100 W Auxiliary Power Supply Eval Board

BD7682FJ-LB-EVK-302

User's Guide

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This document describes an evaluation board consisting for a 100 W auxiliary power supply solution around the BD7682FJ AC/DC quasi-resonant flyback control IC and the SCT2H12NZ, a 1700V SiC MOSFET from ROHM Semiconductor.

The BD7682FJ is an AC/DC quasi-resonant flyback controller IC from ROHM Semiconductor and offers an Auxiliary Power Supply Solution if combined with the 1700 V SiC MOSFET (SCT2H12NZ). The BD7682FJ and SCT2H12NZ combined together have been used to develop an isolated 100 W 24 V output auxiliary power solution with a very accurate voltage regulation. The design shown in this evaluation board achieves a peak efficiency of 92% and targets applications such as industrial power converters that demand a high power requirement from the auxiliary power supplies.

This user guide contains a schematic of the evaluation board and a Bill of Materials (BOM) and also describes the functioning of the evaluation board itself. Additionally, the user guide contains important notices and warnings that need to be carefully reviewed prior to use of the board. This user guide is further augmented by a more detailed application note which can also be obtained from ROHM.

Important Notice

This evaluation board is intended for **product evaluation in a research and development context only** and is not intended for resale to end consumers and it is not authorised for end customer or household use. This board may not comply with CE or similar standards (including, but not limited to the EMC directive 2004/EC/108) and may not fulfil other requirements of the country it will be operated in by the user. The user shall ensure that the evaluation board will be handled in a way that is compliant with all the standards and regulations in the country it will be operated in.

The evaluation board provided here has only been subjected to functional testing under typical load conditions. The design of this evaluation board is tested by ROHM only as described in the user guide for this board. The design is not qualified in terms of safety requirements, manufacturing and operation over the entire operating temperature range or lifetime.

This evaluation board may only be used by authorised personnel that is properly trained in recognizing and dealing with the dangers of testing high voltage equipment and generally experimenting with high voltage circuits. Ensure you review this user guide as it contains important safety warnings. At all times, follow the applicable safety rules for dealing with high voltages. Do not connect or disconnect any wires or probes to the evaluation board, while it is connected to a power supply. Take care that capacitors on the board have discharged fully before touching any part of the board. Always place the evaluation board under appropriate covers, such as in a Perspex box, to protect against accidental touching of high voltage parts BEFORE applying a voltage supply to the board.

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SEP.2020

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BD7682FJ & SCT2H12N evaluation board 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.

Contents

1. Safety Precautions

Caution: This evaluation board may only be used by authorised personnel that is properly trained in recognizing and dealing with the dangers of testing high voltage equipment and generally experimenting with high voltage circuits. This board should only be used in a lab facility properly equipped for the safe testing of power electronic systems at the relevant voltage levels. Failure to comply may result in damage to equipment, personal injury or death.

Warning: The DC link and input voltage of this board may reach up to 900 V. Ensure that only suitable high voltage differential probes are used to measure at this voltage. Failure to do so may result in damage to equipment, personal injury or death.

Warning: This evaluation board contains DC bus capacitors which take time to discharge after removal of the power supplies. Before working on the evaluation board wait at least six minutes after deactivating all connected power supplies to ensure that the capacitors have discharged to a safe level.

Warning: In case the evaluation board is connected to the grid through a non-isolated system, such as an external rectifier, a direct connection to the grid exists during testing. Therefore, in such situations only high voltage differential probes may be used to measure on the board. Failure to do so may result in damage to equipment, personal injury or death.

Warning: Before disconnecting, connecting or reconnecting wires or measurement probes to the board or before touching the board or performing any manipulations on the board ensure that all external power is removed or disconnected from the board and at least six minutes have passed to ensure the capacitors have discharged to a safe level and then ensure that the capacitor voltages have dropped to a safe level.
Failure to do so may result in damage to equipment, personal injury or death.

