



## METAL-CLAD RECTIFIER SEMICONDUCTOR SUBSTATIONS KVPP

■ INDUSTRY ■

# METAL-CLAD RECTIFIER SEMICONDUCTOR SUBSTATIONS KVPP

Metal-Clad Rectifier Semiconductor Substations KVPP produced by PLUTON are designed for power supply of 230 V DC consumers, DC power supply of industrial plants workshops networks, including electric drive.

Substation KVPP includes:

- V-TPED and V-TPPD rectifiers, equipped with RESIBLOC® transformers (or similar);
- cabinets with automatic equipment;
- busbar bridges.



## Main technical features of KVPP

Name of parameter	Value
Number of units	One-unit, two-units, three-units
Unit rated current, A	1000, 1250, 2000, 4000
Units design	right, left
Remote control of HV circuit breaker and outgoing lines circuit-breaker	via RS-485 interface, Ethernet, dry contacts
Parameters transfer to the upper level	I, U, P, insulation monitoring
Interference immunity	comply with all requirements of standards
Generator voltage frequency permissible variation, continuous	+2/-3



## V-TPED, V-TPPD SERIES RECTIFIERS

Rectifiers of V-TPED, V-TPPD series are designed and manufactured with application of modern technologies and solutions. This applies the cabinet design solutions, rectifier power part, software, rectifier protection, diagnostics and control systems, diagnostics of converter transformer, electrical installation, maintenance and repair technologies.

Commonly, rectifiers are equipped with modern dry transformers with RESIBLOC® windings (or similar).

The rectifiers are based on 2500 A class 25 power tab diodes manufactured by VISHAY (or ABB).

The following types of rectifiers are developed:

Type	Rectification circuit
V-TPED-2.0k-230N V-TPED-4.0k-230N V-TPPD-4.0k-230N	zero circuit with smoothing reactor
V-TPED-2.0k-230M V-TPED-2.0k-230-12P V-TPED-4.0k-230-12P	bridge 12-pulse 12-pulse

Main parameters:

- / "diode-diode" rectifier power part (with Np+1 protection class according to EN 50328 standard);
- / output voltage: 230 V  
rectified current: 2000, 4000 A;
- / connection of AC power supply in the upper or the lower rectifier side;
- / rectifier cooling type – natural air (AN), forced (AF).



▲ Rectifier

## BENEFITS

### Maintainability:

- / the lowest maintenance;
- / easy access to the circuit components for simplification of technical maintenance;
- / application of maintenance-free contact joints technology in the power part of rectifiers;
- / controlled diodes pressure load due to application of calibrated crimping components for "diode-cooler" assembly.

### Cost saving:

- / long lifetime and a high level of technical and performance characteristics due to application of modern high-quality, reliable and safe components;
- / space-saving overall dimensions.

## BENEFITS

### Compliance with international standards

PLUTON regularly proves compliance of its rectifiers with the requirements of IEC 60146-1-1:2009-06, EN 50328:2003 international standards by type-testing for compliance with the specified standards in test center IPH Institut (Berlin, the Federal Republic of Germany).



### Reliability and safety:

- / innovative circuit and technical solutions;
- / microprocessor protection, diagnostics and control system;
- / continuous monitoring of power semiconductor devices parameters;
- / temperature monitoring and reverse voltage distribution on each diodes pair;
- / high overload capacity;
- / effective multilevel protection system against internal switching and external overvoltages;
- / rectifiers are manufactured for various failure modes (T, F, R modes) of semiconductor devices according to EN 50328.

## TRANSFORMERS

The following transformers are applied in KVPP:

- RESIBLOC® (600, 800, 1250, 1600) kVA,
- TSZPU-(1000, 2000) /10 GT.

Transformer with RESIBLOC® windings has the following advantages:

- fire safety;
- environmental compatibility;
- "cold" start with maximum load;
- high resistance to dynamic loads under overloads and short circuits;
- overvoltage resistibility;
- minimum maintenance;
- reliable operation under conditions of high pollution, high humidity, low temperatures.

Transformers have original design of HV and LV winding made of wire and foil. Windings are shrouded with epoxy-impregnated fiberglass string. High content of fiberglass (approximately 80 %) in combination with lateral and longitudinal reinforcement makes winding with a very high lateral and longitudinal strength. Transformer windings mechanical strength is 650-750 N/mm<sup>2</sup>.

Transformers operate under condition of 100 % humidity, water vapor condensation, and chemical pollution. Transformers can be equipped with low noise radial fans. Forced cooling system allows to increase transformers rated capacity up to 40 %.



