

iW1602-00+iW600-00+iW673-00 for 5V3A Small Size Charger Design

(EBC10107)

General Design Specification:

- 1. AC Input Range 90-264V_{AC}
- 2. DC Output 5V/3A
- 3. Meet "30mW" No-Load standby Power Consumption Requirement
- 4. Meet "CoC_V5.0 Tier2" Requirement
- 5. Max Output Ripple & Noise < 80mV

...personal ...portable ...connected

Dec 18, 2015

Warning

This evaluation board is powered either by the AC mains voltage or a low AC or DC voltage. When powered by the AC mains voltage, the evaluation board generates non-insulated high voltages on exposed pins and pads on both the top and bottom of the PC board. Contact with these may produce electrical shock, burn, and/or fire hazards, resulting in risk of property damage, personal injury, and/or death. When the design indicates isolation, the output(s) is electrically isolated from the AC mains input voltage.

When the evaluation board is powered, never touch the board or its electrical circuits since they may be operating at high voltages that can cause an electrical shock hazard.

WORK AREA AND PERSONAL SAFETY

This board should be used in a test area/laboratory specifically designed and designated for working with, and evaluating high-voltage electrical devices. Only trained and qualified professional personnel with experience, knowledge and training in the use of high-voltage electrical circuits should use this evaluation board. Trained personnel must use required personal protective equipment and required laboratory equipment when working with the evaluation board.

The professional personnel operating this evaluation board and the test area/laboratory in which it is operated must be qualified according to the local regulations, guidelines and labor laws applicable to working with non-isolated mains voltages and high voltage circuits.

An isolated housing is highly recommended when using this evaluation board.

Use this evaluation board at your own risk.

TO BE USED FOR EVALUATION PURPOSES ONLY

This board is intended for evaluation purposes only and not intended for commercial use in an end product. Any other use is strictly prohibited by Dialog Semiconductor.

NOT AGENCY APPROVED

This evaluation board has not been agency tested or approved for safety, technical performance, and/or regulatory requirements, such as electromagnetic interference or other technical regulatory or safety requirements.



1. Specification

Description	Symbol	Min	Тур	Max	Units	Comment
Input						
Voltage	Vin	90		264	VAC	2 Wire
Frequency	fline	47	50/60	63	Hz	
No-load Input Power (230VAC)				30	mW	
Output						
Output Voltage	Vouτ	4.75	5.0	5.55	V	Measured at the end of USB(CDC=300mV)
Output Current	Ιουτ		3		A	
Output Ripple Voltage	VRIPPLE			80	mV _{P_P}	Note1
Total Output Power						
Continuous Output Power	Р оит		15		W	
Over Current Protection	Іоср			3.6	A	Auto-restart
Active Mode Efficiency(CoC Tier2 Requirement)	η		81.84		%	
Environmental						
Conducted EMI		Ме	ets CISPR2	2B / EN550	22B	
Safety		Designed t	o meet IEC	60950, UL1	950 Class II	
Ambient Temperature	Тамв	0		45	°C	Free convection, sea level

Note1: Add 0.1uF Ceramic capacitor and 10uF E-cap at the end of connector and set oscilloscope at 20MHz bandwidth.

2. Schematic







ltem	Qty.	Ref.	Description
1	1	U1	iW1602-00, Off-line Digital PSR & PWM & VMS Controller, SOT23-6
2	1	U51	iW673-00, SR Controller,SOT23-6
3	1	U52	iW600-00, Secondary Voltage Positioning (SVP) Controller, SOT23
4	1	BD1	ABS210, 2A 1000V, Rectifier Bridge
5	1	C1	22pF, 25V, X7R, SMD-0603
6	1	C3	470pF, 500V, X7R, SMD-0805
7	2	C4,C51	4.7uF, 25V, X7R, SMD-0805
8	1	C52	100nF, 25V, X7R, SMD-0603
9	2	CE1,CE2	15uF, 400V, Low-ESR E-Cap, Φ10mm X 12mm
10	1	CE51	680uF,7.5V,Solid E-cap,Ф6.3mm Х9mm
11	1	CY1	220pF,Y-Cap
12	1	D1	1N4148, Fast Rectifier Diode,SMD-323
13	1	D2	FR102, 1A200V, Fast switching diode(Trr=150nS), SMD-1206S
14	1	D3	S2MF, 2A1000V,Fast Recovery Rectifier (Trr=500ns),SMF
15	1	F1	2A250V, Fuse
16	1	L1	220uH,Differential-mode inductor, Ф5x11, Wire:0.23mmX80T
17	1	L2	4.7uH, MPH201210S4R7MT, Sunlord
18	1	L3	30uH, Common-mode inductor, T8X5X3, Wire: 0.30mmX8T
19	1	Q1	SW7N65D,7A650V, N-channel MOSFET, TO-252
20	1	Q2	HGS048N06SL,60V N-Channel MOSFET,SOIC-8
21	1	RT1	SCK052, 5R, NTC Thermistor, 5D-7
22	1	R1	2Ω ±5%, SMD-0603
23	2	R2,R10	130Ω ±5%, SMD-1206
24	1	R3	240KΩ ±5%, SMD-1206
25	1	R4	1Ω ±1%, SMD-1206
26	1	R5	18KΩ ±1%, SMD-0603
27	1	R6	4.7KΩ ±1%, SMD-0603
28	2	R7,R13	1.2KΩ ±5%, SMD-0603
29	1	R8	3.3KΩ ±1%, SMD-0603
30	2	R9,R11	3.3MΩ ±5%, SMD-1206



