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Design Note

DN-Charger_Adapter 40W-1

CoolSET™
40W 12V Board with ICE2A365

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Power Management & Supply

Never stop thinking

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Introduction

This document is an engineering report that describes an universal input power supply designed in a typical off line flyback converter topology that utilizes the **ICE2A365 CoolSET™**. The application operates in discontinous current mode using the burst 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 an AC/DC power supply for laptops, palmtops, battery chargers, video games, satellite decoders, settop and cable boxes, color TV etc. in the power range up to approx. 60 W.

The switch mode power supply **ICE2A365** chip used is a current-controlled pulse width modulator with an internal **CoolMOS™** power switch.

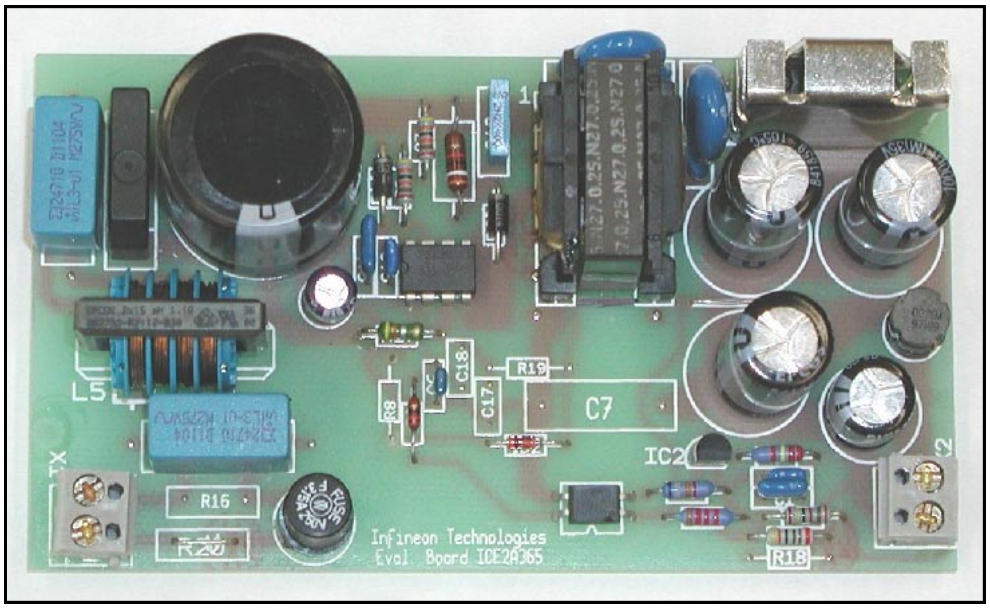


Figure 1 Charger_Adapter 40W

This board was designed to allow testing and demonstrates the basic performance features and the increased power capability of the new **ICE - 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 **ICE2A365**
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 to European Comission

Table 1 – List of Features

Power Supply Specification

Description	Symbol	Min	Typ	Max	Units
Input Section					
Input Voltage	V_{ACIN}	85	115/230	270	V_{AC}
Line Regulation (85...270V)			< 1		%
Input Frequency	f	47	50/60	64	Hz
No Load Input Power ($90V_{AC}$)[3]			200		mW
No Load Input Power ($230V_{AC}$)[2]			0.6		W
Output Section					
Output Voltage	V_{OUT}	11.5	12	12.5	V_{DC}
Output Voltage Ripple ($90V_{AC}$)	V_{Ripple}		100		mV_{P-P}
Output Current	I_{OUT}	3.38	3.4	3.42	A_{DC}
Output Power	P_{OUT}	0	40	51	W
Total Regulation			±2		%
Load Regulation (10...100%)			< 1		%
Efficiency ($90V_{AC}$)	η		81		%
Efficiency ($270V_{AC}$)	η		85		%
Environmental					
Conducted EMI					EN55022B
Ambient Temperature	T_A	0	25	50	°C