## TECHNICAL PARAMETERS

### Main technical features of rectifiers with zero rectification circuit

Name of parameter	Unit	V-TPED- 2.0k-230N	V-TPED- 4.0k-230N	V-TPPD- 4.0k-230N
Rated output active power	kW	460	920	
Rated output voltage	V	230		
Rated output current	A	2000	4000	
Rated input voltage	kV	6;	6.3;	10; 10.5
Rated input frequency	Hz	50 (60)		
Number of rectifier input voltage phases	-	6		
Type of rectifier cooling	-	natural (AN), forced (AF)*		
Voltage of auxiliary circuit	V	~220		
Capacity coefficient (design), no less than	r.u.	0.95		
Efficiency coefficient (design), no less	%	98		
Rated power of converter transformer	kVA	800	1600	
Type of converter transformer	-	RESIBLOC® 800 (or similar)	RESIBLOC® 1600 (or similar)	
		TSZPU-1000/10	TSZPU-2000/10	TSZP-1600/10
Ratio of permissible overcurrent and time of permissible overloads according to IEC 60146-1-1:1991		1.25 - 7200 s, twice in 24 hours** 1.5 - 300 s, 1 time per 30 minutes.*** 2.0 - 60 s, 1 time per 30 minutes.***		
Rectifier overall dimensions, no more than				
width	mm	600	1000	1200
depth		600	600	600
height		2200	2200	2200
Weight of rectifier, no more than	kg	200	450	

\* Rectifiers can be manufactured with air natural (AN) and air forced (AF) cooling (according to EN 50328). Air forced cooling is actually combined natural air and forced air cooling. The rectifier operates with natural cooling under loads lower or close to the rated ones. In case of risk of diodes overheating under overloads, fans are switched on and force-cool the diodes. Fans switch off automatically after overload disappearance and diodes temperature drop.

\*\*RMS current value per any 8 hours during the day should not exceed rated current.

\*\*\* RMS current value per any 30 minutes should not exceed rated current, and if during these 30 minutes 100 % overload takes place, the averaging time should be 5 minutes.

## Main technical features of rectifiers with bridge and twelve-pulse rectification circuit

Name of parameter	Unit	V-TPED- 2.0k-230M	V-TPED- 2.0k-230-12P	V-TPPD- 4.0k-230-12P
Rated output active power	kW	460		920
Rated output voltage	V	230		
Rated output current	A	2000		4000
Rated input voltage	kV	6;	6.3; 10;	10.5
Rated input frequency	Hz	50 (60)		
Number of rectifier input voltage phases	-	3		
Type of rectifier cooling	-	natural (AN), forced (AF)*		
Voltage of auxiliary circuit	V	~220		
Capacity coefficient (design), no less than	r.u.	0.95		
Efficiency coefficient (design), no less	%	98		
Rated power of converter transformer	kVA	600	1250	1250
Type of converter transformer	-	RESIBLOC® 600 (or similar)	RESIBLOC® 1250 (or similar)	RESIBLOC® 1250 (or similar)
Ratio of permissible overcurrent and time of permissible overloads according to IEC 60146-1-1:1991		1.25 - 7200 s, twice in 24 hours** 1.5 - 300 s, 1 time per 30 minutes.*** 2.0 - 60 s, 1 time per 30 minutes.***		
Converter section overall dimensions, no more than				
width		1000		2000
depth	mm	600		600
height		2200		2200
Weight of rectifier, no more than	kg	450		900

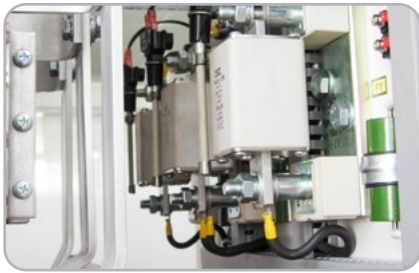
\*Rectifiers can be manufactured with air natural (AN) and air forced (AF) cooling (according to EN 50328). Air forced cooling is actually combined natural air and forced air cooling. The rectifier operates with natural cooling under loads lower or close to the rated ones. In case of risk of diodes overheating under overloads, fans are switched on and force-cool the diodes. Fans switch off automatically after overload disappearance and diodes temperature drop.

\*\*RMS current value per any 8 hours during the day should not exceed rated current.

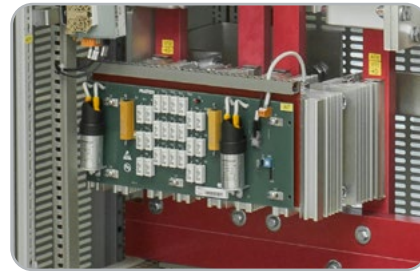
\*\*\* RMS current value per any 30 minutes should not exceed rated current, and if during these 30 minutes 100 % overload takes place, the averaging time should be 5 minutes.