4.2 Bill of Material(Cont.)

ltem	Qty.	Ref.	Description
31	1	R14	4.3Ω ±1%, SMD-0805
32	1	R15	33.2KΩ ±1%, SMD-0603
33	1	R16	6.8KΩ ±1%, SMD-0603
34	1	R18	10KΩ ±5%, SMD-0805
35	1	R17	100Ω ±5%, SMD-0603
36	1	R51	15KΩ ±5%, SMD-0603
37	1	R52	10Ω ±5%, SMD-0603
38	1	R53	51Ω ±5%, SMD-0603
39	1	T1	EE16L, Transformer, Vertical Type
40	1	USB	USB, Horizontal, 2.0A current
41	1	PCB	Double Side Board, FR-4



5. Transformer Drawing





ELECTRICAL SPECIFICATIONS:

- 1. Primary Inductance (Lp) = $600 \pm 5\%$ uH @10KHz
- 2. Electrical Strength = 3KV, 50/60Hz,1Min

MATERIALS:

- 1. Core : (Ferrite Material JP95 or equivalent)
- 2. Bobbin : Vertical
- 3. Magnet Wires (pri): Type 2-UEW
- 4. Magnet wires(sec): Triple Insulated Wire
- 5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

1. Varnish the complete assembly





6. Regulation and Efficiency Measurement

V _{IN}	P _{IN}	V _{OUT}	Ι _{ουτ}		Pour	η	Average	OCP	CoC_V5_Tier2	
(V _{AC})	(W)	(V)	(A)	(mV _{P-P})	(W)	(%)	η(%)	(A)	CoC_V5_Tier2 Requirement 1. Minimum Efficiency in Active Mode at 10% load of full rated output current is 72.48%. 2. Minimum Four Point (25%, 50%, 75% and 100%) Average Efficiency in Active Mode is 81.84%.	
	0.011	5.010	0	20						
	4.29	5.030	0.75	38	3.77	87.94				
90	8.66	5.090	1.50	48	7.64	88.16	97.65	3.35		
	13.26	5.170	2.25	49	11.63	87.73	67.05			
	18.12	5.240	3.00	58	15.72	86.75			1. Minimum	
	0.012	5.010	0	20					Efficiency in Active Mode at	
	1.74	5.015	0.30	44	1.50	86.42				
115	4.28 5.030	0.75	43	3.77	88.14		3 33	load of full rated		
115	8.62	5.090	1.50	42	7.64	88.57	00.07	0.00	output current is	
	13.15	5.170	2.25	46	11.63	88.46	00.27		<u>72.48%.</u>	
	17.88	5.240	3.00	56	15.72	87.92				
	0.025	5.010	0	22						
	1.81	5.015	0.30	38	1.50	82.94			2. Minimum Four	
230	4.36	5.040	0.75	48	3.78	86.70		3 27	Point (25%, 50%,	
250	8.72	5.090	1.50	48	7.64	87.56	87.63	5.21		
	13.21	5.170	2.25	52	11.63	88.06	07.03		Efficiency in	
	17.82	5.240	3.00	58	15.72	88.22			Active Mode is	
	0.033	5.010	0	22					<u>81.84%.</u>	
	4.41	5.040	0.75	45	3.78	85.71				
264	8.81	5.090	1.50	50	7.64	86.66	86.87	3.26		
	13.31	5.170	2.25	54	11.63	87.40	00.07		2. Minimum Four Point (25%, 50%, 75% and 100%) Average 	
	17.92	5.240	3.00	64	15.72	87.72				

*Note: Output voltage is measured at the end of PCB.

