LXCOS V1.0

Voltage regulator for generators

FEB 2014 **Instruction Manual**

Revision history

The table below provides a historical summary of the changes made to the LXCOS AVR.
Revisions are listed in chronological order.

Product version	**1.0.0**	**Change**
Hardware version	1.0.0	*First release.*
Software version	1.0.0	
Manual version	1.0.0	

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

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

The LXCOS AVR is designed as a replacement for the Cosimat N+ AVR, incorporating at least the same standard functionality.
The LXCOS AVR is a digitally operating AVR, providing optimal flexibility and configurability as is reflected by the additional capabilities of the LXCOS AVR. Nevertheless installation, maintenance and adjustment don't require special application software.

Additional features

Selectable mode of operation:
- Volt per Hertz control
- Constant voltage control

Modes of control:
- Constant voltage control
- Power factor control (PFC)
- 0-100% generator current control
- 0-100% generator voltage control
- Quadrature voltage droop for parallel operation
- Current limited motor start and volt per hertz control

Protections:
- Generator phase loss
- AVR over temperature
- Generator over voltage
- Generator over current
- Generator over temperature
- Loss of excitation during PFC
- Loss of current sensing during PFC

Flexible protections:
- User adjustable underspeed knee
- User adjustable field over excitation
- User adjustable generator current limit

Communication:
- CAN bus
- AVR status LED
- AVR status contact

1.1 AVR dimensions

The AVR LXCOS is size compatible to the original Cosimat N+ and therefore easy to exchange. The AVR is protected from the environment by a PUR coating.
Prefabricated links are provided for CAN1-CAN2, TH1-TH2, S-T, AVR1-AVR2, UH1-UH1’, WH1–WH1’, I1–I1’ and K1 – K1’.

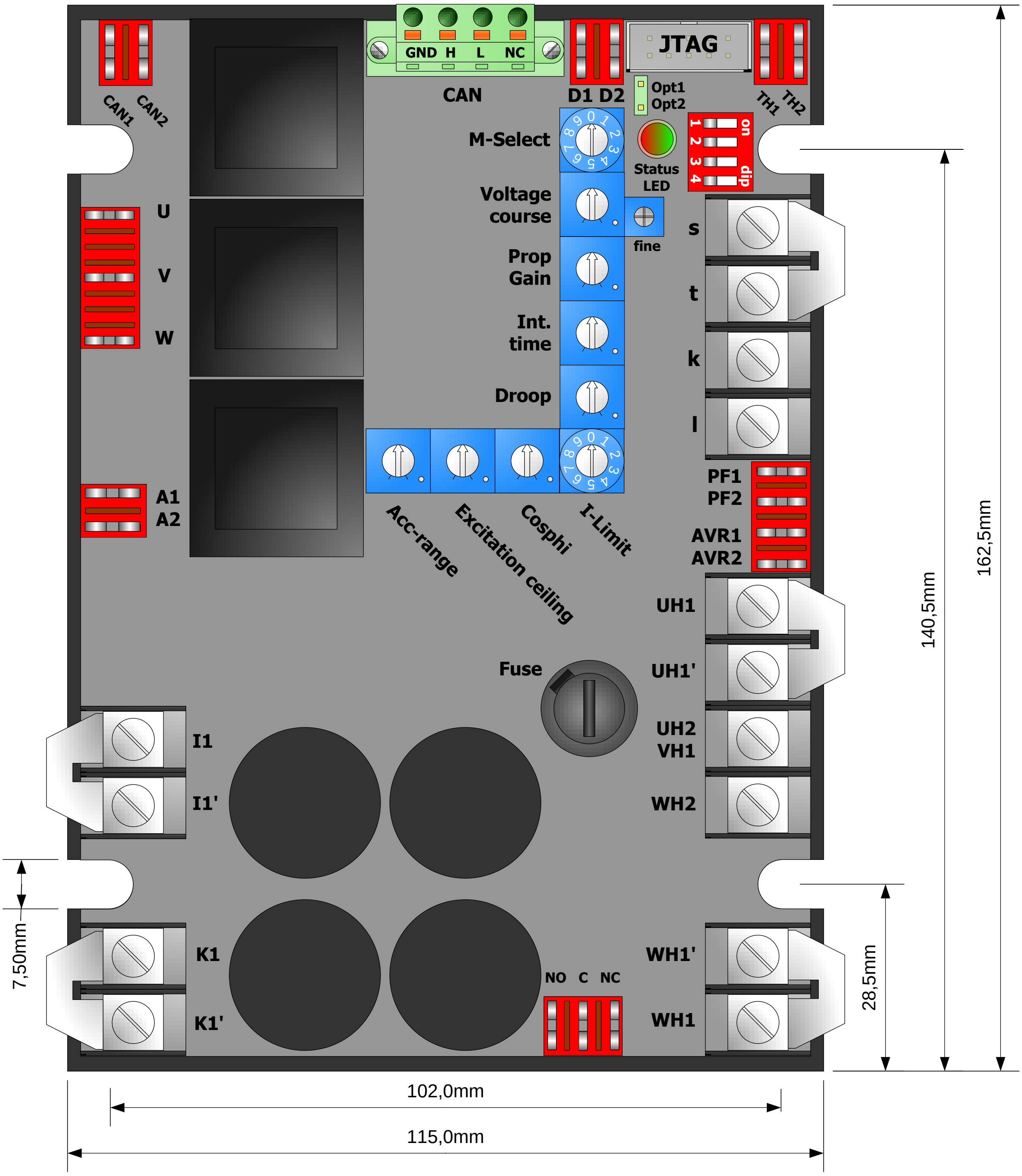


Fig 1. AVR dimensions

- Measurements in mm
- height ± 70mm

1.2 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U, V, W	Voltage sensing input	480 V, < 30 s @ 50Hz	-	520	V_{AC}
I,K	AVR field current	< 10 s	-	15*	A_{DC}
UH1-UH2 WH1-WH2 UH1-VH1-WH1	Supply input	UH1-UH2, WH1-WH2, UH1-VH1-WH1 DC or 25 - 400 Hertz	15 15	240 135	V_{AC} V_{DC}
UH1-UH2	Supply input self excitation	DIP4 must be ON	6	-	V_{AC}
R_{field}	Field resistance	@ 50 V_{AC} supply @ 150 V_{AC} supply	5 15	- -	Ω Ω
T_{AMB}	Operating temperature	95 % RHD non condensing	-40	+70*	°C
T_{STG}	Storage temperature	95 % RHD non condensing	-40	+70	°C
A1, A2	Accessories input **		-12	+12	V_{DC}
k, l	Droop, PFC, Limit CT 0,5A	2 VA, isolated CT < 30 s	-	1,5	A_{AC}
D1,D2	Analoge output		0 0	10 20	V_{DC} mA_{DC}
I_{C-NO}, I_{C-NC}	Status contact switching current	U_{MAX} 30V_{DC} U_{MAX} 230V_{AC}	- -	5 5	A_{DC} A_{AC}

Table 1. Absolute maximum ratings

* Always mount with heatsink fins aligned vertically and allow for sufficient airflow.
** Isolated.

1.3 Commissioning information

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

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

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

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

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

2. INSTALLATION

For a complete wiring diagram see Chapter 6.

2.0 Interfaces overview

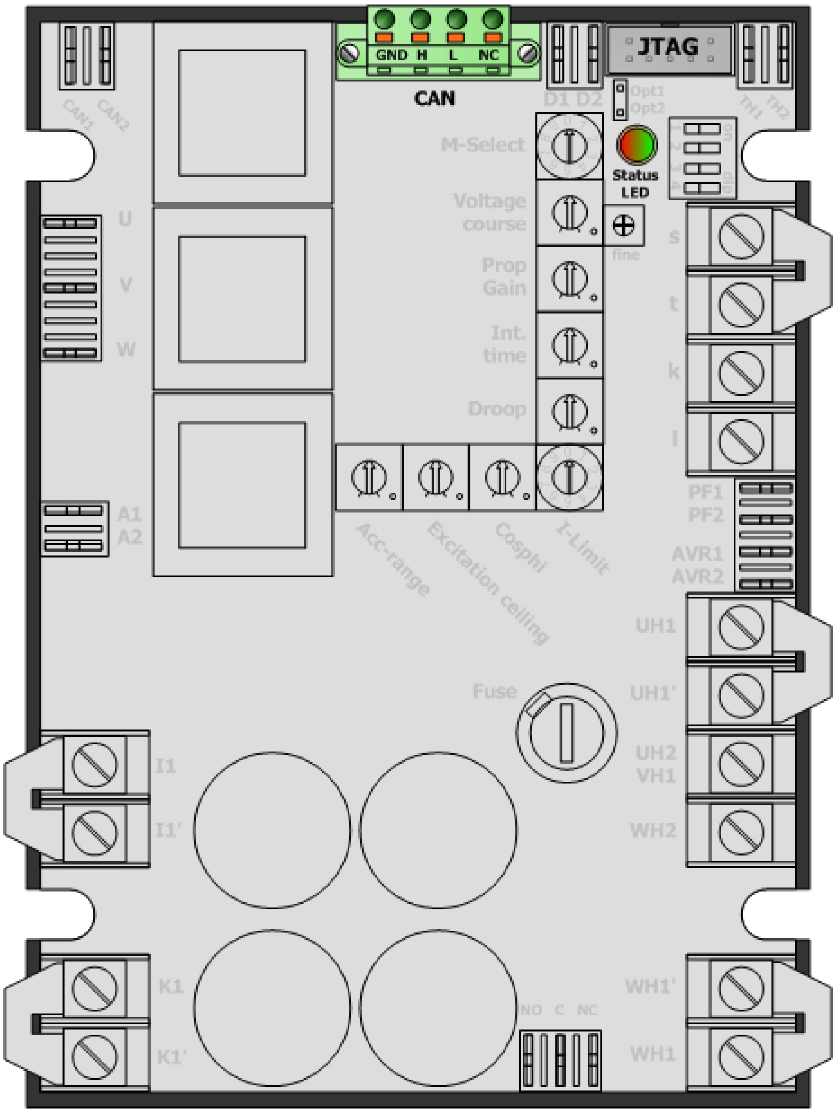


Fig 2. Interfaces overview

Symbol	Description	Notes
Status LED	AVR control mode & Error diagnostics	See Table 6 and 8
CAN Interface	CAN bus I/O	
JTAG Interface	Maintenance port	

Table 2. Interfaces

2.1 Adjustments overview

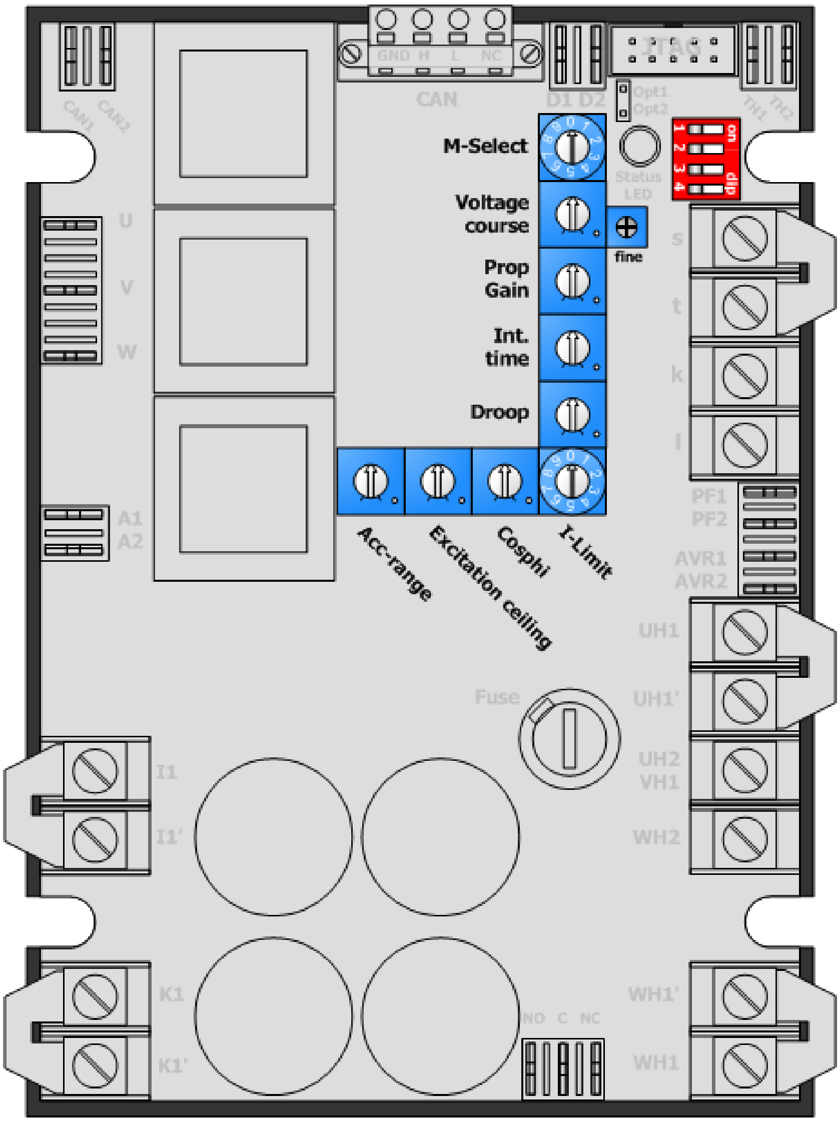


Fig 3. Adjustments overview

Symbol	Description	Notes
Voltage coarse	Course generator voltage setpoint	See 5.8 for voltage range selection
Voltage fine	Fine generator voltage setpoint	See 5.8 for voltage range selection
I-Limit	Generator current limit setting	
M-Select	AVR mode selection	Also special control modes, see 5.2
Prop. Gain	Proportional gain setpoint	Stability adjustment
Int. time	Integral time setpoint	Stability adjustment
Droop	Voltage droop setpoint	For parallel operation
Acc-range	Accessory input range adjustment	A1+,A2-
Excitation ceiling	Over excitation setpoint	
Cosphi	Cosphi setpoint	Only enabled during parallel PFC
Dipswitches	Voltage range and SE options	See 5.8.

Table 3. Adjustments

2.2 Terminals overview

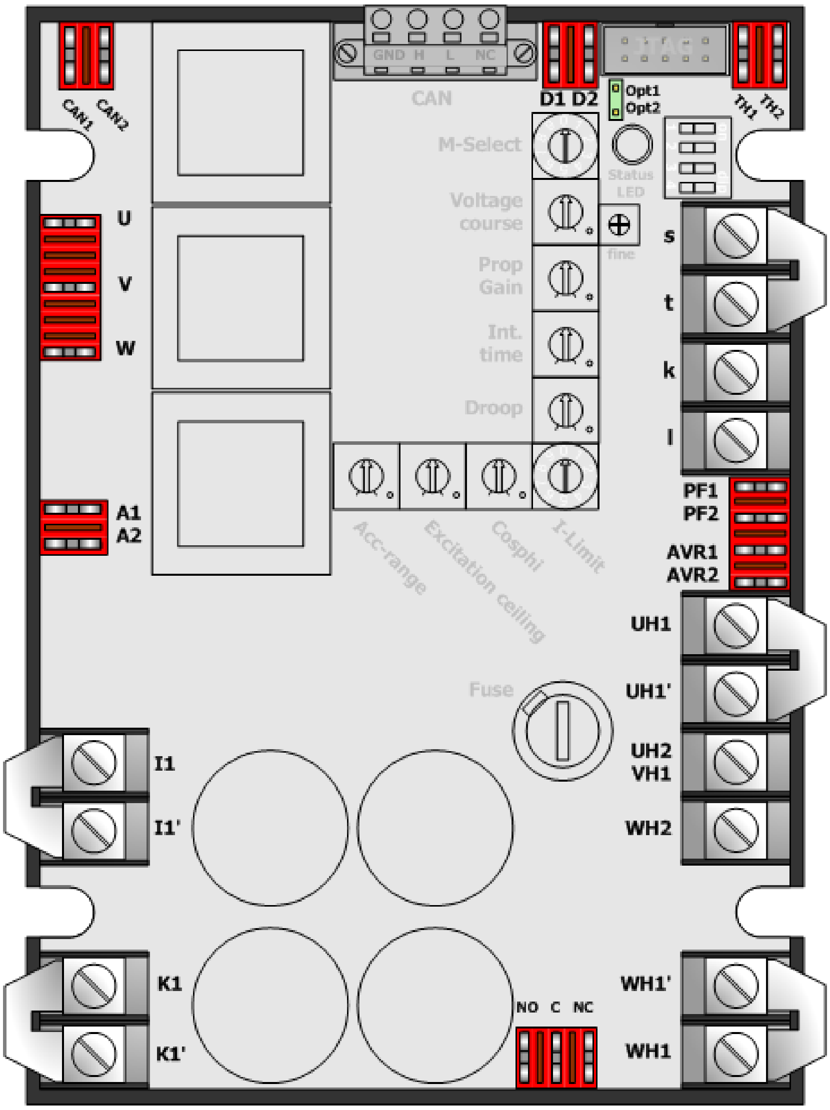


Fig 4. Terminals overview

Symbol	Description	Notes
U, V, W	Voltage sensing input	phase sequence U → V → W (Clockwise)
s, t	External voltage adjust input	
AVR1, AVR2	AVR On / Off input	Off for ≥ 10s. resets previous AVR errors
UH1,UH2/VH1, WH1, WH2	Supply inputs	
I1, K1	Field excitation output	I1 = Field+, K1 = Field-
A1, A2	Accessory input (Isolated)	Function dependent on M-select setting
k, l	CT input for current sensing	0,5A_{ac} input (or original AVK CT)
TH1, TH2	Thermistor sensing input	Open for temperature error >2k Ohm
PF1, PF2	PFC on/offl input	Closed for PFC
CAN1, CAN2	Can termination contact	Can bus termination 120 Ohm when placed
OPT1,OPT2	Advanced options input	See chapter 5.9.2 for all options
D1,D2	Optional analoge output	0-10Vdc / 0-20mAdc
NC, C, NO	Status contact	C-NO closed when AVR operational

Table 4. Terminals

2.3 Electrical characteristics

Symbol	Parameter	Condition	Min	Max.	Unit
U, V, W	Voltage sensing input	50-60 Hz, Clockwise (CW)	-	520	V_{AC}
I1, K1 ***	AVR field current	@ $T_{AMB} \leq 70$ºC	-	7*	A_{DC}
UH, UH2/VH,WH	Supply input	30 - 400 Hertz	20	200	V_{AC}
UH1-UH2	Supply input for self excitation	DIP3-DIP4 must be ON	5	-	V_{AC}
R_{field}	Field resistance		15	-	Ω
T_{AMB}	Operating temperature	95 % RHD non condensing	-40	+70*	°C
T_{STG}	Storage temperature	95 % RHD non condensing	-40	+70	°C
	Static control accuracy			1	%
A1, A2	Accessory input A1+, A2-**	Constant voltage control 0-100% Control	-10 0	+10 +10	V V
k, l	Droop, PF CT, Limit CT	Isolated CT, 0,01 Ω	-	0,5	A_{AC}
S,T	External Volt adjust	$R_{s\text{-}t}$ 250Ω $R_{s\text{-}t}$ 500Ω	0 0 -	-10 -20 680	% % Ω
D1,D2	Analoge output D1+, D2-		0 0	10 20	V_{DC} mA_{DC}
I_{status}	Status contact switching current	U_{MAX} 30V_{DC} U_{MAX} 230V_{AC}		3 3	A_{DC} A_{AC}

Table 5. Electrical characteristics

* Always mount with heatsink fins aligned vertically and allow for sufficient airflow.
** Isolated.
*** See below for the safe operation area of the LXCOS voltage regulator.