Caution: The heatsink and some component surfaces on the evaluation board may become hot during testing and remain hot for a certain time after turn-off. Take appropriate measures while handling the board after use. Failure to do so may cause personal injury.

Caution: Incorrect connection of power supplies or loads can damage the board. Carefully review the information in this document.

2. Introduction

The Evaluation Board has been implemented in the form of a printed circuit board (PCB), with dimensions of approximately 9 cm by 9 cm. All surface mount devices (SMD) components are assembled on the bottom side. On the top side the through hole devices and connectors are mounted as shown in Figure 1.

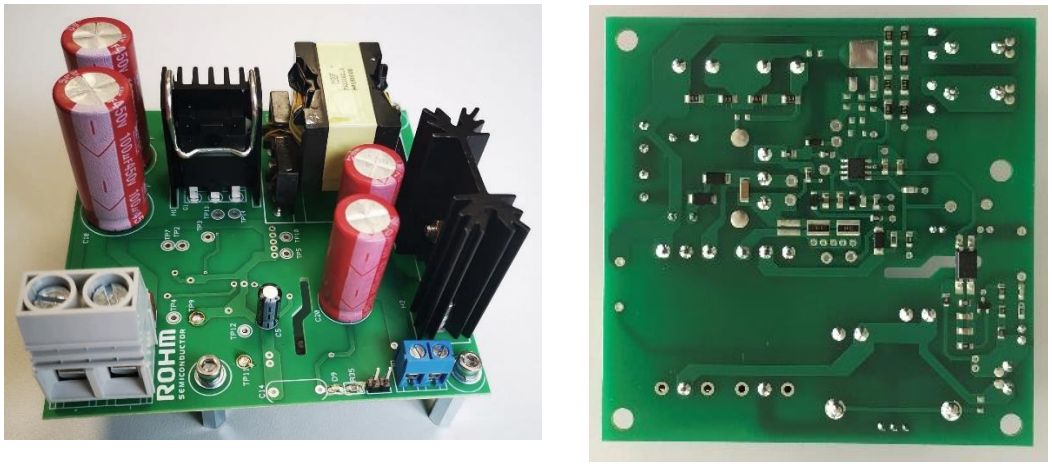

Figure 1: Top side (left) and bottom side (right) of the evaluation board

In the following sections, some details on the specification of the evaluation board as well as the connections to inputs and outputs are given. This is followed up by a selection of experimental results at different input voltages and output power.

3. Board details

The main specifications for the evaluation board are summarized in Table 1 below.

Table 1: Specification of evaluation board

Parameter	Description	Value
V_{IN}	Input voltage	300 V to 900 V (DC)
V_{OUT}	Output voltage	24 V
f_{SW}	Switching frequency	60 kHz to 120 kHz
C_{IN}	Input capacitance	50µF (2x 100µF, 450V in series)
C_{OUT}	Output capacitance	940 µF, 35V

For your reference the key design parameters of the used transformer are:

- Primary Inductance L_p = 1.1 mH
- Isolation = 5 kV
- A*L = 544 nH/turn^2
- Core TDK PC47EI50-Z
- Transformer Windings: N_p = 45, N_s = 5, N_{Aux} = 5

Note: The input and output capacitors are used to ensure local energy storage. The input capacitors maybe completely removed or made smaller in case the energy supply is from a nearby local power source (e.g., output capacitance of a rectification stage).

4. Connections and Operating Instructions

In order to operate and function properly, the BD7682FJ-LB-EVK-302 evaluation board needs to be supplied by a minimum DC voltage of 300 V. At start-up it is highly recommended to have a no load condition at the output. The connectors, jumpers and test points on the board can be seen in Table 2.

Start-up routine:

- Disconnect the load
- Connect and set the input voltage to at least 300 V DC
- Connect the load

Shut down routine:

- Turn off the input voltage
- Disconnect the load
- Wait at least 6 minutes before touching to the board.

