THE POWER OF SYNERGY

6GA2491

(Control card)

&

6GA2492

(Control card with power module)

Instruction Manual V2.1

Product version V1.3.0.0

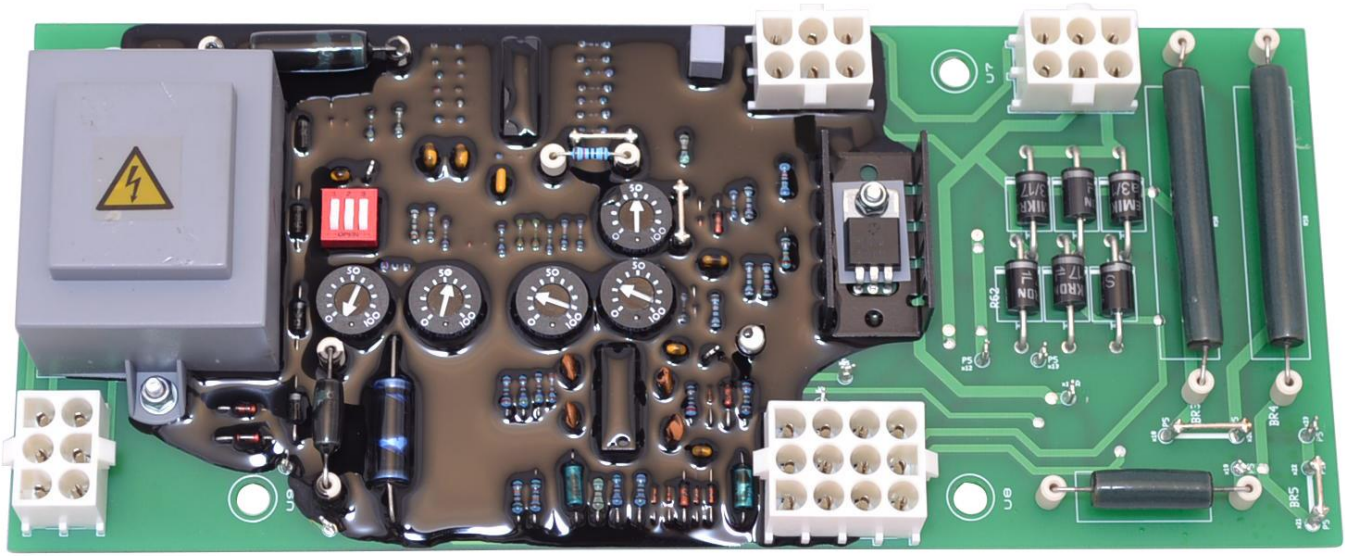
EMRI ELECTRONICS

POWER IN CONTROL

MANAGEMENTSYSTEEM CERTIFICATIE DNV·GL ISO 9001 = VCA*

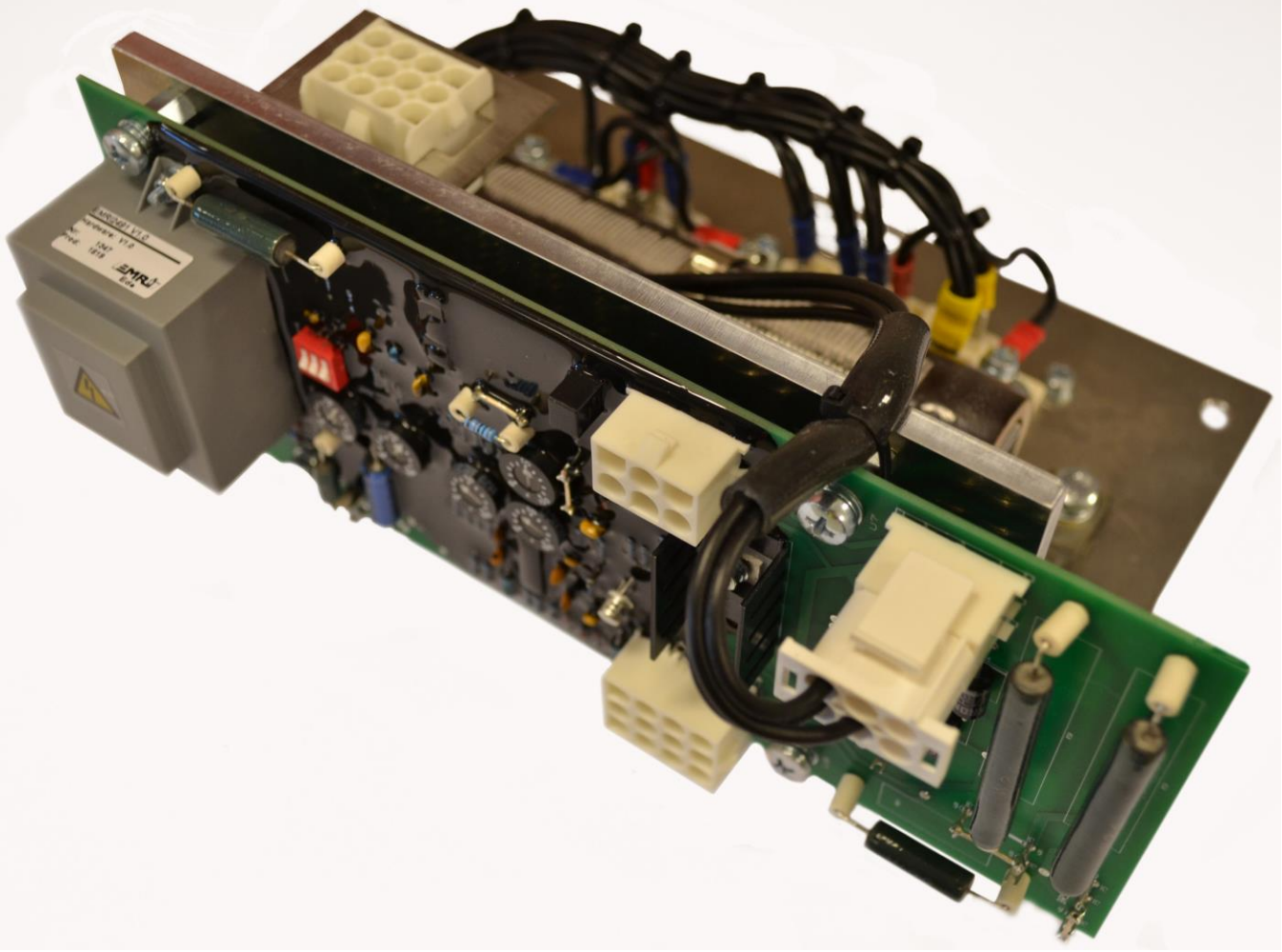
EMRI 6GA2491

Control card



EMRI 6GA2492

Control card with power module



WARNINGS AND COMMISSIONING INFORMATION

HAZARDOUS VOLTAGES.
DO NOT OPERATE WHEN NOT FAMILIAR WITH GENERATORS.

