

Design Note

DN-PC Standby-1

CoolSET™ 17W PC Standby with ICE2A165

Author: Rainer Kling

Published by Infineon Technologies AG

<http://www.infineon.com>

Power Management & Supply



Never stop thinking

Table of Contents

INTRODUCTION	3
LIST OF FEATURES.....	4
POWER SUPPLY SPECIFICATION	4
SCHEMATIC.....	5
DESCRIPTION	6
<i>Introduction</i>	<i>6</i>
PRIMARY SIDE.....	6
<i>Line Input</i>	<i>6</i>
<i>Startup</i>	<i>6</i>
<i>Operation Mode</i>	<i>6</i>
<i>Softstart</i>	<i>6</i>
<i>Snubber Network</i>	<i>6</i>
<i>Limitation of primary current</i>	<i>6</i>
<i>Feedback Network</i>	<i>6</i>
SECONDARY SIDE.....	7
<i>Output Voltage.....</i>	<i>7</i>
<i>Regulation.....</i>	<i>7</i>
EMI FILTER.....	7
PCB LAYOUT.....	8
BILL OF MATERIAL EVALS-ICE2A265	9
TRANSFORMER CONSTRUCTION DOCUMENTATION.....	10
PERFORMANCE DATA.....	11
EFFICIENCY.....	11
FREQUENCY REDUCTION	12
NO-LOAD INPUT POWER	12
REGULATION AND POWER LIMITING	13
OUTPUT VOLTAGE DURING STARTUP	15
STARTUP BEHAVIOR SOFTSTART PHASE.....	16
REFERENCES	17

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 discontinuous 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.

