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Design Note

DN-PC Standby-1

CoolSET™
17W PC Standby with ICE2A165

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Power Management & Supply

Never stop thinking

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Introduction

This document is an engineering report that describes a small input power supply designed in a typical off line flyback converter topology that utilizes the **ICE2A165 CoolSET™**. The application operates in discontinous current mode using the normal mode during standby condition. The board has two output voltages 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 **ICE2A165** chip used is a current-controlled pulse width modulator with an integrated **CoolMOS™** power switch.

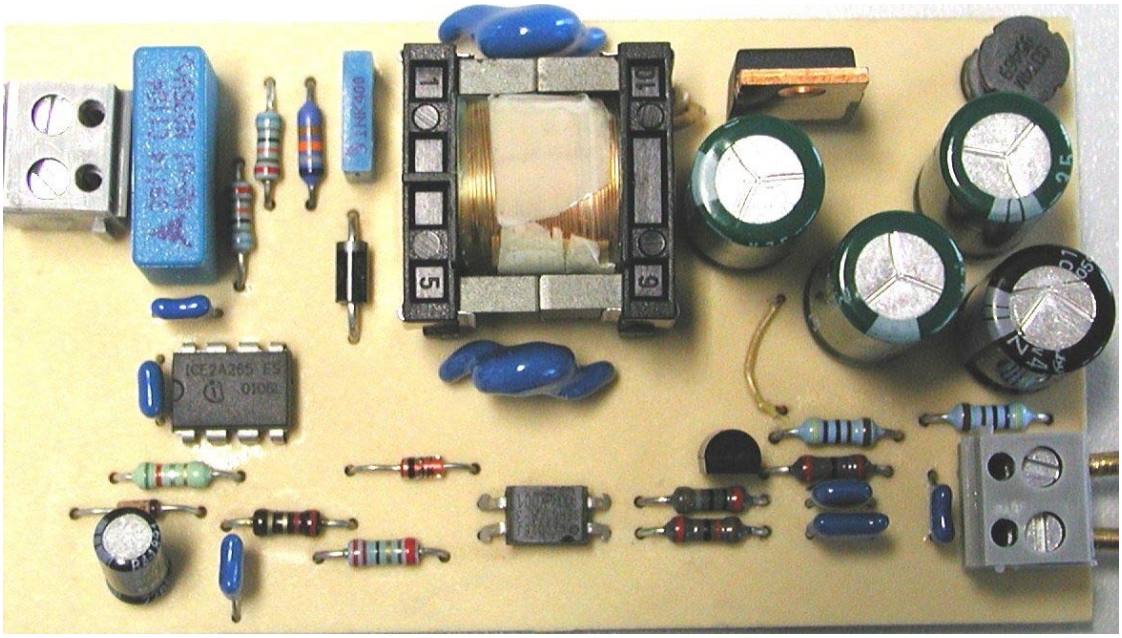


Figure 1 PC Standby

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 **ICE2A165**
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}	200	200/380	380	V_{DC}
Line Regulation (200...380V)			<1		%
Input Frequency	f	47	50/60	64	Hz
No Load Input Power ($200V_{AC}$)[3]					W
No Load Input Power ($380V_{AC}$)[2]					W
Output Section					
Output Voltage I	V_{OUT1}	4.75	5.0	5.25	V_{DC}
Output Voltage II	V_{OUT2}	3.1	3.3	3.55	V_{DC}
Output Voltage Ripple ($380V_{AC}$)[3]	$V_{Ripple1}$		0.06		V_{P-P}
Output Voltage Ripple ($380V_{AC}$)[4]	$V_{Ripple2}$		0.06		V_{P-P}
Output Current I	I_{OUT1}	1.95	2.00	2.05	A_{DC}
Output Current II	I_{OUT2}	1.95	2.00	2.05	A_{DC}
Output Power	P_{OUT}	0	20	25	W
Total Regulation			±2		%
Load Regulation (10...100%)			<1		%
Efficiency ($200V_{DC}$)[4]	η	74			%
Environmental					
Conducted EMI					
Ambient Temperature	T_A	0	50	75	°C

