

Desing Note

DN-SMPS Multistage 40W-1

CoolSET™ 40W SMPS Multistage 40W using ICE2A365

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Power Management & Supply



Never stop thinking

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40W SMPS Multistage using ICE2A365

The board described here was designed as a typical power supply in flyback converter topology with one output voltage and secondary control. This type of switch mode power supply is particularly suitable as an AC/DC power supply for battery chargers, video games, satellite decoders, etc. The switch mode power supply **ICE2A365** chip used for this application is a current-controlled pulse width modulator with integrated CoolMOS power switch. Special efforts have been made to compensate temperature dependency and to achieve a very high accuracy of the 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 **hiccup** mode.

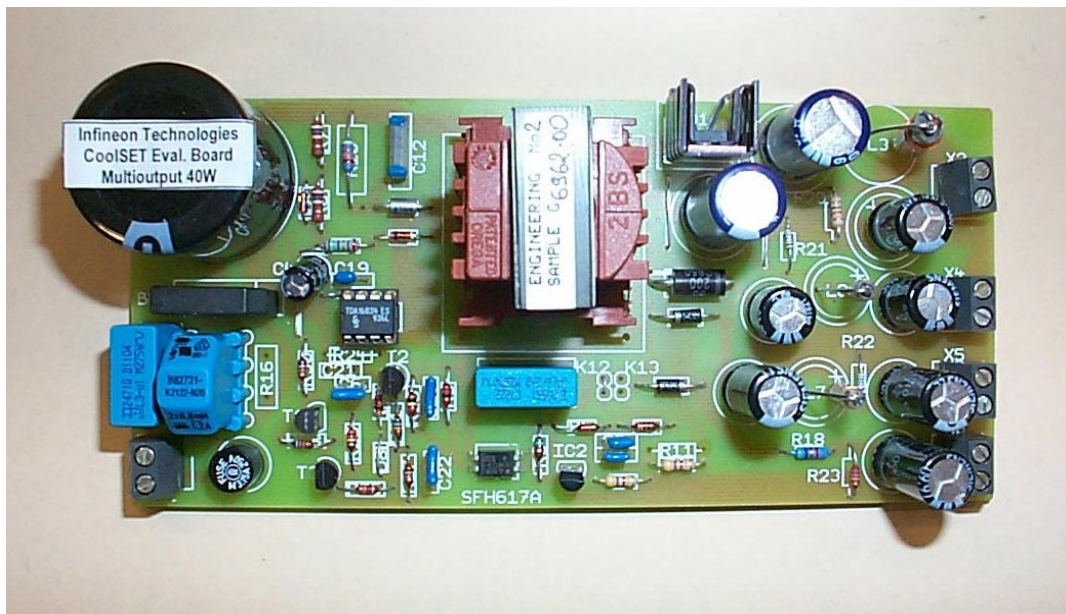


Fig: Evaluation board

Other output voltages can also be implemented very easily by a simple modification of the transformer and the output circuitry.

Technical specifications:

Input Voltage Range	90 ... 264V AC
Input Frequency	50, 60 Hz
Output Voltage 1	5V +-1%
Output Voltage 2	+12V +-8%
Output Voltage 3	-12V +-8%
Output Voltage 4	+30V +-10%
Output Power 1	20W @230V
Output Power 2	15W @230V
Output Power 3	5W @230V
Output Power 4	1W @230V
Line Regulation (85 ...270V)	< 1% @ 5V
Load Regulation (10% ... 100%)	< 1% @ 5V
Efficiency	80%
Output Ripple Voltage	< 100mV
Switching Frequency	21....100 kHz
Temperature Range	0 ... 70°C

Circuit description:

Introduction

The **ICE2A365** chip used here was particularly designed for the use in flyback converters. As shown on the circuit diagram (p. 5), only a few additional components are required to create an AC/DC power supply.

Input Stage

The AC line input side comprises the input fuse F1 as overcurrent protection the choke L5 and X2-capacitors C8 and C22 as radio interference suppressors. After the bridge rectifier BR1 and the input capacitor C3, a voltage of 90 to 380 VDC depending on input voltage is available.