7. No-Load Standby Power Consumption



No-Load Standby Power Consumption







Note:

- 1) Output voltage is monitored at end of PCB
- 2) Output voltage is with CDC=300mV

9. Turn-on Delay Time



90V_{AC}, No Load

TST_DELAY=2.812

 $90V_{AC},\,Full\,Load$

TST_DELAY=2.856S



10. AC Startup Voltage



No Load

 V_{IN} STARTUP = <u>54.1</u> Vac

Full Load VIN_STARTUP=70.4VAC



11. AC Brownout Voltage



No Load

 $V_{IN}BROWNOUT = 13.3 V_{AC}$

Full Load Vin_brownout=<u>64.9</u>Vac



2 X < 10 Hz 3.40 V

12. One-time DLR



* Note: Output voltage is monitored at end of PCB.



*Note: CH1: IOUT, 1A/Div; CH2: VBULK, 20V/Div; CH3: VOUT, 2V/Div

14. Output Short Circuit



 $V_{IN}=264V_{AC}$, $P_{IN}_{S/C}=25mW$



VIN=90VAC, IS/C_PEAK=4.16A



VIN=264VAC, IS/C_PEAK=4.08A



15. Output Over Voltage Protection



*Note: CH1: V_{SENSE}, 1V/Div; CH2: V_{OUT}, 1V/Div

16. Thermal Test for Critical Component

ltem	$V_{IN}=90V_{AC}, V_{O}$	_{UT} =5V I _{OUT} =3A	V_{IN} =264 V_{AC} , V_{OUT} =5 V_{OUT} =3A		
i.cm	Temp.(°C)	Rising Temp.(°C)	Temp.(°C)	Rising Temp.(°C)	
Input Bulk_Cap(CE1, 15uF/400V)	80.0	55.0	74.9	49.9	
Transformer(T1, EE16L)	85.2	60.2	82.8	57.8	
MOSFET(Q1,SW7N65D)	79.4	54.4	82.5	57.5	
Solid capacitior(CE51, 680uF/7.5V)	73.3	48.3	72.6	47.6	
PWM IC(U1, iW1602-00)	79.9	54.9	77.0	52.0	
MOSFET(Q2, HGS048N06SL)	79.8	54.8	77.0	52.0	
RCD(D3, S2MF)	81.8	56.8	76.3	51.3	
Ambient(Chamber) Temp.	25	5.0	25.0		



90V/60Hz







264V/60Hz







 $V_{\text{IN}}{=}230V_{\text{AC}}{/}50\text{Hz},$ Live

 V_{IN} =230 V_{AC} /50Hz, Natural





*Note: Resistive & Full load; output (-) is floating.



18. Radiated EMI

VIN=230VAc/50Hz, Vertical



Level [dBµV/m]

VIN=230VAC/50Hz, Horizontal



MEASUREMENT RESULT: "IWTT1113404 red"

11/13/2015 12	2:08PM							
Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
30.000000	32.10	-10.0	40.0	7.9		100.0	97.00	VERTICAL
70.821643	18.60	-21.6	40.0	21.4		100.0	138.00	VERTICAL
109.699399	21.80	-18.1	40.0	18.2		100.0	192.00	VERTICAL
166.072144	29.70	-21.8	40.0	10.3		100.0	157.00	VERTICAL
173.847695	26.40	-21.3	40.0	13.6		100.0	157.00	VERTICAL
996.112224	30.70	-3.0	47.0	16.3		100.0	205.00	VERTICAL

*Note: 1) Resistive & Full load 2) Output (-) is floating

MEASUREMENT RESULT: "IWTT1113403 red"

1	/13/2015 12	2:07PM							
	Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
	30.000000	21.80	-10.0	40.0	18.2		300.0	142.00	HORIZONTAL
	94.148297	20.20	-18.6	40.0	19.8		100.0	9.00	HORIZONTAL
	168.016032	29.00	-21.8	40.0	11.0		300.0	272.00	HORIZONTAL
	173.847695	27.80	-21.3	40.0	12.2		300.0	272.00	HORIZONTAL
	243.827655	23.60	-17.2	47.0	23.4		100.0	83.00	HORIZONTAL
	996.112224	31.20	-3.0	47.0	15.8		300.0	320.00	HORIZONTAL



20. Maximum Drain Voltage of SR MOSFET



21. Transformer Flux Density



(Np=56.5Ts, Lm=0.63mH, Ae=40mm²-EE16L)



CH1: IP ,200mA/div

 $I_{\rm P}$ is monitored at 90Vac and 3A (full load) $I_{\rm P} = 944 m A \label{eq:IP}$

$$B_{MAX} = \frac{L_{PRI} \times I_P}{N_P \times A_e} = \frac{0.63 \times 944}{56.5 \times 40} = 0.263 (Tesla)$$