- ***Check the isolation of the generator windings before installation.***
  Poor isolation will cause damage to the AVR and dangerous situations for persons.
- 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.
- Never work on a LIVE generator. Unless there is another person present who can switch off the power supply or stop the engine.
- 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.
- Defects in the generator or AVR may cause consequential loss. Precautions must be taken to prevent this from occurring.
- 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.
- Never change the rotary switch or dipswitch settings during operation.
- Never apply supply voltage when generator is not running, unless exciter field is disconnected.

REPLACEMENT INSTRUCTIONS

Before replacing an existing AVR is it strongly advised to copy and verify potentiometer, dipswitch and wire bridge settings. In case a 6GA2492 AVR is replaced the power resistor, mounted on the heatsink, must also be checked. If the resistance is not equal, adjust the wiper position accordingly. Do not adjust the compounding transformer tapping from the factory settings.

REVISION HISTORY

Version				Change
Product	Hardware	Manual	Date	
V1.0	1.0	1.0	Apr-2009	First release
V1.1	1.1	1.38	Jul-2013	*Minor hardware update.*
V1.2.0.0	1.1	2.0	Jul-2020	*New manual layout*
V1.3.0.0	1.2.0.0	2.1	Nov-2020	*Minor hardware improvement.*

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

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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GENERAL DESCRIPTION

This manual contains instructions for installing, operating and maintaining the 6GA2491 and 6GA2492 automatic voltage regulators (AVR).
The information in this manual applies to the 6GA2491 AVR and the 6GA2492 AVR which in addition to the control card includes additional power electronics mounted on a heatsink.

Both incorporate analogue controller circuitry and are specifically designed for Siemens® and Siemens® licensed Hyundai®, Uljanik® and Fenxi® brushless synchronous machines. The 6GA2491 is suitable for controlling generator series 1FC6 18 to 28. The 6GA2492 is suitable for controlling generator series 1FC6 35 to 56.

The 6GA2491 and 6GA2492 are designed for use in generators with a compounding system. The AVR operates according to a subtractive principle meaning that any excess excitation current generated by the generator compounding is dissipated in a shunt resistance.

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Condition	Min.	Max.	Unit
X1 – 3/1	Voltage sensing input 400Vac (2)	50Hz, continuous	-	450	V_{AC}
		60Hz, continuous	-	480	V_{AC}
X1 – 3/5	Voltage sensing input 230Vac (2)	50Hz, continuous	-	260	V_{AC}
		60Hz, continuous	-	275	V_{AC}
X2 – 7/10/11	Total compounding current	6GA2491 (per phase) (1)	-	1.8	A_{AC}
X4 – 1 to 6	Total compounding current	6GA2492 (per phase) (1)	-	15	A_{AC}
I_{SHUNT}	AVR shunt current	6GA2491 (1)	-	3	A_{DC}
I_{SHUNT}	AVR shunt current	6GA2492 (1)	-	9.5	A_{DC}
X2 – 5/9	Droop	Isolated CT	-	0.5	A_{AC}
X2 – 1/3	Remote adjust	≥ 1W	-	4.7	kΩ
X40 – 2/3	Setpoint control	Isolated source	-5	+5	V_{DC}
T_{AMB}	Operating temperature	95% RHD non condensing (1)	0	+70	°C
T_{STG}	Storage temperature	95% RHD non condensing	-45	+85	°C

(1) Always allow for sufficient airflow.
(2) Isolated input.

ABSOLUTE MAXIMUM RATING

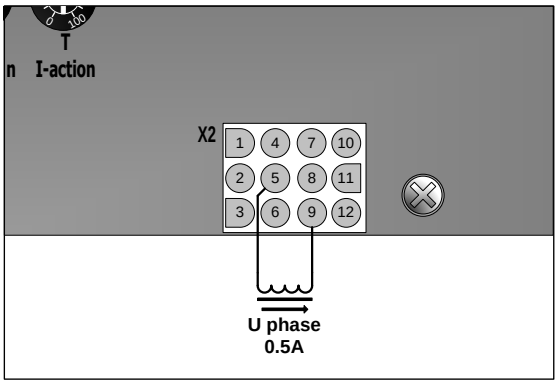
Symbol	Parameter	Condition	Min.	Max.	Unit
X1 – 3/1	Voltage sensing input 400Vac (2)	50Hz, intermitted < 30s.	-	470	V_{AC}
		60Hz, intermitted < 30s.	-	500	V_{AC}
X1 – 3/5	Voltage sensing input 230Vac (2)	50Hz, intermitted < 30s.	-	270	V_{AC}
		60Hz, intermitted < 30s.	-	285	V_{AC}
X2 – 7/10/11	Total compounding current	6GA2491 (per phase) (1)	-	3	A_{AC}
X4 – 1 to 6	Total compounding current	6GA2492 (per phase) (1)	-	22.5	A_{AC}
I_{SHUNT}	AVR shunt current	6GA2491 (1)	-	4.5	A_{DC}
I_{SHUNT}	AVR shunt current	6GA2492 (1)	-	13.5	A_{DC}
X2 – 5/9	Droop	Isolated CT	-	0.6	A_{AC}
X40 – 2/3	Setpoint control	Isolated source	-7	+7	V_{DC}
T_{AMB}	Operating temperature	95% RHD non condensing (1)	0	+70	°C
T_{STG}	Storage temperature	95% RHD non condensing	-45	+85	°C

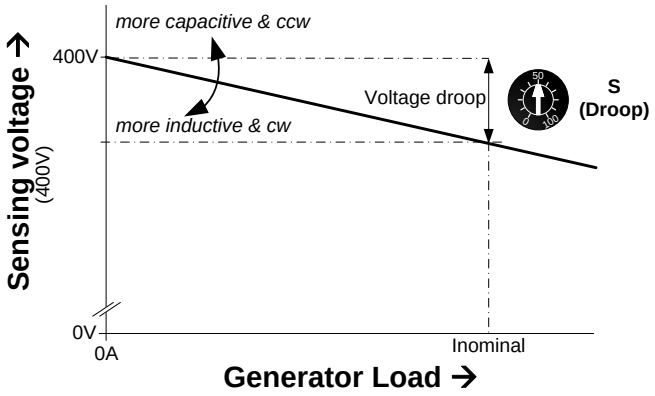
(1) Always allow for sufficient airflow.
(2) Isolated input.

