Isolation Fly-back Conveter PWM method
Output 40W 24V
BM2P060MF-EVK-001

User's Guide

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BM2P060MF evaluation board (BM2P060MF-EVK-001) 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.

AC/DC Converter

Flyback Type PWM Mode Isolated 24 V 1.67 A 40 W BM2P060MF Evaluation Board

BM2P060MF-EVK-001

General Description

This evaluation board outputs an isolated voltage of 24 V from an input of 90 Vac to 264 Vac, and the maximum output current is 1.67 A.

BM2P060MF which is PWM method DC/DC converter IC built-in 650 V MOSFET is used.

Low on-resistance 0.7 Ω 650 V MOSFET built-in contributes to high efficiency (91 % typ).

PWM controller for AC / DC power supplies, the BM2P060MF provides the optimum system for all products with outlets.

Figure 1. BM2P060MF-EVK-001

No. 64UG011E Rev.001
MAY.2021

Performance Specification

Not guarantee the characteristics is representative value.

Unless otherwise specified V_{IN} = 230 Vac , I_{OUT} = 1.67 A , Ta = 25 °C

Parameter	Symbol	Min	Typ	Max	Units	Conditions
Input Voltage Range	V_{IN}	90	230	264	V	
Input Frequency	f_{LINE}	47	-	63	Hz	
Output Voltage	V_{OUT1}	22.8	24.0	25.2	V	
Output Current Range *(Note 1)*	I_{OUT1}	0	-	1.67	A	
Maximum Output Power	P_{OUT}			40.0	W	
Standby Input Power	P_{INSTBY}	-	47	100	mW	I_{OUT} = 0 A V_{IN} = 230 V
Power supply efficiency	η	88.0	91.0	-	%	
Output Ripple Voltage *(Note 1)*	V_{RIPPLE}	-	0.10	0.24	Vpp	
Oprating Temperature		-10	+25	+65	°C	

(Note 1) Not include spikes noise.

Derating

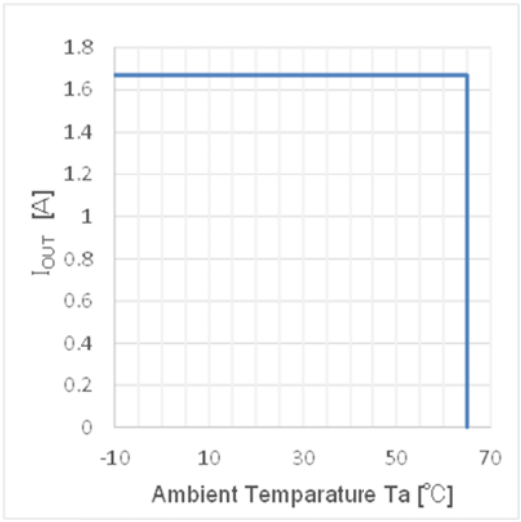


Figure 2. Temperature derating curve

Operation Procedure

1. Operation 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

2. Connect method

(1) Preset the AC power to 90 Vac to 264 Vac and turn off the power output.
(2) Set the load below the rated current of each output to disable the load.
(3) Connect the N pin of the power supply to the CN1-1: AC (N) pin and the L pin to the CN1-2: AC (L) pin with a pair of wires.
(4) Connect each load to VOUT pin from the positive pin and to GND pin with a pair of wires.
(5) When connecting a power meter, connect as follows. (For details, refer to the User's Manual of the electricity meter you are using.)
(6) Connect the positive pin of the DC voltmeter to VOUT pin and the negative pin to GND pin for output voltage measurement.
(7) AC power supply switch is ON.
(8) Make sure that the DC voltmeter reading is at the set voltage (24 V).
(9) Electronic load switch is ON.

