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UNIFIED MODULAR POWER SUPPLIES

«JETA» series power supplies

Reference specification

Review: 0

2015

Content

1 GENERAL INFORMATION

1.1 Application area

1.1.1 These reference technical materials (RTM) are applied to unified modular secondary power supplies of JETA series (also referred to as units or modules in following text) with input voltages 115, 230 VAC, frequency of 47 to 440 Hz, as well as to 3-phase voltage 400 VAC with 47 to 440 Hz frequency.

1.2 Classification, basic parameters and dimensions

1.2.1 Types of produced modules, their basic characteristics, dimensions and service functions are given in Table 1.

1.2.2 Classification and reference designations are given in Picture 1.

1.2.3 The units have one, two or three output channels. The first one (main channel) – is a channel put on the left in voltage group, whose nominal power must be not less than 50% of nominal power of the unit itself.

1.2.4 Multi-channel units have galvanically isolated output channels.

1.2.5 Nominal values of the modules' output voltage (U_{nom}) as per normal climatic conditions are chosen from the range 5, 9, 12, 15, 24, 27, 48 V. Exceptionally, by agreement with manufacturer, units with U_{nom} within a range of 3…60 V may be produced (must be agreed upon order placement).

1.2.6 The power supply units are non-repairable.

1.2.7 The power supply units are manufactured in all-climatic version.

1.2.8 The power supply units are produced in metal heat-conducting cases with compound potting.

1.2.9 The power supply units with output power of 700 W and higher are supplied with external feedback outputs for load wires' voltage drop compensation and outputs for parallel connection with even load distribution of several units.

1.2.10 The low-budget units (with «B» index) are manufactured with a limited set of functions by agreement with a customer.

1.2.11 Holes in the heat-conducting surface of the unit's housing are acceptable, if they are covered by PCB mounting spacers or pop-rivets, holding the cover of the case, and not protruding beyond the heat-conductive plain surface.

1.2.12 The units may be used without a heat sink only on condition if they are attached, with a thermal conductive paste, by a heat-conducting base plate, whose length and width match the unit's case dimensions, and thickness not less than 1,5 mm for JETA60; 2 mm for JETA120; 2,5 mm for JETA300; 3 mm for JETA700; 3,5 mm for JETA1200; 4 mm for JETA2000; 6 mm – for JETA3000.

1.2.13 Advertising label can be placed on the surface of the unit. Technical parameters, mentioned on this label, are the maximum allowable, upon condition of agreement with manufacturer.

1.2.14 An example of a unit's indication for the order placement and in documentation:

"power supply unit JETA120-230WT051212-SCN"

Table 1 - Types, basic characteristics and service functions of the units

<table>
<tr><th rowspan="2">Nominal output power, W</th><th rowspan="2">Type of the unit</th><th rowspan="2">Number of output channels</th><th rowspan="2">Version</th><th rowspan="2">Dimensions, mm, not more than</th><th colspan="4">Input voltage range, (index)</th><th colspan="2">Operating case temperatures (index), °C</th><th rowspan="2">Input-output isolation, kV</th><th rowspan="2">Remote switch-off</th><th rowspan="2">Channels isolation</th><th rowspan="2">Output voltage adjustment</th><th rowspan="2">External feedback</th><th rowspan="2">Parallel operation</th><th rowspan="2">PFC</th><th rowspan="2">Fan feed output</th><th colspan="2">EMC standard National state standard P 51318.22 (EN55022)</th></tr>
<tr><th>~100 … ~242 V or = 141…= 343 V (230W)</th><th>~176 …~242 V or = 248 … = 343 V (230)</th><th>~80 …~140 V or =113 …=198 V (115)</th><th>~304 …~456 V or = 430 …= 643 V (400)</th><th>-40 ... +85 (N)</th><th>-50 ... +85 (N)</th><th>Class B</th><th>Class A</th></tr>
<tr><td>60</td><td>JETA60</td><td rowspan="3">1,2, 3</td><td rowspan="8">SH, SC</td><td>101x51x18,5</td><td rowspan="6">+</td><td rowspan="6">+</td><td rowspan="2">+</td><td rowspan="6">-</td><td rowspan="8">+</td><td rowspan="8">+</td><td rowspan="8">3</td><td rowspan="2">-</td><td rowspan="4">+</td><td rowspan="2">-</td><td rowspan="3">-</td><td rowspan="3">-</td><td rowspan="2">-</td><td rowspan="3">-</td><td rowspan="2">+</td><td rowspan="2">+</td></tr>
<tr><td>120</td><td>JETA120</td><td>111x61x21</td></tr>
<tr><td>300</td><td>JETA300</td><td>134x84x28</td><td rowspan="6">-</td><td rowspan="6">+</td><td rowspan="6">+</td><td rowspan="6">+</td><td rowspan="2">with JETAF5 filter</td><td>+</td></tr>
<tr><td>700</td><td>JETA700</td><td>1,2</td><td>175x93x28,6</td><td rowspan="5">+</td><td rowspan="5">+</td><td rowspan="5">+</td><td>+</td></tr>
<tr><td>1200</td><td>JETA1200</td><td rowspan="4">1</td><td>211x117x39</td><td rowspan="4">-</td><td>with JETAF10 filter</td><td>+</td></tr>
<tr><td>2000</td><td>JETA2000</td><td>250x140x39</td><td>with JETAF20 filter</td><td>+</td></tr>
<tr><td>2000</td><td>JETA2000</td><td>250x140x39</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">+</td><td>with JETAF15 filter</td><td>+</td></tr>
<tr><td>3000</td><td>JETA3000</td><td>300x170x40</td><td>with JETAF15 filter</td><td>+</td></tr>
</table>

JET A 120 - 230 T 051212 - S C N D B

B – low-budget design

DIN-rail mounting index:
D – with a clip for mounting on a DIN-rail

Operating case temperature range:
N – from -40 °C to +85 °C;
P – from -50 °C to +85 °C

Version index:
C –with terminal blocks
H –with blade solder pins

S –with polymer potting protection

Nominal output voltage, V:
- two figures per channel

Number of output channels:
S – one;
D – two;
T – three.

Nominal input voltage index:
115 (from 80 to 140 VAC or from 113 to 198 VDC);
230 (from 176 to 242 VAC or from 248 to 343 VDC);
230W (from 100 to 242 VAC or from 141 to 343 VDC);
400 (from 304 to 456 VAC or from 430 to 643 VDC)

Maximum output power, W

Voltage conversion class:
A – AC/DC

JET series

Picture 1 – Classification and reference indices

2 SPECIFICATIONS

2.1 Basic parameters and characteristics

2.1.1 Requirements to electrical parameters

2.1.1.1 Output voltage deviation as per normal climatic conditions, with the input electric power quality matching the values given in table 2, must not exceed ±2 % for the first channel and ±6 % for the second (third) channel.

Table 2 – Electric power quality norms at the input

Index, unit of measurement	Electric power quality norms at the input with the nominal input voltage, frequency from 47 to 440 Hz			
	Index «115»	Index «230»	Index «230W»	Index «400»
Input AC voltage deviation, frequency from 47 to 440 Hz, V	from 80 to 140	from 176 to 242	from 100 to 242	from 304 to 456
Transient deviation, V	from 80 to 140	from 176 to 264	from 100 to 264	from 304 to 456
Transient deviation duration, MAX, s	1	1	1	1

Note – DC supply of the units is acceptable, with nominal voltage:
- 160 V for input voltage «115» with deviation from 113 to 198 V;
- 320 V for input voltage «230» with deviation from 248 to 343 V;
- 320 V for input voltage «230W» with deviation from 141 to 343 V;
- 565 V for input voltage «400» with deviation from 430 to 643 V.

2.1.1.2 Peak current, supplied by the input power at the moment of the first "cold" start-up of the unit, at the nominal input voltage value, must not exceed the values presented in table 3.

Table 3 – Peak current, mains-feed at the moment of switching on

Nominal input voltage index	Peak current, A, from mains-feed at the moment of switch-on of the units, depending on the type of the unit						
	JETA60	JETA120	JETA300	JETA700	JETA1200	JETA2000	JETA3000
«115»	14	17	-	-	-	-	-
«230»	17	33	22	110	130	130	-
«230W»	28	33	22	110	130	130	-
«400»	-	-	-	-	-	250	250

2.1.1.3 Value of full input power of the units in steady-state must not exceed the following value:

$$P = 1,4 \cdot (P1max + P2max + P3max), \quad (2.1)$$

where: P1max, P2 max, P3max – the maximum output power of the first, second and third channels correspondingly, W.

2.1.1.4 Period of time, needed for output voltage to gain its nominal value, after the nominal input voltage is set, must not exceed 0,8 seconds for JETA60, JETA120, JETA300 and two-channel modification of JETA700. For single-channel modification of JETA700, JETA1200, JETA2000 – not more than 0,12 seconds. For 3-phase JETA2000, JETA3000 - not more than 0,2 seconds.

2.1.1.5 Peak-to-peak amplitude of the output voltage ripple must not exceed 2 %.

2.1.1.6 Total output voltage instability (Ins_{sum}) must not be more than ±4 % of $Uout_{nom}$ for the first channel and ±13 % for other channels, herein:

a) output voltage instability of the first channel with fluent input voltage change (Ins_u) must not be more than ±0,5 %, that of the other channels – not more than ±1 %;

b) output voltage instability of the first channel with fluent output current change (Ins_I) of this channel must not exceed ±2 %, for other channels - not more than ±7 %. In case when nominal output voltage of the second and third channels differ by more than 20 % from the first channel, overall output voltage instability of the second and third channels, with fluent output current change, must not exceed ± 12 %;

c) output voltage instability of the first channel with ambient temperature change (Ins_T) must not exceed ±1 %, that of other channels – ±3 % of output voltage;

d) output voltage instability of the modules' in time (Ins_t) must not be more than ±0,5 %.

2.1.1.7 Minimum efficiency values of PSUs are presented in Table 4. Efficiency measurement mode – at nominal input voltage, at nominal output load.

Table 4 – Efficiency vs input voltage index

Uin Index	«230W», «230»					
Uout, V	5	12	15	24	27	48
JETA60	0,8	0,84	0,84	0,86	0,86	0,86
JETA120	0,8	0,84	0,84	0,86	0,86	0,86
JETA300	-	0,82	0,82	0,84	0,84	0,86
JETA700	-	0,84	0,84	0,88	0,88	0,89
JETA1200	-	0,84	0,84	0,88	0,88	0,89
JETA2000	-	-	-	0,91	0,91	0,92
Uin Index	«115»					
U_{out}, V	5	12	15	24	27	48
JETA60	0,78	0,82	0,82	0,84	0,84	0,84
JETA120	0,78	0,82	0,82	0,84	0,84	0,84
Uin Index	«400»					
U_{out}, V	5	12	15	24	27	48
JETA2000	-	-	-	0,92	0,92	0,93
JETA3000	-	-	-	0,92	0,92	0,93

Note to Table 4:

- efficiency of two- and three-channel units, such as JETA60, JETA120, JETA300, JETA700 is 1% less than the value, shown in the table, depending on input power.

2.1.1.8 The units must have full protection, such as:

- short circuit protection with automatic return to voltage regulation after short circuit elimination;
- output overcurrent with automatic return to stability mode after overcurrent elimination;
- input overvoltage protection of the first channel. When reaching the output voltage value of (1,1;1,5) · Uout for JETA60…JETA300 units, and (1,2;1,25) · Uout for JETA700…JETA3000, with automatic return to output voltage stabilization after fault elimination.

2.1.1.9 Output voltage values for operation at zero load must not exceed the value of 1,05 · $Uout_{nom}$ for the first channel, and 1,1 · $Uout_{nom}$ – for the other channels.

2.1.1.10 For JETA300…JETA1200, remote switch off must be executed by connecting «+REM», «-REM» outputs to a voltage within range from 3 to 5 V from independent source.

2.1.1.11 For JETA2000, JETA3000 remote switch off must be executed by connecting «+REM», «-REM» outputs to a voltage within a range from 3 to 5 V from independent source or by shorting «AUX» to «+REM» output.

2.1.1.12 Transient output voltage deviation must not exceed 10 % from nominal output voltage for the first channel, and 15 % - for other channels in cases:

- if it's influenced by transient input voltage deviation within acceptable values indicated in 2.1.1.1 of this reference specification with minimum edge time of 0,5 ms,

- with instant output current change within a range from I_{nom} to $0,1 \cdot I_{nom}$ with minimum edge time 0,5 ms for single-channel units; and from I_{nom} to $0,3 \cdot I_{nom}$ with minimum edge time 0,5 ms for multi-channel units.

2.1.1.13 Power coefficient (λ) values of the units:

- JETA300…JETA1200 and JETA2000 (one-phase) with PFC – not less than 0,96;
- JETA60, JETA120 without PFC – not less than 0,5;
- three-phase JETA2000, JETA3000 with PFC – not less than 0,85;

2.1.1.14 Harmonics composition of input current of the units:

- JETA300 … JETA1200 and one-phase JETA2000 – must meet the requirements of EN61000-3-2 standard, class D.
- JETA2000, JETA3000 - must meet the requirements of EN61000-3-2 standard, class D, except harmonics 5 and 7.