Startup

From the DC input voltage, the chip's starting current supply is derived using the resistors R6 and R7. Because of the low current drain of <55 μ A, high-value resistors can be used. Series connection of the resistors is necessary for reasons of insufficient dielectric strength of the individual resistors.

Mode of Operation

During operation, the VCC pin is supplied via a separate transformer winding with associated rectification D2 and buffering C4, C19. The Resistor R8 is used for current limiting during the charging of C4. In order to not exceed the maximum voltage at the VCC pin, an external zenerdiode D7 is applied for voltage limitation.

Softstart

The Soft-Start function is realised by an internal resistor and the external capacitor C21.

Clamping Network

R10, C12 and D3 dissipate the energy of the leakage inductance.

Limitation of primary current

The CoolMOS source current is sensed by an external shunt resistor R24. When the voltage at R24 exceeds the internal current-limit threshold, the gate driver is shut off immediately.

Output Stage

On the secondary side the power is coupled out via a fast-acting diodes D1, D4, D5, D6 with low forward voltage. The capacitors C5, C20, C13, C15, C17 provide energy buffering, a filter L3, C9; L8, C14; L7, C16 reduces the output voltage ripple considerably.

All storage capacitors are designed to have an internal resistance as small as possible (ESR). This minimizes the output voltage ripple caused by the triangular current characteristic. The output voltage level is set by resistors R1, R2.

Regulation

The output voltage is controlled using a type TL431 reference diode.

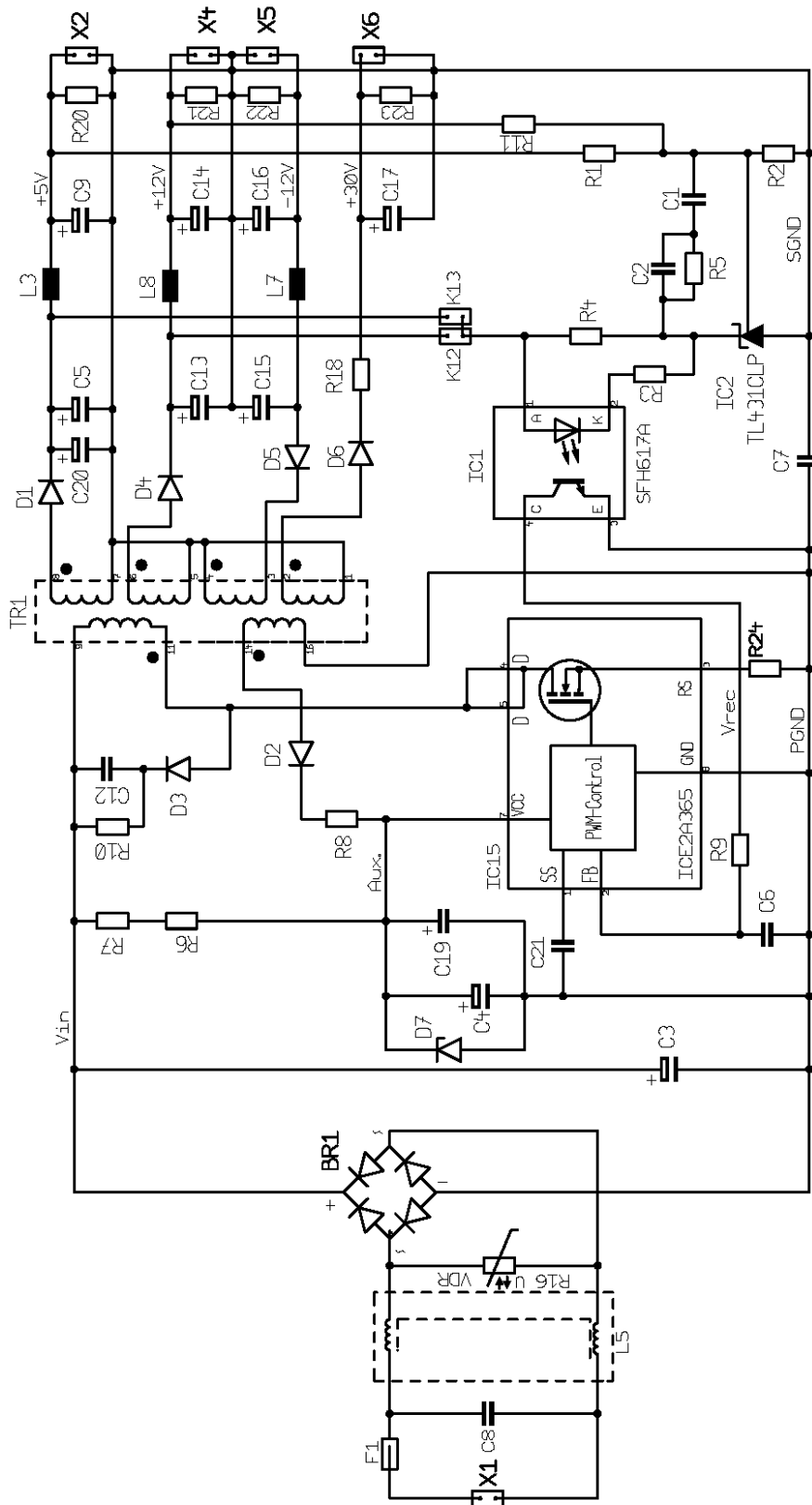
This device incorporates the voltage reference the error amplifier, and a driver stage. The compensation network C1, C2, R1, R5 constitutes the external circuitry of the error amplifier of IC2.