Table 2: Important connections and test points

Label		Descriptions
Input	+	300 V to 900 V input power supply
	-	Ground of the power supply
Output 24 V	+	Isolated output to load
	-	Return path to load
Test Point	TP13	Connected to Drain of MOSFET
	TP14	Connected to Source of MOSFET
	TP2	Connected to Output of the controller IC (Gate of MOSFET)
	TP9	Connected to Primary Ground
	TP3	Connected to Power Supply Pin of the IC
	TP10	Ground Pin / Ground of the Current Sense Resistors
	TP5	Connected to Auxiliary Winding Output
Jumper	J4	Allows the connection of the LED

5. Test board connections and schematic

5.1. Input and output connections to the EVK

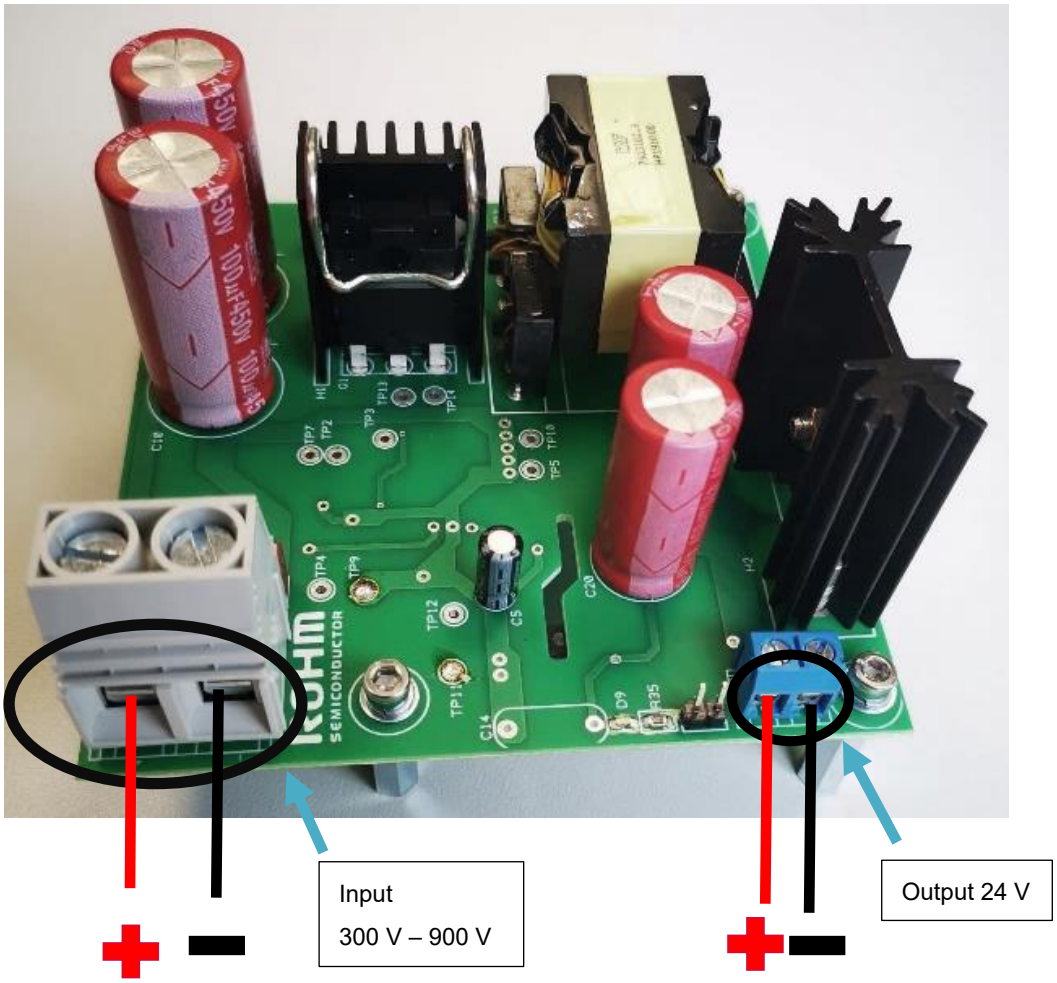

Figure 2: Top view of the evaluation board highlighting input and output connectors