2.1.1.15 The units must have overheating protection with automatic return to stable functioning after overheating elimination, with the case temperature in a range from +82 to +95 °C.

2.1.1.16 Norms for conductive industrial radio-noise at input power line clamps of power supplies must meet the following requirements:

– JETA60, JETA120 – class B Nat. Standard 51318.22-2006 (EN55022-2006);
– JETA300, JETA700, JETA1200, JETA2000, JETA3000 – class A Nat. Standard 51318.22-2006 (EN55022-2006).

2.1.1.17 Single-channel power supplies JETA700 - JETA3000 must possess output voltage adjustment function within a range from -30 % to +10 % of the nominal value, by means of connecting of external potentiometer to «ADJ»,«+OUT»,«-OUT» outputs.

2.1.1.18 Single-channel power supplies JETA300 - JETA3000 and two-channel JETA300, JETA700 must possess output voltage adjustment function with a minimum value ± 5 % of the nominal value, by using «ADJ» potentiometer installed in the unit.

2.1.1.19 JETA2000, JETA3000 units must have «OGOOD» outputs. If the output voltage is higher than 70% of its nominal value, +OGOOD and –OGOOD outputs must have «open transistor collector» signal.

2.1.1.20 Units' switching frequency is permanent and should be within range:

- JETA60, JETA120 – 180-220 kHz;
- JETA300, JETA700, JETA1200, JETA2000 – 125-150 kHz;
- JETA3000 – 110-130 kHz.

2.1.2 Environmental resistance

2.1.2.1 The units must function and maintain their parameters and appearance during and after exposure to the mechanical and climatic factors in accordance with values in Table 5.

Table 5 – Environmental conditions

Parameter	Parameter value	
	«N» index	«P» index
Decreased ambient temperature, °C	-40	-50
Increased ambient temperature, °C	+85	
High temperatures and humidity	95 % with 35 °C	
Temperature cycling, °C	from -60 to +85	

Parameter	Parameter value	
	«N» index	«P» index
Sinusoidal vibration (resistance) - frequency range - acceleration amplitude (g) - vibration displacement amplitude	 1 - 500 Hz 50 m / s^2 (5 g) 0,5 mm	
Single-acting mechanical impact: - impact acceleration peak value (g) - impact acceleration action duration	 1000 m/s^2 (100 g) 1-2 ms	
Low atmospheric pressure, Pa (mm of mercury)	6 x 10^4 (500)	
High atmospheric pressure, Pa (mm of mercury)	12 x 10^5 (9000)	
Note – Case temperature of the unit must not exceed +85 °C		

2.1.2.2 The units must function and maintain their parameters and appearance in an environment of increased temperature in accordance with Table 5 and after exposure to critically high temperature of 358 °K (85 °C).

2.1.2.3 The units must function and maintain their parameters and appearance in an environment of decreased temperature in accordance with Table 5.

2.1.2.4 The units must function and maintain their parameters and appearance after being exposed to temperature cycling in accordance with Table 5.

2.1.2.5 The units must function and maintain their parameters and appearance when exposed to increased air humidity in accordance with Table 5.

2.1.2.6 The units must be resistant to influence of sinusoidal vibration with certain acceleration amplitude within the frequency range, as shown in Table 5.

2.1.2.7 Reliability, endurance and life service requirements are given in Table 6.

Table 6 - Reliability, endurance and life service requirements

Reliability index	JETA60, JETA120	JETA300, JETA700	JETA1200, JETA2000, JETA3000
MTBF with case temp. 50 °C and 0,7 · Pout max, hours	50 000	40 000	30 000
Average life, years	15		
Average shelf life, years	15		
Gamma-percentile life, case temp. 50 °C and 0,7 · Pout max, hours	150 000 (y = 0,95)		

2.2 Requirements to raw materials and purchased parts

2.2.1 Materials, protective coating and components, used in power supplies, must meet the requirements of engineering documentation.

2.2.2 All components, installed into the units, are put through initial testing and their warranty shelf life must not be exceeded by more than 50%.

2.3 Design and technical requirements

2.3.1 The design of units must guarantee their steady functioning in any position and absence of mechanical resonance when influenced by sinusoidal vibration within frequency range up to 100 Hz with vibration displacement amplitude 0,5 mm.

2.3.2 In terms of design, dimensions, mounting and connection dimensions, general appearance and coating of units must comply with the requirements of engineering documentation of a particular.

2.3.3 Weight of units must not exceed the values indicated in Table 7.

Table 7 – Weight of the units

Parameter	Module type						
	JETA60	JETA120	JETA300	JETA700	JETA1200	JETA2000	JETA3000
Weight, kg	0,16	0,22	0,5	0,8	1,5	1,9	3,5

2.3.4 The insulation resistance of electric circuits, galvanically isolated from each other or the unit's case, measured at a voltage of 500 V, must be:

- provided normal climatic conditions - not less than 20 MOm;
- provided increased humidity - not less than 1 MOm;
- provided increased temperature - not less than 5 MOm.

2.3.5 Dielectric strength of electric circuits, galvanically isolated from each other or the unit's case, should ensure the absence of breakdown and surface flashover when exposed to an alternating voltage of 50 Hz and effective value:

- in normal climatic conditions (input-output)	~ 3 kV; for «B» version ~ 1,5 kV;
- in normal climatic conditions (input-case)	~ 1,5 kV;
- in normal climatic conditions (output-case)	~ 0,5 kV;
- in normal climatic conditions («REM», «AUX», «OGOOD» - input)	~ 3 kV; for «B» version ~ 1,5 kV;
- in normal climatic conditions («REM», «AUX», «OGOOD» - output)	~ 0,5 kV;
- in normal climatic conditions («REM», «AUX», «OGOOD» - case)	~ 0,5 kV;
- in normal climatic conditions («REM», «AUX» - «OGOOD»)	~ 0,5 kV;
- in normal climatic conditions (output- output)	= 0,5 kV;
with a higher humidity	~ 0,5 kV.

2.3.6 Leakage current of the units at nominal input voltage must not exceed 0,7 mA for units with the input voltage of «230», «230W» and 2,6 mA for units with the input voltage «400».

2.3.7 Connectors for «SH» version must be mechanically resistant and without any mechanical defects sustain a maximum tension force of:

- for connector pins 2,8 mm in width - 40 N;
- for connector pins 6,3 mm in width - 80 N.

2.3.8 Connectors coating for «SH» version must ensure solderability without any additional maintenance during 12 months and allow triple resoldering without connectors crippling and electrical characteristics impairment.

2.4 Completion

2.4.1 Each individually delivered power supply unit must be supplied with warranty (technical passport) as per norms, existing in the manufacturing company.

2.4.2 Each individually delivered power supply unit from JETA300…JETA3000 line must be supplied with complementary part of the service connector X3.

2.4.3 As an option, each delivery batch may be provided with thermo paste. This option is to be stipulated upon order placement.

2.4.4 As an option, each delivery batch may be provided with a stencil for thermo paste coating. This option is also to be stipulated upon order placement.

2.4.5 As an option, each delivery batch may be provided with an appliance for output ripple measurement.

2.5 Packing and marking requirements

2.5.1 There must be a particular marking on the surface of each unit.

2.5.2 Marking and its application method must comply with engineering documentation. Marking must be applied onto parts of the unit that are visible upon inspection as a part of the equipment.

2.5.3 Packaging must comply with transportation and storage requirements.

2.6 Transportation and storage requirements

2.6.1 The units’ design and packaging must allow their transportation over any distance by means of auto, railway, water and air transport.

2.6.2 The units must withstand storage in primary packaging in non-heated premises.

3 SAFETY REQUIREMENTS

3.1 Units' safety is provided by construction of equipment, which the units are installed into.

3.2 All kinds of operations with the units are to be carried out in strict compliance to current safety regulation documents.

3.3 Only trained personnel with special qualification and practical skills with electric appliances are allowed to work with the power supply units.

3.4 It is forbidden to connect and disconnect connection wires during PSU operation.

3.5 Any devices in the working area must be prepared for operation in accordance with their instructions.

4 TRANSPORTATION AND STORAGE

4.1 The units are to be transported in packaging, preventing it from mechanical impact and direct contact with atmospheric condensation, in all kinds of transport.

4.2 The units are stored in primary manufacture packaging or installed into equipment in any storage areas, except outdoor areas.

5 GENERAL OPERATION

5.1 Units' ESD protection

5.1.1 Units must be used with consideration of ESD protection requirements.

5.2 Installation and attachment of units in the equipment

5.2.1 Installation of units and their mounting in the equipment must be executed accounting for mechanical loads, with which the equipment operates, and heat dissipation.

5.2.2 Upon request, any customer can be provided with the dimensional drawings of units in *.STEP or *.DXF formats.

5.2.3 Modules must be fastened onto the heat sink with screws through the holes at the corners of the units. Recommended tightening torques, depending on the strength class of the screws, are shown in Table 8.

Table 8 – Screw torque

Screw	Tightening torques, depending on the strength class of the screws, N*m				
	4,6	4,8	5,6	5,8	8,8
M2,5	0,279	0,372	0,349	0,465	0,745
M3	0,478	0,638	0,598	0,797	1,27
M4	1,1	1,47	1,37	1,83	2,94

5.2.4 For JETA1200, JETA2000, JETA3000 series, it is necessary to use central socket, to ensure a more profound and tight clamping of a unit to the heat sink. Tightening torque is 0,5-1 N*m. The fastening screw must go into the housing of the module to a depth of no more than is indicated in the dimensional drawing of a unit. Violation of these requirements may result in a unit's breakdown and warranty disclaimer.

5.2.5 First the screw is driven into the central socket (if available), after one pair of diagonally placed screws, then another pair. During the first pass screws are not tightened. During the second pass all the screws are driven further with recommended tightening torques, in sequence mentioned above.

5.2.6 It is forbidden to switch on the units during tests by means of contact devices with short contact breaks (bouncing).

5.2.7 It is forbidden to install and connect modules to electrical circuits under voltage.

5.2.8 For units with «C» configuration:

- tightening torque of screw terminals and recommended conductor cross-section that can be connected to the unit, are given in the dimensional drawings of PSUs;
- after 15 minutes pause, it is necessary to repeat tightening of the screws.

5.2.9 For units with «H» configuration:

- soldering of the units' output channels is recommended to perform with electrical soldering device with maximum power of 60 W at a maximum temperature of 260 °C for not more than 5 seconds per output. Soldering is allowed not more than three times at a distance of at least 2 mm from the edge of potting (compound). Bending the pins when soldering is not allowed;
- tin coating of the units' outputs is allowed to do with solder Sn60Pb40, as example, using neutral solder flux at a distance of at least 1 mm from the case and with pre-stripping of oxide layers;
- when cutting, bending and forming the connector pins, it is necessary to use special templates to ensure the immobility of connector pins between the place of bending and the case of a unit. Twisting connector pins about the axis is not permitted;
- after soldering, connector pins of the units may be covered with any type of varnish used for coating of solder joints (for example, Zapon).

5.3 Thermal conditions, thermal performance of the units

5.3.1 To ensure case temperature not more than +85 ^{o}C, units, as a rule, require their direct installation on a heat sink with firm adherence of their surface through the thermal paste with a heat conducting coefficient not less than 3,5 W/m.K, for example Dow Corning TC-5021. Heat conductive paste must be applied in a layer not more than 50-100 mkm along the whole heat conductive surface of a unit's case by means of a special stencil. Engineering documentation for a stencil production may be provided upon request or the whole order may be equipped with the stencil (to be agreed upon order placement).

5.3.2 It is strictly forbidden to use any kinds of thermal pads instead of thermal paste, as they are rather thick and in most cases of a lesser heat conduction coefficient, so it does not provide sufficient thermal contact of a PSU with a heat sink.

5.3.3 Provided that the module is installed on a heat sink correctly, temperature difference between them will not be more than 2-4 ^{o}C.

5.3.4 The units may be used without a heat sink only upon condition – if they are bonded (with a thermal conductive paste) to a heat-conducting base plate, whose length and width match the unit's case dimensions with thickness not less than:

- for JETA60 – 1,5 mm;
- for JETA120 – 2 mm;
- for JETA300 – 2,5 mm;
- for JETA700 – 3 mm;
- for JETA1200 – 3,5 mm;
- for JETA2000 – 4 mm;
- for JETA3000 – 6 mm.

5.3.5 Values of thermal resistance «Case-Environment» of the units, reference values of Pout max without a heat sink for the units (with thermal conductive base plate) and ambient temperature, at which Pout max starts decreasing, are all given in Table 9.