Table 2 – PC Standby Specification

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

Schematic

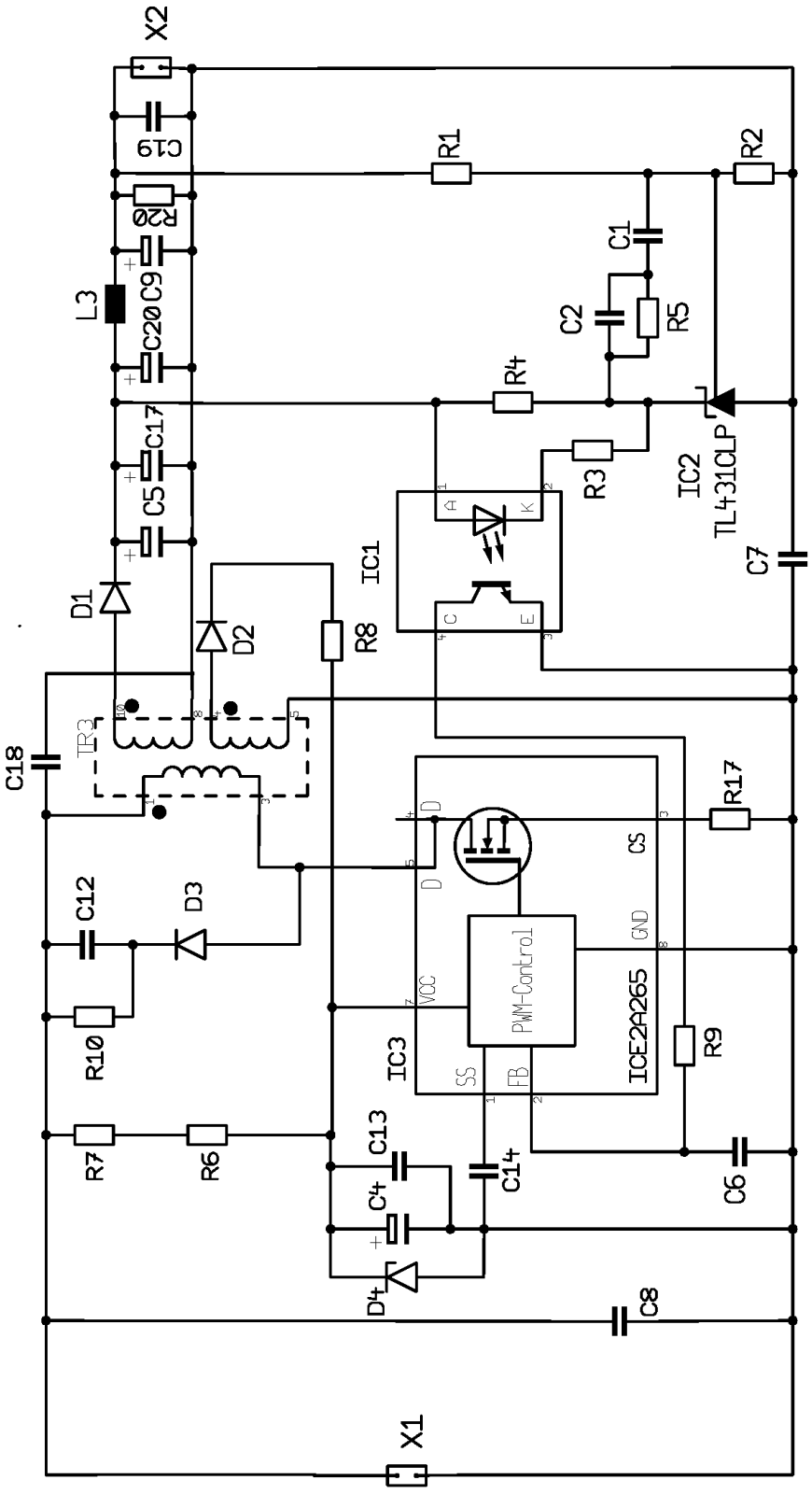


Figure 2 PC Standby Schematic

Description

Introduction
The PC Standby is a low cost flyback switching power supply using the ICE2A165 CoolSET integrated circuit from the *CoolSET™-F2* family. The circuit shown in Figure 2 details a 5.0V, 17W PC Standby that operates from an input voltage range of 200 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 ICE2A165 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 ICE2A165 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