5.2. Schematic of the evaluation board

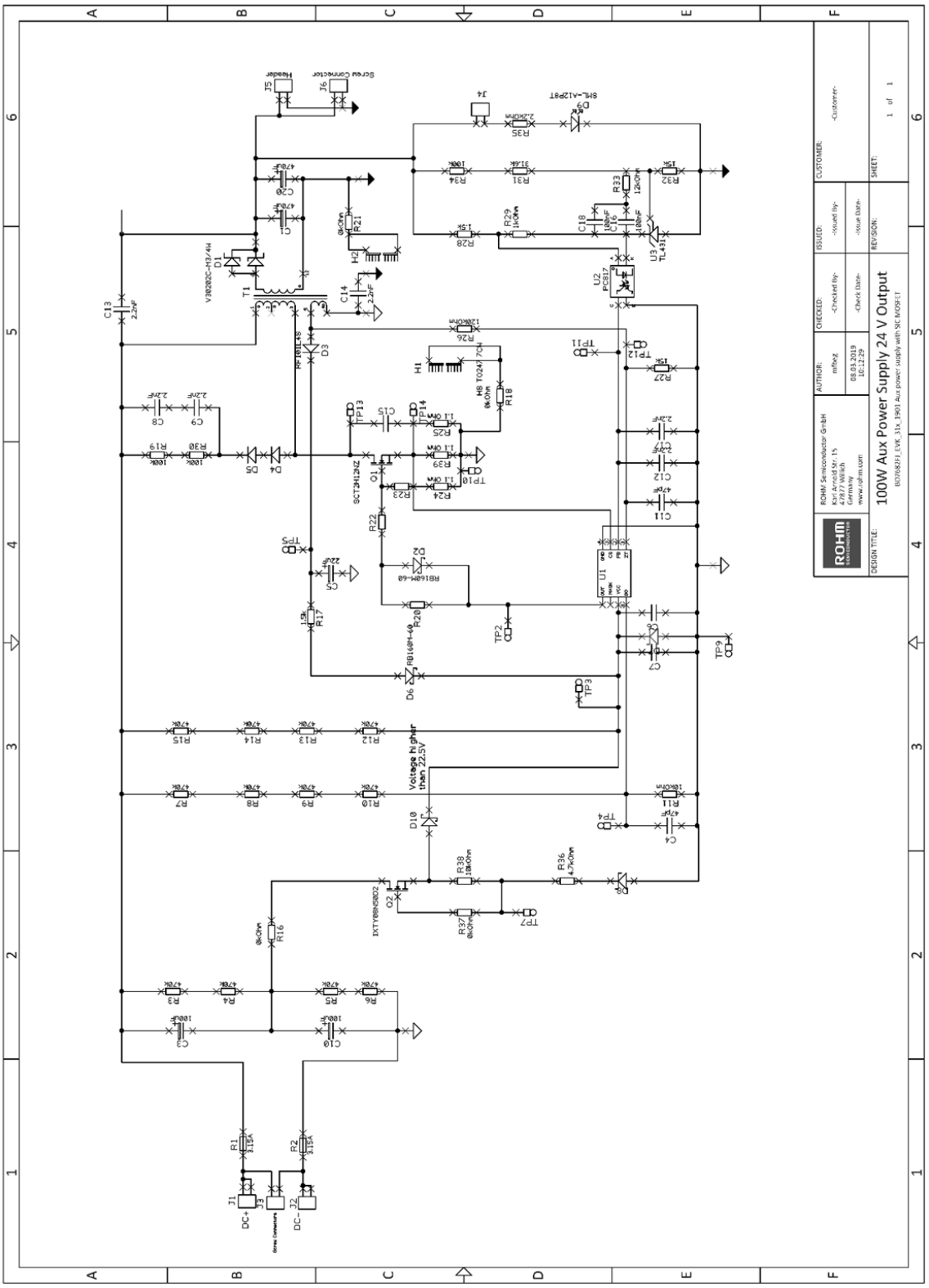

Figure 3: Schematic of the evaluation board

5.3. Bill of Materials (BOM)

Component Name	Value	Description	Producer	Producer Code
C1,C20	470uF	Electrolytic Aluminum capacitor 470uF 35V 5mm pitch 13mm diameter	WÜRTH ELEKTRONIK	860040778013
C3, C10	100uF	Electrolytic Aluminum capacitor 100uF 450V 7.5mm pitch 16mm diameter	WÜRTH ELEKTRONIK	860241480001
C4, C11	47pF	Ceramic Capacitor 0805 47pF 10% 50V COG	WÜRTH ELEKTRONIK	885012007055
C5	22uF	Electrolytic Aluminum capacitor 22uF 50V 2mm pitch 5mm diameter	WÜRTH ELEKTRONIK	860040672001
C6	2.2uF	Ceramic capacitor 0805 2.2uF 35V X7R TDK	TDK	C2012X7R1V225K085AC
C7, C16, C18	100nF	Ceramic capacitor 0805 100nF 50V X7R WURTH	WÜRTH ELEKTRONIK	885012207098
C8, C9	2.2nF	Ceramic capacitor 2.2nF 1kV 5mm pitch 8.5mm diameter	TDK	CK45-B3AD222KYNNA
C12, C17	2.2nF	Ceramic capacitor 0805 2.2nF 50V X7R WURTH	WÜRTH ELEKTRONIK	885012207088
C13, C14	2.2nF	Y1 Ceramic capacitor 2.2nF 4kV 10mm pitch 12mm diameter	VISHAY	VY1222M47Y5UQ63V0
C15	100pF	Ceramic Capacitor 1808 100pF 2000V	MURATA	GR442QR73D101KW01L