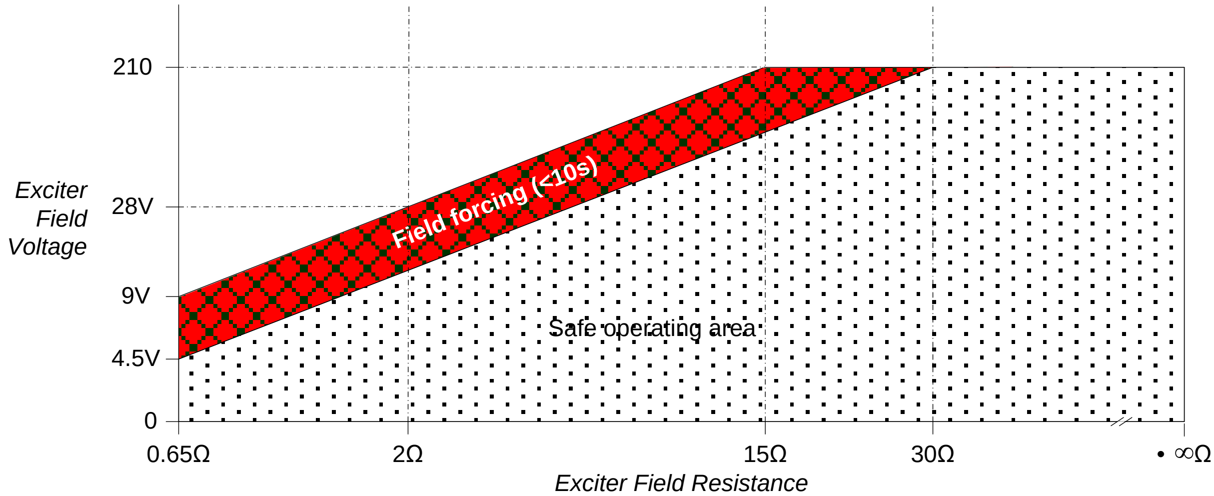


Diagram 1. Operation area

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

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

LED Color / Blinks	AVR status	Colour code
	Idle	Green blink
	Buildup	Orange blink
	Voltage control	Continuous green
	Current control/ PF control	Continuous orange
	Underspeed	Continuous red
	Error code	Red/ green blink

Table 6. AVR status

3.1 Modes of control

3.1.0 Idle

When a supply is connected to the AVR and contact AVR1-AVR2 (AVR On/Off) is open, the AVR enters idle mode. During idle mode, field excitation is inhibited and protections are reset.
The AVR will start from idle mode after resetting an error condition.
When dipswitch 4 is on, the AVR will start field flashing.
For more information about this option see 3.1.1 and 3.1.2

3.1.1 Buildup (PMG only)

When contact AVR1-AVR2 (On/Off) is closed, the AVR enters build up mode.
Protections are enabled and the generator voltage is ramped up to the nominal voltage.
When the generator voltage is close to the nominal setpoint, the status contact is energized. Diagram 2 shows the sequence of events.
Dipswitch 3 and 4 must be OFF, for PMG operation!

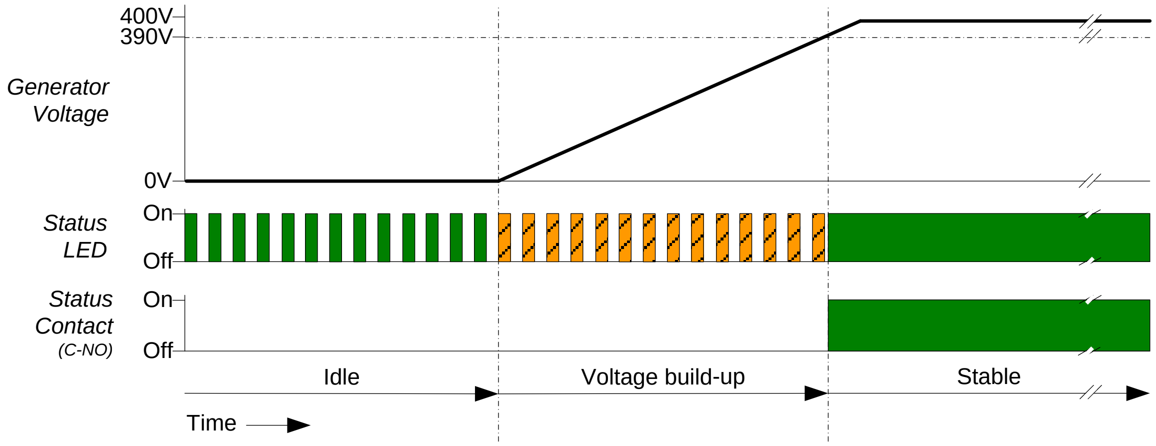


Diagram 2. Build up (PMG)

3.1.2 Buildup (Self Excited)

For self excitation (SE) mode, a link over AVR1-AVR2 must be placed and dipswitch 3 and 4 must be ON. After starting the generator, the AVR will field flash and enter build up mode.
Protections are enabled and the generator voltage is ramped up to the nominal voltage. When the generator voltage is close to the nominal setpoint, the status contact is energized.
Diagram 3 shows the sequence of events.

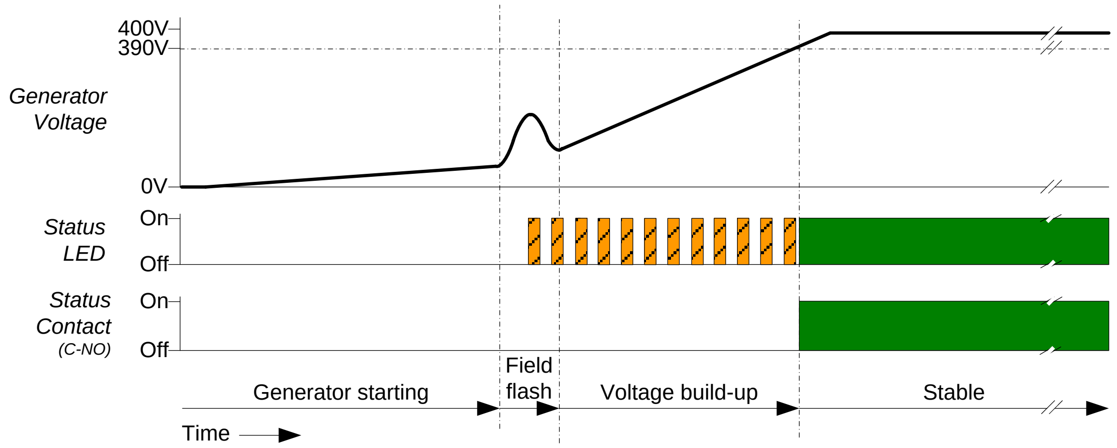


Diagram 3. Build up (SE)

3.1.3 Constant Voltage control

The AVR starts constant voltage control after finishing the build up mode when this is selected with the M-Select switch (M-select mode 0, 1, 4, 5).
The voltage/frequency characteristics are depicted in diagram 4.

Below the underspeed frequency, the generator voltage is controlled according a Volt per Hertz slope. Both the underspeed knee frequency and the VPH slope are user adjustable.
For a detailed description see table 10.

When the generator frequency drops below 25 Hertz, the generator voltage is always controlled to a low level. In PMG-mode 15% of Unom (voltage selection) and in Self excitation-mode the mininimum SEsetpoint (See 5.10.1).
An underspeed situation is visualized by a continuously red status LED.

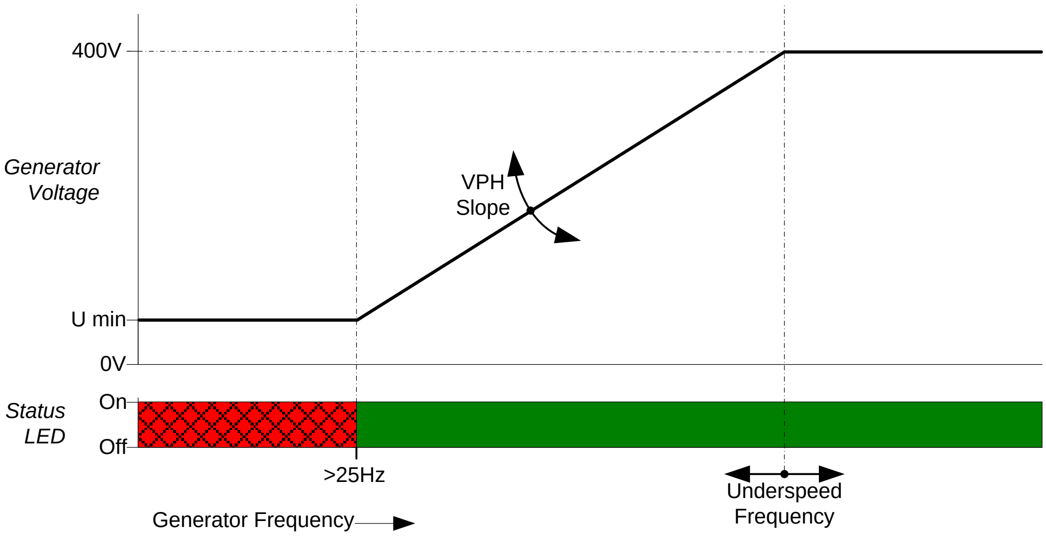


Diagram 4. Constant Voltage control

3.1.4 Volt per Hertz control

The AVR performs Volt Per Hertz (VPH) control after finishing the build up mode when this is selected with the M-select switch (M-select mode 8, 9). The voltage/frequency characteristics are depicted in diagram 5. Note that the voltage is limited to a maximum of 500V irrespective of the generator frequency.

When the generator frequency drops below 25 Hertz, the generator voltage is always controlled to a low level. In PMG-mode 15% of Unom (voltage selection) and in Self excitation-mode the minimum SE setpoint (See 5.10.1).
An underspeed situation is visualized by a continuously red status LED.

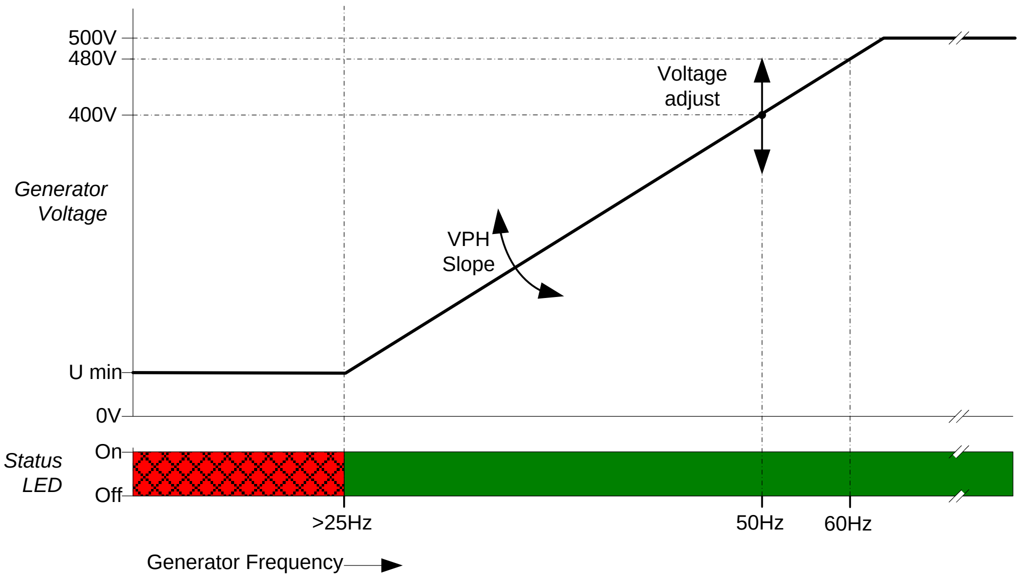


Diagram 5. VPH control

3.1.5 Current control

The AVR switches to current control when the generator current exceeds the generator current limit. The current limit is user selectable from 60% to 300% of the nominal generator current. To ensure sufficient supply voltage to the AVR during current limiting an external supply or PMG is usually required.

3.1.6 Power factor control

The AVR performs Power Factor Control (PFC) when contact PF1-PF2 is closed.
When the AVR is in Power factor control, both loss of excitation protection as well as the loss of current sensing protection are enabled. The power factor is user adjustable from 0.9 capacitive to 0.6 inductive. For more details about setting the power factor, see 5.7.

3.1.7 Error condition

If an error condition triggers the AVR’s protections, field excitation is disabled and an error code is signaled by the status LED.
See Chapter 4 (Error conditions) for a detailed description of the AVR ’s protections.

3.2 Special Applications

3.2.0 Parallel operation

If the generator operates in parallel operation with one or more generators, reactive current sharing can be accomplished by means of Quadrature Droop Compensation (QDC). The amount of voltage droop must be precisely set equal for all generators under equal load conditions. The influence of the voltage droop on the generator voltage is depicted in diagram 6.

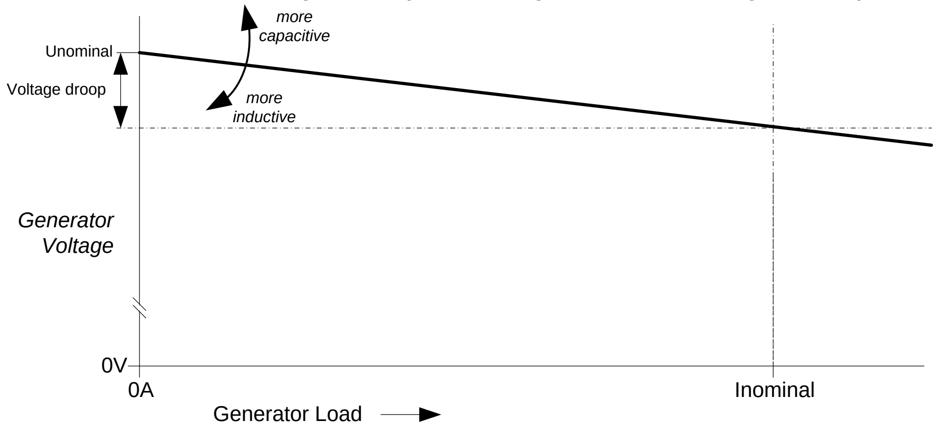


Diagram 6. Voltage droop

If current limiting is enabled during parallel operation, all generators must have the same current limit and M-select (mode of control) settings.

3.2.1 Parallel soft start

When several AVR's are used in parallel for a motor start application, all AVR's must have the same current limit setting and M-select (mode of control) setting. To perform a synchronous start, it is required to make all AVR1-AVR2 (AVR On/Off) contacts simultaneously. To ensure sufficient supply voltage to the AVR during current limiting an external supply or PMG is usually required. Diagram 7 shows a sequence of events of a parallel soft start application.

