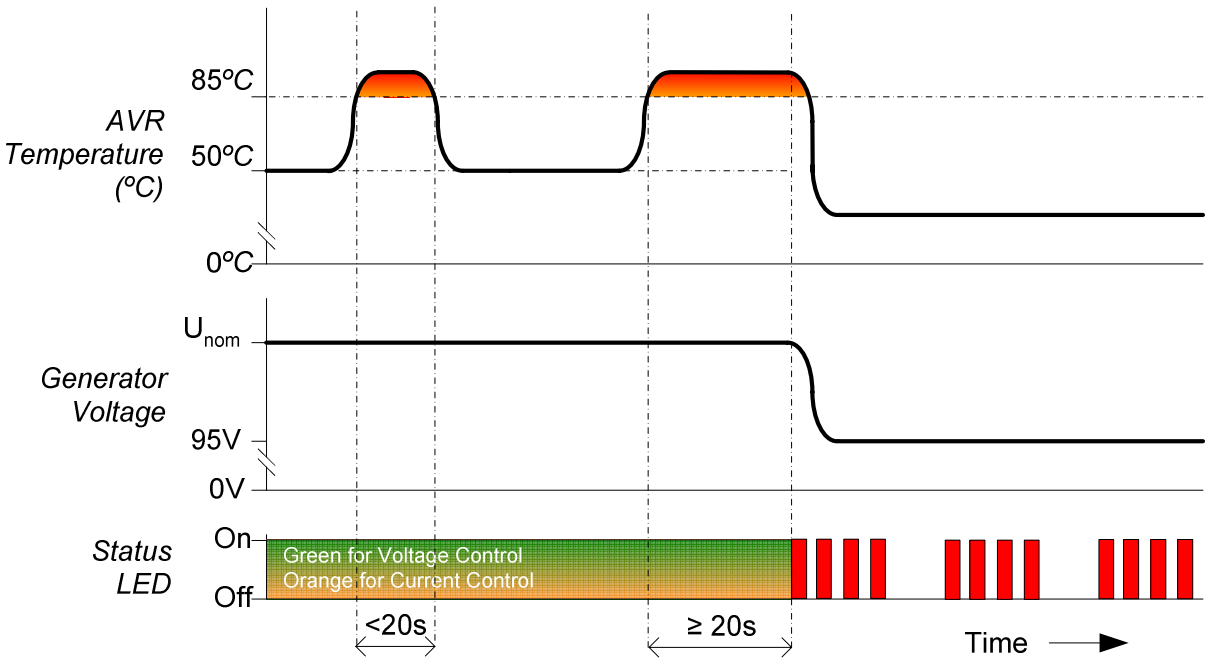


Diagram 13. AVR over temperature

4.2.4 Phase loss / phase sequence protection

The functionality of the protection is twofold.

First; The phase sequence protection validates the order of the phase sequence connected to terminals U, V and W to be clockwise (U→V→W).
Second, the phase loss protection validates the presence of all three generator phases on the terminals U, V and W.

In case an incorrect phase sequence is measured, the protection is usually triggered during the build up mode of the AVR. The protection decreases the generator voltage to 95V and visualizes the error by blinking the status LED red five times.

Second; In case one of the phases U, V or W is not sensed for at least 500ms, the phaseloss protection is triggered.

If the phaseloss protection is triggered, the generator voltage setpoint is decreased to 95V and the error is visualized by the status LED blinking red five times.

The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagram 14 shows a sequence of events for diagnosis purposes in case of a phaseloss error.

