



# PILLER400

*Voltage regulator for generators*

**Instruction Manual V2.2.1**  
Product version V2.3

# 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 of 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.

# Table of contents

## **1. General information**

<b>1.0</b>	<b>General description</b>	<b>4</b>
<b>1.1</b>	<b>AVR Layout</b>	<b>5</b>
<b>1.2</b>	<b>Absolute maximum ratings</b>	<b>6</b>
<b>1.3</b>	<b>Commissioning information</b>	<b>6</b>
<b>1.4</b>	<b>Troubleshooting information</b>	<b>6</b>

## **2. Installation**

<b>2.0</b>	<b>Adjustments overview</b>	<b>7</b>
<b>2.1</b>	<b>Terminals overview</b>	<b>8</b>
<b>2.2</b>	<b>Electrical characteristics</b>	<b>9</b>
<b>2.3</b>	<b>Droop / Parallel operation</b>	<b>10</b>

## **3 Settings and adjustments**

<b>3.1</b>	<b>Generator voltage</b>	<b>11</b>
<b>3.2</b>	<b>P &amp; I stability</b>	<b>11</b>
<b>3.3</b>	<b>Droop</b>	<b>11</b>
<b>3.4</b>	<b>Voltage selection</b>	
<b>3.5</b>	<b>Factory settings</b>	<b>12</b>

## **4 Wiring diagrams**

<b>4.1</b>	<b>Wiring diagram for NKT generator with droop CT</b>	<b>13</b>
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## **Appendix**

<b>A.1</b>	<b>General Installation information</b>	<b>14</b>
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## 2. GENERAL INFORMATION

### General description

This manual contains instructions for installing, operating and maintaining the PILLER400 automatic voltage regulator (AVR).

The PILLER400 is a replacement AVR for Anton Piller voltage regulators used in PILLER NKT generators. The PILLER400 dimensions, specifications and shunting operating principle are compatible to the original AVR's, designated by type numbers 49.2.777, - 036 et cetera

In addition to the standard functionality this AVR features quadrature voltage droop, which enables parallel operation with other generators fitted with identical droop system.

## 1.1 AVR Layout

The AVR is protected from environmental influences by a protective coating.