Table 9 – Thermal performance

Type of PSU	$Pout_{nom}$, W	Thermal resistance «Case-Environment», °C/W	Efficiency, %	Pout max without a heat sink at 50 °C, W	Ambient temperature, at which Pout max starts decreasing (without a heat sink), tdecr, °C
JETA60	60	6,4	80	22	-11
JETA120	120	4,8	80	29	-59
JETA300	300	2,7	82	59	-93
JETA700	700	1,8	84	102	-155
JETA1200	1200	1,2	84	153	-189
JETA2000	2000	0,8	91	442	-73
JETA3000	3000	0,6	92	671	-72

5.3.6 A more preferable position for the units is a vertical one, when its long side is placed horizontally.

5.3.7 Surface area of a heat sink depends upon many factors - actual efficiency of a PSU, atmospheric pressure, pressing force of a heat sink onto the surface of a PSU, quality of the surface treatment of a heat sink and its level of black, its position, availability or absence of air-cooling, etc.

5.3.8 The cross-plots of the maximum output power and ambient temperature are specified in Appendix A. They establish the nature of dependence between maximum output power without additional heat sink (or heat-distributing plate) and ambient temperature in conditions of natural convection cooling with an input voltage from 176 to 242 V. Power output cross-plots are shown as a reference to make a right choice of a heat sink. The horizontal axis represents the ambient temperature values, and the vertical - the maximum power output values, at which case temperature will not exceed its maximum value. Horizontal area of the temp. curve relates to the Pout of the unit, and case temperature in this area has approximately identical temperature difference ΔT relative to the ambient temperature, which is:

$$\Delta T = R_{case\text{-}environment} \cdot P_{losses} \qquad (5.1)$$

Dropping part of the temp curve is defined by same case temperature, which equals Tmax.

Curves for Pout max vs input voltage set the type of dependence of the maximum output power on input voltage in conditions of different ambient temperatures.

Note. At temperature curves in Appendix A in ♦, ■ and ▲ there are several limiting parameters present, for example, combination of the maximum case temperature and maximum output power. Long-term operation of power supplies in these points is not applicable.

5.3.9 To calculate and choose a heat sink, it is necessary to know the following values:

- Maximum power loss (P_{loss}). The value is defined as difference between measured input (P_{in}) and output power (P_{out}) (preferable variant).

$$P_{loss} = P_{in} - P_{out} \qquad (5.2)$$

Or can be calculated as per following formula:

$$P_{loss} = P_{out} \cdot (1-\eta) / \eta \qquad (5.3)$$

where: η – efficiency of a unit, which values are given in Table 4;

- Maximum efficiency generally corresponds to 70-90% of output power;
- maximum temperature at the unit's case (T_{case}) depends upon maximum ambient temperature ($T_{ambient}$) a PSU will be working in, and can be calculated by following formula:

$$T_{case} = T_{ambient} + R_{case\text{-}ambient} \bullet P_{loss}, \quad (5.4)$$

where:

$R_{case\text{-}ambient}$ – thermal resistance «Case-Ambient», ºC/W;

P_{loss} – maximum power loss of the unit.

Calculated value gives us reasonability of a heat sink usage;

- value of the acceptable thermal overload of a unit's case in relation to ambient temperature ΔT is set by the constructor or can be calculated according to formula 5.1.

Still, it is necessary to remember, that each increase of a case temperature by 10-15 °C, reduces MTBF circa by twice.

5.3.10 Definition of geometric dimensions of a heat sink

Power supply units can be mounted on heat sinks of any design. For example, this may be the walls of some cabinet unit, housing elements of some equipment having sufficient thickness for the conductive heat distribution. The best option for a heat sink material is copper, then goes aluminum, and the least optimal - steel. It is necessary to control that maximum case temperature of the unit does not exceed its maximum of 85 °C. The measurements are necessary to conduct in the most severe operating conditions for the module: at maximum output power and maximum ambient temperature.

If you use some standard product as a heat sink, its choice must be made according to the value of its thermal resistance ($R_{heat\ sink\ \text{-}ambient}$):

$$R_{heat\ sink\text{-}ambient} \leq \Delta T \cdot R_{case\text{-}ambient} / (P_{loss} \bullet R_{case\text{-}ambient} - \Delta T), \text{ ºC/W}, \quad (5.5)$$

where:

P_{loss}- maximum loss power, W;

$R_{case\text{-}ambient}$ – thermal resistance «Case-Ambient», ºC/W;

ΔT - value of an acceptable overheating for PSU, ºC.

For any heat sink, for which the abovementioned condition is true, ΔT value will not exceed the set value. Thermal resistance values, «Heat sink - Ambient», are given in instruction/technical manuals for the heat sink.

Calculated thermal resistance values «Heat sink - Ambient» for the units are given in Table 10.

Table 10 –Thermal resistance «Heat sink-Ambient», ºC/W for different types of modules

Type of a unit	$Pout_{nom}$, W	Thermal resistance «Case-Ambient» ºC/W	Efficiency %	Value of an acceptable overheating for PSU in relation to ambient temperature ΔT, ºC	Thermal resistance Rha «Heat sink-Ambient» , ºC/W
JETA60	60	6,4	80	15	1,19
JETA120	120	4,8	80		0,56
JETA300	300	2,7	82		0,25
JETA700	700	1,8	84		0,12
JETA1200	1200	1,2	84		0,069
JETA2000	2000	0,8	91		0,08
JETA3000	3000	0,6	92		0,064

5.3.11 It is recommended to use heat sinks with black anodized coating or expose it to etching with dark filling to secure the level of blackness more than 0,85. When using heat sink without coating, its thermal resistance is increased by 10-15%.

5.3.12 It is necessary to place the PSU in a geometric center of a heat sink. The heat sink must be oriented in such a way, so that its sides and ribs could be air-cooled by free circulating air flows.

5.3.13 Forced convection provided by fan can significantly diminish the size of a heat sink. Airflow coming through heat-conductive surface of a unit or through the heat sink with a speed of 1 m/sec (60 m/min) decreases thermal resistance «Case-Ambient» and «Heat sink-Ambient» approximately twice, which means twice as larger effective heat-conductive surface in comparison with free air convection.

5.3.14 It is recommended to use fans when connecting them to some undervoltage source unit (for example, using Zener diode), thus, reliability of a fan raises dramatically. VDC for «+FAN», «-FAN» output channels equals 9,5…13 V with maximum load current of 200 mA.

5.3.15 With fan cooling, orientation of a unit in space does not matter, but airflow must pass along the ribs of a heat sink. Design of the equipment must provide division of airflows in a cooling system, entry cool airflow and outgoing hot airflow. Recommended airflow feeding method is pumping air into the cooling system. Construction elements of equipment must secure free entry and exit of airflows within cooling system.

5.3.16 For any cooling method, it is necessary to make sure there is an air gap 20-30 mm in width from a heat sink to the nearest elements of the equipment.

5.3.17 Unit's case lid has vent holes, it is necessary to make sure there is an air gap 20-30 mm in width, from a heat sink to the nearest elements of the equipment in case of free air convection. When the unit is cooled by air, it's recommended to stream part of the airflow directly under the lid, and in such case the holes may be covered by other elements of the equipment.

5.3.18 It is essential to control the temperature at the units' base, whereupon the unit itself has to be placed on the heat sink or heat conductive plate. Center of the lower heat conductive surface of a PSU is considered to be the most preferable variant for placement of a control heat sensor. For that matter, it is necessary to make a measuring hole in a heat sink. Of course, heat conductive paste must be used to lower thermal resistance between the sensor and metal housing of a PSU. Measuring part of a heat sensor (10-15 mm) must go through a controllable area and must be completely submerged into the paste.

5.3.19 In cases when it is impossible to use the desired point for measurements, it is allowed to place the temperature sensor 1-3 mm higher above the heat sink in the center of the long side. Side for measurement is the right side (when looking at the PSU from the input), when pins are directed upwards. In addition, heat conductive paste must be used to reduce thermal resistance between the sensor and metal case of a PSU. Measuring part of a temperature sensor (10-15 mm) must go through the controllable area and must be completely submerged into the paste. To the attained value of the case temperature, in this case, it is necessary to add 5° C to compensate for any mistake made possible by changing temperature sensor placement.

5.3.20 It is not recommended to use contact-free IR-measuring devices to monitor the case temperature, because choosing a surface with a correct reflectivity coefficient may be a problem resulting in their insufficient measurement accuracy.

5.4 Connecting units to input power

Reconnecting the units to input power, after its disconnection, is allowed after at least 30 seconds.

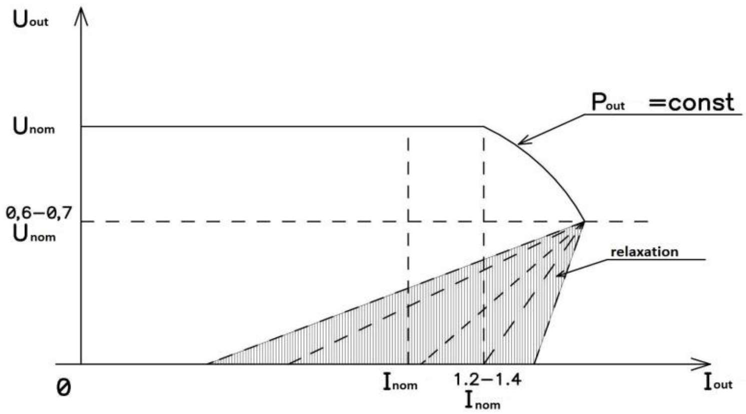
In order to decrease the input current surge in the input circuit and network at startup, there is a built-in protection element at the input - negative temperature coefficient thermistor (NTC). This element has sufficiently high resistance when cold and low when hot. This is the reason why it is necessary to provide some time for thermistor to cooldown after the PSU was switched off.

Failure to comply with this requirement may result in breakdown of a PSU.

5.5 Power overload protection and output short circuit protection

5.5.1 For such units as - JETA60, JETA120, JETA300, and double-channel JETA700:

- overload protection is implemented by the output power limitation. When the output power is too high, control system starts decreasing output voltage of the unit, limiting maximum output power. If output load increases further and output voltage decreases to 60-70 % of its nominal value, the PSU enters the relaxation mode. When the overload or short circuit is eliminated, normal operation is recovered automatically.
- control and output power limitation is carried out on the input side of the unit. In this respect, special attention must be paid to the channels’ load in multi-channel units and not to exceed values, stated in technical documentation.
- short-circuit protection - is a snap-action, which is why even short-period power overshoot is recognized as short-circuit mode by the PSU. Dramatic capacity values at the unit’s output or power-consuming operation (relay, electric motors), leading to short-period nominal output power overshoot, may cause failure to start or to enter steady work mode. Maximum total capacity of output capacitors for the typical connection scheme is presented in Table 12.



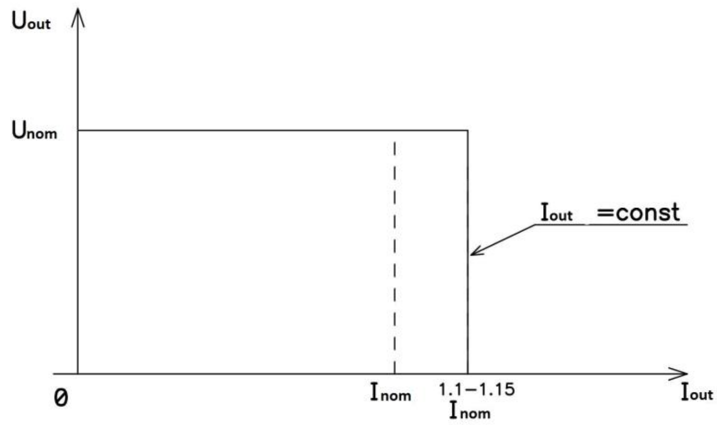
Picture 5.2 – Current-versus-voltage characteristics of the units from p. 5.5.1

- typical overload protection threshold for units with the input voltage 115, 230 equals 1,2-1,4 of the output current nominal value, measured at nominal input voltage.
- typical overload protection threshold for units with the input voltage 230W equals 1,2-1,4 of the output current nominal value, measured at nominal input voltage, and 1,7-2,1 – measured at minimum input voltage 100 V (with consideration of decreasing P_{out} nom).

5.5.2 For single-channel versions of units – JETA700, JETA1200, JETA2000, JETA3000.

5.5.2.1 Input voltages 230, 400 V

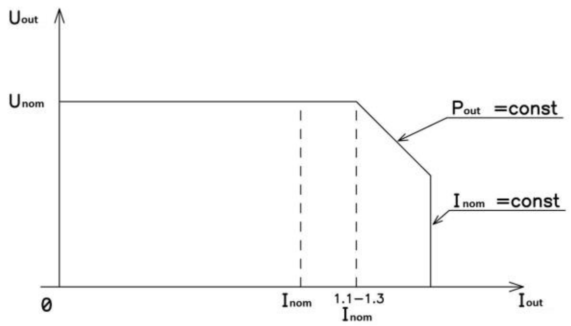
- overload protection is performed by output current limitation. When exceeding output overcurrent protection threshold, control system limits output current value, and the unit goes into constant current generator mode. Output voltage can decrease to zero, and output current will remain constant.
- typical protection threshold for units equals 1,1-1,15 of the output current nominal value, measured at nominal input voltage. Output current control is carried out on the output side of the unit.



