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# Design Note

## DN-Server Standby-1

## CoolSET™
## 20W Server Standby with ICE2A265

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**Power Management & Supply**

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# Introduction

This document is an engineering report that describes a universal input power supply designed in a typical off line flyback converter topology that utilizes the **ICE2A265 CoolSET™**. The application operates in discontinous current mode using the normal mode during standby condition. The board has one output voltage with secondary regulation.

Special efforts have been made to compensate temperature dependency and to achieve a very high accuracy of switching frequency. Furthermore overload and open loop protection is implemented by controlling the feedback line. In case of overload or open loop the IC is working in **auto restart mode**. The integrated energy saving concept causes a very low standby power during no load and light load condition.

This type of switch mode power supply is also suitable as a DC standby power supply for PCs.

The switch mode power supply **ICE2A265** chip used is a current-controlled pulse width modulator with an internal **CoolMOS™** power switch.

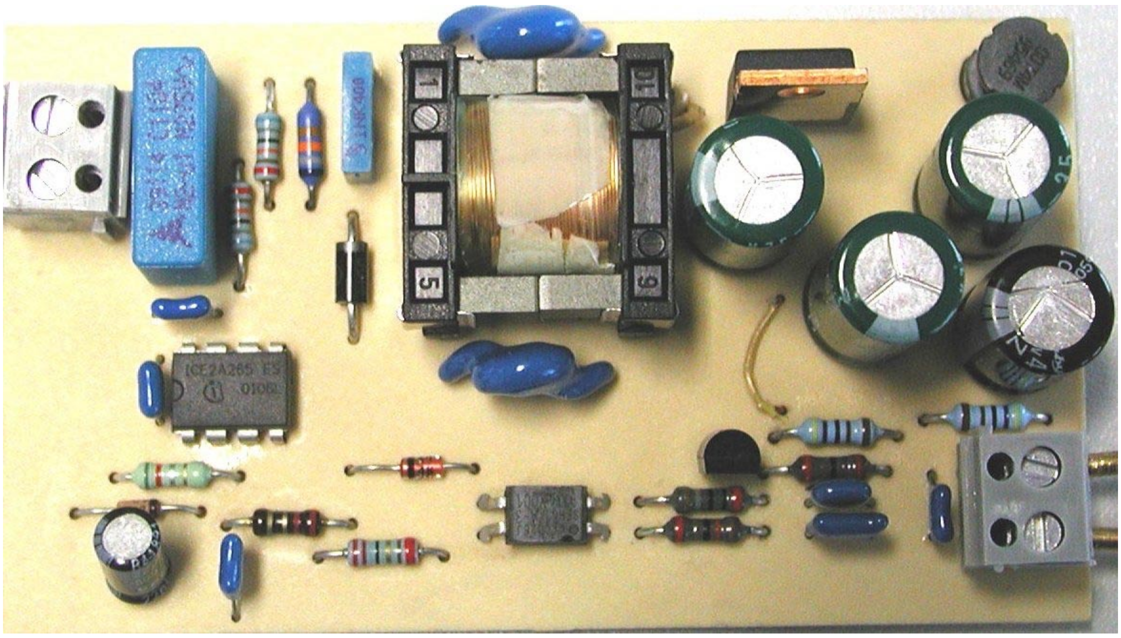


**Figure 1** Server Standby

This board was designed to allow testing and demonstrates the basic performance features of **CoolSET™**.

This document contains the power supply specification, schematic, bill of materials and the transformer construction documentation. Typical operating characteristics are presented at the rear of the report and consist of performance curves and scope waveforms.
Note:
Design calculations for the components and the transformer were performed in accordance with **Application Note "AN–SMPS–ICE2AXXX for OFF – Line Switch Mode Power Supplies"**.

# List of Features

| Feature |
|---|
| CoolSET™ Device **ICE2A265** |
| External Sense |
| Adjustable Softstart |
| Modulated Gatedrive |
| Over Load Protection with auto restart |
| Over Current Protection with auto restart |
| Over Temperature Shut Down with auto restart |
| Open Loop Protection with auto restart |
| Under Voltage Lock Out with auto restart |
| Drain Source Voltage 650V[1] |
| Frequency Reduction |
| Internal Leading Edge Blanking |
| 100 kHz working frequency |
| DIP8 Package |
| Standby Power according the European Commission |

**Table 1** – List of Features

# Power Supply Specification

| Description | Symbol | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| **Input Section** | | | | | |
| Input Voltage | $V_{DCIN}$ | 120 | 155/325 | 380 | $V_{DC}$ |
| Line Regulation (120...380V) | | | <1 | | % |
| Input Frequency | f | 47 | 50/60 | 64 | Hz |
| No Load Input Power (155$V_{AC}$)[3] | | | 0.23 | | W |
| No Load Input Power (325$V_{AC}$)[2] | | | 0.32 | | W |
| **Output Section** | | | | | |
| Output Voltage | $V_{OUT}$ | 4.75 | 5.0 | 5.25 | $V_{DC}$ |
| Output Voltage Ripple (380$V_{AC}$)[3] | $V_{Ripple}$ | | 0.06 | | $V_{P-P}$ |
| Output Current | $I_{OUT}$ | 3.95 | 4.00 | 4.05 | $A_{DC}$ |
| Output Power | $P_{OUT}$ | 0 | 20 | 25 | W |
| Total Regulation | | | ±2 | | % |
| Load Regulation (10...100%) | | | <1 | | % |
| Efficiency (120$V_{AC}$)[4] | $\eta$ | 74 | | | % |
| **Environmental** | | | | | |
| Conducted EMI | | | | | |
| Ambient Temperature | $T_A$ | 0 | 25 | 90 | °C |

