Quasi-Resonant method
Isolated Output Power 90W
BM1Q104FJ-EVK-001

User's Guide

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＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BM1Q104FJ evaluation board (BM1Q104FJ-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.

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AC/DC Converter

Quasi-Resonant method Isolated 90W 20V 4.5A BM1Q104FJ Evaluation Board

BM1Q104FJ-EVK-01

General Description

This evaluation board outputs an isolated voltage of 20 V from an input of 90 Vac to 264 Vac,
and the maximum output current is 4.5 A.
The BM1Q104FJ, the QR controller for AC/DC power supplies, provides the optimal system for all products where an outlet is present.



Figure 1. BM1Q104FJ-EVK-004

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Performance Specification

Electrical characteristic

Not guarantee the characteristics is representative value.

Unless otherwise specified V_{IN} = 230 Vac, I_{OUT} = 4.5 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_{OUT}	19.0	20.0	21.0	V	
Output Current Range *(Note 1)*	I_{OUT1}	0	-	4.5	A	
Maximum Output Power *(Note 1)*	P_{OUT}			90	W	
Standby Input Power	P_{INSTBY}	-	105	-	mW	I_{OUT} = 0 A V_{IN} = 230V
Power supply efficiency	η	86	90.4	-	%	
Output Ripple Voltage *(Note 2)*	$V_{ripple1}$	-	0.18	0.20	Vpp	
Opareting Temperature		-10	+25	+65	℃	

Derating

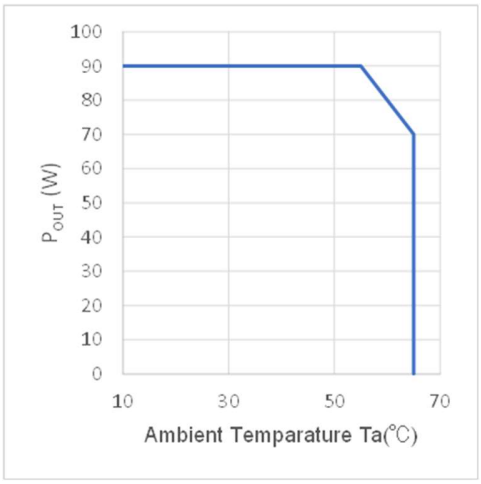


Figure 2. Temperature derating curve

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Operation Procedure

1 Necessary Equipment

(1) AC power supply (90 Vac to 264 Vac, 200 W or more)

(2) Load equipment (5 A at maximum value)

(3) DC voltmeter

2 Connect to Each Equipment

(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 terminal of the power supply to the CN1-1: AC (N) terminal and the L terminal to the CN1-2: AC (L) terminal with a pair of wires.

(4) Connect load to VOUT terminal from the positive terminal and to GND terminal 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 terminal of the DC voltmeter to VOUT terminal and the negative terminal to GND terminal for output voltage measurement.

(7) AC power supply switch is ON.

(8) Make sure that the DC voltmeter reading is at the set voltage (20 V).

(9) Electronic load switch is ON.

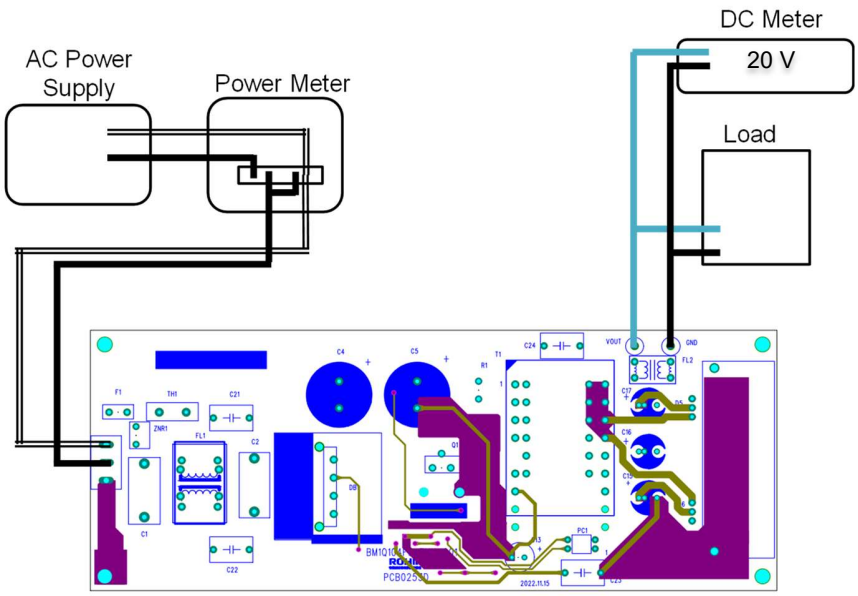


Figure 3. Diagram of How to Connect

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Application Circuit

This evaluation board operates in Quasi-Resonant method.
The output (20 V) voltage is monitored by a feedback circuit and feed back to the FB pin of BM1Q104FJ through a opto - coupler.
At startup, the voltage at the VCC pin rises as the voltage is supplied from the VH pin to the VCC pin through the start circuit.
When the VCC pin voltage exceeds the UVLO release voltage of 13.5 V (Typ), the BM1Q104FJ starts operating.
After start of switching, the startup circuit is turned off and it cut the supply from the VH pin, in order to have low power consumption for instance in standby mode.