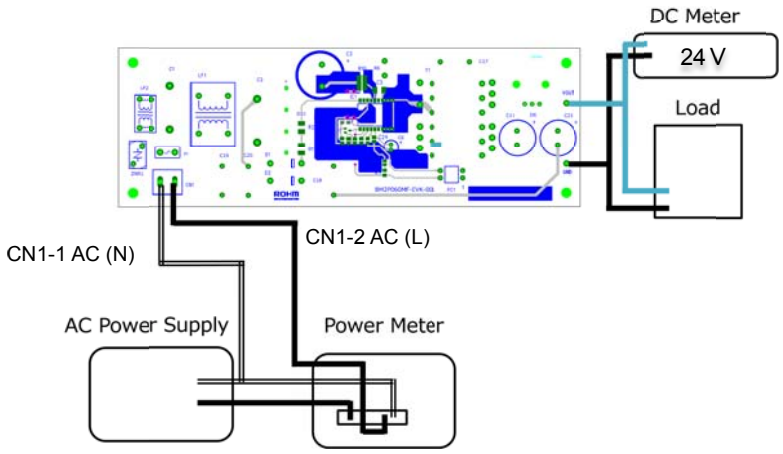


Figure 3. Diagram of How to Connect

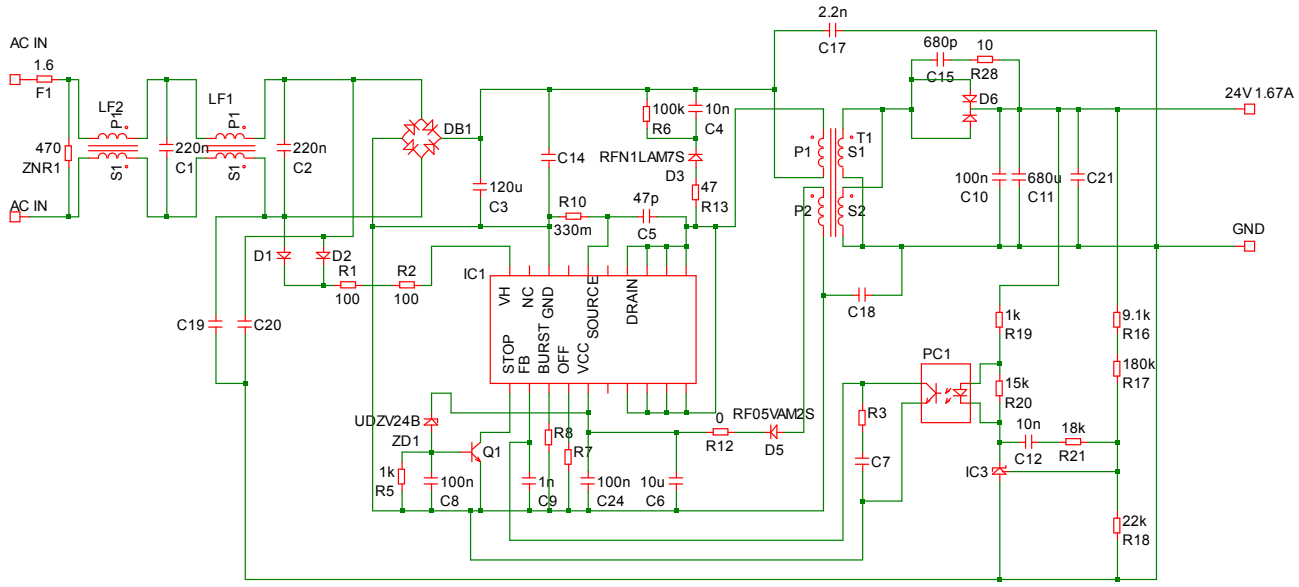
Application Circuit

This evaluation board operates in flyback mode at a maximum frequency of around 65 kHz..

The output (24 V) voltage is monitored by a feedback circuit and fed back to the FB pin of BM2P060MF through a opto - coupler.

At startup, the voltage at the VCC pin rises as the voltage is supplied from the DRAIN pin to the VCC pin through the start circuit.

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



BM2P060MF General Description

Features

- AC Low Voltage Protection Function (AC UVLO)
- X Capacitor Discharge Function
- VCC Pin Low Voltage Protection (VCC UVLO)
- PWM Type Current Mode Control
- Frequency Reduction Function
- Burst Operation at Light Load
- External Burst voltage setting function
- Minimum ON width adjustment at light load
- Soft Start Function
- FB Pin Overload Protection Function (FB OLP)
- Over Current Protection Function by cycle
- Over Current Compensation by AC voltage detection.
- External Stop Function
- Dynamic Over Current Protection
- Leading Edge Blanking

Key Specifications

- Operation Power Supply Voltage Range
  VCC Pin Voltage: 11 V to 60 V
  DRAIN Pin Voltage: 650 V (Max)
- Current at Switching Operation: 850 μA (Typ)
- Current at Burst Operation 400 μA (Typ)
- Switching Frequency 65 kHz (Typ)
- MOSFET ON Resistor 0.70 Ω (Typ)
- Operation Temperature Range -40 °C to +105 °C