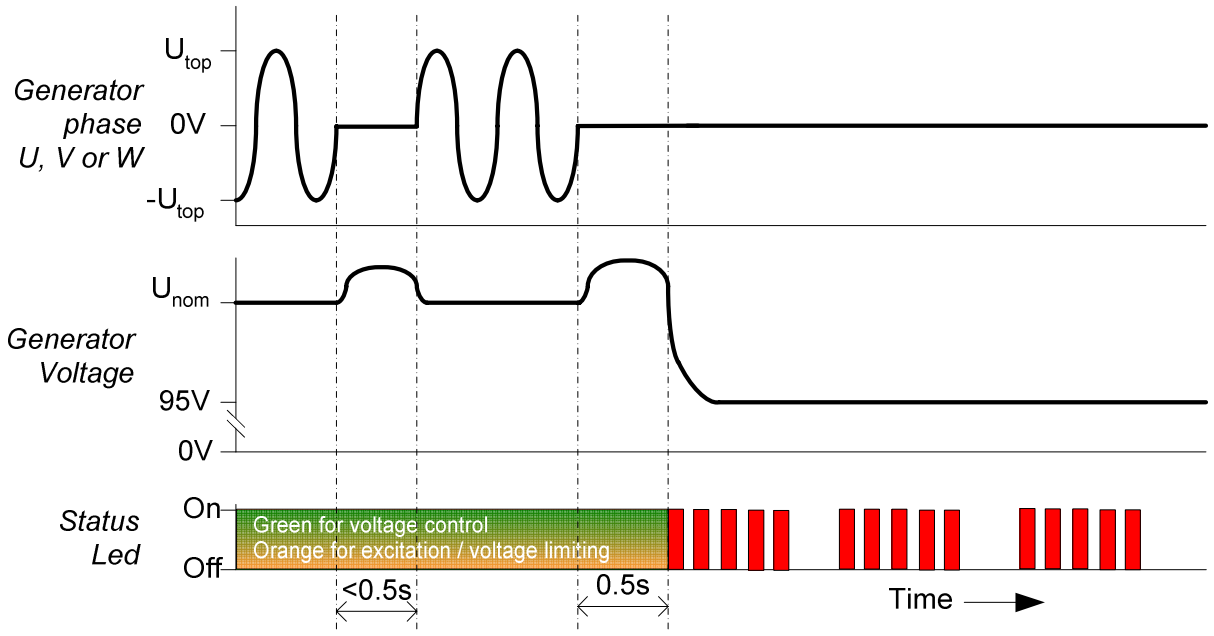


Diagram 14. Phaseloss

4.2.5 Over voltage protection 110%

The 20% over voltage protection validates the generator voltage on terminals U,V and W.
If an over voltage condition is detected but relieved within two seconds, the protection is not triggered and normal control proceeds.

If the over voltage limit of 110% is exceeded for at least 2 second, the over voltage protection is triggered and the generator voltage setpoint is decreased to 95V.
The over voltage error is visualized by the status LED blinking six times.

The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagrams 15 shows a sequence of events for diagnosis purposes in case of an 110% over voltage error.

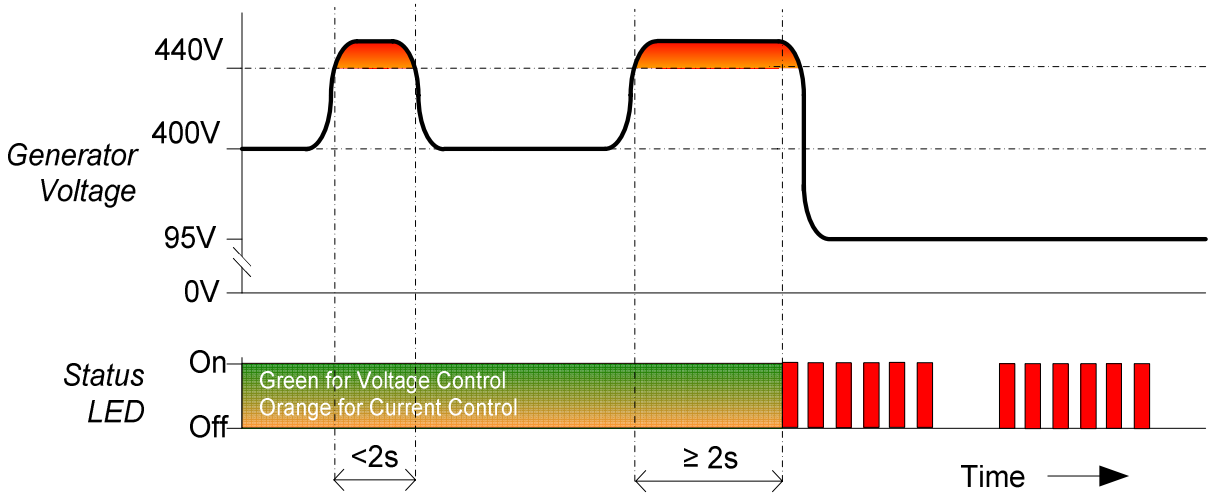


Diagram 15. 110% Over voltage

4.2.6 Over voltage protection 125%

The 125% over voltage protection validates the generator voltage on terminals U,V and W.
If an over voltage condition is detected but relieved within one second, the protection is not triggered and normal control proceeds.