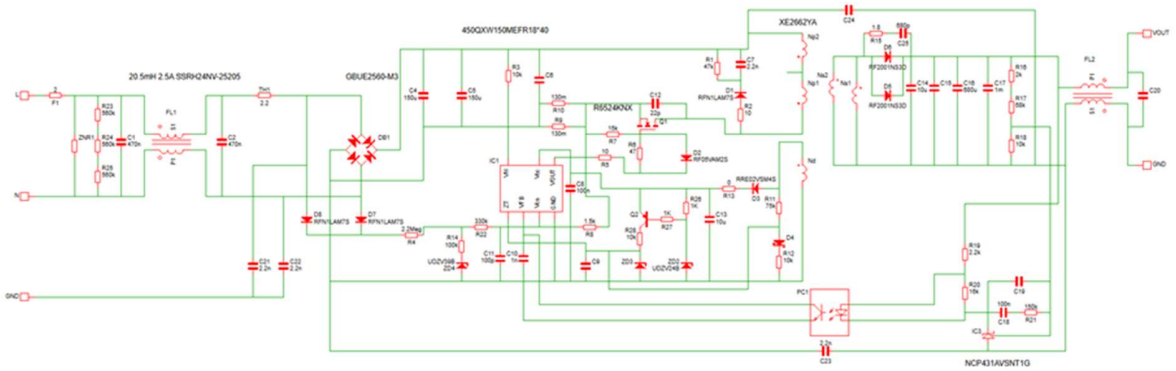


Figure 4. Application Circuit

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BM1P104FJ General Description

Features

- Quasi-Resonant method
- Built-in 650V tolerate starter Circuit
- Low consumption Power in Light load
- Bottom skip control
- Sound of transformer reduction function
- VCC Pin Under-Voltage Protection
- Over-current protection (cycle-by-cycle)
- OUT pin : H voltage protection
- Soft Strart
- ZT trigger mask function
- ZT Over voltage protection
- FB Over Load protection (Auto-restart)
- CS pin open protection (Auto-restart)

Key Specifications

- Operation Power Supply Voltage Range
  VCC Pin Voltage: 14.0 V to 30.0 V
  DRAIN Pin Voltage: 650 V (Max)
- Current at Switching Operation: 0.60 mA (Typ)
- Current at Burst Operation 0.37 mA (Typ)
- Operation Temperature Range -40 °C ～ +105 °C

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

SOP-J8 6.00 mm x 4.90 mm x 1.65 mm
Pitch: 1.27 mm (Typ)



Pin Configuration

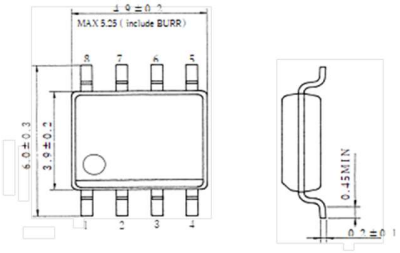


Figure 5. Pin Configuration

Applications

Printer, AC adapter, Copy machine etc

Pin Descriptions

Table 1.BM1Q104FJ Pin Configuration

No.	Pin Name	I/O	Function
1	ZT	I	Zero current detect pin
2	FB	I	Feedback signal input pin
3	CS	I	Primary current sensing pin
4	GND	I/O	GND pin
5	OUT	O	External MOS drive pin
6	VCC	I/O	Power supply pin
7	N.C.	-	Non Connection pin
8	VH	I	Starter circuit pin

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Measurement Data

1 Load Regulation

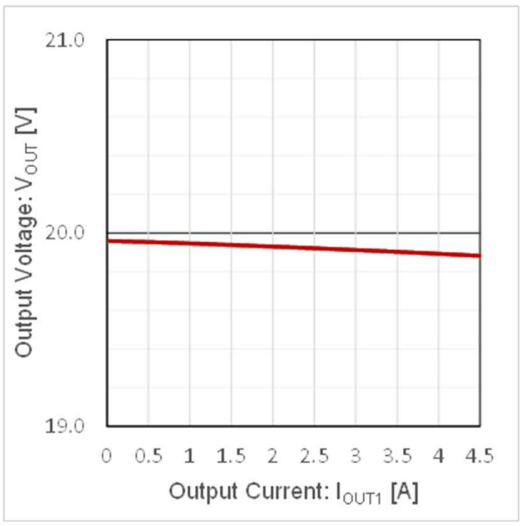


Figure 6. Load Regulation (V_{OUT} vs I_{OUT})