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

SOP20A 12.8 mm x 10.3 mm x 2.65 mm

Applications

AC Adapters, Each Household Applications and Power Supplies for Motor

Pin Configuration

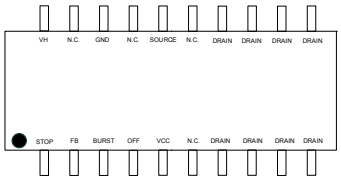


Figure 4. Pin Configuration

Pin Descriptions

No.	Pin name	I/O	Function	No.	Pin name	I/O	Function
1	STOP	I	External stop pin	11	DRAIN	I/O	MOSFET Drain pin
2	FB	I/O	Feedback pin	12	DRAIN	I/O	MOSFET Drain pin
3	BURST	I	Burst setting pin	13	DRAIN	I/O	MOSFET Drain pin
4	OFF	I	MIN on setting pin	14	DRAIN	I/O	MOSFET Drain pin
5	VCC	I/O	Power supply input pin	15	N.C.	-	No connection
6	N.C.	-	No connection	16	SOURCE	I/O	MOSFET source pin
7	DRAIN	I/O	MOSFET Drain pin	17	N.C.	-	No connection
8	DRAIN	I/O	MOSFET Drain pin	18	GND	I/O	GND pin
9	DRAIN	I/O	MOSFET Drain pin	19	N.C.	-	No connection
10	DRAIN	I/O	MOSFET Drain pin	20	VH	I	AC voltage start-up pin

