

3.6 kW Totem Pole PFC with SiC MOSFETs Evaluation Board

TPPFCSIC-EVK-301-qs

The TPPFCSIC-EVK-301 implements a single-phase AC/DC conversion stage in Totem Pole PFC topology. Key components are ROHM's Gen. 4 SiC MOSFETs (SCT4045DR) as the main high-frequency switching elements, as well as the BM61S41 single-channel isolated gate driver IC. In addition, SJ MOSFETs (R6076ENZ4) and the BM2P101EK-LB PWM controller IC for the auxiliary power supply, among other components from ROHM, were utilized to create a high-performance AC/DC circuit for single-phase operation.

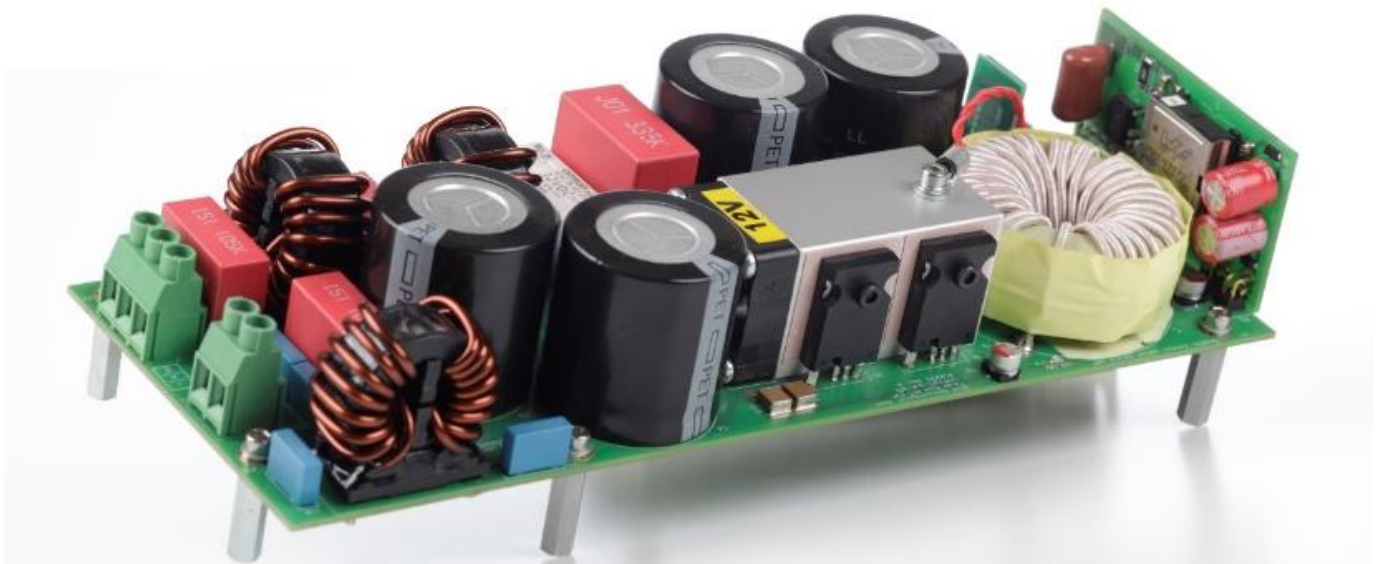


Figure 1: ROHM TPPFCSIC-EVK-301

This quick start guide will help you understand the connection, operating instructions and important notices and warnings that must be carefully reviewed prior to the use of the board (Figure 1). For further information please refer to the user guide (No. 66UG009E).

Important Notice

This evaluation board including any embedded software is intended for **product evaluation in a research and development environment only**. It is neither intended for resale to end consumers nor authorized to be used by end customer or for 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 in which it will be operated. The user is responsible for ensuring that the evaluation board is handled in a manner that is compliant with all standards and regulations in the country of operation.

The microcontroller contained within this EVK is pre-programmed with embedded control software. The user is not authorized to modify the embedded software or make attempts to use it for any other purpose than the operation of this evaluation board. This evaluation board and embedded software have only undergone functional testing under typical load conditions. The design of the board has been tested by ROHM only as described in the user guide. It has not been qualified in terms of safety requirements, manufacturing, and operation over the entire temperature range, or lifetime.