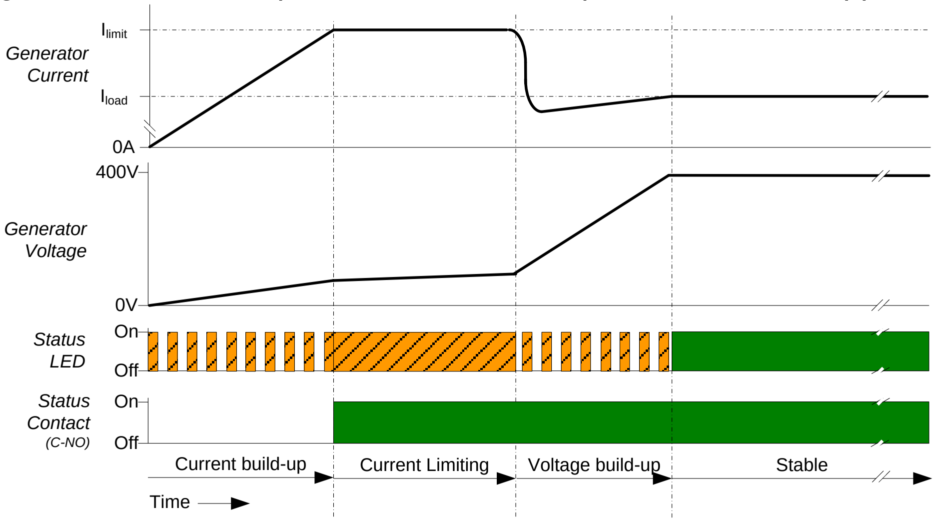


Diagram 7. Parallel soft start

3.2.2 0-100% Voltage control

When M-select (mode of operation) is set to position 2 or 6, the generator voltage setpoint is controlled by an external supply source. The generator voltage setpoint is linear proportional with the voltage level supplied at terminals A1-A2. Terminal A1 is connected to the positive side of the external supply, terminal A2 connects to the negative supply side.
The accessories range potentiometer may be used to adjust the generator's voltage range as is depicted in diagram 8. If the Acc- range potentiometer is completely clockwise, $10V_{dc}$ input on A1-A2 corresponds with the generator voltage setpoint as set with the voltage potentiometers. If the Acc- range potentiometer is completely counter clockwise, influence on the generator voltage by A1-A2 is effectively disabled. To ensure sufficient supply voltage to the AVR during current limiting an external supply or PMG is usually required.
During 0-100% voltage control, underspeed protection is disabled!.
Note: DIP3 and DIP4 must be off.

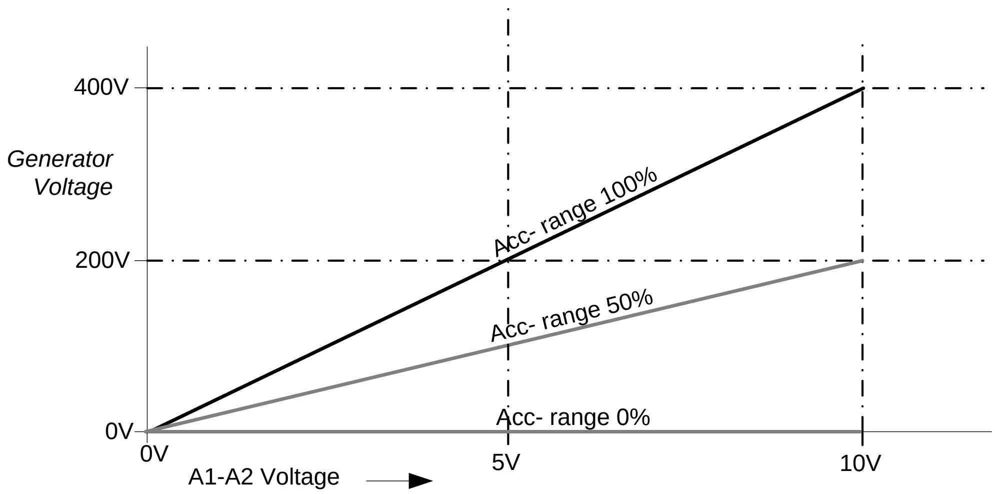


Diagram 8. Acc- range influence

3.2.3 0-100% Current control

When M-select (mode of operation) is set to position 3 or 7, the generator current limit setpoint is controlled by an external supply source. The generator current limit setpoint is linear proportional with the voltage level supplied at terminals A1-A2. Terminal A1 is connected to the positive side of the external supply, terminal A2 connects to the negative supply side.
The accessories range potentiometer may be used to adjust the generator's current limit range as is depicted in diagram 9. If the Acc- range potentiometer is completely clockwise, $10V_{dc}$ input on A1-A2 corresponds with the generator current limit setpoint as set with the current limit potentiometer. If the Acc- range potentiometer is completely counter clockwise, influence on the generator current limit by A1-A2 is effectively disabled. To ensure sufficient supply voltage to the AVR during current limiting an external supply or PMG is usually required.
Note: DIP3 and DIP4 must be off.

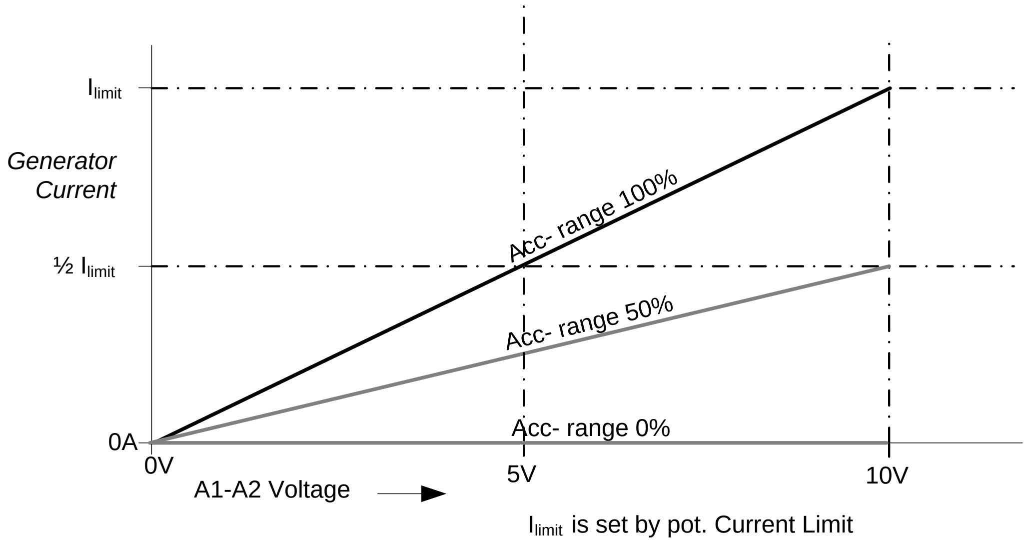


Diagram 9. Acc- range influence

3.2.4 Options

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

Type	Description	Interface
Droopkit	Required for Droop, PFC, Current limit	AVR terminals k-l
LX_VMA	Required for voltage matching	AVR terminals A1-A2
3F-Filter	For filtering the generator sensing voltage.	AVR terminals U-V-W

Table 7. LXCOS options

4. Protections and diagnosis

4.0 Led error codes

If the AVR stops field excitation due to a fault condition, the fault that caused this is indicated by the status LED. Table 8 shows the relation between the number of red blinks and the error condition.

LED Color / Blinks		Error condition
	1	Overvoltage
	2	Overcurrent
	3	Excitation error
	4	Overtemperature AVR
	5	Overtemperature Gen
	6	Phaseloss / Phase sequence error
	7	Loss of excitation during PFC
	8	Loss of current sensing during PFC

Table 8. Error codes

The AVR may be reset from the error condition by opening contact AVR1-AVR2 (AVR On/Off) for at least 10 seconds. After a successful reset the AVR commences in idle mode and any information concerning the causing error is lost. In Self excitation-mode you must shut down the generator. If AVR is not working at all check fuse on AVR.

4.1 Protections for Self Excited generators

When a protection is triggered and excitation is consequently stopped, this effectively also interrupts the AVR supply source for a Self Excited generator. Because the supply to the AVR is interrupted, the AVR is reset and will restart building up voltage again. If the cause of the error is still present this will cause a continuous tripping and restarting of the system.

4.2 Protections

4.2.0 Over voltage

The over voltage protection validates the generator voltage on terminals U,V and W.
If the over voltage limit is exceeded for 1 second, the AVR switches off the status contact.
See 5.8.0 for over voltage value.

If the error condition still exists 1 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the over voltage condition is relieved within 1 second after opening the status contact, the contact closes again and normal operation proceeds.

An over voltage error is visualized by the status LED blinking red once. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Diagram 10 shows a sequence of events for diagnosis purposes in case of an over voltage error with a 400V Unom voltage range selection.

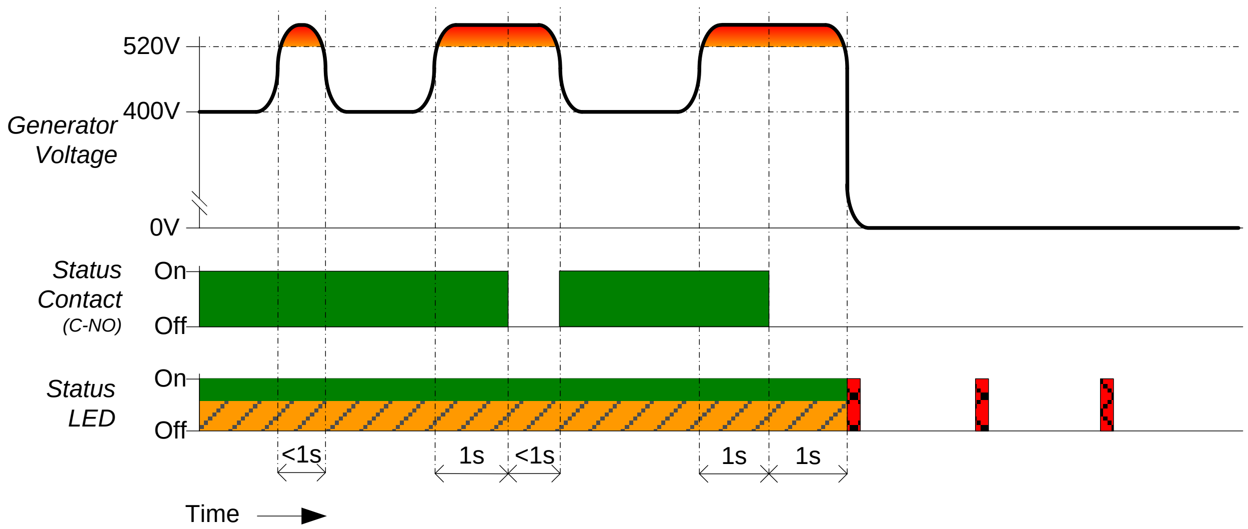


Diagram 10. Over voltage

4.2.1 Over current

The over current protection validates the generator current measured on terminals k and l.
If the current limit, set by the user, is exceeded by 200% for 1 second, the AVR switches off the status contact.

If the error condition still exists 1 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the over current condition is relieved within 1 second after opening the status contact, the contact closes again and normal operation proceeds.

An over current error is visualized by the status LED blinking red twice. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

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

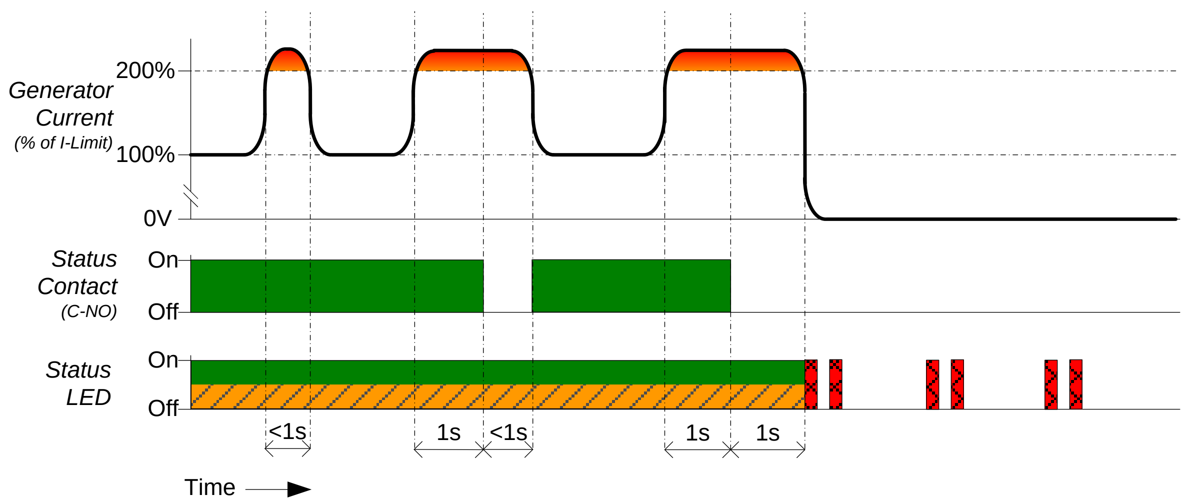


Diagram 11. Over current

4.2.2 Over excitation

The over excitation protection validates the generator field excitation measured on terminals I1 (+) and K1 (-). If the field excitation current exceeds the Excitation ceiling setpoint for more than 0,3 sec, the AVR switches off the status contact. The Excitation ceiling setpoint is user adjustable, from 1 Amps to 15 Amps, by means of the Excitation ceiling potentiometer.

If the error condition still exists 10 seconds after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the over excitation condition is relieved within 10 seconds after opening the status contact, the contact closes again and normal operation proceeds.

An over excitation error is visualized by the status LED blinking red three times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Diagram 12 shows a sequence of events for diagnosis purposes in case of an over excitation error.

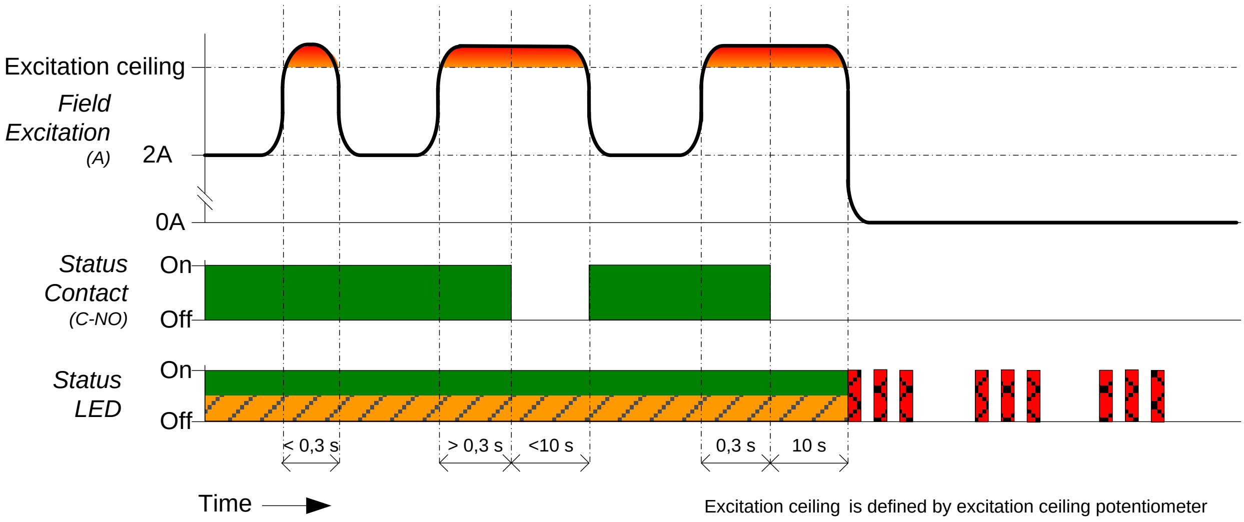


Diagram 12. Over excitation

4.2.3 AVR over temperature

The AVR over temperature protection validates the AVR temperature, measured internally.
If the over temperature limit of 85°C is exceeded for 10 seconds, the AVR switches off the status contact.

If the error condition still exists 10 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the AVR over temperature condition is relieved within 10 second after opening the status contact, the contact closes again and normal operation proceeds.

An AVR over temperature error is visualized by the status LED blinking red four times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

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

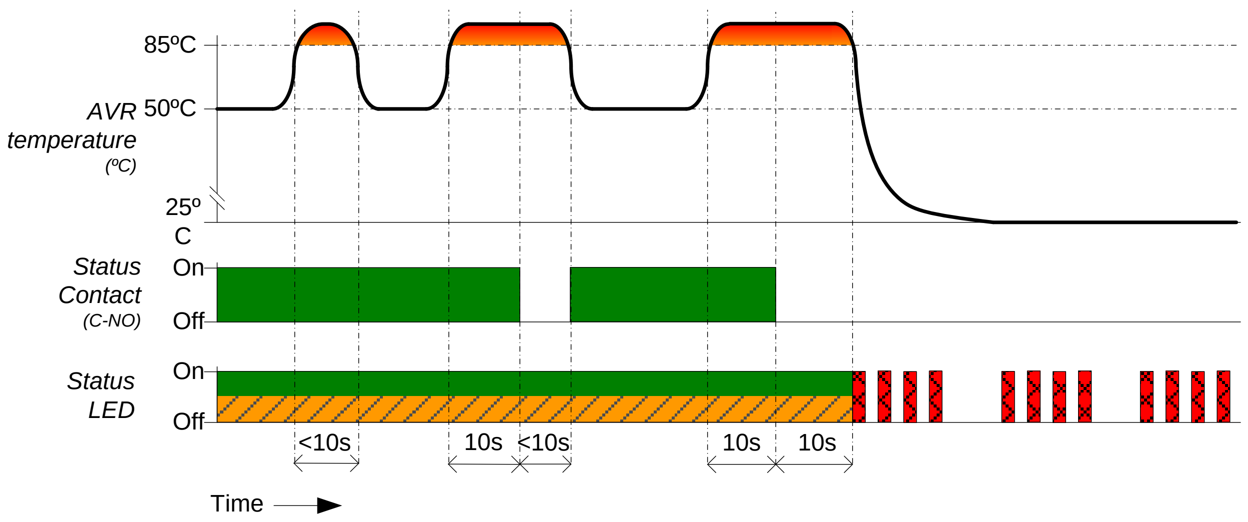


Diagram 13. AVR over temperature

4.2.4 Generator over temperature

The generator over temperature protection validates the generator temperature, measured on terminals TH1-TH2. Either a clixon or thermistor may be connected, providing a high impedance signal (>2k Ohm) in case of temperature error. If no temperature protection is required, terminals TH1-TH2 must be shorted.