CH1: IP ,200mA/div I_P is monitored at 90Vac and 3.35A (Max P_{OUT}) $I_P = 1070mA$ $B_{MAX} = \frac{L_{PRI} \times I_P}{N_P \times A_e} = \frac{0.63 \times 1070}{56.5 \times 40} = 0.298(Tesla)$



Appendix. Vcc Supply Voltage

The purpose of this test is to verify range of V_{CC} voltage under different loading conditions.

ltem	V _{CC} range [Max:20V, Min:5.5V]								
Input V _{AC}	VIN=90VAC	VIN=115VAC	VIN=230VAC	VIN=264VAC					
Output No-load	7.06V	7.07V	7.14V	7.16V					
Output Full-load (3A)	13.14V	12.96V	12.73V	12.2V					
Max load (CC/CV corner)	13.88V	13.21V	13.02V	12.65V					

Above test result show all voltage measuring points & is within normal operating range.

				Parameter	Symbol	Test Conditions	Min	Тур	Мах	Unit		
iW1602				V _{CC} SECTION (Pin 1)								
Ч			_	Operating voltage (Note 2)	V _{cc}				20	V		
1	V _{CC} OU	TPUT	6	Start-up threshold	V _{CC(ST)}	V_{CC} rising	12.7	13.7	14.7	V		
			_	Under-voltage lockout threshold	V _{CC(UVL)}	V _{cc} falling	5.2	5.5	5.8	V		
2	VSENSE	GND	5	Latch release threshold	V _{CC(RLS)}	V _{CC} falling	4.2	4.5	4.8	V		
				V_{CC} over-voltage protection level	V _{CC(OVP)}	V_{CC} rising		23		V		
3	CFG C	CS/FS	4	Start-up current (Note 2)	I _{IN(ST)}	V _{CC} = 8V		1		μA		
				Quiescent current	Iccq	100pF at OUTPUT, V _{SENSE} = 1.4V		3.5		mA		
				Quiescent current, low power mode, Adapter	I _{CC_NL_AD}			0.22		mA		

Disclaimer

Disclaimer

Information in this document is believed to be accurate and reliable. However, Dialog Semiconductor does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information. Dialog Semiconductor furthermore takes no responsibility whatsoever for the content in this document if provided by any information source outside of Dialog Semiconductor.

Dialog Semiconductor reserves the right to change without notice the information published in this document, including without limitation the specification and the design of the related semiconductor products, software and applications.

Applications, software, and semiconductor products described in this document are for illustrative purposes only. Dialog Semiconductor makes no representation or warranty that such applications, software and semiconductor products will be suitable for the specified use without further testing or modification. Unless otherwise agreed in writing, such testing or modification is the sole responsibility of the customer and Dialog Semiconductor excludes all liability in this respect.

Customer notes that nothing in this document may be construed as a license for customer to use the Dialog Semiconductor products, software and applications referred to in this document. Such license must be separately sought by customer with Dialog Semiconductor.

All use of Dialog Semiconductor products, software and applications referred to in this document are subject to Dialog Semiconductor's, <u>Standard Terms and</u> <u>Conditions of Sale</u>, unless otherwise stated.

Evaluation Boards

In addition to the above "Disclaimer," Dialog Semiconductor provides this evaluation board under the following conditions: This evaluation board is provided for evaluation purposes only and is not intended for commercial use in any end product. Dialog Semiconductor expressly disclaims all warranties, express, implied or statutory, including (but not limited to) the implied warranties of non-infringement, suitability for a specific application(s) or end product(s), product quality or reliability. All risks and liability regarding quality, use or performance of this evaluation board are those of the customer/user and/or customer/user's employer.

This evaluation board must be used in a test area/laboratory specifically designed and designated for working with, and evaluating high-voltage electrical devices. Only trained and qualified professional personnel with experience, knowledge and training in the use of high-voltage electrical circuits should use this evaluation board. Trained personnel must use required personal protective equipment and required laboratory equipment when working with the evaluation board.

The user, and/or user's employer, if user is using this evaluation board for employer-related purposes:

- Assumes all responsibility and liability for proper and safe handling of the evaluation boards and indemnifies Dialog Semiconductor from any and all claims arising from use of the evaluation board.
- Assumes all responsibility for using this evaluation board in a test area or laboratory which is qualified and/or certified according to the local regulations, guidelines and labor laws applicable to working with non-isolated mains voltages and high voltage circuits
- Understands that this evaluation board has not been agency tested or approved for safety, technical performance, and/or regulatory requirements, by any agency. This includes electromagnetic interference or other technical regulatory or safety testing and certifications.



The power to be...



...personal ...portable ...connected