Measurement Data

1. Load Regulation

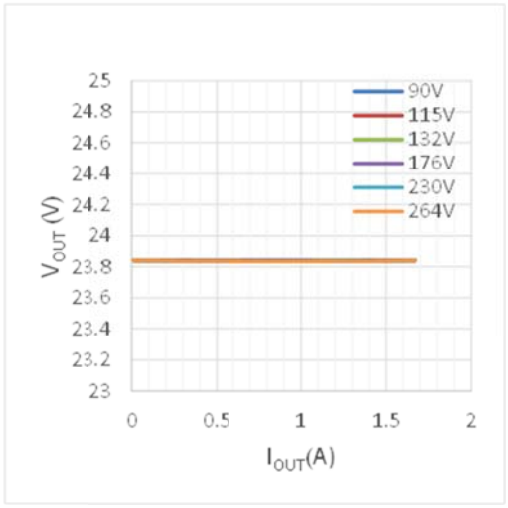


Figure 5. Output Voltage vs Output Current

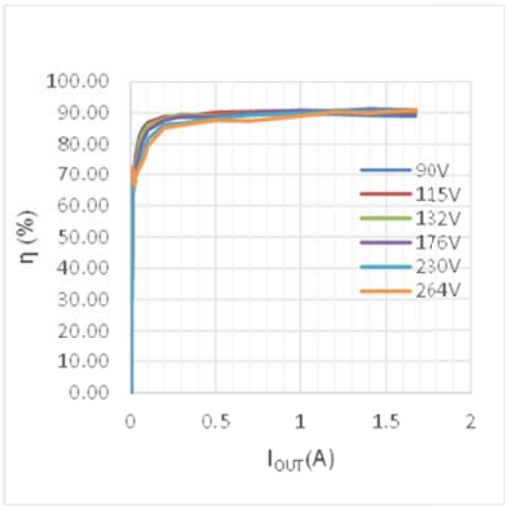


Figure 6. Efficiency vs Output Current

2. Line Regulation

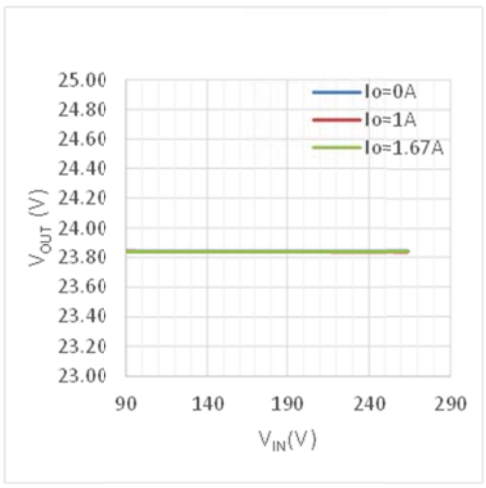


Figure 7. Output Voltage vs V_{IN}

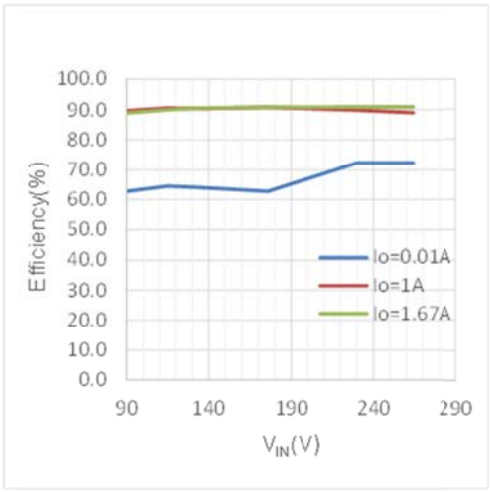


Figure 8. Efficiency vs Input Voltage

Measurement Data – continued

3. Switching Frequency

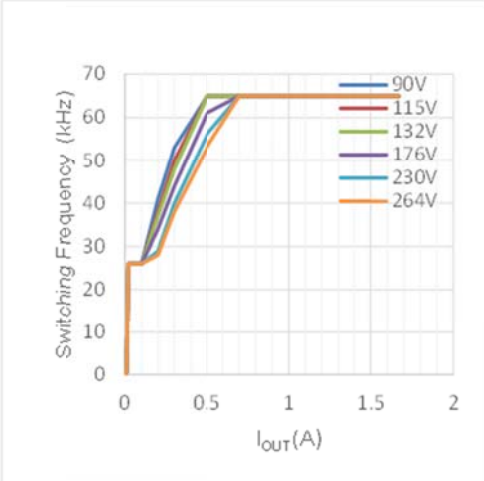


Figure 9. Frequency vs Output Power

4. Input Voltage Slowup

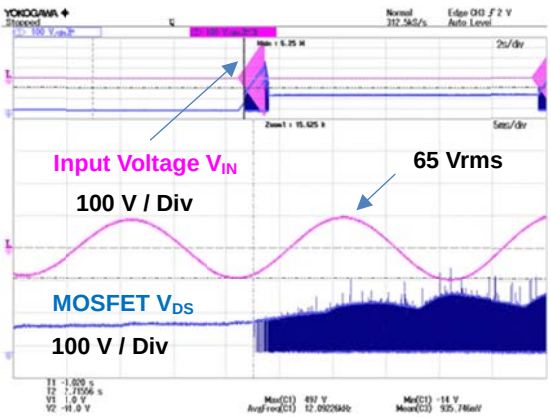


Figure 10. VIN 0 V to 230 V

Measurement Data – continued

5. Switching Wave Form

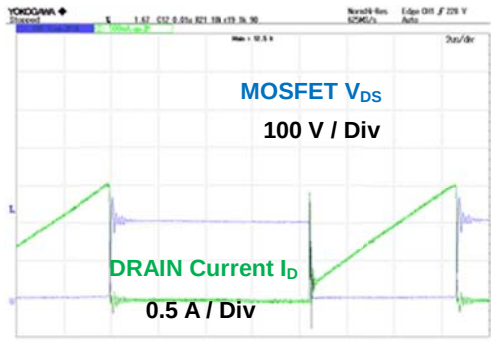


Figure 11. V_{DS},I_D V_{IN} = 90Vac,I_{OUT}=1.67A