If an over temperature error is detected for 10 seconds, the AVR switches off the status contact.

If the error condition still exists 5 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the generator over temperature condition is relieved within 5 second after opening the status contact, the contact closes again and normal operation proceeds.

A generator over temperature error is visualized by the status LED blinking red five times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Diagram 14 shows a sequence of events for diagnosis purposes in case of a generator over temperature error.

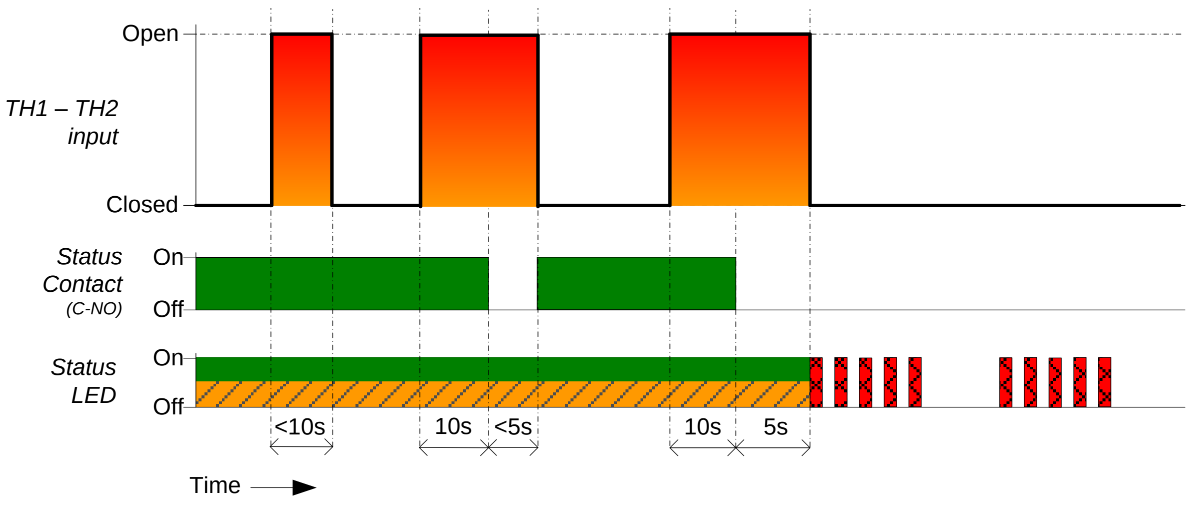


Diagram 14. Generator over temperature

4.2.5 Phase loss

The phase loss protection validates the presence of three generator phases on the terminals U, V and W.

Upon missing of one or more phases for 300ms, the AVR switches off the status contact and decreases the voltage set point to a low level. phase loss is visualized by the red status LED.

If the error condition still exists 5 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the generator phase loss condition is relieved within 5 seconds after opening the status contact, the contact closes again and the voltage set point is ramped up again.

A phase loss error is visualized by the status LED blinking red six times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Phase loss protection is disabled in current control and the generator voltage is below 10% of Unom (voltage selection).

Diagram 15 shows a sequence of events for diagnosis purposes in case of a phase loss error.

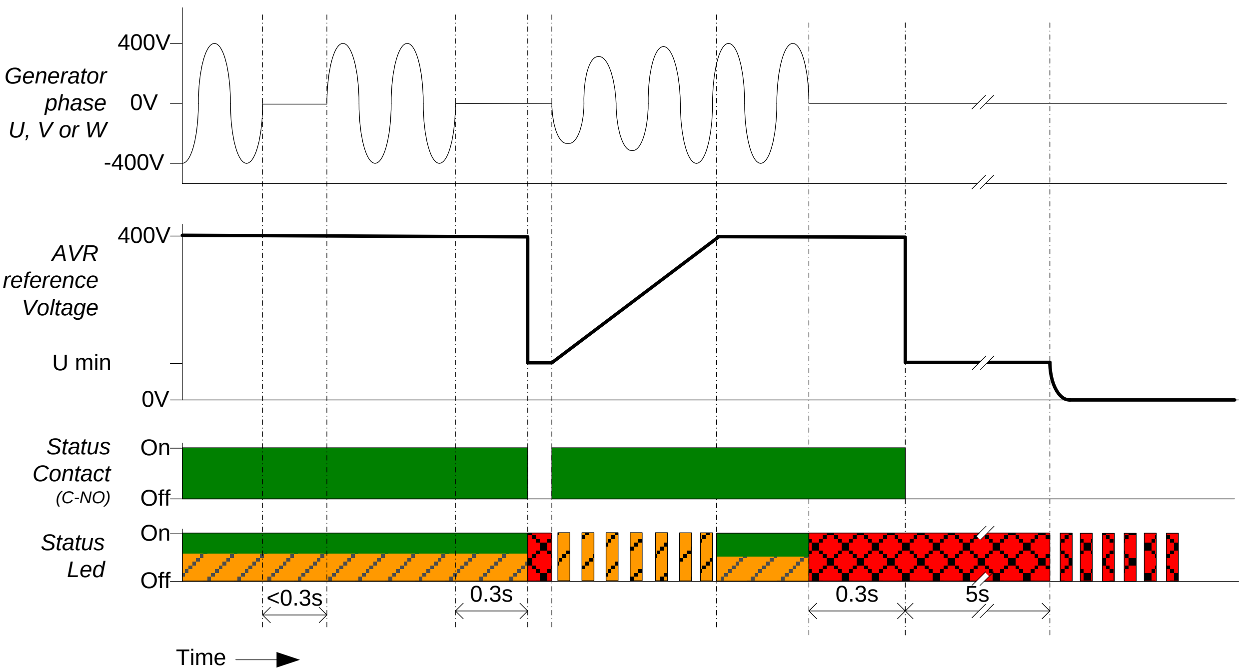


Diagram 15. Phaseloss

4.2.6 Loss of excitation (only for PFC)

If the AVR is in Power factor control, by shorting the PF1-PF2 terminals, the loss of excitation protection is enabled.

The loss of excitation protection validates the field excitation current on terminals I1 (+), K1 (-).

If an excitation current lower than 250mA is detected for 5 seconds, the AVR switches off the status contact. This status signal can be used to disconnect the generator from the bus.

If the error condition still exists 1 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the loss of excitation condition is relieved within 1 second after opening the status contact, the contact closes again and normal operation proceeds.

A loss of excitation error is visualized by the status LED blinking seven times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Diagram 16 shows a sequence of events for diagnosis purposes in case of a loss of excitation error.

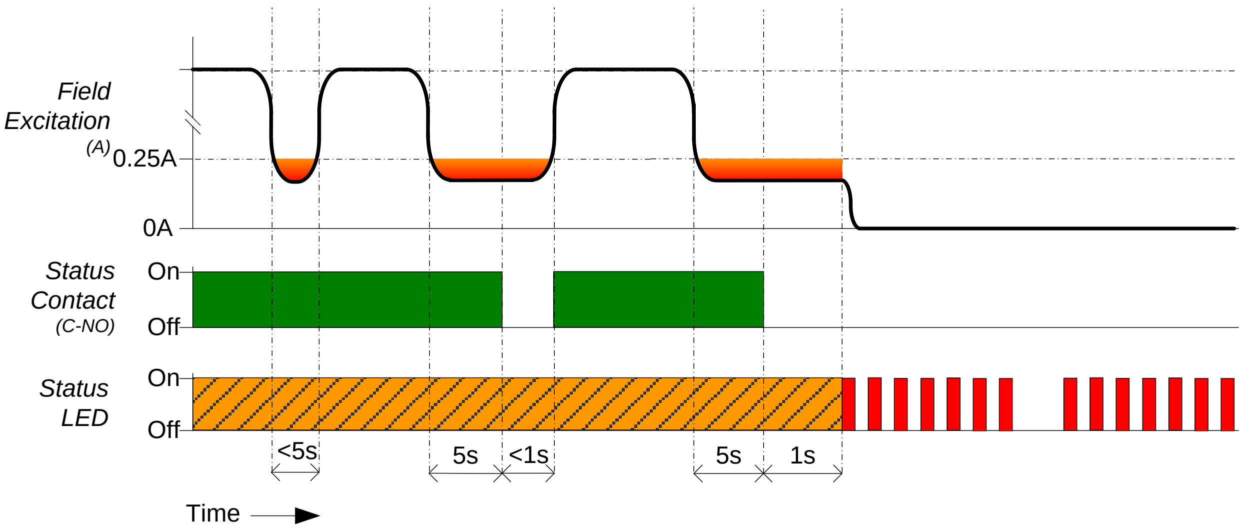


Diagram 16. Loss of excitation

4.2.7 Loss of current sensing (only for PFC)

If the AVR is in Power factor control, by shorting the PF1-PF2 terminals, the loss of current sensing protection is enabled.

The loss of current sensing protection validates the generator current on terminals k, l.

If a generator current lower than 1.5% of I nominal is detected for 5 seconds, the AVR switches off the status contact. This status signal can be used to disconnect the generator from the bus.

If the error condition still exists 1 second after opening the status contact, field excitation is stopped. In Self excitation-mode the AVR will shutdown and restart buildup, there for you must shut down the generator in case of an error.

If the loss of current sensing condition is relieved within 1 second after opening the status contact, the contact closes again and normal operation proceeds.

A loss of current sensing error is visualized by the status LED blinking eight times. Removing the power supply by stopping the generator or opening the AVR On/Off contact at terminals AVR1-AVR2 for 10 seconds will reset the AVR.

Diagram 17 shows a sequence of events for diagnosis purposes in case of a loss of curent sensing error.

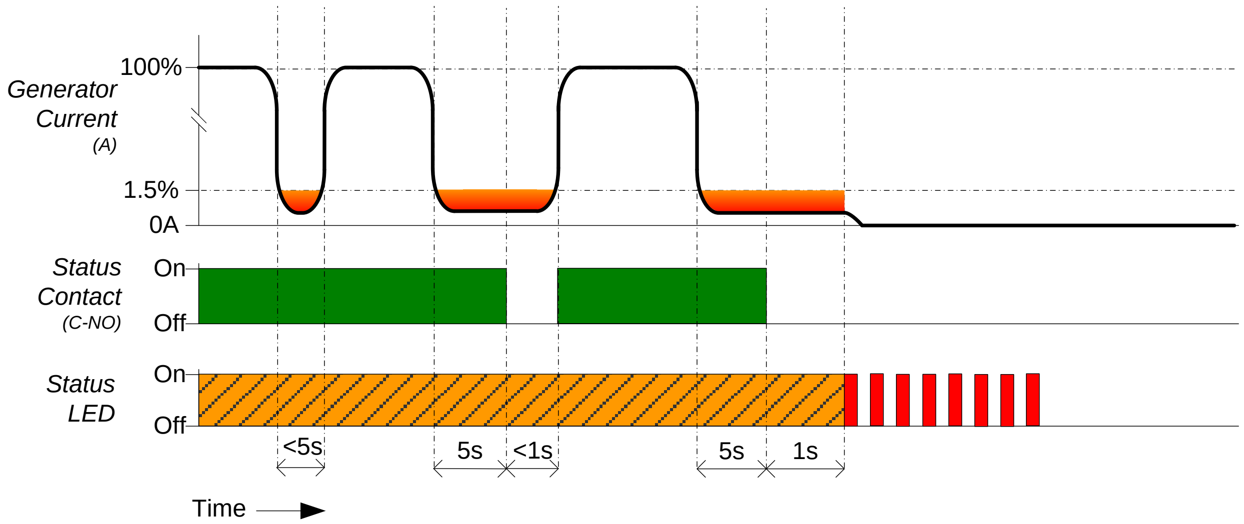


Diagram 17. Loss of current sensing

5. Settings and adjustments

5.0 Generator Voltage

The generator voltage setpoint is user adjustable by means of two voltage potentiometers. For range voltage setpoint See 5.8.0.
The fine voltage potentiometer range is U_{nom} ±1,5%.
Turning the potentiometers clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage.

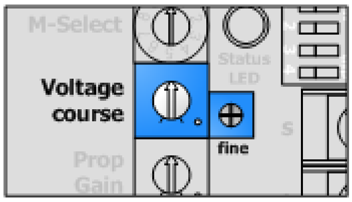


Fig 5. Voltage adjustments

5.1 Current Limit

The generator current limit is adjustable by means of the I-limit switch. The switch positions and corresponding current limits are depicted in table 9. The current limit percentages are derived from the nominal generator current. The nominal generator current of 100% corresponds with a 0,5A_{ac} current on terminals k – l.
Please note that switch position 9 disables current limiting as well as the over current protection. Operation with current limit settings above the generator's nominal current should always take place under continuous qualified supervision and within the limits set by the generator thermal damage curve.

Switch position	Current Limit
0	60%
1	80%
2	100%
3	125%
4	150%
5	175%
6	200%
7	250%
8	300%
9	Unlimited

Table 9. Current limit

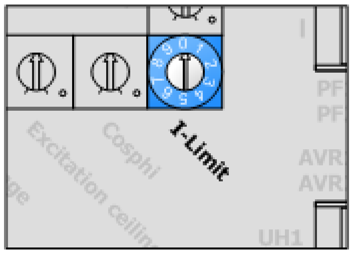


Fig 6. Current Limit

5.2 M-select (mode of operation)

The M-select (mode of operation) switch determines the AVR's mode of operation and underspeed characteristics. The switch positions and corresponding modes are depicted in table 10. Ensure that the AVR's is in idle mode before changing the M-select setting. For a more elaborate description of the control modes refer to Chapter 3.

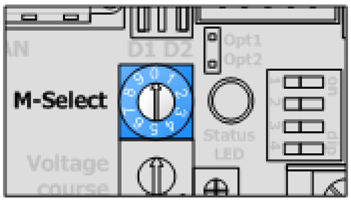


Fig 7. M-select

Switch position	Description Control Mode	A1-A2 range	Underspeed Frequency	Underspeed VPH slope *
0	Constant Voltage Control	$\pm 10V_{dc}$	47 Hz	8 V/Hz
1	Constant Voltage Control	$\pm 10V_{dc}$	47 Hz	16 V/Hz
2	0-100% Voltage Control with A1-A2	$0\text{-}10V_{dc}$	-	-
3	0-100% Current Control with A1-A2	$0\text{-}10V_{dc}$	47 Hz	8 V/Hz
4	Constant Voltage Control	$\pm 10V_{dc}$	57 Hz	8 V/Hz
5	Constant Voltage Control	$\pm 10V_{dc}$	57 Hz	16 V/Hz
6	0-100% Voltage Control with A1-A2	$0\text{-}10V_{dc}$	-	-
7	0-100% Current Control with A1-A2	$0\text{-}10V_{dc}$	57 Hz	8 V/Hz
8	Volt per Hertz Control	$\pm 10V_{dc}$	-	8 V/Hz
9	Volt per Hertz Control	$\pm 10V_{dc}$	-	8 V/Hz

Table 10. M- select (mode of operation)

* VPH slope by Unom is 400V.

5.3 Stability

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

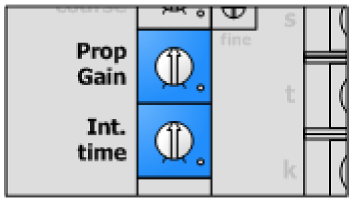


Fig 8. Stability adjustments

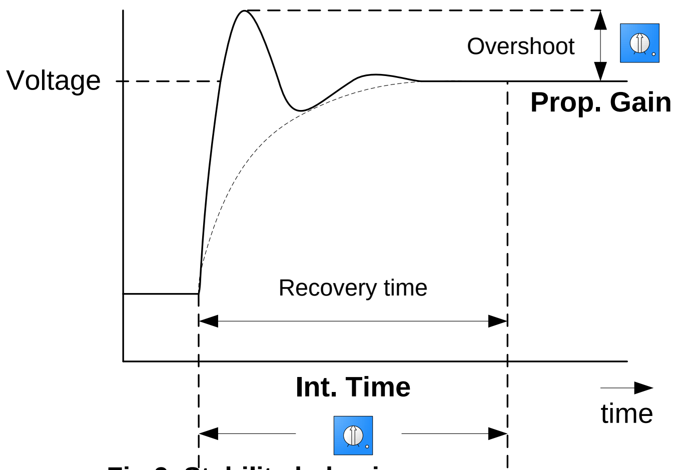


Fig 9. Stability behavior

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 potentiometer. The droop potentiometer range is U_{nom} - 5% @ cosphi 0,85 inductive. 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 3.2.0.