Stresses above “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 listing of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability and lifetime.

ADJUSTMENTS I

Droop

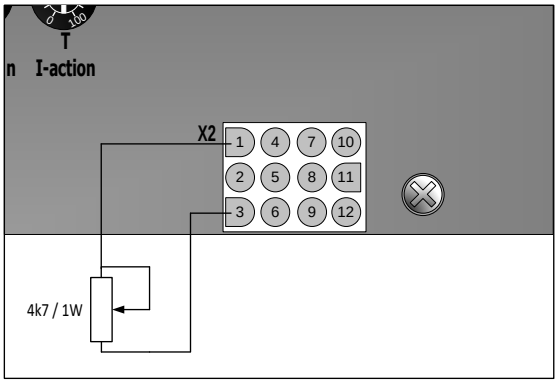




Droop range is Unom – 20% @ power factor 0.

Remote adjust

S1

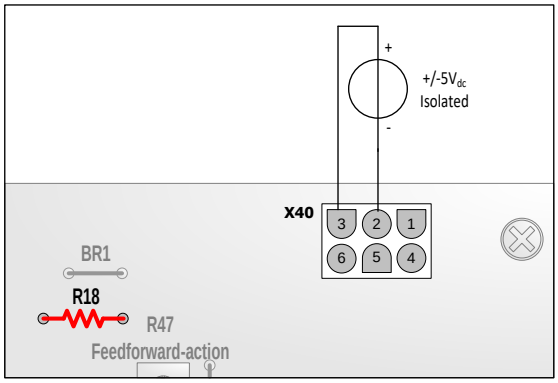


If the generator voltage setpoint is to be adjusted externally, a 4.7kΩ/1W potentiometer can be fitted between terminals X2:1 and X2:3. In this case dipswitch S1:3 must be open.

It Is recommended to set potentiometer U (Voltage) to 50% when an external voltage potentiometer is fitted.

Maximum value for potentiometer is 4K7.

Setpoint control



The generator voltage setpoint can be influenced by external control equipement by means of a potential free ±5V_{dc} signal. The influence of the applied setpoint adjust voltage on the nominal generator voltage can be calculated with the following formula:

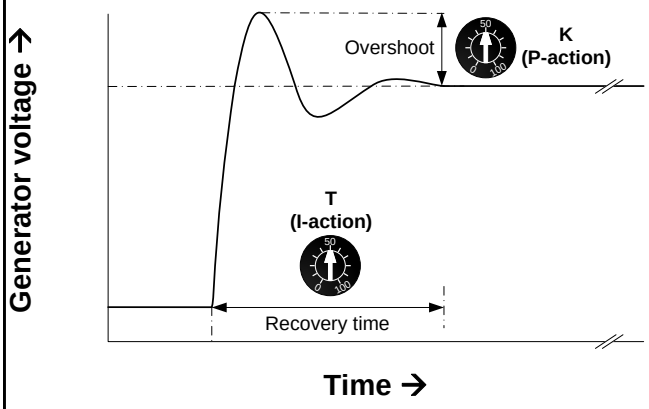
$\Delta U_{GEN} = -1.4 \times (U_{NOM} / R18) \times U_{SET}$

ΔU_{GEN} = Change in generator voltage
U_{SET} = Input voltage at terminals X40/2 and X40/3
U_{NOM} = Nominal generator voltage setpoint
R18 = Resistance (in kΩ)

Resistor R18 is default fitted with a 10kΩ resistor but can be adjusted to fit the external setpoint adjustment range to a specific application.

ADJUSTMENTS II

Stability control



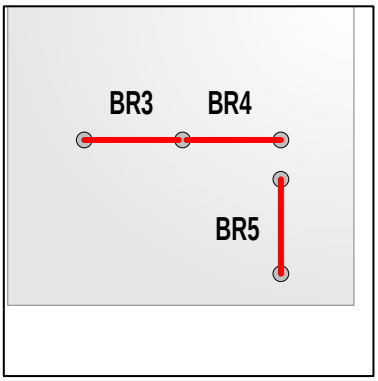
When the control rate must be reduced beyond the range adjustable with the potentiometers, the P-action potentiometer range can be reduced by a factor 4 by interrupting wire bridge BR1.

Another possibility to reduce control rate is to increase the shunt resistance. A trade-off in this case is that an increase in shunt resistance can increase the minimum settable voltage setpoint.

Turning the P/I control must be performed by a control specialist to prevent damage to the AVR and generator.

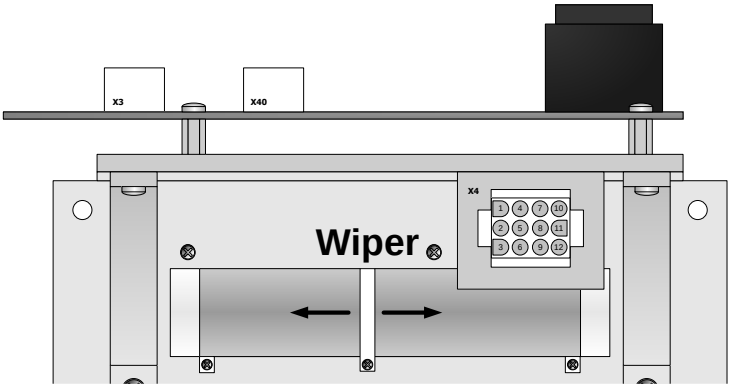
Shunt resistor adjustment 6GA2491

BR3	BR4	BR5	Resistance (Ω)	Notes
Open	Open	Open	∞	Do not use
Open	Open	Closed	10	
Open	Closed	Open	25	
Open	Closed	Closed	10	
Closed	Open	Open	15	
Closed	Open	Closed	6	Default
Closed	Closed	Open	15	
Closed	Closed	Closed	0	Do not use



Note that an increase in shunt resistance will result in a slower control characteristic and can increase the minimum settable voltage setpoint. The opposite is is valid for a decrease in shunt resistance.