This evaluation board is intended for use only by authorized personnel who have been properly trained to recognize and handle the dangers associated with testing high-voltage equipment and experimenting with high-voltage circuits. It is important to review the user guide, as it contains essential 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. Ensure that all capacitors on the board have fully discharged before touching any part of the board. Always place the evaluation board under appropriate covers to protect against accidental contact with high-voltage parts before energizing the board.

<High Voltage Safety Precautions>

◇ Read all safety precautions before use

Please note that this document covers only the TPPFCSIC-EVK-301 evaluation board and its functions. For additional information, please refer to the datasheets of the specific products.

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



This board operates with lethal voltage levels.

Please read and follow all safety precautions described in the red box below.

Before Use

- [1] Please inspect the parts/components for any damage or missing pieces, which may have resulted from dropping.
- [2] Check that there are no conductive foreign objects on the board.
- [3] Avoid solder splashes when soldering the module and/or evaluation board to prevent damage to nearby components or the device's functionality.
- [4] Check that there is no condensation or water droplets on the circuit board.

During Use

- [5] Be careful not to allow conductive objects to come into contact with the board. This also includes conductive tools such as tweezers and screwdrivers.
- [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.**
- [7] If used beyond its rated voltage, the board may be damaged, resulting in malfunctions such as short-circuit, explosion, or other permanent damage.
- [8] Do not manipulate the board during operation and ensure that it is adequately covered to prevent accidental electrical shock, or injuries due to shrapnel in the event of an explosion.
- [9] Use suitable PPE when testing the board. Proper ear protection is a must, as a circuit malfunction can lead to an explosion that could damage your hearing.

After Use

- [10] The evaluation board contains capacitors that can hold a hazardous voltage even after power is cut. Therefore, ensure that the circuit is fully discharged after use and confirm this by other means before handling the board.
- [11] Even though the board should never be handled with charged capacitors, please wear insulated gloves when handling it as an additional safety measure to prevent electric shock."

This evaluation board is intended for use only in research and development facilities and should be 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.

Safety Precautions



Caution: This evaluation board may only be used by authorized personnel who are trained to recognize and deal with the dangers of testing high voltage equipment and experimenting with high voltage circuits. It should be used only in a laboratory environment 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 can reach up to 450 V. Please use only appropriate high voltage differential probes to measure this voltage, especially if the board is connected directly to the grid. Failure to do so may result in equipment damage, personal injury, or death.



Warning: Before disconnecting, connecting, or reconnecting wires or measurement probes to the board, or before touching or manipulating the board in any way, ensure that all external power is removed or disconnected from the board. **Wait at least three minutes** to ensure that the capacitors have discharged to a safe level. Always check by other means that the circuit is fully discharged. Failure to do so may result in equipment damage, 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 board connection information in this document.



Caution: The ground reference (GND_REF) on this board is placed on AC live/neutral (depending on L/N connection). Do not connect the board to any voltage source (AC source) while a flashing tool is connected to the P9 connector. Additionally, do not establish a UART communication with the board through the unpopulated A4 connector. Failure to do so may result in equipment damage, personal injury, or death. Bluetooth communication with the board is consistently recommended for safer operation.



Mandatory: It is strongly recommended to use ear protection to avoid potential hearing damage from any explosions that may occur due to a catastrophic failure of the board.