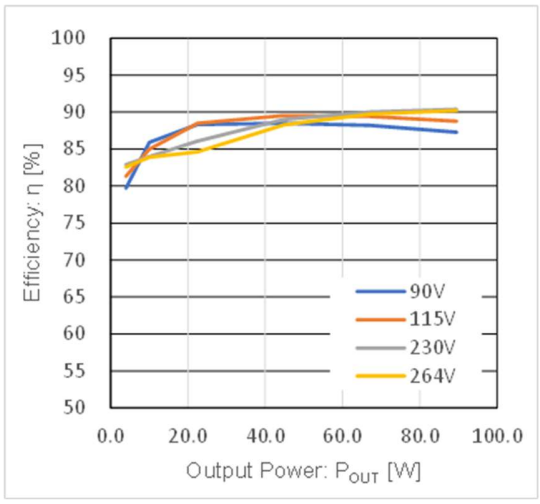


Figure 7. Efficiency vs P_{OUT}

2. Line Regulation

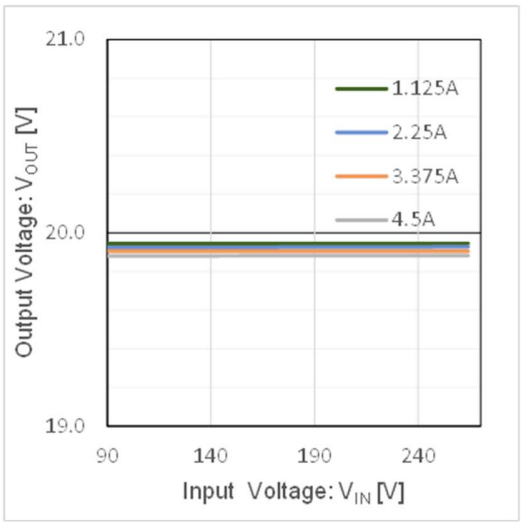


Figure 8. Line Regulation (V_{OUT} vs I_{OUT})

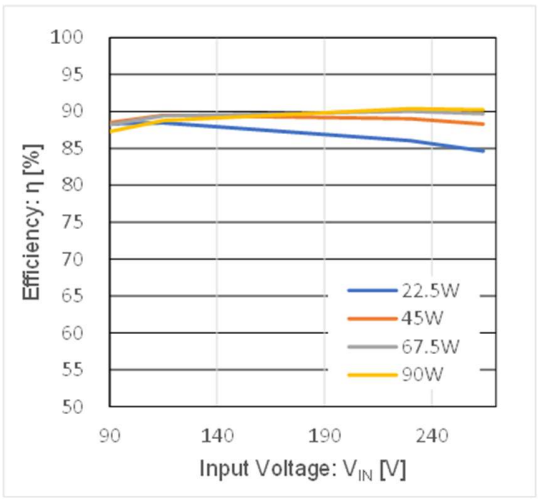


Figure 9. Efficiency vs Input Voltage

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Measurement Data – continued