Picture 5.3 – Current-voltage characteristic of the units from p. 5.5.2.1

5.5.2.2 Input voltage range 230W

- for the input voltage range 176-242 V, protection functions in the same way, as in p. 5.5.2.1
- typical protection threshold for the units equals 1,1-1,3, measured at the minimum input voltage of 100 V (with consideration of P_{out} nom).
- control and output power limitation for the input voltages less than 176V is carried out on the input side of the unit. The unit enters current generator mode only after output current surpasses a threshold set on the output.

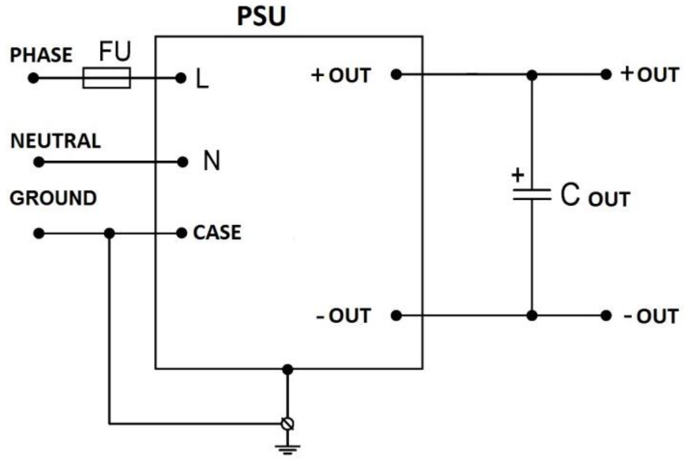


Picture 5.4 – Current-voltage characteristic of the units from p. 5.5.2.2

5.5.2.3 Such technical solution lets a unit operate with a long-term, almost unlimited, capacity load.

5.6 Standard configurations

5.6.1 Typical unit switching modes illustrated by example of a single-channel unit are shown in Figure 5.5. To improve the quality of power supply within the equipment, it is necessary to bridge output circuits of the units with tantalum or aluminum capacitors with low impedance of a corresponding voltage (Low ESR). Capacity and recommended types of output capacitors, whose utilization provides basic parameters of single-channel units, are shown in Table 11. The capacitors must be located as close as possible to the output circuits.



Cout corresponds with capacity values of output capacities from Table 11
Picture 5.5 – Typical connection scheme for a single-channel unit

5.6.2 The maximum input current of the pre-fuse is chosen on the basis of the minimum input voltage and maximum output power, taking into consideration efficiency and power factor. During connection of the PSU to input network, an input current surge, several times greater than the input current in steady mode, is taking place (see Table 3). Therefore, slow fuses with sufficient response time and safety requirements must be used. It is recommended to use fuses with a current operation equal to three-time maximum input current of the PSU.

5.6.3 Compliance with the correct connection of phase and neutral wires helps to avoid any danger of electrical shock, should the unit break down, because internal fire fuse is installed into the phase wire.

5.6.4 Connection scheme for application in especially sensitive to impulse noise equipment is shown in Figure 5.6. The necessity to supply filter modules has to be specified upon order placement. Application of the filter modules along with the power modules is shown in Table 13.

5.6.5 If there are long wires (longer than 20 cm) from the outputs to the connector pins or fed circuits, it is necessary to connect ceramic capacitors of appropriate voltage rating on route of such wires in accordance with Figure 5.7.

Table 11 – Capacity of output capacitors C_{out} for the typical connection scheme

Nominal Pout, W	Capacity of output capacitors C_{out} at the nominal output voltage, µF			
	Up to 6 V incl.	6 V – 15 V incl.	15V -32V incl.	32V – 60V
60	330UF 10V (ELXV 100ELL331MH12D Nippon Chemi-Con)	82UF 25V (ELXV 250ELL820MFB5D Nippon Chemi-Con)	39UF 50V (ELXV 500ELL390MFB5D Nippon Chemi-Con)	22uF 100V (ELXV 101ELL220MH12D Nippon Chemi-Con)
120	470UF 10V (ELXV 100ELL471MH15D Nippon Chemi-Con)	220UF 25V (ELXV 250ELL221MH15D Nippon Chemi-Con)	120uF 50V (ELXV 500ELL121MJ16S Nippon Chemi-Con)	68uF 100V (ELXV 101ELL680MJ25S Nippon Chemi-Con)
300	1000UF 10V (ELXV 100ELL102MJ20S Nippon Chemi-Con)	560UF 25V (ELXV 250ELL561MJ25S Nippon Chemi-Con)	220uF 50V (ELXV 500ELL221MJ25S Nippon Chemi-Con)	100uF 100V (ELXV 101ELL101MK20S Nippon Chemi-Con)
700	-	1000UF 25V (ELXV 250ELL102MK25S Nippon Chemi-Con)	470uF 50V (ELXV 500ELL471MK25S Nippon Chemi-Con)	220uF 100V (ELXV 101ELL221ML25S Nippon Chemi-Con)
1200	-	2200UF 25V (ELXV 250ELL222MK40S Nippon Chemi-Con)	1000uF 50V (ELXV 500ELL102ML30S Nippon Chemi-Con)	470uF 100V (ELXV 101ELL471ML40S Nippon Chemi-Con)

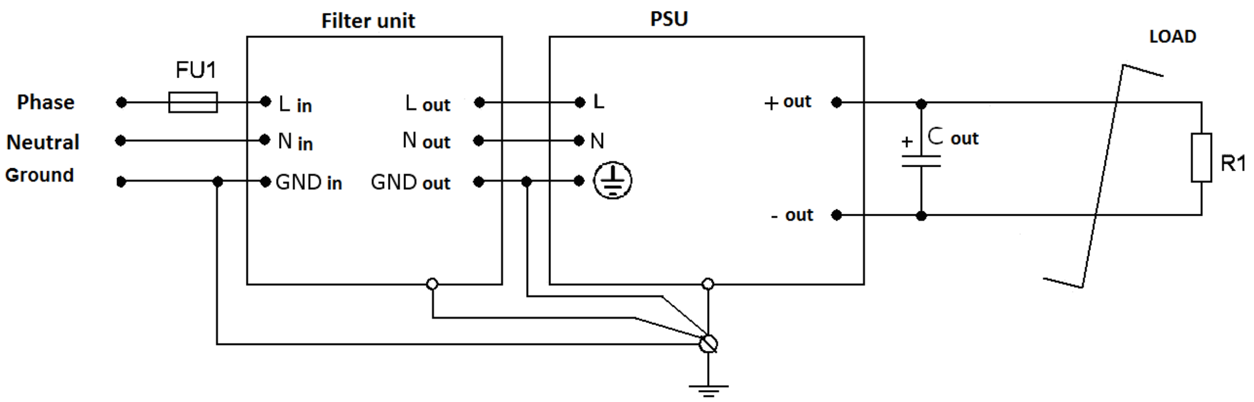
Nominal Pout, W	Capacity of output capacitors C_{out} at the nominal output voltage, µF			
	Up to 6 V incl.	6 V – 15 V incl.	15V -32V incl.	32V – 60V
2000	-	-	2200uF 50V (ELXV 500ELL222MM40S Nippon Chemi-Con)	2 x 470uF 100V (ELXV 101ELL471ML40S Nippon Chemi-Con)
3000			2x2200uF 50V (ELXV 500ELL222MM40S Nippon Chemi-Con)	4 x 470uF 100V (ELXV 101ELL471ML40S Nippon Chemi-Con)

Table 12 – Maximum total capacity of output capacitors C_{out} for the typical connection scheme

Nominal Pout, W	Maximum total capacity of output capacitors C_{out}, µF					
	Uout=5V	Uout=12V	Uout=15V	Uout=24V	Uout=27V	Uout=48V
JETA60	64 000	11 000	7 000	2 700	2 100	650
JETA120	120 000	21 600	14 400	5 600	4 400	1 400
JETA300	150 000	27 000	18 000	7 000	5 500	1 700
JETA700-D	220 000	38 000	24 000	9 300	7 300	2 300
JETA700-S, JETA1200, JETA2000, JETA3000	Not limited					

Notes for Table 12:

1. The maximum total capacity of the output capacitors C_{out} is given for 50 % load at nominal input voltage.
2. For non-standard output voltages, other than those specified in Table 12, the maximum total output capacity is calculated on the basis of Cout * U^2out max /2 being a constant value.
3. For double-channel versions, capacity of each of the channels will be twice as small, for a three-channel version - half less for the first channel and four times less for the second and third channels.



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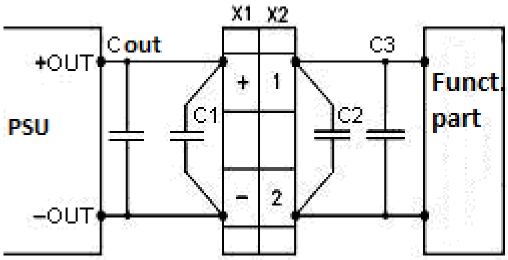
Cout – Nominal value equals Cout from Table 11

Picture 5.6 – Typical connection scheme PSUs combined with filters

Table 13 - Application of PSUs with filters

PSU type	Filter type
JETA300	JETAF5-230
JETA700	JETAF5-230, JETAF10-230
JETA1200	JETAF10-230
JETA2000	JETAF20-230
JETA2000 (3-phase input)	JETAF15-400
JETA3000 (3-phase input)	JETAF15-400



C1, C2 Capacitor Murata GRM 0,47 - 1,5 μF of a corresponding voltage

Picture 5.7 – Typical load connection scheme with long wires

5.7 Grounding function application

5.7.1 Grounding of a unit's case through «GND» output must be performed with a discrete conductor. Its cross-sectional area must be in a range of 1,5 - 2 mm^2, with maximum length of 60 mm.

5.8 Output voltage ripple measurement

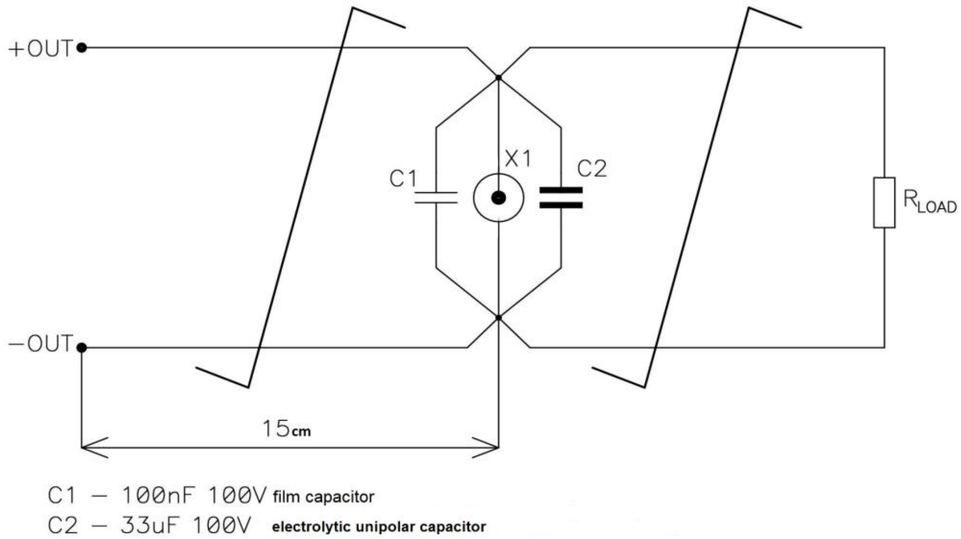
5.8.1 Output voltage ripples consist of:

- low-frequency ripple of 100 Hz for one-phase input and about 300 Hz for 3-phase input.
- ripple with operational frequency of the unit. This frequency is constant, within a range from 110 kHz to 220 kHz (depending upon a unit's type).
- high-frequency noise, from ones to tens of MHz – connected with switching of power semiconductor components.

5.8.2 Output ripple is measured and stated as peak-to-peak, with all its components, using oscilloscope with a frequency band of 20 MHz.

5.8.3 To measure the output voltage ripple, it is necessary to use a special ripple measurement attachment. Attachment scheme with values of the used elements is given below. The design should provide direct output current flow through the pins of elements C1, C2. On the left, the wires laid in a twisted pair (the length of about 15 cm), are coming from the output terminals of the unit. On the right, the load wires are also arranged in a twisted pair. Wires for output current up to 40 A are at least 2.5 mm^2, for output current from 40 A are at least 3,5 mm^2 in cross-sectional area. Standard oscillograph probe is connected to the BNC connector X1, which is structurally located directly at C1, C2. The attachment for output ripple measuring is available and can be ordered.

