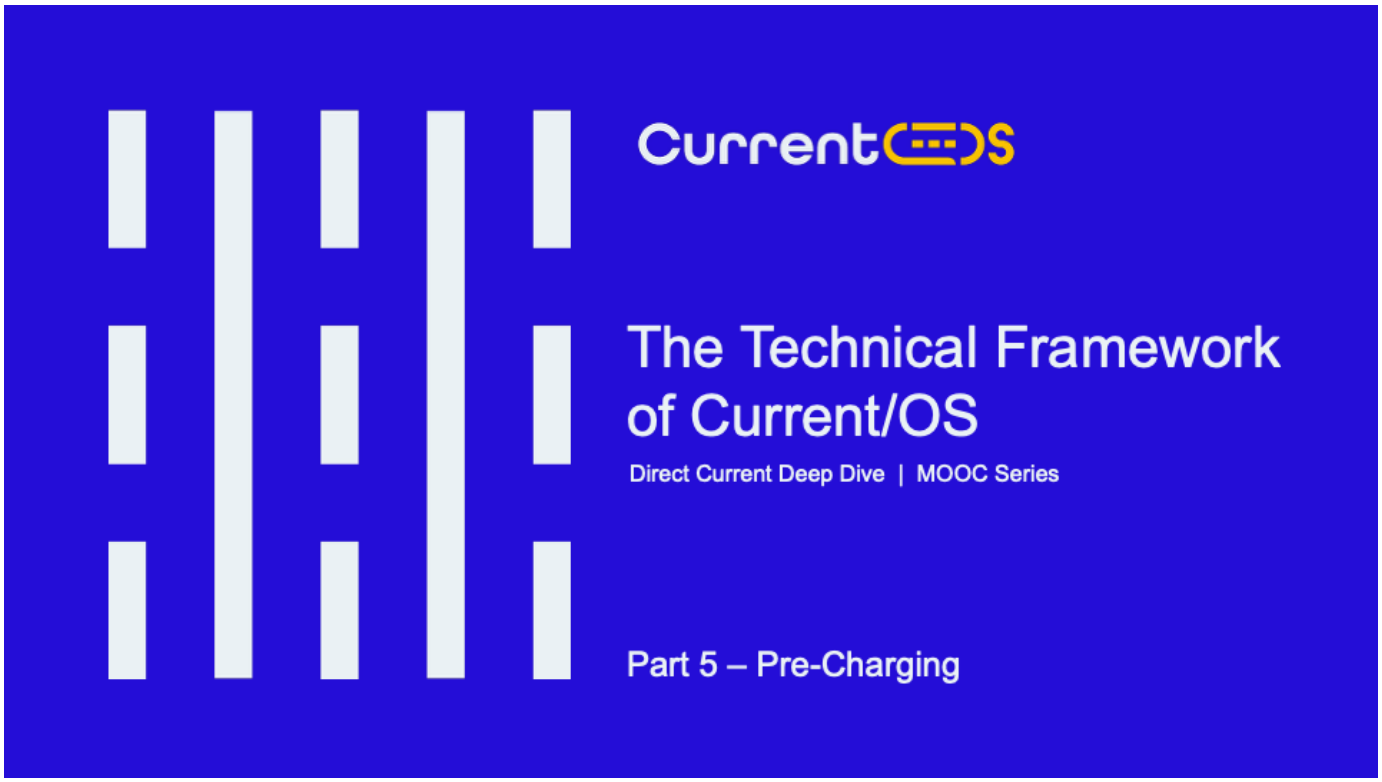


Welcome to the Direct Current Deep Dive Series: the Technical Framework of Current OS" , a MOOC designed to dive into the principles behind Current OS technical decisions and their role in defining the standard for Direct Current electrical systems, also commonly referred to as DC-coupled systems, or DC microgrids

This video is part 5 of a six-part series. Explore the remaining videos on the Current OS YouTube Channel to continue learning about the world of Direct Current.