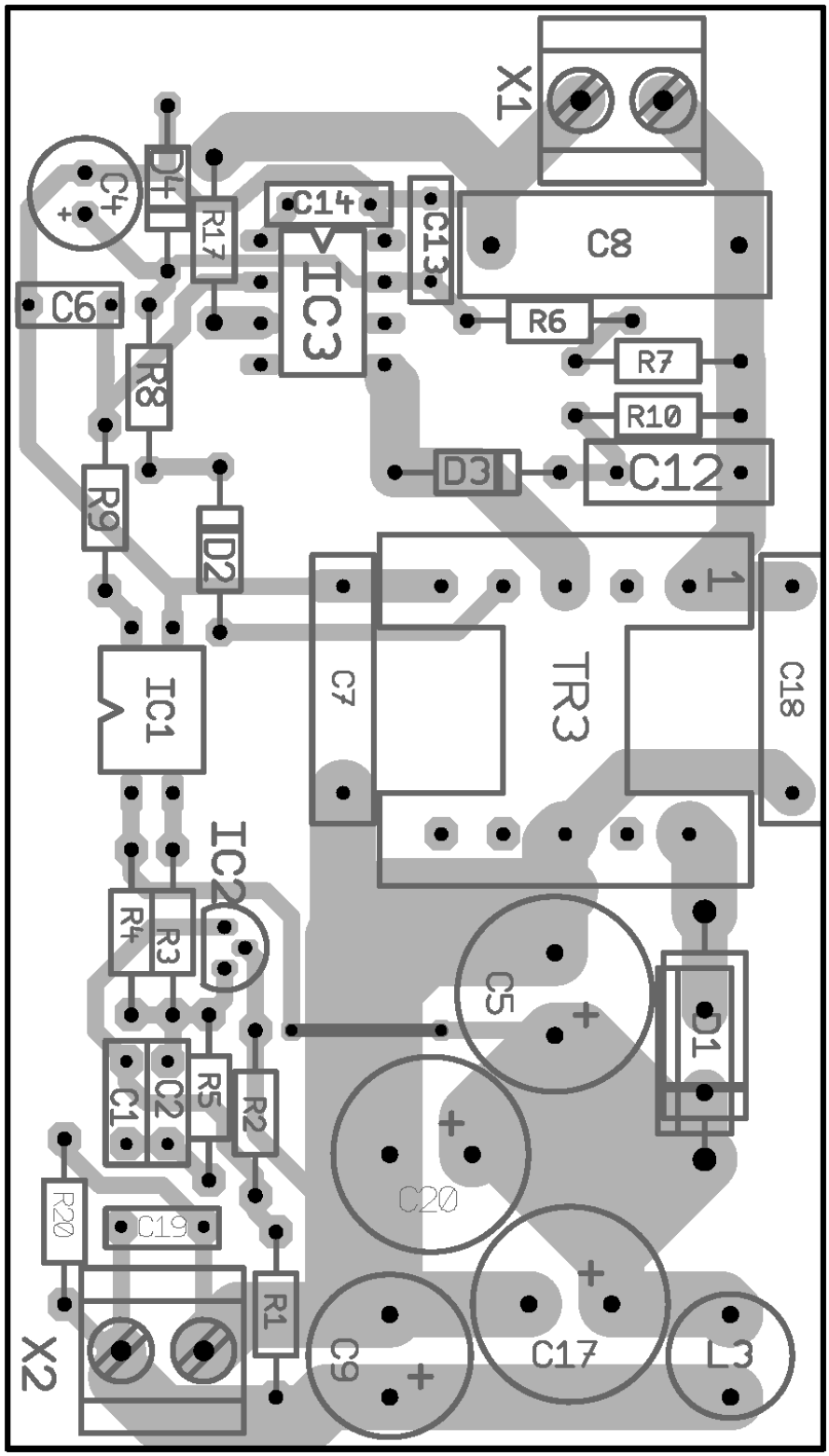


Figure 3 – PCB layout component side shown

Bill of Material PC Standby

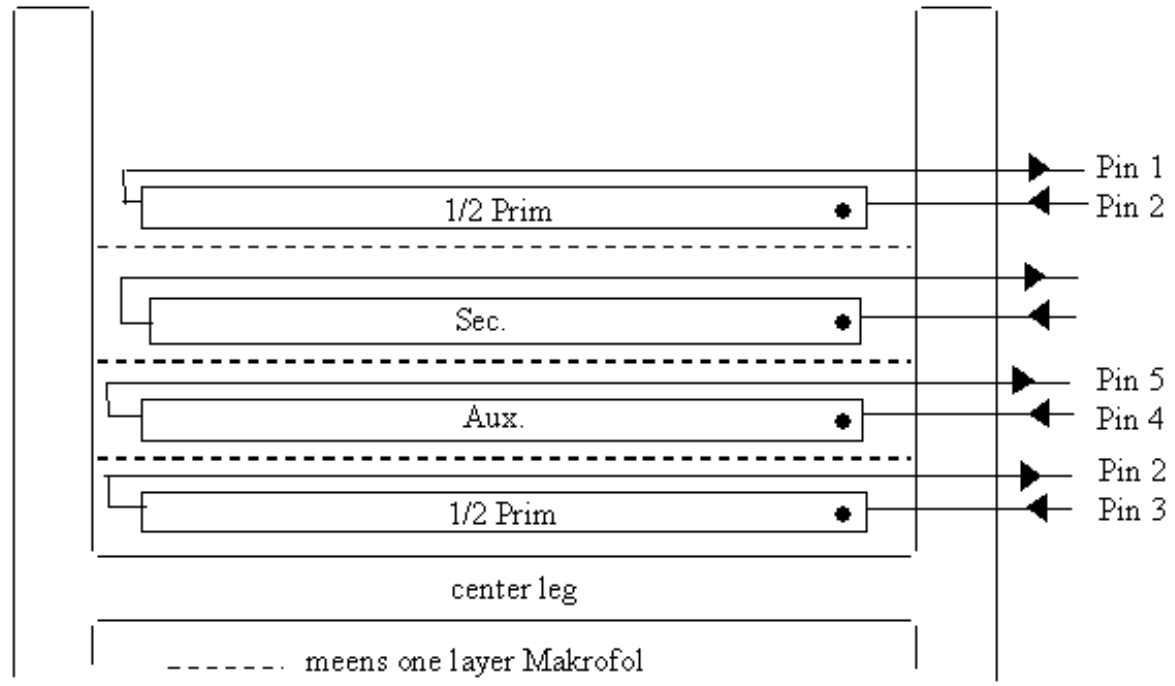
Pos.	Part		Type	Ordering Code	Manuf.
1	C1	1	470nF, 50V	B37984-M5474-K	Epcos
2	C2	1	22nF, 50V	B37979-G5223-J	Epcos
3	C4	1	22uF, 50V	B41821-A6226-M	Epcos
4	C5, C17, C20	3	470uF, 35V	KZE 35VB470MK20	(NCC) Alfatec
5	C6	1	2.2nF, 50V	B37979-G5222-J	Epcos
6	C7, C18	2	1nF,250V, Y1		
7	C8	1	0.1uF, 275V, X2	B81133-D1104-M	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} = 31,9mm²; 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