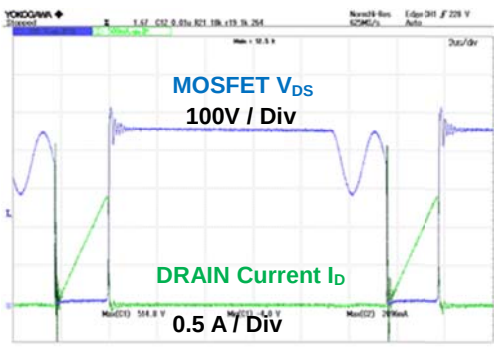


Figure 12. V_{DS},I_D V_{IN} = 264Vac,I_{OUT}=1.67A

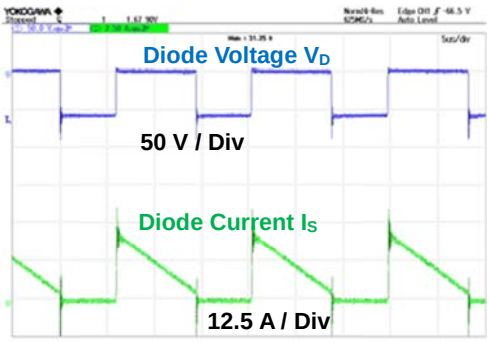


Figure 13. V_{DS},I_D V_{IN} = 90Vac,I_{OUT}=1.67A

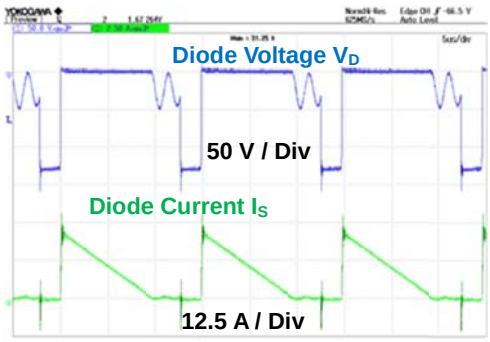


Figure 14. V_{DS},I_D V_{IN} = 264 Vac,I_{OUT}=1.67 A

Measurement Data – continued

5. Switching Wave Form- continued

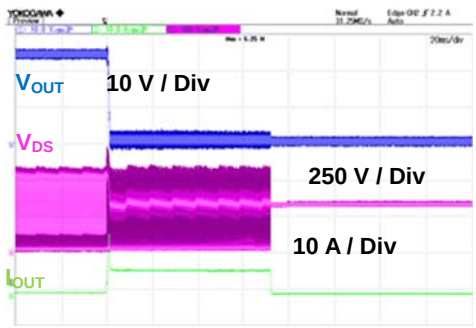


Figure 15. VIN = 90 Vac, V_{OUT} Shorted

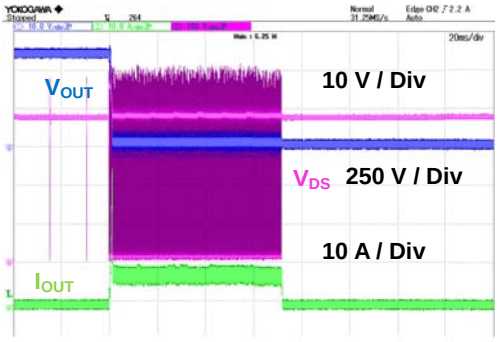


Figure 16. VIN = 264 Vac, V_{OUT} Shorted

6. Startup Wave Form

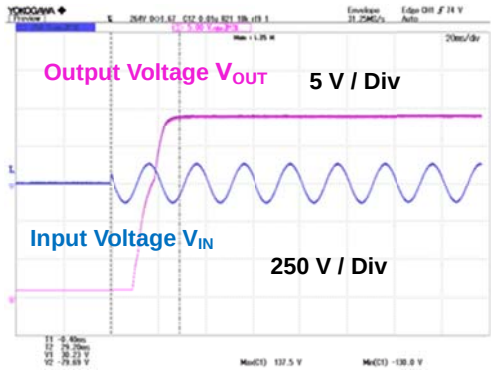


Figure 17. V_{IN} = 90 Vac, I_{OUT} = 1.67 A

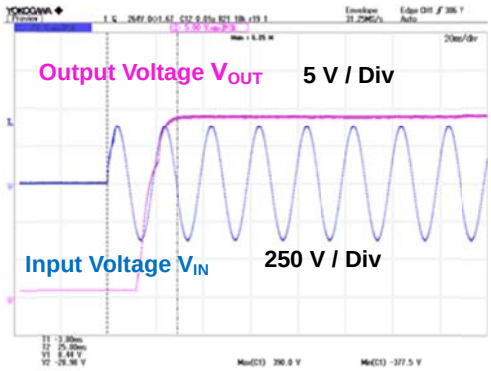


Figure 18. V_{IN} = 264 Vac, I_{OUT} = 1.67 A

Measurement Data – continued

