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ICE1PCS02

ICE1PCS02 Based Boost Type CCM PFC Design Guide

Power Management & Supply

Never stop thinking.

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Abstract

Continuous conduction mode (CCM) PFC controller, named ICE1PCS02, is developed based on the modification of ICE1PCS01. Both of ICE1PCS01 and ICE1PCS02 use average current control to achieve the unity power factor without direct sine-wave sensing reference signal from the AC mains. Compared to ICE1PCS01, ICE1PCS02 has additional protection function for AC brown-out shut down. The difference between ICE1PCS01 and ICE1PCS02 is illustrated in this application note.

1 Introduction

The Pin layout of ICE1PCS01 and ICE1PCS02 is shown in Figure 1.

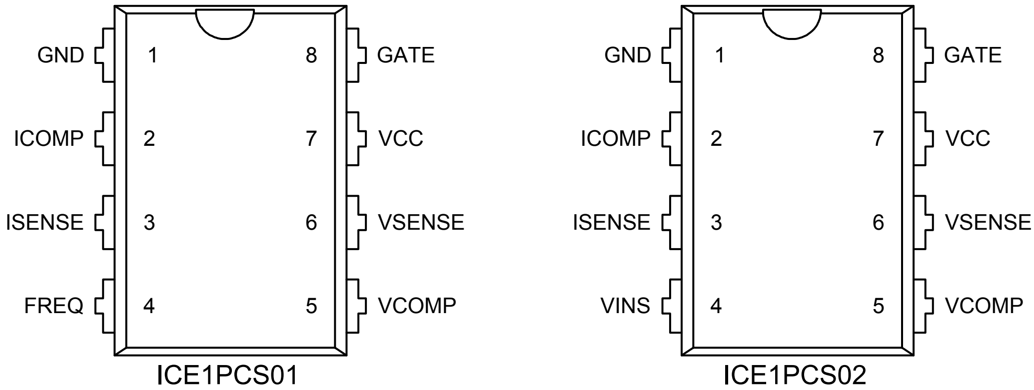

Figure 1 Pin Layout of ICE1PCS01 and ICE1PCS02

From the layout, it can be seen that most of Pins in ICE1PCS02 are the same as ICE1PCS01 except Pin 4. In ICE1PCS01, Pin 4 is to set the switching frequency. However, for ICE1PCS02, Pin 4 is for AC brown out detection and at the same time the switching frequency is fixed by internal oscillator at 65kHz. The typical application circuit of ICE1PCS02 is shown in Figure 2.

