

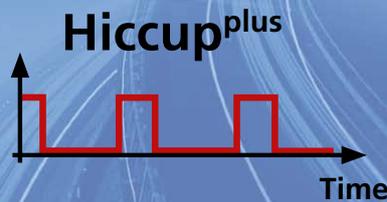
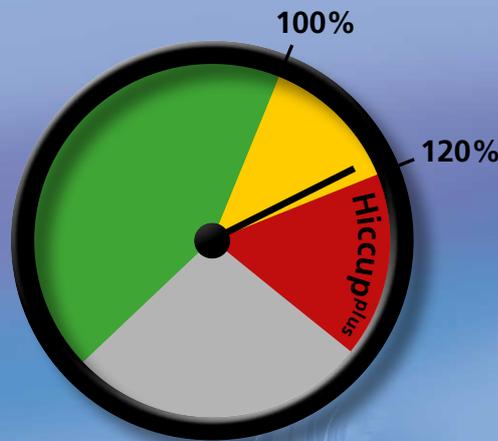
Rediscovered and Refined: Power Supplies with Hiccup Overload Behavior

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Technological progress gives new life to a circuit rarely used in today's designs.

PULS has rediscovered the old Hiccup mode and refined it into the Hiccup^{plus}.

The addition of micro-controllers in power supply designs, has made it possible to eliminate the weaknesses in what in principle is a good technology.



Hiccup circuitry was considered too sensitive in conjunction with motors or loads that are equipped with large input capacity. Paralleling of power supplies or battery charging could be critical with the old Hiccup overload behavior. In principle, the Hiccup overload behaviour is a safe choice when it comes to the protection of cables or loads.

The low effective short circuit current at the output avoids damage in cases of load or wire failures. The whole system can be designed with more economical wire sizes, and ultimately power supplies are less expensive and up to 20% more compact. With the Hiccup^{plus} mode, PULS has found a new way to eliminate the weaknesses and exploit the advantages.

Switch-mode power supplies limit the output current during overload. If the maximum current is reached, the power supply automatically switches from voltage regulation mode to the current regulation mode. The following functions can be identified in the current regulation mode:

- "Fold-Back Characteristics" (A) :
Here the current is reduced depending on the level of the overload. This behavior is inappropriate to start-up heavy loads and it is mainly used for linear regulated power supplies.
- "Constant Current Characteristics" (B) :
Here the current remains almost constant at overload.
- "Fold-Forward Characteristics" (C) :
Considered the most practical overload behavior, but carries the risk of a high short circuit current.
- "Hiccup Mode" (D) :
Switches off power in cases of overload or short circuit and carries out periodic attempted restarts until the fault is eliminated.

Danger can arise due to the high short circuit current which is often not monitored closely enough, particularly with more powerful power supplies. The fact that the impact of the current has on cables, terminals and contacts which dramatically increases with the current strength is underestimated. An increase in current from 20A to 30A generates an increase in losses from 20W to 45W with 50mOhm connection (corresponds approximately to 7m of 2.5mm² wire). That is more than 125% loss with a power increase of only 50%! A further complication is that the surface of the cables, which serves as cooling, changes only minimally with an increase in the conductor cross section.

Even more critical is the situation which occurs with redundant systems. To increase the reliability usually two power supplies in a 1+1 configuration are connected together via a diode or redundancy module. If for example, 15A is required, two 20A power supplies are chosen. With an "fold-forward characteristic", a 20A power supply provides almost 30A short circuit current. This means that with a short circuit, a continuous current of 60A flows and the losses compared to the nominal current of 15A increase to a factor of 16. The Hiccup mode is clearly an advantage here.

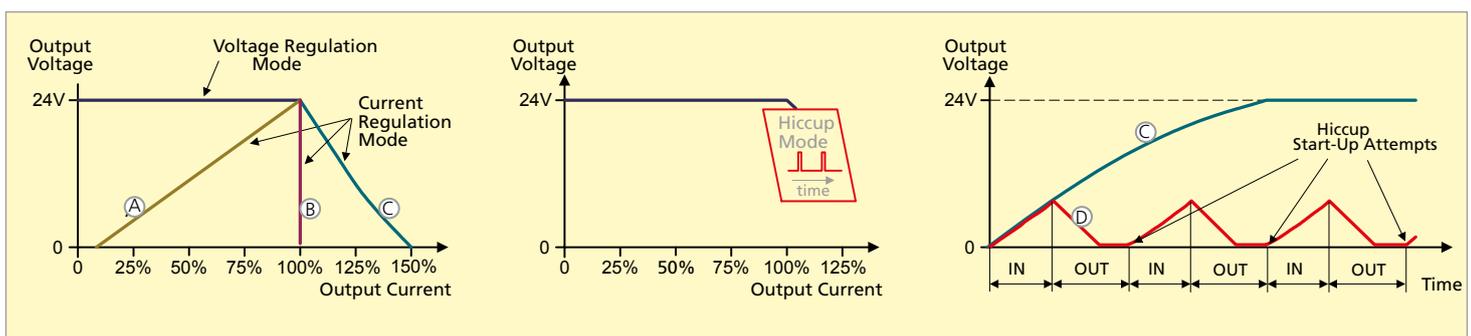


Figure 1
 (A) Fold-Back Characteristic
 (B) Constant Current Characteristic
 (C) Fold-Forward Characteristic