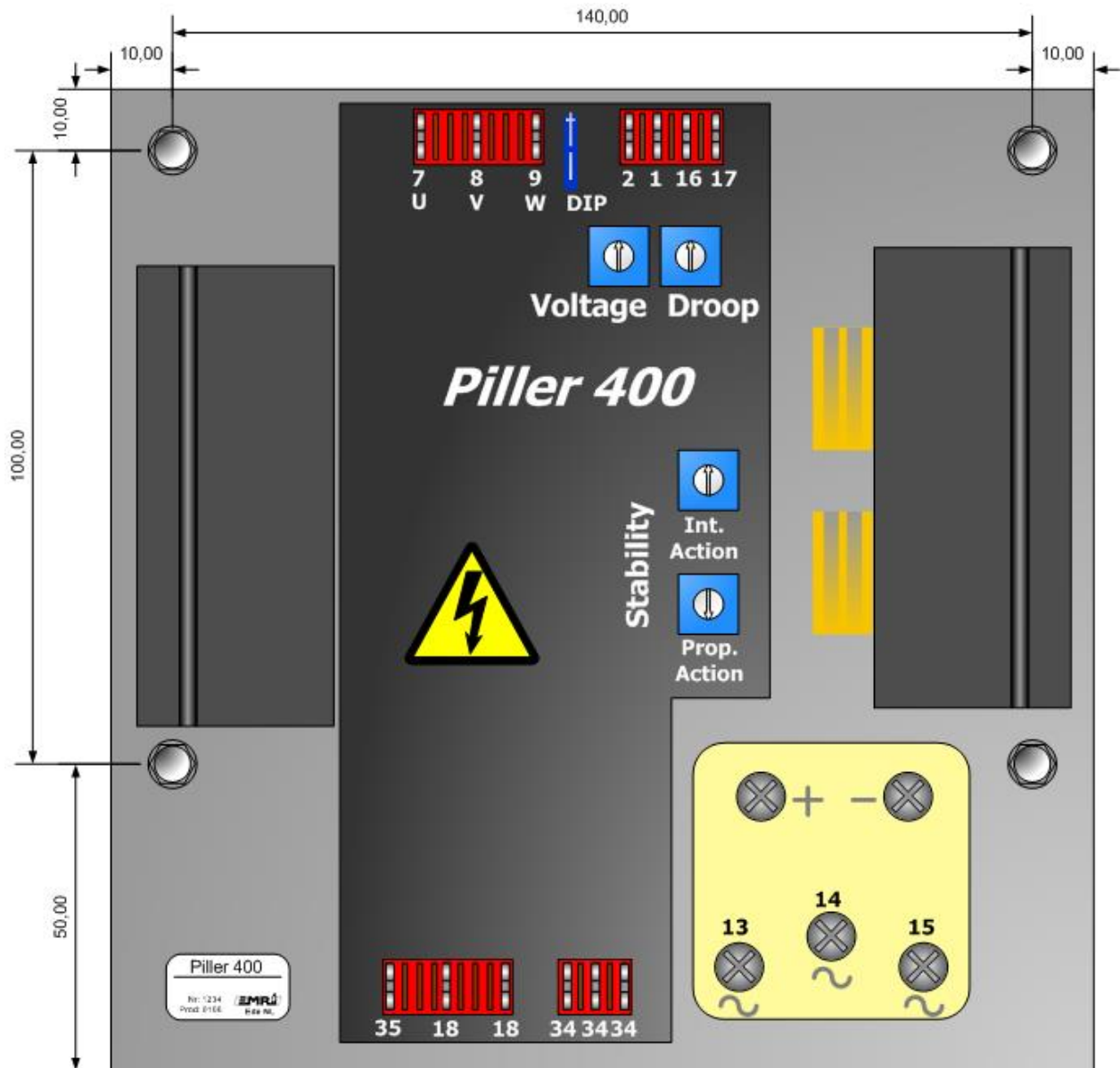


Fig 1. AVR layout

## 1.2 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
7, 8, 9, U, V, W	Voltage sensing input	< 30 s.	-	500	V <sub>AC</sub>
18, 34	AVR shunting power	30Vdc @ terminals + & -	-	50	W
T <sub>AMB</sub>	Operating temperature	95 % RHD non condensing	-20	+50	°C
T <sub>STG</sub>	Storage temperature	95 % RHD non condensing	-20	+85	°C
16, 17 S1, S2	Droop set current	Isolated CT – continuous Isolated CT - < 10 s	-	0.5 1.5	A <sub>AC</sub> A <sub>AC</sub>
EXT. POT.	External Volt adjust		-	1	kΩ

Table 1. Absolute maximum ratings

### 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.

### Troubleshooting information

If the generator voltage remains (too) high despite adjustment of the Voltage potentiometer, adjustment of the air gap of the excitation power supply may be necessary, or there may be a defect in this power supply system.

If this does not improve the situation, decreasing the resistance between the terminals 34 and 35 may help. This can be done either external or by exchanging the two 25W resistors on the AVR.

## 2. INSTALLATION

For a complete wiring diagram refer to chapter 4.

