Flyback Type High Power Factor AC/DC Converter Isolated 35 V 1.2 A (BD7693FJ Evaluation Board)

User's Guide

<High Voltage Safety Precautions>

◇ Read all safety precautions before use

Please note that this document covers only the BD7693FJ evaluation board (BD7693FJ-EVK-002) and its functions. For additional information, please refer to the datasheet.

To ensure safe operation, please carefully read all precautions before handling the evaluation board

Depending on the configuration of the board and voltages used,

Potentially lethal voltages may be generated.

Therefore, please make sure to read and observe all safety precautions described in the red box below.

Before Use

[1] Verify that the parts/components are not damaged or missing (i.e. due to the drops).
[2] Check that there are no conductive foreign objects on the board.
[3] Be careful when performing soldering on the module and/or evaluation board to ensure that solder splash does not occur.
[4] Check that there is no condensation or water droplets on the circuit board.

During Use

[5] Be careful to not allow conductive objects to come into contact with the board.
[6] **Brief accidental contact or even bringing your hand close to the board may result in discharge and lead to severe injury or death.**

Therefore, DO NOT touch the board with your bare hands or bring them too close to the board.
In addition, as mentioned above please exercise extreme caution when using conductive tools such as tweezers and screwdrivers.

[7] If used under conditions beyond its rated voltage, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.
[8] Be sure to wear insulated gloves when handling is required during operation.

After Use

[9] The ROHM Evaluation Board contains the circuits which store the high voltage. Since it stores the charges even after the connected power circuits are cut, please discharge the electricity after using it, and please deal with it after confirming such electric discharge.
[10] Protect against electric shocks by wearing insulated gloves when handling.

This evaluation board is intended for use only in research and development facilities and should by handled **only by qualified personnel familiar with all safety and operating procedures.**
We recommend carrying out operation in a safe environment that includes the use of high voltage signage at all entrances, safety interlocks, and protective glasses.

User's Guide

AC/DC Converter

Flyback Type High Power Factor AC/DC Converter Isolated 35 V 1.2 A BD7693FJ Evaluation Board

BD7693FJ-EVK-002

General Description

This evaluation board can output a voltage of 35 V isolated from an input of 90 Vac to 264 Vac, and the maximum output current is 1.2 A.

The one-converter flyback type achieves a high power factor (PF > 0.9).

The control IC uses BD7693FJ,which use the critical mode.

Switching loss and noise are reduced by zero current detection.

A circuit that lowers total harmonic distortion (THD) us used to support IEC610003-2 Class C and Class D.

Figure 1. BD7693FJ-EVK-002

No. 64UG141E Rev.001
APR.2022

Performance Specification

Not guarantee the characteristics is representative value.

Unless otherwise specified V_{IN} = 230 Vac , I_{OUT} = 1.2 A Ta = 25 °C

Parameter		Min	Typ	Max	Units	Conditions
Input Voltage Range	V_{IN}	90	230	264	Vac	
Input Frequency	f_{LINE}	47	50/60	63	Hz	
Output Voltage	V_{OUT}	33.25	35.0	36.75	V	
Output Current Range (Note1	I_{OUT}	0.06	-	1.2	A	
Maximum Output Power (Note1	P_{OUT}	0.0	-	42	W	
Total Harmonic Distortion (THD)	THD		7.5	10	%	
Power Factor (PF)	PF	0.90	0.93	-	-	
Efficiency	η	88.0	91.5	-	%	
Output Ripple Voltage (Note 2)	V_{RIPPLE}	-	1.0	1.75	Vpp	
Operating Temperature Range	T_{Opr}	-10	+25	+60	°C	

(Note 1) Adjust the load application time so that the component surface temperature does not exceed 105 °C.

(Note 2) Not include spikes noise.

Derating

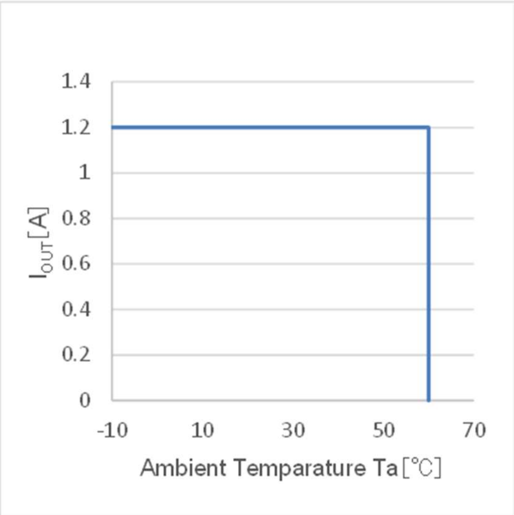


Figure 2. Temperature derating curve

Operation Procedure

1. Necessary Equipment

(1) AC power supply (90 Vac to 264 Vac, 100 W or more)

(2) Load equipment (2 A at maximum value)

(3) DC voltmeter

(4) Power meter

2. Connect to Each Equipment

(1) AC power supply presetting range 90 Vac to 264 Vac, Output switch is OFF.

(2) Electronic load setting under 1.2 A, Load switch is OFF.