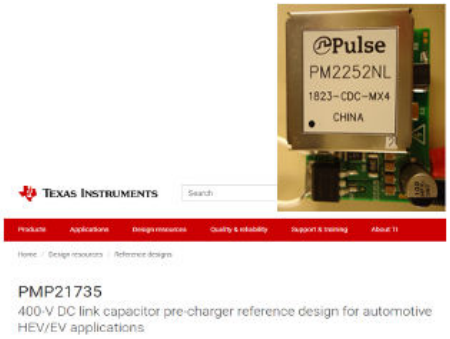
In this video, we'll explain the underlying principles that

drive Current OS's technical choices on electrical protection and the definition of risk categories. The aim is to deliver an arc-free solution that simplifies system design, while reducing the need for cables and electrical equipment.

DC Capacitor Management: Pre-Charge as Standard Practice

- In AC, breakers are specified to withstand in-rush overcurrent (up to 7 or 10 In on motors at Un)
- In DC, capacitors initial charging is similar to a short circuit.
- Capacitor management is a very classical topic in DC to avoid protections tripping and allow the system starting.
- Precharge can be at source level for "fixed" loads
- Precharge must be at load level for "hot pluggable" loads
- Pre-charge current profiles have to be specified.

Off-the-Shelf chips are available for Pre-Charge implementation



In direct current systems, capacitors are everywhere. This creates a significant challenge: at startup, they generate very high inrush currents. It gets even more critical—an empty capacitor essentially acts as a short circuit. Without proper management, this could trigger all the protections the moment the system powers on. To avoid this, every DC device must include a pre-charging system.

This concept might seem "exotic" to those accustomed to alternating current systems, but pre-charging is a standard practice in DC systems. For example, all electric vehicles with DC chargers already have built-in pre-charging systems. Companies like Texas

Instruments have even developed dedicated chips to control pre-charging.

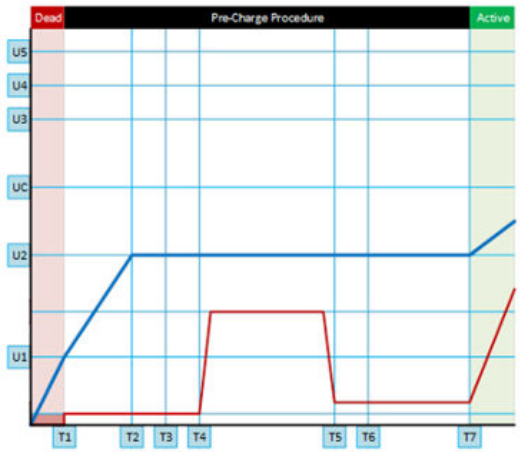
Managing the pre-charge of capacitors in DC systems is a well-established process for ensuring smooth operation in DC installations.

DC Capacitor Management: Pre-Charge as Standard Practice

Current/OS specifies a black start and precharge procedure:

- **Step 1**: black start with almost no current to allow the bus to reach U2
- **Step 2**: precharge the capacitors with limited current to avoid over current protections tripping
- **Step 3**: activation of the loads

Device Connection Protocol Current/OS



Current OS has defined a specific startup sequence for DC systems.

The system starts, reaches U1, the initial voltage level, where sources start contributing to bring the system up to U2, the lower end of the nominal voltage band.

At this point, a brief pause is implemented before allowing loads to draw current within specific limits of time and amperage.

After this, loads return to a standby state, allowing processors and the broader system to initialize.

Next, the system transitions into full operation, permitting current and power demands to increase progressively.

This startup sequence—beginning with the Black Start phase, moving through pre-charging, and energizing and finally activating loads—has been codified within Current OS standards.

It ensures that products from various manufacturers can function harmoniously without tripping circuit breakers upon connection.

This is for General Purpose LVDC Systems. Each piece of equipment includes its own pre-charging function. This maximises interoperability between products from different manufacturers and simplifies maintenance. Any device can be disconnected, replaced, or reconnected independently without affecting the rest of the installation.

In the case of Specialized LVDC Systems, for example data centers or dedicated industrial process islands, other approaches exist.