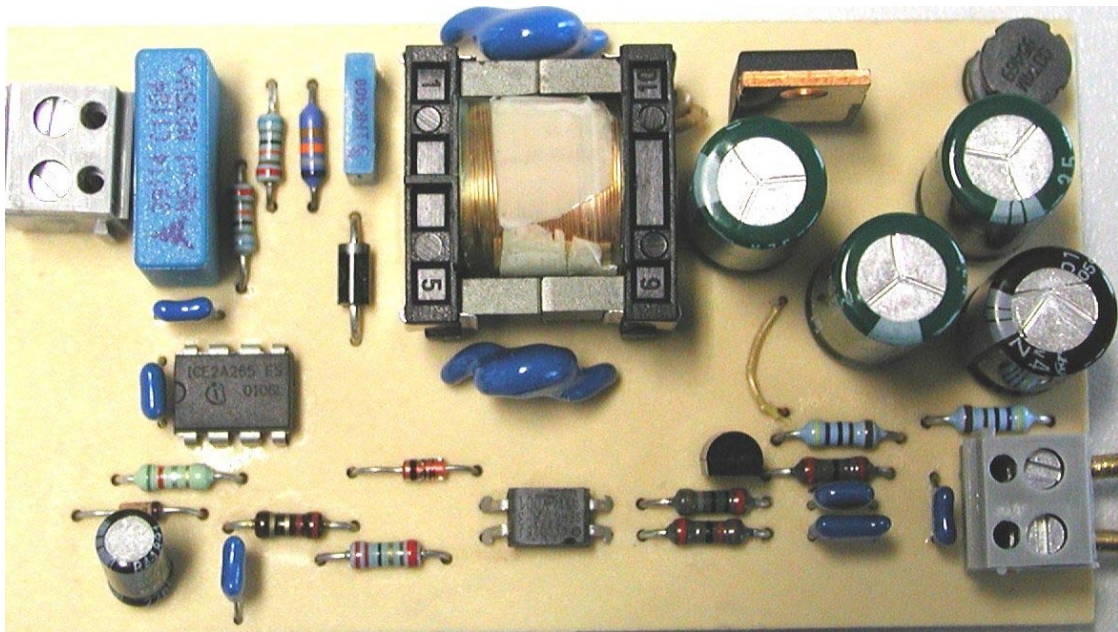


Figure 1 PC Standby

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 $T_j = 110^\circ\text{C}$

² Burst Mode

³ At nominal load

⁴ At nominal load

Schematic

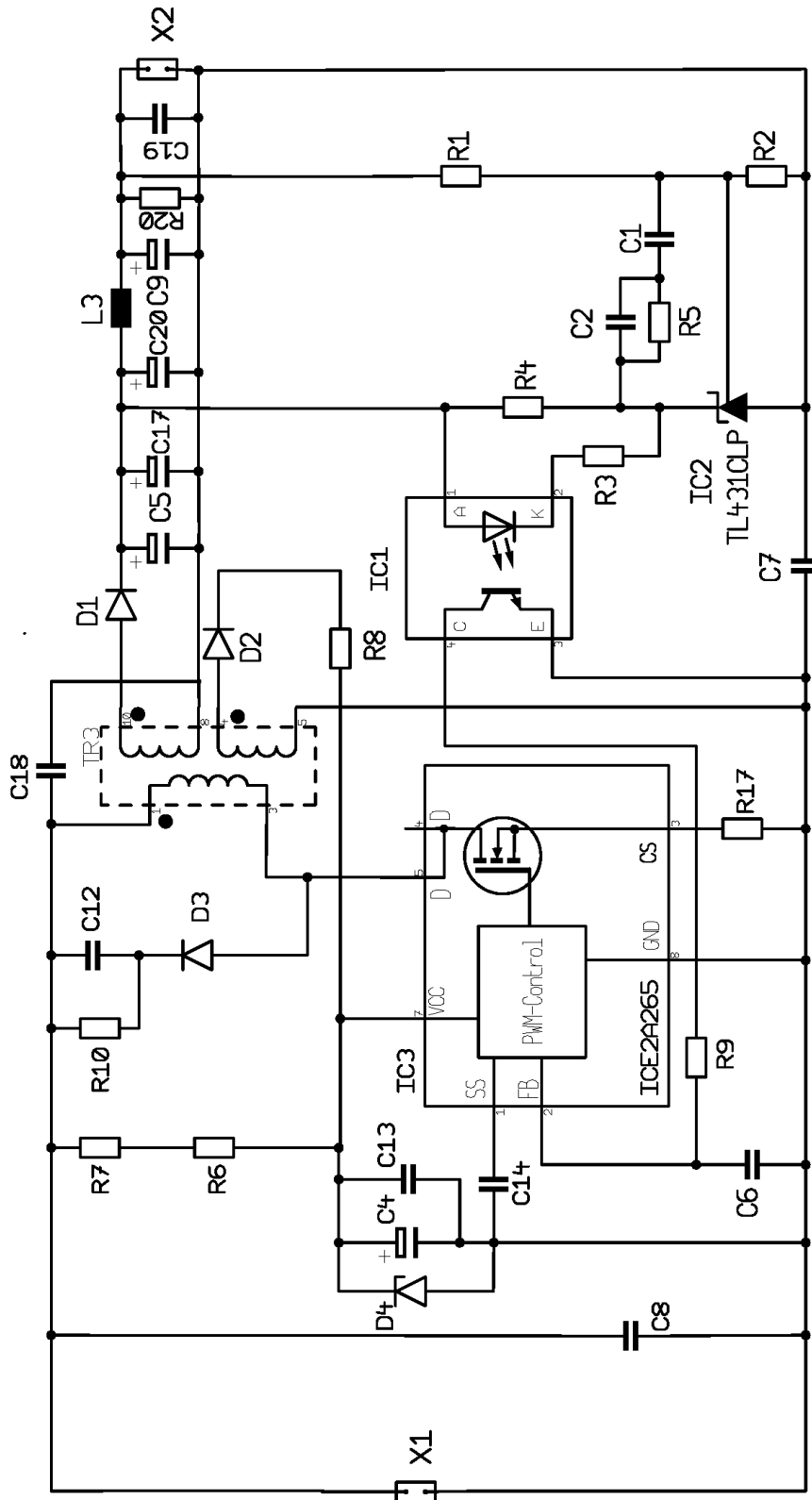


Figure 2 PC Standby Schematic

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, R1 and 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

