Application notes on a fanless solution: UHP-1000

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MEAN WELL's UHP-1000 series has been designed to provide a fanless solution. The unique fanless design solves dust ingression issues, thus effectively reducing equipment maintenance frequency, cost overhead, while at the same time making UHP-1000 perfectly suitable for indoor equipment with silent operation requirements. Its comprehensive functionalities are widely used in various applications, some of which are detailed in depth, below, as application examples.

UHP-1000's adaptive control and flexible heat dissipation options makes it a suitable solution for a wide range of applications, from industrial constant voltage applications to charging systems. The semi-potted design makes UHP-1000 a strong and slim fanless power supply resilient to vibrations and dust ingression along with considerably extended lifetime. It comprises international certifications for IEC/EN/UL 62368-1, and compliance with both EN61558-1 and household safety EN60335-1 are available upon request. It is also capable of a high-altitude operation of 5000m under a wide working temperature range from -30°C to +70°C and with universal AC mains input. The inclusive output voltage range of 12V, 24V, 36V and 48V of UHP-1000 makes it adaptable to various systems.

Figure 1: UHP-1000

Programmable output:

Along with DC OK signal, Remote ON-OFF control, and an auxiliary 12V output, UHP-1000 also comprises Programmable Voltage (PV) and Programmable Current (PC) functions, thus allowing a wide output voltage range, with fixed or dynamic control to fit most applications. For example, a thermal

controlled chamber might sense the temperature and adjust the power supply output voltage to control the heating element accordingly. Programmable Current can be useful for charging applications or LED control.

As shown in Figure 2 below, UHP-1000 output voltage can be adjusted with an external DC 2.5V to 6V signal, allowing an extra adjustment from 50% to 120% of the rated output voltage. When using PV control, the maximum output current is automatically adapted taking into consideration the set output voltage to prevent overpower or overheat.

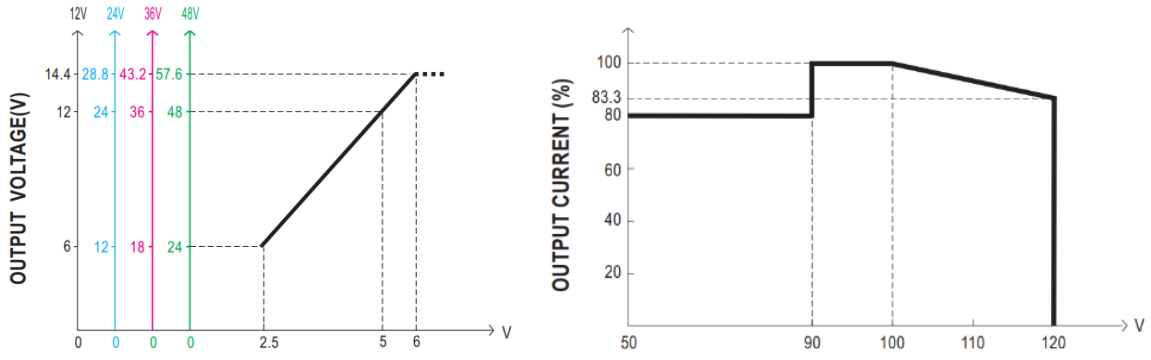

Figure 2: PV control and automatic derating curve

PC mode can limit the current down to 20% of the rated output current (Figure 3). Many applications such as motors or capacitive loads create high inrush currents. PC control is particularly useful to limit this inrush current to a certain constant current value determined by the user. Programmable current control is also suitable for other applications that require constant current operation, such as LED lighting for brightness adjustment or charging systems.

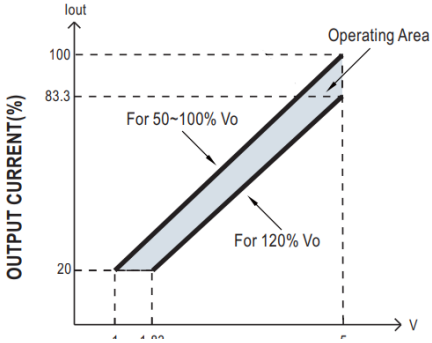

Figure 3: Output current programming

A combination of both PV and PC controls is possible which makes UHP-1000 very flexible and suitable for charging applications (cf. Application Example 1) as well as for applications with high inrush currents (cf. Application Example 2).