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 the resistors R3 and R4.

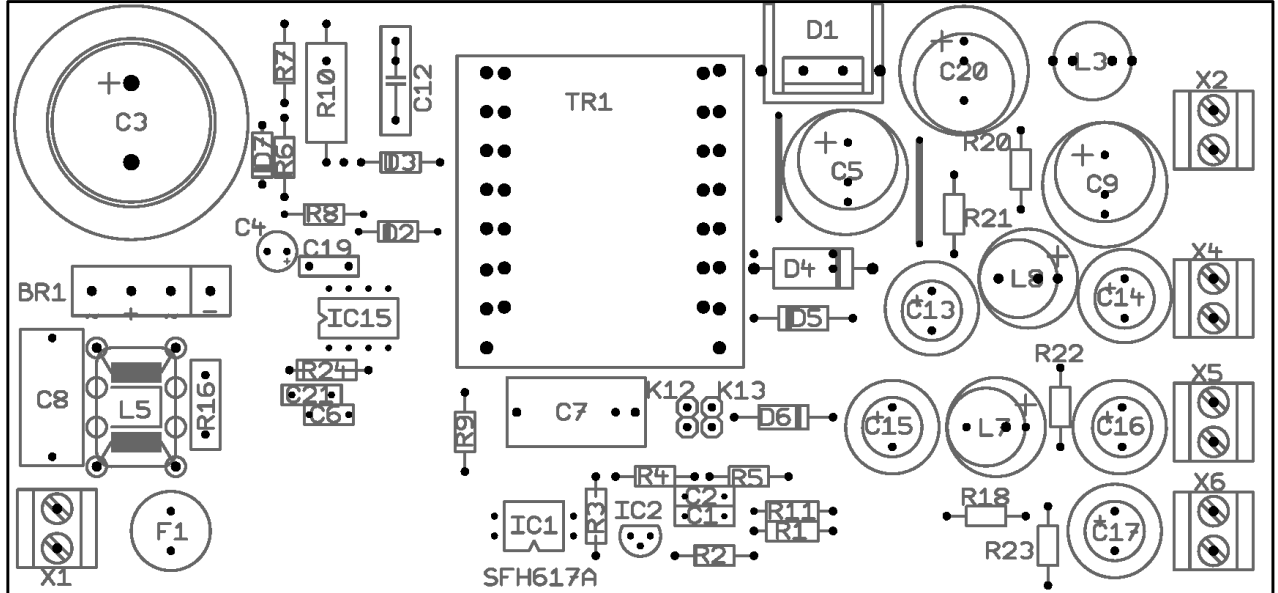
Optocoupler IC1 is used for floating transmission of the control signal to the "Feedback" input of the **ICE2A365** control device. The optocoupler meets DIN VDE 884 requirements.