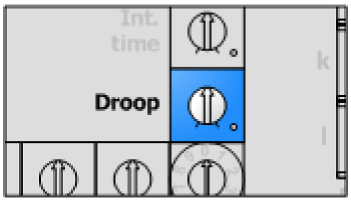


Fig 10. Droop adjustment

5.5 Accessories Range

Terminals A1-A2 are used to connect external accessories that influence the AVR's setpoint. The amount of influence can be adjusted by means of the Accessories range potentiometer.
Terminals A1-A2 accept 0-10V or +/-10V, dependent on the mode of operation as is described in table 11. If the no external accessory is connected to terminals A1-A2, disable the input by turning the accessories range potentiometer completely counter clockwise.
Setpoint is limited by voltage range maximum. See 5.8

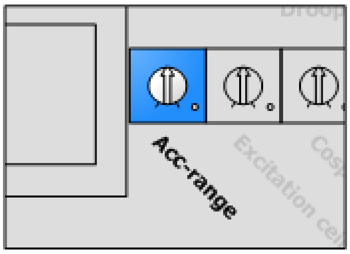


Fig 11. Accessories adjustment

Description Control Mode	A1-A2 range	Accessories influence on setpoint	
		c.c.w.	c.w.
Constant Voltage Control	±10V_{dc}	0% $U_{nominal}$	±40% $U_{nominal}$
0-100% Voltage Control with A1-A2	0-10V_{dc}	0% $U_{nominal}$	+100% $U_{nominal}$
0-100% Current Control with A1-A2	0-10V_{dc}	0% $I_{nominal}$	+100% $I_{nominal}$

Table 11. Accessories influence

5.6 Excitation ceiling

The excitation ceiling potentiometer is used to adjust the trip level of the over excitation protection. The excitation ceiling potentiometer range is linear, ranging from 1 to 15 Amps. Turning the potentiometer clockwise increases the excitation ceiling current setpoint, turning counter clockwise decreases the excitation ceiling current setpoint.
Be aware that increasing the excitation ceiling above generator limits can cause permanent damage to the generators exciter field. For a more detailed description of the over excitation protection see 4.2.2.

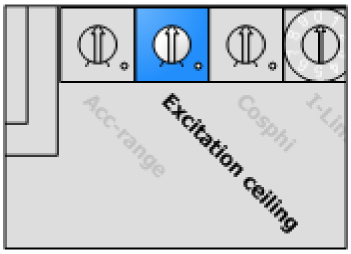


Fig 12. Excitation ceiling

5.7 Cosphi

The cosphi potentiometer is used to adjust the power factor setpoint for power factor control. The cosphi potentiometer range is 0.9 capacitive to 0.6 inductive.
Turning the potentiometer clockwise will set a more inductive power factor setpoint, turning counter clockwise a more capacitive setpoint. Centre position corresponds with power factor 1.

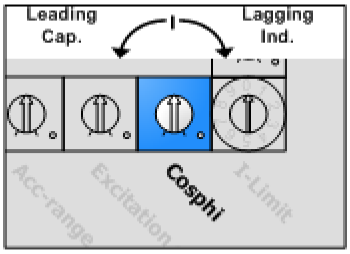


Fig 13. Cosphi adjustment

5.8 Selection switches

The dipswitch can be used to set voltage range and buildup settings. DIP 1 and 2 configure the input voltage range on the terminals U, V and W. The switch positions and corresponding modes are depicted in table 12. Ensure that the AVR's is in idle mode before changing the dipswitch setting.
DIP 3 and 4 configure Self Excite (SE) options. The switch positions and corresponding modes are depicted in table 13.
Before DIP4 setting is altered the generator must be stopped and the AVR power supply must be disconnected.

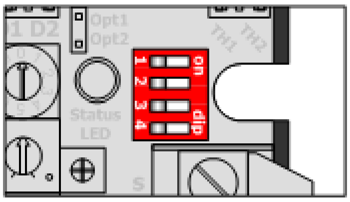


Fig 14. DIP Switches

5.8.0 Voltage range selection

DIP1	DIP2	Voltage selection Unom	Range		Over voltage value
			Minimum	Maximum	
OFF	OFF	100V	88	132	138V
ON	OFF	200V	158	253	263V
OFF	ON	not permitted			
ON	ON	400V	300	500	520V

Table 12. Voltage selector switches

5.8.1 Self Excite options

Switch	Description	Notes
DIP3	Enable/disable minimum setpoint SE mode	See 5.10.1
DIP4	Enable/disable Self Excite (SE)	Minimum supply input $5V_{AC}$

Table 13. Self Excites settings

5.9 Factory settings

All new or AVR's returned from service are supplied with factory settings as described in table 14. 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}
Current limit	125%	I_{nom}
Control mode	Constant voltage	
Underspeed knee	47	Hz
Underspeed ramp	8	V/Hz
Prop. gain	50	%
Int. time	50	%
Droop	0	V_{ac}
Acc. range	0	%
Excitation Ceiling	100	%
Cosphi	1	
TH1-TH2	Linked	
s-t	Linked	
AVR1-AVR2	Linked	
CAN1-CAN2	Linked	
PF1-PF2	Open	
Dipswitch 1	On	
Dipswitch 2	On	
Dipswitch 3	Off	
Dipswitch 4	Off	
Fuse	10AFF	5x20mm

Table 14. Factory settings

5.10 Advanced settings

The LXCOS features the option to change several advanced settings to optimize regulation. This chapter describes which settings can be adjusted and how to change those settings. The advanced settings are available for firmware version 1.0 and higher.

Read this chapter carefully before changing any settings!

5.10.0 Flowchart adjusting advanced settings

Advanced settings can be adjusted according the following flowchart.

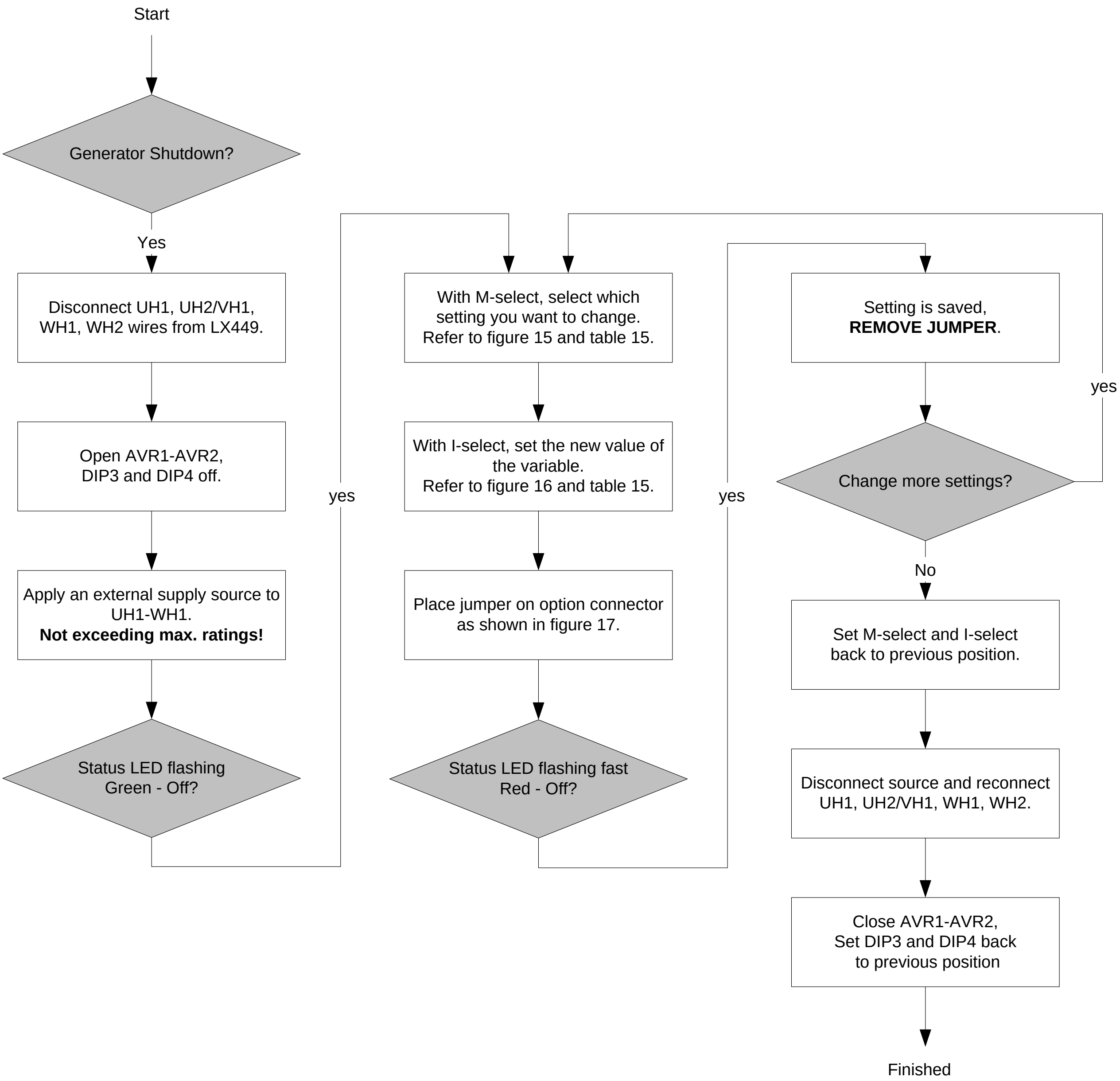


Diagram 18. Flowchart advanced settings

The M-select switch is used for selecting which setting to adjust.
The I-limit switch is used for adjusting the selected setting.

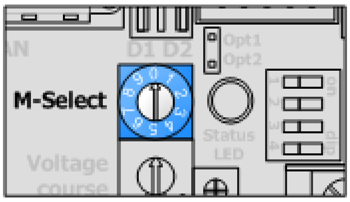


Fig 15. M-select for variable select

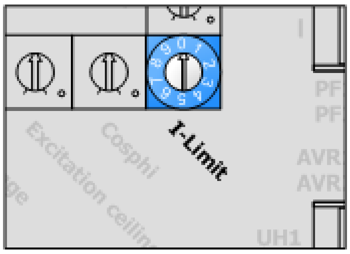


Fig 16. I-limit for variable changing

Place the programming jumper as shown on fig 17. Damage to the AVR can occur in case the jumper is misplaced

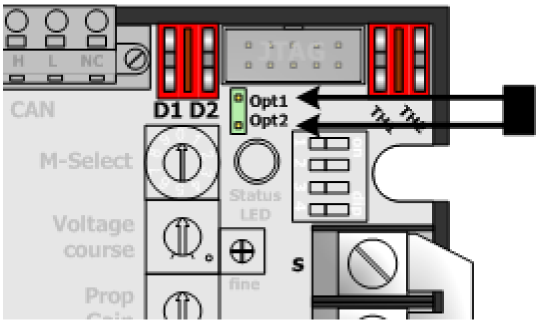


Fig 17. Jumper on option connector

5.10.1 Advanced settings table

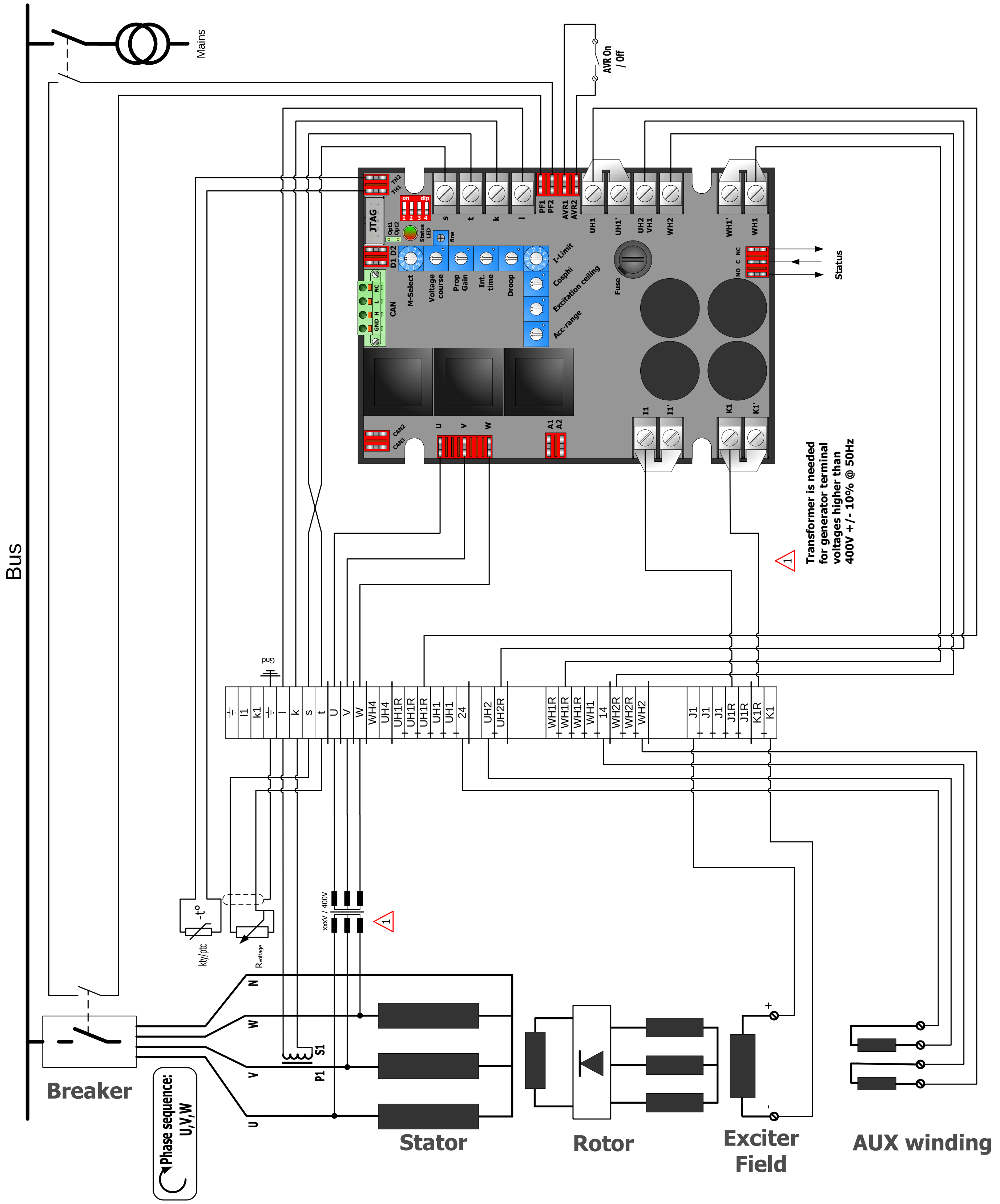
M-select / I-limit	Pos. 1: Buildup gain (MULT)	Pos. 2: Stability gain (DIV)	Pos. 3: Min. setpoint, SE mode.	Pos. 4: Protections	Pos. 5: Buildup time @ startup	Pos. 6: Option output	Pos. 7: ACC input modes	Pos. 8: Operation modes
Pos. 0	0,1 (slowest)	1 (fastest)	0%	Excitation loss disabled	1 sec.		Voltage Match disabled	Inverted. output disabled
Pos. 1	0,2	5	7,5%	Excitation loss enabled	3 sec.		Voltage Match enabled	Inverted output enabled
Pos. 2	0,5	10	15%	Phase loss disabled	5 sec.		Cosphi setpoint disabled	Unused
Pos. 3	1	15	22,5%	Phase loss enabled	7 sec.		Cosphi setpoint enabled	Unused
Pos. 4	2	20	30%	Current loss disabled	10 sec.	Unused	Unused	Unused
Pos. 5	4	25	37,5%	Current loss enabled	20 sec.		Unused	Unused
Pos. 6	6	30	45%	Unused	30 sec.		Unused	Unused
Pos. 7	8	35	52,5%	Unused	45 sec.		Unused	Unused
Pos. 8	10	40	60%	Unused	60 sec.		Unused	Unused
Pos. 9	14 (fastest)	45 (slowest)	67,5%	Unused	Cosphi setpoint 0..255 sec.		Unused	Unused
Description	Extra multiplication factor for proportional gain. Only applied during field flash.	Extra division factor for proportional gain.	Initial setpoint from which the AVR's ramps up after field flash. Setpoint in % of voltage range selection Unom	Enable or disable the desired protections.	The speed by which the AVR ramps up from the minimum setpoint to the nominal setpoint.	Unused	Enable or disable the desired modes of operation.	Enable of disable mode of operation

Table 15. Advanced settings

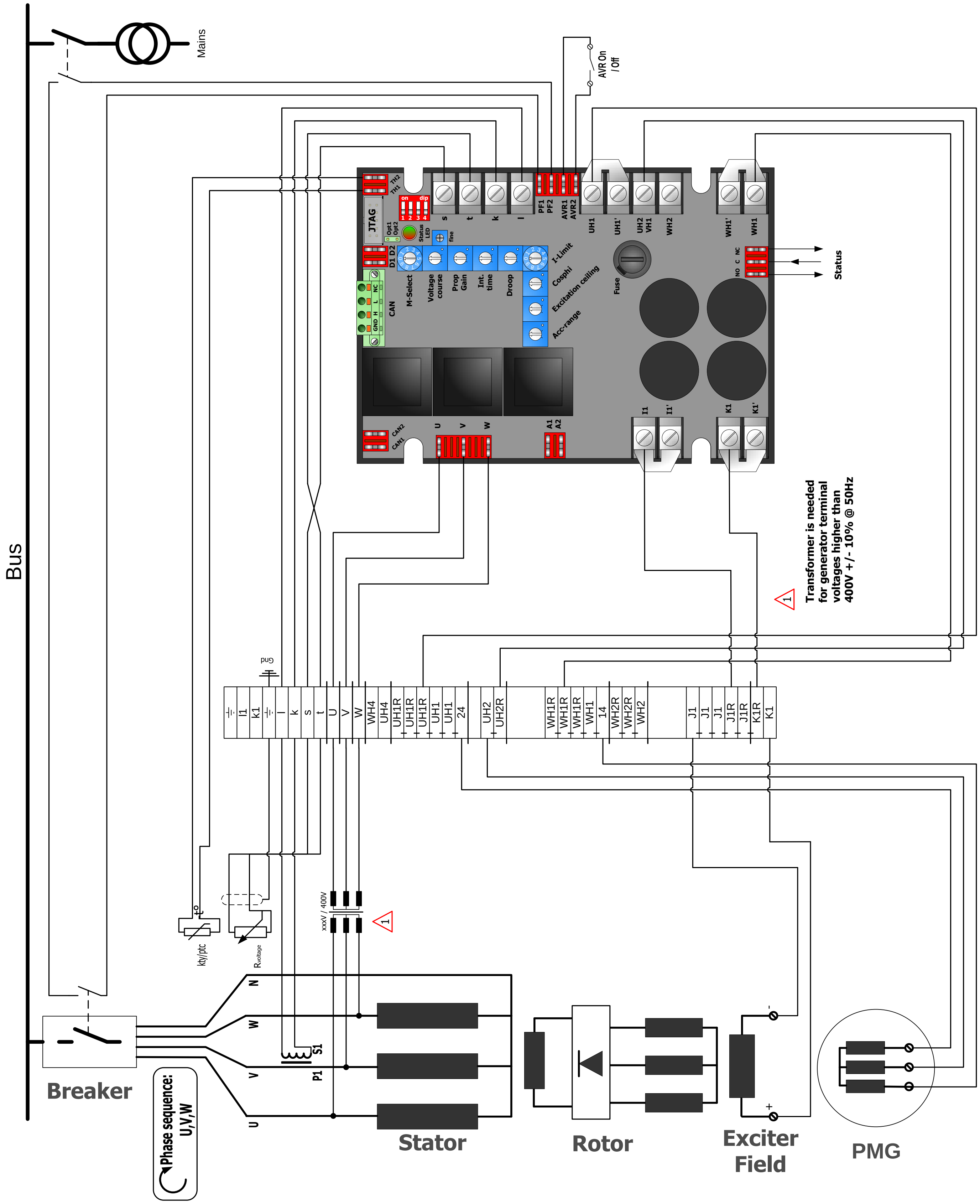
By setting both M-select and I-limit at 9 and by placing the programming header will reset the AVR to **factory default** settings. **Default factory** settings are highlighted in table 15.