If the over voltage limit of 125% is exceeded for at least 1 second, the over voltage protection is triggered and the generator voltage setpoint is decreased 95V.
The over voltage error is visualized by the status LED blinking seven times. The AVR may be reset from the error condition by interrupting the AVR supply (LH1-LH2 and LH3-LH4) for at least 5 seconds. In case an auxiliary supply winding is used this can be accomplished by stopping the generator.

Diagrams 16 shows a sequence of events for diagnosis purposes in case of an 125% over voltage error.

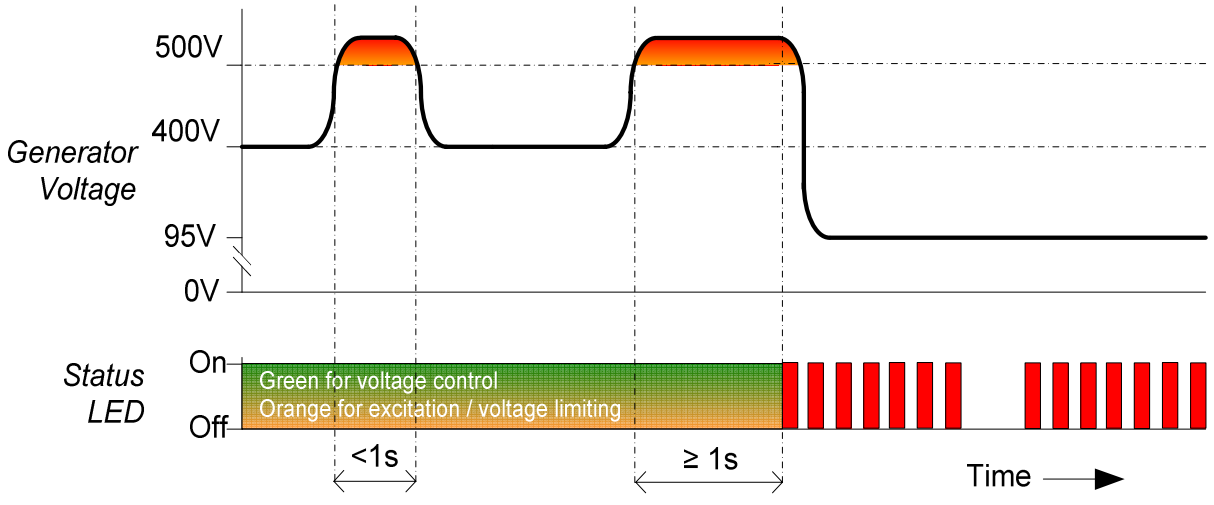


Diagram 16. 125% Over voltage

5. Settings and adjustments

5.1 Generator Voltage

The generator voltage setpoint is user adjustable by means of the V potentiometer. The voltage potentiometer range is U_{nom}±12.5%. Turning the potentiometer clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage.

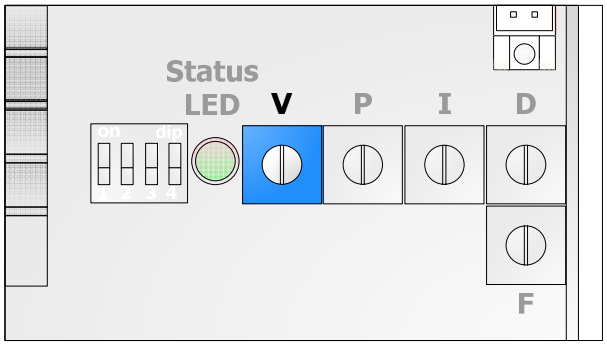


Fig 5. Voltage adjustment

5.2 P & I stability

The generator stability and dynamic response are adjustable by means of the P, proportional, and I, integral action, potentiometers.
Turning the proportional action potentiometer clockwise increases the proportional gain, turning counterclockwise decreases the proportional gain.
Turning the integral action potentiometer clockwise decreases the integral time, turning counterclockwise increases the integral time.
Tuning the PI-controller must be performed by a control expert to prevent damage to the AVR and generator.