Vibration and shocks:

The semi-potted structure associated with the aluminum case of UHP-1000 result in a strong and reliable mechanical design capable of withstanding 5G vibrations that meets the high demand in terms of resilience to shocks and vibrations in the automotive industry.

Thermal considerations and design guide:

The aluminum enclosure itself has been specially conceived to efficiently dissipate the generated heat, while getting over the need for using integrated fans. This considerably increases the lifetime and the reliability of UHP-1000, while making it suitable for audible noise sensitive applications, and dust prone environments. The optimized thermal management makes it possible to achieve a low-profile design of 41mm along with high power density. Its slim form factor enables its use for applications with limited available space.

In order to take full advantage of the potential of UHP-1000, special attention should be brought to the cooling method. Many options are available, making UHP-1000 seamlessly integrable into already existent systems:

1) <u>Convection cooling:</u>

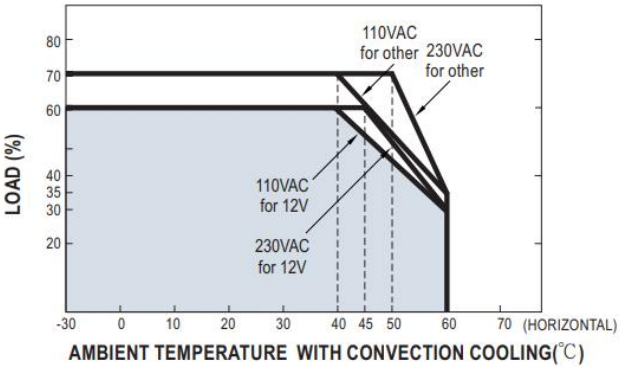

Figure 4: Convection cooling derating curve

Convection cooling is the most convenient way to dissipate the heat generated during power supply operation. It requires no fan, thus there is no emission of audible noise and no forced dust ingression inside the power supply. This solution is viable for loads drawing below 60-70% of the rated power. To allow natural airflow out of the unit, a clearance distance of 10cm above it should be respected. For higher power demand, forced air cooling and conduction cooling are more suitable.

2) <u>Forced air cooling:</u>

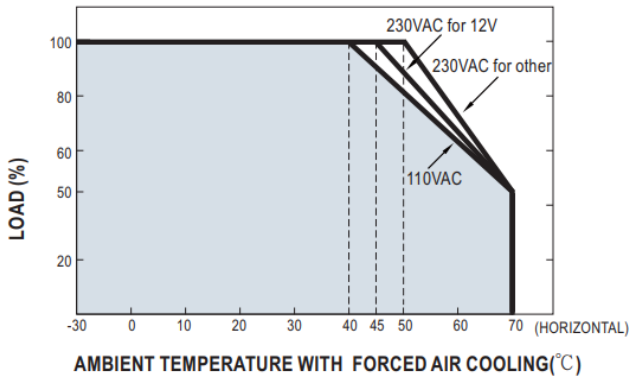

Figure 5: Forced air cooling derating curve

If a need for higher power arises, forced air cooling is an option. Adding an external fan to the side of the UHP-1000 will allow a better heat dissipation. A suggested installation is shown below:

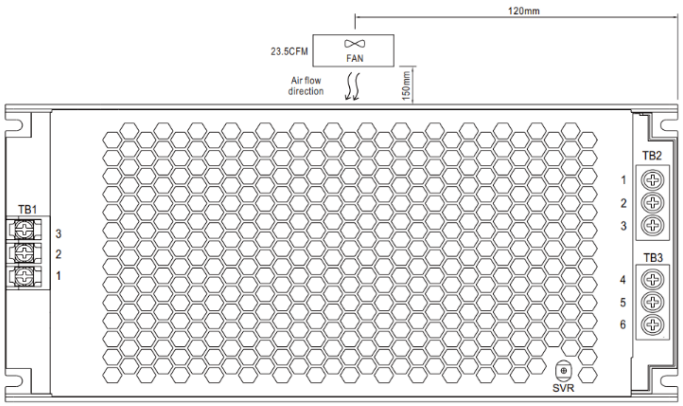

Figure 6: Fan configuration

This solution can take advantage of an already existing fan in your installation, as long as it provides enough airflow to maintain the unit to a temperature comprised within its operation range.