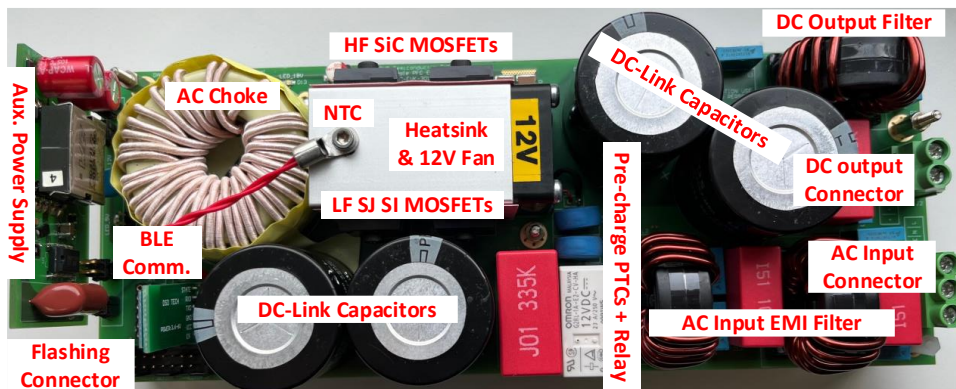


Figure 2: TPPFC5IC-EVK-301 overview with main circuit functions

1. Board details

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

Table 1: Specification of the evaluation board

Parameter	Specification
Input voltage (freq.)	85 – 265 V _{AC} (50±3 Hz or 60±3 Hz)
Output voltage	400V (± 5% voltage ripple)
Output power	3.6 kW @ 230V _{AC}
Switching frequency	100 kHz
Efficiency (at half load & 230Vac)	98.5%
Cooling	Forced air, small fan
Topology	Totem Pole
HF Switch (Q ₃ , Q ₅)	SCT4045DR (TO-247-4L)
LF Switch (Q ₄ , Q ₆)	R6076ENZ4
Flyback Switching Regulator	BM2P101FK-LB
Form factor	233 x 89 x ca.40/45 mm (*)

(*): The height of the EVK may vary depending on the availability of the used Aluminum capacitor.

2. Board overview and connections

Figure 2 provides an overview of the EVK with main circuit functions. The description of the EVK’s connectors is given in Table 2.

Table 2: Connectors list

Ref. designator	Description	
P1	Input	85-265 V AC input connector
J2	Output	400 V DC output connector
P9	COM	Programming connector
J3	Input	Temperature sensor connector
P8	COM	MCU fine-mode connector [Not populated]

3. Operating Instructions

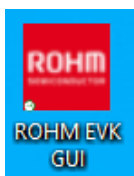
Before starting up, the user must ensure that the load at the DC output connector is equal to or greater than 1 kΩ. This EVK is designed to automatically initiate startup without requiring a load or with loads of up to 160 W. Once the DC bus reaches its nominal voltage of 400 V, the user can then apply any load up to the rated output power of 3.6 kW. This EVK does not support start-up at full load.

3.1. Start-up routine

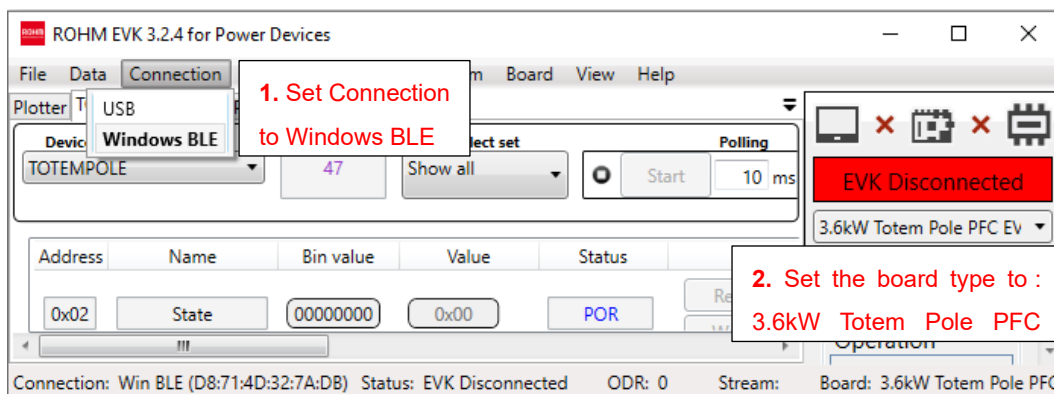
- While the AC supply is turned off, connect the AC input lines as marked on the PCB top silkscreen (PE, N, L)
- Connect the DC load as marked on the PCB top silkscreen (+, -). **At start up, the load should be ≥ 1 kΩ.**
- [Optional]: Add appropriate measurement probes:
 - Place a current probe on the AC input line.
 - Place a differential voltage probe on the AC input.
 - Place a differential voltage probe on the DC output.
- Place the EVK under an appropriate safety cover or enclosure such as a Perspex box, to protect against accidental contact with high voltage parts during operation.
- Apply AC voltage at the input connector.
- **Wait approximately 3 seconds** until the DC bus reaches 400 V, then apply any load up to 3.6 kW.

