A high-power offline supply is nothing more than a half- or full-bridge dc/dc converter. Rectifying the ac line yields a dc voltage that feeds the converter. At power-supply turn-on, the bulk capacitor of the uncontrolled rectifier is completely discharged. It results in a huge charging current for a high instantaneous line voltage because the discharged bulk capacitor temporarily short-circuits the diodes of the rectifier stage. The high inrush current can trigger a mains circuit breaker, burn a fuse, or even destroy a power supply’s rectifier diodes unless you take precautions. The circuit in Figure 1 limits the inrush current.

At turn-on, if the instantaneous rectified ac-line voltage, $V_{ACR}$, is greater than approximately 10V, Point A in Figure 2, MOSFET $Q_2$ turns on, forcing thyristor $Q_1$ off. In this situation, a little current flows through $R_1$ and $Q_2$, injecting a small charge into bulk capacitor $C_O$, Path A to B in Figure 2.
When \( V_{ACR} - V_O \leq 8\text{V} \) or so, where \( V_O \) is the output voltage, \( Q_2 \) is off, letting \( Q_1 \) conduct. In this situation, the bulk capacitor receives the necessary charge through \( Q_1 \), Path B to C in Figure 2, to match \( V_O \) to \( V_{ACR} \). After this point, \( V_{ACR} \) falls below \( V_O \), and the bulk capacitor alone must support any power the dc/dc converter demands until \( V_{ACR} - V_O \geq 5\text{V} \) or so, Path C to D in Figure 2. At Point D, \( V_{ACR} - V_O \approx 5\text{V} \) and thyristor \( Q_1 \) triggers, which conducts the capacitor’s charge current and the current the dc/dc converter demands until \( V_{ACR} \) matches the sinusoidal peak at Point E.

When \( V_{ACR} \) falls, thyristor \( Q_1 \) cuts off, and the bulk capacitor alone feeds the dc/dc converter. The thyristor conducts again when \( V_{ACR} \) matches \( V_O \) to the sinusoidal peak. This process then repeats. Use a nonsensitive gate thyristor with a breakdown voltage of at least 400V for an ac voltage of 220V rms (root mean square) and with twice the rms-current rating of the rectifier diodes.

This circuit uses a TYN610 thyristor. You can calculate the value of \( R_1 \) using \( R_1 = \frac{6.8 - V_{GT}}{I_{GT} - 20^\circ} \), where \( V_{GT} \) is the minimum gate-cathode voltage necessary to produce the gate-trigger current for \( Q_1 \) and \( I_{GT} \) is the minimum gate current to trigger \( Q_1 \) down to \(-20^\circ\). The NTD4815NHG MOSFET is suitable for this circuit. A MOSFET with a different threshold voltage may require different values for \( R_2 \) and \( R_3 \).