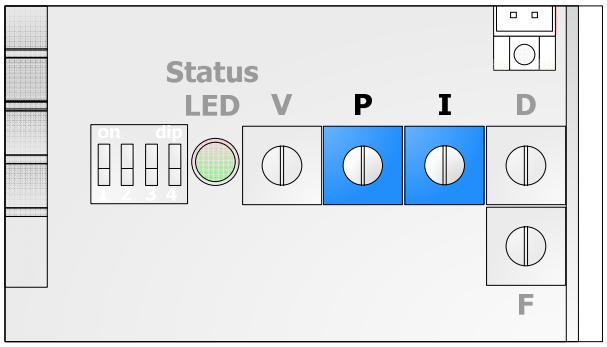


Fig 6. Stability adjustments

5.3 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}±10% at P.F. ±0.1 and a secondary CT current of 0.25A at terminals S1-S2. 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 3.3.0

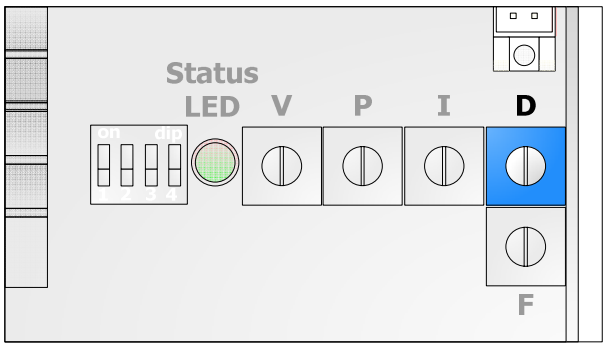


Fig 7. Droop adjustment

5.4 Underspeed frequency

Potentiometer F sets the underspeed frequency setpoint. The underspeed frequency setpoint is used to decrease voltage, according a VPH slope, at low rpm. This protects the exciter field against over excitation during constant voltage control. For more information, see diagram 2.

As shown in figure 9, turning the potentiometer completely counter clockwise disables the underspeed protection.
Be aware that disabling the underspeed protection is not recommendable. This could lead to over excitation, which will inflict serious damage to the generator.

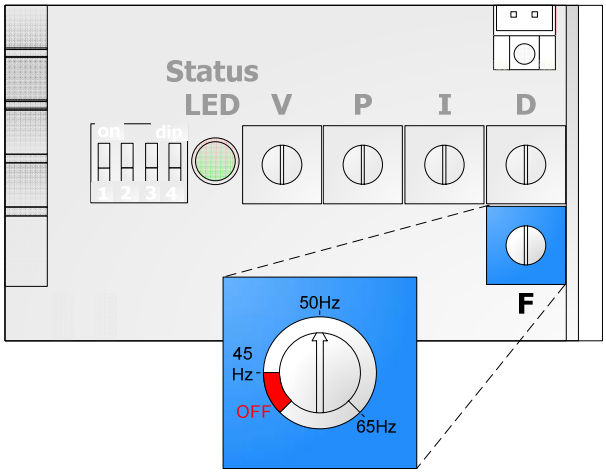


Fig 8. Underspeed adjustment

Turning clockwise increases the frequency setpoint from 40Hz to 65Hz

5.5 Dipswitch settings

The dipswitches are used for enabling or setting several AVR functions. The layout and positions are depicted in table 12.
Dipswitch positions must not be changed during operation. Always interrupt the AVR supply or stop the generator before switching any of the dipswitches.

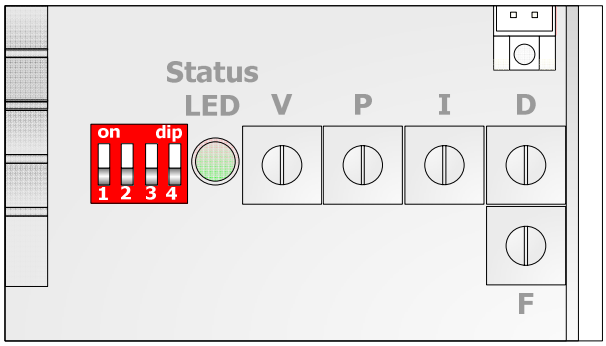


Fig 9. Dipswitch settings

Dipswitch	Description	OFF	ON
1	Sensing Voltage selection	400V_{ac}	230V_{ac}
2	Phaseloss protection	Protection disabled	Protection enabled
3	Control mode selection	Constant Voltage	Volt Per Hertz
4	Overexcitation threshold	2A	4A

Table 12. Dipswitch settings

5.6 T.Disable header

When no generator over temperature limiting or protection is desired, this can be disabled by shorting the T.Disable header with a prefabricated link. In this case it is still allowed, but not required to connect a temperature sensor at terminals T1, T2.