5.8.4 Using a standard oscillograph probe with a relatively long ground terminal (about 15 cm) as a device for ripple measurement leads to a large high-frequency noise induction on the measured signal. The reason is the "loop", created by the ground output, on which noise, emitted by the PSU, is induced.



Picture 5.8 - Attachment scheme for output ripples measurement

5.9 Output voltage adjustment function

5.9.1 Output voltage can be adjusted by a variable resistor ADJ, placed on PCB in the output terminals area. When adjusting, it is necessary to pay due consideration to the fact that adjustable resistor has a limited rotation. The tool must fluently fit into the slot of an adjustable resistor.

5.9.2 Output voltage adjustment is performed within ± 5% range of the nominal output voltage value. It is necessary to consider that in cases, when PSU operates with increased output voltage, nominal output power should not be exceeded.

5.9.3 In special cases, by agreement with a manufacturer, units with nominal output voltage in range 3-60 V may be produced (agreed upon order placement).

5.10 Output voltage adjustment function application by means of ADJ channel, for JETA700, JETA1200, JETA2000, JETA3000 series

5.10.1 Output voltage adjustment can be performed by means of ADJ terminal, located in connector X3 at the output.

5.10.2 Output voltage adjustment is possible within a range from - 30 % to + 10 % from nominal output voltage value. It is necessary to consider that in cases, when PSU operates with increased output voltage, nominal output power should not be exceeded.

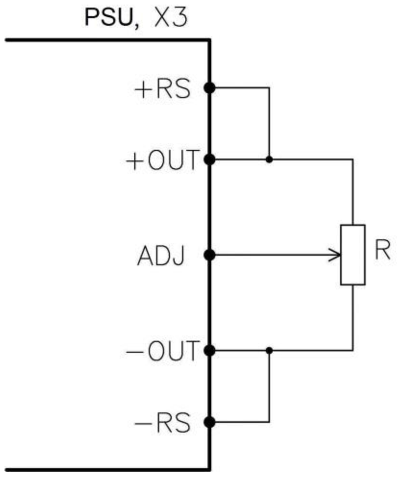
5.10.3 It is not allowed to combine adjustments as per method discussed in p. 5.9 to increase the output voltage by more than 10%.

5.10.4 By reducing the output voltage, maximum output current should not exceed its nominal value; otherwise output overcurrent protection is activated.

5.10.5 Wiring diagram is shown in Fig. 5.9. The resistance value of the potentiometer is 22-33 kOhm. Before switching on, the potentiometer should be brought in such a position that the resistance between the +OUT and ADJ is about 1/3 of its nominal value. After switching on the unit, adjust output voltage to a value in range from p. 5.10.2.

5.10.6 It is forbidden to connect capacitors or RC-circuits to ADJ terminal, as it may cause unstable operation of a PSU.

5.10.7 Conductors, used for connecting a potentiometer, must be as short as possible and twisted together.



Picture 5.9 - Connection diagram for external potentiometer, used for output voltage adjustment by means of ADJ terminal.

5.11 Thermal protection

5.11.1 Units' cases are made of a relatively thin aluminum sheet, 1-3 mm, depending on power. If the unit is not properly installed onto the heat sink, dissipated power cannot be distributed evenly along the surface of the case. Thus, local overheating may appear on the case. Temperature of the point, in which the heat sensor is located, can dramatically differ from the temperature of the points of local overheating. It can cause thermal breakdown of the PSU.

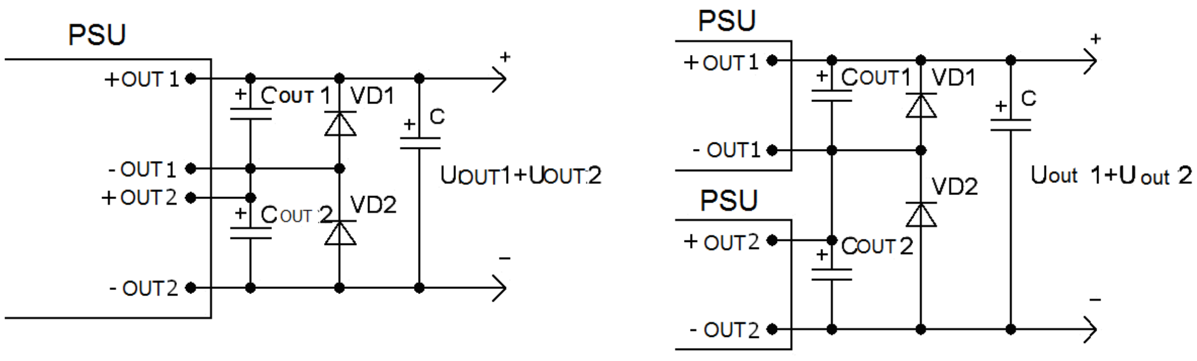
5.11.2 When the heat protection is activated, output voltage equals zero. After a cool down, the unit resumes normal operation automatically.

5.11.3 Thermal protection temperature is within the range from +82 to +95 °C. Switch on/off hysteresis of thermal protection is 2-3 °C.

5.12 Connecting output channels in series

5.12.1 Output channels of single-channel and multi-channel modules can be connected in series to increase the output voltage. The output of each channel must be bridged in reverse by diodes with low forward voltage drop, for example, Schottky diodes, with maximum forward current higher than maximum load current and maximum reverse voltage by 20-25 % more than the total output voltage.

Examples of series connection of output channels of modules, as a way to increase the output voltage, are shown in Figure 5.10.



Picture 5.10 - Examples of series connection of output channels of modules as a way to increase the output voltage

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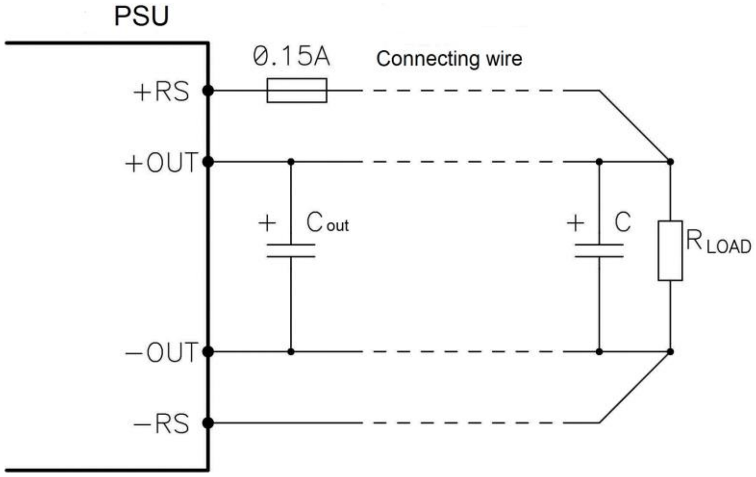
5.13 External feedback function application

5.13.1 Application of external feedback function allows compensating output voltage drop in connecting wires and separation diodes by as much as 5 % from output voltage value at Pout nominal. To use external feedback function, outputs «+RS» и «-RS» must be connected straight to the load in compliance with polarity. Connection is to be carried out by twisted pair of conductors with a minimum cross-sectional area of 0,1 mm^2. Connection example is given in picture 5.11.



Picture 5.11 – External feedback function realization

Capacity value of capacitor C depends on dynamic characteristics of the load. Total capacity, Cout and C, must not exceed the values, given in Table12.

5.13.2 Before using circuits of external feedback, it is necessary to eject two jumpers, shorting «+OUT», «+RS» and «-OUT», «-RS» (jumpers are installed in service connector X3).

5.13.3 It is strictly forbidden to switch on and use a PSU with unconnected terminals «+RS» and «-RS».

5.13.4 If the external feedback function is not used, two jumpers to short «+OUT», «-OUT» and «+RS», «-RS», must be installed. If the unit operates in vibration/shaking conditions, it is recommended to delete those jumpers and connect «+RS» и «–RS» with corresponding outputs «+OUT» and «-OUT» with a wire 0,25…0,4 mm in diameter.

5.13.5 It is recommended to install fuses for 0,15 A in external feedback circuit to eliminate breakdown of drive circuits should load circuit disconnect (with connected external feedback circuit).

5.14 Parallel operation function application

5.14.1 Connection of the units into parallel is carried out through paralleling of output circuits to powerful collector bars and their parallel operation outputs' interconnection as per pic. 5.12 –5.16. Also, it is necessary to follow these recommendations:

– the units must be located in immediate proximity. Isolation diodes and fuses must be connected with corresponding outputs of the units in the shortest possible way;

– conductors that connect outputs with collector bars must be the same, of minimum length and heavy-gauge. In addition, special attention must be paid to “minus” outputs – they must be as close to each other as possible. Voltage drop in such connection can cause additional voltage drift at «PAR» terminal, which may result in increase of input currents unbalance. Connection into «minus» terminals of output currents of isolation diodes and current-sense resistors is not allowed;

– collector bars also must be placed in immediate proximity to the output terminals, and these bars must have cross-sectional area N times bigger, than of those conductors connecting the units with collector bar, where N is a number of units connected in parallel;

– connection of collector bars to the load must be done in the middle part of the bars;

– remote feedback circuits have to be connected by a twisted pair of wires directly to the load with compliance with polarity;

- conductor, connecting «PAR» terminals of the units, must be placed far from the noise sources, should there be any of them in equipment. It is forbidden to connect capacitors, resistors or RC-circuits to «PAR» terminal, as it may cause unstable operation of units.

5.14.2 It is strictly forbidden to switch the output circuits when the units are in operation. Violation of these requirements leads to the failure of the control system of parallel operation of the module and entails waiver of the warranty.

5.14.3 Ampermeters to monitor the uniform power distribution among the units must be connected only to the input circuits of units.

5.14.4 Fuses (which are placed inside the module) and output separation diodes isolate the faulty module from the rest of the power supply system in case of failure.

5.14.5 As the dividing diodes VD1, VD2, VD3, Schottky diodes, with minimum voltage drop, are used. Their maximum reverse voltage must be 1,5–2 times greater than nominal output voltage of the modules. The maximum forward current of diodes should be at least twice as the maximum output current of the single module.

5.14.6 The possibility of parallel connection of outputs to work with a common load (pic. 5.12– 5.16) allows you to increase the total power output of the modules to the value of:

$$P_{total} = 0{,}7 \cdot N \cdot P_{nom}, \qquad (5.7)$$

Where:

0,7 – recommended load coefficient;

N – number of units, connected in parallel;

P_{nom} – nominal output power, W.

If the units are properly connected in parallel, unbalance of input circuits does not exceed 10 %.

5.14.7 The maximum quantity of units connected in parallel must not exceed 20 pcs.

5.14.8 For successful parallel operation, it is necessary to use power supply units of equivalent power with the same nominal output voltage, with a spread of not more than 1 %. It is strongly recommended to use power supplies from one production batch.

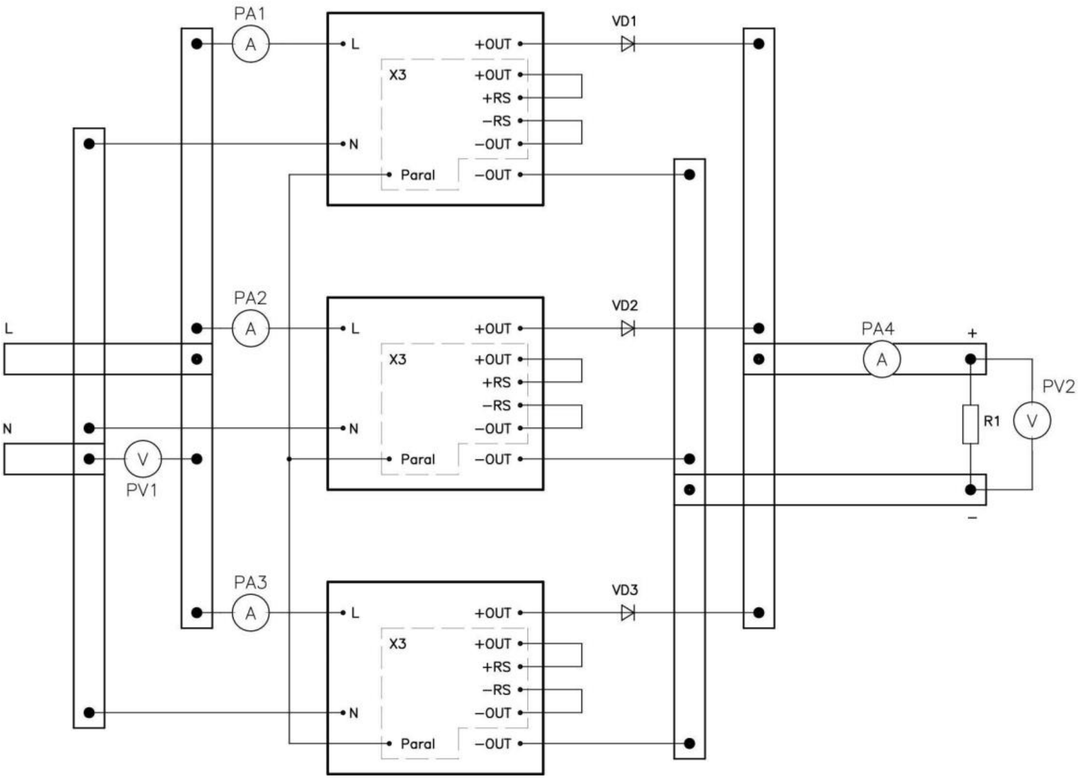
5.14.9 Voltage at the «PAR» terminal regarding «-OUT» at service connector X3 with 100 % load must be in a range 2–2,1V, and must alternate in direct proportion to output current.