6. Wiring Diagrams

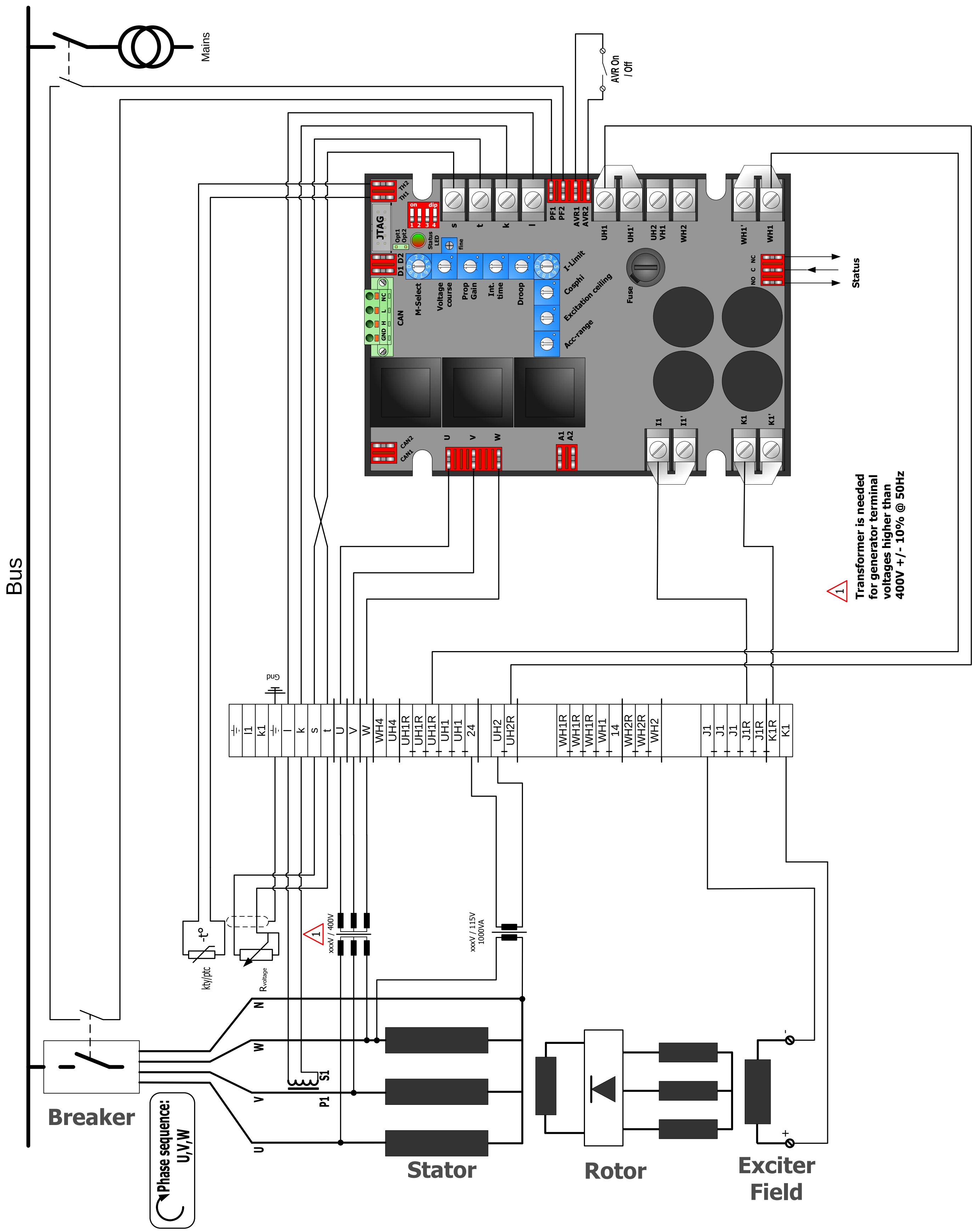
6.0 Wiring diagram LXCOS with aux windings



6.1 Wiring diagram LXCOS with PMG



6.2 Wiring diagram LXCOS self excite



7. CAN Interface

For external monitoring of the LXCOS EMRI give you the possibility to read out several values by a serial CAN interface.

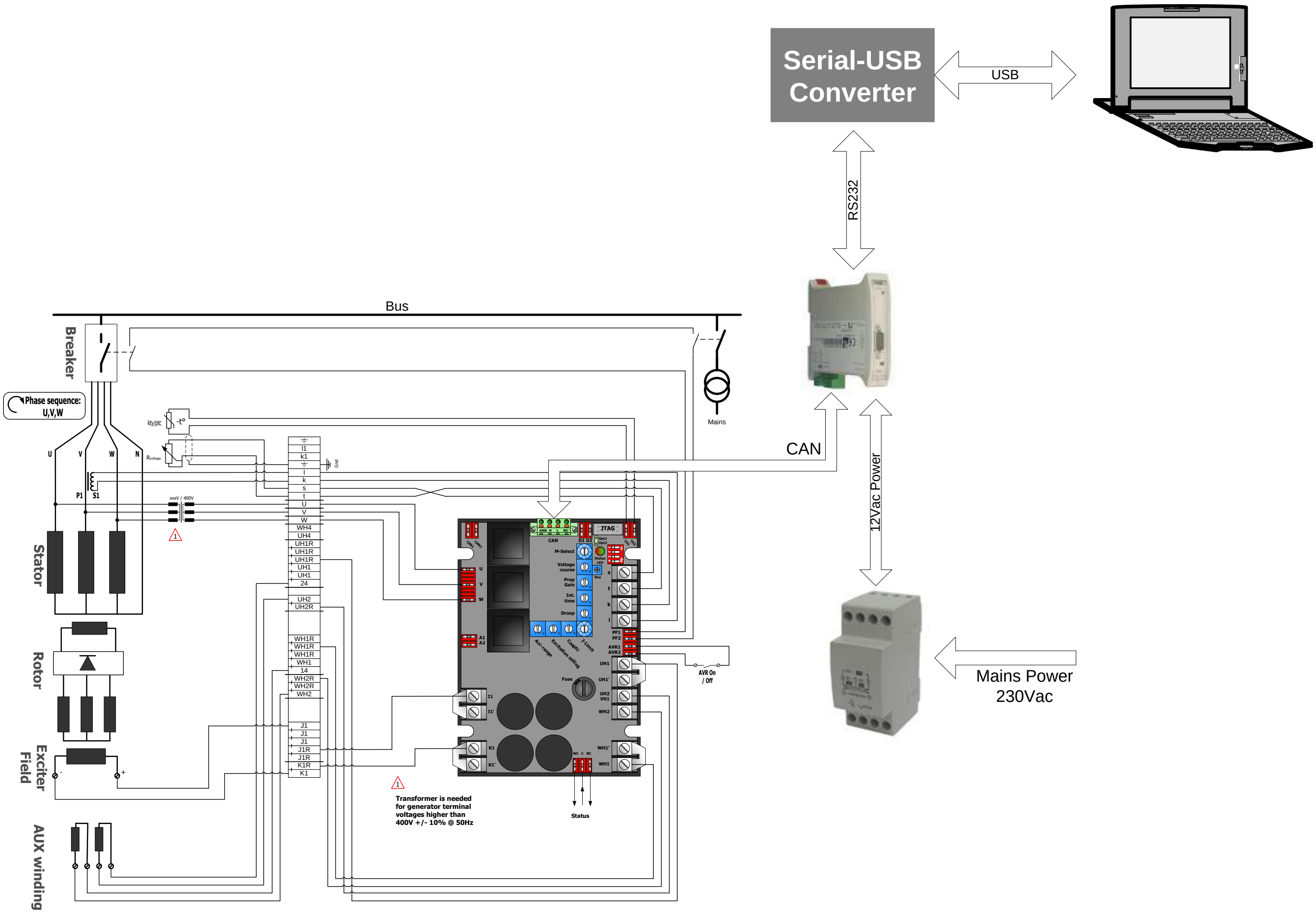


Fig 18. CAN interface

For more information about this option please contact EMRI.

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 I1 (+) and K1 (-), or Phase and neutral, s and t.
- Avoid current carrying conductors next to sensing or control wiring. Especially current controlled by SCR’s or PWM controlled transistors.
- If sensitive sensing signal cables need to be laid across distance along other cabling, shielded cable is preferred.

  Keep the shield as long as possible and the wiring outside the shield as short as possible. Do not solder or shrink the shield to a regular wire. Connect the original shield to ground at one side with an as large as possible contact surface.

Additional installation information

- When the product is supplied by means of a transformer, it should never be an auto-transformer. Auto-transformers react as voltage sweep up coil and may cause high voltage peaks.
- Standard fit capacitors or over-voltage suppressers across I1 (+) 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.

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A.2 Contact

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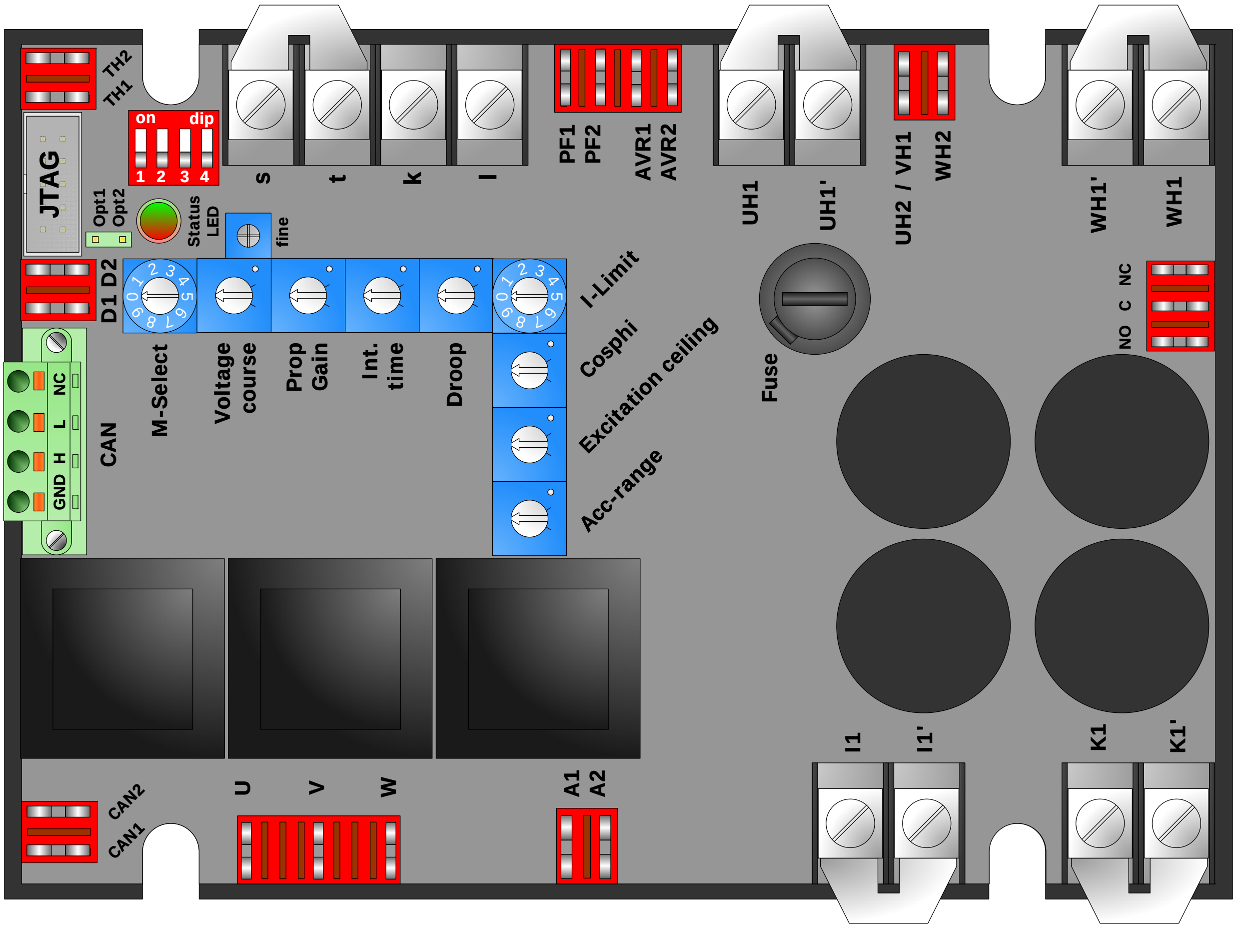
TH2
TH1
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on
dip
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Opt1
Opt2
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fine
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l
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AVR1
AVR2
UH1
UH1'
UH2 / VH1
WH2
WH1'
WH1
NO C NC
I-Limit
Cosphi
Excitation ceiling
Acc-range
Fuse
NC
L
H
GND
CAN
M-Select
Voltage course
Prop Gain
Int. time
Droop
CAN2
CAN1
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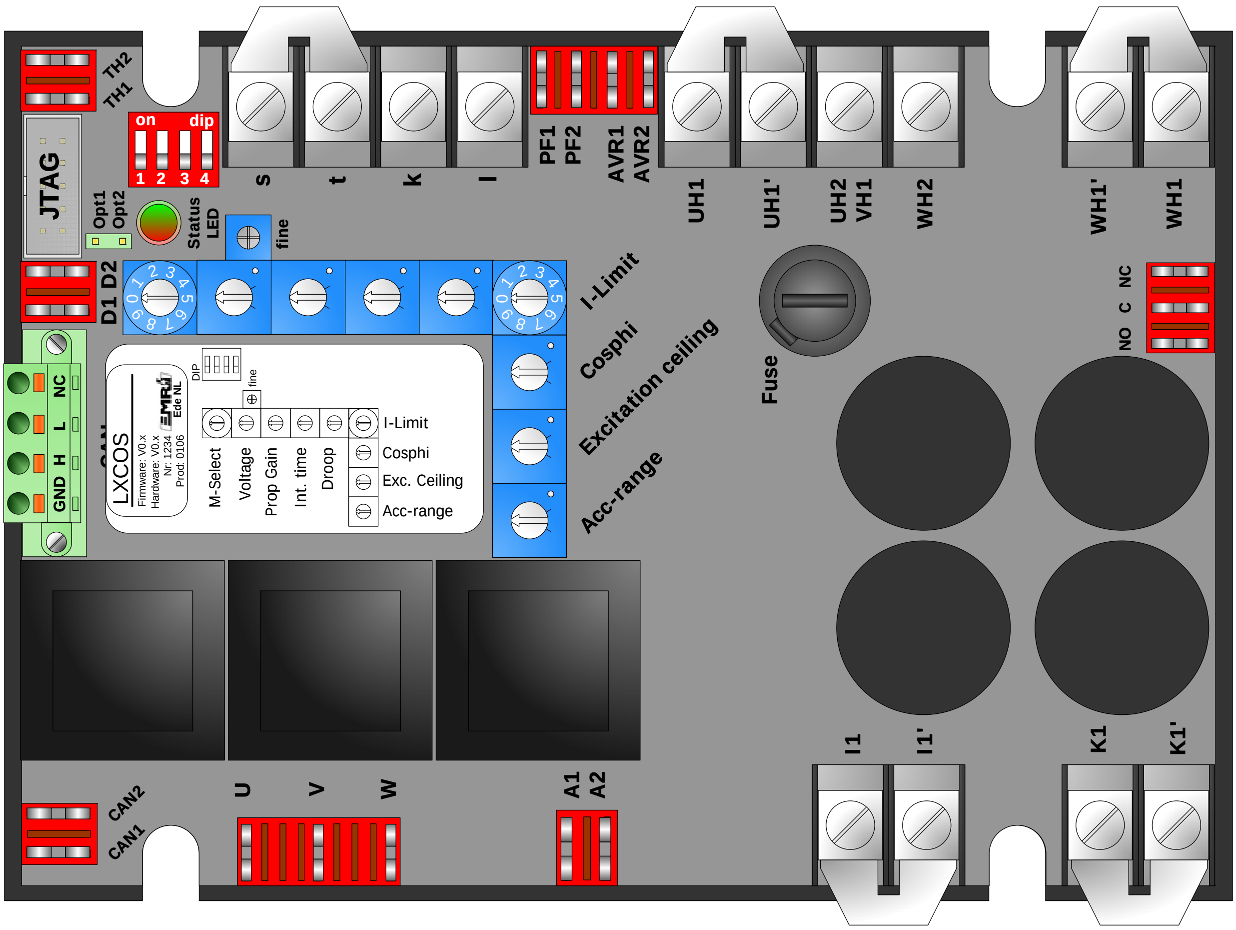
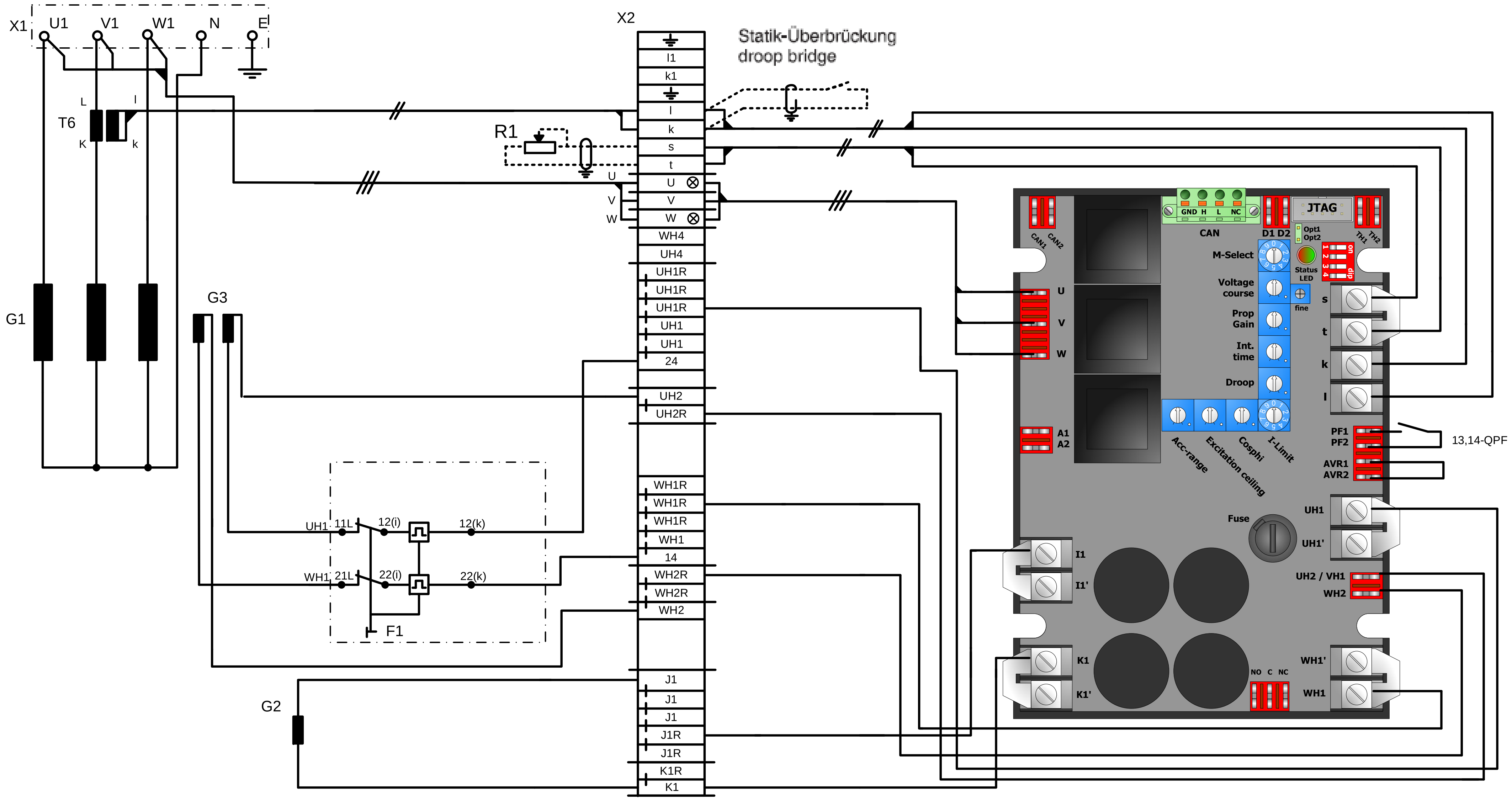
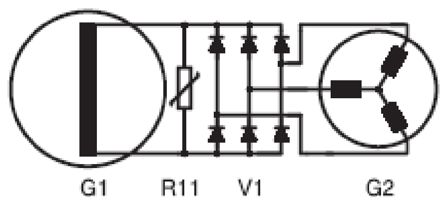
A1
A2
I1
I1'
K1
K1'