(3) The reference board connects to measuring equipments and power supplies as in Figure.3.

(4) AC power supply switch is ON.

(5) Check that output voltage is 35 V.

(6) Electronic load switch is ON.

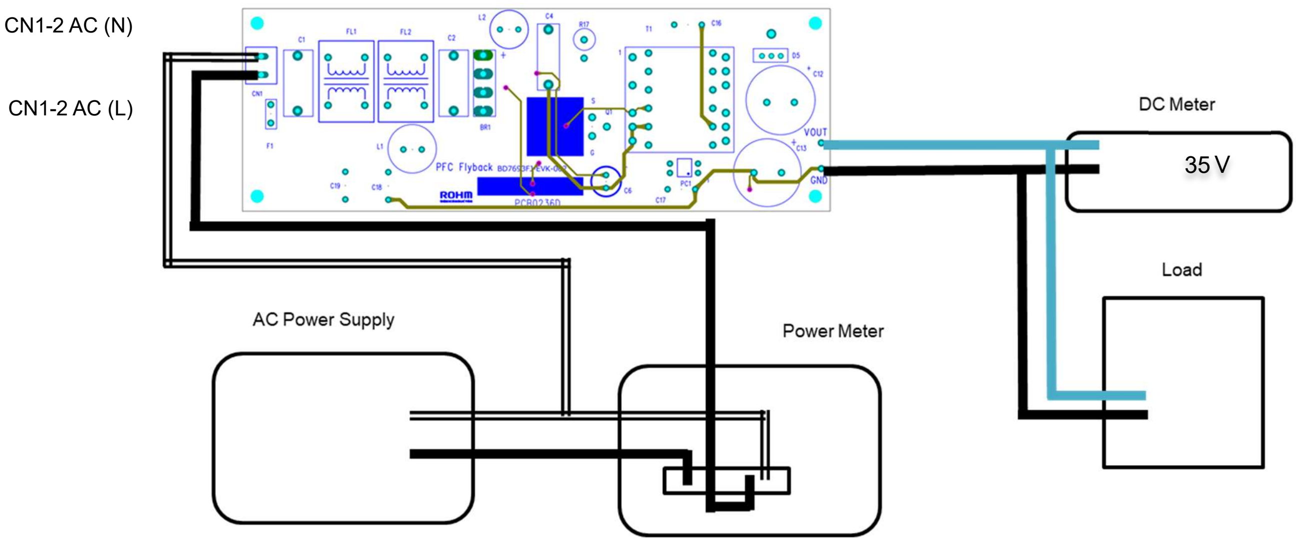


Figure 3. Diagram of How to Connect

Application Circuit

This evaluation board is a one-converter flyback type high power factor ACDC converter.

Operates in critical mode.

The output (35 V) voltage is monitored by a feedback circuit and fed back to the EO pin of BD7693FJ through a opto-coupler.

At startup, the voltage from the emitter pin of Q2 to the VCC pin is supplied through the startup circuit, and the voltage at the VCC pin rises.

When the VCC pin voltage exceeds the UVLO release voltage of 13.0 V (Typ), the BD7693FJ will start operating.

The voltage divided by the resistors R6 and R7 from the VCC voltage is applied to the VS pin.

When the VS pin voltage exceeds the VS short protection voltage VSHORT 0.30 V (Typ), BD7693FJ starts switching.

When the output voltage rises, the VCC voltage is raised from the auxiliary winding of the transformer via R8 and D3 to turn off the starting transistor Q2.

The demo board schematic is shown in the figure below, and the list of parts is shown on page 13.