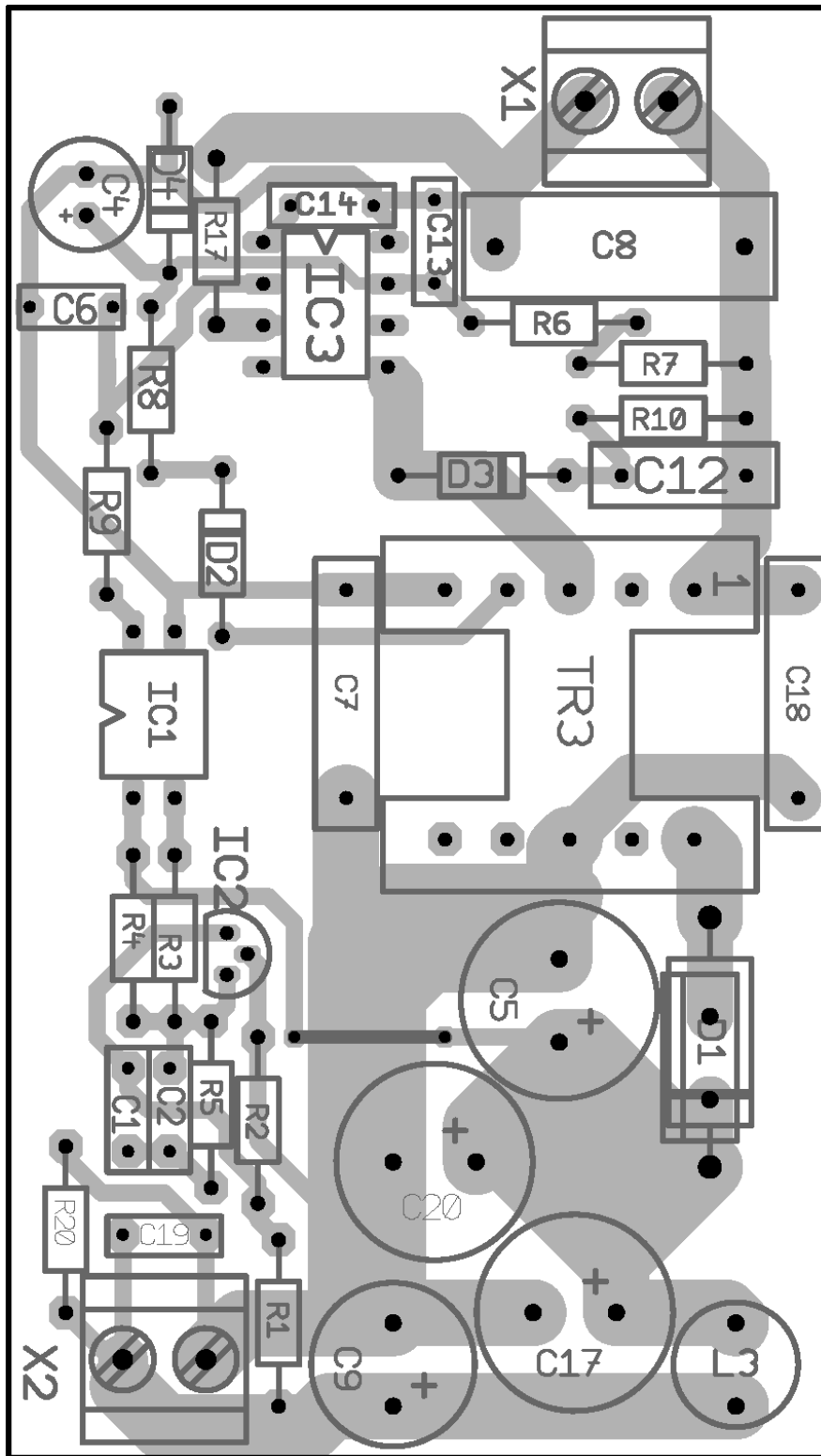


Figure 3 – PCB layout component side shown

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

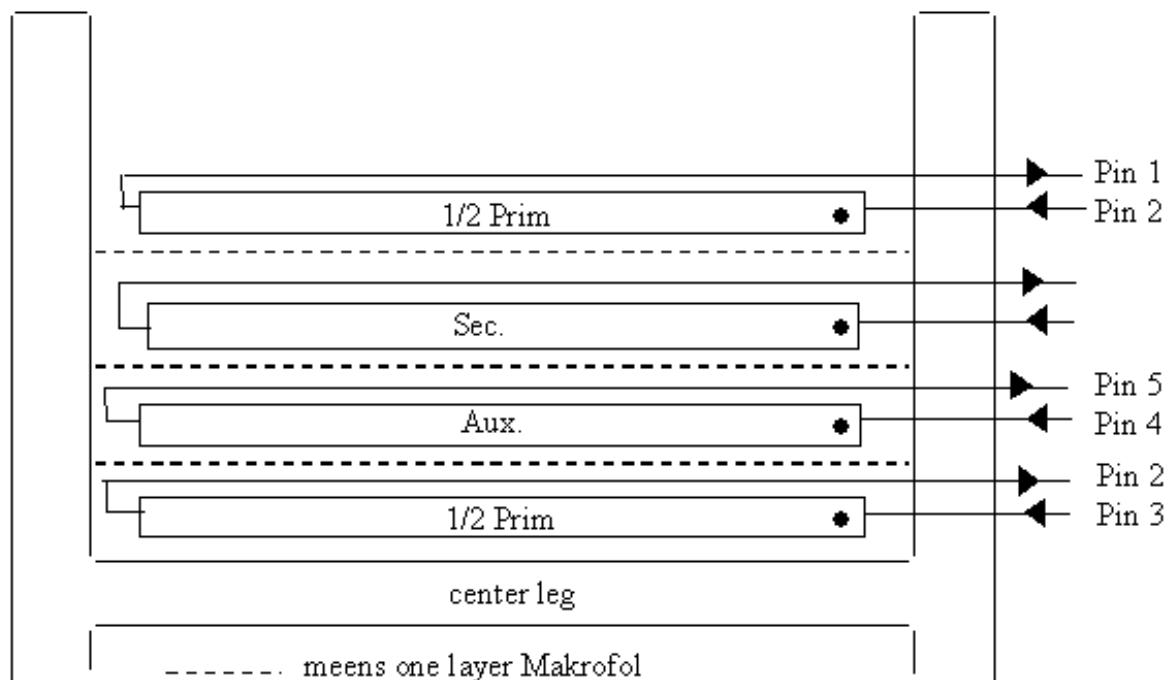
Transformer Construction Documentation

20W/100 kHz Flyback Transformer

Coil former: horizontal version

Core E20/10/6; N67; $A_{MIN} = 31,9\text{mm}^2$; total gap = 1,0mm; $A_L = 62\text{ nH}$;