D1	V30202C-M3/4W	Schottky Barrier Diode 200V 30A	Vishay	V30202C-M3/4W
D2, D6	RB160M-60	Schottky Diode 60V 1A	ROHM	RB160M-60
D3	RF101L4S	Fast Diode 400V 1A	ROHM	RF101L4S
D4, D5	BYG21M-E3/TR	Fast Diode 1kV 1.5A DO214AC-SMA BYG21M-E3/TR Vishay	VISHAY	BYG21M-E3/TR
D7	KDZVTR24B	Zener Diode 24V 1W	ROHM	KDZVTR24B
D8	KDZVTR18B	Zener Diode 18V 1W	ROHM	KDZVTR18B
D9	SML-A12P8T	SML-A12P8T Side LED Green 20mA ROHM	ROHM	SML-A12P8T
D10	RB160M-60	Schottky Diode 60V 1A	ROHM	RB160M-60
H1	HS TO247 7CW	Heatsink for TO247 Transistor	OHMITE	WA-T247-101E
H2	513102B02500G	Heatsink for TO220 Transistor	AAVID THERMALLOY	513102B02500G
J1, J2, J5	Header	Header connector male pitch 2,54mm 2 pins 90 degree bend	WÜRTH ELEKTRONIK	61300211021
J3	Screw Connector	Connector pitch 10.16mm Horiz. Entry Modular 2 poles	WÜRTH ELEKTRONIK	691 219 610 002
J4	Header	Header connector male pitch 2,54mm	3M	961102-6404-AR
J6	Screw Connector	Connector pitch 5mm Horiz. Entry Modular 2 poles	WÜRTH ELEKTRONIK	691 219 610 002
Q1	SCT2H12NZ	1700V 3.7A SIC MOSFET	ROHM	SCT2H12NZ
Q2	IXTY08N50D2	500V 800mA normally on JFET	IXYS	IXTY08N50D2
R1, R2	3.15A	Fuse 3.15A 250V	Littelfuse	4001315