5.14.10 Back-up system construction by N+M method with interchangeable modules (Pic. 5.12). It is necessary to place isolation diodes at each unit’s output. Output voltage at the load directly would be less than the output voltage of the unit by a voltage drop at VD1–VD3 and connecting wires. Voltage drop can be compensated by output voltage adjustment function, by means of variable resistor ADJ (installed in the unit), within a range of 5 % of the output voltage value. For that matter, before connecting units in parallel, output voltage of each unit **separately** is adjusted to the necessary value.

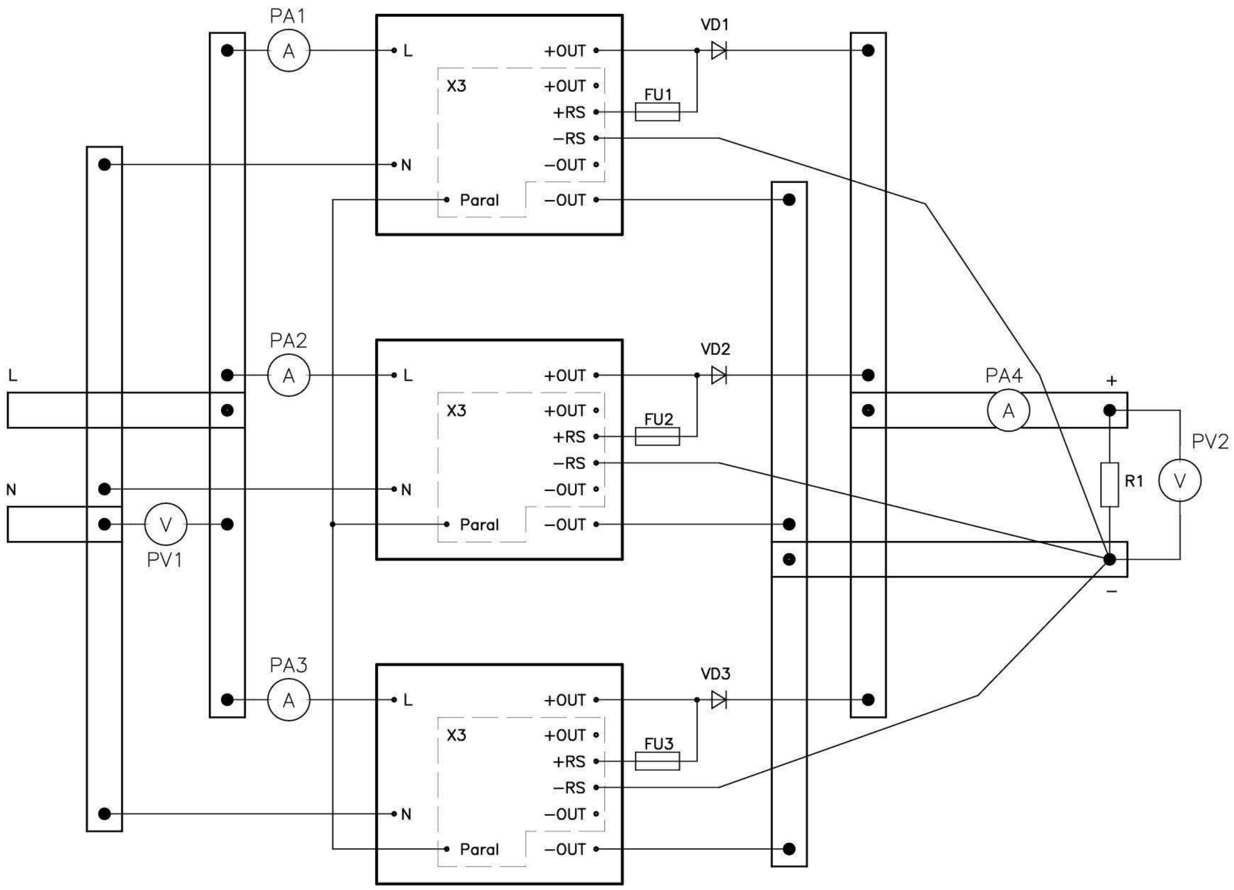
5.14.11 Building a back-up system by N+M method with interchangeable units (pic. 5.13), using external feedback function. Terminals «+RS» и «-RS» of each unit are connected directly to diode anodes VD1–VD3 and load with compliance with polarity. External feedback can compensate voltage drop in connecting wires up to 10 %.

5.14.12 Of course, there are other ways to build a back-up system, which can be stipulated by peculiarities of the customer’s equipment and primary power supplies. In this case, it is necessary to ask a manufacturer for any additional consulting materials.

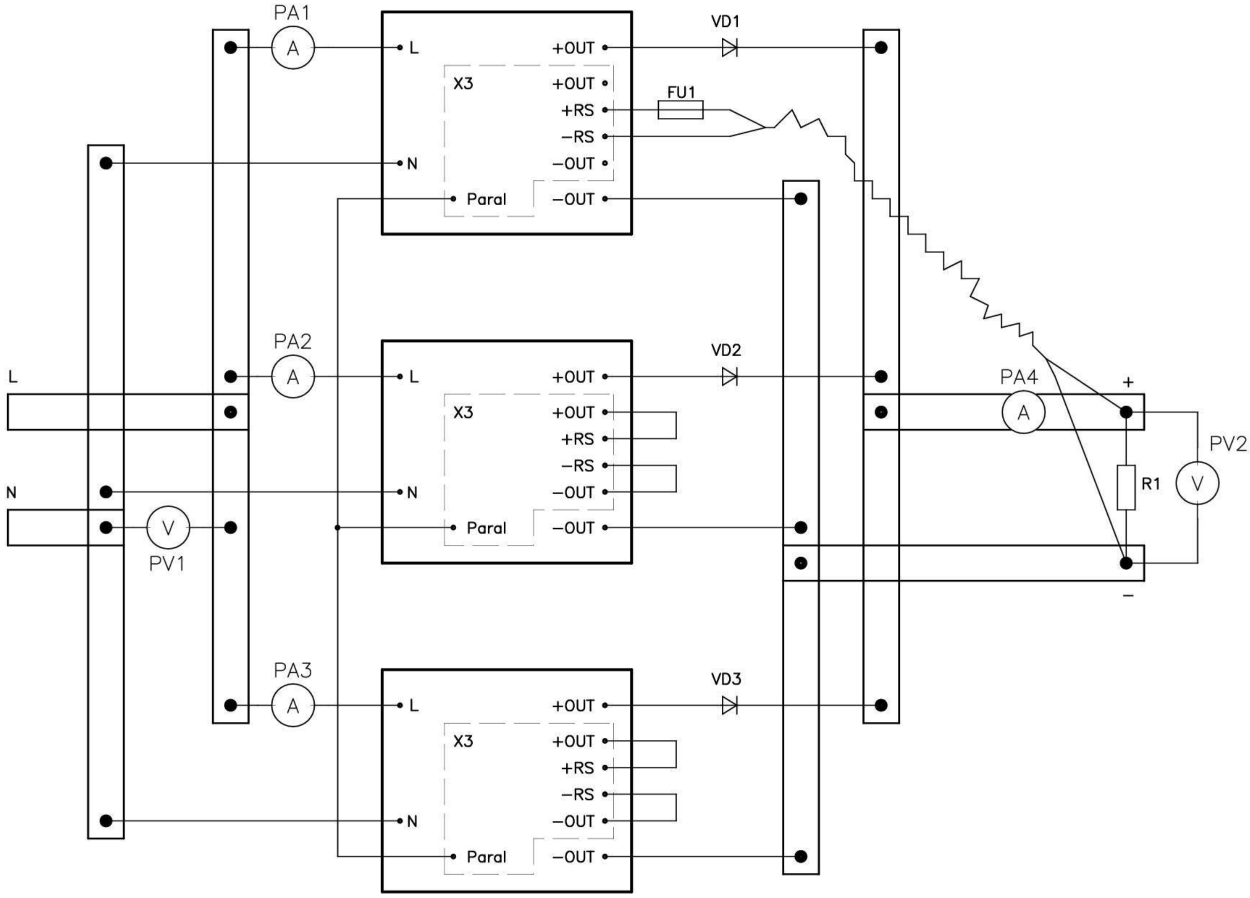
5.14.13 System construction as per «master-slave» method, limited back-up (pic. 5.14). External feedback terminals «+RS» и «-RS» of only one unit are connected directly to the load with polarity compliance. This unit can be a master, others are slaves. In master units, «+RS» и «-RS» terminals are connected directly to «+OUT» and «-OUT» correspondingly.



Picture 5.12 - Back-up system built by N+M method with interchangeable modules



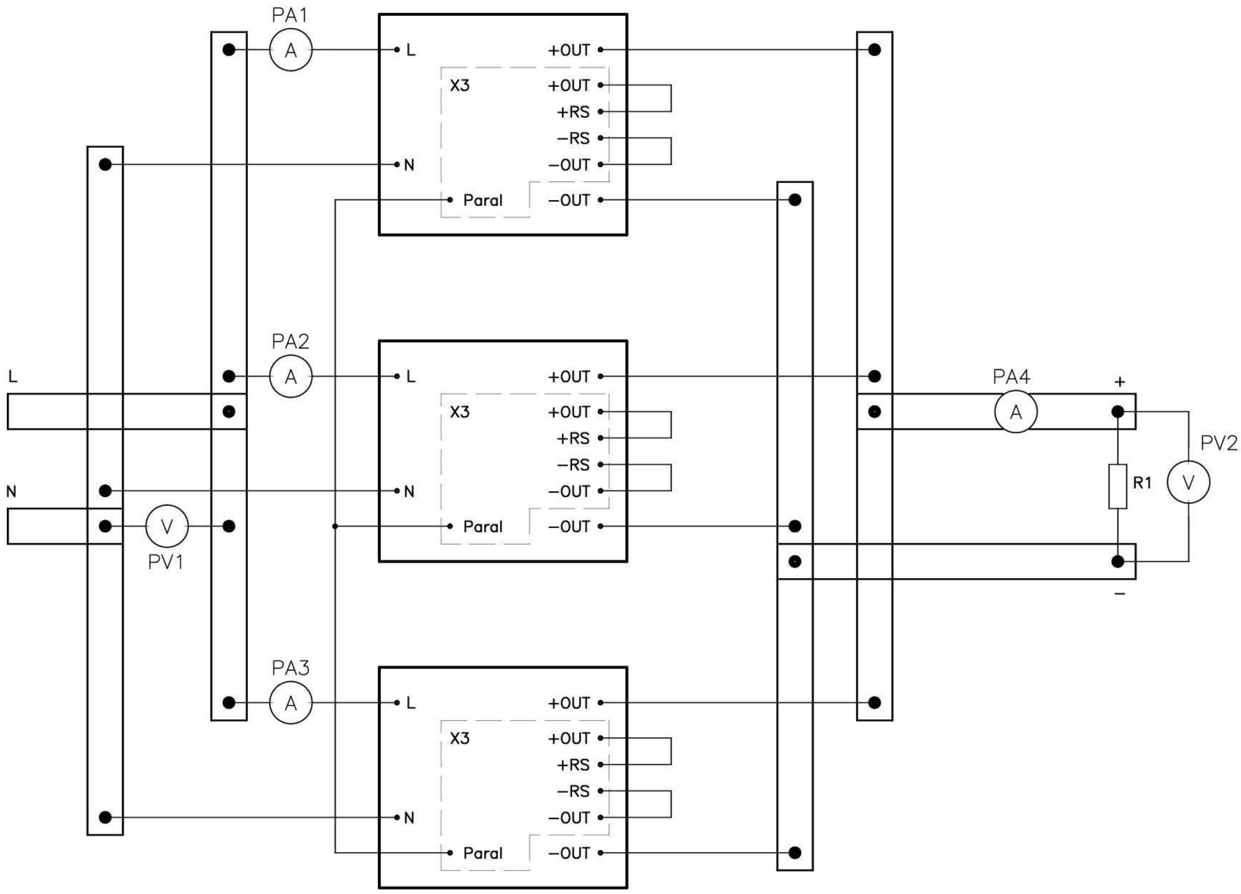
Picture 5.13 - Back-up system, built by N+M method with interchangeable modules and external feedback function application