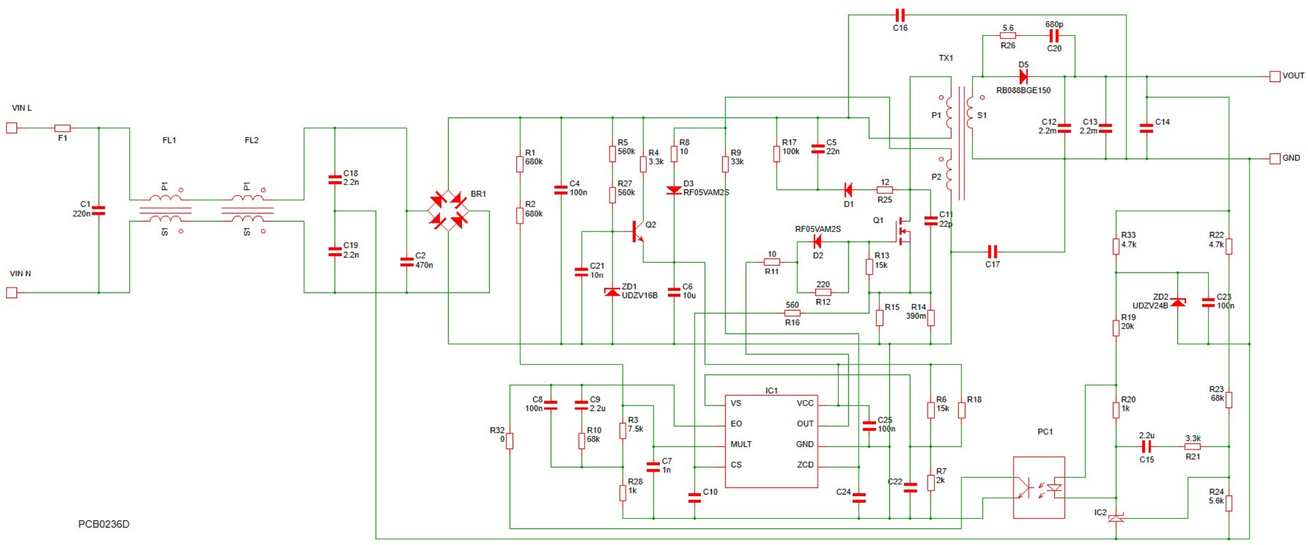


Figure 4. BD7693FJ-EVK-002 Schematics

BD7693FJ Overview

Feature

- Boundary Conduction Mode PFC
- Low THD Circuit Incorparation
- VCC Under Voltage Lock Out Function
- ZCD by Auxiliary Winding
- Static OVP by The VS Pin
- Error Amplifier Input Short Protection
- Stable MOSFET Gate Driving
- Soft Start Function

Key Specification

- Operating Power Supply Voltage Range 10.0 V to 38.0 V
- Circuit Current 0.58 mA (Typ.)
- Operating Temperature Range -40 °C to +105 °C

Package W(Typ) x D(Typ) x H(Max)

SOP-J8 4.90 mm x 6.00 mm x 1.65 mm

Pitch 1.27 mm

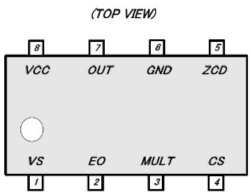


Figure 5. Block Diagram

Table 1. BD7693FJ PIN description

Pin No.	Pin Name	I/O	Function	ESD Diode	
				VCC	GND
1	VS	I	Feedback input pin	-	○
2	EO	O	Error amp output pin	-	○
3	MULT	I	Multiplier input pin	-	○
4	CS	I	Over current protection pin	-	○
5	ZCD	I	Zero current detection pin	-	○
6	GND	-	GND pin	○	-
7	OUT	O	External MOSFET driver pin	-	○
8	VCC	I	Power supply pin	-	○