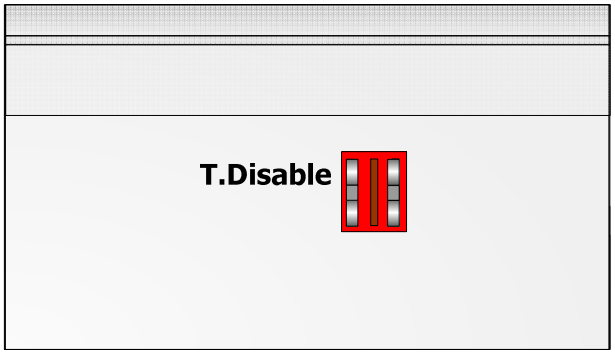


Fig 10. T.Disable header

5.7 SE header

Caution: Never fit or remove the SE link when the generator is operation, this could result in serious electrical shock.

Shorting the SE header with a supplied prefabricated link, enables the self excitation function of the AVR. Self excitation can be used if the AVR supply voltage is insufficient to start voltage control. See 3.3.0 for an explanation of this feature.

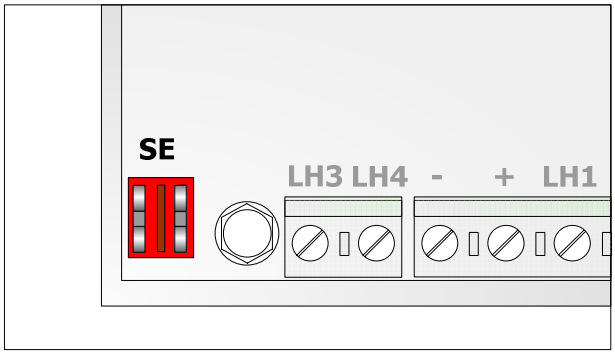


Fig 11. Self excitation header

5.8 EXT.POT. header

The generator voltage setpoint is also user adjustable by means of an external 10 kΩ potentiometer. The external potentiometer range is U_{nom} -15%. Increasing the impedance, decreases the generator voltage. When no external potentiometer is fitted, the EXT.POT. terminals must be shorted with one of the supplied links.

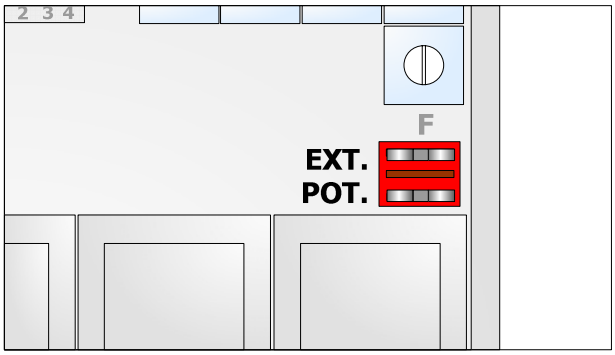


Fig 12. EXT.POT. header

5.9 CAN Termination header

Shorting the CAN Termination header, by placing a prefabricated link, enables CAN bus termination. The terminator resistance is 120 Ohm. The header must be shorted if the AVR is connected as a CAN bus endpoint.