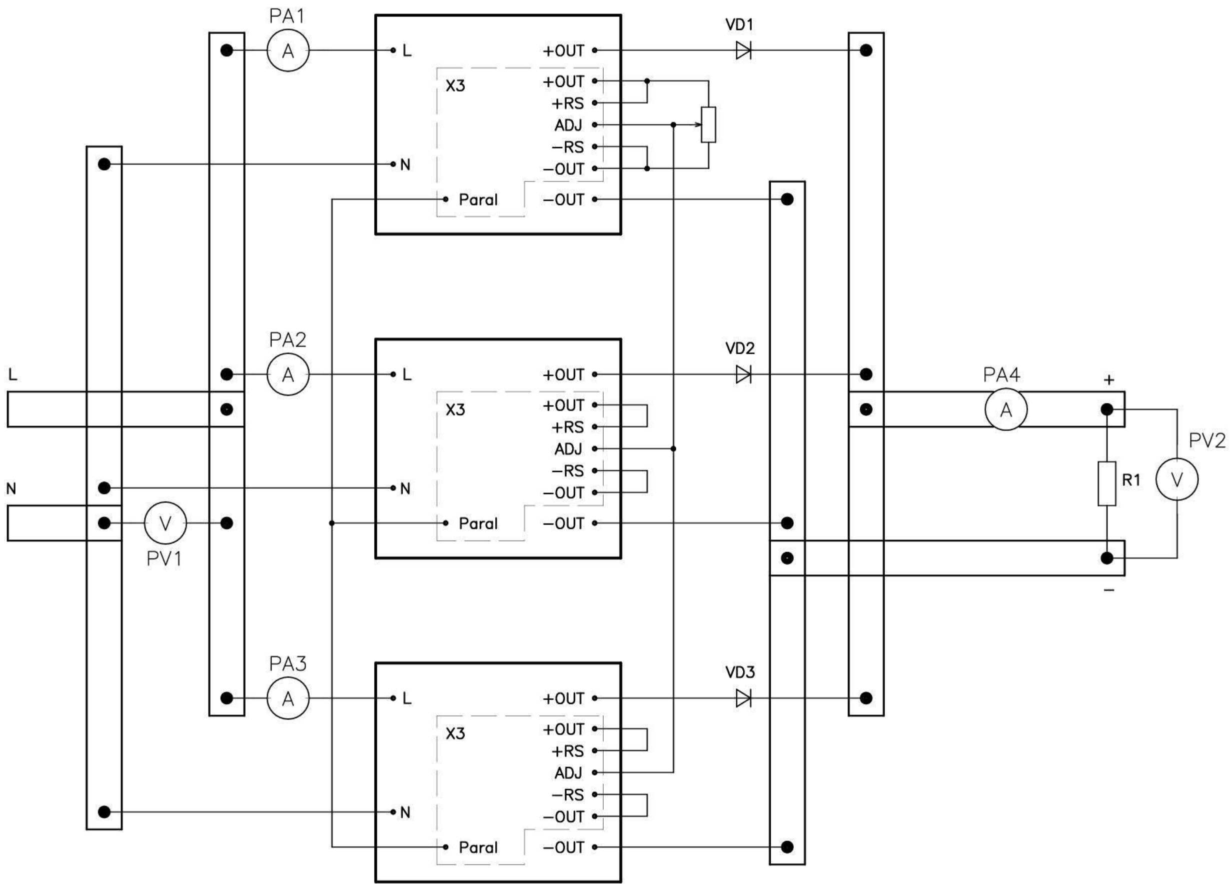
Picture 5.14 - System built according to «master-slave» method

5.14.14 Increasing the output power. In those cases, when no back-up is needed, but still it is necessary to increase the output power, it is possible to apply the scheme without isolation diodes (pic. 5.15). When using such method, it is extremely important to check all the modes, in which the equipment will be working, with respect to stable operation (stability of the output voltage, current unbalance, launching). As far as stable operation mode is concerned, scheme with isolation diodes is more preferable, because the diodes exclude influence of the units on each other.

5.14.15 Total output voltage adjustment of the units connected in parallel (pic.5.16). Output voltage adjustment is carried out within a range from – 30 % to + 10 % of the nominal value of the parameter. «ADJ» terminals of the units, connected in parallel, must be connected together and connected to the middle pin of external regulation potentiometer. To secure stable operation of the units connected in parallel, plus and minus conductors of potentiometer must be connected to «+RS» and «–RS» terminals of one of the units. Conductors to the external adjustment must be short and twisted together, if possible. Output voltage adjustment has no influence on input current distribution among the units.



Picture 5.15 - Scheme for increasing output power



Picture 5.16 - Total output voltage adjustment function for modules connected in parallel

5.14.16 When applying parallel connection, it is strictly forbidden, during units functioning, to perform output voltage adjustment by means of variable resistor ADJ, installed in the units. For that purpose it is necessary to follow recommendations in p. 5.14.15.

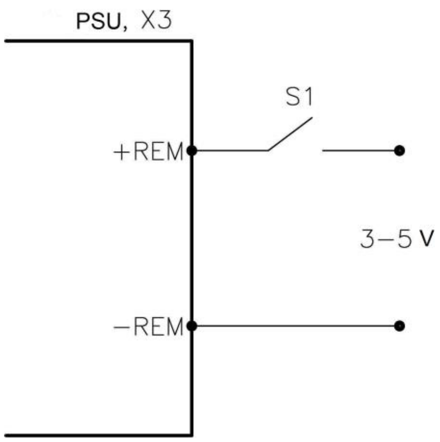
5.14.17 Common output of the units connected in parallel must be bridged by tantalum and aluminum capacitors with low full resistance (Low ESR). Capacity and recommended types of capacitors are given in Table 11, capacity has to be increased by N-times, where N is a number of modules being connected in parallel.

5.14.18 In order to get acquainted with parallel operation function, it is recommended to use EVA-JETA device. The device consists of three units connected in parallel, those can be JETA700, JETA1200 or JETA2000 types. There is a possibility to monitor following parameters of each unit: input voltage, input current, input power, power factor, output voltage, case temperature. And also, common parameters, such as output current and output peak-to-peak ripple and noise.

5.15 Remote on/off function

5.15.1 For JETA300…JETA3000 units remote on/off is performed by applying/removing voltage (3–5 V) on «+REM», «-REM» terminals from a separate source. Current in circuit «+REM», «-REM» must not exceed 5 mA.

5.15.2 Typical example of remote on/off function realization is given in pic. 5.17.

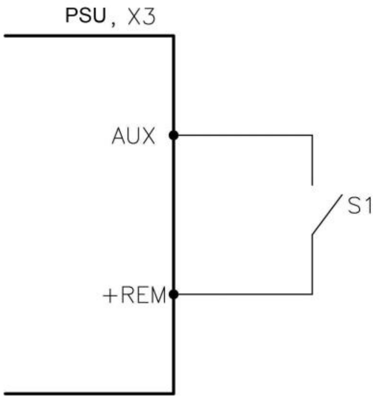


Picture 5.17 – Typical scheme for remote on/off function connection

5.15.3 If remote on/off function is not used, «+REM», «-REM» terminals must be left unconnected.

5.15.4 For JETA2000, JETA3000 types, remote on/off may be additionally performed by connecting/disconnecting of («clean» contact) «AUX» and «+REM» terminals. Output voltage at «AUX» in respect to «-REM» does not exceed 7 V.

5.15.5 Typical scheme for remote on/off function implementation (by means of AUX terminal) is given in pic.5.18.



Picture 5.18 – Typical scheme for remote on/off function implementation (by means of AUX terminal)

5.16 OGOOD function application (OUTPUT GOOD)

5.16.1 The signal shows the status of the output voltage and is galvanically isolated from the input, output circuits and the case. It is used to verify, that the output voltage is within the prescribed limits and is steady before connecting the load, or to determine the broken unit, for example, in a back-up power supply system.

5.16.2 If output voltage is above 70 % of its nominal value, +OGOOD and –OGOOD terminals must have «open collector transistors» indication signal.

5.16.3 The maximum voltage that can be applied between +OGOOD и –OGOOD, is 20 V, sink current must not exceed 15 mA.

5.17 Minimal load currents, zero load

5.17.1 The units can be safely switched on with zero load. The unit must have stable output voltage, without relaxation.

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5.17.2 Application of modules with current loads less than $0{,}1 \cdot I_l$ is allowed. The amplitude of the output voltage ripple is not specified, but usually it does not exceed 2-3 %. The output voltage in this case must not exceed the values specified in 2.1.1.9.

5.18 Full-load amperage

5.18.1 Long-term operation of the module (more than 1 minute) at load currents exceeding maximum values is strictly prohibited.

5.18.2 During connection of output terminals of the units for a more even load current distribution, it is necessary to use all available contacts (pins, outputs of terminal blocks).

5.19 Transient load operation

5.19.1 When operating with transient load, in order to reduce transient instability, it is recommended to shunt the output pins of the unit by tantalum or aluminum electrolytic capacitors, with capacity not less than shown in Table 11, and not more than shown in Table 12. Connection schemes are shown in Figure 5.5. The capacitors must be located as close as possible to the output circuits of the unit.

5.20 DC mains operation

5.20.1 Feed from DC is allowed, with such nominal voltage:

- 320 V for input voltage «230» and steady deviation range from 248 to 343 V;
- 320 V for input voltage «230W» and steady deviation range from 141 to 343 V;
- 160 V for input voltage «115» and steady deviation range from 113 to 198 V.

Input voltage is fed to «L», «N» terminals without any compliance with polarity.

5.20.2 Feed from DC mains is allowed, with such nominal voltage:

- 565 V for input voltage «400» and steady deviation range from 430 to 643 V. Input voltage is fed to any terminals «A», «B», «C» without any compliance with polarity.

5.21 Reduction of high-frequency noises

5.21.1 If there are any EMC requirements to the units, it is necessary to connect filters to the input. Connection scheme of PSUs together with filters along is illustrated in pic. 5.6.

5.22 Operation of modules at negative ambient temperatures

5.22.1 Startup of JETA60, JETA120 series at Tamb = -40 °C takes maximum 5 seconds, at Tamb = -50 °C, maximum 10 seconds.

5.22.2 For JETA60, JETA120 series output voltage peak-to-peak ripple will reach maximum level of 2 % during 15 seconds from the moment of startup, Tamb = -40 °C. With ambient temperature being -50 °C this period will equal 20 seconds.

5.22.3 For JETA300, JETA700, JETA1200, JETA2000 series with input voltage within a range 100…176 V, output voltage peak-to-peak ripple settles at the level of 2% during 5–15 seconds from the moment of startup at ambient temperature -50 … -40 °C.

5.22.4 When using power supplies within an ambient temperature range from –50 °C to –10 °C maximum output power is necessary to specify in accordance with graphs given in Appendix A. If the units are used with Pout exceeding values limited by the corresponding curve (grey area in the graph), some of the parameters may outcome the limits, stipulated by this specification. For example, startup time can be increased, maximum level of output voltage peak-to-peak ripple may be exceeded.

5.23 Electrical safety rules for units' operation

5.23.1 Anyone under the age of 18 cannot be allowed to work with the power supply units. Special training with electrical safety qualification level at least 3 (operation with electric appliances/equipment up to 1000 V), as well as certificate of a relevant format, is obligatory.

5.23.2 «Case» terminal of the unit must be connected with ground electrode by grounding conductor. Grounding conductor's cross-sectional area must be at least 1,5 mm^2 for isolated copper wires and not less than 2,5 mm^2 for aluminum wires.

5.23.3 In electrical installations up to 1 kV with solidly grounded neutral wire, to provide automatic disconnection of faulty circuit, it is necessary that conductivity of phase (L terminal) and neutral (N terminal) conductors must be such, that in case of short-circuit to case or neutral protective wire there would flow a short-circuit current of a value:

- three times higher than the nominal current of melting element of the nearest fuse;
- three times higher than the nominal current of non-adjustable CB (circuit-breaker) or a set value of adjustable CB of automatic switch, with inverse proportion of switch-off time to flowing current.

5.23.4 When circuits are protected by automatic CB switches, with electromagnetic breaker only, conductivity of mentioned wires must provide current higher than set value of instant action, multiplied by a tolerance coefficient of manufacturer's regulations and additional margin coefficient of 1,1. Without manufacturer's regulations for automatic switchers with nominal current up to 100 A, short-circuit current multiplication coefficient should be not less than 1,4; for switches with current of more than 100 A – 1,25.

5.23.5 Overall conductivity of a zero protective conductor (terminal N) in all cases must be not less than 50 % of a phase conductor conductivity.

