The current error in DCM, $2v_{\text{err}}(n)$, has been validated by experimental results. Controller, prototype introducing sensors, parasitic information feasibility and the industry control most commonly used boost power factor correction (PFC) converters in the power converter. The influences of major non-ideal effects, including turn-on delay, turn-off delay, and current distortion caused by the parasitic oscillation in discontinuous conduction mode (DCM), are analyzed in detail, and an algorithm for accurate estimation is proposed accordingly. In contrast to the power metering implemented by input voltage and current sensors, this study provides an approach to monitor input power without introducing any additional system complexity, cost, or power loss. A 400W prototype has been built based on the HR1211GY digital PFC and LLC combo controller, and the feasibility and the accuracy of the theoretical analysis have been validated by experimental results.

**Solution**

Based on the multi-mode control scheme shown above, ideally, $I_{\text{dc}}$ can be used to calculate the input power. However, compensating for the error caused by the non-ideal effects is a key to guarantee the estimation accuracy. In CCM, the error is mainly introduced via the turn-on delay $T_{\text{on}}$ and the turn-off delay $T_{\text{off}}$.

\[
\Delta V_{\text{in}}(n) = \frac{1}{2} I_{\text{in}}(n) T_{\text{on}} + \frac{1}{2} I_{\text{in}}(n) T_{\text{off}}
\]

In DCM, the error is mainly introduced by the turn-off delay $T_{\text{off}}$ and the DCM oscillation. Besides, the error modeling is also different based on whether the oscillation is free or clamped by the body diode of the boost MOSFET.

\[
\Delta V_{\text{in}}(n) = \frac{1}{2} I_{\text{in}}(n) T_{\text{off}}
\]

Where the complete equation can be found in the full paper.

**Results**

For verification, a 400W prototype is designed and implemented based on the HR1211GY, a digital multi-mode PFC and LLC combo controller. The key parameters of the power supply can be programmed by a user-friendly GUI, and also the instant states required for the power estimation are accessible through the integrated UART interface of HR1211GY in real time.

The transition angular between CCM and DCM can be deduced based on the input voltage and the reference current at the boundary conduction.

\[
P_{\text{ac}}(t) = \frac{2}{\pi} \left[ I_{\text{in}}(t) V_{\text{in}}(t) \right]_	ext{avg}
\]

Where $V_{\text{in}}(t)$ is reconstructed input voltage, considering $V_{\text{rise}}$ as the forward voltage of one bridge rectifier diode and $R_{\text{f}}$ is the total equivalent resistance of all the filter inductors.

\[
I_{\text{rise}}(t) = I_{\text{rise}}(t) + 2 I_{\text{rise}}(t) + 2 I_{\text{rise}}(t)
\]

**Conclusion**

This paper studied the feasibility of implementing active input power estimation without any additional sensors for boost PFC converter. The analysis in this paper accounts for the influence of parasitic effects, such as turn-on and turn-off delays, DCM oscillation, transition between DCM and CCM, and active power loss on passive components. Based on the mathematical modeling of the system and parasitic effects, an algorithm for accurately estimating the input power has been proposed. It takes the characteristics of the mainstream multi-mode PFC control scheme into consideration, and is able to support a wide operating range. The proposed estimation approach has been verified by experimental results on a 400W boost PFC prototype based on the HR1211GY. As digital PFC controllers are becoming more and more popular in practical applications, this study provides a possible approach to reduce system complexity and cost, as well as to improve reliability for power supply products in the future, by implementing basic power metering functions without adding any additional sensors.

**References**


[4] … (Full reference list to be found in the paper)