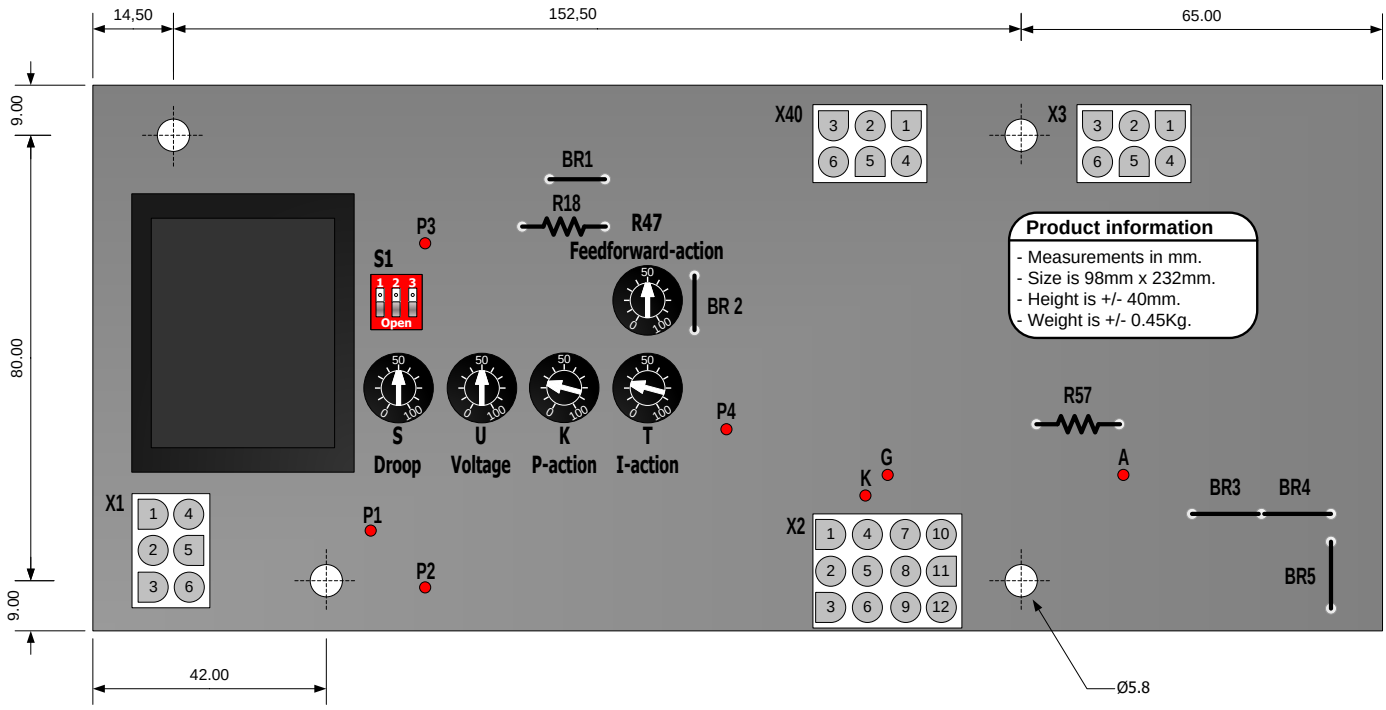
Shunt resistor adjustment 6GA2492



For the 6GA2492 AVR the resistance can be adjusted by adjustment of the wiper position on the power resistor, mounted on the heat sink.

Note that an increase in shunt resistance will result in a slower control characteristic and can increase the minimum settable voltage setpoint. The opposite is is valid for a decrease in shunt resistance.

QUICK REFERENCE I



U (Voltage)

- +

Voltage range : Unom -15% .. +30%.

S (Droop) *(Page 8)*

0% 100%

Droop range : Unom – 20% @ power factor 0.

K (P-action) *(Page 8)*

- +

Opening BR1 reduces P-action bij 4.

T (I-action) *(Page 8)*

- +

R47 (Feedforward-action)

0% 100%

Opening BR2 disables feedforward action

S1 (Dipswitch) *(Page 9)*

1 phase sensing	3 phase sensing	Remote adjust off	Remote adjust on
Dip 1 & Dip2 closed	***Dip 1 & Dip2 open***	***Dip 3 closed***	***Dip 3 open***

Dipswitch is closed when the switch is level with the topside of the dipswitch. The dot is on the topside.

Factory settings	
Parameter	***Setpoint***
U (Voltage)	400Vac
S (Droop)	0Vac
K (P-action)	25%
T (I-action)	25%
R47 (Feedforward-action)	50%
Dipswitch S1:1	Closed
Dipswitch S1:2	Closed
Dipswitch S1:3	Closed