Measurement Data

1. Load Regulation

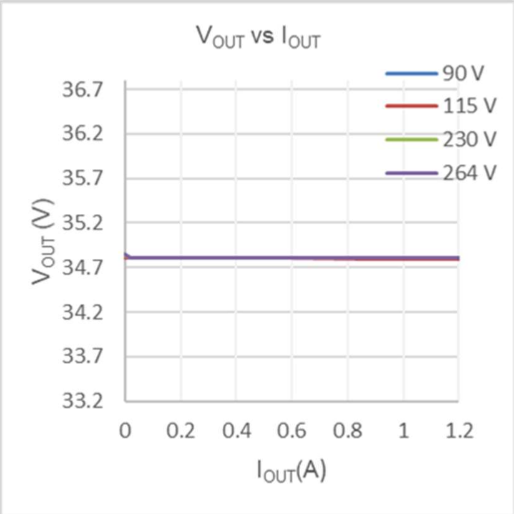


Figure 6. Output Voltage vs Output Current

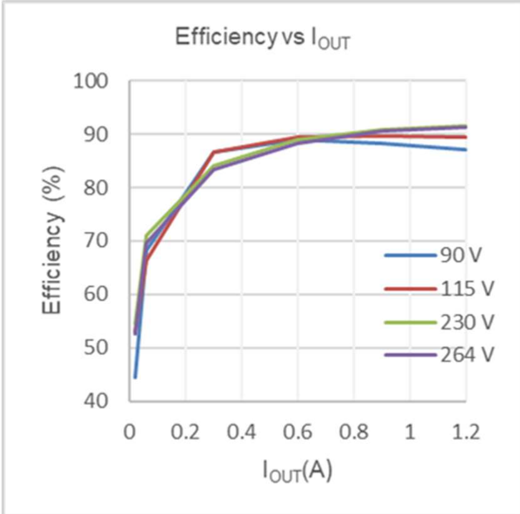


Figure 7. Efficiency vs Output Current

2. Line Regulation

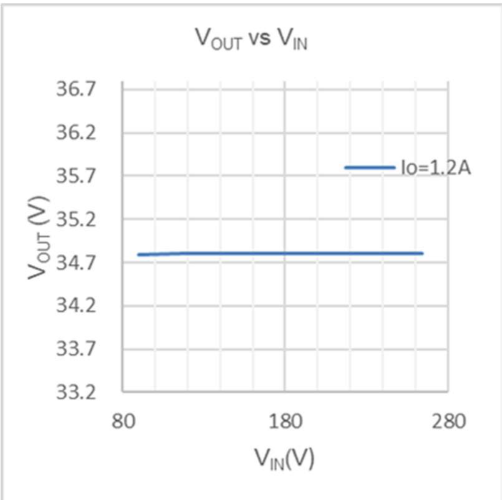


Figure 8. Output Voltage vs Input Voltage

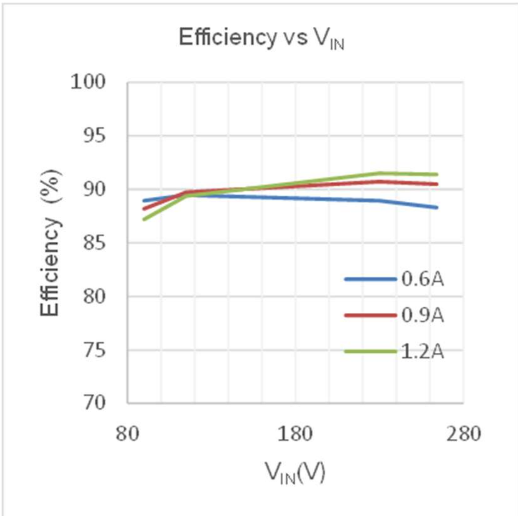


Figure 9. Efficiency vs Input Voltage

Measurement Data – continued

3. PF (Power Factor)

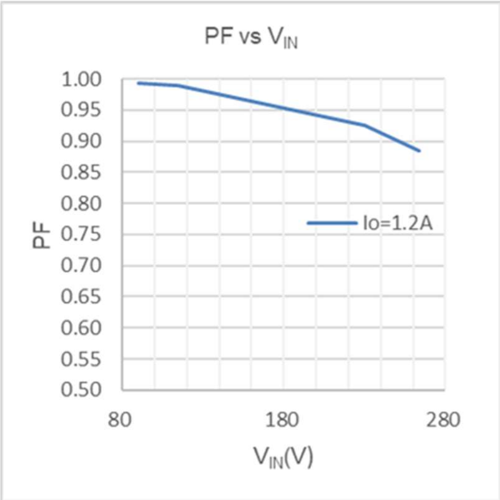


Figure 10. PF vs Input Voltage

4. Total Harmonic Distortion of input current

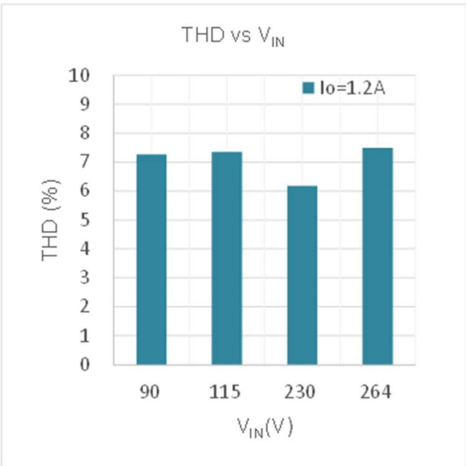


Figure 11. THD vs Input Voltage

Measurement Data – continued

5. Harmonic current