Component Name	Value	Description	Producer	Producer Code
R3, R4, R5, R6, R7, R8, R9, R10, R12, R13, R14, R15	470k	Resistor 470kOhm 1206 footprint ROHM KTR18EZPJ474	ROHM	KTR18EZPJ474
R11	10kOhm	Resistor 10kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1002
R38	10kOhm	Resistor 10kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1002
R16	0kOhm	Resistor 0 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10EZPJ000
R17, R28	1.5k	Resistor 1.5kOhm 0805 Anti Surge Automotive	ROHM	ESR10EZPJ152
R18	0kOhm	Resistor 0 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10EZPJ000
R19, R30	100k	Resistor 100 KOhm 2W VISHAY	VISHAY	PR02000201003JA100
R20	100Ohm	Resistor 100 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1000
R21	0kOhm	Resistor 0 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10EZPJ000
R22	10 Ohm	Resistor 10 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF10R0
R23	47kOhm	Resistor 47kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF4702
R24, R25	1.1 Ohm	Resistor footprint 1020 Wide ROHM LTR	ROHM	LTR50UZPF1R10
R39	1.1 Ohm	Resistor footprint 1020 Wide ROHM LTR	ROHM	LTR50UZPF1R10
R26	120kOhm	Resistor 120kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1203
R27, R32	15k	Resistor 15kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1502
R29	1kOhm	Resistor 1kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1001
R31	31.6k	Resistor 31.6kOhm 0805 footprint ROHM KTR	ROHM	KTR10EZPF3162
R33	12kOhm	Resistor 12kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1202
R34	100k	Resistor 100kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF1003
R35	3.9kOhm	Resistor 3.9kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF3901
R36	4.7kOhm	Resistor 4.7kOhm 0805 footprint ROHM MCR10	ROHM	MCR10ERTF4701
R37	0kOhm	Resistor 0 Ohm 0805 footprint ROHM MCR10	ROHM	MCR10EZPJ000
T1	750318219	Flyback Transformer 3 windings primary (2 series), secondary (2 parallel) and Auxiliary	WÜRTH ELEKTRONIK	750318219
U1	BD7682	ACDC flyback driver for SIC MOSFET	ROHM	BD7682
U2	PC817	5kV Optocoupler	SHARP	PC817XNNIP0F
U3	TL431	Voltage reference 2.49V	TI	TL431AIDBZR