3 Switching Frequency

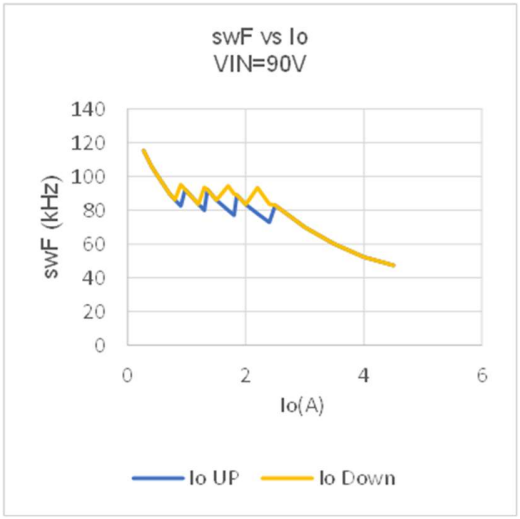


Figure 10. Switching Frequency vs I_{OUT}

4 Switching Wave Form

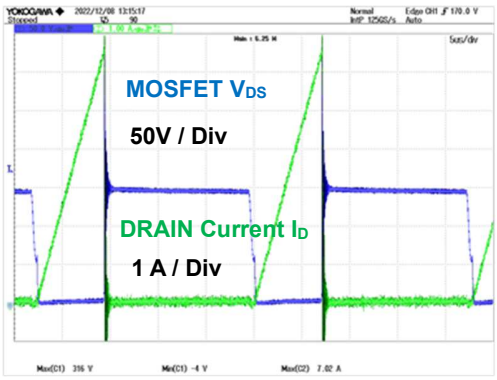


Figure 11. MOSFET Wave Form V_{IN} = 90 Vac, I_{OUT}=4.5A

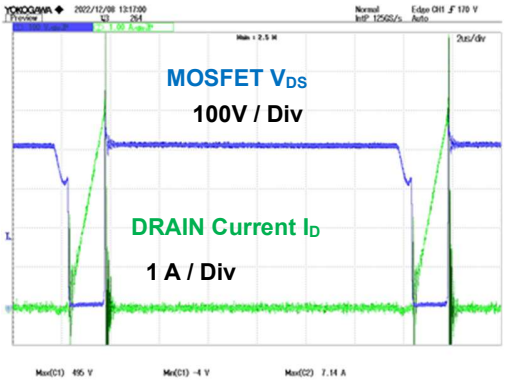


Figure 12. MOSFET Wave Form V_{IN} = 264 Vac, I_{OUT}=4.5A

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Measurement Data - continued

4 Switching Wave Form

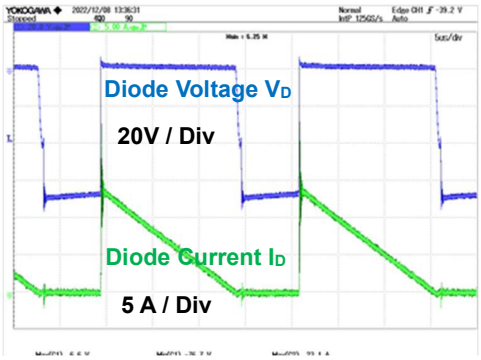


Figure 13. Diode Wave Form V_{IN} = 90Vac,I_{OUT}=4.5A

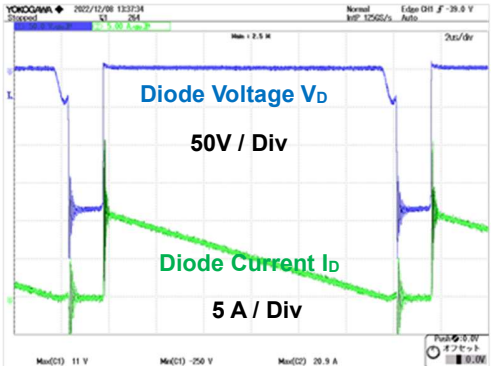


Figure 14. Diode Wave Form V_{IN} = 264Vac,I_{OUT1}=4.5A

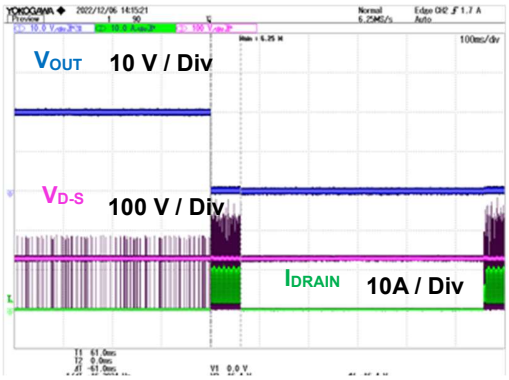


Figure 15. Drain Wave Form V_{IN}=90 Vac V_{OUT} Shorted

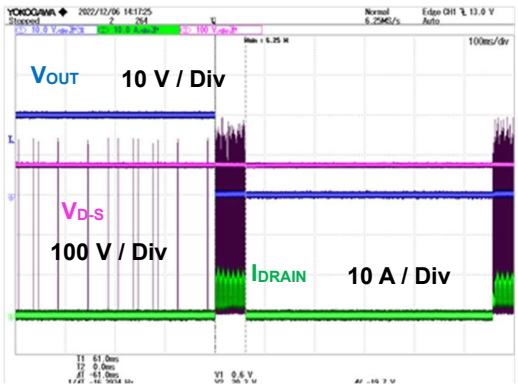


Figure 16. Drain Wave Form V_{IN}=264 Vac V_{OUT} Shorted

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Measurement Data - continued