Table 2 – Power Supply Specification

[1] V_{DSBR} at Tj = 110°C
[2] Burst Mode

Schematic

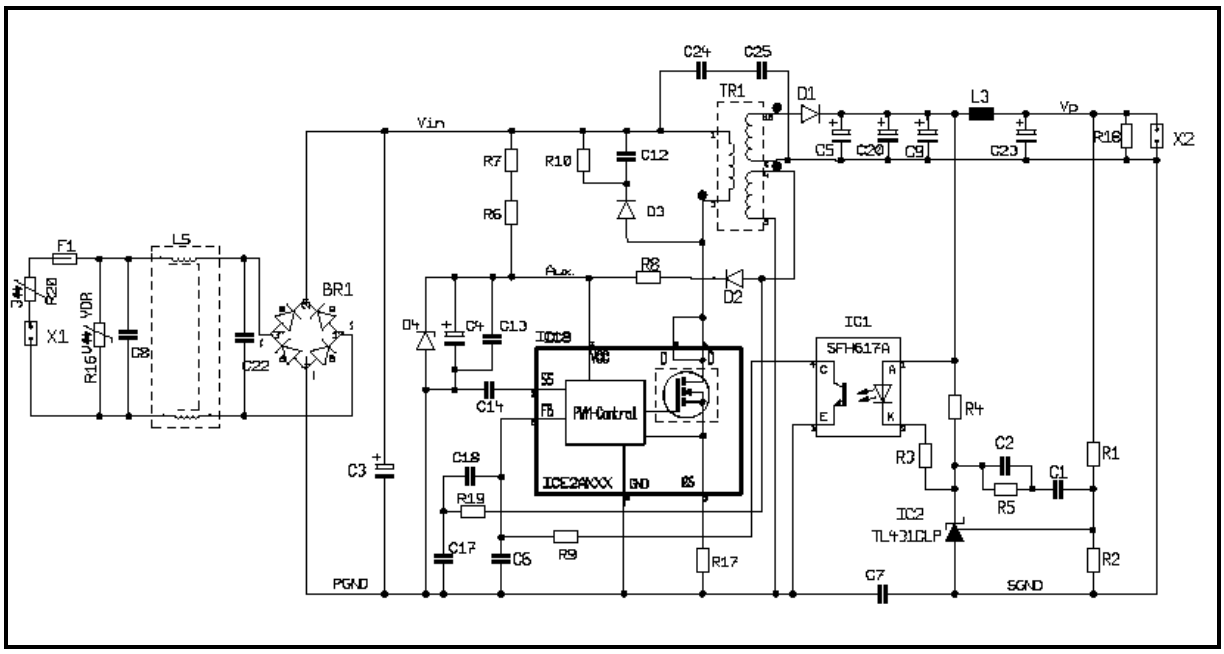


Figure 2 – 40W 12V ICE2A365 Power Supply Schematic

PCB Layout

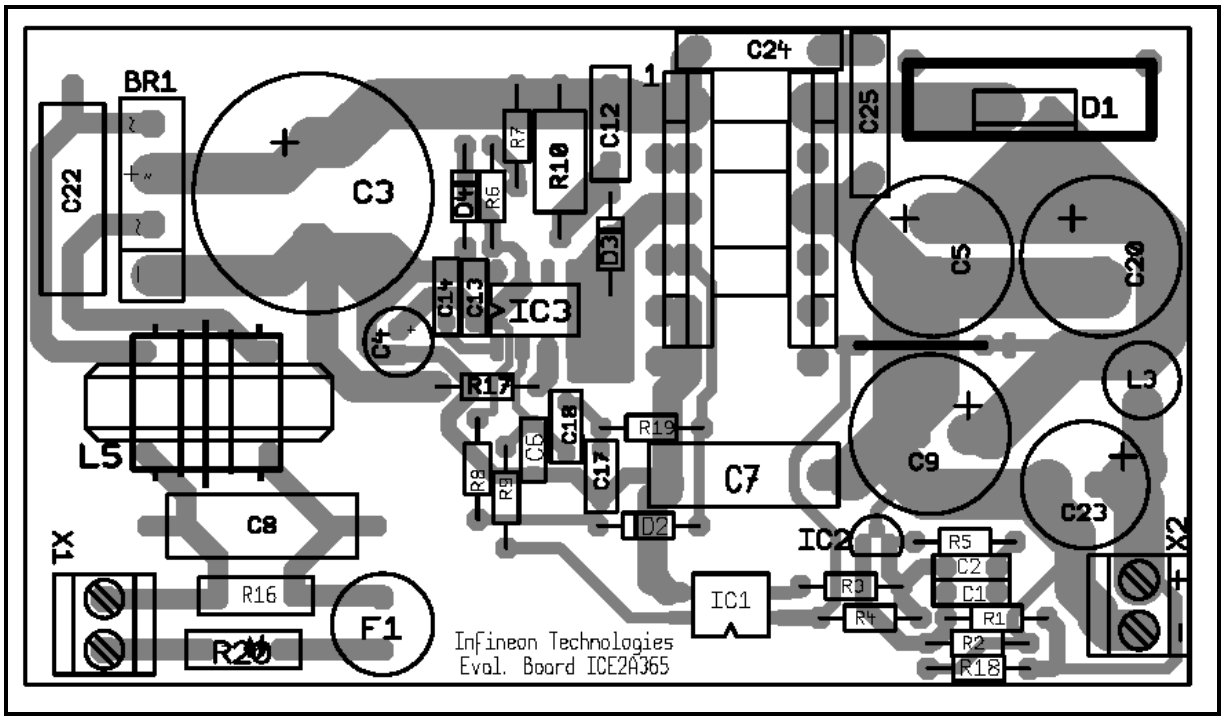


Figure 3 – PCB Layout Component Side shown

Description

Introduction

The Charger_Adapter 40W is a low cost flyback switching power supply using the *ICE2A365* integrated circuit from the *CoolSET™-F2* family. The circuit shown in Figure 2 details a 12V, 40W supply that operates from an line input voltage range of 85 to 265V_{AC}, suitable for applications requiring either an open frame supply or an enclosed adapter.

Line Input

The AC line input side comprises of an input fuse F1 as line input over current protection as well as choke L5 and the X2 capacitor C8 as radio interference suppressors. The NTC resistor R20 limits the switch on peak current. After bridge rectifier BR1 and input capacitor C3, a voltage of 90 to 380 V_{DC}, depending on input voltage, is available. Only a 150 µF input capacitor is required due to the wider duty cycle DC_{MAX} of the ICE-F2-family.

Startup

From this voltage, the chip starting the current supply is derived using resistors R6 and R7. Because of the very low start up current of typically 27µA, a high-value resistor 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 light load condition (P_{OUT} = W) the switching frequency is reduced down to 21kHz in order to reduce the switching losses.

Note:

During no load condition, the board creates a burst mode situation to improve the 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 resistors R17. The very accurate value of the shunt due to the two parallel resistors improve the peak power limitation shown in the curve peak power limitation in the rear of this report.

Output Voltage

Power is coupled out on the secondary side via a fast-acting diode D1 with low forward voltage. Capacitor C5 performs energy buffering, a following filter C23 with a choke L3 and C23 considerably reduces the output voltage ripple. Storage output capacitor C5 is designed to exhibit as small an internal resistance as possible (ESR) in order to minimize the output voltage ripple caused by the triangular current characteristic. The output voltage is set with resistors R1, R2.

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, 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, R4. Optocoupler IC1 is used for floating transmission of the control signal to the “Feedback” input via resistor R9 and capacitor C6 of the ICE2A365 control device. The optocoupler used meets DIN VDE 884 requirements.