**Table 2** – Server Standby Specification

[1] $V_{DSBR}$ at Tj = 110°C
[2] Burst Mode
[3] At nominal load

# Schematic

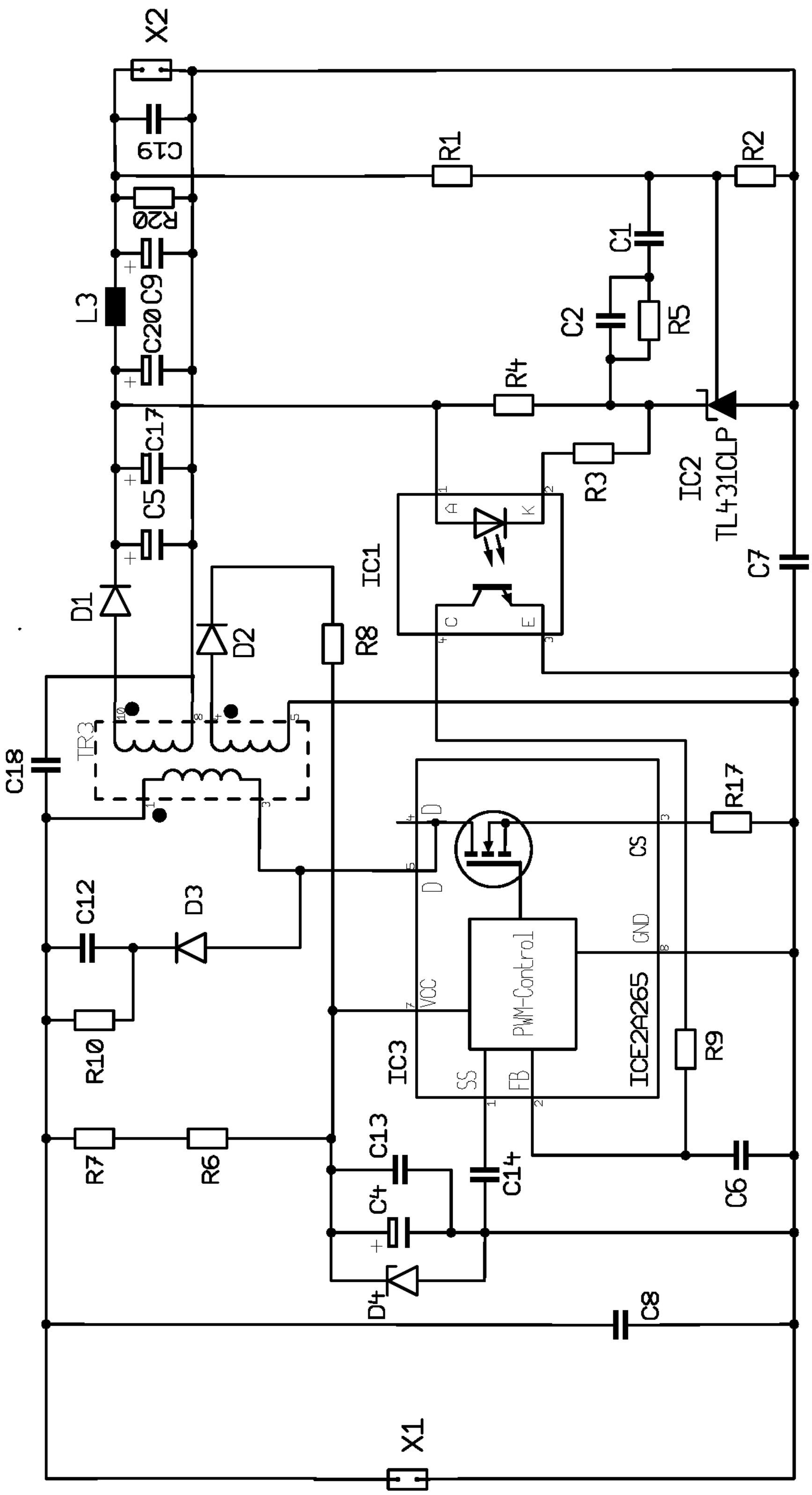



**Figure 2** Server Standby Schematic

# Description

**Introduction**
The Server Standby is a low cost flyback switching power supply using the ICE2A265 CoolSET integrated circuit from the *CoolSET™-F2* family. The circuit shown in Figure 2 details a 5.0V, 20W Server Standby that operates from an input voltage range of 120 to 380 $V_{DC}$, suitable for applications requiring either an open frame supply or an enclosed surrounding.

## *Primary Side*

**Line Input**
Just a ceramic capacitor (C8) is needed for the input voltage stage used as radio interference suppressors.

**Startup**
During the startup phase, the chip supply capacitor C4 will be charged by resistors R6 and R7. Because of the very low start up current of typically 27µA, high-value resistors can be used.

**Operation Mode**
During operation, the $V_{CC}$ pin is supplied via a separate transformer winding with associated rectification D2 and buffering C4, C13. Resistor R8 is used for current limiting during the charging of C4. In order not to exceed the maximum voltage at $V_{CC}$ pin an external zener diode D4 limits this voltage. During no load condition ($P_{OUT}$ = 0W) the switching frequency is reduced down to 21kHz in order to reduce the switching losses for a low standby power.

**Softstart**
The Soft-Start function is realized by an internal resistor and the adjustable external capacitor C14.

**Snubber Network**
The network R10, C12 and D3 clamp the DRAIN voltage spike caused by transformer leakage inductance to a safe value below the drain source break down voltage $V_{DSBR}$ = 650V maximum.

**Limitation of primary current**
The CoolMOS™ drain source current is sensed via external shunt resistor R17. The very accurate value of the shunt improves the peak power limitation shown in the curve peak power limitation in the rear of this report.

**Feedback Network**
Optocoupler IC1 is used for floating transmission of the control signal to the “Feedback” input via resistor R9 and capacitor C6 of the ICE2A265 control device. The optocoupler used meets DIN VDE 884 requirements.

## Secondary Side

**Output Voltage**

Power is coupled out on the secondary side via a fast-acting diode D1 with low forward voltage. Capacitors C5, C17 and C20 perform energy buffering, a following filter C9 with one serial choke L3 considerably reduces the output voltage ripple. Storage output capacitors C5, C17 and C20 are designed to exhibit a low internal resistance as possible (ESR) in order to minimize the output voltage ripple caused by the triangular current characteristic. The output voltage is set by the voltage divider R1 and R2. The ceramic capacitor C19 reduces high voltage spikes at the output stage. R20 leads to a safety operation in normal mode during no load condition.