3) <u>Conduction cooling:</u>

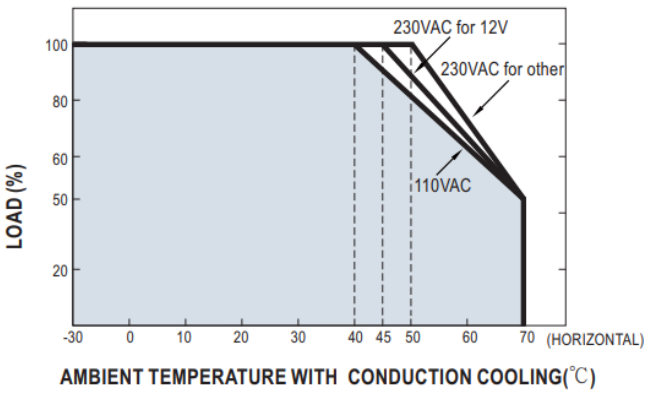

Figure 7: Conduction cooling derating curve

This cooling method is particularly adapted to situations with high power demand, and when the use of a fan is undesired. The UHP-1000 should be attached to a large metal mass that can help the unit absorb and dissipate the heat. Many options are available, among which one reference design using an aluminum plate is shown here:

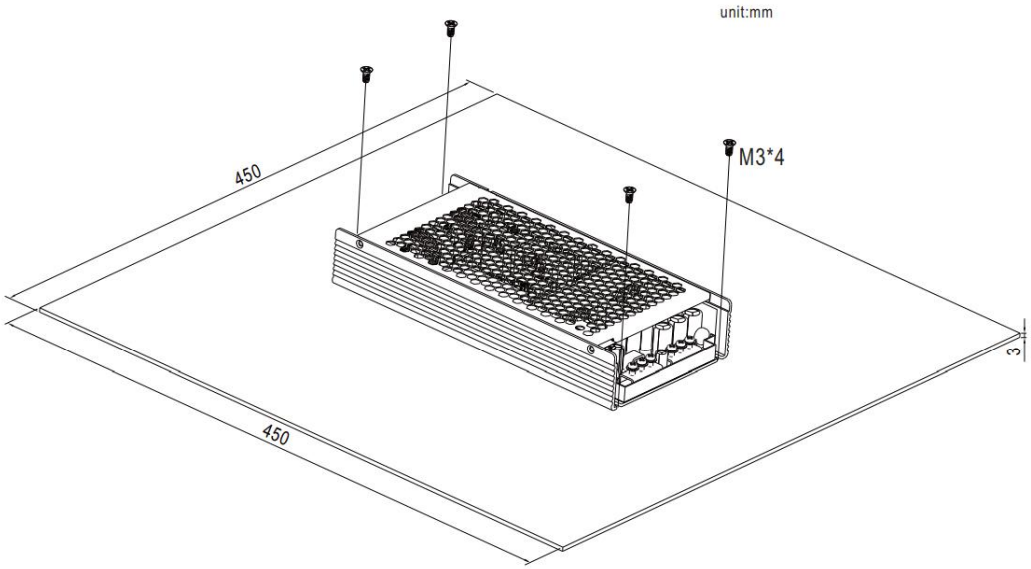

Figure 8: Aluminum plate configuration

The conduction cooling method can be very convenient if the UHP-1000 can be mounted directly onto a metal chassis as long as the surface is smooth and thinly coated with thermal grease.

Verification of the thermal design:

No matter what is the selected solution, here is a simple way to verify that the chosen cooling method is adapted:

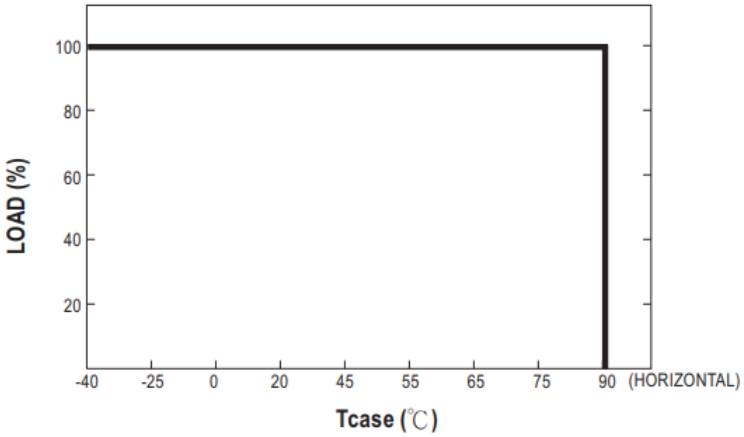

Figure 9: Case temperature derating curve

The measurement of the case temperature (at t_c point, shown below) after a few hours of operation is a good indicator of the reliability of the cooling design: as long as the temperature does not approach 80-90°C, the thermal design is valid.