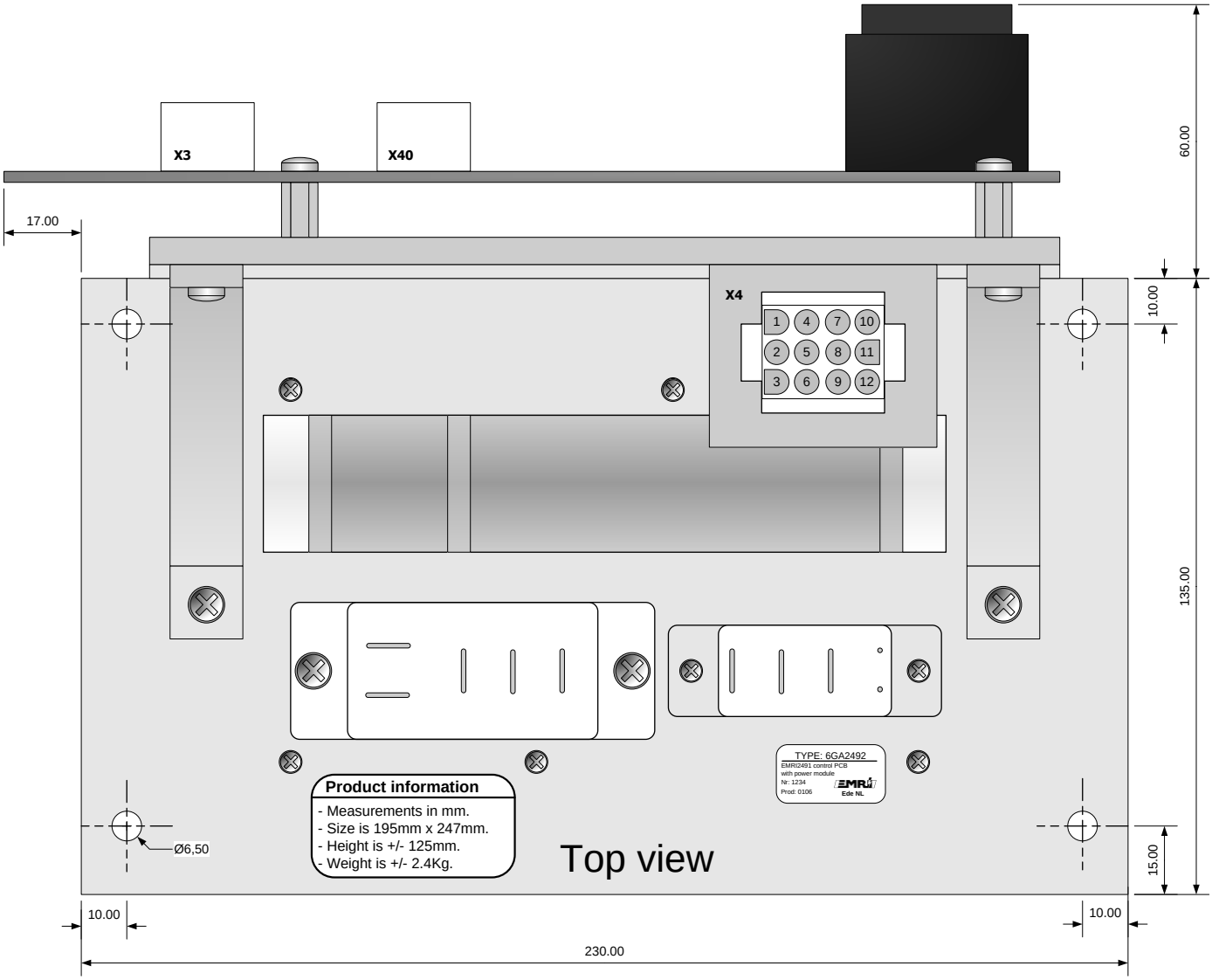
Factory settings	
Parameter	***Setpoint***
BR1	Closed
BR2	Closed
BR3	Closed
BR4	Open
BR5	Closed
R18	10kΩ

QUICK REFERENCE II

Terminals			
Header	**Terminal**	**Description**	**Notes**
X1	1	400Vac voltage sensing	
	2	Not connected	
	3	0Vac voltage sensing	
	4	Not connected	
	5	230Vac voltage sensing	
	6	Not connected	
X2	1	External voltage adjustment potentiometer	
	2	6GA2491 circuit ground	
	3	External voltage adjustment potentiometer	
	4	Field excitation -	For 6GA2491
	5	CT input for voltage droop	
	6	External sensing influence	
	7	Compound transformer input AC1	
	8	6GA2491 gate drive	Link with X2.4 6GA2491
	9	CT input for voltage droop	
	10	Compound transformer input AC2	
	11	Compound transformer input AC3	
	12	Field excitation +	For 6GA2491
X3	1	Voltage sensing rectifier -	
	2	Voltage sensing rectifier +	
	3	6GA2492 gate drive	
	4	Field excitation +	
	5	Compound transformer input AC1	
	6	Field excitation -	6GA2491 circuit ground
X40	1	Controller actual value	
	2	External setpoint input -	
	3	External setpoint input +	
	4	Compound transformer input AC1	
	5	6GA2492 gate drive	
	6	6GA2491 PCB ground / Field excitation -	

Test points		
Symbol	**Description**	**Notes**
P1	6GA2491 circuit ground	
P2	CT input for voltage droop	Connected to X2.9
P3	External setpoint input -	Connected to X40.2
P4	Controller output	
K	Thyristor cathode	
A	Thyristor anode	
G	Thyristor gate	

Wire bridges		
Symbol	**Description**	**Notes**
BR1	Controller proportional gain adjust	Opening reduces P-action bij 4
BR2	Controller feedforward link	Opening disables feedforward action
BR3	Shunt resistor selection	See page 9 (Adjustments II)
BR4	Shunt resistor selection	See page 9 (Adjustments II)
BR5	Shunt resistor selection	See page 9 (Adjustments II)
R18	External setpoint range resistor	Adjusts external setpoint range
R57	Excitation bridge resistor	Normally not fitted.

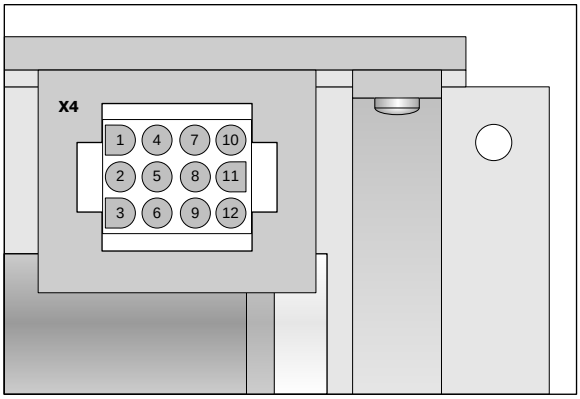


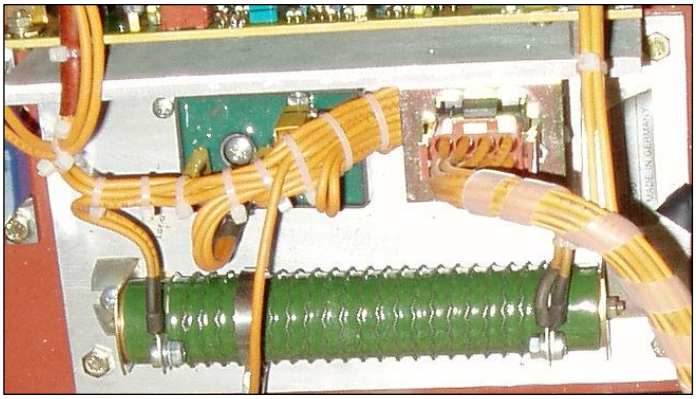
Terminals			
Header	**Terminal**	**Description**	**Notes**
X4	1	Compound transformer input AC3	
	2	Compound transformer input AC2	
	3	Compound transformer input AC1	
	4	Compound transformer input AC3	
	5	Compound transformer input AC2	
	6	Compound transformer input AC1	
	7	Field excitation +	
	8	Field excitation +	
	9	Field excitation +	
	10	Field excitation -	
	11	Field excitation -	
	12	Field excitation -	