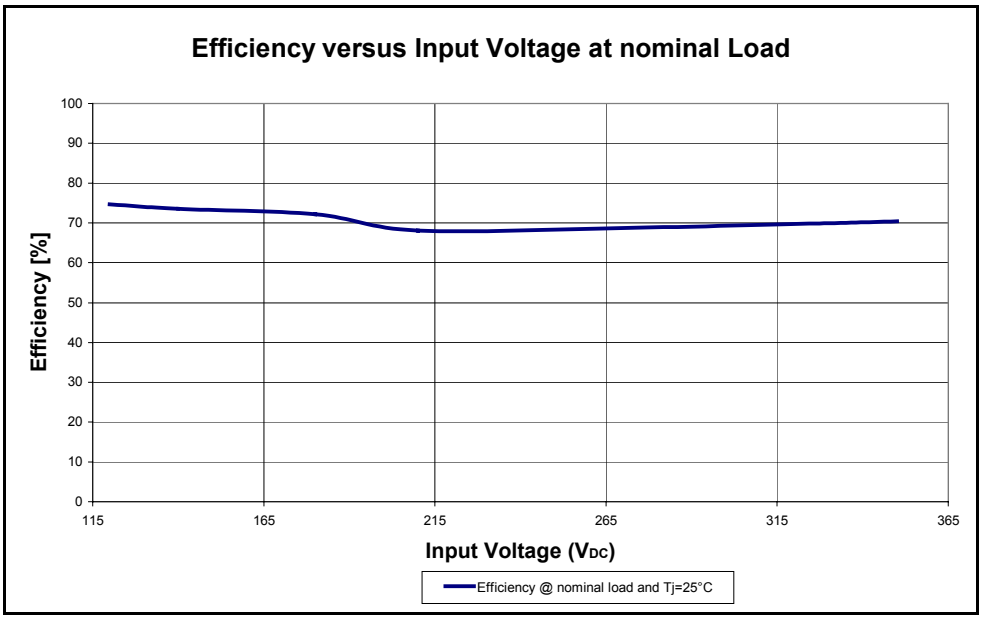


Figure 5 – Efficiency versus Line Input Voltage at Nominal Load

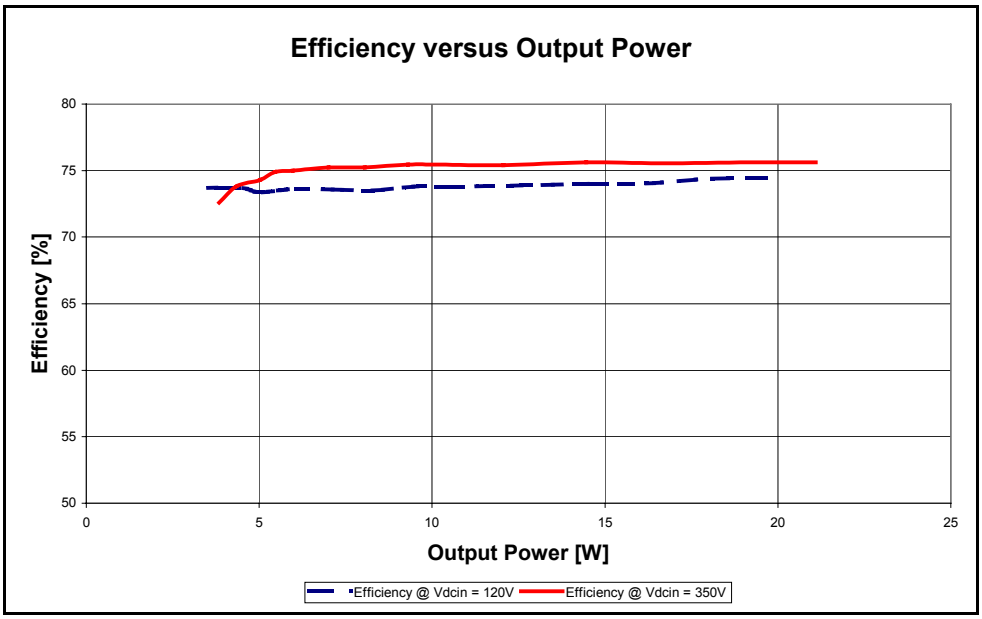


Figure 6 – Efficiency versus Output Power

Frequency Reduction

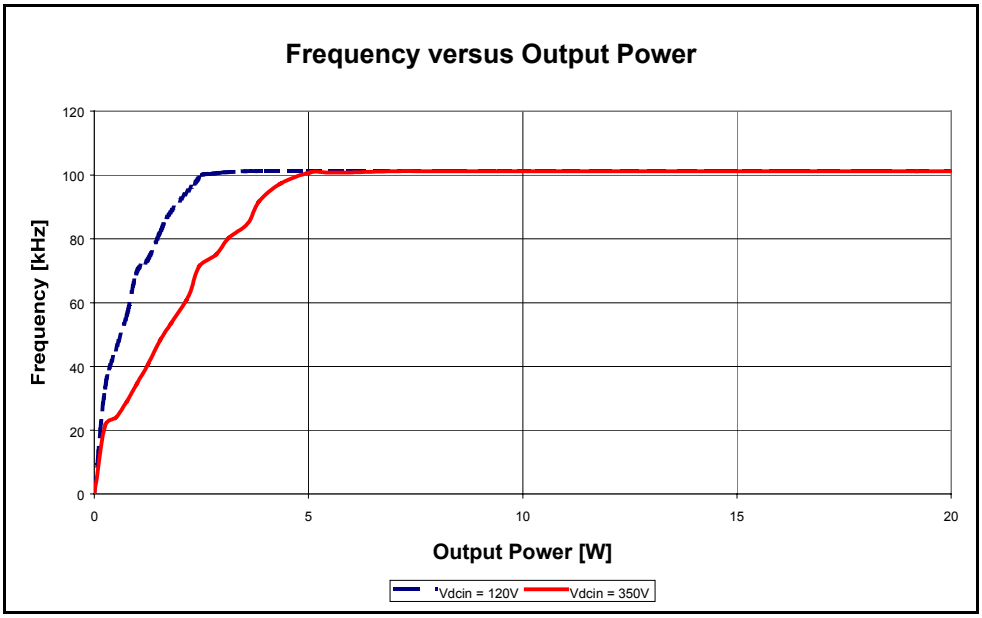


Figure 7 – Frequency versus Output Power