6. Measurements and Efficiency Results

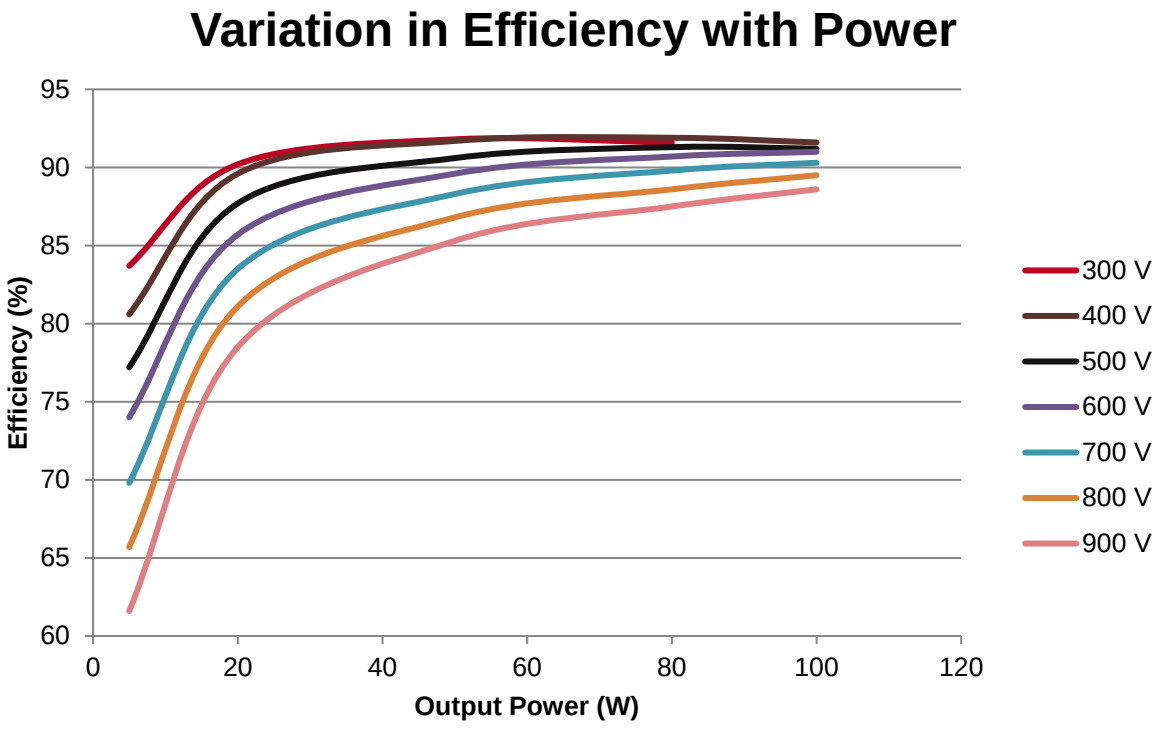

Figure 4: Efficiency for variation in output power and input voltage

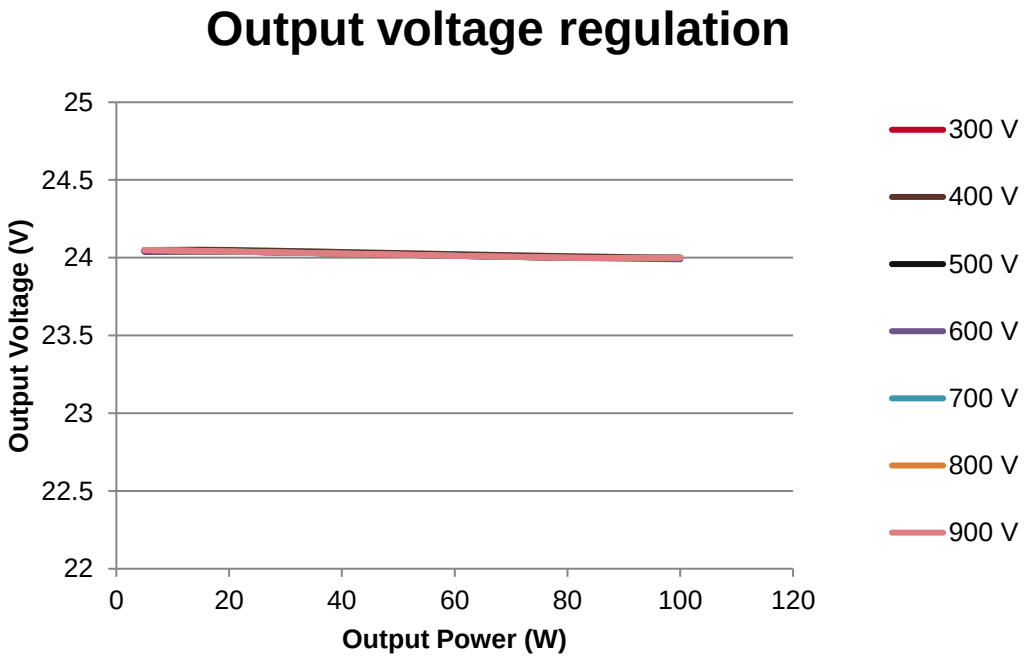

Figure 5: Output voltage regulation as load and input voltage changes

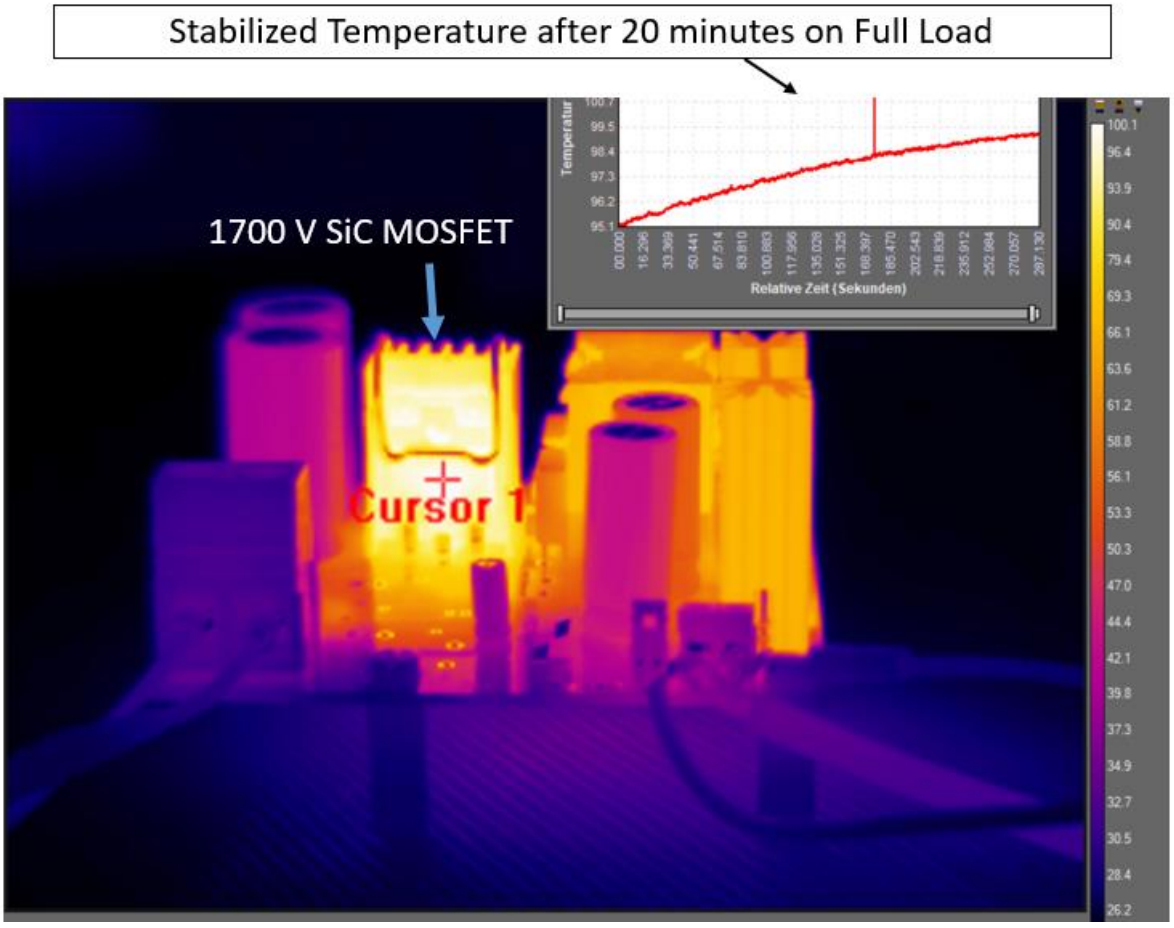

Figure 6: Temperature of the SiC MOSFET at 900V input voltage and full load (T_{amb}: ca. 25°C)

Revision History

Revision	Date	Description of change
Rev.001	Tbd	Initial version

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 Products 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.

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