# COMPONENTS

## Internal and external overvoltage protection



Diodes are protected against internal switching surges with RC-circuits and against external switching surges combined with RC- circuits and varistors.



Galvanic isolation boards provide protection against overvoltage with RC- circuits, supply information for diagnostics system controller analysis.



## Control and Diagnostics System



Rectifiers are equipped with microprocessor control and diagnostics system based on **SOTA® controller**, with information displaying on the **visualization panel**.



The system provides each diode parameters monitoring in dynamic mode during operation of the rectifier. It also provides events logging, visualization of temperature distribution, voltage and other diodes parameters, protection against rectifier and transformer overheating, protection against diodes breakdown, communication with SCADA system etc.

## Power diodes



Tab power diodes manufactured by VISHAY, ABB are applied.

# CONTROL AND DIAGNOSTICS SYSTEM

Rectifiers are equipped with microprocessor control and diagnostics system. This system issues the following criteria information about state of each diode on visualization panel: "normal operation", "parameters derating", "breakdown", as well as diodes temperature. Control system is based on SOTA® controller, that meets IEC 61131 series of standards for PLC, and provides support of IEC 61850 protocol.

Due to application of Weintek visualization panel, the required information is displayed in convenient intuitive form and control is provided by tapping the touch screen.

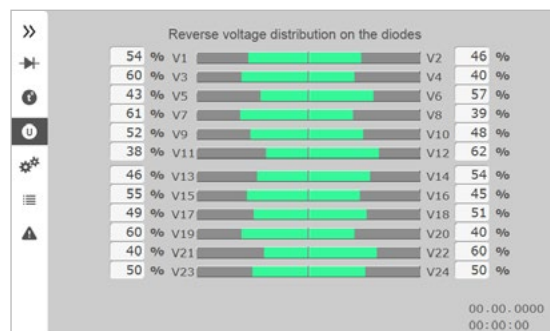
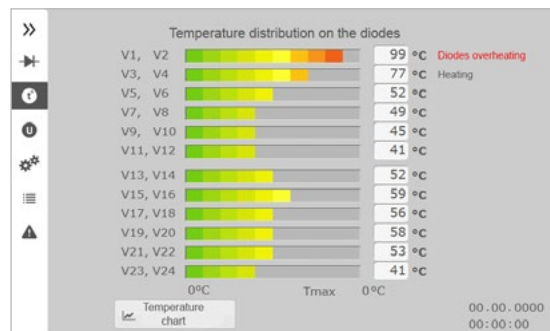
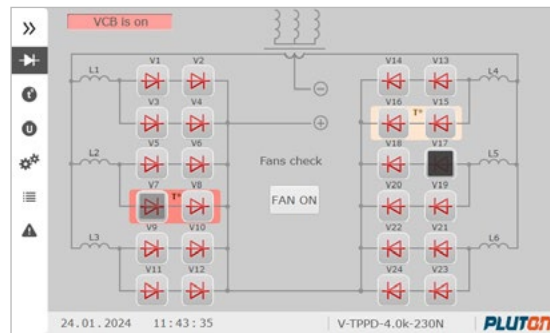
Each diode parameters are monitored dynamically, during rectifier operation.

Diagnostics according to the mentioned criteria allows to significantly increase the period of rectifier troublefree operation.

In case of diode parameters changing to critical for this circuit level, the power diode should be replaced before its breakdown. In case of one diode breakdown, rectifier continues its operation without power loss till replacement of the broken diode.

Information about state of the rectifier and its components can be displayed on visualization panel, mobile devices (smartphone, tablet) or on the computer display via Web interface or special software.

The rectifier is connected with medium voltage switchgear protection devices and upper lever of SCADA system.



The following data is displayed on visualization panel:

- rectifier single-line diagram;
- events log;
- diodes temperature;
- diodes temperature diagram;
- voltage distribution between two diodes in series;
- signals:
  - transformer overheating;
  - doors condition;
  - rectifier overheating;
  - diode parameters derating.



## CABINETS WITH AUTOMATIC EQUIPMENT



Cabinets with automatic equipment are designed for power supply and protection of 230 V DC circuits at iron and steel works crane substations.

Types of cabinets:

- SHLA – linear switching cabinet;
- SHVA – incoming switching cabinet;
- SHSA – sectionalizing switch cabinet;
- SHSR - sectionalizing disconnector cabinet.

Cabinets with automatic equipment include automatic circuit breakers of the leading European manufacturers (ABB, Schneider Electric) having the following advantages:

- withdrawable or fixed design;
- high switching capacity, up to 65 kA;
- electronic or thermomagnetic tripping device.