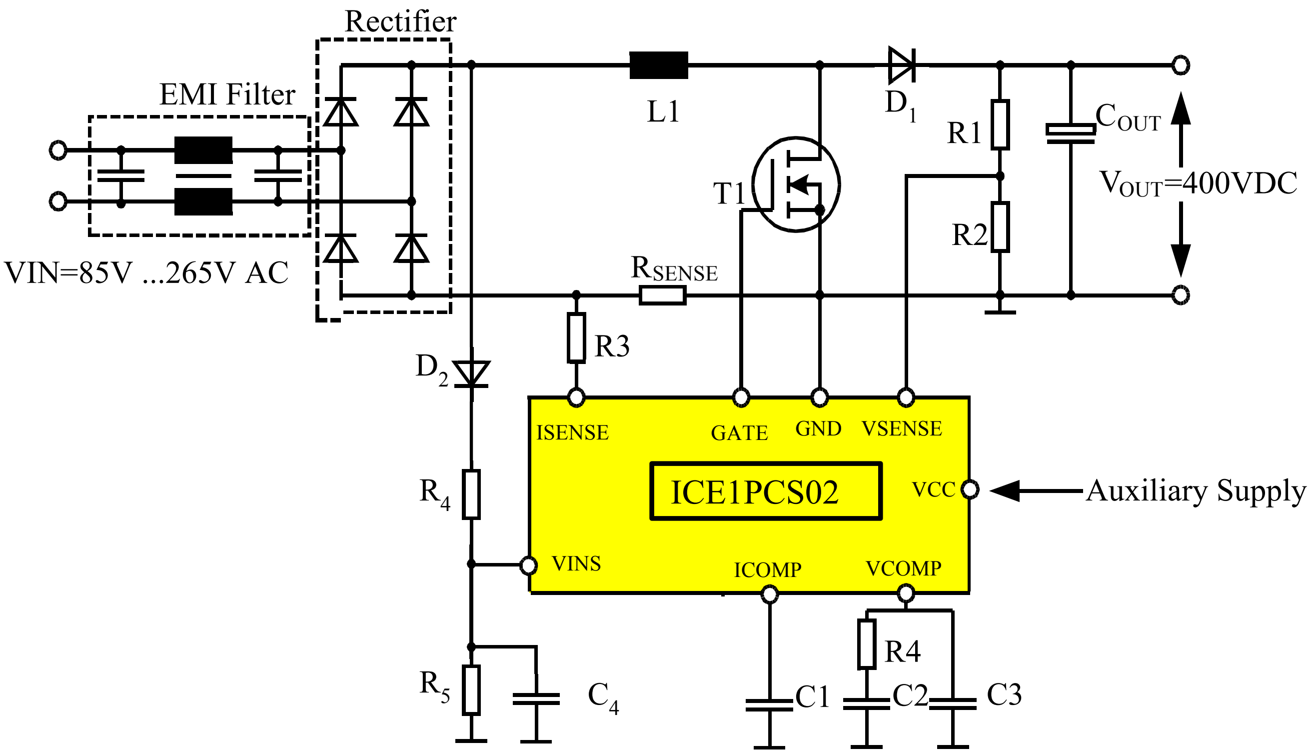

Figure 2 Typical application circuit of ICE1PCS01

As the same as ICE1PCS01, ICE1PCS02 does not need direct sin-wave sensing signal as well. In this application note, the specific features of ICE1PCS02, which are different from ICE1PCS01, are described in detail. The other features (enhance dynamic response, gate drive, current sense, control loop) are the same as ICE1PCS01 and the external component design is referred to the application notes for ICE1PCS01.

2 AC input Undervoltage Protection / Brown Out Protection

Brown-out occurs when the input voltage VAC falls below the minimum input voltage of the design (i.e. 85V for universal input voltage range) and the VCC has not entered into the VCCUVLO level yet. For a system without input brown out protection (IBOP), the boost converter will increasingly draw a higher current from the mains at a given output power which may exceed the maximum design values of the input current. ICE1PCS02 provides a new IBOP feature whereby it senses directly the input voltage for Input Brown-Out condition via an external resistor/capacitor/diode network as shown in Figure 3. This network provides a filtered value of VIN which turns the IC on when the voltage at Pin 4 (VINS) is more than 1.5V. The IC enters into the standby mode and gate is off when VINS goes below 0.8V. The hysteresis prevents the system to oscillate between normal and standby mode. Note also that input voltage needs to at least 16% of the rated VOUT in order to overcome open loop protection and powerup the system (referred to application note of ICE1PCS01).