**Regulation**

The output voltage is controlled using a type TL431 reference diode. This device incorporates the voltage reference as well as the error amplifier and a driver stage. Compensation network C1, C2, R1and R5 constitutes the external circuitry of the error amplifier of IC2. This circuitry allows the feedback to be precisely matched to dynamically varying load conditions, thereby providing stable control. The maximum current through the optocoupler diode and the voltage reference is set by using resistors R3 and R4. Optocoupler IC1 is used for floating transmission of the control signal to the “Feedback” input via resistor R9 and capacitor C6 of the ICE2A265 control device. The optocoupler used meets DIN VDE 884 requirements.

## EMI Filter

To reduce negative EMI effects, two Y capacitors (C18 & C7) are set in parallel to the transformer.
Note:
Place the Y capacitor as close as possible to the transformer.

# PCB Layout

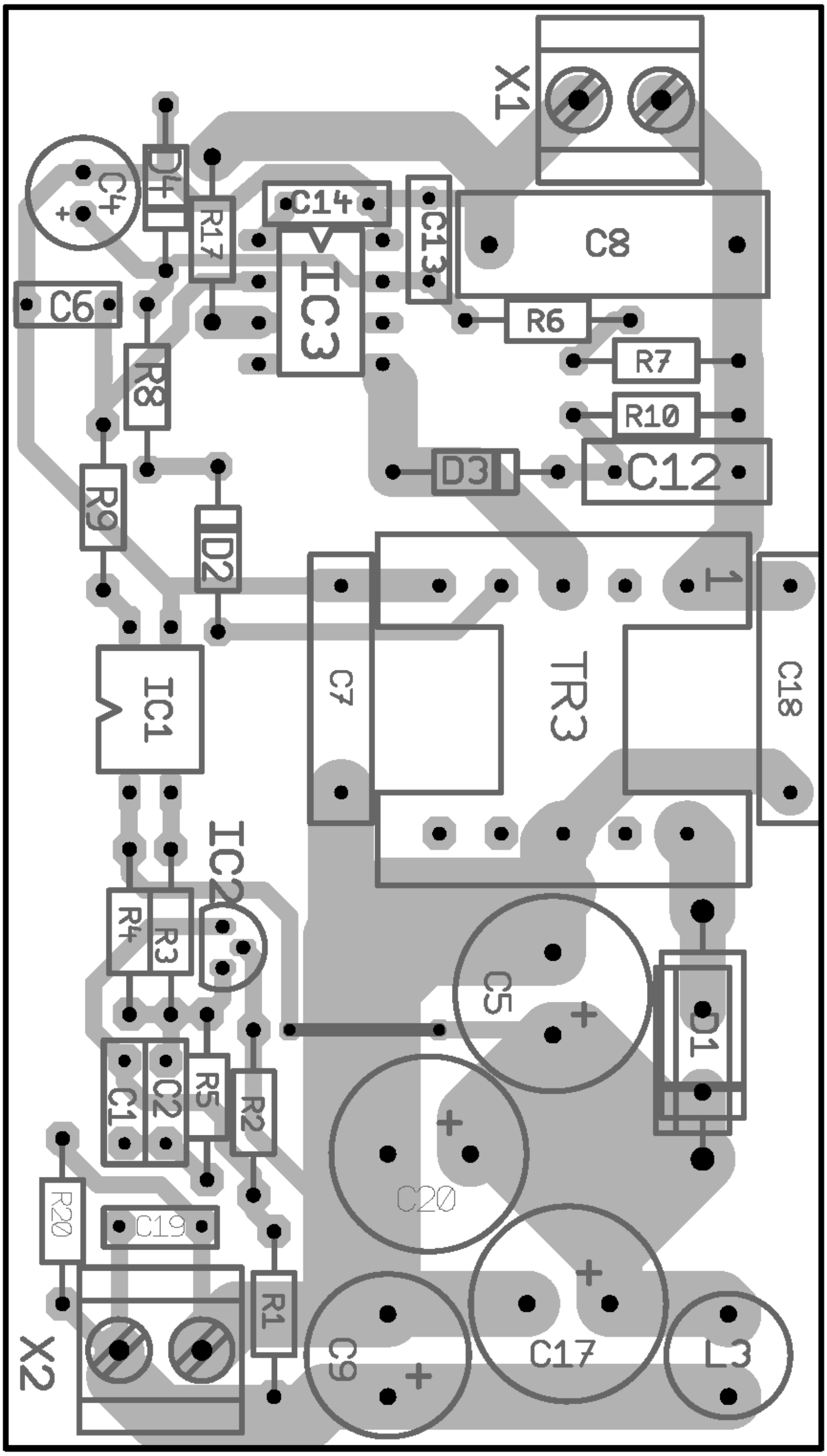



**Figure 3** PCB layout component side shown

# Bill of Material Server Standby

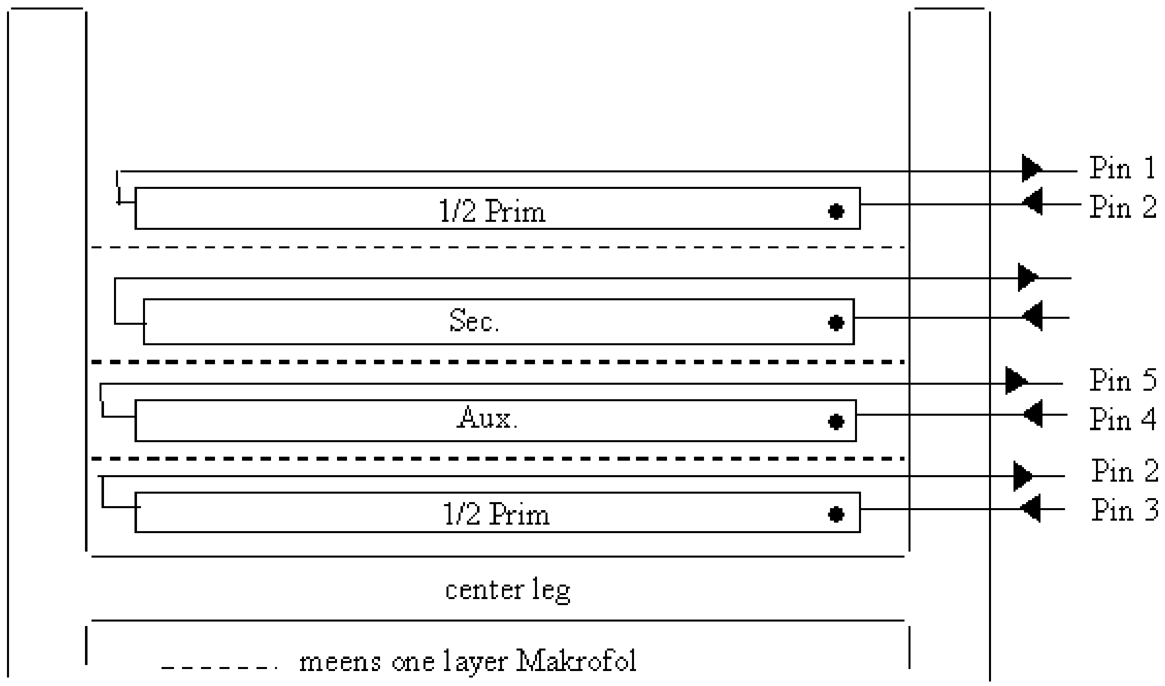
| Pos. | Part | | Type | Ordering Code | Manuf. |
|---|---|---|---|---|---|
| 1 | C1 | 1 | 470nF, 50V | B37984-M5474-K | Epcos |
| 2 | C2 | 1 | 22nF, 50V | B37979-G5223-J | Epcos |
| 3 | C4 | 1 | 22uF, 50V | B41821-A6226-M | Epcos |
| 4 | C5, C17, C20 | 3 | 470uF, 35V | KZE 35VB470MK20 | (NCC) Alfatec |
| 5 | C6 | 1 | 2.2nF, 50V | B37979-G5222-J | Epcos |
| 6 | C7, C18 | 2 | 1nF,250V, Y1 | | |
| 7 | C8 | 1 | 0.1uF, 275V, X2 | B81133-D1104-M | Epcos |