### Main features of cabinets with automatic equipment

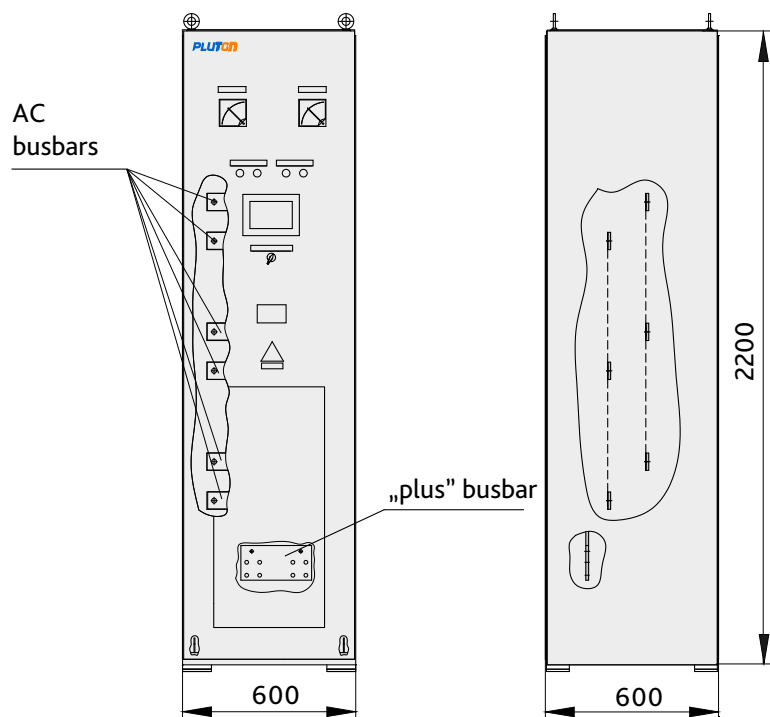
Name of parameter	Unit	Value
Cabinet designation	-	L-linear, S-sectionalizing, V-incoming
Rated current of circuit-breaker, $I_n$	A	800, 1000, 1200 (1250), 1600, 2000, 2500, 3200, 4000
Max. tripping device current setting	A	(1,5; 2,5; 4; 8)* $I_n$ *
Design	-	left, right
Outgoing line connection	-	busbar, cable
Maintenance	-	single-sided, double-sided

\* to be specified upon ordering

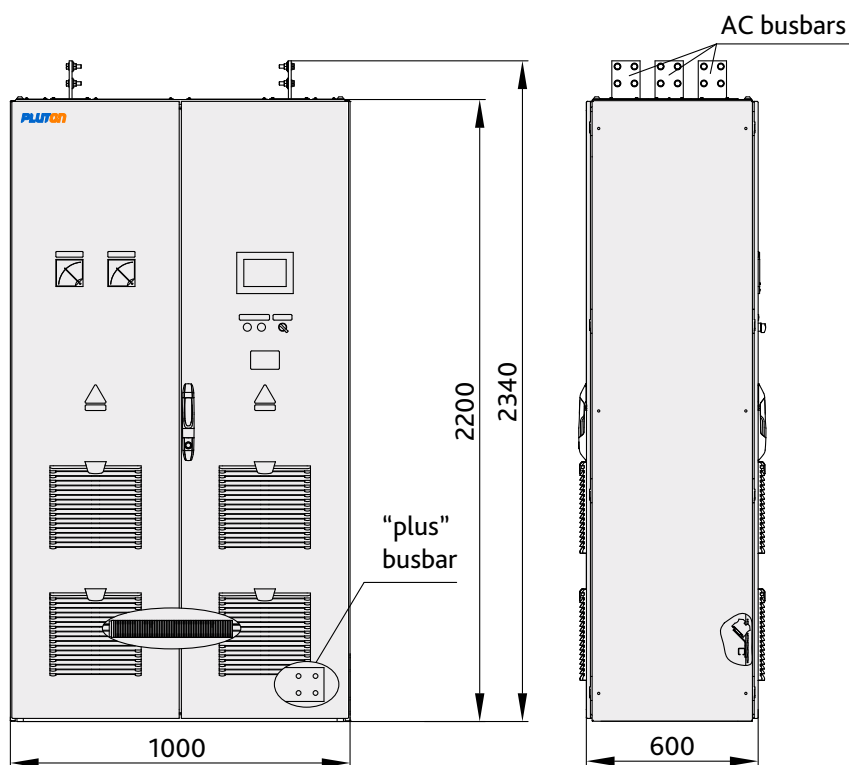
EDT type disconnectors manufactured by Elpro (Germany) are used for switching of electric power circuit in sectionalizing disconnector cabinets. Disconnectors have a unique crimp-type contact system design with double gap and wiping contacts, geared by a small-sized electric drive.