$L_p = 435\mu\text{H}$



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

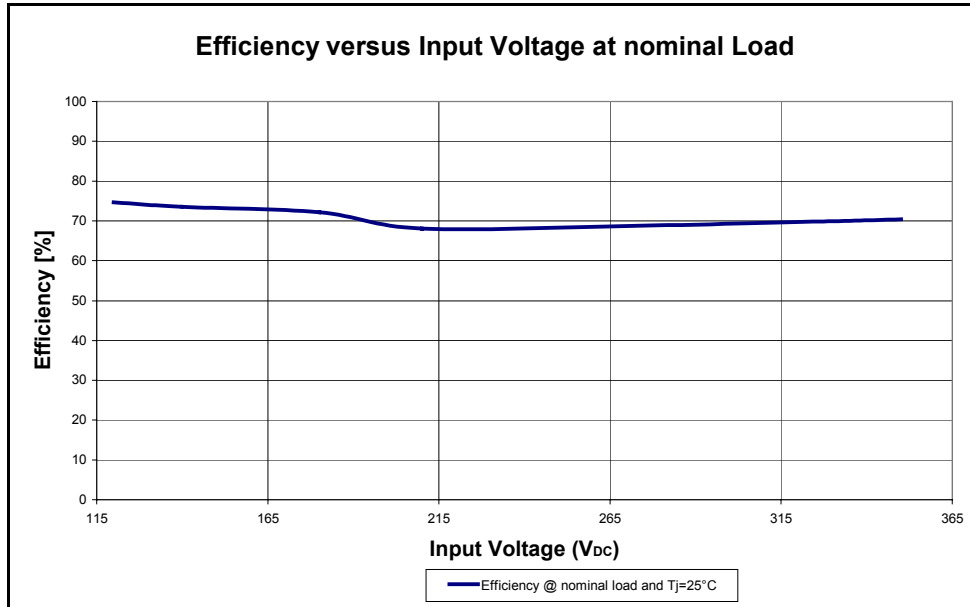


Figure 5 – Efficiency versus Line Input Voltage at Nominal Load

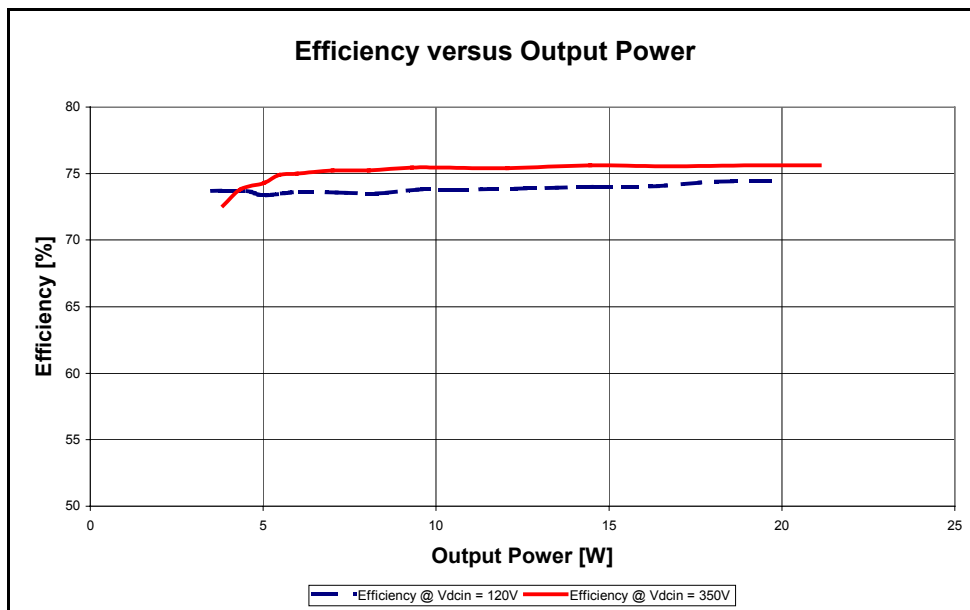


Figure 6 – Efficiency versus Output Power

Frequency Reduction

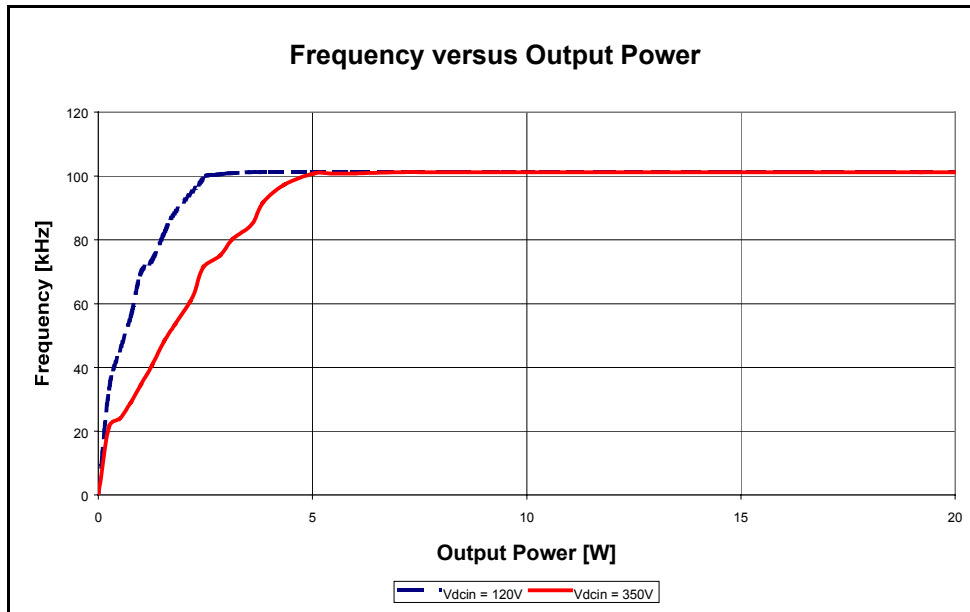


Figure 7 – Frequency versus Output Power

No-load input power