| 8 | C9 | 1 | 470uF, 25V | KZE 25VB1000MK20 | (NCC) Alfatec |
| 9 | C12 | 1 | 1nF, 400V | B32520-C6102-K | Epcos |
| 10 | C13, C19 | 2 | 100nF, 50V | B37987-F5104-K | Epcos |
| 11 | C14 | 1 | 68nF, 50V | B37987-F5224-K | Epcos |
| 12 | D1 | 1 | MBR745 | | |
| 13 | D2 | 1 | 1N4148 | | |
| 14 | D3 | 1 | 1N4937 | | |
| 15 | D4 | 1 | ZPD18 | | |
| 16 | IC1 | 1 | SFH617A-3X016 | | Infineon |
| 17 | IC3 | 1 | ICE2A265 | | Infineon |
| 18 | IC2 | 1 | TL431CLP | | |
| 19 | L3 | 1 | 1uH, 3,7A | 822LY-1R0M | Componex |
| 20 | R1, R2 | 2 | 4.7k, 1% | | |
| 21 | R3 | 1 | 180R | | |
| 22 | R4 | 1 | 1.2k | | |
| 23 | R5 | 1 | 2.7k | | |
| 24 | R6 | 1 | 680k | | |
| 25 | R7 | 1 | 680k | | |
| 26 | R8 | 1 | 6.8R | | |
| 27 | R9 | 1 | 22R | | |
| 28 | R10 | 1 | 68k, 1W | | |
| 29 | R17 | 1 | 0.82R, 0.6W, 1%, | | |
| 30 | R18 | | * | | |
| 31 | R20 | 1 | 3.3k | | |
| 32 | TR1 | 1 | E20 Coil Former | | |
| 33 | TR1 | 1 | E20/10/6, 0,5 N27 | see also Transformer Construction | |
| 34 | X1, X2 | 2 | Connector 2pol. | | |

* Only for multiple output boards

# Transformer Construction Documentation

## 20W/100 kHz Flyback Transformer

Coil former: horizontal version
Core E20/10/6; N67; $A_{MIN} = 31{,}9mm^2$; total gap = 1,0mm; $A_L = 62$ nH;
Lp = 435uH




| | | | | |
|---|---|---|---|---|
| Primary winding | 42 + 42 turns | 0,25 mm Ø | | |
| Auxiliary winding | 13 turns | 2 x 0,25 mm Ø | spread | |
| Secondary winding | 5 turns | 2 x 0,90 mm Ø | spread | with triple Insulation |

Bottom View:

| | |
|---|---|
| Pin 5 • | • Pin 6 |
| Pin 4 • | • Pin 7 |
| Pin 3 • | • Pin 8 |
| Pin 2 • | • Pin 9 |
| Pin 1 • | • Pin 10 |