EDT disconnectors are classified as maintenance-free components, with the mechanical strength — 20.000 cycles (more than 20 years lifetime). Disconnectors are equipped with a noiseless efficient electric drive, capacity of 18 W. Application of electric drives controlled with automation system reduces risk of disconnectors and support insulation damage in case of false staff operation with undue exertion.

# OVERALL DIMENSIONS OF RECTIFIERS

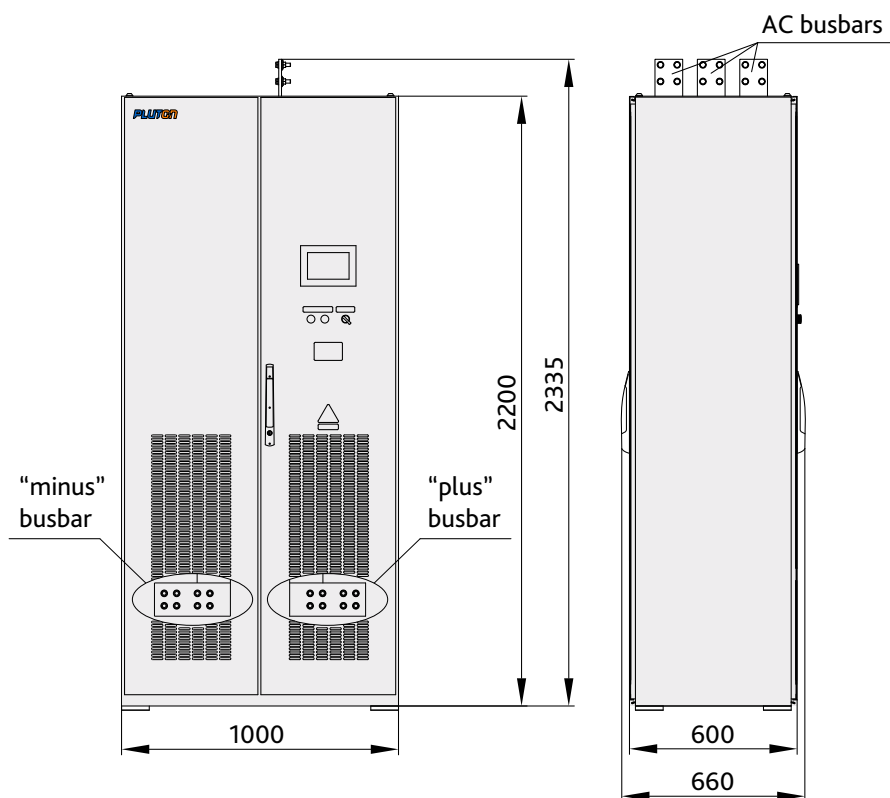


Rectifier V-TPED-2.0k-230N

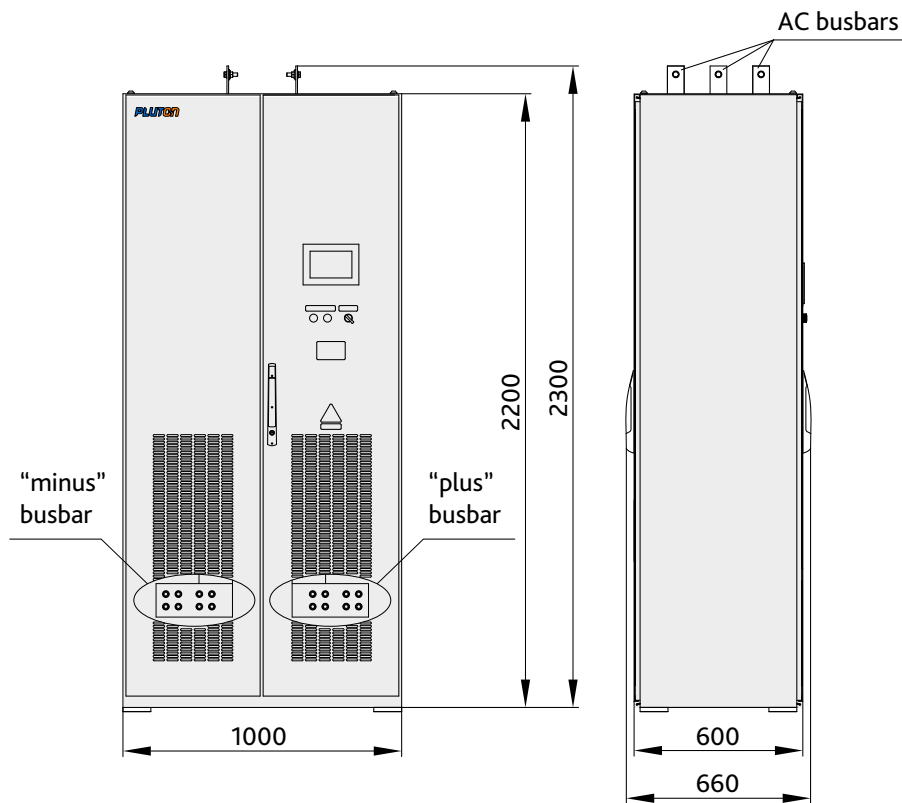


Rectifier V-TPED-4.0k-230N

# OVERALL DIMENSIONS OF RECTIFIERS

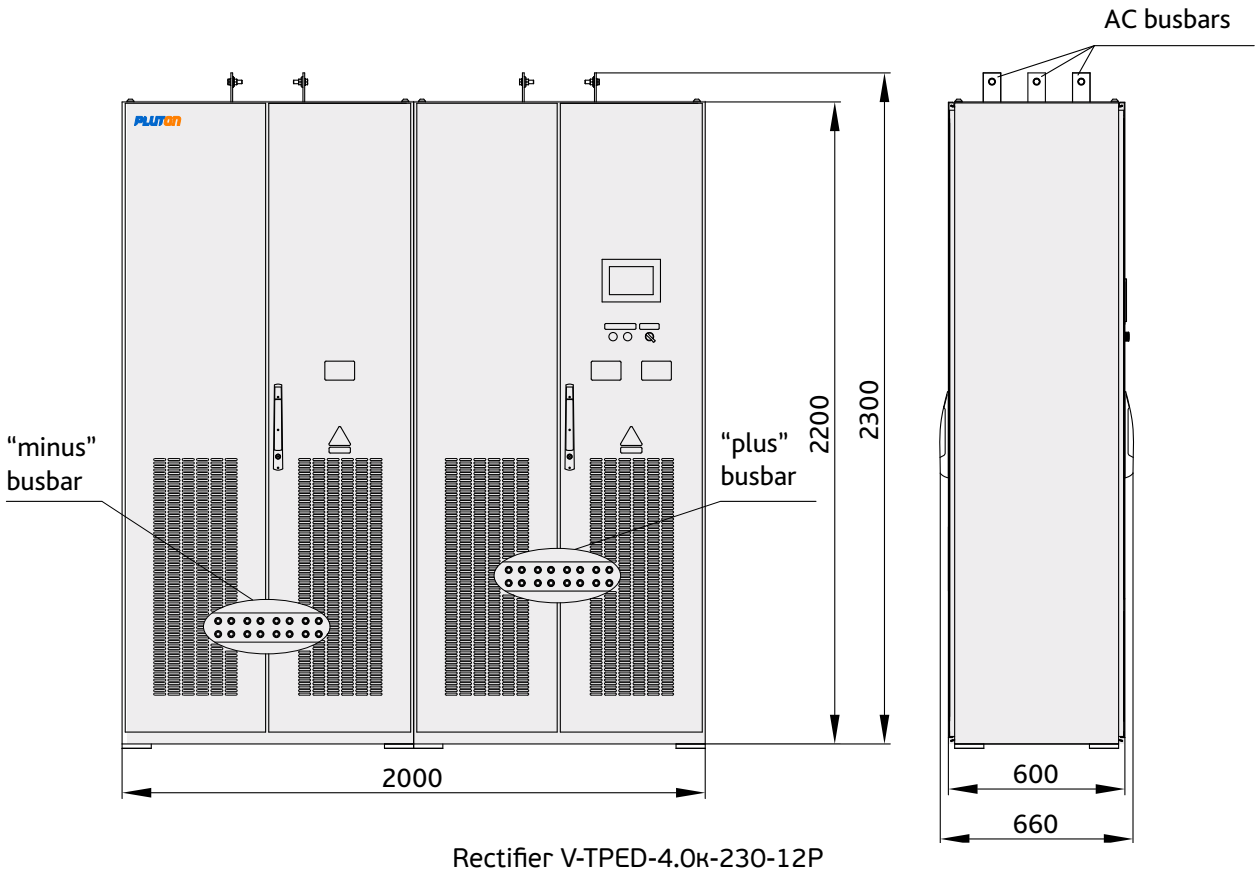


Rectifier V-TPED-2.0K-230M



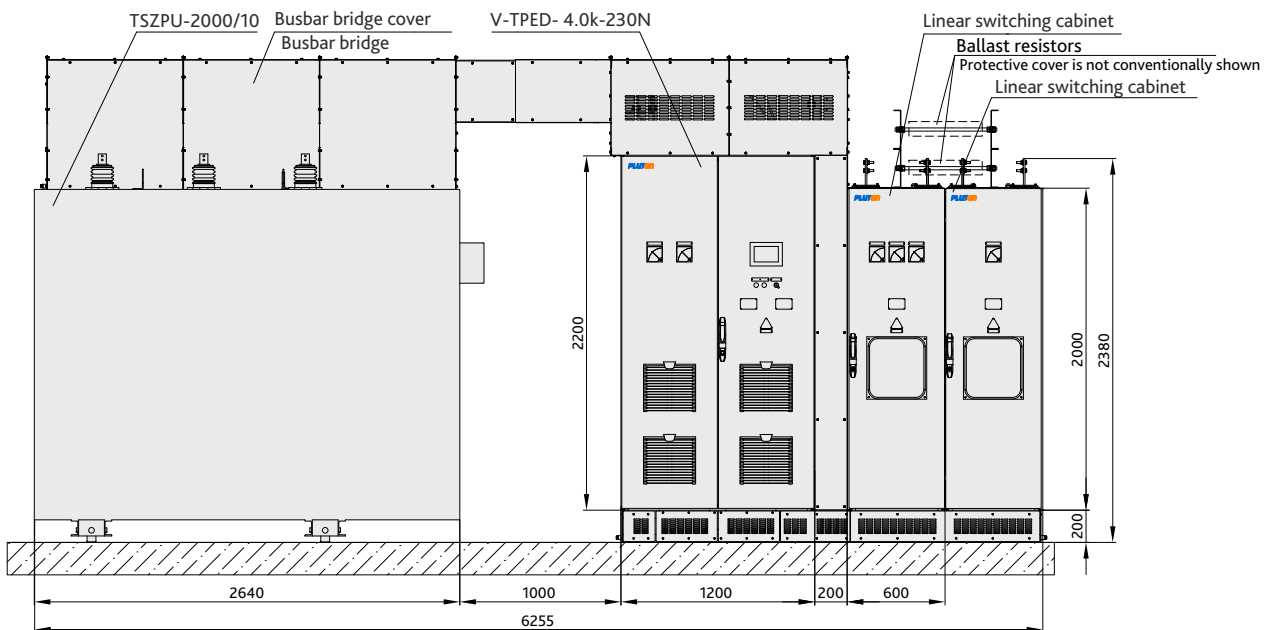