Design calculations for the components and the transformer were performed in accordance with the **Application Note "AN-SMPS-ICE2AXXX for OFF – Line Switch Mode Power Supplies"**.

Schematic:

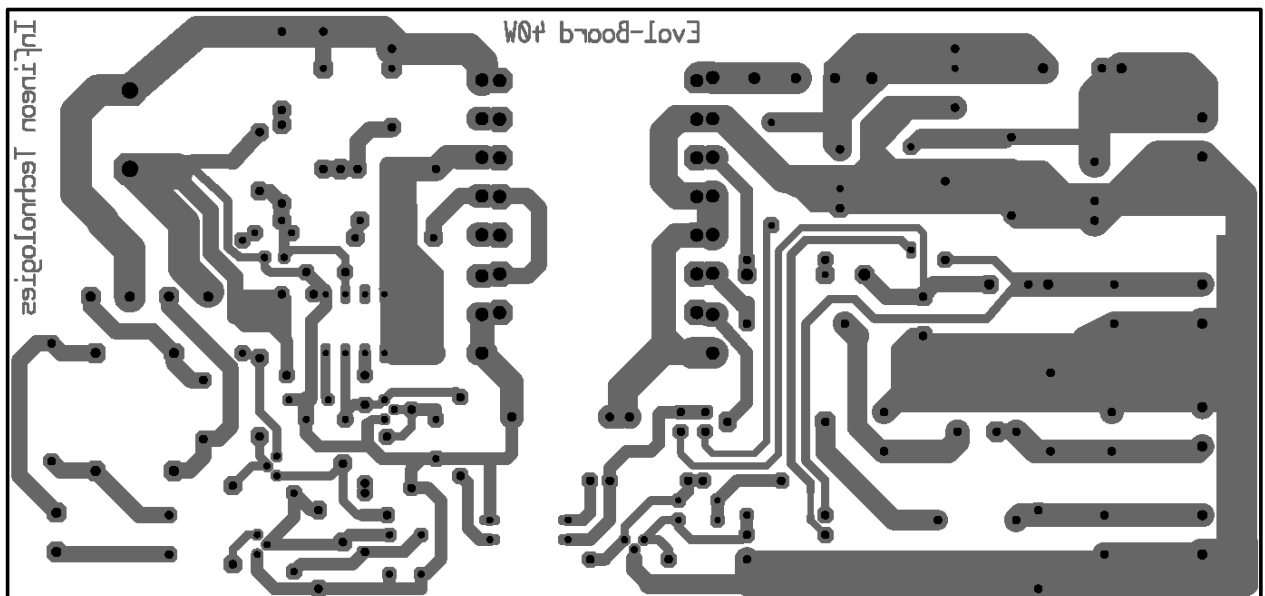


Component Legend:



Board Layout:

Component side shown



Component List:

40W Flyback Converter with ICE2A365

Part List

22.02.2001

Pos.	Part	Type	Ordering Code	Manuf.
1	BR1	B380 C1500		
2	C1	330nF, 50V	B37984-M5334-K	Epcos
3	C2	2,2nF, 50V, COG	B37979-G5222-J	Epcos
4	C3	150uF, 400V	B43503-G0157-M	Epcos
5	C4	100uF, 25V		Epcos
6	C5	2200uF, 25V	B41856-A5228-M	Epcos
7	C6	2,2nF, 50V, COG	B37979-G5222-J	Epcos
8	C7	2,2nF, 250V, Y1	B81123-C1222-M	Epcos
9	C8	0,22uF, 275V, X2	B81130-C1224-M	Epcos
10	C9	1000uF, 16V	B41856-A5108-M	Epcos
11	C12	1nF, 400V, MKT	B32520-C6102-K	Epcos
12	C13	220uF, 35V	B41856-A7227-M	Epcos
13	C14	220uF, 35V	B41856-A7227-M	Epcos
14	C15	47uF, 25V	B41821-A5476-M	Epcos
15	C16	47uF, 25V	B41821-A5476-M	Epcos
16	C17	47uF, 50V	B41821-A6476-M	Epcos
17	C19	100nF, 50V	B37987-F5104-K	Epcos
18	C20	2200uF, 25V	B41856-A5228-M	Epcos
19	C21	470nF, 50V		
20	C22	*		
21	C23	*		
22	C24	1uF, 50V, X7R	B37984-M5105-K	Epcos
23	D1	MBR1045		
24	D2	1N4148		
25	D3	1N4937		
26	D4	BYW98-200		
27	D5	UF4003		
28	D6	UF4003		
29	D7	ZPD18		
30	D8	wire		
31	D9	*		
32	F1	Microfuse, 3,15A		
33	F1	Socket for Microfuse		
34	IC1	SFH617A-3X016		Infineon
35	IC2	TL431CLP		
36	IC11	ICE2A365		Infineon
37	L3	3,3uH, 5,4A	262LYF-0077M	Componex
38	L5	6,8mH, 1,2A	B82721-K2122-N20	Epcos
39	L7	6,8uH, 4A	262LYF-0079M	Componex
40	L8	6,8uH, 4A	262LYF-0079M	Componex
41	R1	4,7k, 1%		
42	R2	4,7k, 1%		
43	R3	560R		
44	R4	1,2k		
45	R5	22k		
46	R6	470k		
47	R7	470k		
48	R8	3,3R		
49	R9	22R		
50	R10	56k 1W		
51	R11	*		
52	R16	*		
53	R18	5,6R		
54	R20	1k		
55	R21	10k		
56	R22	10k		
57	R23	27k		
58	R24	0,39R, 0,6W		
59	R25	*		
60	R26	*		
61	R27	*		
62	R28	*		
63	R29	*		
64	R30	*		
65	R31	*		
66	T1	*		
67	T2	*		
68	T3	*		
69	TR1	SMT 19M	G6962-00	OREGA
70	K12	wire		
71	K13	*		
72		Heatsink for D1	FK237-SA220-O	Fischer
73	X1	Connector 2pol.		
74	X2	Connector 2pol.		
75	X4	Connector 2pol.		
76	X5	Connector 2pol.		
77	X6	Connector 2pol.		

* = not assembled

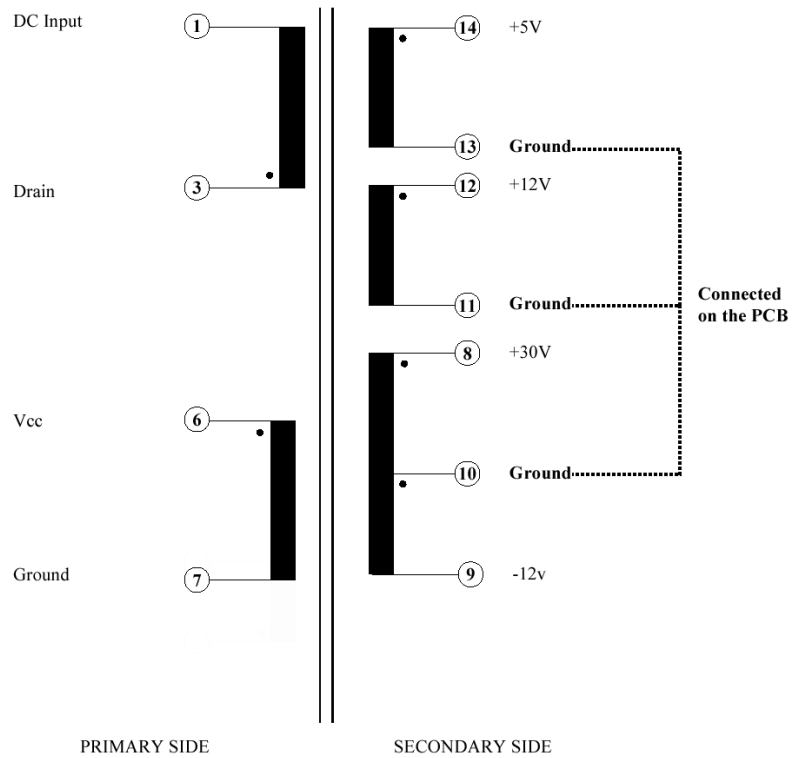
Transformer Construction:

<p align="center">THOMSON MULTI MEDIA GRAY PLANT</p> <p align="center">Route de Noiron B.P. 24 - 70101 GRAY Cedex FRANCE</p> <p align="center">Fax factory : (33) 03 84 65 18 45 Tel.: (33) 03 84 64 54 00 Fax Lab.: (33) 03 84 64 54 28</p>	SMT 19M	40346-xx
	SPF : G6962-00	

OUTPUT CHARACTERISTICS

Pins	Value	Loads	Remarks
14 - 13/11/10	+5v	4000 mA	
12 - 13/11/10	+12v	1250 mA	
8 - 13/11/10	+30v	3 mA	
13/11/10 - 9	-12v	420 mA	
6 - 7	12v	/	Vcc

CIRCUIT DIAGRAM



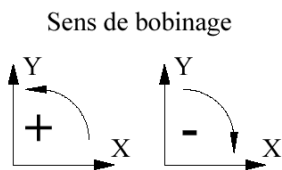
THOMSON MULTI MEDIA GRAY PLANT Route de Noiron B.P. 24 - 70101 GRAY Cedex FRANCE Fax factory : (33) 03 84 65 18 45 Tel.: (33) 03 84 64 54 00 Fax Lab.: (33) 03 84 64 54 28	SMT 19M	40346-xx
	SPF : G6962-00	

Spécification de bobinage

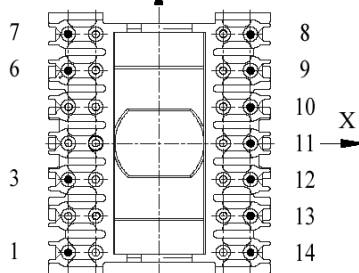
○ Picot relais

N° Gal.	N° Enroul.	Tension / observation	Nb de spires	Sens	Ø fil (mm)	Entrée	Sortie	Classe du fil
I	1	Vcc	7	+	0.25	6	7	Grade 2
II	2	5V	3	+	0.25	14	13	Grade 2
	3	12V	7	-	0.25	13	12	Grade 2
	4	30V	9	-	0.25	12	8	Grade 2
III	5	Primaire	28	+	0.25	3	1	Grade 2
IV	6	5v	3	-	0.25	10	14	Grade 2
	7	5v	3	+	0.25	14	13	Grade 2
	8	12v	7	-	0.25	13	12	Grade 2
	9	-12v	7	-	0.25	9	13	Grade 2
V	10	Primaire	28	+	0.25	3	1	Grade 2
VI	11	5V	3	-	0.25	10	14	Grade 2
	12	5V	3	+	0.25	14	11	Grade 2
	13	12V	7	-	0.25	11	12	Grade 2
VII	14	Primaire	28	-	0.25	1	3	Grade 2
VIII	15	5V	3	-	0.25	10	14	Grade 2
	16	5V	3	+	0.25	14	11	Grade 2
	17	12v	7	-	0.25	11	12	Grade 2
IX	18	Primaire	28	-	0.25	1	3	Grade 2

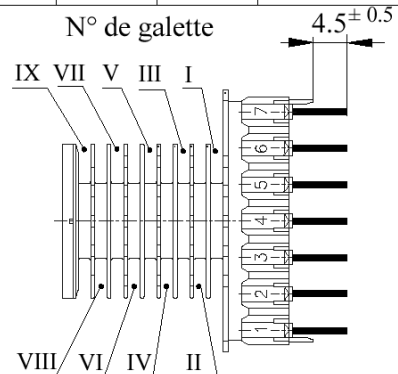
Al	260 nH
Entrefer	/
Carcasse	Sans clips
Recoupe picot	/
Carcasse en	Ultramid