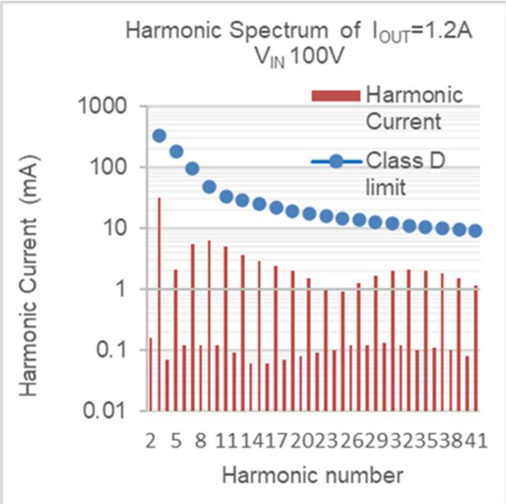


Figure 12. Harmonic current V_{IN} = 100 Vac, I_{OUT} = 1.2 A

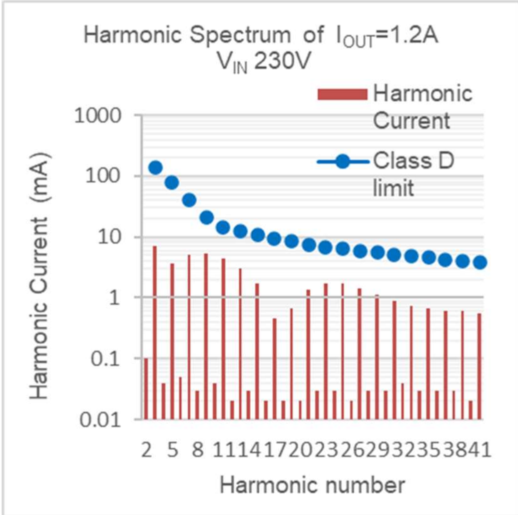


Figure 13. Harmonic current V_{IN} = 230 Vac, I_{OUT} = 1.2 A

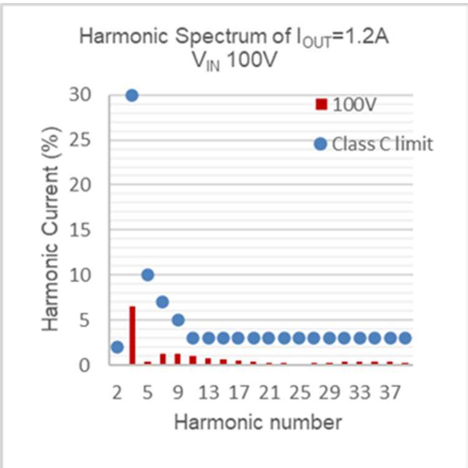


Figure 14. Harmonic current V_{IN} = 100 Vac, I_{OUT} = 1.2 A

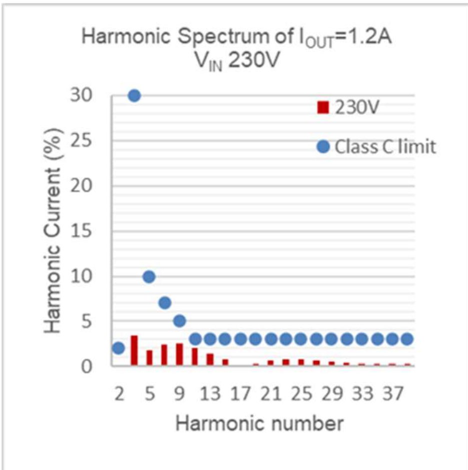


Figure 15. Harmonic current V_{IN} = 230 Vac, I_{OUT} = 1.2 A

Measurement Data – continued

6. Input waveform

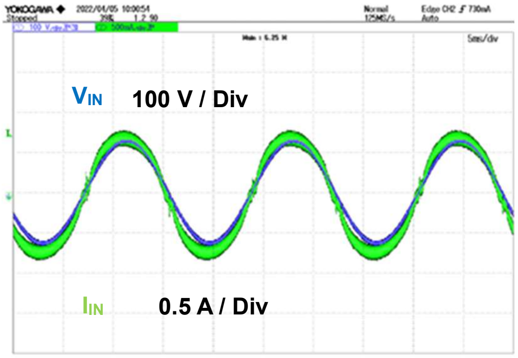


Figure 16. Input Voltage、Input Current V_{IN} = 90 Vac

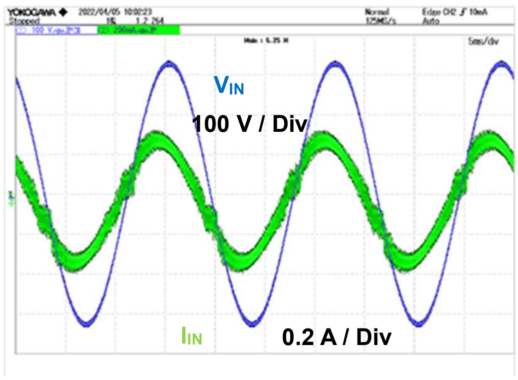


Figure 17. Input Voltage、Input Current V_{IN} = 264 Vac

7. Startup Wave Form

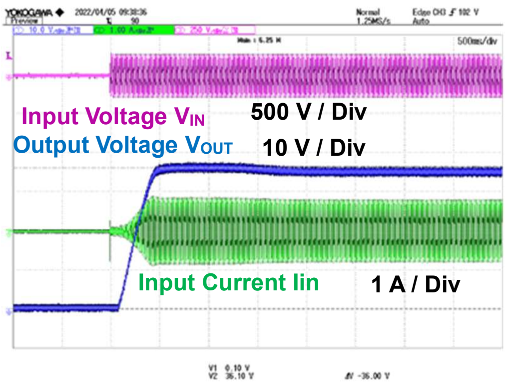