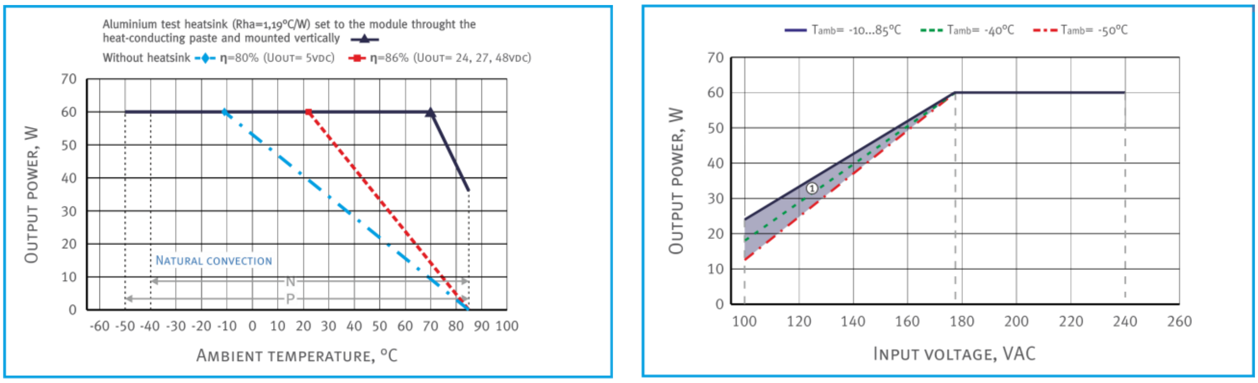
5.23.6 In circuits of ground and zero protective conductors there must be no disconnection devices or fuses.

5.23.7 Single-pole circuit breakers must be installed in phase conductors (terminal L), but not in neutral conductor (terminal N).

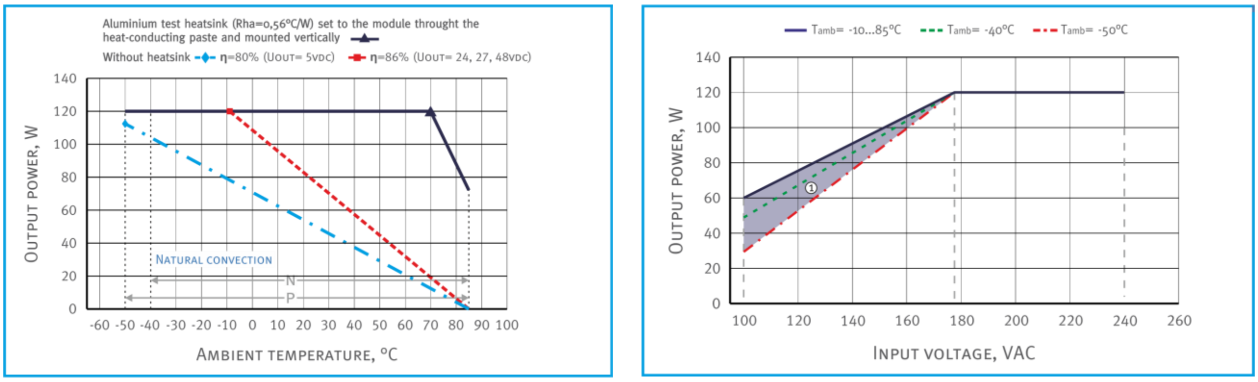
5.23.8 Every unit must be connected to grounding circuit by individual wiring. Series connection into grounding or zero protective conductor of the units, being grounded, is not allowed.

APPENDIX A

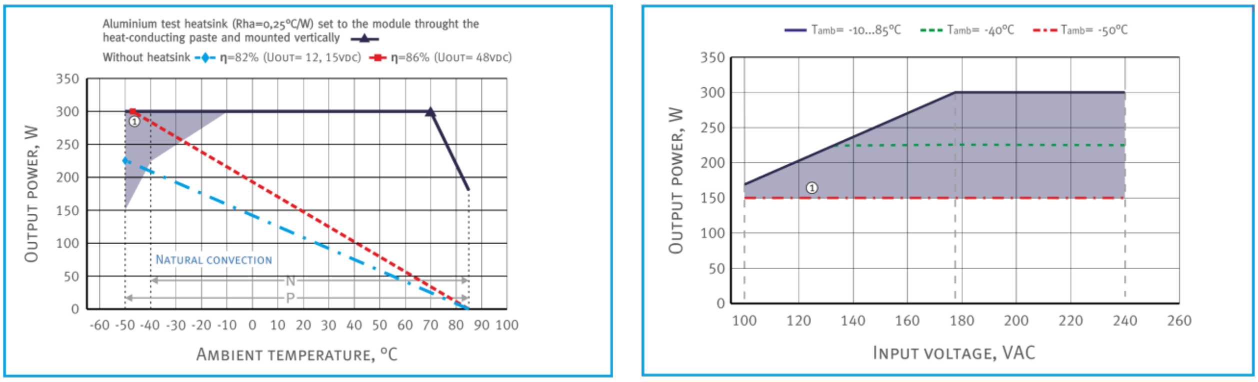
Maximum output power vs Ambient temperature with input voltage within 176…264 V and vs Input voltage in conditions of natural air convection



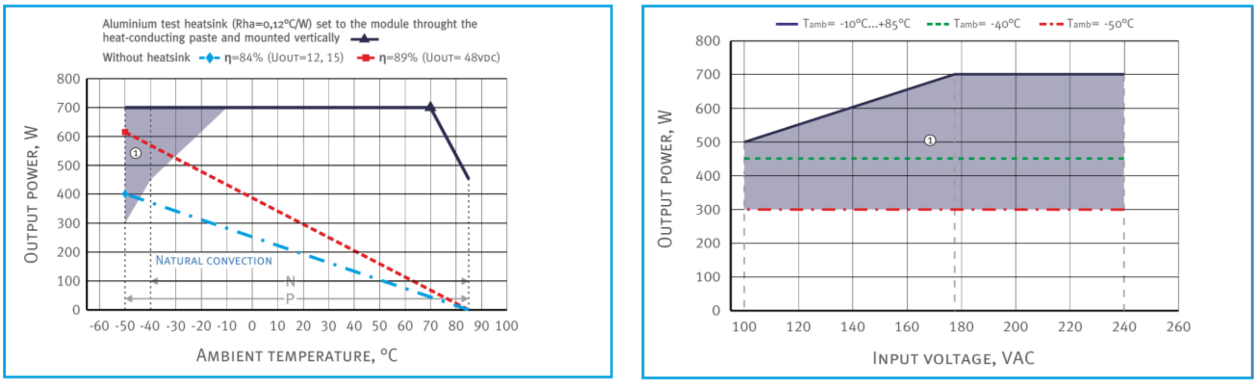
Picture A.1 – for JETA60



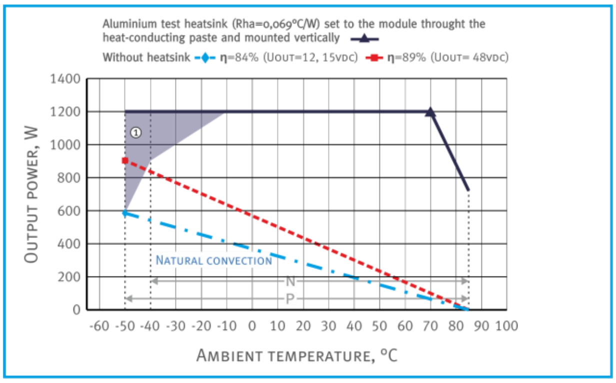
Picture A.2 - for JETA120

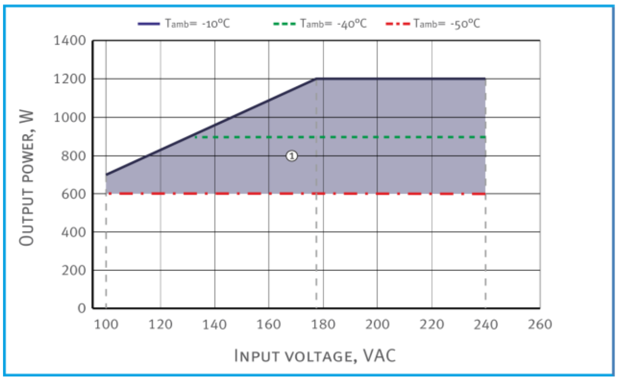


Picture A.3 - for JETA300

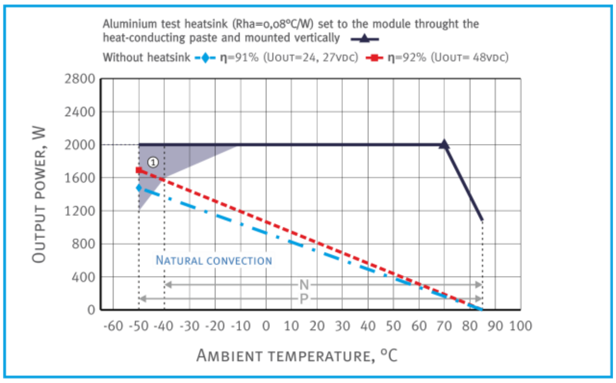


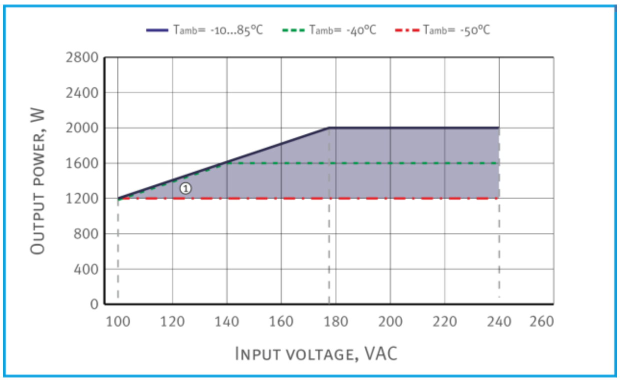
Picture A.4 - for JETA700



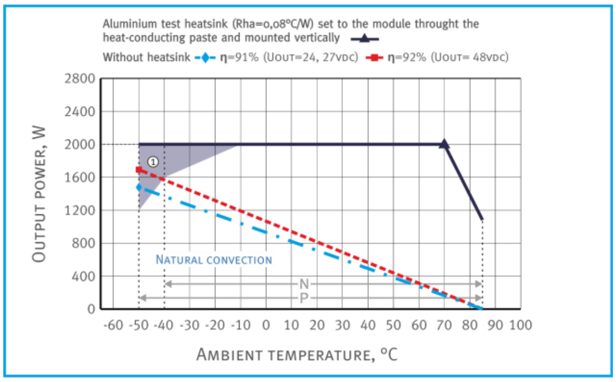


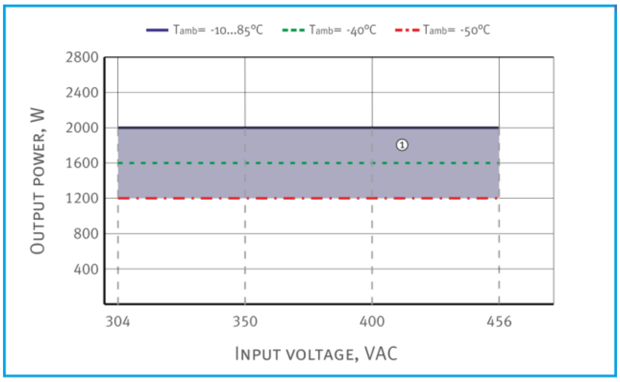
Picture A.5 - for JETA1200



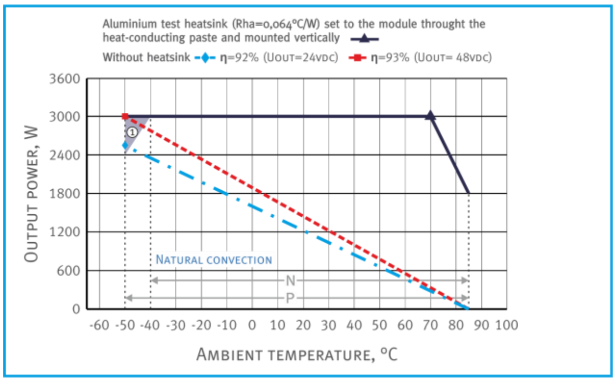


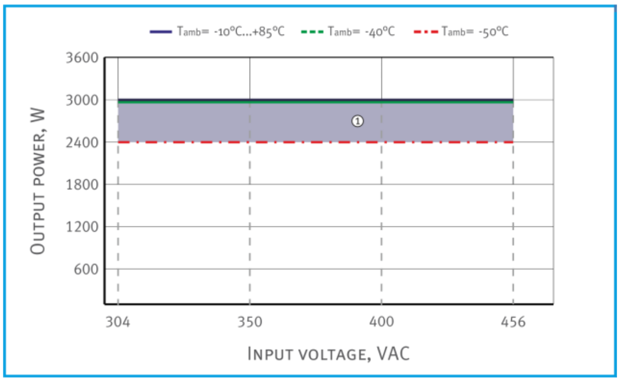
Picture A.6 - for JETA2000





Picture A.7 - for JETA2000 (3-phase)





Picture A.8 - for JETA3000 (3-phase)