7. Dynamic Load Fluctuation

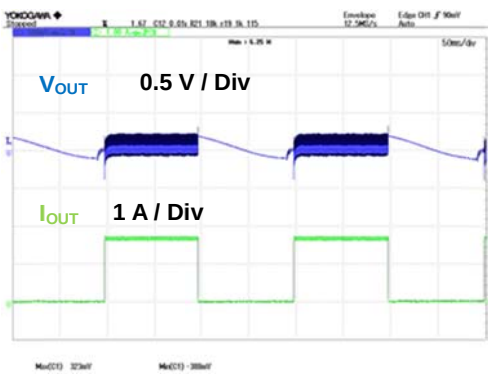


Figure 19. V_{IN} = 115 Vac,I_{OUT} = Switch 0 A / 1.67 A

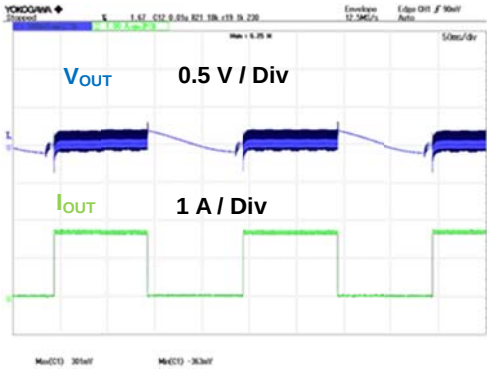


Figure 20. V_{IN} = 230 Vac,I_{OUT} = Switch 0 A / 1.67 A

8. Output Voltage Ripple Wave Form

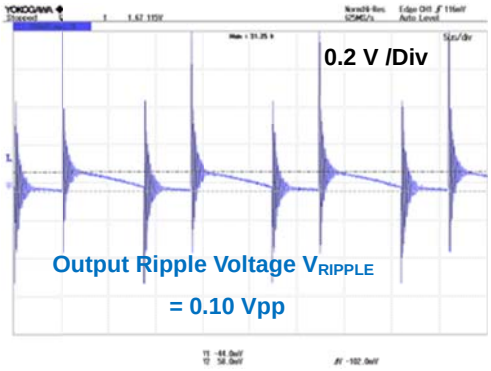


Figure 21. V_{IN} = 115 Vac, I_{OUT} = 1.67 A

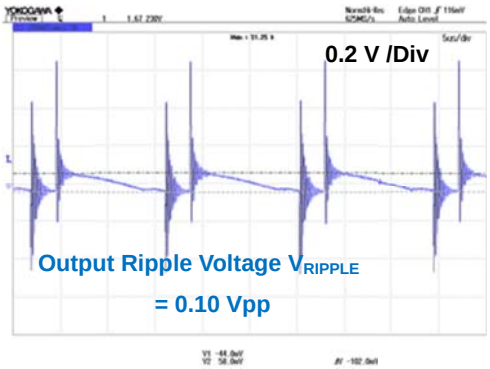


Figure 22. V_{IN} = 230 Vac, I_{OUT} = 1.67 A

9. Temperature of Parts Surface

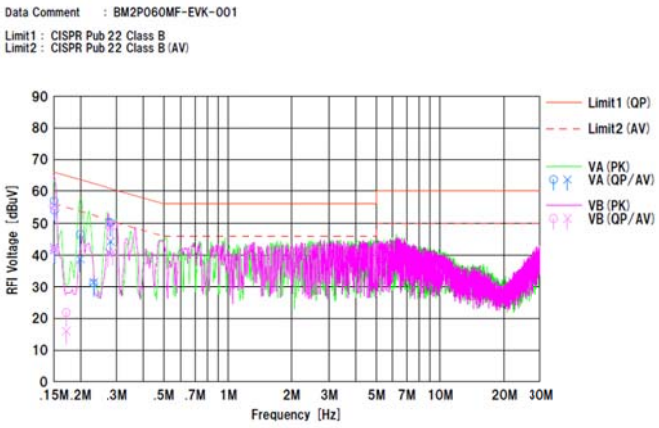
They are measured after 15 minutes from applying a power supply.

Table 1. Surface Temperature of Parts (Ta = 20 °C)

Part	Condition	
	V_{IN} = 90 Vac, I_{OUT1} = 1.3 A	V_{IN} = 264 Vac, I_{OUT1} = 1.3 A
IC1	60.4 °C	61.3 °C
Diode D1	61.6 °C	62.3 °C