TH2
TH1
JTAG
on
dip
1 2 3 4
Opt1
Opt2
Status LED
fine
D1 D2
s
t
k
l
PF1
PF2
AVR1
AVR2
UH1
UH1'
UH2
VH1
WH2
WH1'
WH1
NO C NC
I-Limit
Cosphi
Excitation ceiling
Acc-range
Fuse
NC
L
H
GND
LXCOS
Firmware: V0.x
Hardware: V0.x
Nr: 1234
Prod: 0106
EMRI
Ede NL
DIP
fine
M-Select
Voltage
Prop Gain
Int. time
Droop
I-Limit
Cosphi
Exc. Ceiling
Acc-range
CAN2
CAN1
U
V
W
A1
A2
I1
I1'
K1
K1'



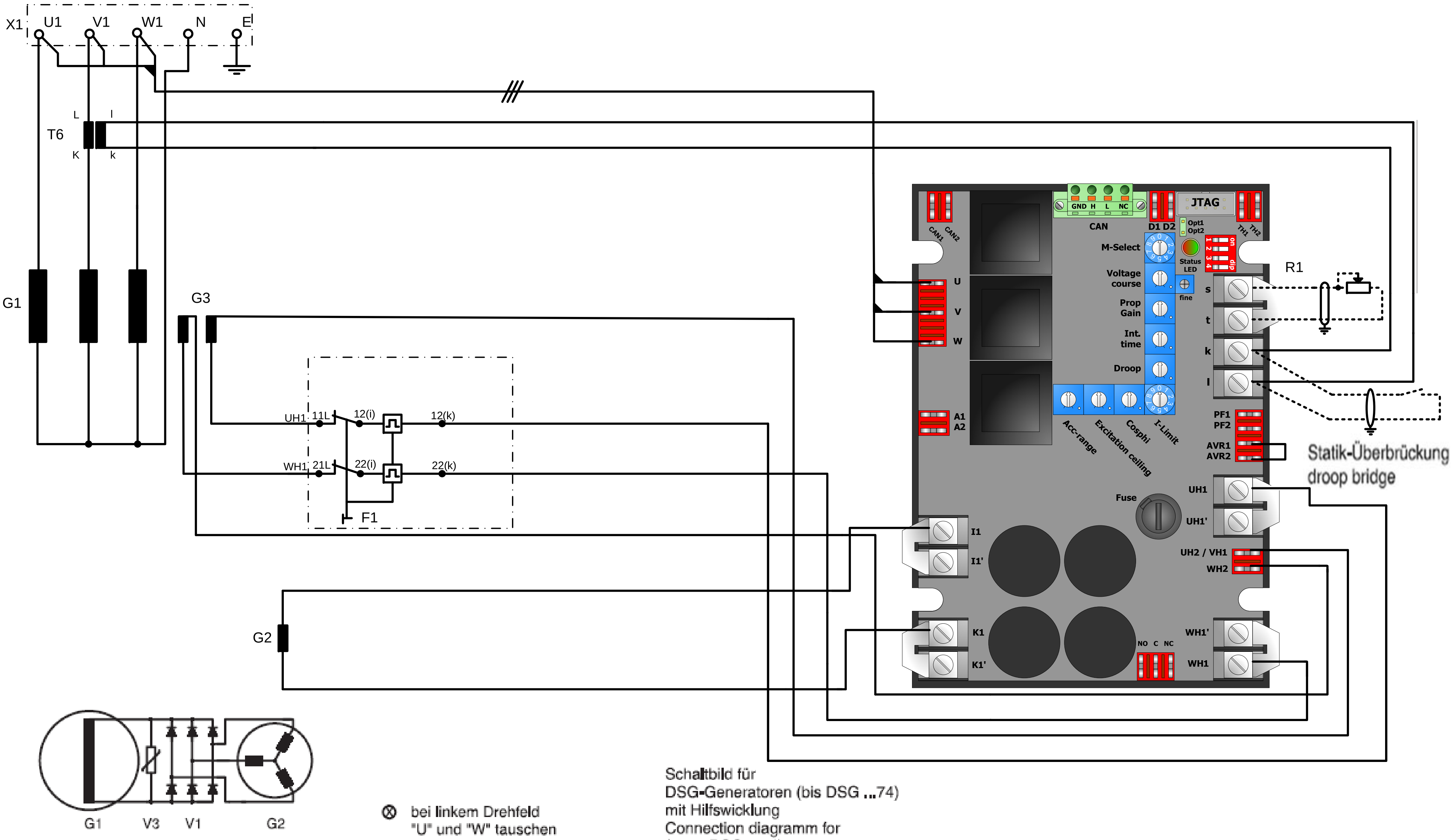


⊗ bei linkem Drehfeld
"U" und "W" tauschen
exchange "U" and "W"
at anti-clockwise rotating field

Schaltbild für DSG-Generatoren (ab DSG 86…)
mit Hilfswicklung
Connection diagramm for DSG-generators
(DSG 86…) with auxiliary windings

AvK DSG 86-125_Low Voltage Generator LX_COS	
ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	2

AvK_DSG_DIG_LX_COS definitief aangepast.vsd



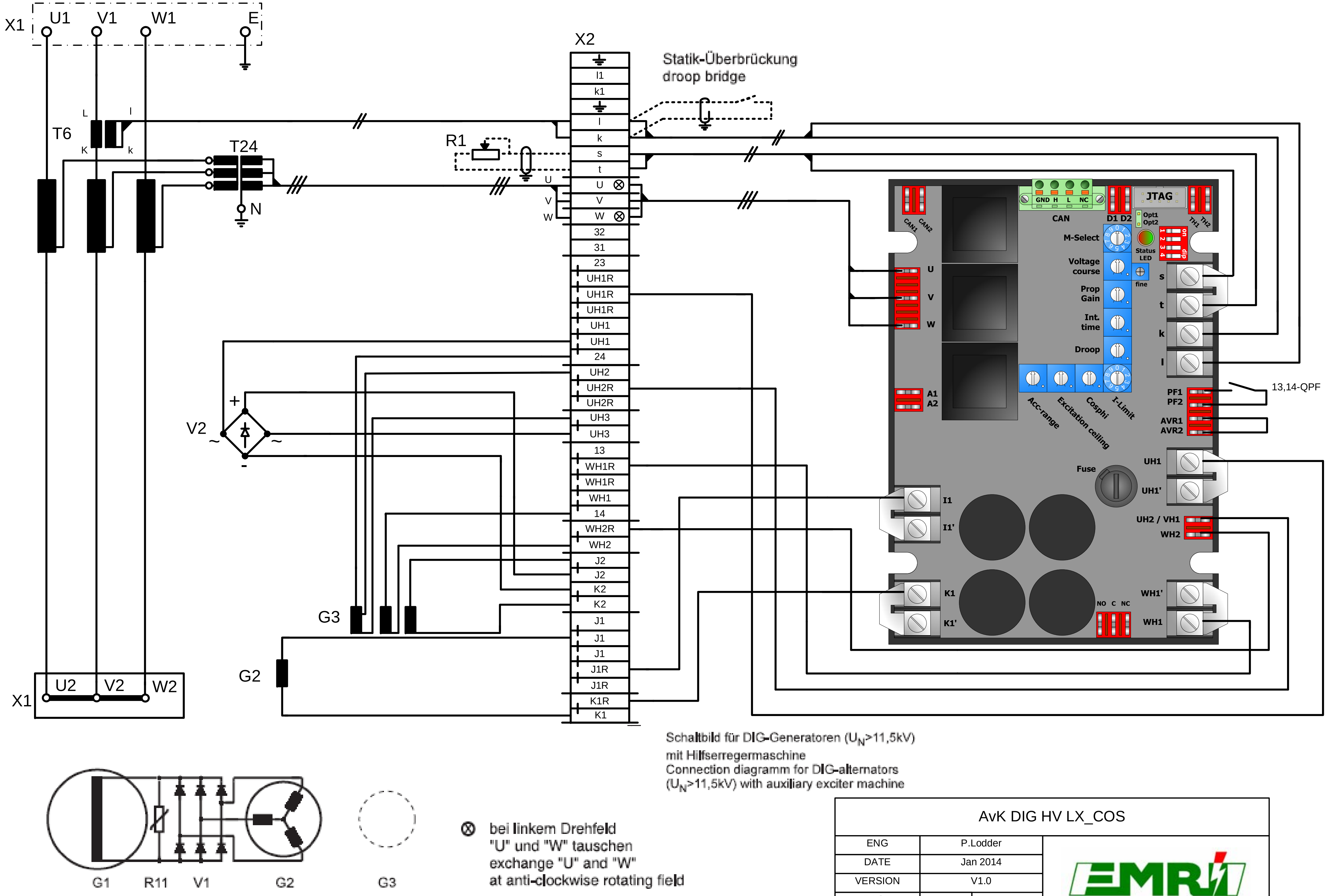
⊗ bei linkem Drehfeld
"U" und "W" tauschen
exchange "U" and "W"
at anti-clockwise rotating field

Schaltbild für
DSG-Generatoren (bis DSG ...74)
mit Hilfswicklung
Connection diagramm for
(up to DSG ...74)
with auxiliary windings

AvK DSG 52-74 Low Voltage Generator LX_COS

ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	3

AvK_DSG_DIG_LX_COS definitief aangepast.vsd



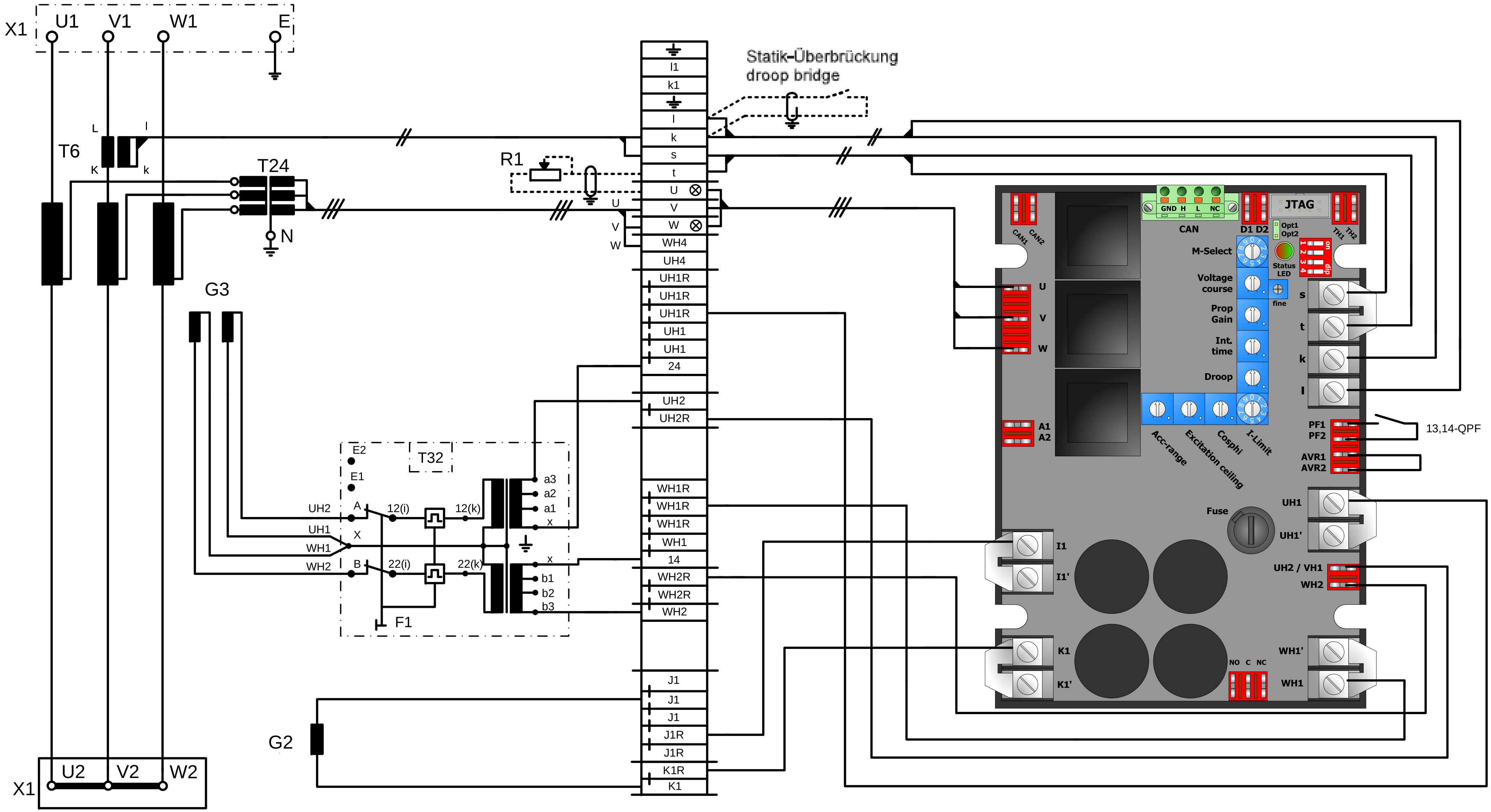
Schaltbild für DIG-Generatoren (U_N>11,5kV)
mit Hilfserregermaschine
Connection diagramm for DIG-alternators
(U_N>11,5kV) with auxiliary exciter machine