**Figure 4 Transformer Construction Data**

# Performance Data

## *Efficiency*

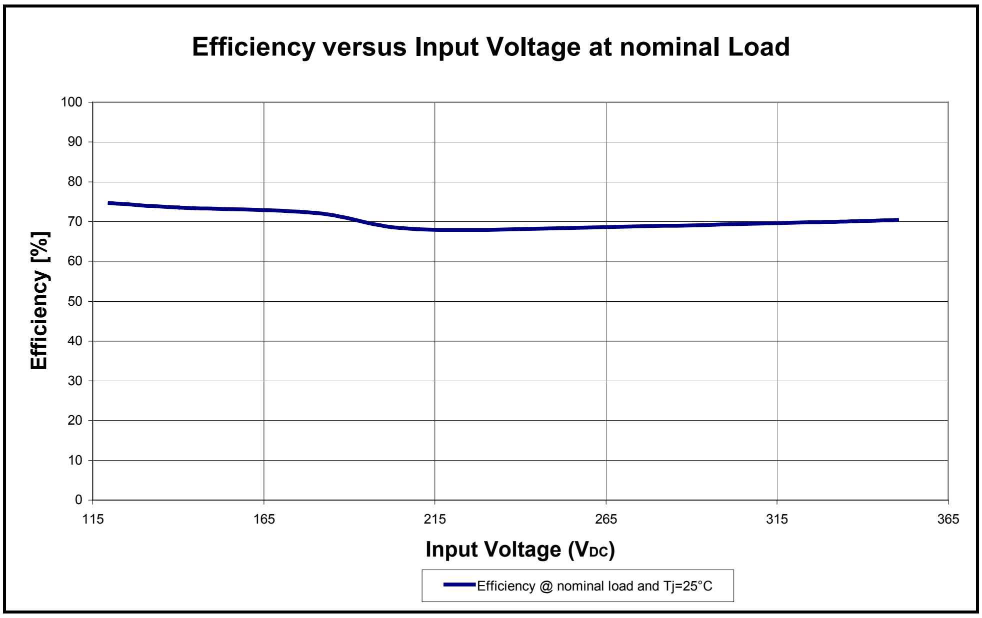



**Figure 5** – Efficiency versus Line Input Voltage at Nominal Load

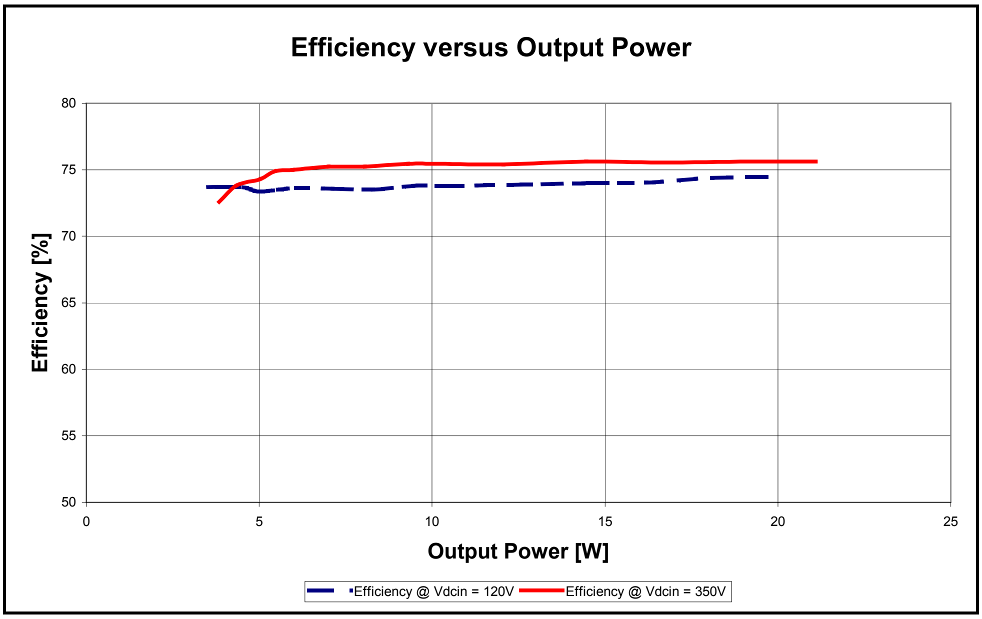



**Figure 6** – Efficiency versus Output Power

## *Frequency Reduction*

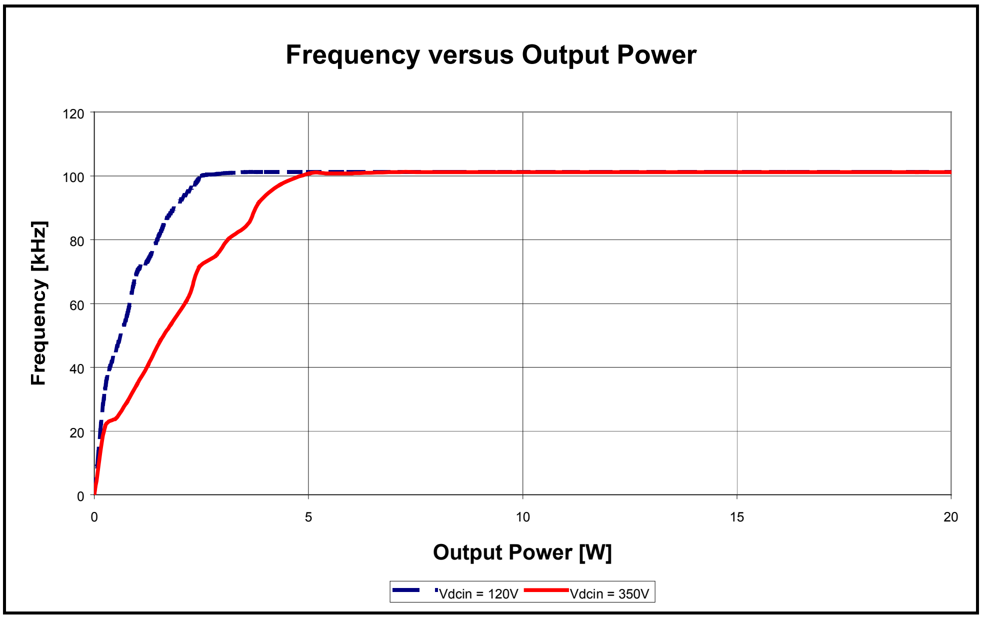



**Figure 7** – Frequency versus Output Power

## *No-load input power*

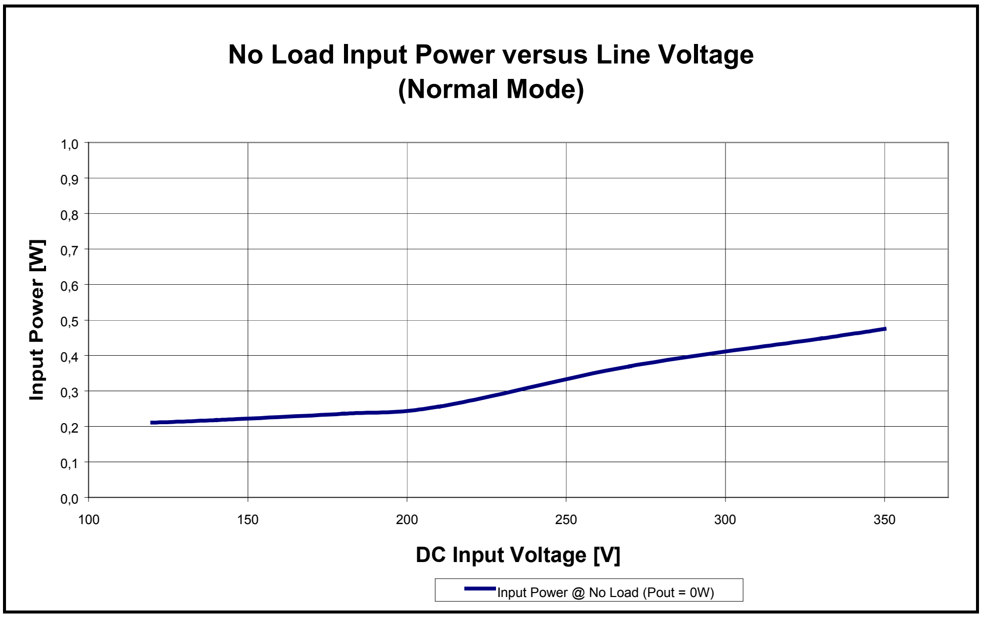



**Figure 8** – No-load Input Power versus Line Input Voltage in Burst Mode

## *Regulation and Power Limiting*

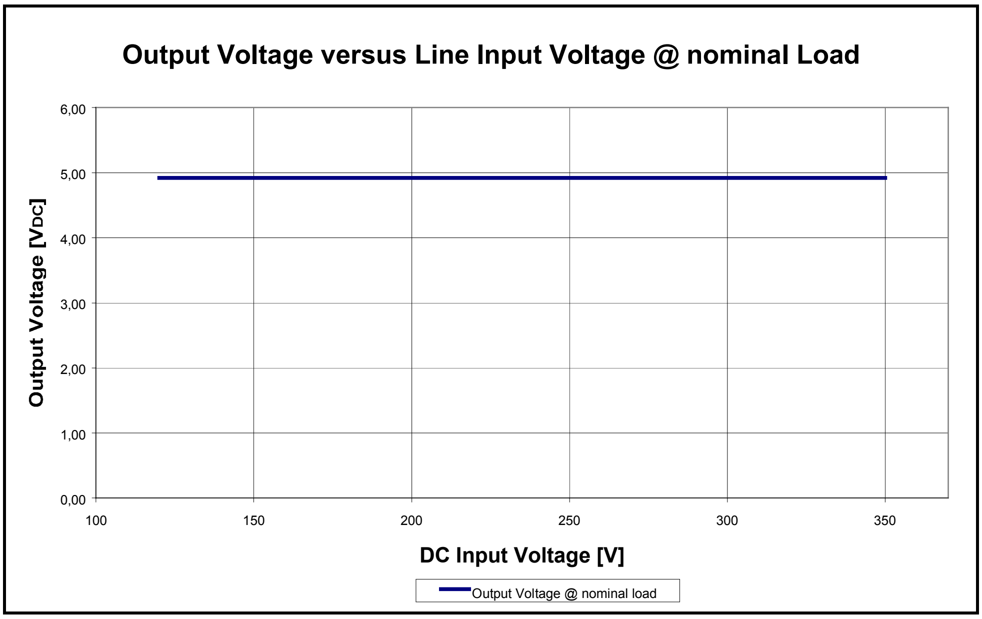