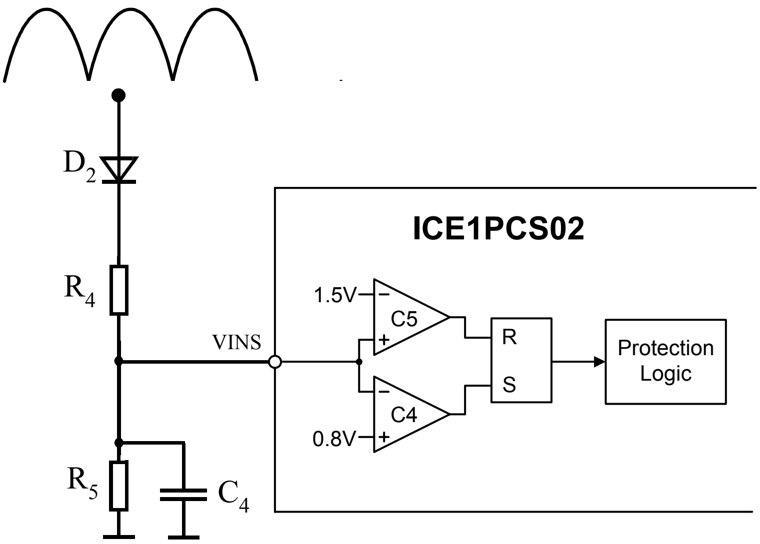

Figure 3 Block diagram of voltage loop

Because of the high input impedence of C4 and C5, R4 can be 10MΩ or above to reduce the loss. R5 is selcted by equation (1).

$$R_5 = \frac{1.5V}{\sqrt{2} \cdot V_{AC\_on} - 1.5V} \cdot R_4 \tag{1}$$

where, V_{AC_on} is the minimum AC input voltage (RMS) to start PFC, for example 85VAC.

C_4 is used to modulate the ripple at the VINS pin. If the bottom level of the ripple voltage touches 0.8V, PFC is in standby mode and gate is off. The ripple and control PFC brown out off threshold of AC input voltage (RMS), V_{AC_off}. C_4 can be obtained from the following equation.

$$\frac{R_5}{R_4 + R_5} \cdot V_{AC\_off} \cdot e^{-\frac{t}{R_5 C_4}} = \frac{R_5}{R_4 + R_5} \cdot V_{AC\_off} \cdot e^{-\frac{1}{R_5 C_4 \cdot 2 f_L}} = 0.8V \tag{2}$$

$$C_4 = \left(2 f_L R_5 \ln \frac{\frac{R_5}{R_4 + R_5} V_{AC\_off}}{0.8V} \right)^{-1} \tag{3}$$

where, V_{AC_off} is the maximum AC input voltage (RMS) to switch off PFC; f_L is the AC input line frequency.

3 Soft start

The soft startup of ICE1PCS02 is different from ICE1PCS01. ICE1PCS01 has a reduced charging current (around 10uA) at V_{COMP} Pin, but ICE1PCS02 has high V_{COMP} charging current as 30uA (typ) in startup. This higher sourcing current in the startup time will charge V_{COMP} faster to its normal operating point, which in turn results in a faster startup for V_{OUT}.

4 Switching Frequency

The switching frequency of ICE1PCS02 is not adjustable and fixed at 65kHz internally. The frequency setting Pin in ICE1PCS01 is replaced by brown out detection Pin in ICE1PCS02.

References

[1] Infineon Technologies: ICE1PCS01 - Standalone Power Factor Correction Controller in Continuous Conduction Mode; Preliminary datasheet; Infineon Technologies; Munich; Germany; Sept. 2002.

[2] Luo Junyang, Jeoh Meng Kiat, Huang Heng Cheong, A New Continuous Conduction Mode PFC IC With Average Current Mode Control, PEDS 2003; pp. 1110-1114, Nov 2003.

[3] Luo Junyang, Jeoh Meng Kiat, Yew Ming Lik, 300W CCM PFC Evaluation Board with ICE1PCS01, CoolMOS™ and SiC Diode thinQ!™, Application note, Infineon Technologies, Munich, Germany, Oct. 2003.

[4] Infineon Technologies: ICE1PCS02 - Standalone Power Factor Correction (PFC) Controller in Continuous Conduction Mode (CCM) at Fixed Frequency, Preliminary datasheet; Infineon Technologies; Munich; Germany; Sept. 2004.

[5] Luo Junyang, Huang Heng Cheong, Jeoh Meng Kiat, ICE1PCS01 Based Boost Type CCM PFC Design Guide - Control Loop Modeling, Application note, Infineon Technologies, Munich, Germany, July, 2004.