Figure 2
 Hiccup Overload Behavior:
 The power supplies switch off and makes periodic start-up attempts

Figure 3
 Start-up Behavior in Combination with Loads Requiring High Inrush Currents
 (C) With Fold-Forward Characteristics
 (D) With Hiccup Overload Behavior

The PULS Hiccup^{plus} Mode

In contrast to conventional Hiccup mode, the new PULS Hiccup^{plus} behavior is a combination of the "fold-forward characteristic" and Hiccup mode. After an overload or short circuit, the power supply unit provides continuous power for two seconds, then it automatically switches to the safe Hiccup^{plus} mode.

During these 2 seconds, the unit delivers 2 times the nominal current. This allows an easy start-up with heavy loads and there is also enough current to trigger a protective device in order to disconnect faulty circuits. Due to the long off-time of 18 seconds, the RMS current is significantly smaller than the nominal current even in the event of a short circuit.

Cables, switch contacts and connection terminals are not overloaded. The Hiccup^{plus} mode is only triggered if the output drops by more than 40%. This prevents undesirable shutdowns when charging batteries or with power supplies connected in parallel to increase the output current where no measures are available for balancing the current.

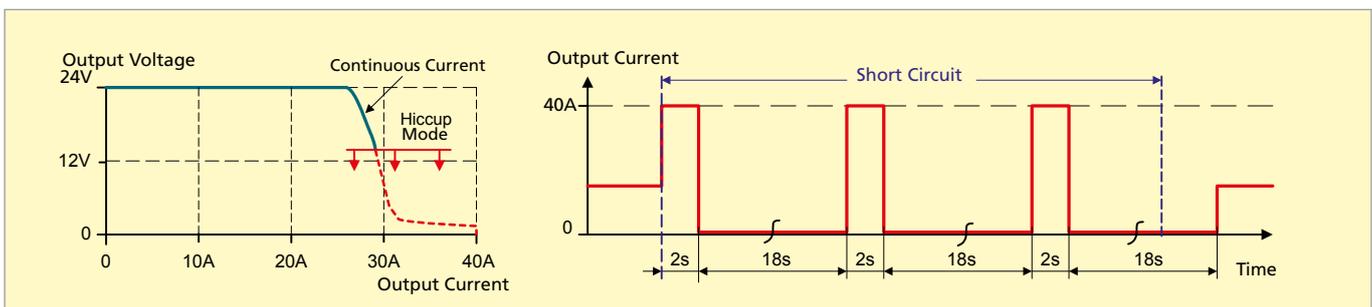


Figure 4
PULS Hiccup^{plus} Overload Behaviour: Supports high start-up currents without the risk of overloading cables in case of short circuits

The Hiccup^{plus} mode is now a standard in all current 480W and 960W 1-phase power supplies from PULS.

The latest addition to this line is the ultra-compact power supply CPS20. With a unit width of only 65mm, the CPS20 devices deliver safe 24V, 20A or 48V, 10A and are equipped with Hiccup^{plus} overload behavior. The full output power is available over a wide temperature range from -25°C to +60°C. To safely trip the output protective device, the unit can provide 4 times the output current at near full output voltage for at least 15ms.

Other features of the CPS20 include: 94% full-load efficiency and excellent partial load efficiency, active PFC, electronic inrush current limitation, DC-OK signal for remote monitoring and a provision for balancing the current when power supplies are connected in parallel.

The units are equipped with a wide range input and can be used in all global 1-phase mains-networks between AC 100V - 240V. There are also models available with ATEX approval and a DC input range of 88 and 375Vdc which round off the CPS20 group.

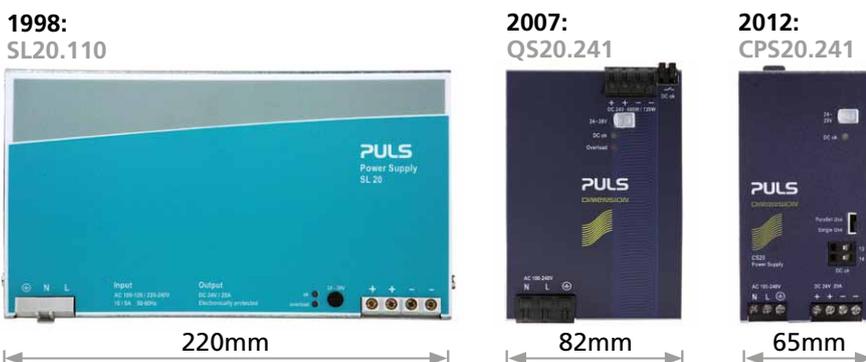


Figure 5
Innovation in 24V, 20A single phase power supplies