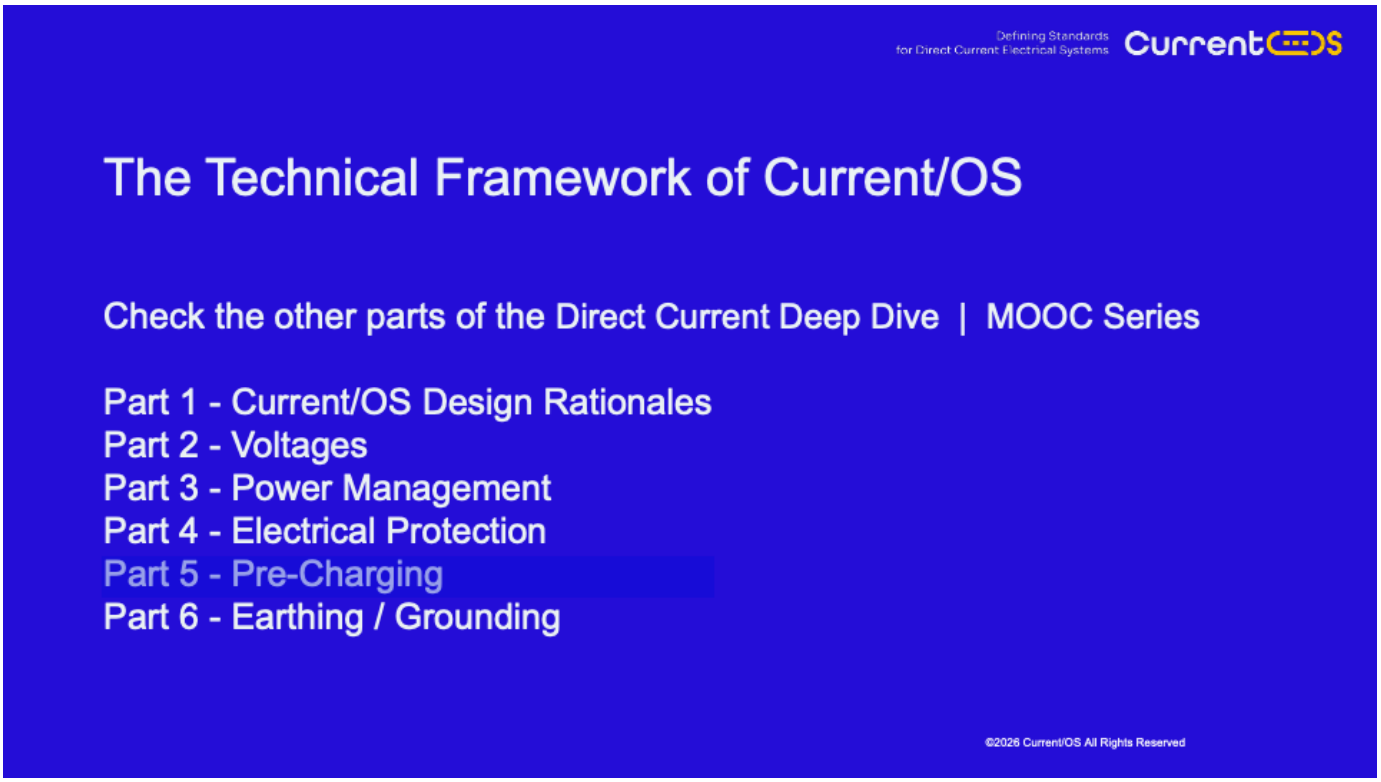
For example, a single, centralised pre-charger may be used for an entire circuit. However, this approach requires every device connected to that circuit to be fully known and carefully coordinated. Future modifications or expansions are

therefore very limited.

Maintenance also becomes more complex. Because all equipment depends on the same pre-charger, the entire group of loads generally needs to be disconnected or shut down simultaneously.

For these reasons, centralised pre-charging is typically reserved for very specific applications, where the equipment configuration is fixed and changes are expected to be rare.

Both Pre-charging approaches are well-established and standard in the realm of DC systems, providing a reliable foundation for consistent performance across installations.



This concludes the introduction of Current OS.

Want to learn more? Check out the other five Current/OS MOOC videos covering an introduction to Current OS, voltages, power management, electrical protection and earthing or grounding

Thank you for watching, see you in the next video!

Defining Standards
for Direct Current Electrical Systems

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