### 2.0 Adjustments overview

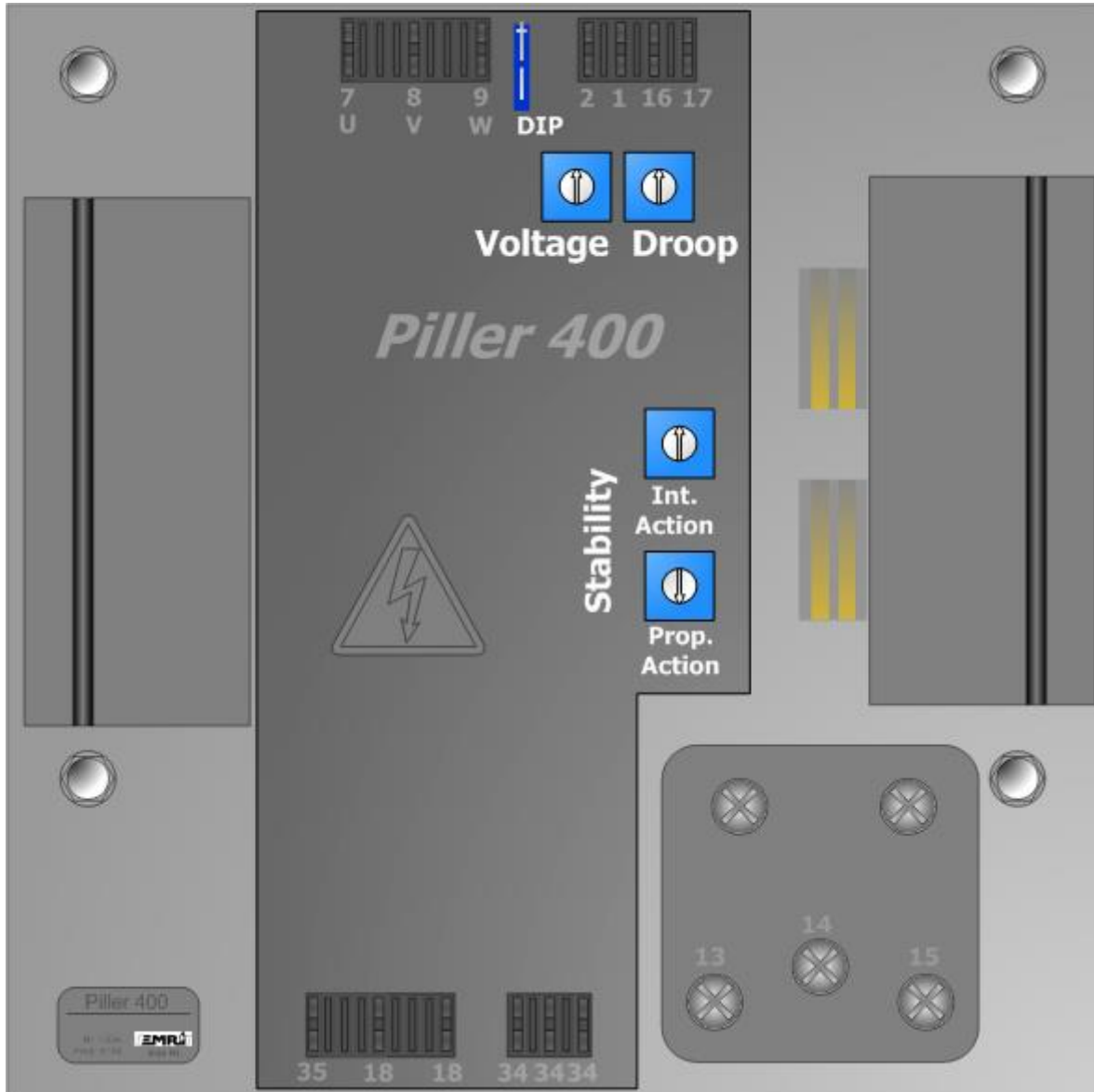


Fig 2. Adjustments overview

Symbol	Description	Notes
Voltage	Generator voltage setpoint	
Prop Action	Proportional gain setpoint	
Integral Action	Integral time setpoint	
Droop	Voltage droop setpoint	For parallel operation
DIP	230/400Vac selection	