No-load input power

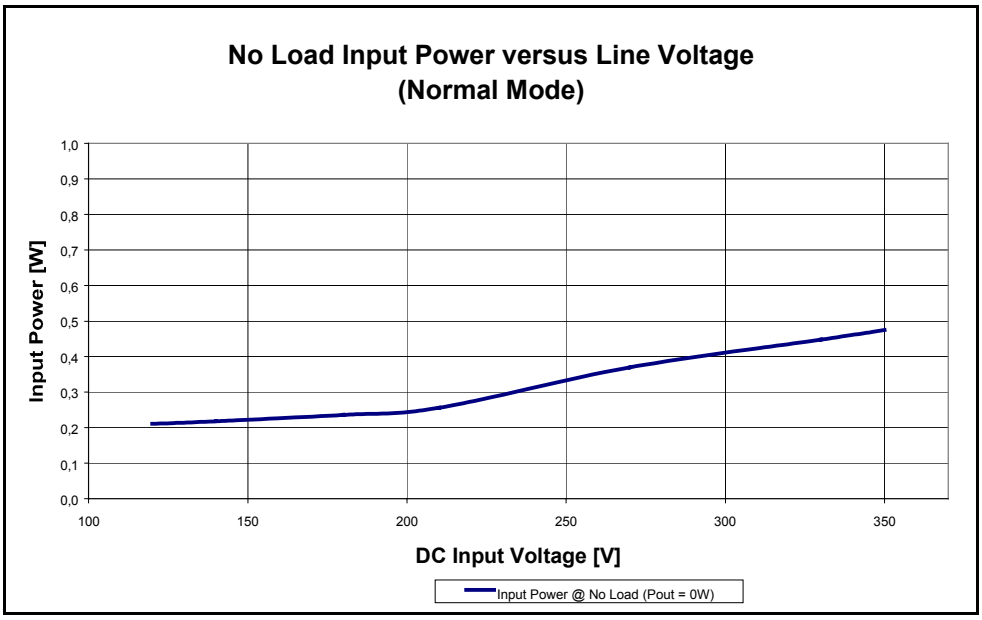


Figure 8 – No-load Input Power versus Line Input Voltage in Burst Mode

Regulation and Power Limiting

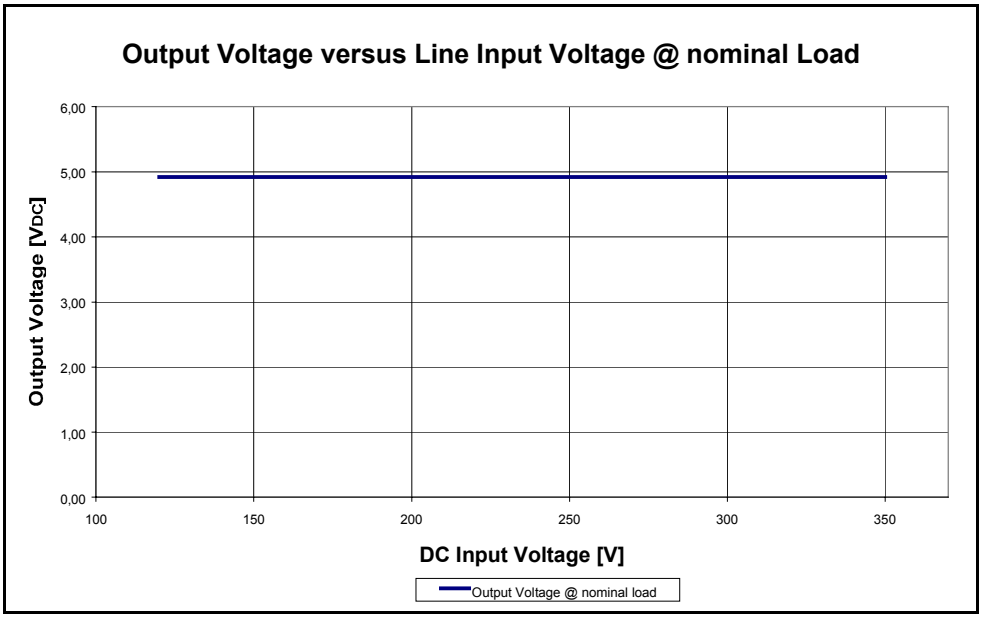


Figure 9 – Output Voltage versus Line Input Voltage @ Nominal Load