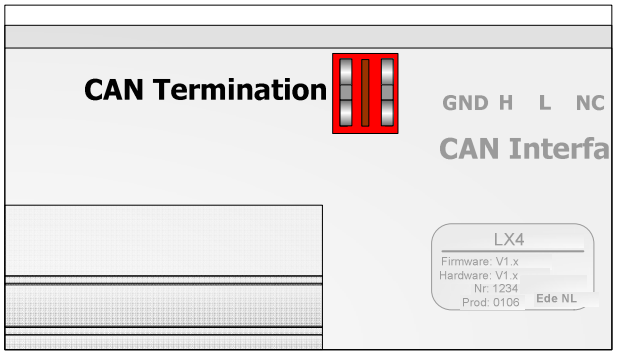


Fig 13. CAN Termination header

5.10 Factory settings

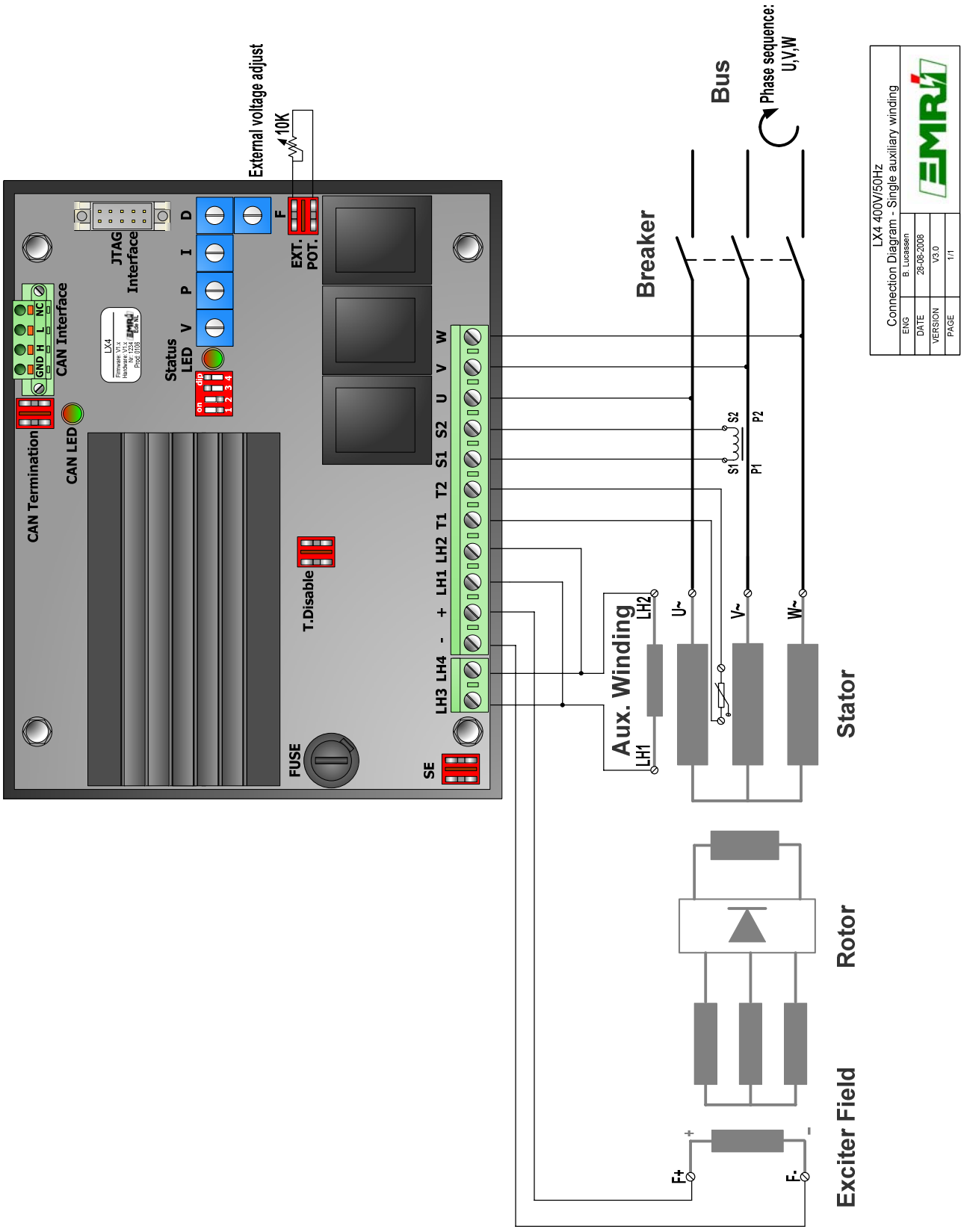
All new or AVR's returned from service are supplied with factory settings as described in table 13. Adjusting the factory settings must only be performed by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