SIEMENS / HYUNDAI

Connector X4 : EMRI 6GA2492 & SIEMENS 6GA2492

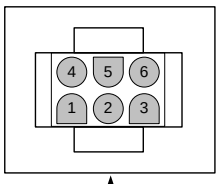
Terminals			
Header	**Terminal**	**Description**	**Notes**
X4	1	Compound transformer input AC3	
	2	Compound transformer input AC2	
	3	Compound transformer input AC1	
	4	Compound transformer input AC3	
	5	Compound transformer input AC2	
	6	Compound transformer input AC1	
	7	Field excitation +	
	8	Field excitation +	
	9	Field excitation +	
	10	Field excitation -	
	11	Field excitation -	
	12	Field excitation -	

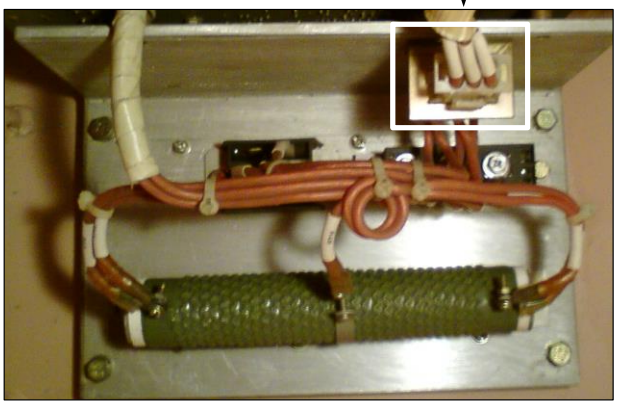




Connector X4 : HYUNDAI 6GA2492

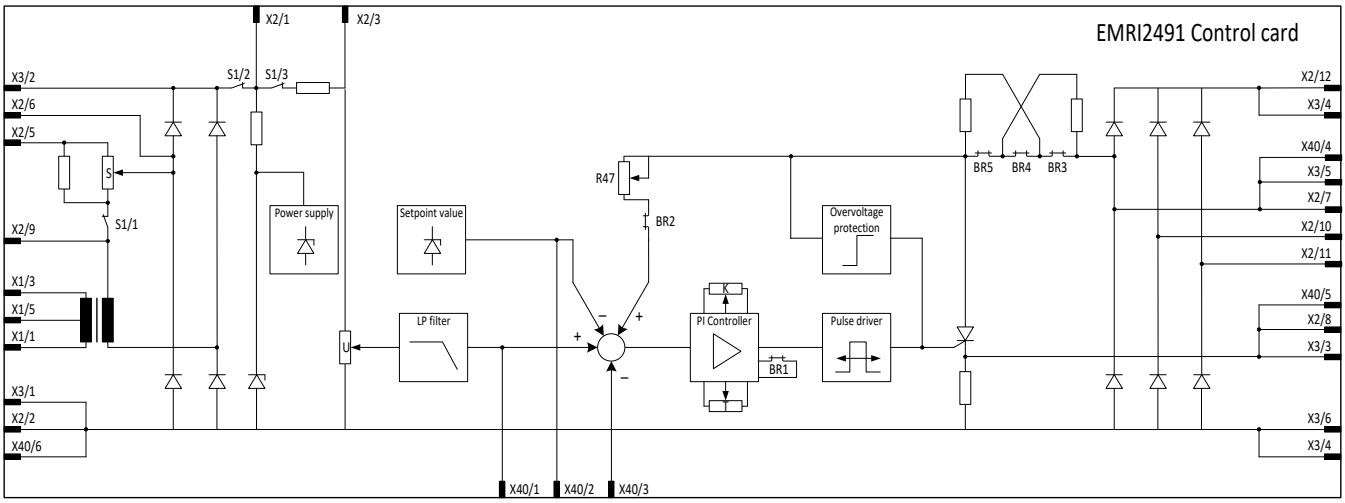
Terminals			
Header	**Terminal**	**Description**	**Notes**
X4	1	Compound transformer input AC3	These pins only if a 6 pin connector is used.
	2	Compound transformer input AC2	
	3	Compound transformer input AC1	
	4	Field excitation +	
	5	Field excitation -	
	6	Not connected	
	7	Not connected	
	8	Not connected	
	9	Not connected	
	10	Not connected	
	11	Not connected	
	12	Not connected	