5 Startup Wave Form

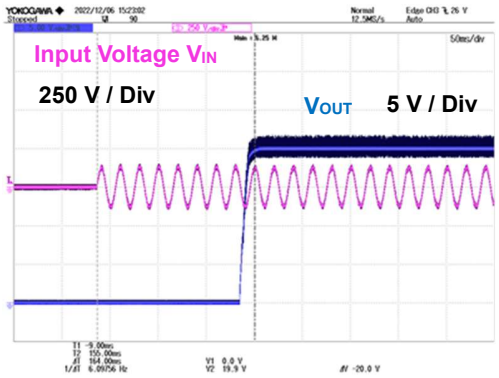


Figure 17. V_{IN} = 90 Vac, I_{OUT} = 4.5 A

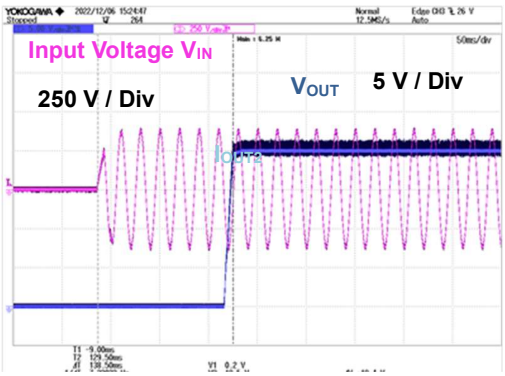


Figure 18. V_{IN} = 264 Vac, I_{OUT} =4.5 A

6 Dynamic Load Fluctuation

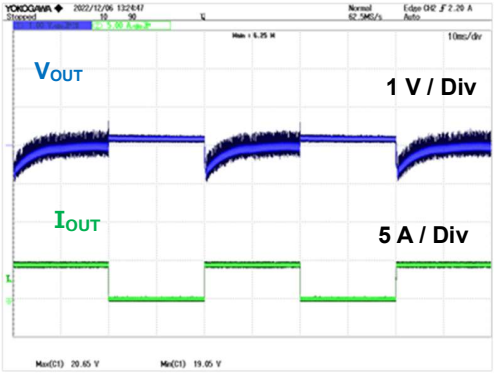


Figure 19. V_{IN} = 90 Vac, I_{OUT} = switch 0 A / 4.5 A

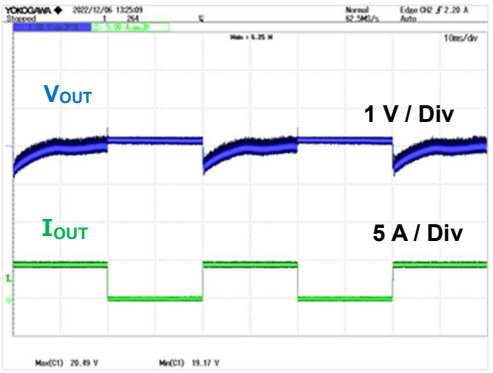


Figure 20. V_{IN} = 264 Vac, I_{OUT} = switch 0A / 4.5 A

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Measurement Data - continued

7 Output Voltage Ripple Wave Form

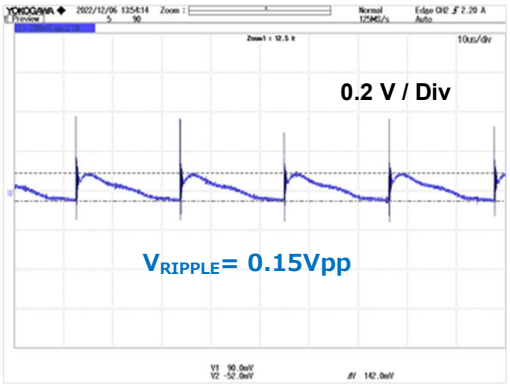


Figure 21. V_{IN} = 90 Vac, I_{OUT}=4.5 A

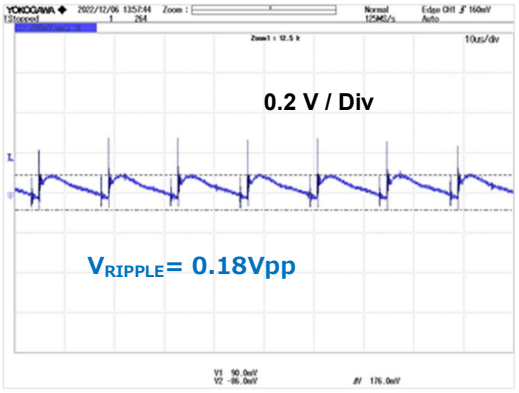


Figure 22. V_{IN} = 264 Vac, I_{OUT} = 4.5 A

8 Temperature of Parts Surface

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

Table 2. Surface Temperature of Parts (Ta = 24.5 °C)

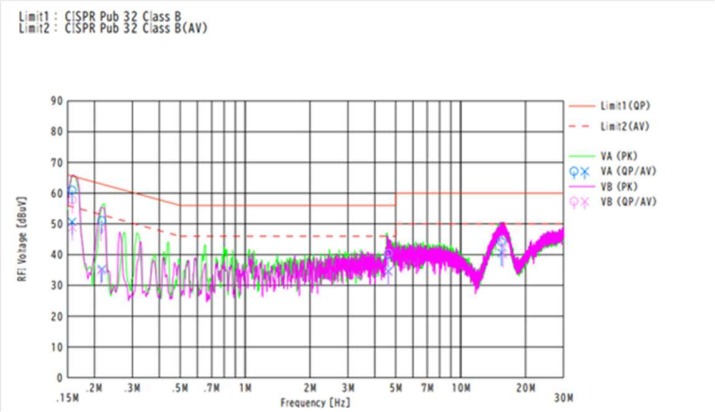
VIN [Vac]	IOUT [A]	IC1 [℃]	Q1 [℃]	DA1 [℃]
90	4.5	55.6	62.3	77.6
264	4.5	54.4	64.1	49.9