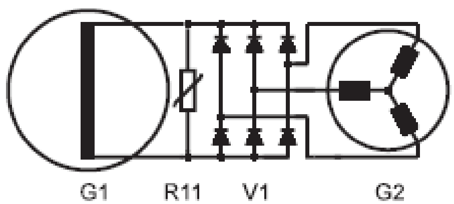
⊗ bei linkem Drehfeld
"U" und "W" tauschen
exchange "U" and "W"
at anti-clockwise rotating field

AvK DIG HV LX_COS

ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	4

AvK_DSG_DIG_LX_COS definitief aangepast.vsd





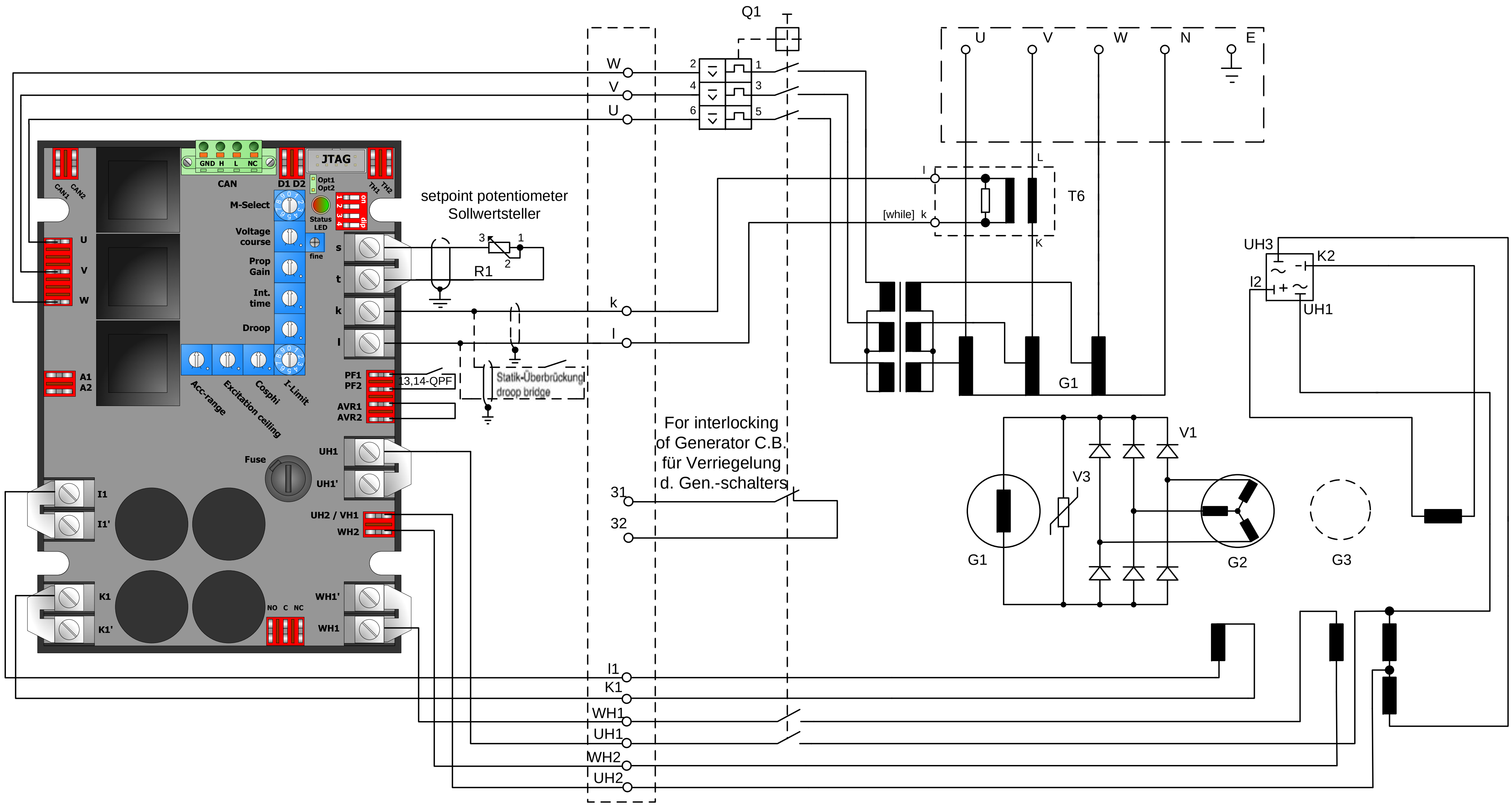
⊗ bei linkem Drehfeld
"U" und "W" tauschen
exchange "U" and "W"
at anti-clockwise rotating field

Schaltbild für DIG-Generatoren ($U_N \leq 11{,}5$kV)
mit Hilfswicklung
Connection diagramm for
DIG-alternators ($U_N \leq 11{,}5$kV) with auxiliary windings

AvK DIG MV LX_COS

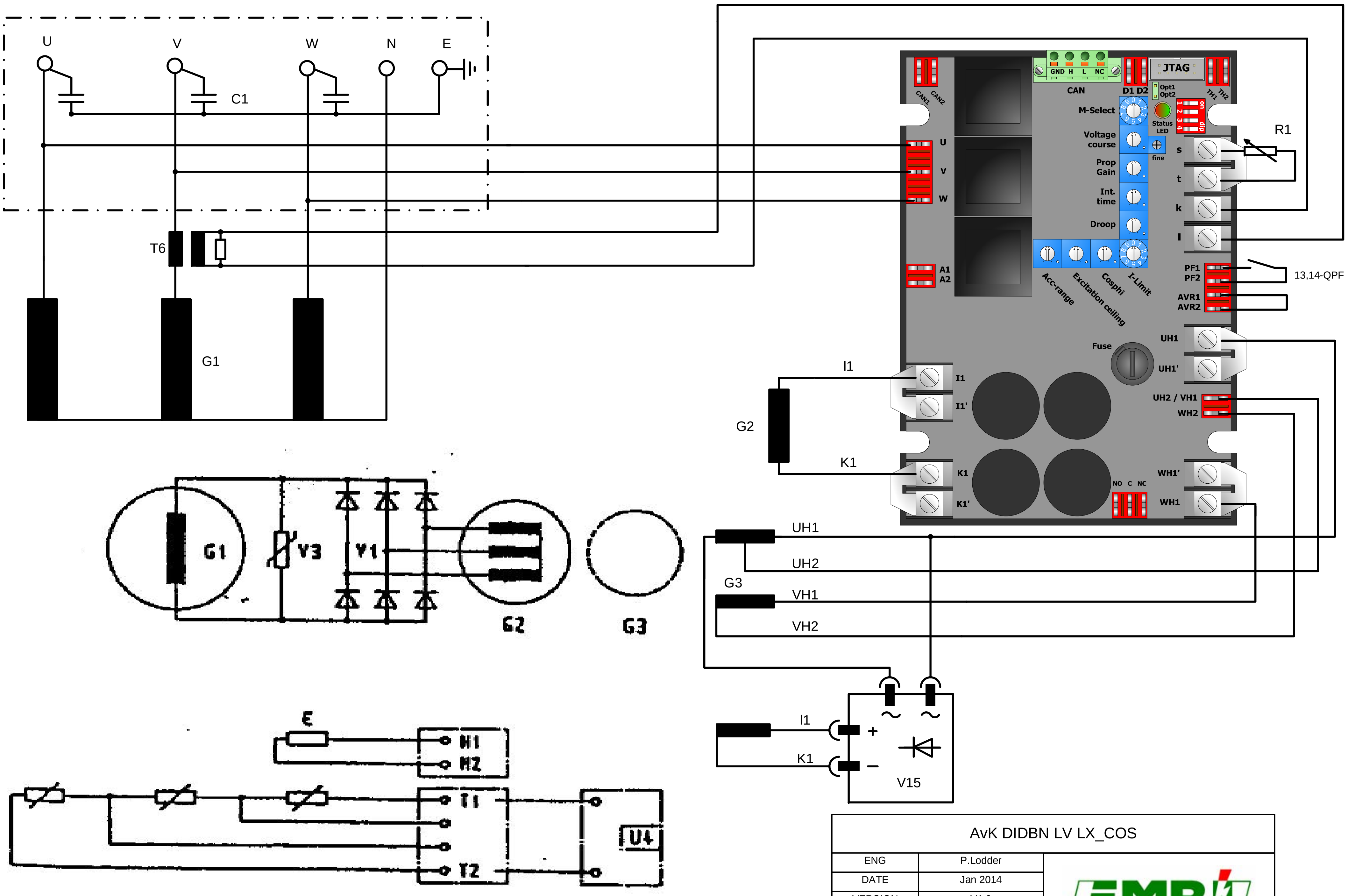
ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	5

AvK_DSG_DIG_LX_COS definitief aangepast.vsd



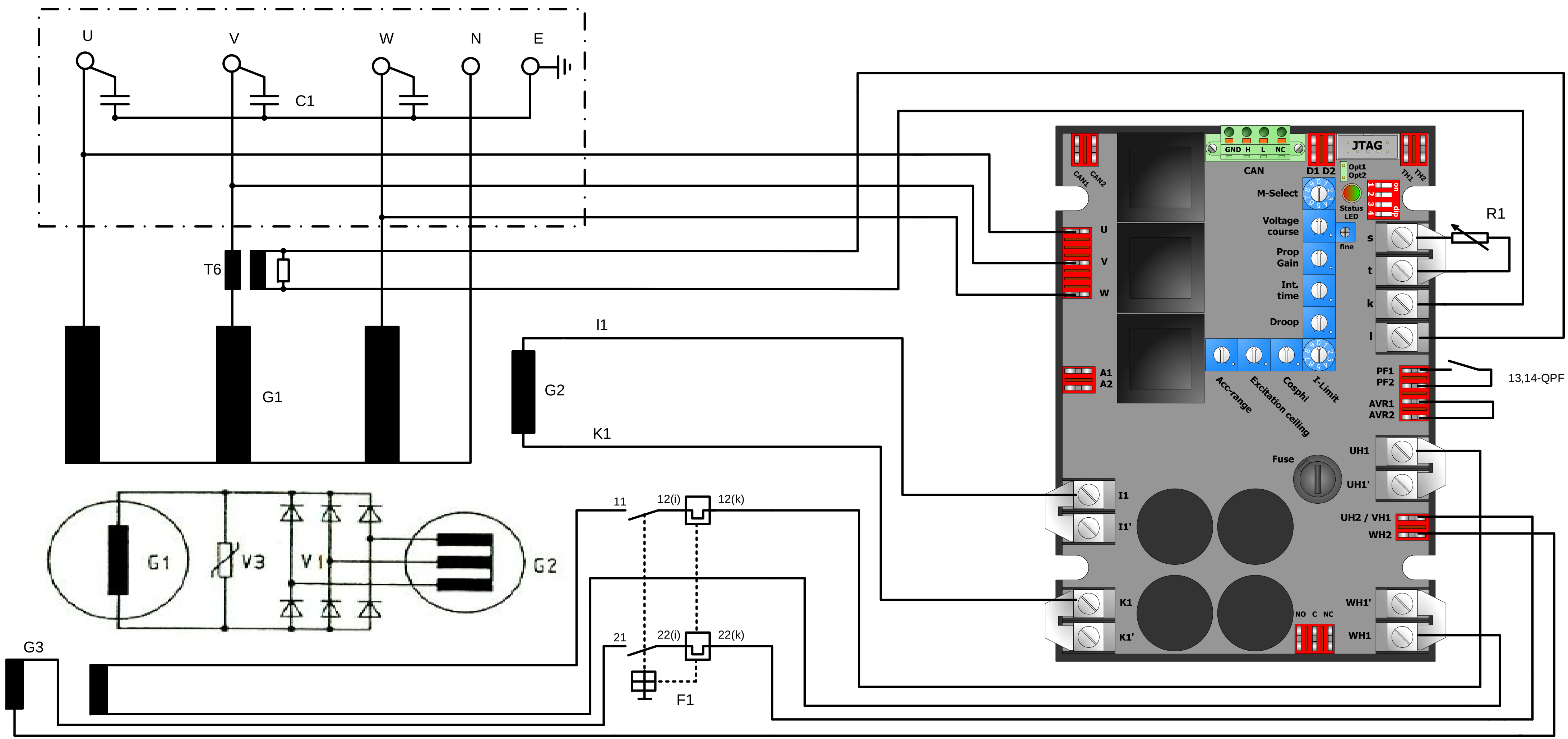
AvK DIDBN HV LX_COS		
ENG	P.Lodder	
DATE	Jan 2014	
VERSION	V1.0	
PAGE	6	

AvK_DSG_DIG_LX_COS definitief aangepast.vsd



AvK DIDBN LV LX_COS	
ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	7

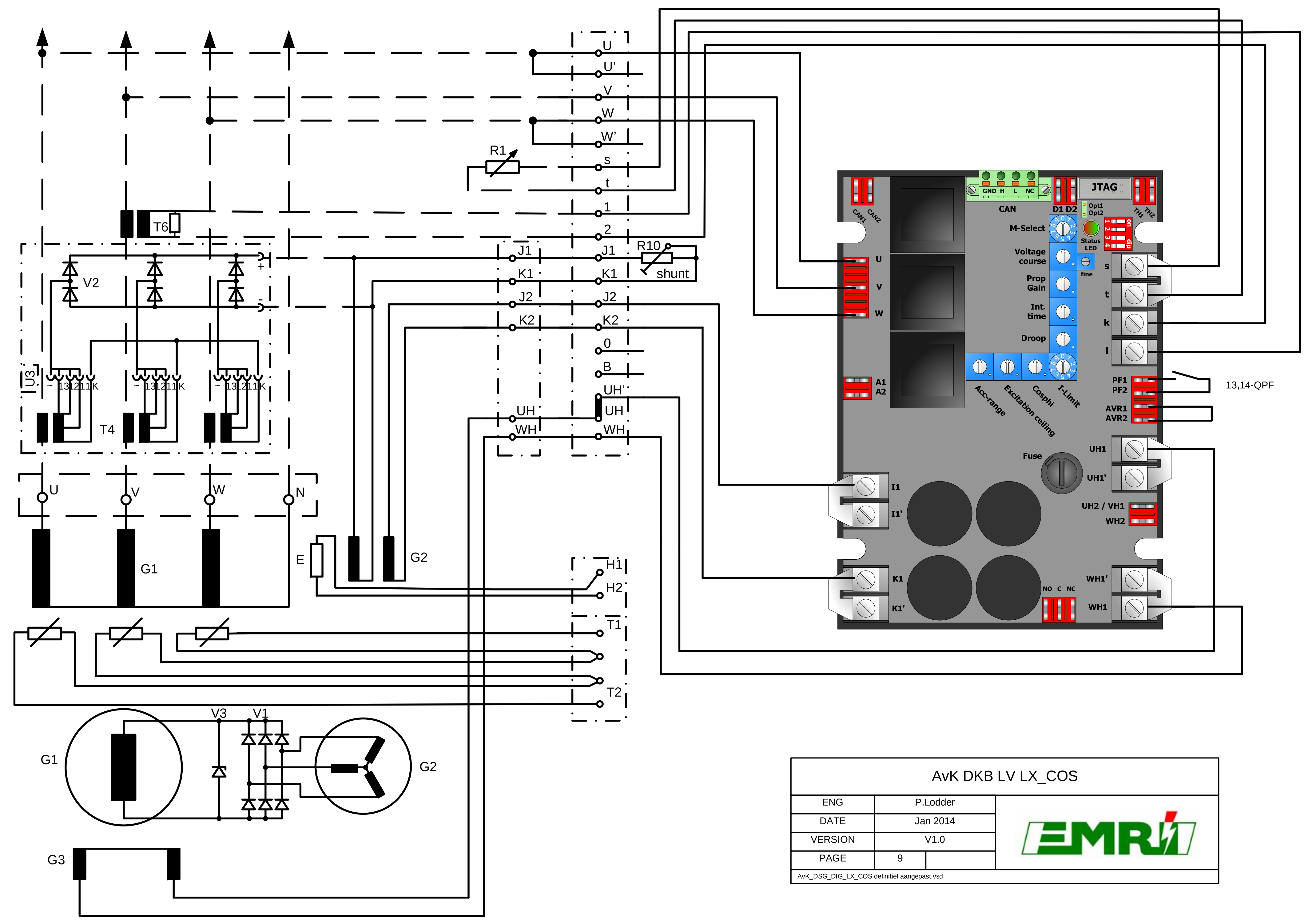
AvK_DSG_DIG_LX_COS definitief aangepast.vsd



AvK DKBN LV LX_COS

ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
PAGE	8

AvK_DSG_DIG_LX_COS definitief aangepast.vsd



AvK DKB LV LX_COS	
ENG	P.Lodder
DATE	Jan 2014
VERSION	V1.0
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AvK_DSG_DIG_LX_COS definitief aangepast.vsd