Rectifier V-TPED-2.0K-230-12P

# OVERALL DIMENSIONS OF RECTIFIERS



Rectifier V-TPED-4.0k-230-12P

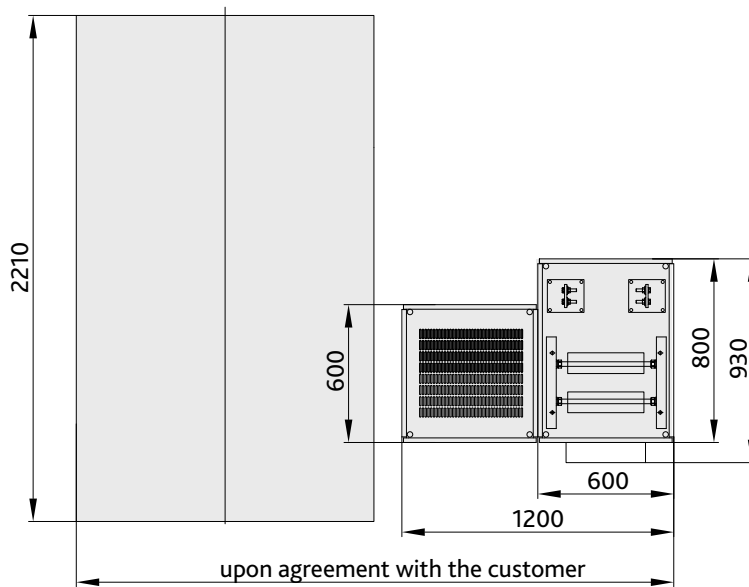
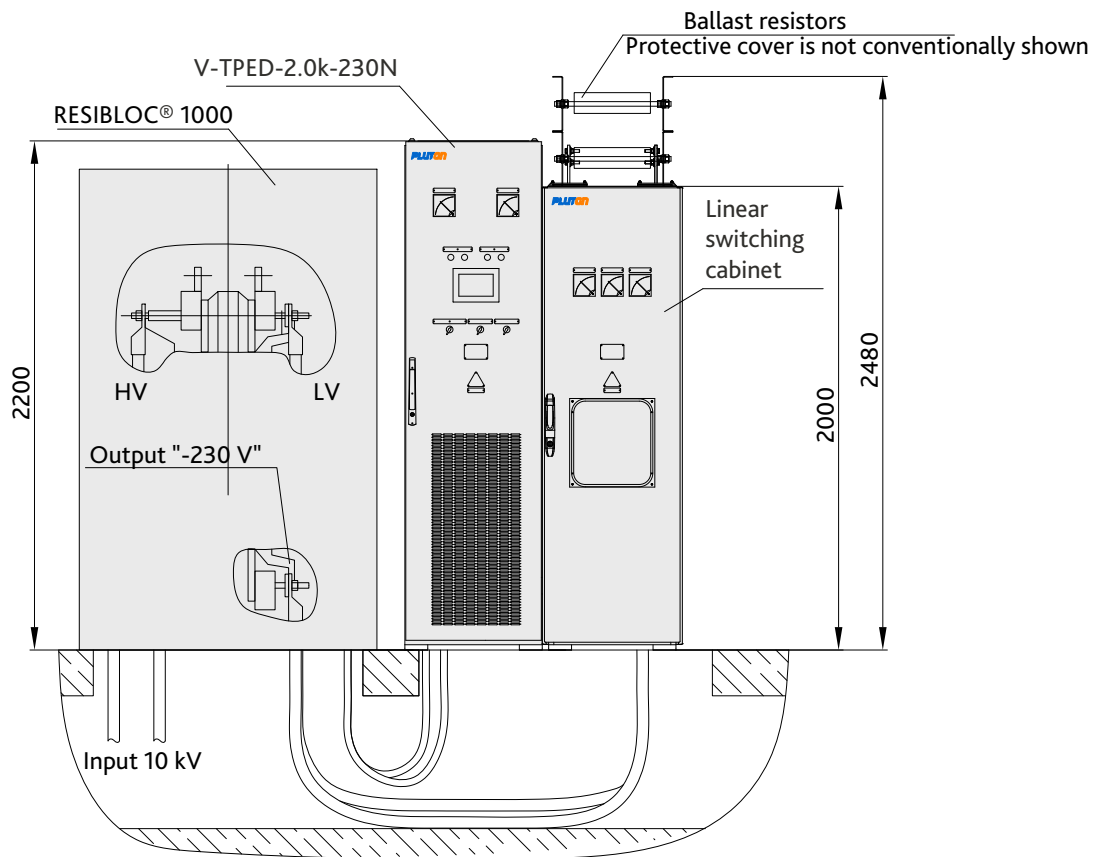
# EXAMPLE OF KVPP DESIGN ARRANGEMENT



Example of KVPP-4.0k-230 single-unit substation design arrangement with RESIBLOC® 1000 transformer, V-TPED-4.0k-230N rectifier, with two linear switching cabinets. Connection - by busbars. Linear switching cabinet with double-sided maintenance.



# EXAMPLE OF KVPP DESIGN ARRANGEMENT



Example of KVPP-2.0k-230 single-unit substation design arrangement with RESIBLOC® 1000 transformer, V-TPED-2.0k-230N rectifier, with one linear switching cabinet. Cable connection. Linear switching cabinet with double-sided maintenance.