Bill of Material

ICE2A365 Charger Adapter 12V/ 40W **05.11.2001**

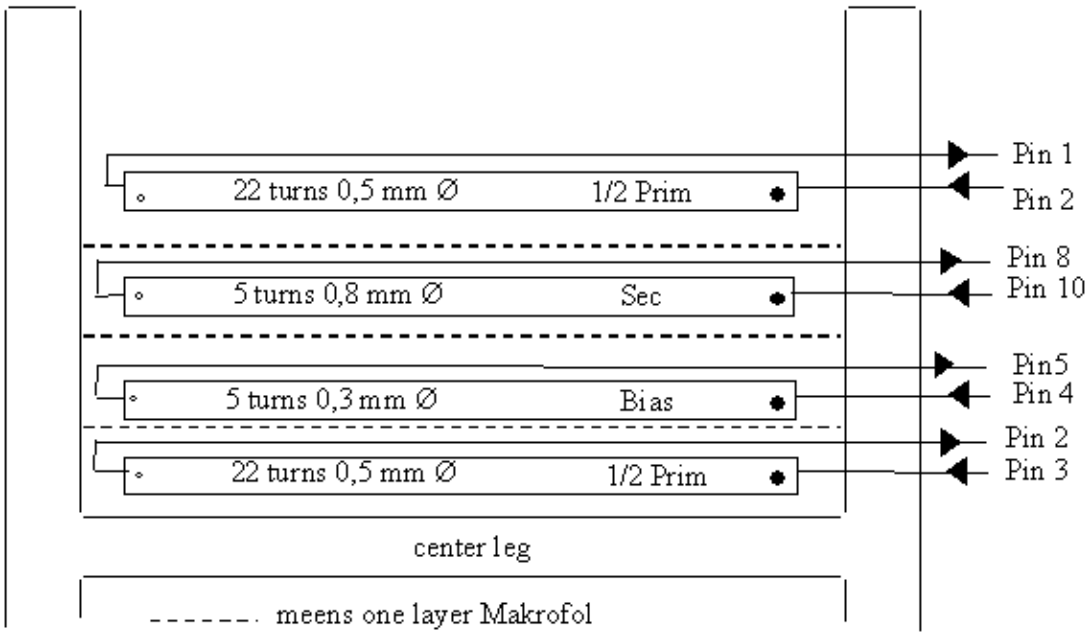
Pos.	Part	Type	Grid	Ordering Code	Manuf.
1	BR1	B500 C1500			
2	C1	680nF, 50V	5mm		Epcos
3	C2	1,2nF, 50V	5mm		Epcos
4	C3	150µF, 400V	10mm	B43501-A9157-M	Epcos
5	C4	68µF, 35V	2,5mm	B41821-A7476-M	Epcos
6	C5	1000µF, 35V	5mm	KZE35VB1000MK25	(NCC) Alfatec
7	C6	2,2nF, 50V	5mm	B37979-G5222-J	Epcos
8	C7	*			
9	C8	0,1µF, 275V, X2	15mm	B81130-C1104-M	Epcos
10	C9	1000µF, 35V	5mm	KZE35VB1000MK25	(NCC) Alfatec
11	C12	2,2nF, 400V	7,5mm	B32520-C6222-K	Epcos
12	C13	100nF, 50V	5mm	B37987-F5104-K	Epcos
13	C14	1µF, 50V	5mm	B37984-M5105-K	Epcos
14	C20	1000µF, 35V	5mm	KZE35VB1000MK25	(NCC) Alfatec
15	C22	0,22µF, 275V, X2	15mm	B81130-C1224-M	Epcos
16	C23	470µF, 35V	5mm	KZE35VB470MJ20	(NCC) Alfatec
17	C24	2,2nF, 250V Y1	12,5mm	WKP 2n2 M	Wima
18	C25	2,2nF, 250V Y1	12,5mm	WKP 2n2 M	Wima
19	D1	DSS10-01A	5mm		IXYS
20	D2	1N4148	10mm		
21	D3	1N4937	10mm		
22	D4	ZPD18	10mm		
23	F1	Microfuse 3,15A	5mm		
24	IC1	SFH617A-3X016			
25	IC2	TL431CLP			Infineon
26	IC3	ICE2A365			
27	L3	1µH, 3,7A	5mm	822LY-1R0M	Componex
28	L5	27mH, 0,9A		B82732-R2901-B30	Epcos
29	R1	18k, 1%	10mm		
30	R2	4,7k, 1%	10mm		
31	R3	510R	10mm		
32	R4	1,5k	10mm		
33	R5	44k	10mm		
34	R6	430k	10mm		
35	R7	430k	10mm		
36	R8	4,7R	10mm		
37	R9	22R	10mm		
38	R10	39k, 2W	10mm		
39	R16	*			
40	R17	0,43R, 0,6W, 1%,	10mm		
41	R18	*			
42	R20	wire	10mm		
43	TR1	E25 Coil Former			
44	TR1	E25/13/7, 0,75 N27		see also Transformer Construction	
45	D1	Heatsink, 18K/W		FK224	Fischer
46	X1	Connector 2pol.			
47	X2	Connector 2pol.			

*** = not assembled**

Transformer Construction Documentation

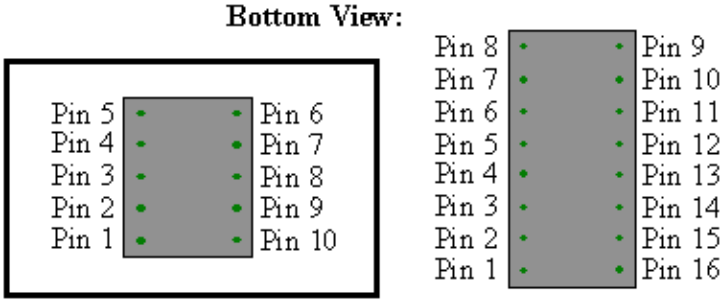
50W/100 kHz Flyback Transformer

Coil former: vertical version
Core E25/13/7; N27; A_{MIN} = _____mm²; total gap = 0,75mm; AL = 111nH; Lp = 215µH



Primary winding	44 turns	0,5 mm Ø	
Bias winding	2*5 turns	0,3 mm Ø	
Secondary winding	2*5 turns	0,8 mm Ø	triple Insulation

Bottom View:



Note:

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

Change service

Issue status	Changes		Date
1.0	First issue		30.08.2001
2.0	Page 6, BOM Pos. 4 / 10 / 13 Page 7 Transformerdata		01.10.2001
3.0	Page 6, BOM Pos. 25 and 26		05.11.2001

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-Charger_Adapter 40W-03		
Actual Release: 3.0 Date: 2001-11-05		Previous Release: V1.0
Page of actual Rel.	Page of prev. Rel.	Subjects changed since last release
--	--	See change service

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