Parameter	Value	Unit
Output Voltage	400	V_{ac}
Overexcitation threshold	2A	I_{exc}
P & I stability	Middle position	
Droop	0	%
Underspeed setpoint	47	Hz
Phaseloss protection	Disabled	-
Control mode selection	Constant Voltage	
T.Disable header	Shorted with link	
SE header	Open	
EXT.POT header	Shorted with link	
CAN termination header	Shorted with link	
Ceramic Fuse 5x20mm	4	AT

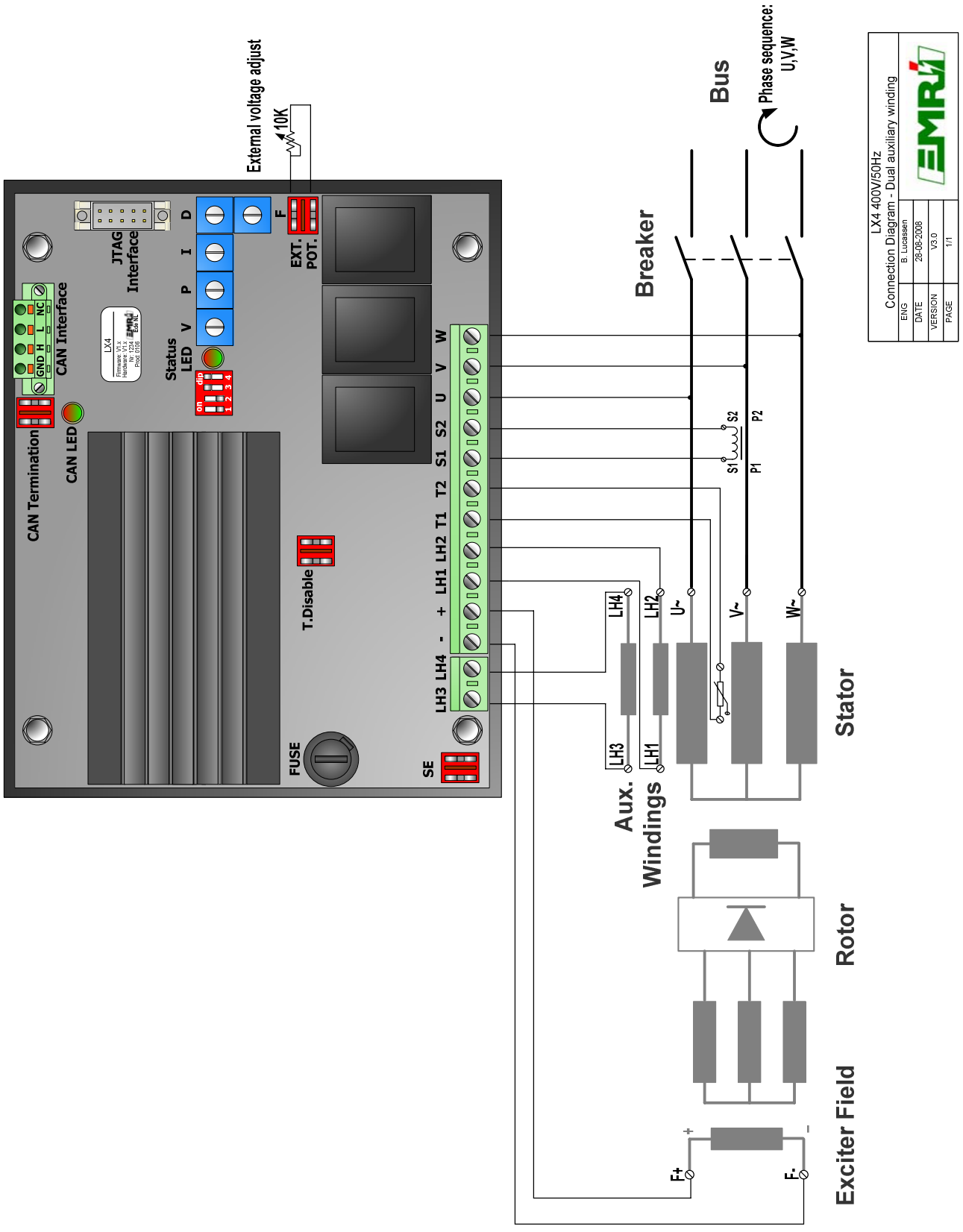
Table 13. Factory settings