Figure 18. V_{IN} = 90 Vac, I_{OUT} = 1.2 A

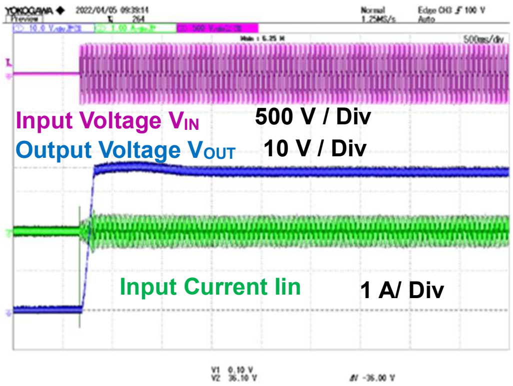


Figure 19. V_{IN} = 264 Vac, I_{OUT} = 1.2 A

Measurement Data – continued

8. Output Voltage Ripple Wave Form

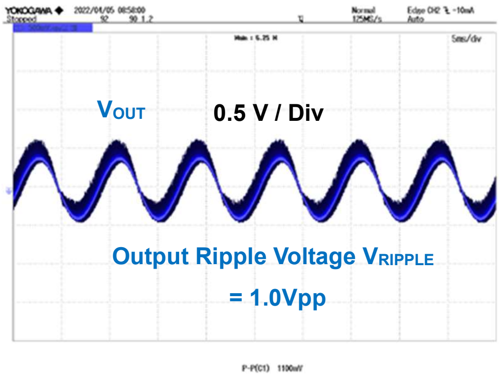


Figure 20. V_{IN} = 90 Vac, I_{OUT} = 1.2 A

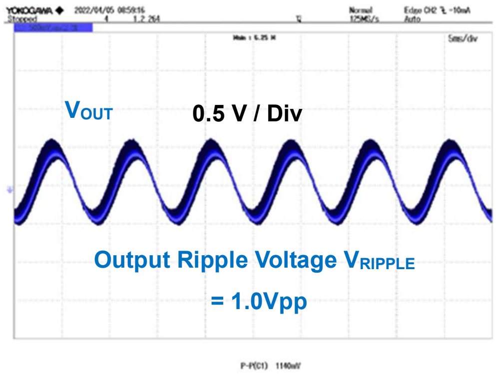


Figure 21. V_{IN} = 264 Vac, I_{OUT} = 1.2 A

9. Temperature of Parts Surface

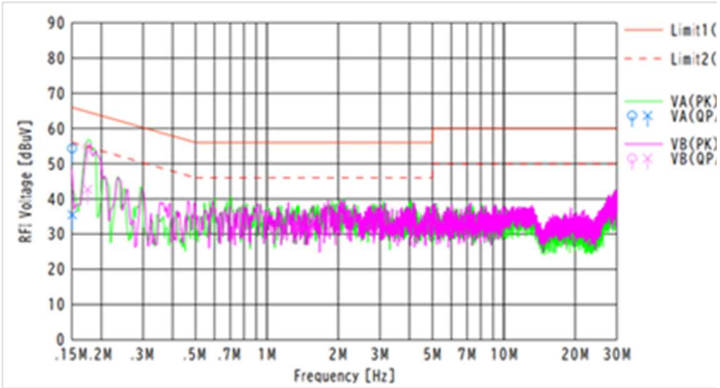
They are measured after 15 minutes from applying a power supply.

Table 2. Surface Temperature of Parts (Ta = 22 °C)

Part	Condition	
	V_{IN} = 90 Vac, I_{OUT} = 1.2 A	V_{IN} = 264 Vac, I_{OUT} = 1.2 A
Q1	57.1 °C	48.5 °C
BR1	64.0 °C	43.6 °C