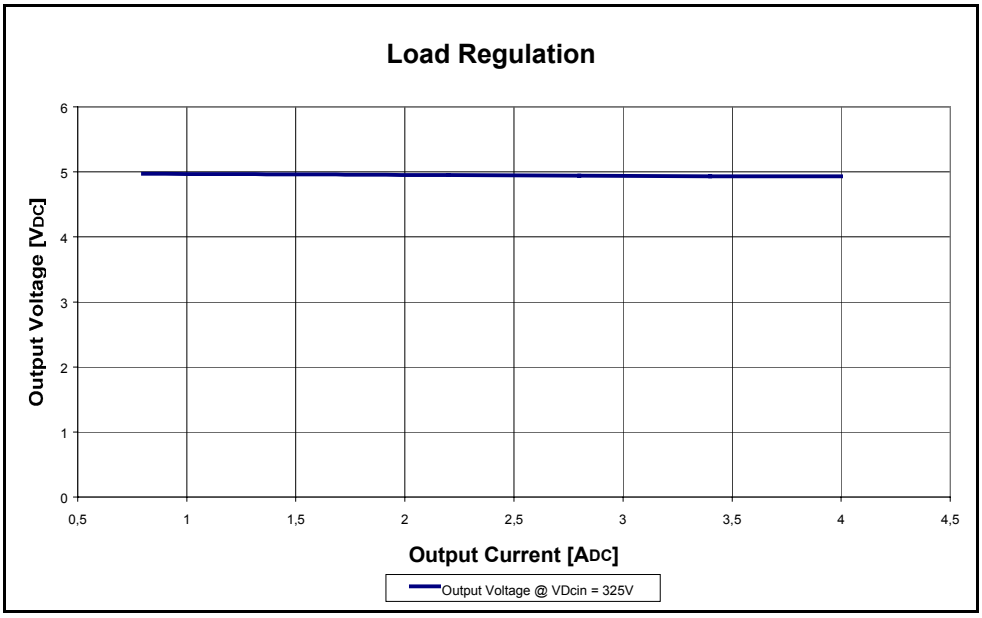


Figure 10 – Load Regulation

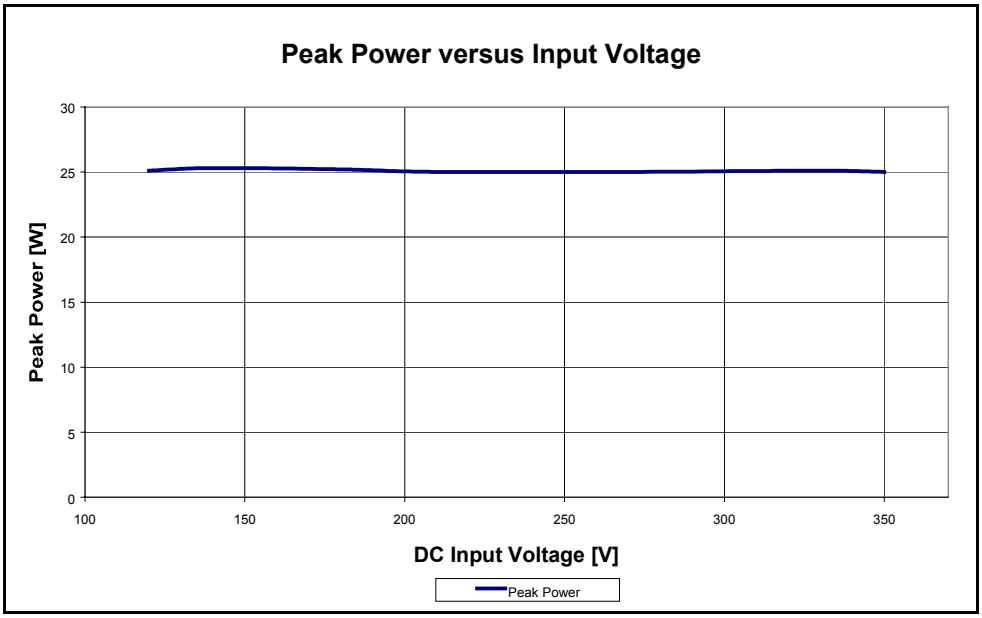


Figure 11 – Peak Power Limitation versus Line Input Voltage

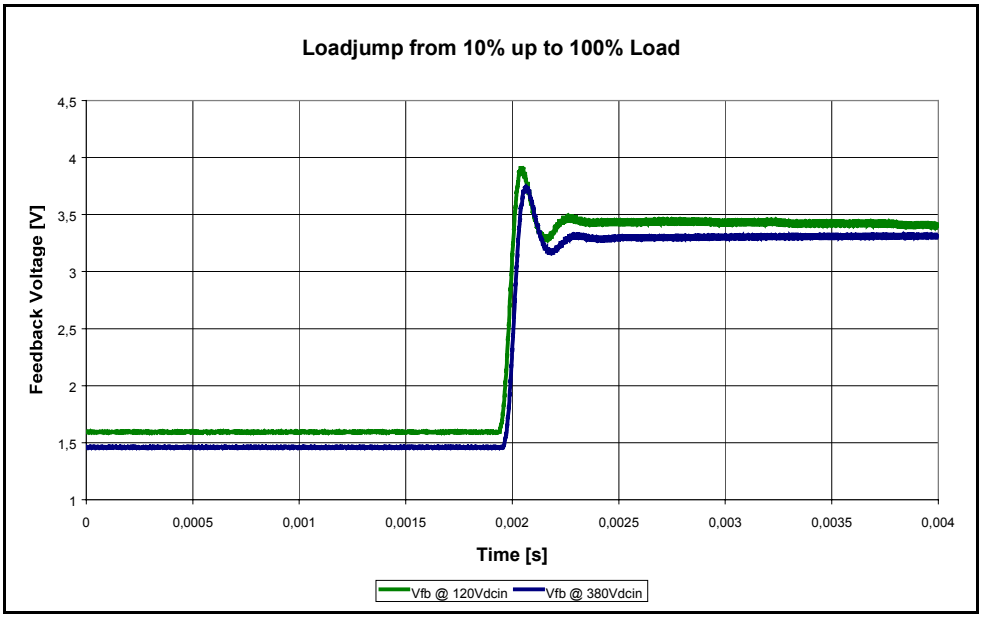


Figure 12 – Feedbackvoltage during Loadjump from 10% up to 100% Load