Table 2. Adjustments

## 2.1 Terminals overview

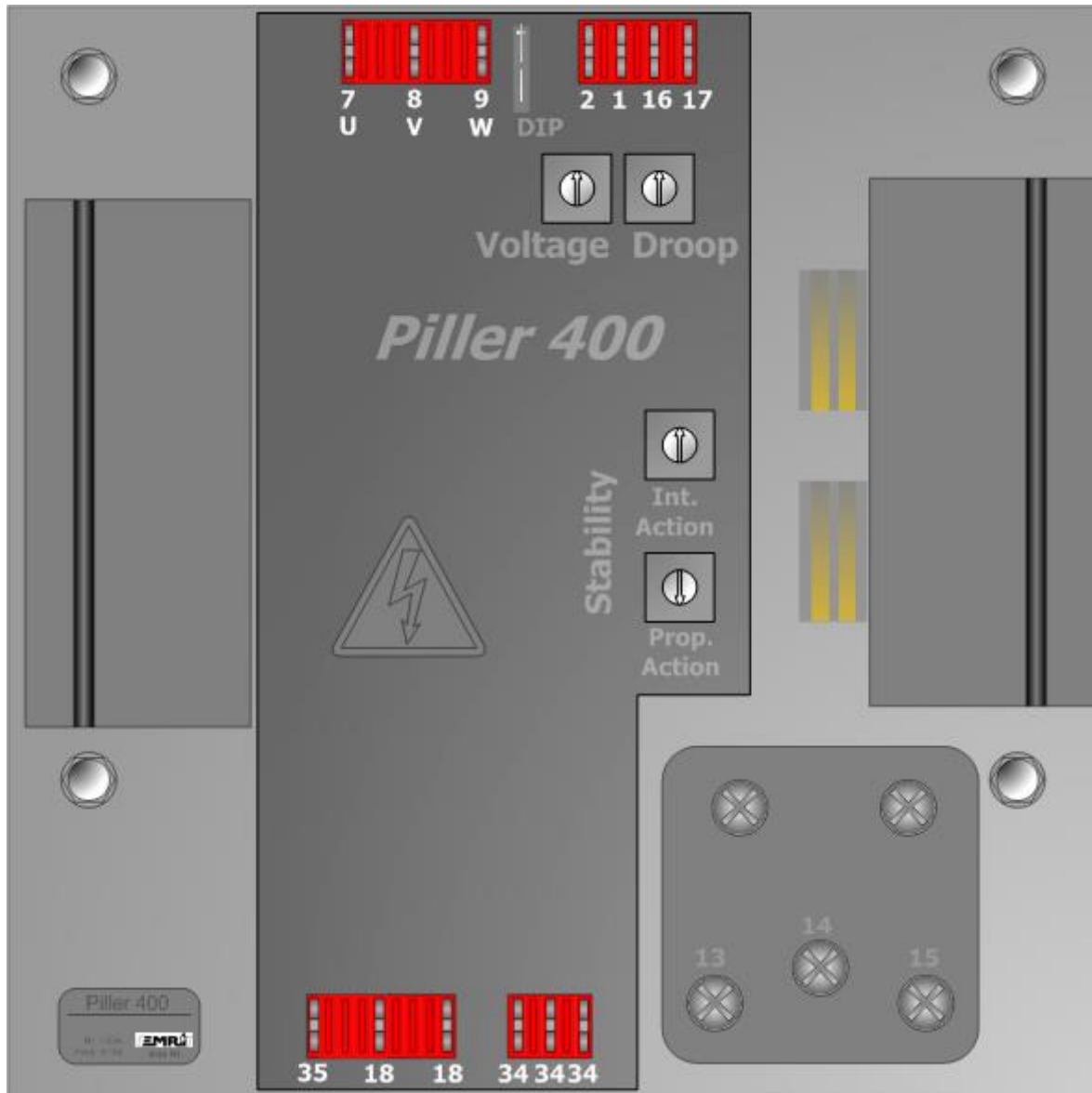


Fig 3. Terminals overview

Symbol	Description	Notes
7, 8, 9 U, V, W	Voltage sensing input	phase sequence U,V,W
2, 1	External voltage adjust input	1 k $\Omega$ potentiometer, or link
16, 17 S1, S2	CT input for voltage droop	0.5A at rated generator current
18, 34	Generator field excitation output	Connected to generator terminals F1 & F2
13, 14 – 15	Supply input	3~ voltage from generator transformers
35 – 34	<i>Shunt resistor connection</i>	<i>Connected internal on AVR</i>
18 – 34	<i>DC field current supply</i>	<i>Connected internal on AVR</i>

Table 3. Terminals

## 2.2 Electrical characteristics

Symbol	Parameter	Condition	Min.	Max.	Unit
7, 8, 9, U, V, W	Voltage sensing input	50 – 60Hz	330	500	V <sub>AC</sub>
18, 34	AVR shunting power	30Vdc @ terminals + & -	-	40	W
T <sub>AMB</sub>	Operating temperature	95 % RHD non condensing	0	+50	°C
T <sub>STG</sub>	Storage temperature	95 % RHD non condensing	-20	+85	°C
16, 17 S1, S2	Droop set current	Isolated CT – continuous	-	0.5	A <sub>AC</sub>
EXT. POT.	External Volt adjust		-	1	kΩ

Table 4. 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.