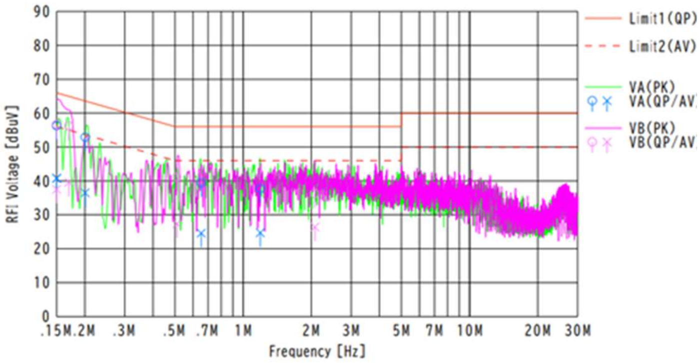
Measurement Data – continued

10. EMI Conducted Emission : CISPR22 Pub 22 Class B



QP margin: 10.1dB
AVE margin: 12.0dB

Figure 22. V_{IN}: 115 Vac / 60 Hz, I_{OUT}: 1.2 A



QP margin: 8.7dB
AVE margin: 15.1dB

Figure 23. V_{IN}: 230 Vac / 50 Hz, I_{OUT}: 1.2 A

Schematics

V_{IN} = 90 Vac to 264 Vac、V_{OUT} = 35 V 1.2 A

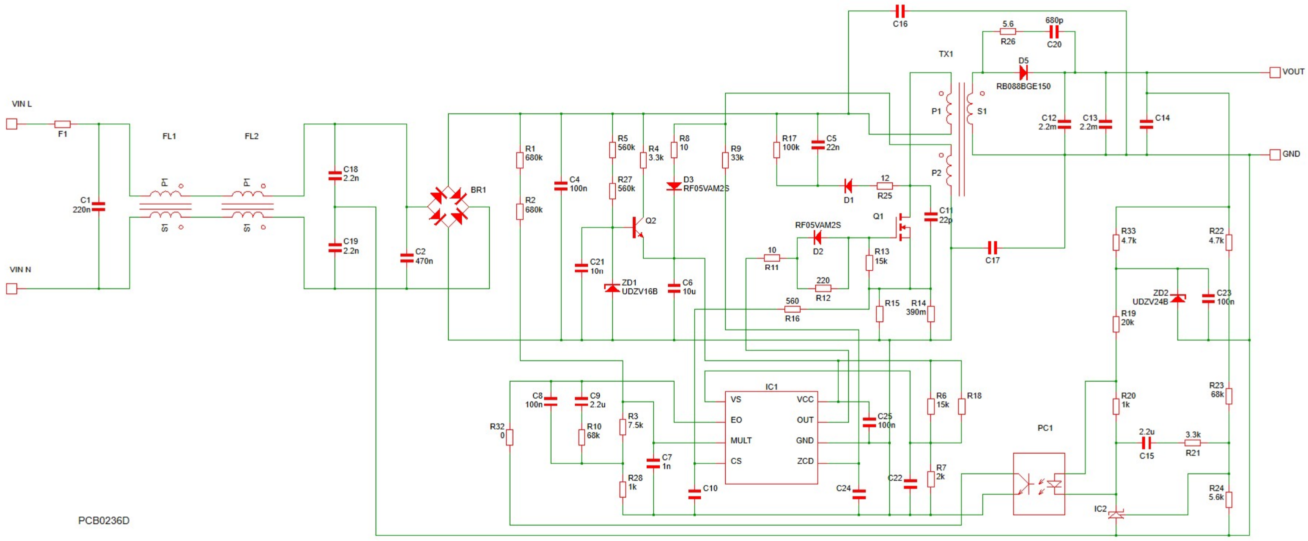


Figure 24. BD7693FJ-EVK-002 Schematics

Parts List

Item	Specification	Parts Name	Manufacurer
C1	0.22 μF, 310 Vac	890334023027	WURTH ELECTRONIK
C2	470 nF, 310 Vac	890334025039CS	WURTH ELECTRONIK
C4	0.1 μF, 630 Vdc	890303425004CS	WURTH ELECTRONIK
C5	22 nF, 630 V	88534220814	WURTH ELECTRONIK
C6	10 μF, 50 V	860130673001	WURTH ELECTRONIK
C7	1000 pF, 100 V	HMK107B7102KA-T	TAIYO YUDEN
C8,C21,C23,C25	0.1 μF, 100 V	HMK107B7104KA-T	TAIYO YUDEN
C9,C15	2.2uF, 2 5 V	GRM188R61E225KA12D	MURATA
C10,C14,C17,C18,C19,C22,C24	–	Non-Mounted	
C11	22 pF,1 kV	885342008008	WURTH ELECTRONIK
C12,C13	2200 μF, 50 V	860010680028	WURTH ELECTRONIK
C16	2200 pF, Y1:300 Vac	DE1E3RA222MA4BP01F	MURATA
C20	680 pF, 250 V	GRM31BR7U3A681JW31	MURATA
CN1	-	B02P-NV	JST
D1	1.0 A,800 V	SARS05	SANKEN
D2,D3	FRD, 0.5 A, 200 V	RF05VAM2STR	ROHM
D4	-	Non-Mounted	
D5	SBD, 10 A, 150 V	RB088T150NZ	ROHM
BR1	2 A, 600V	D2SBA60	SHINDENGEN
F1	1.6 A, 300 V	36911600000_	LITTELFUSE
FL1,FL2	47.5 mH,0.6 A	SSR10V-06475	TOKIN
HS1	22.9 k/W	IC-1625-STL	SANKYO THRMOTECH
HS2	32.7 k/W	OSH-1525-SFL	SANKYO THRMOTECH
IC1		BD7693FJ	ROHM
IC2		TL431BIDBZT	TI
PC1		LTV-817-B	LITEON
Q1	800 V, 9 A	R8009KNX	ROHM
Q2	400 V,0.1 A	2SCR346PT100Q	ROHM
R1,R2	680 kΩ	KTR18EZPJ684	ROHM
R3	7.5 kΩ	MCR03EZPJ752	ROHM
R4	3.3 kΩ	ESR18EZPJ332	ROHM
R5,R27	560 kΩ	ESR18EZPJ564	ROHM
R6	15 kΩ	MCR03EZPF1502	ROHM
R7	2 kΩ	MCR03EZPFX2001	ROHM
R8,R11	10 Ω	ESR18EZPJ100	ROHM
R9	33 kΩ	ESR18EZPJ333	ROHM
R10	68 kΩ	MCR03EZPJ683	ROHM
R15,R18,R29,R30	-	Non-Mounted	
R12	220 Ω	MCR10EZPJ221	ROHM
R13	15 kΩ	MCR03EZPJ153	ROHM
R14	0.39 Ω	LTR18EZPFLR390	ROHM
R16	560 Ω	ESR18EZPJ561	ROHM
R17	100 kΩ	MOS2CT52R104J	KOA
R19	20 kΩ	MCR03EZPJ203	ROHM
R20	1 kΩ	MCR03EZPJ102	ROHM
R21	3.3 kΩ	MCR03EZPJ332	ROHM
R22	4.7 kΩ	MCR03EZPFX4701	ROHM
R23	68 kΩ	MCR03EZPFX6802	ROHM
R24	5.6 kΩ	MCR03EZPFX5601	ROHM
R25	12 Ω	ESR18EZPJ120	ROHM
R26	5.6 Ω	ESR18EZPJ5R6	ROHM
R28	1 kΩ	MCR03EZPFX1001	ROHM
R31,R32	0 Ω	MCR03EZPZJ000	ROHM
R33	4.7 kΩ	MCR03EZPJ472	ROHM
T1		XE2620Y A	ALPHA
TP1,TP2		CD-10-15	MAC8
ZD1	Zener Diode, 16 V	UDZVTE-1716B	ROHM
ZD2	Zener Diode, 24 V	UDZVTE-1724B	ROHM
L2		Jumper	
		P-43MC 3×8	YAWATANEJI
		P-43MC 3×8	YAWATANEJI
PCB		PCB0236D	

Materials may be changed without notifying.