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Measurement Data – continued

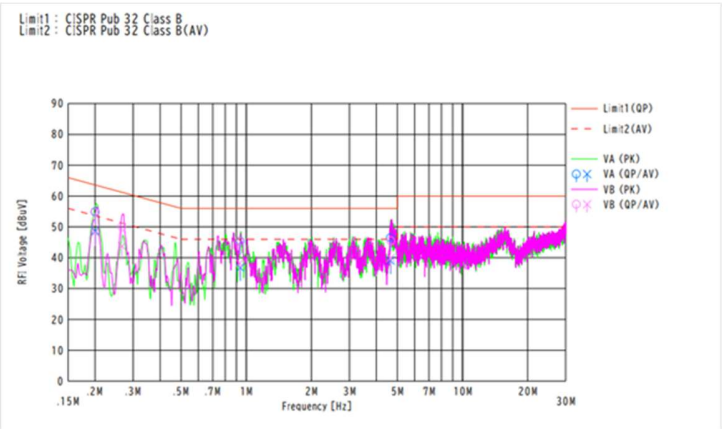
9 EMI

9.1 Noise Pin Voltage



QP margin: 4.6 dB
AVE margin: 4.9 dB

Figure 23. V_{IN}: 115 Vac / 60 Hz, I_{OUT}: 4.5 A



QP margin: 4.9 dB
AVE margin: 6.0 dB

Figure 27. V_{IN}: 230 Vac / 50 Hz, I_{OUT}: 4.5 A

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Schematics

V_{IN} = 90 Vac～264 Vac、V_{OUT} = 20 V 4.5 A

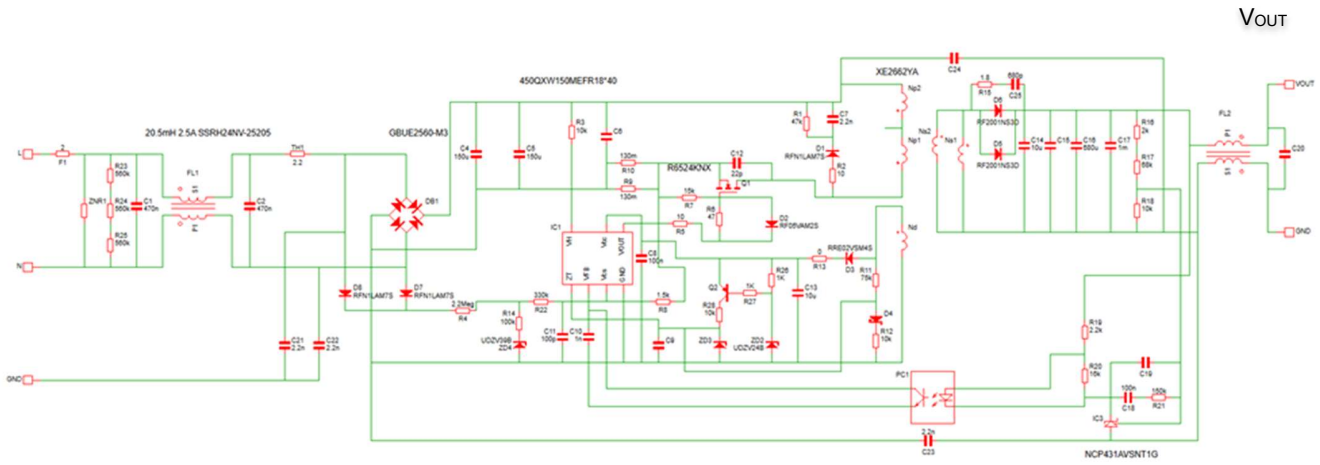


Figure 25. BM1Q104FJ-EVK-001 Schematics

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Parts List

Table 3. BoM of BM1Q104FJ-EVK-004

Items	Specifications	Parts name	Manufacture
C1,C2	0.47uF/310V	890334025039CS	WURTH ELECTRONIK
C4,C5	150uF/450V	450QXW150M	Rubycon
C7	2.2nF/500V	GRM31BR73A222KW01	MURATA
C8,C18	0.1uF/100V	HMK107B7104KA-T	TAIYO YUDEN
C10	1000pF	HMK107B7102KA-T	TAIYO YUDEN
C11	100pF	HMK107SD101KA-T	TAIYO YUDEN
C12	22pF/1kV	885342008008	WURTH
C13	33uF/50V	860020672012	WURTH ELECTRONIK
C14	10uF/35V	GRM31CC8YA106KA12L	MURATA
C16	680uF/35V	860080578019	WURTH ELECTRONIK
C17	1000uF/35V	860080578021	WURTH ELECTRONIK
C21,C22,C23	2200 pF, Y1:300 Vac	DE1E3RA222MA4BP01F	MURATA
C25	680pF / 630V	GRM31A7U2J681JW31-00B	MURATA
CN1		B03P-NV	JST
D1,D7,D8	FRD 700 V / 0.8 A	RFN1LAM7STR	ROHM
D2	FRD 200 V / 0.5 A	RF05VAM2STR	ROHM
D3	400 V / 0.2 A	RRE02VSM4STR	ROHM
D4	SBD 40 V / 0.1 A	RB500VM-40TE17	ROHM