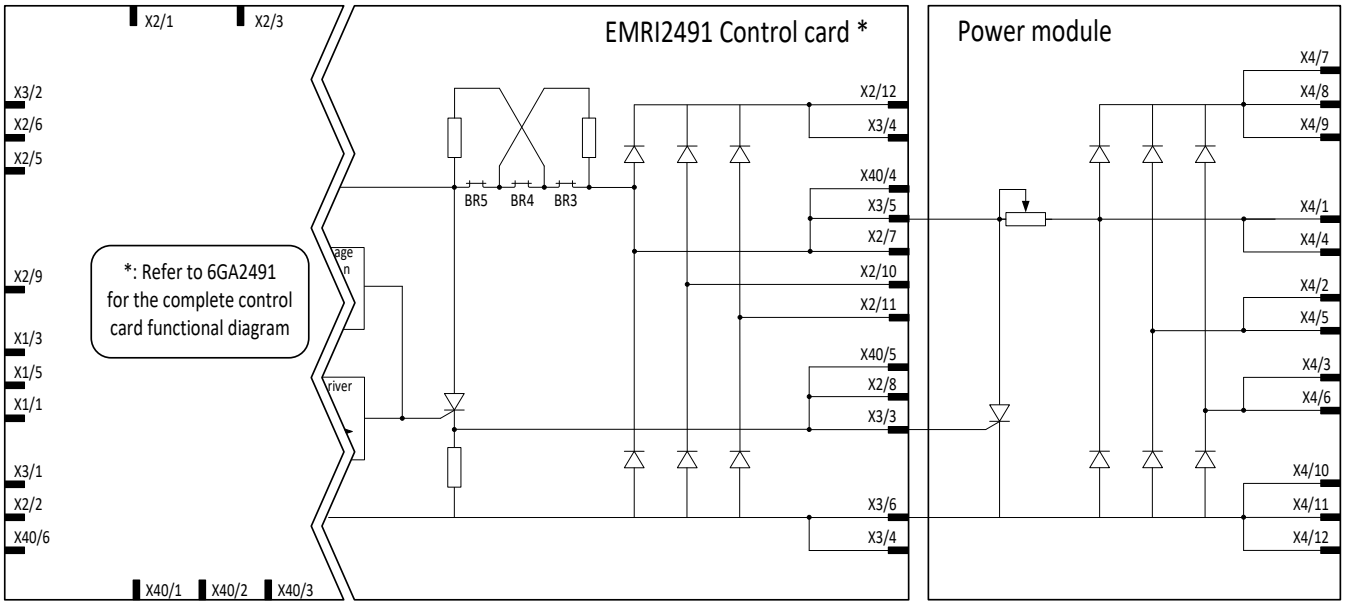


FUNCTION BLOCK DIAGRAM

6GA2491

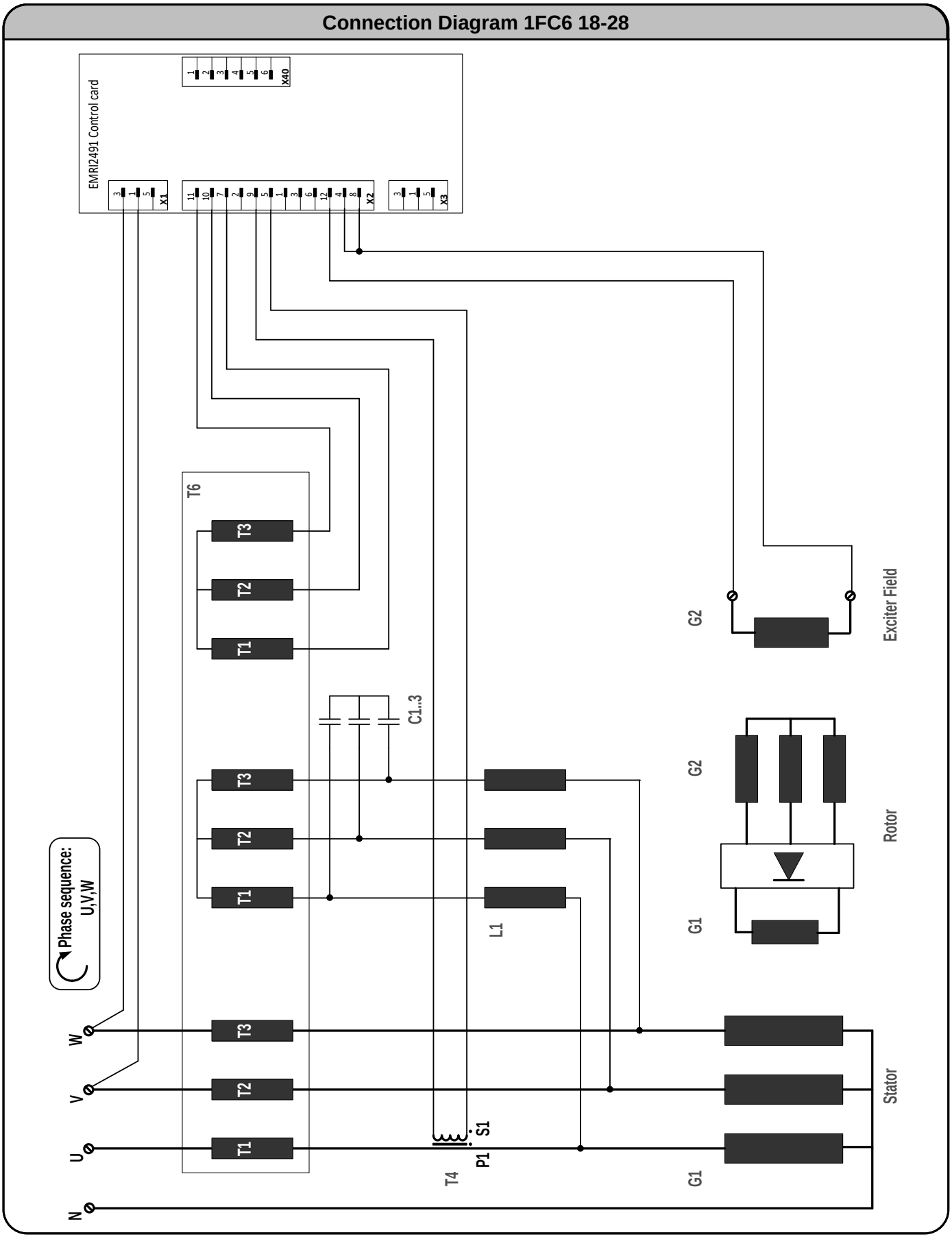


6GA2492



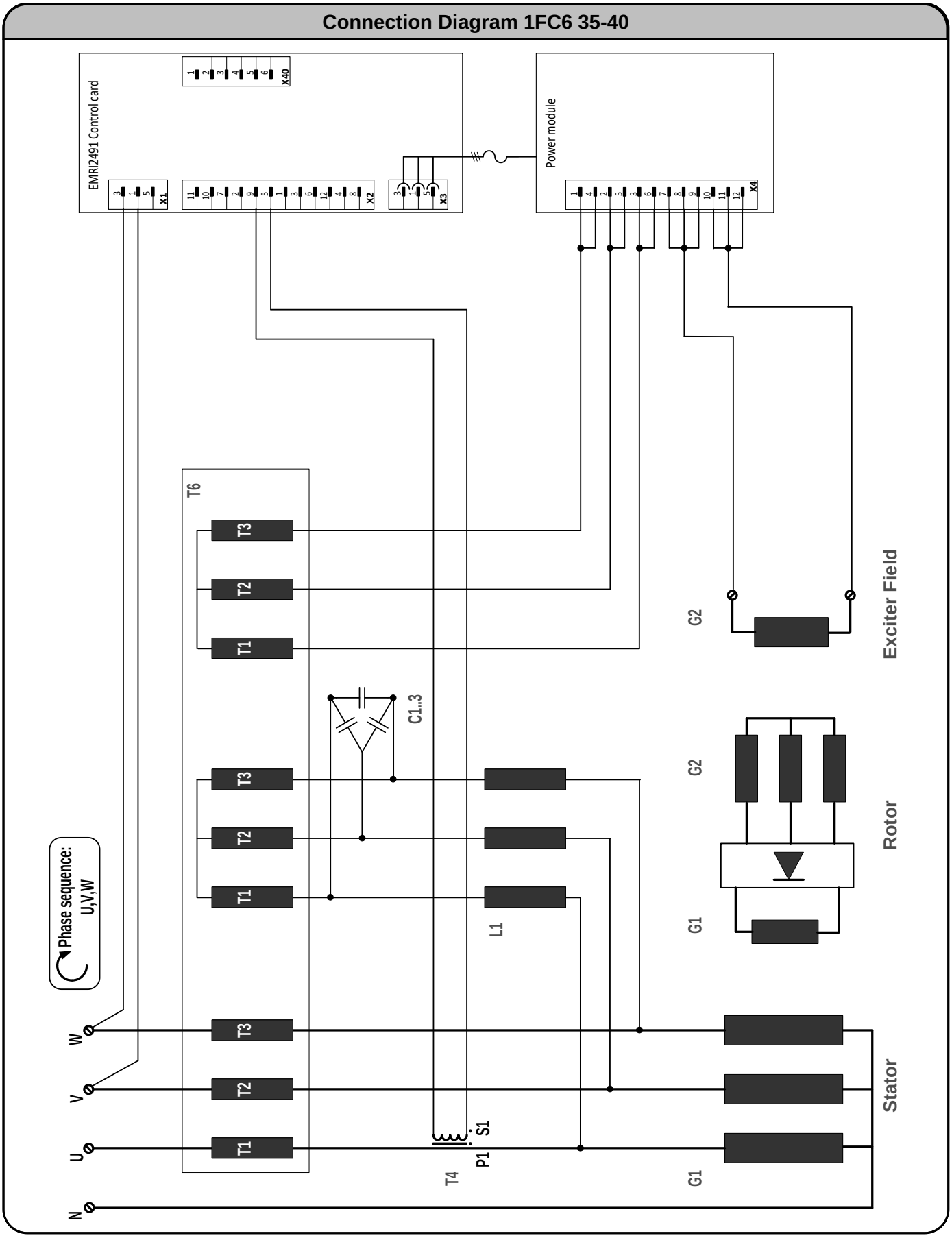
WIRING DIAGRAM I

Connection Diagram 1FC6 18-28



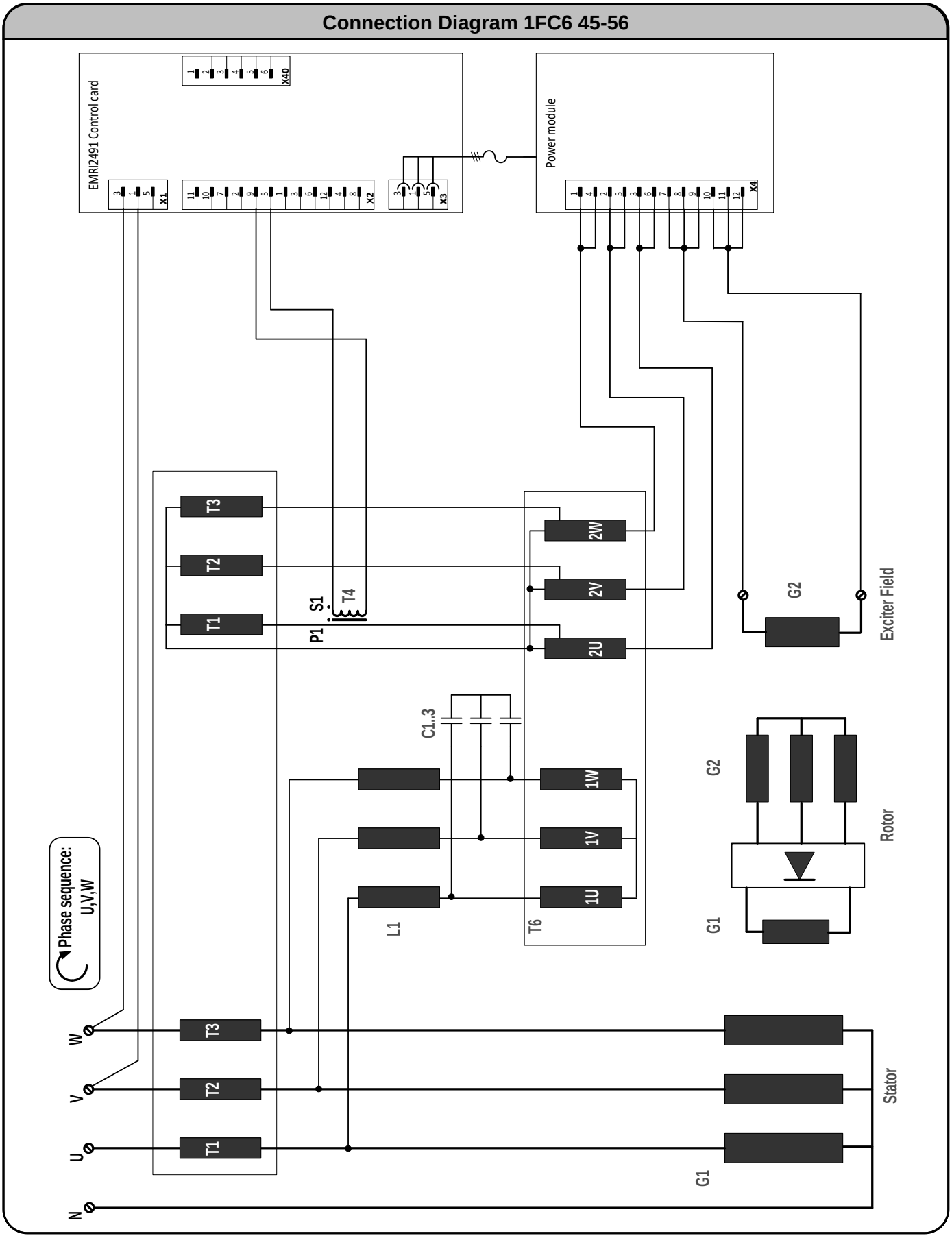
WIRING DIAGRAM II

Connection Diagram 1FC6 35-40



WIRING DIAGRAM III

Connection Diagram 1FC6 45-56



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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.
- maximum cooling (direction of cooling ribs and direction of airflow) is achieved.
- Mounting no humid air can flow through the product or condensation occurs.
- dust or other materials or residue will not remain in or on the product.
- the maximum vibration is not exceeded.
- 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 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 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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