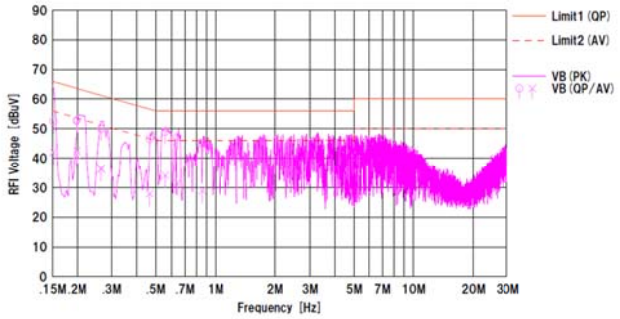
Measurement Data – continued

10. EMI Conducted Emission:CISPR22 Pub 22 Class B



QP margin: 9.0dB
AVE margin: 6.4dB

Figure 23. V_{IN}: 115 Vac / 60 Hz, I_{OUT}: 1.67 A



QP margin: 7.0dB
AVE margin: 10.4dB

Figure 24. V_{IN}: 230 Vac / 50 Hz, I_{OUT}: 1.67 A

Schematics

V_{IN} = 90 Vac to 264 Vac、V_{OUT} = 24 V 1.67 A

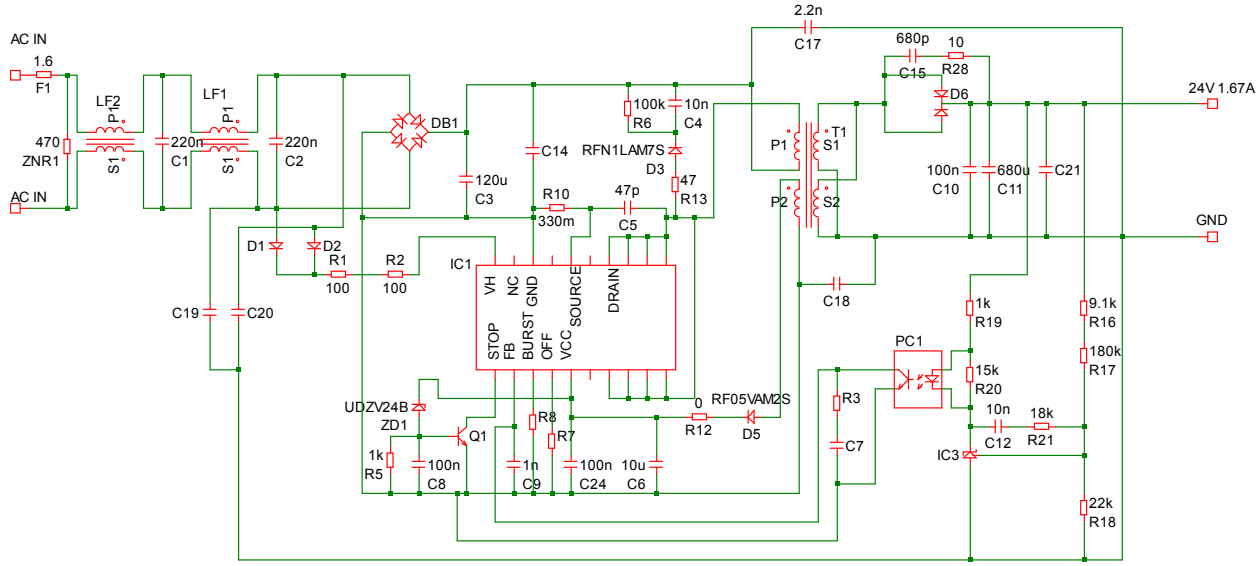


Figure 25. BM2P060MF-EVK-001 Schematics

Parts List

Item	Spec	Parts Name	Manufacturer
C1,C2	220 n, 310 Vac	890334025027CS	WURTH
C3	120 µ, 450 V	450CXW120MEFC18×31.5	RUBYCON
C4	10 nF, 500 V	885342208009	WURTH
C5	47 p, 630 V	GRM31A5C2J470JW01D	MURATA
C6	10 µF, 50 V	860160672009	WURTH
C7,C14,C18,C19,C20,C21	Non.mounted		
C8,C10,C24	0.1 µF, 100 V	HMK107B7104KA-T	Taiyo Yuden
C9	1000 pF, 100 V	HMK107B7102MA-T	Taiyo Yuden
C11	680 µF, 35 V	860080578019	WURTH
C12	0.01 µF, 100 V	C0603C103K5RACTU	KEMET
C15	680 pF, 1 kV	GRM31B5C2J681FW01L	MURATA
C17	2200 pF, AC 300 V	DE1E3RA222MJ4BP01F	MURATA
D1,D2	1 A, 1000 V	1N4007	
D3	FRD, 0.8 A, 700 V	RFN1LAM7S	Rohm
D5	FRD, 200 V, 0.5 A	RF05VAM2S	Rohm
D6	FRD, 300 V, 20 A	RF2001T3D	Rohm
PC1		LTV-817-B	Liteon
Q1	TR, 50 V, 0.1 A	2SCR523UB	Rohm
DB1	600 V, 4 A	D3SBA60	Shindengen
R1,R2	100 Ω	ESR18EZPJ101	Rohm
R3,R7,R8	Non.mounted	-	Rohm
R5	1k	MCR03EZPJ102	Rohm
R6	100 kΩ	MOS2CT52R104J	Rohm
R10	330 mΩ	LTR50EZPZFLR330	Rohm
R12	0 Ω	MCR18EZPJ000	Rohm
R13	47 Ω	ESR18EZPJ470	Rohm
R16	9.1 kΩ	MCR03EZPFX9101	Rohm
R17	180 kΩ	MCR03EZPFX1803	Rohm
R18	22 kΩ	MCR03EZPFX2202	Rohm
R19	1 kΩ	MCR03EZPJ102	Rohm
R20	15 kΩ	MCR03EZPJ153	Rohm
R21	18 kΩ	MCR03EZPJ183	Rohm
R28	10 Ω	ESR18EZPJ100	Rohm
F1	1.6 A, 300 V	36911600000	Littelfuse
ZNR1	300 V, 400 A, φ 5 mm	V470ZA05P	Littelfuse
LF1	34.5 mH	SSR21NV-M12345	TOKIN
LF2	60 µH	LF1246Y	アルファトランス
T1	PQ 26	XE2395Y_B	アルファトランス
IC1		BM2P060MF	Rohm
IC2	Non.mounted		
IC3		NCP431AVSNT1G	Onsemi
ZD1	24V	UDZVTE-1724B	Rohm
HEAT1	22.9 k/W	IC-1625-STL	
CN1		B02P－NV(LF)(SN)	ＪＳＴ
TP1,TP2		CD-10-15	ＭＡＣ８

Materials may be changed without notifying.