D5,D6	FRD 300 V / 20 A	RF2001T3DNZC9	ROHM
DB1	600 V	GBUE2560-M3/P	VISHAY
F 1	2A 300 V	36912000000	LITTELFUSE
FL1	20.5mH 2.5A	SSRH24NV-25205	TOKIN
FL2	14μH	744841414	WURTH
IC1		BM1Q104FJ	ROHM
IC3		NCP431AVSNT1G	On-semi
PC1		LTV-817	LITE-ON
Q1		R6524KNX3C16	ROHM
Q2		2SAR523UBTL	ROHM
R1	47 k / 2 W	ERG2SJ473E	Panasonic
R2,R5	10Ω	ESR18EZPJ100	ROHM
R3	10 kΩ	KTR18EZPJ103	ROHM
R4	2.2Meg	KTR18EZPJ225	ROHM
R6	47Ω	ESR10EZPJ470	ROHM
R7	15k	MCR03EZPJ153	ROHM
R8	1.5k	ESR18EZPJ152	ROHM
R9,R10	0.13	LTR18EZPLR130	ROHM
R11	75k	MCR03EZPJ753	ROHM
R12,R28	10k	MCR03EZPJ103	ROHM
R13	0	MCR18EZPJ000	ROHM
R14	100k	MCR18EZPJ104	ROHM
R15	1.8	MCR25JZHFL1R80	ROHM
R16	2k	MCR03EZPF2001	ROHM
R17	68k	MCR03EZPF6802	ROHM
R18	10k	MCR03EZPF1002	ROHM
R19	2.2k	MCR03EZPJ222	ROHM
R20	16k	MCR03EZPJ163	ROHM
R21	150k	MCR03EZPJ154	ROHM
R22	330k	MCR18EZPJ334	ROHM
R23,R24,R25	560k	MCR18EZPJ564	ROHM
R26,R27	1k	MCR03EZPJ102	ROHM
T1		XE2662Y A	ALPHA TRANS
TH1	2 Ω, 4 A	2D2-13LD	SEMITEC
ZD2	24V	UDZVTE-1724B	ROHM
ZD4	39V	UDZVTE-1739B	ROHM
C6,C9,C15,C19,C20,C24,ZD3,ZNR1	-		
HEAT1	11.5℃/W	30PBE30	MARUSAN DENKI
HEAT2	14 ℃/W	E2A-T220-38E	OHMITE
HEAT 3	8.3 ℃/W	20PBE55-25B	MARUSAN DENKI
TP1,TP2		CD-10-15	MAC8
Screw1,Screw2		P-4 3MC 3×8	YAWATANEJI
PCB		PCB0253D	SIGNUS

Materials may be changed without notifying.

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Layout

Size: 191 mm x 73 mm

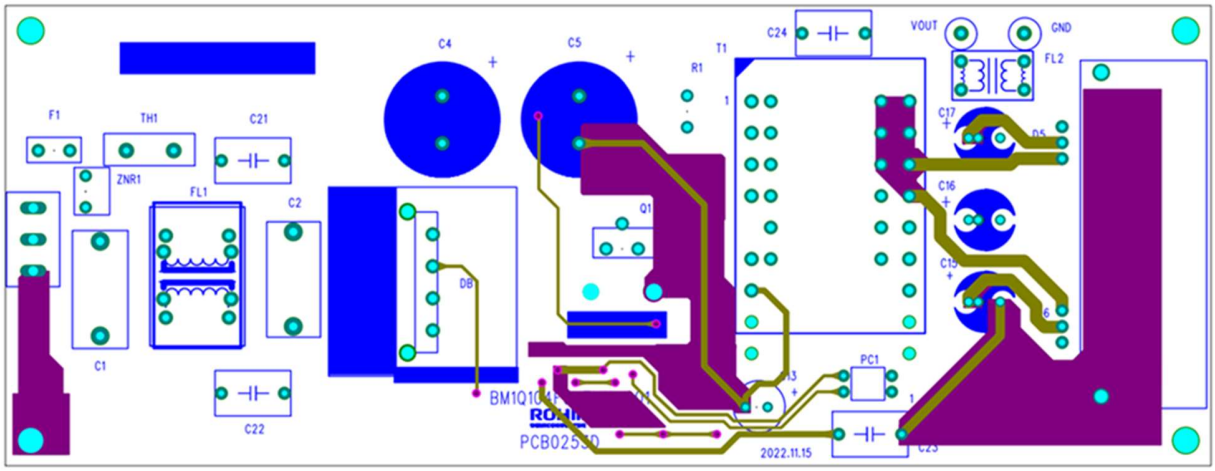


Figure 26. TOP Silkscreen (Top view)

