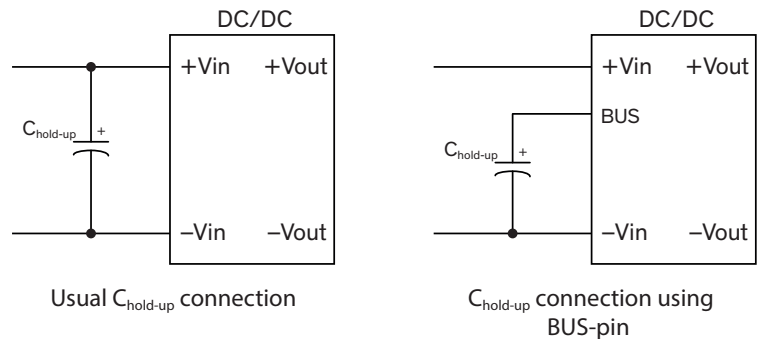


Summary

- 25 V capacitors can be used (independent of input voltage)
- Size reduction of hold-up capacitors
- Cost reduction of hold-up capacitors
- Inrush current reduction due to capacitance



Overview

One of the most common standards for railway applications is EN 50155 which describes for example the conditions of input voltage, ambient temperature, isolation and interruptions. To meet the specifications of EN 50155 power modules need to be able to provide voltages from 24 to 110 VDC with the following range:

Voltage Range	Duration	Criteria
0.7 to 1.25 U_n	continuous	A
1.25 to 1.4 U_n	≤ 1000 ms	B
0.6 to 1.4 U_n	≤ 100 ms	A

The TEP 40UIR and TEP 60UIR series are power modules capable to provide an ultra-wide input voltage range of 9 to 75 VDC or 14 to 160 VDC to suit a wide range of railway applications. This covers the extended range of 0.6 U_n (in the case of 24 VDC = 14.4 VDC) and 1.4 U_n (in the case of 110 VDC = 154 VDC).

Also, the TEP 40UIR and TEP 60UIR series come with an enhanced hold-up function to meet EN 50155 class S2. Usually, to meet the conditions of S2, S3 and C2 a variety of aluminium capacitors is needed to provide the energy to keep the module running. It is often difficult to choose the right capacitors to fit different voltage systems. The additional BUS-pin is an auxiliary power supply providing a fixed 21.4 VDC. This not only enables the possibility to use the same capacitors for the whole voltage range but also gives the option to use relatively cheap 25 V capacitors instead of many different high withstand voltage capacitors which usually are more expensive.

Interruptions and Change Over

Due to short-circuit on a DC supply distribution line and subsequent operation of fuse/circuit breakers, input voltage may drop to 0 VDC for a short period. When equipment supply is switched between different sources the equipment shall operate satisfactorily.

Class	Requirements
S1	No performance criterion is required but the equipment shall operate as specified afterwards
S2	Performance criteria A for voltage interruptions up to 10 ms
S3	Performance criteria A for voltage interruptions up to 20 ms
C1	Performance criteria A for a duration of 100 ms at 0.6 Un
C2	Performance criteria B for supply breaks with a duration of 30 ms

When there is an interruption on the supply voltage, the input voltage will drop to the BUS voltage and the hold-up capacitor starts providing energy to the module. For best hold-up results UVLO should not be used.

The required capacitance of the hold-up capacitor can be calculated by using the following formulas:

$$\text{TEP xx-36xxUIR: } C_{\text{hold-up}} = 0.0077 \times P_{\text{in}} \times t$$

$$\text{TEP xx-72xxUIR: } C_{\text{hold-up}} = 0.0096 \times P_{\text{in}} \times t$$

Example:

TEP 40-3618UIR

40 W output power; Efficiency = 91%; S2 interruption duration = 10 ms

$$P_{\text{in}} = 40 \text{ W} / 0.91 = 43.96 \text{ W}$$

$$C_{\text{hold-up}} = 0.0077 \times P_{\text{in}} \times t = 0.0077 \times 43.96 \times 0.01 = 3'384.6 \mu\text{F} \approx 3'400 \mu\text{F} / 25 \text{ V}$$

Inrush Current

The inrush current is an important characteristic that must be considered. In order to meet the requirements of S2, S3 or C2 a capacitor of considerable capacitance is to be used in the system. Usually, the hold-up capacitors will cause high inrush currents when power is supplied to the module. This may blow fuses or cause malfunction at other devices. By connecting the hold-up capacitors to the BUS-pin this effect can be reduced. The inrush current is restricted effectively via the internal charging path and can reduce the need of external components for the whole system.