Layout

Size: 160 mm x 55 mm

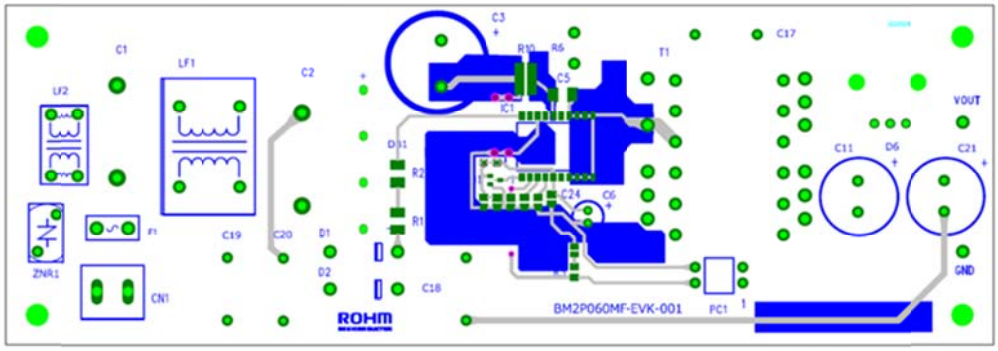


Figure 26. TOP Layout (Top view)

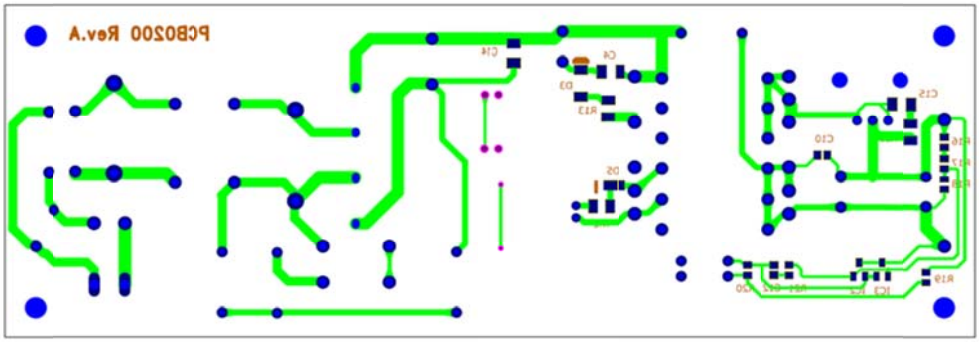


Figure 27. Bottom Layout (Top View)

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: XE2395Y_B
Bobbin: 12PIN
Core: PQ26

- Primary Inductance: 500 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)

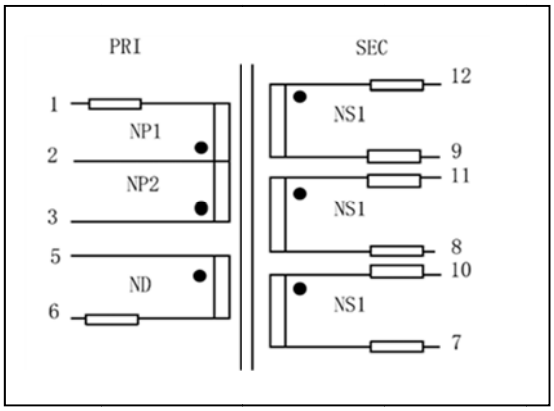


Figure 28. Circuit Diagram

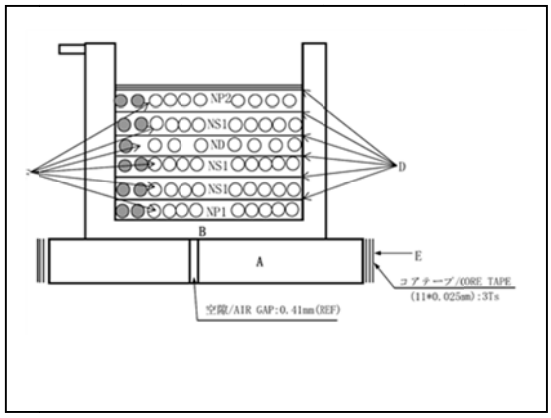


Figure 29. Structure Diagram

Table 2. Product Specification of XE2395Y_B

No.	Transformer	Winding Pin		Wire	Turn Number	Tape Layer	Wire Specification
		Start	Finish				
1	NP1	3	2	2UEW / Φ0.29 x 2	19	1	COMPACT
2	NS1	10	7	TEX / Φ0.32 x 2	11	1	COMPACT
3	NS1	11	8	TEX / Φ0.32 x 2	11	1	COMPACT
4	ND	5	6	2UEW / Φ0.15 x 1	8	1	COMPACT
C5	NS1	12	9	TEX / Φ0.32 x 2	11	1	COMPACT
6	NP2	2	1	2UEW / Φ0.29 x 2	19	3	COMPACT

Revision History

Date	Rev.	Changes
12.May.2021	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.

12) When providing our Products and technologies contained in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, including without limitation the US Export Administration Regulations and the Foreign Exchange and Foreign Trade Act.

13) This document, in part or in whole, may not be reprinted or reproduced without prior consent of ROHM.

ROHM SEMICONDUCTOR

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