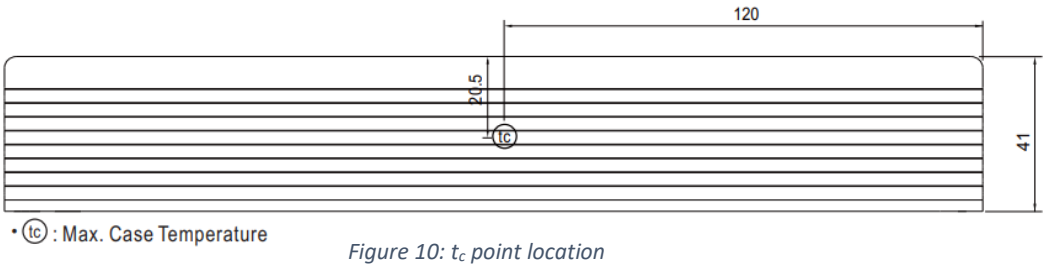

Figure 10: t_c point location

Another important factor to take into account is the ambient temperature. For all cooling methods, if the ambient temperature reaches 40-50°C, user should limit himself the power drawn from UHP-1000 according to the derating curves. If necessary, it is recommended to upgrade to higher power products to ensure the reliability of the system.

Application examples:

1. **Charging applications:**

The versatility of UHP-1000 allows its use for many charging applications: from lead-acid batteries to super-capacitor banks, UHP-1000 can efficiently and reliably adapt to each situation:

Lead-Acid battery

Below are the ratings of a 12V/200Ah Lead-Acid battery as an example:

Nominal Voltage	12V
Number of Cells	6
Rated Capacity (77°F/25°C)	200Ah (20 Hour Rate to 10.5V)
Reference Capacity (77°F/25°C)	C3: 152.9Ah
	C5: 172.3Ah
	C10: 190.5Ah
	C20: 200Ah
Internal Resistance	3.5 mΩ
Self-discharge Rate (77°F/25°C)	<3% / month
Float Charge Voltage (77°F/25°C)	13.6V~13.8V
	Temperature Compensation: -18mV/°C
Cycle Use Voltage (77°F/25°C)	14.4V~14.8V
	Temperature Compensation: -24mV/°C
Equalization Voltage (77°F/25°C)	14.2V
Max Charge Current	60A

- Constant voltage charging operation:

The constant charging voltage level should be set to 14.4V with the help of the integrated potentiometer or with PV control.

- Constant current operation:

According to the battery specifications, the maximum charging current is 60A. Hence, PC control should be set at 60A by applying an external voltage of 4.5V to PC pins.

- Floating operation:

The charging voltage should be reduced to 13.6V here. This can be done by tuning down the integrated potentiometer SVR or, by applying an external voltage of 5.6V to PV pins.

Supercapacitor banks:

Regarding super-capacitor banks, attention should be brought to the maximum capacity of the bank. If the capacity of the bank exceeds these values, the power supply will enter Under Voltage Protection mode because of the low voltage imposed at the beginning of the process by the discharged bank, and will shut-down after 3s.

UHP-1000 version	Maximum bank capacity (1)
12V	114F
24V	33F
36V	15F
48V	10F

Table 1: Supercapacitor bank maximum capacity

Note 1: Values given for a constant current charging of 110% of the rated output current, with the capacitor bank directly attached to UHP-1000, without current limiting device.

2. Heating element:

The amount of heat generated by the heating element can be conveniently controlled using PV function. Indeed, the power dissipated by a resistive element is $P=V^2/R$, so the output voltage is directly correlated to the amount of heat produced. This can be particularly useful when the system needs different heating stages, with different temperatures.

Also, most heating elements have the characteristic of presenting an extremely low resistance at start-up which will lead to high inrush current. UHP-1000 automatically clamps the inrush current

at 105-120% of the rated output current as long as it lasts less than 3s. Otherwise, the unit will enter Overload Protection mode and will shut down after 3s.