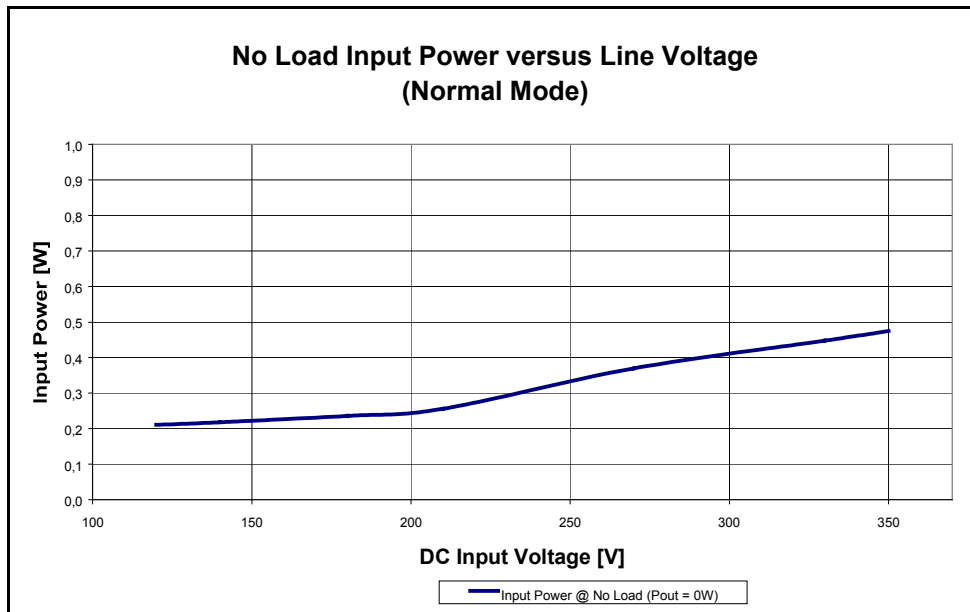


Figure 8 – No-load Input Power versus Line Input Voltage in Burst Mode

Regulation and Power Limiting

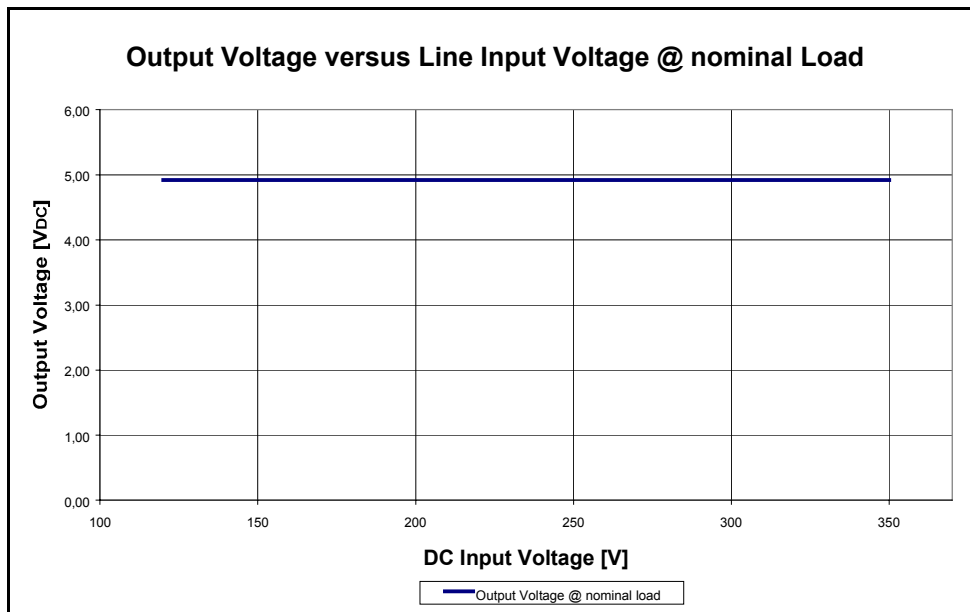


Figure 9 – Output Voltage versus Line Input Voltage @ Nominal Load

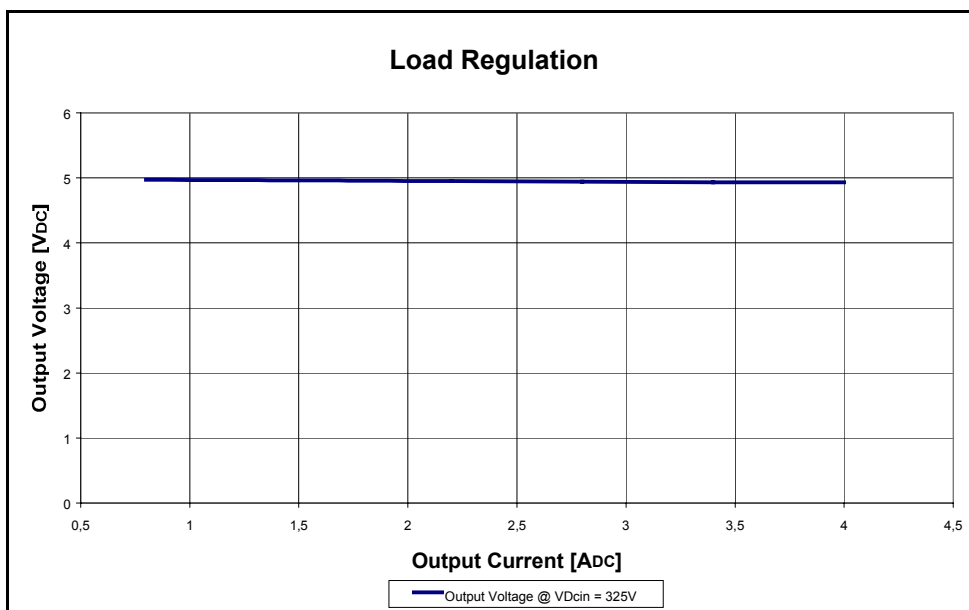


Figure 10 – Load Regulation

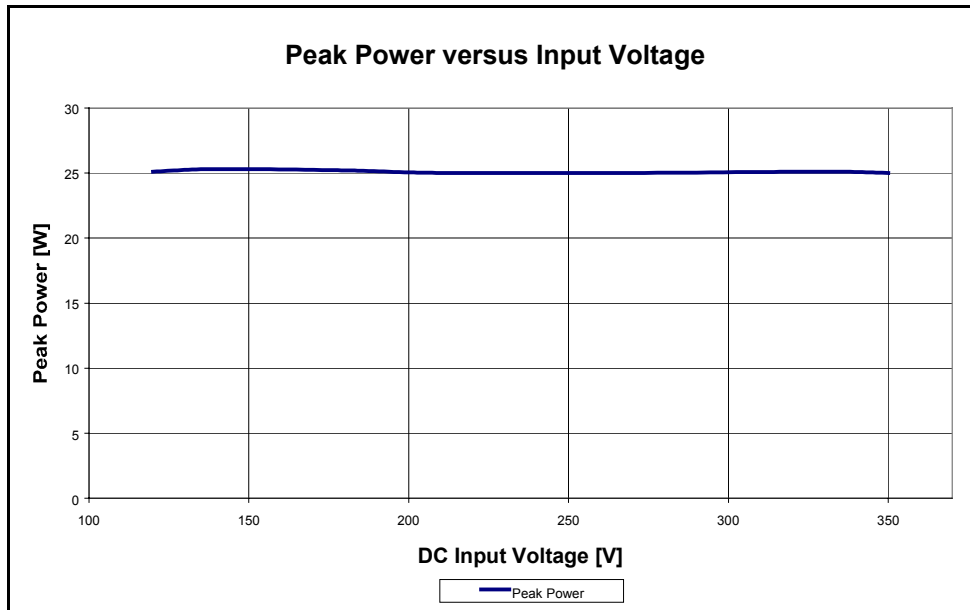


Figure 11 – Peak Power Limitation versus Line Input Voltage