**Figure 9** – Output Voltage versus Line Input Voltage @ Nominal Load

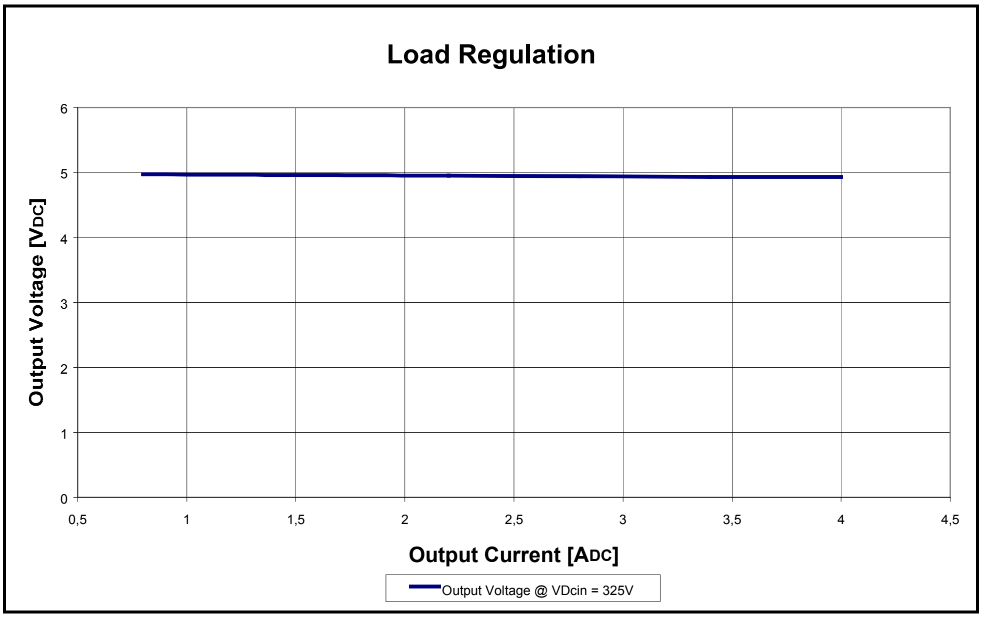



**Figure 10** – Load Regulation

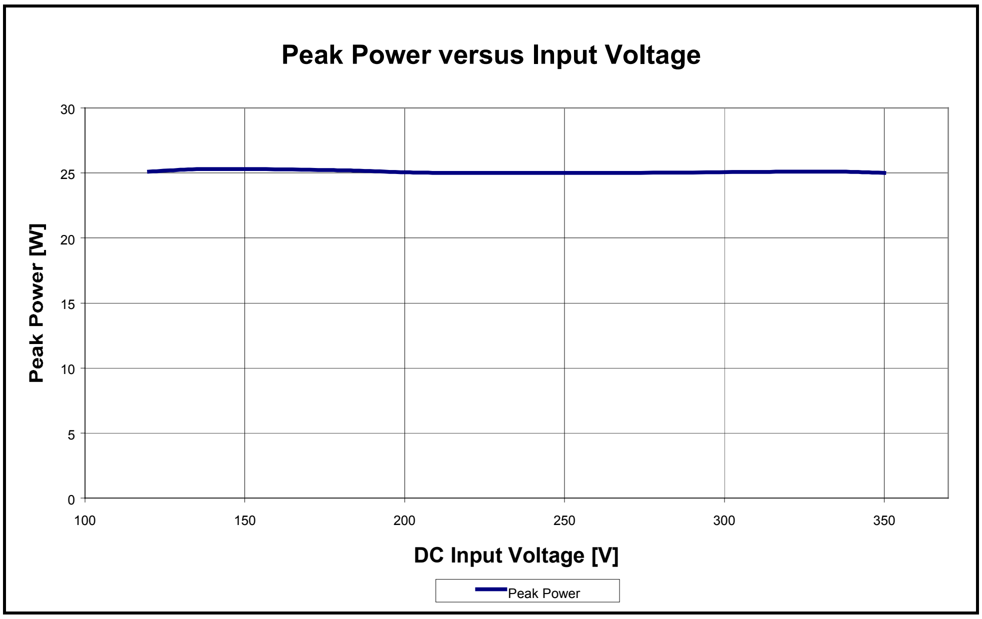



**Figure 11** – Peak Power Limitation versus Line Input Voltage

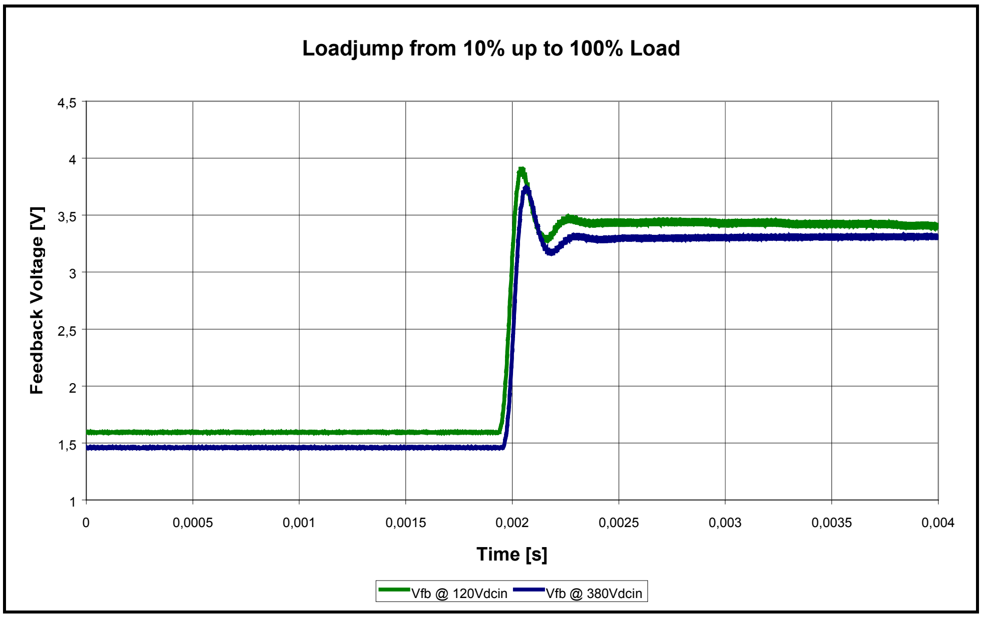



**Figure 12** – Feedbackvoltage during Loadjump from 10% up to 100% Load

*Output voltage during startup*

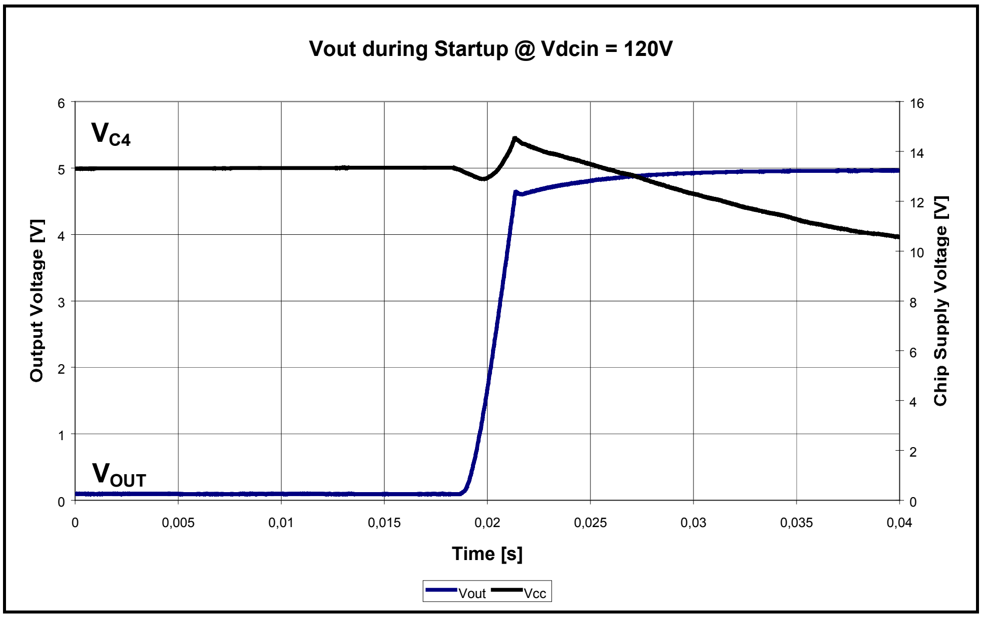