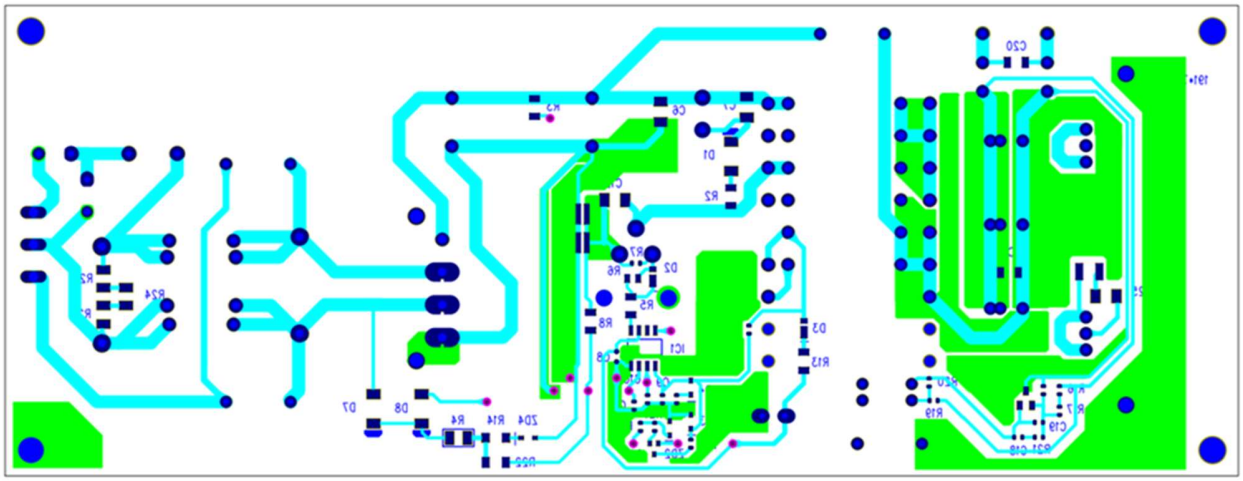


Figure 27. Bottom Layout (Top View)

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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: XE2662Y_A
Bobbin: 18PIN
Core: ER39

- Primary Inductance: 0.11mH± 15 %
  (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)

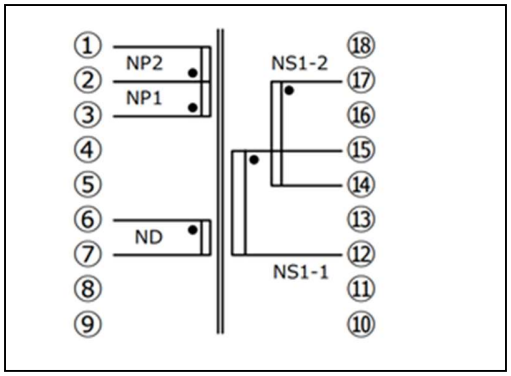


Figure 28. Circuit Diagram

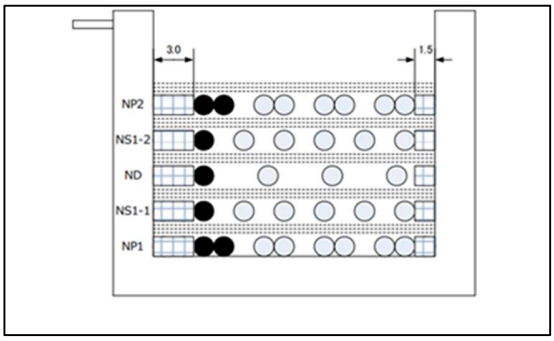


Figure 29. Structure Diagram

Table 4. Product Specification of XE2662Y_A

No.	Transformer	Winding Pin		Wire	Turn Number	Tape Layer	Wire Specification
		Start	Finish				
1	NP1	3	2	2UEW / Φ0.45 x 2	10	1	COMPACT
2	NS1	15	12	2UEW / Φ0.1 x 60	9	1	COMPACT
3	ND	6	7	2UEW / Φ0.20 x 1	8	1	COMPACT
4	NS1	17	14	2UEW / Φ0.1 x 60	9	1	COMPACT
5	NP2	2	1	2UEW / Φ0.45 x 2	10	2	COMPACT

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Revision History

Date	Rev.	Changes
14.February.2023	001	New Release

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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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