6. Wiring Diagrams

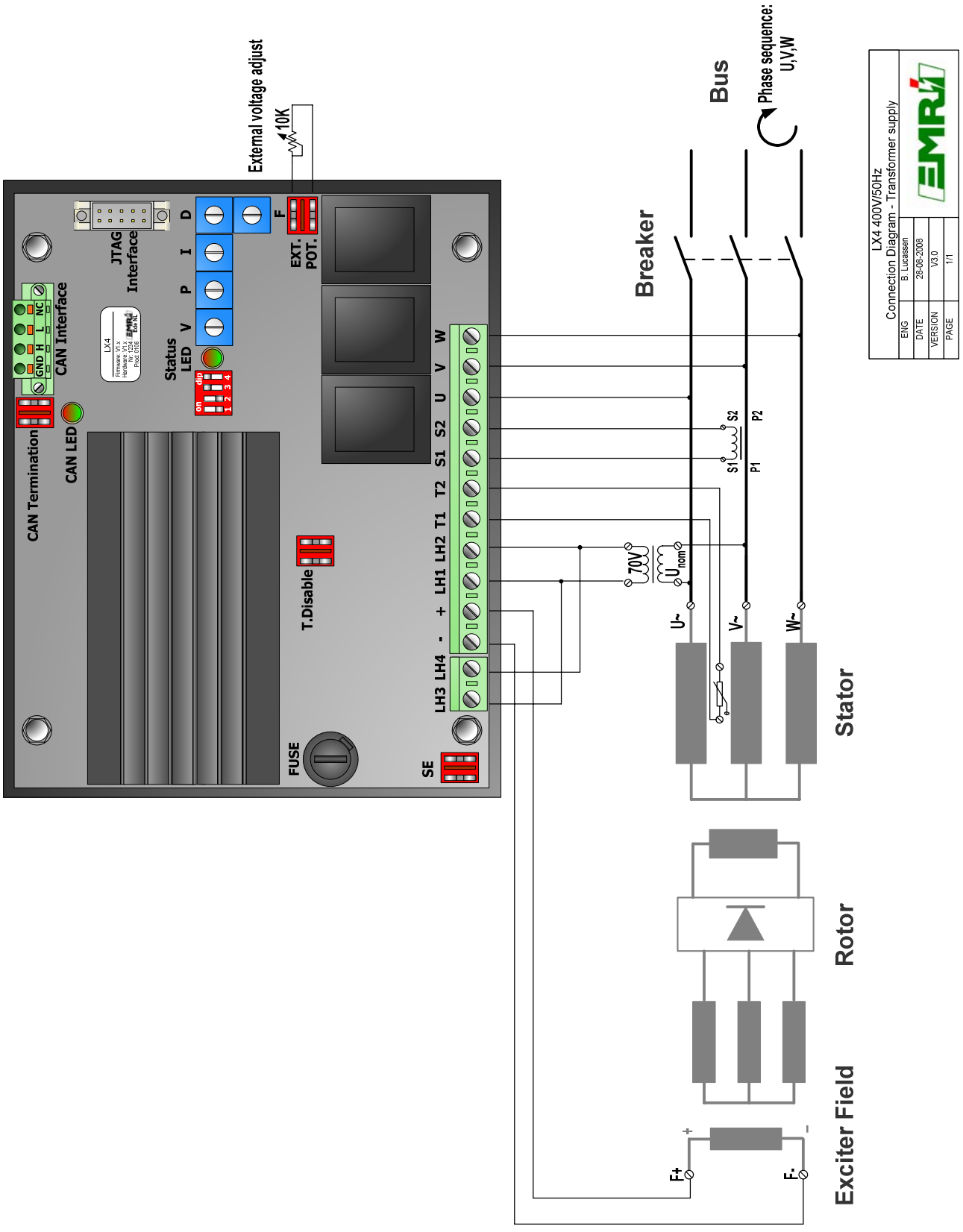
6.1 Wiring diagram single auxiliary supply winding



6.2 Wiring diagram double auxiliary supply winding



6.3 Wiring diagram transformer 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.

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 LH1-LH2 and LH3-LH4, 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 J1 and K1 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.