Layout

Size: 160 mm x 55 mm

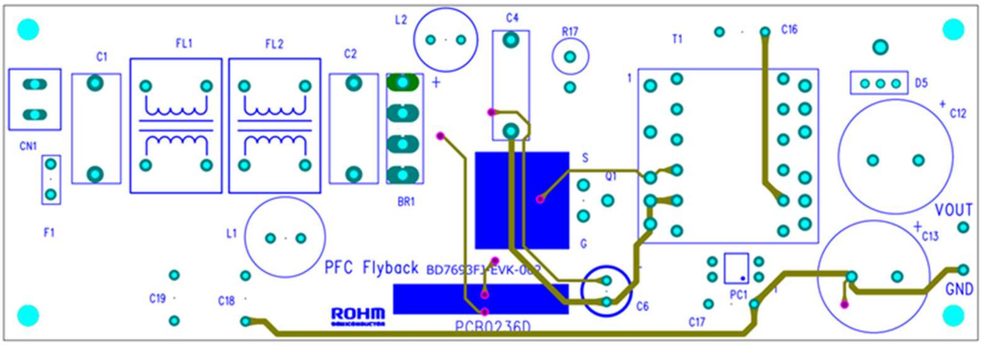


Figure 25. TOP Silkscreen (Top view)

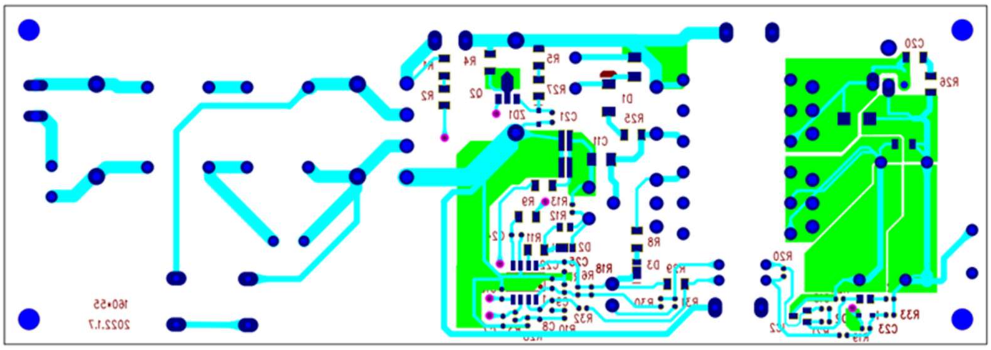


Figure 26. Bottom Layout (Top View)

Specification of the Transformer

Manufacture Alphatrans Co., Ltd. (1-7-2, Bakurou-cho, Chuo-ku, Osaka City, 541-0059, Japan)
http//www.alphatrans.jp/

Product Name: XE2620Y
Bobbin: 12PIN
Core: PQ26

- Primary Inductance: 650 µH ±10 %
  (100 kHz, 1 V)
- Withstand Voltage
  Between Primary and Secondary: AC1500 V
  Between Primary and Core: AC1500 V
  Between Secondary and Core: AC500 V
- Insulation Resistance 100 MΩ or more (DC500 V)

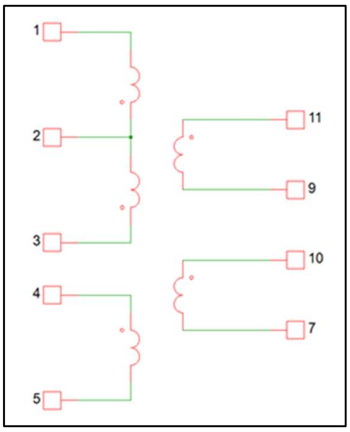


Figure 27. Circuit Diagram

Table 3. Product Specification of XE2620Y

No.	Transformer	Winding Pin		Wire	Turn Number	Tape Layer	Wire Specification
		Start	Finish				
1	NP1	3	2	2UEW / Φ0.35 x 1	26	1	COMPACT
2	NS1	11	9	2UEW / Φ0.40 x 2	10	1	COMPACT
3	ND	4	5	2UEW / Φ0.20 x 1	6	1	COMPACT
4	NS1	10	7	2UEW / Φ0.40 x 2	10	1	COMPACT
5	NP2	2	1	2UEW / Φ0.35 x 1	26	2	COMPACT

Revision History

Date	Rev.	Changes
18.April.2022	001	New Release

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.

6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

10) ROHM has used reasonable care to ensure the accuracy of the information contained in this document. However, ROHM does not warrants that such information is error-free, and ROHM shall have no responsibility for any damages arising from any inaccuracy or misprint of such information.

11) Please use the Products in accordance with any applicable environmental laws and regulations, such as the RoHS Directive. For more details, including RoHS compatibility, please contact a ROHM sales office. ROHM shall have no responsibility for any damages or losses resulting non-compliance with any applicable laws or regulations.

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ROHM SEMICONDUCTOR

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