Output voltage during startup

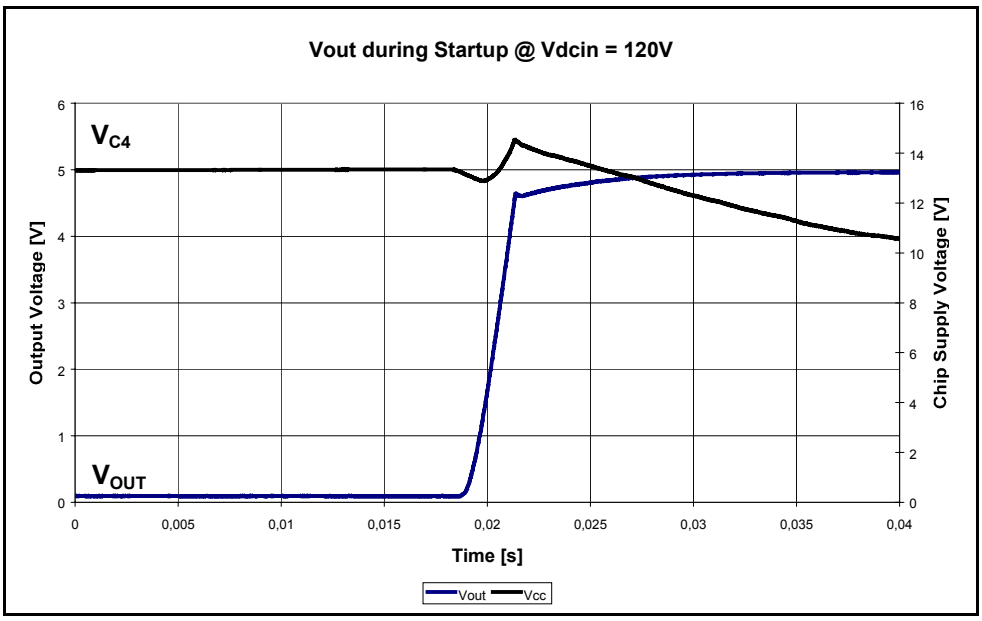


Figure 13 – Startup with full Load Condition at V_{DCIN} = 120V, V_{C4} and V_{OUT}

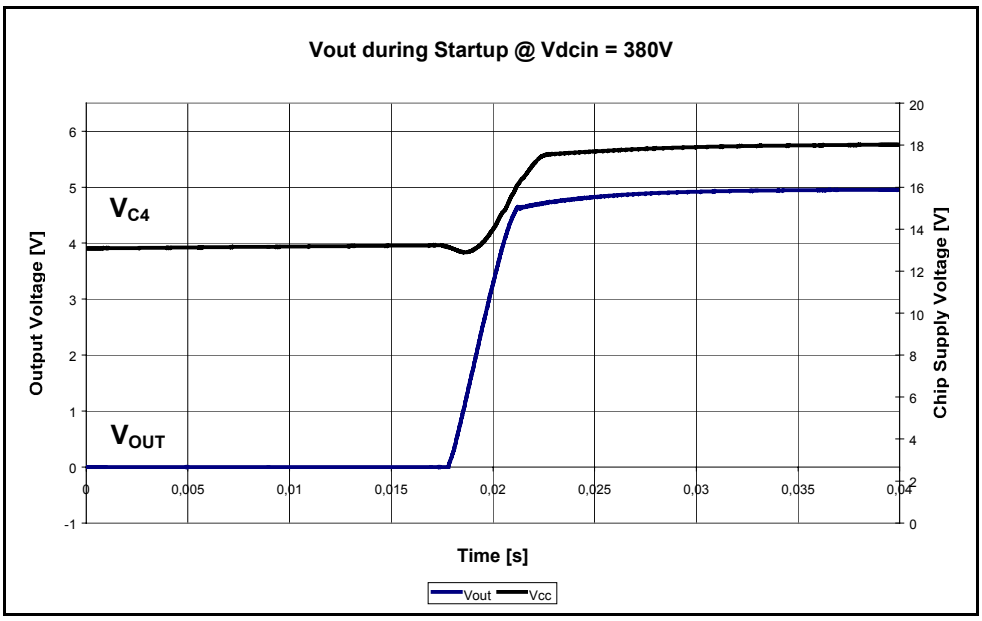


Figure 14 – Startup with Full Load Condition at V_{DCIN} = 380V, V_{C4} and V_{OUT}