**Figure 13** – Startup with full Load Condition at $V_{DCIN}$ = 120V, $V_{C4}$ and $V_{OUT}$

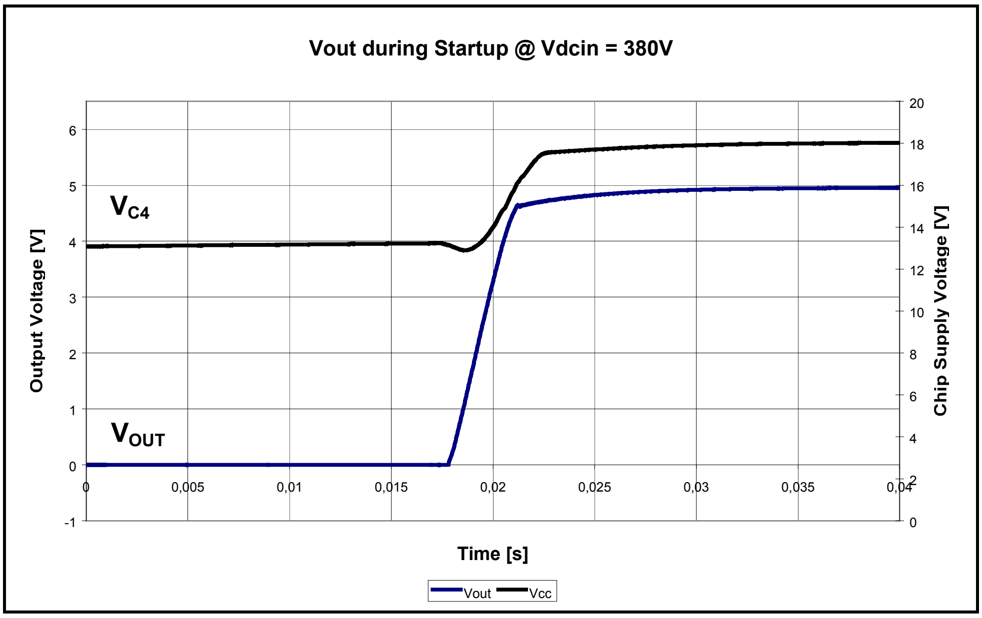



**Figure 14** – Startup with Full Load Condition at $V_{DCIN}$ = 380V, $V_{C4}$ and $V_{OUT}$

## Startup Behavior Softstart Phase

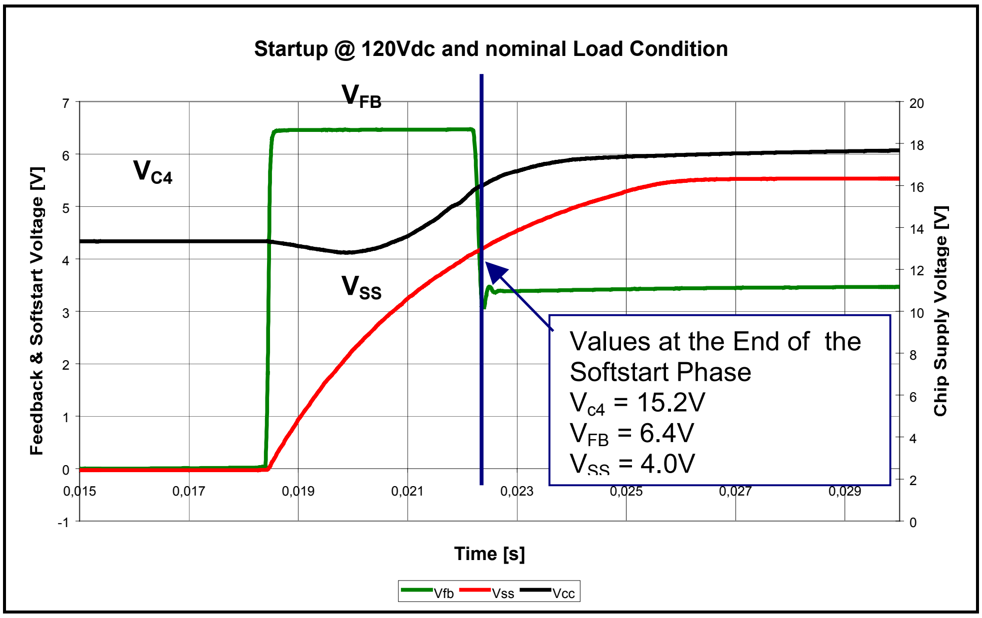



**Figure 15** Startup Behavior at Nominal Load Condition @ $V_{DCIN}$ = 120V

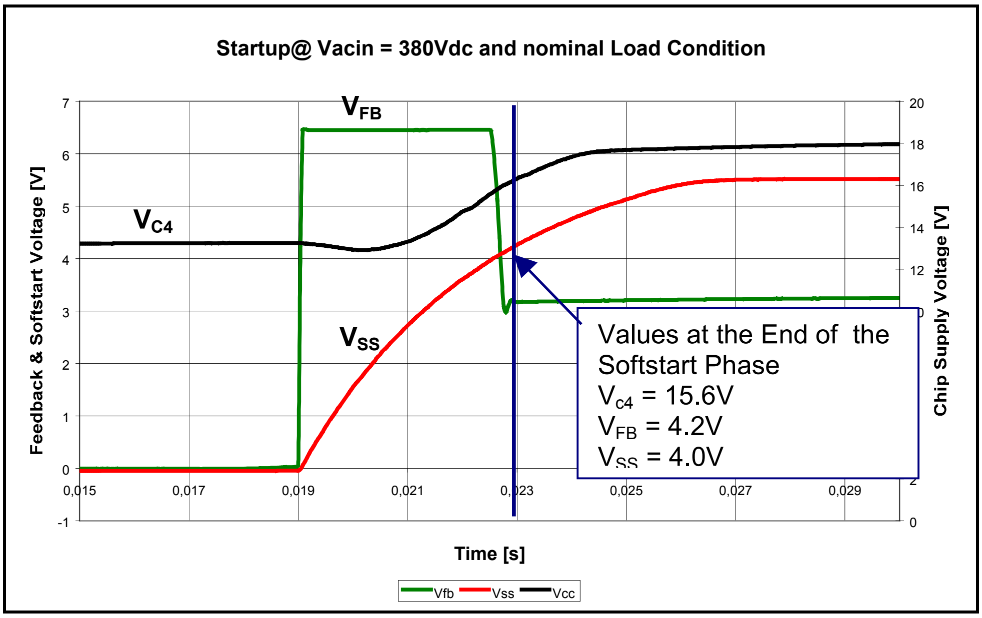



**Figure 16** Startup Behavior at Nominal Load Condition @ $V_{DCIN}$ = 380V

# References

[1] ICE2AXXX for OFF-Line Switch Mode Power Supplies
Application Note, Infineon Technologies

[2] CoolSET -II
Off-line SMPS Current Mode Controller with High Voltage CoolMOS on Board
Datasheet, Infineon Technologies

| Revision History | | |
|---|---|---|
| **Application Note AN-Server Standby-1** | | |
| Actual Release: 1.0<br>Date: 23.11.2001 | | Previous Release: 1.0<br>Date:23.11.2001 |
| Page of actual Rel. | Page of prev. Rel. | Subjects changed since last release |
| | | |
| | | |

**Note:**

The built-in transformer does **not** comply with EN60950 safety requirements in respect of electrical isolation.

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