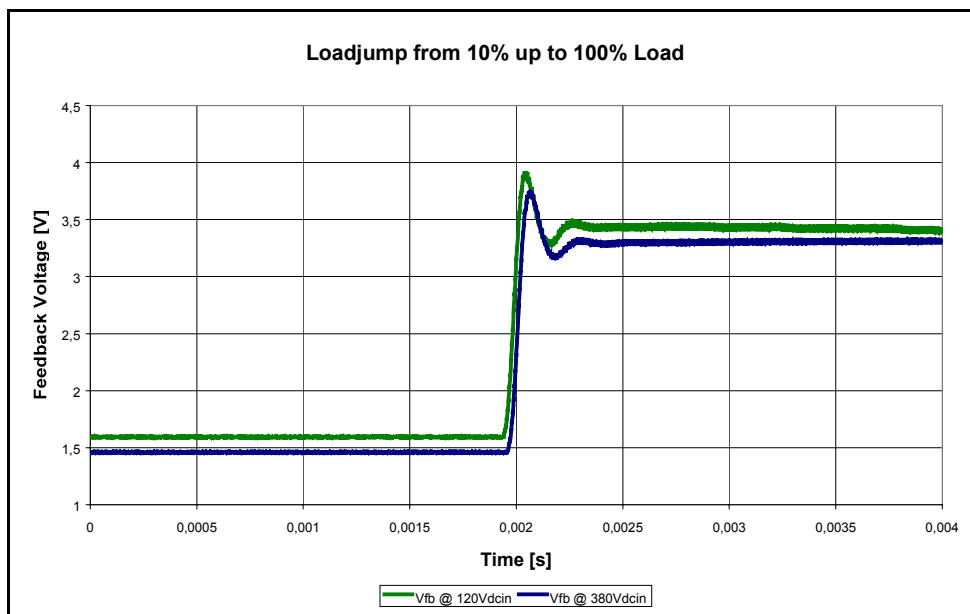


Figure 12 – Feedbackvoltage during Loadjump from 10% up to 100% Load

Output voltage during startup

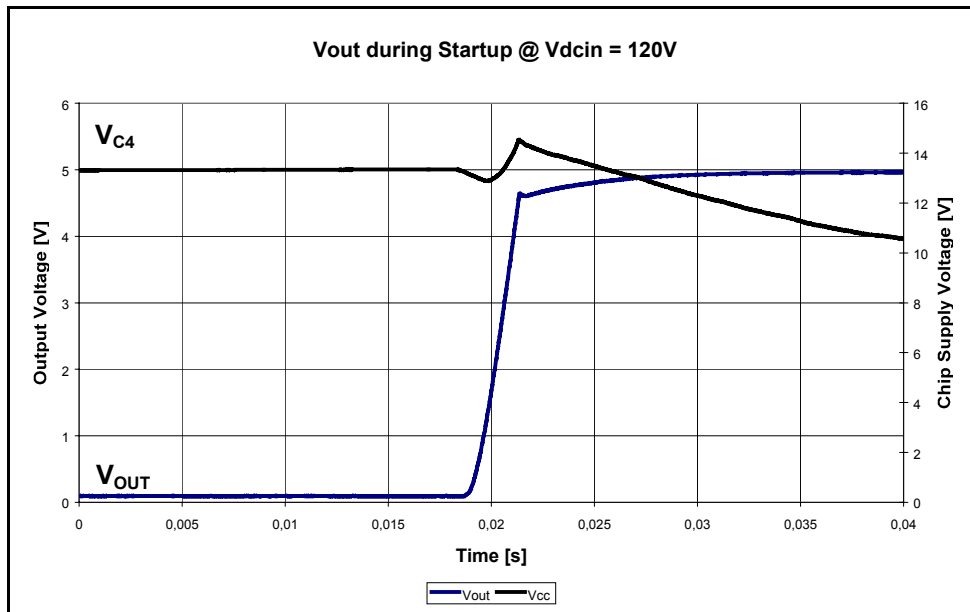


Figure 13 – Startup with full Load Condition at V_{DCIN} = 120V, V_{C4} and V_{OUT}

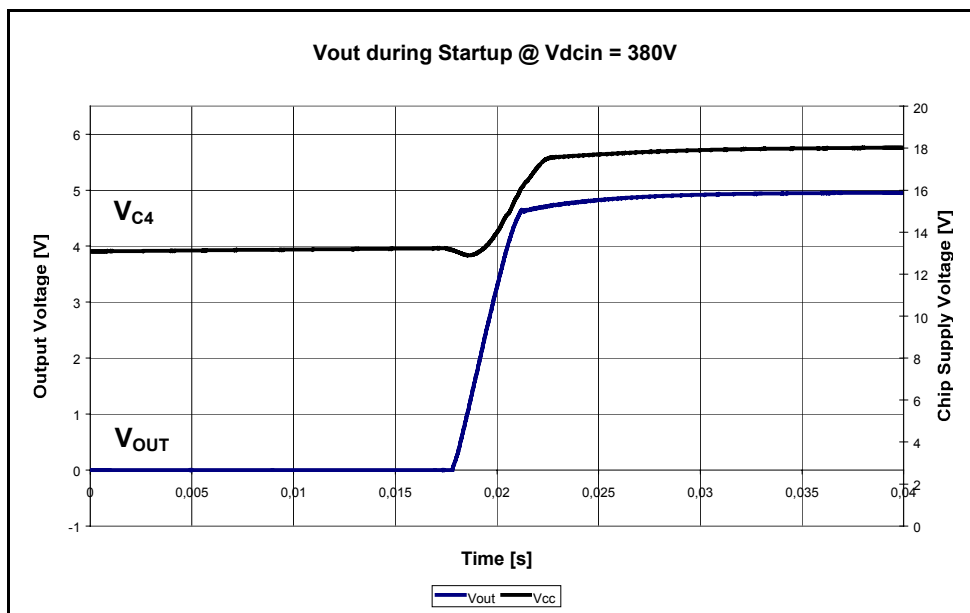


Figure 14 – Startup with Full Load Condition at V_{DCIN} = 380V, V_{C4} and V_{OUT}