## 2.3 Droop / 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 1.

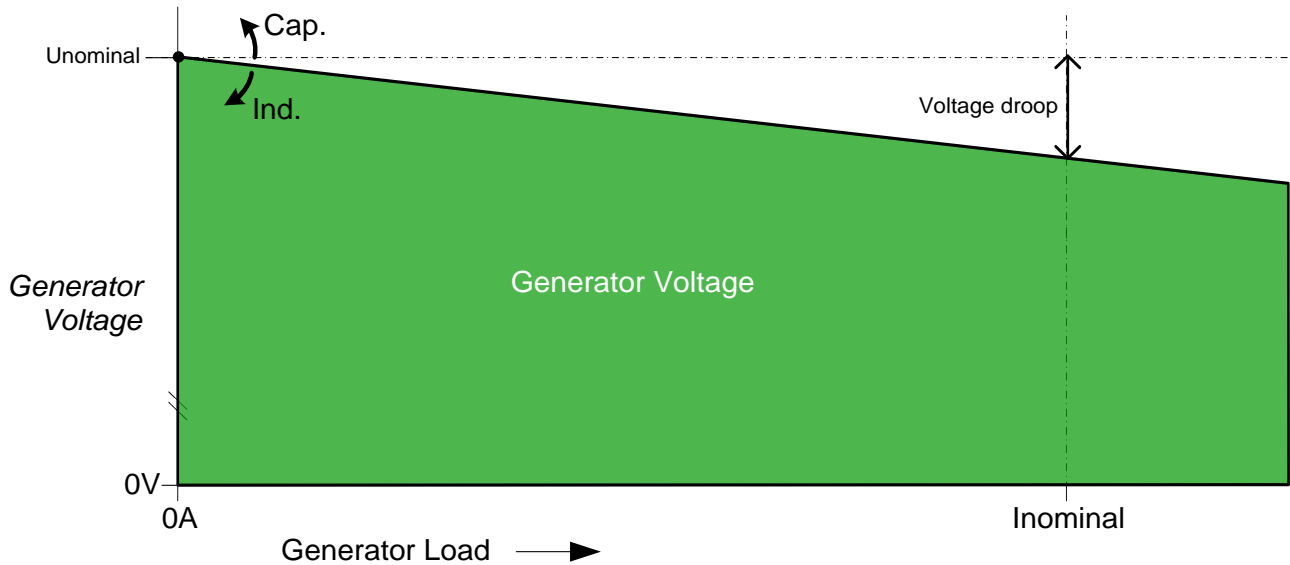


Diagram 1. Voltage droop

## 2. Settings and Adjustments

### 3.1 Generator Voltage

The generator voltage setpoint is user adjustable by means of the V potentiometer. The voltage potentiometer range depends on the generator frequency. Turning the potentiometer clockwise increases the generator voltage, turning counter clockwise decreases the generator voltage. The adjustment range is affected by the external potmeter setting or link between 1 and 2.



Fig 4. Voltage adjustment

### 3.2 P & I stability

The generator stability and control 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 specialist to prevent damage to the AVR and generator.



Fig 5. Stability adjustments

### 3.3 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.

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 2.3



Fig 6. Droop adjustment

### 3.4 Voltage selection

Normally the voltage selection switch is open, the AVR will regulate 400Vac when the generator frequency is 50Hz. By closing the dipswitch it is possible to set the voltage setpoint to 230Vac when the generator frequency is 50Hz.