Vue de dessous



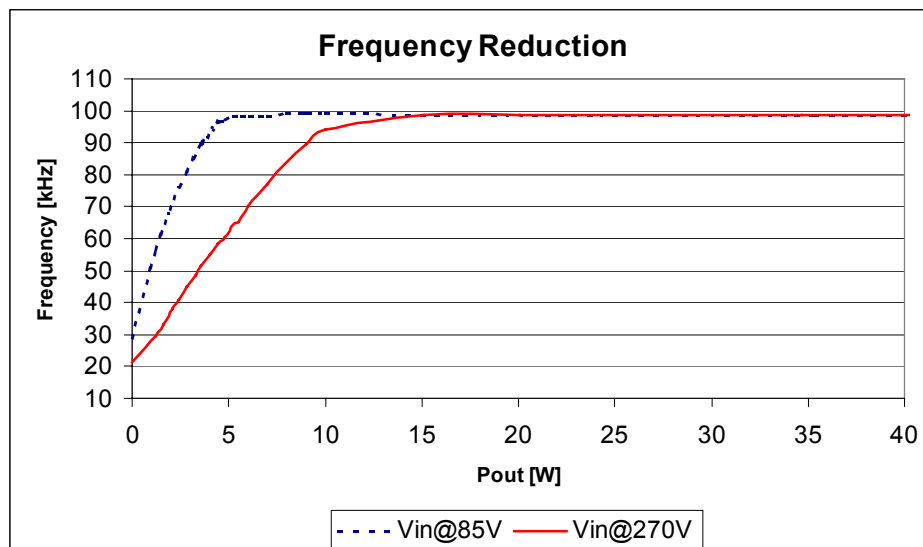
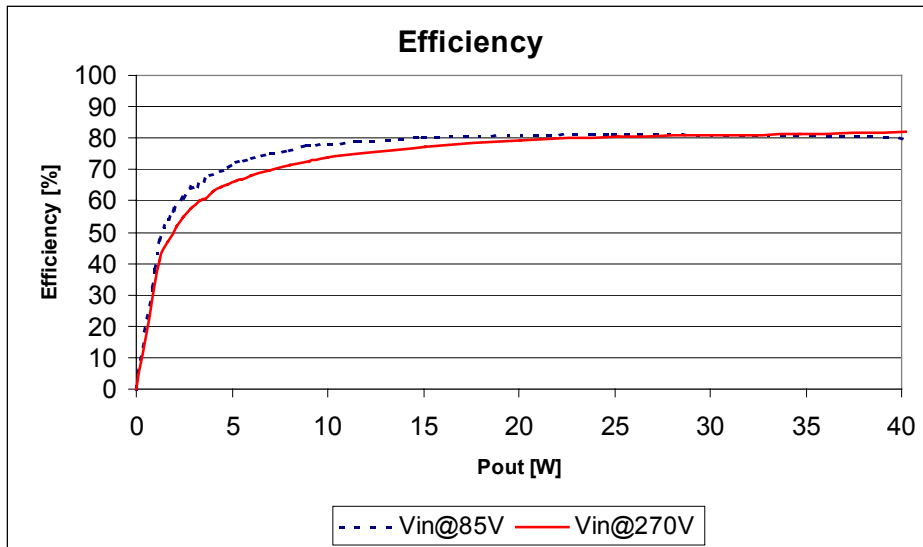
N° de galette



OREGA	PRODUCT SPECIFICATIONS	Annexe 2
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Mesurements:



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-EVALM-ICE2A365-1		
Actual Release: V1.0 Date:15.02.2001		Previous Release: V1.0
Page of actual Rel.	Page of prev. Rel.	Subjects changed since last release
14	--	First Issue

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