Startup Behavior Softstart Phase

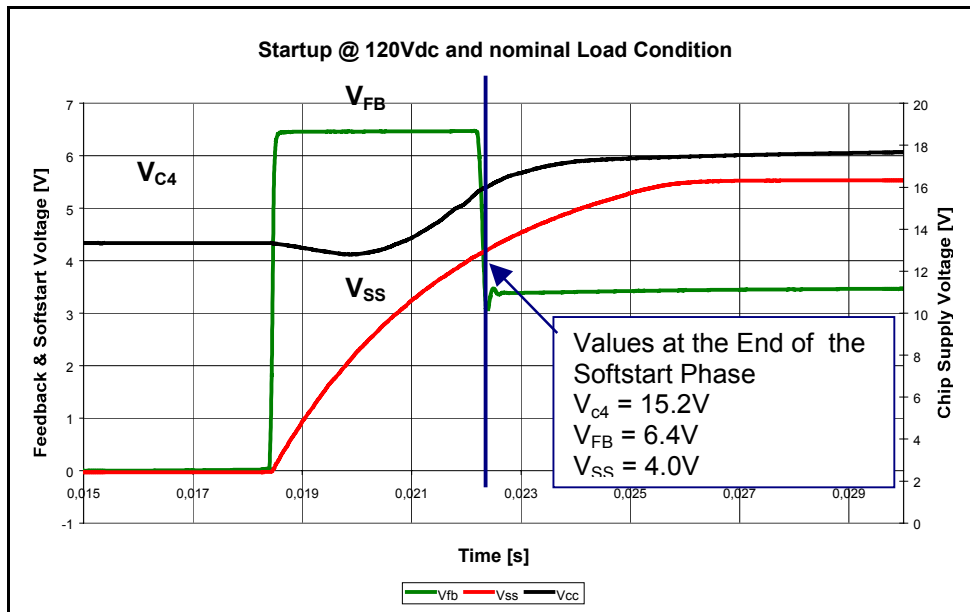


Figure 15 Startup Behavior at Nominal Load Condition @ V_{DCIN} = 120V

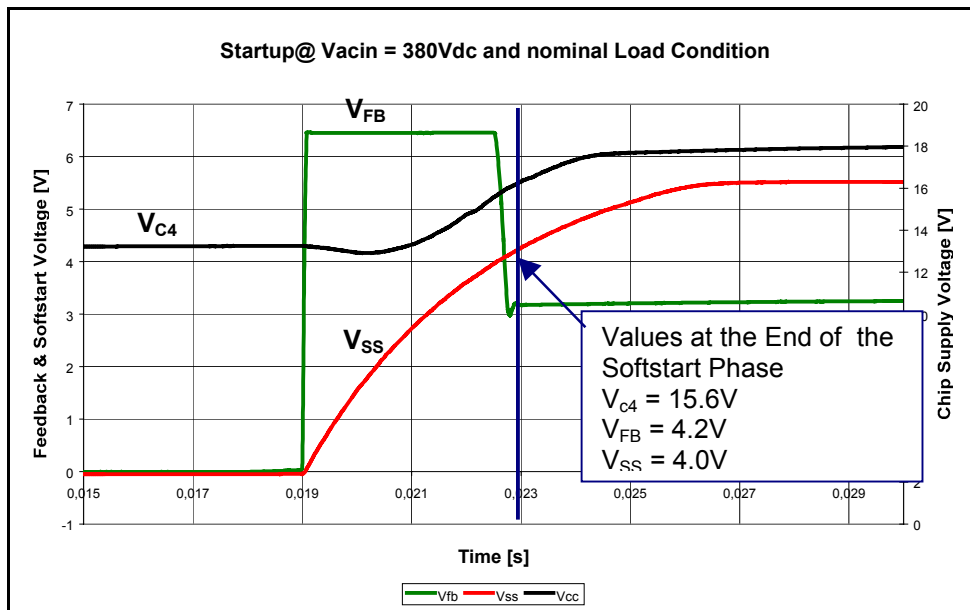


Figure 16 Startup Behavior at Nominal Load Condition @ V_{DCIN} = 380V

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:

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

For questions on technology, delivery and prices please contact the Infineon Technologies Offices in Germany or the Infineon Technologies Companies and Representatives worldwide: see the address list on the last page or our webpage at

<http://www.infineon.com>

CoolMOS™ and CoolSET™ are trademarks of Infineon Technologies AG.

We listen to Your Comments

Any information within this dokument that you feel is wrong, unclear or missing at all?

Your feedback will help us to continuously improve the quality of this dokument.

Please send your proposal (including a reference to this dokument) to:

mcdoku.comment@infineon.com



Edition 2001-11--23

**Published by Infineon Technologies AG,
St.-Martin-Strasse 53,
D-81541 München**

© Infineon Technologies AG 2000.

All Rights Reserved.

Attention please!

The information herein is given to describe certain components and shall not be considered as warranted characteristics.

Terms of delivery and rights to technical change reserved.

We hereby disclaim any and all warranties, including but not limited to warranties of non-infringement, regarding circuits, descriptions and charts stated herein.

Infineon Technologies is an approved CECC manufacturer.

Information

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office in Germany or our Infineon Technologies Representatives worldwide (see address list).

Warnings

Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

Infineon Technologies AG sales offices worldwide –partly represented by Siemens AG