Fig 7. DIP Voltage selection

### 3.5 Factory settings

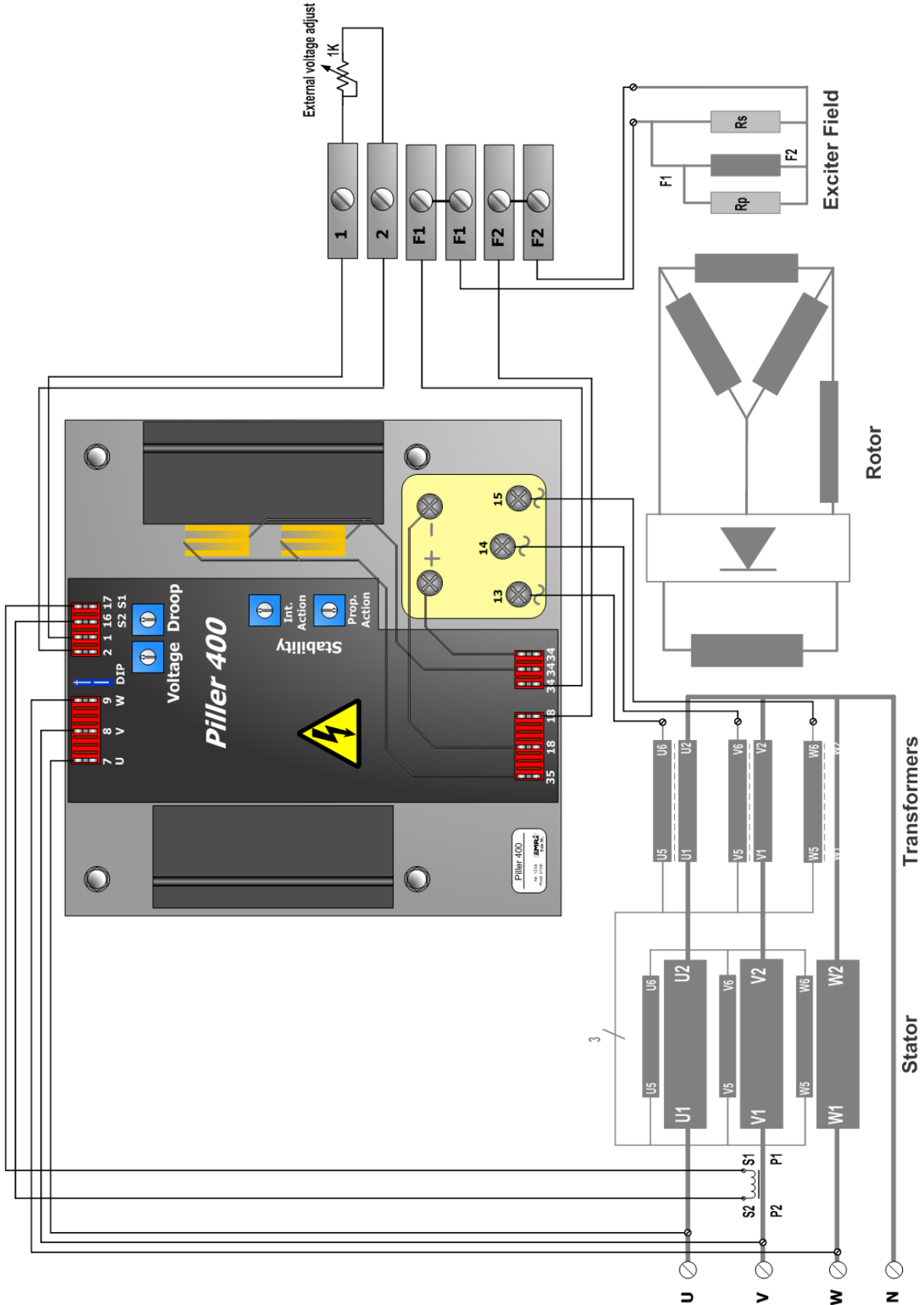
All new or AVR's returned from service are supplied with factory settings as described in table 5. Adjusting the factory settings must only be performed by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

Parameter	Value	Unit
Output Voltage	400	V <sub>ac</sub>
P & I stability	Middle position	
Droop	50	%
DIP	Open	

Table 5. Factory settings

# 4. Wiring Diagrams

## 4.1 Wiring diagram for NKT generator with droop CT (optional)



# 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.

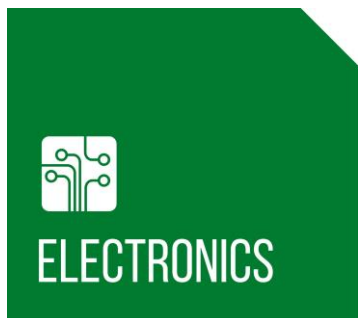
### Wiring

- 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 LH1-2, 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 F+ and F- or exciter field terminals inside the generator should be removed.
- When the product is supplied by means of a transformer, it should be able to carry at least the maximum expected current. Advisable is, to have a transformer which can carry twice the maximum expected current. Inductive loads make voltage sags and peaks into the secondary voltage of a transformer, from which the device may malfunction.
- It is not recommended to apply switches in dc outputs. It is preferred to use switches in the ac supply inputs of devices. In case it is unavoidable to have switches in the dc output of a device, action must be taken to avoid over voltage damage to the device due to contact arcing. Use a voltage suppressor across the output.
- It is not recommended to apply switches or fuses in the sensing lines. Defects can cause high voltage situations due to over-excitation.
- When using a step down transformer in medium or high voltage generators, the transformer should be 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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