Startup Behavior Softstart Phase

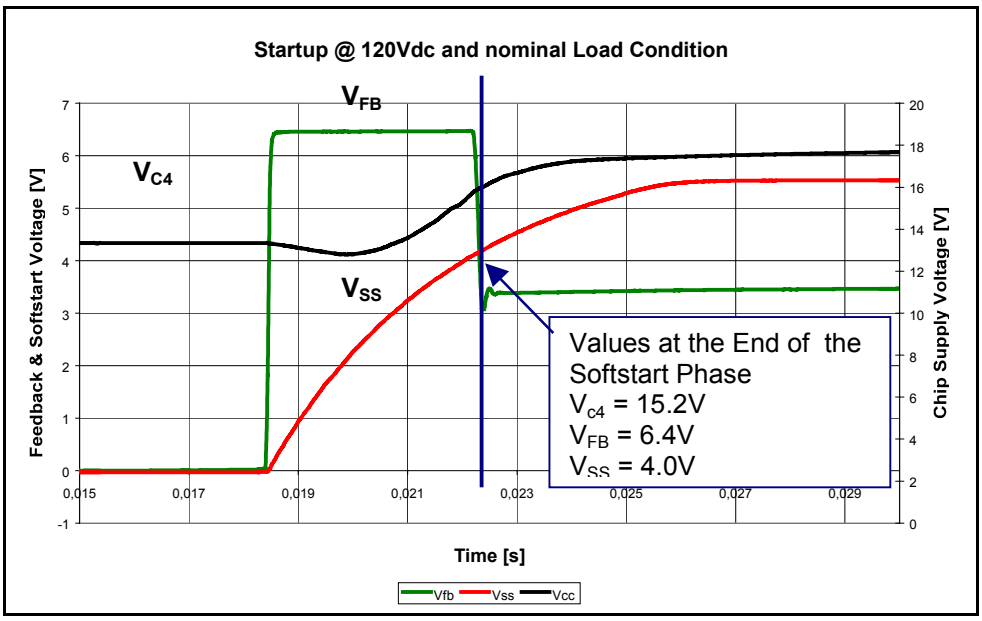


Figure 15 Startup Behavior at Nominal Load Condition @ V_{DCIN} = 120V

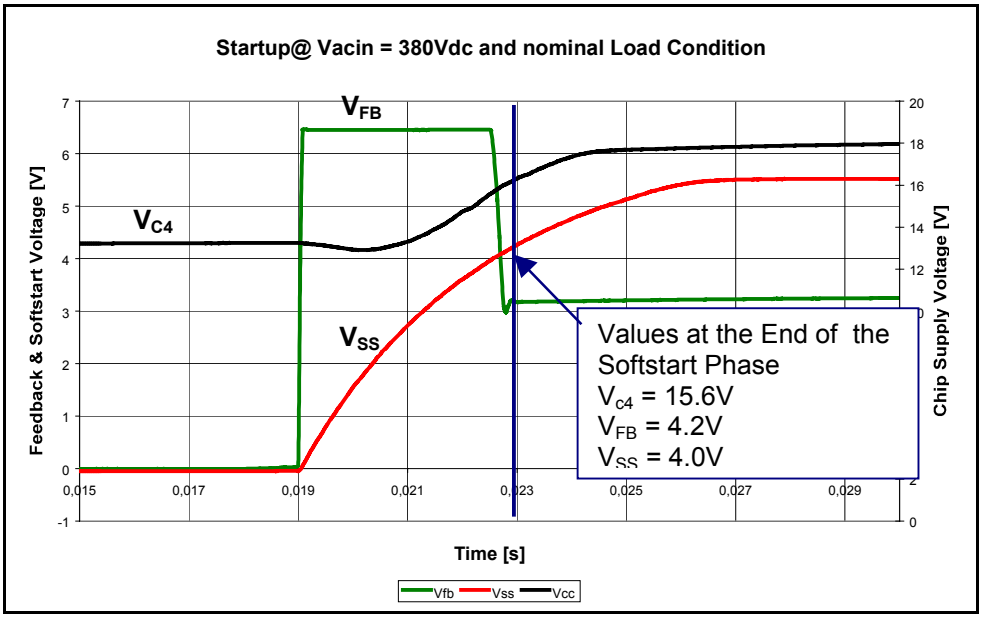


Figure 16 Startup Behavior at Nominal Load Condition @ V_{DCIN} = 380V

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-PC Standby-1		
Actual Release: 1.0 Date: 23.11.2001		Previous Release: 1.0 Date:23.11.2001
Page of actual Rel.	Page of prev. Rel.	Subjects changed since last release

Note:

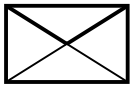
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