<p>A Siemens AG Österreich Erdberger Lände 26 A-1031 Wien T (+43)1-17 07-3 56 11 Fax (+43)1-17 07-5 59 73</p> <p>AUS Siemens Ltd. 885 Mountain Highway Bayswater,Victoria 3153 T (+61)3-97 21 21 11 Fax (+61)3-97 21 72 75</p> <p>B Siemens Electronic Components Benelux Charleroisesteenweg 116/ Chaussée de Charleroi 116 B-1060 Brussel/Bruxelles T (+32)2-5 36 69 05 Fax (+32)2-5 36 28 57 Email:components@siemens.nl</p> <p>BR Siemens Ltda. Semiconductores Avenida Mutinga,3800-Pirituba 05110-901 São Paulo-SP T (+55)11-39 08 25 64 Fax (+55)11-39 08 27 28</p> <p>CDN Infineon Technologies Corporation 320 March Road,Suite 604 Canada,Ontario K2K 2E2 T (+1)6 13-5 91 63 86 Fax (+1)6 13-5 91 63 89</p> <p>CH Siemens Schweiz AG Bauelemente Freilagerstrasse 40 CH-8047 Zürich T (+41)1-4 953065 Fax (+41)1-4 955050</p> <p>D Infineon Technologies AG Völklinger Str.2 D-40219 Düsseldorf T (+49)2 11-3 99 29 30 Fax (+49)2 11-3 99 14 81 Infineon Technologies AG Werner-von-Siemens-Platz 1 D-30880 Laatzen (Hannover) T (+49)5 11-8 77 22 22 Fax (+49)5 11-8 77 15 20 Infineon Technologies AG Von-der-Tann-Straße 30 D-90439 Nürnberg T (+49)9 11-6 54 76 99 Fax (+49)9 11-6 54 76 24 Infineon Technologies AG Weissacher Straße 11 D-70499 Stuttgart T (+49)7 11-1 37 33 14 Fax (+49)7 11-1 37 24 48</p> <p>D Infineon Technologies AG Halbleiter Distribution Richard-Strauss-Straße 76 D-81679 München T (+49)89-92 21 40 86 Fax (+49)89-92 21 20 71</p> <p>DK Siemens A/S Borupvang 3 DK-2750 Ballerup T (+45)44 77-44 77 Fax (+45)44 77-40 17</p> <p>E Siemens S.A. Dpto.Componentes Ronda de Europa,5 E-28760 Tres Cantos-Madrid T (+34)91-5 14 71 51 Fax (+34)91-5 14 70 13</p>	<p>F Infineon Technologies France, 39/47,Bd.Ornano F-93527 Saint-Denis CEDEX2 T (+33)1-49 22 31 00 Fax (+33)1-49 22 28 01</p> <p>FIN Siemens Components Scandinavia P.O .Bo x 6 0 FIN-02601 Espoo (Helsinki) T (+3 58)10-5 11 51 51 Fax (+3 58)10-5 11 24 95 Email: scs@components.siemens.se</p> <p>GB Infineon Technologies Siemens House Oldbury GB-Bracknell,Berkshire RG12 8FZ T (+44)13 44-39 66 18 Fax (+44)13 44-39 66 32</p> <p>H Simacomp Kft. Lajos u.103 H-1036 Budapest T (+36)1-4 57 16 90 Fax (+36)1-4 57 16 92</p> <p>HK Infineon Technologies Hong Kong Ltd. Suite 302,Level 3, Festival Walk, 80 Tat Chee Avenue, Yam Yat Tsuen, Kowloon Tong Hong Kong T (+8 52)28 32 05 00 Fax (+8 52)28 27 97 62</p> <p>I Siemens S.A. Semiconductor Sales Via Piero e Alberto Pirelli,10 I-20126 Milano T (+39)02-66 76 -1 Fax (+39)02-66 76 43 95</p> <p>IND Siemens Ltd. Components Division No.84 Keonics Electronic City Hosur Road Bangalore 561 229 T (+91)80-8 52 11 22 Fax (+91)80-8 52 11 80</p> <p>Siemens Ltd. CMP Div,5th Floor 4A Ring Road,IP Estate New Delhi 110 002 T (+91)11-3 31 99 12 Fax (+91)11-3 31 96 04</p> <p>Siemens Ltd. CMP Div,4th Floor 130,Pandurang Budhkar Marg, Worli Mumbai 400 018 T (+91)22-4 96 21 99 Fax (+91)22-4 96 22 01</p> <p>IRL Siemens Ltd. Electronic Components Division 8,Raglan Road IRL-Dublin 4 T (+3 53)1-2 16 23 42 Fax (+3 53)1-2 16 23 49</p> <p>IL Nisko Ltd. 2A,Habarzel St. P.O.Box 58151 61580 Tel Aviv -Isreal T (+9 72)3 -7 65 73 00 Fax (+9 72)3 -7 65 73 33</p>	<p>J Siemens Components K.K. Talanawa Park Tower 12F &17F 3-20-14,Higashi-Gotanda, Shinagawa-ku Tokyo T (+81)3-54 49 64 11 Fax (+81)3 -54 49 64 01</p> <p>MAL Infineon Technologies AG Sdn Bhd Bayan Lepas Free Industrial Zone1 11900 Penang T (+60)4 -6 44 99 75 Fax (+60)4 -6 41 48 72</p> <p>N Siemens Components Scandinavia Østre Aker vei 24 Postboks 10,Veitvet N-0518 Oslo T (+47)22-63 30 00 Fax (+47)22-68 49 13 Email: scs@components.siemens.se</p> <p>NL Siemens Electronic Components Benelux Postbus 16068 NL-2500 BB Den Haag T (+31)70-3 33 20 65 Fax (+31)70-3 33 28 15 Email:components@siemens.nl</p> <p>NZ Siemens Auckland 300 Great South Road Greenland Auckland T (+64)9-5 20 30 33 Fax (+64)9-5 20 15 56</p> <p>P Siemens S.A. an Componentes Electronicos R.Irmaos Siemens,1 Alfragide P-2720-093 Amadora T (+351)1-4 17 85 90 Fax (+351)1-4 17 80 83</p> <p>PK Siemens Pakistan Engineering Co.Ltd. PO Box 1129,Islamabad 44000 23 West Jinnah Ave Islamabad T (+92)51-21 22 00 Fax (+92)51-21 16 10</p> <p>PL Siemens SP.z.o.o. ul.Zupnicza 11 PL-03-821 Warszawa T (+48)22-8 70 91 50 Fax (+48)22-8 70 91 59</p> <p>ROK Siemens Ltd. Asia Tower,10th Floor 726 Yeoksam-dong,Kang-nam Ku CPO Box 3001 Seoul 135-080 T (+82)2-5 27 77 00 Fax (+82)2-5 27 77 79</p> <p>RUS INTECH electronics ul.Smolnaya,24/1203 RUS-125 445 Moskva T (+7)0 95 -4 51 97 37 Fax (+7)0 95 -4 51 86 08</p> <p>S Siemens Components Scandinavia Österögatan 1,Box 46 S-164 93 Kista T (+46)8-7 03 35 00 Fax (+46)8-7 03 35 01 Email: scs@components.siemens.se</p>	<p>RC Infineon Technologies Asia Pacific Pte.Ltd. Taiwan Branch 10F,No.136 Nan King East Road Section 23,Taipei T (+8 86)2-27 73 66 06 Fax (+8 86)2-27 71 20 76</p> <p>SGP Infineon Technologies Asia Pacific,Pte.Ltd. 168 Kallang Way Singapore 349 253 T (+65)8 40 06 10 Fax (+65)7 42 62 39</p> <p>USA Infineon Technologies Corporation 1730 North First Street San Jose,CA 95112 T (+1)4 08-5 01 60 00 Fax (+1)4 08-5 01 24 24 Siemens Components,Inc. Optoelectronics Division 19000 Homestead Road Cupertino,CA 95014 T (+1)4 08-2 57 79 10 Fax (+1)4 08-7 25 34 39 Siemens Components,Inc. Special Products Division 186 Wood Avenue South Iselin,NJ 08830-2770 T (+1)7 32-9 06 43 00 Fax (+1)7 32-6 32 28 30</p> <p>VRC Infineon Technologies Hong Kong Ltd. Beijing Office Room 2106,Building A Vantone New World Plaza No.2 Fu Cheng Men Wai Da Jie Jie 100037 Beijing T (+86)10 -68 57 90 -06,-07 Fax (+86)10 -68 57 90 08 Infineon Technologies Hong Kong Ltd. Chengdu Office Room14J1,Jinyang Mansion 58 Tidu Street Chengdu, Sichuan Province 610 016 T (+86)28-6 61 54 46 /79 51 Fax (+86)28 -6 61 01 59 Infineon Technologies Hong Kong Ltd. Shanghai Office Room1101,Lucky Target Square No.500 Chengdu Road North Shanghai 200003 T (+86)21-63 6126 18 /19 Fax (+86)21-63 61 11 67 Infineon Technologies Hong Kong Ltd. Shenzhen Office Room 1502,Block A Tian An International Building Renim South Road Shenzhen 518 005 T (+86)7 55 -2 28 91 04 Fax (+86)7 55-2 28 02 17</p> <p>ZA Siemens Ltd. Components Division P.O.B.3438 Halfway House 1685 T (+27)11-6 52 -27 02 Fax (+27)11-6 52 20 42</p>
---	---	---	--