## TYPE DESIGNATION

### **KVPP - XXXX - 230**

K	metal-clad;
V	rectifier;
P	semiconductor;
P	substation;
XXXX	rated output current: 1000, 1250, 2000, 4000 A;
230	rated output voltage, V

Example: *KVPP - 4000 - 230*

### **SHXX - 230 - IC\* - X\*\***

SH	cabinet;
X	designated purpose: L - linear, V - input, S - sectionalizing;
X	designation by power breaker type: A - automatic circuit breaker, R - disconnecter;
230	rated voltage, V;
IC	with insulation control unit (for SHVA, SHLA);
X	number of linear circuit breakers in cabinet: 1, 2.

\* indicated only in case of insulation control unit;

\*\*optional (may be indicated in case there are SHLA cabinets with different number of circuit breakers as part of KVPP)

Example: *SHLA - 230 - CI - 1*

### **V - TPXD - XXX - 230X**

V	rectifier;
T	feeding line current type: three-phase;
P	output current type: direct;
X	cooling: E — air natural (AN), P — forced (AF);
D	type of applied main semiconductor units of power circuit: diodes;
XXX	value of rated output current: 2.0k — 2.0 kA, 4.0k — 4.0 kA;
230	value of rated output voltage, V;
X	rectification circuit: N - zero, M - bridge, -12P - 12-pulse.

Example: *V - TPED - 4.0k - 230N*

## EXAMPLES OF IMPLEMENTED PROJECTS



Republic of Uzbekistan, Joint stock company Uzmetkombinat  
one-unit KVPP-4.0k-230



Ukraine, Zaporizhstal steel works  
two-unit KVPP-4.0k-230



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