3.2. Use of the graphical user interface (GUI)

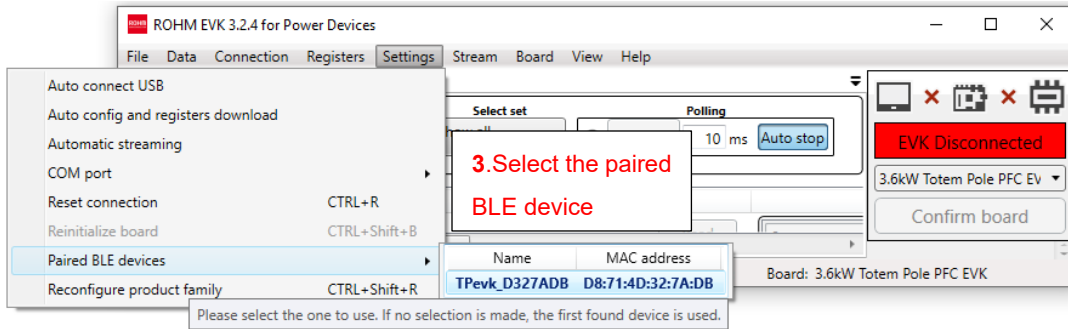
- If the software has not been installed yet, you can download the latest installer file from the ROHM Semiconductor website, and then follow the instructions to complete the installation process:
https://fscdn.rohm.com/en/products/library/software/reference_design/TPPFCSIC-EVK-301_SW.zip
- While the EVK is operating, the user can control the board by using ROHM's GUI software. To do so, first open Windows settings, then open "Bluetooth & other devices" and finally search for "TPevk_xxxxxxx" and pair it with your computer.
- Double-click the ROHM EVK GUI icon on the desktop to launch the application.



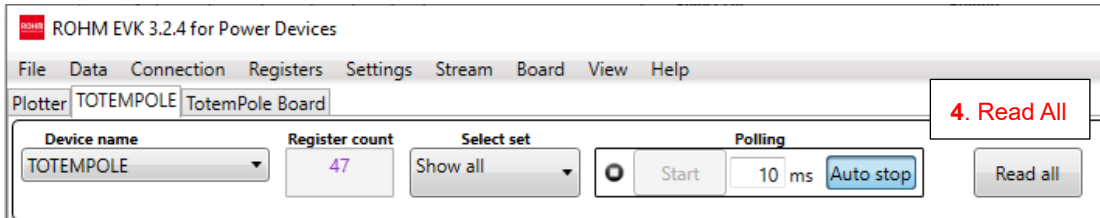
- After launching, the GUI window will pop up. At this stage, the GUI status will be "EVK Disconnected". Set the connection to "Windows BLE" and the board type to "3.6kW Totem Pole PFC EVK".



- Click on “Settings”, go to “Paired BLE devices”, and select the “TPevk_xxxxxx” you previously paired.



- Now, the “Confirm board” button will start to blink and the GUI status will change to “EVK Connected”. Click on the “Confirm board” button to connect the GUI. The status will now change to “EVK Ready”.
- If the status didn’t change to “EVK Ready”, you may need to reset the connection. To do this, go to “Settings”, and click on “Reset connection” or press “CTRL+R” on the keyboard.
- Finally, click on the “Read all” button to read all the default parameters of the EVK.



- For more details about the registers content and how to use them to control the EVK, please refer to the user guide [No. 66UG009E Rev.001]
- For more details about the usage of the ROHM EVK GUI software, please visit the ROHM Semiconductor website. https://fscdn.rohm.com/en/products/databook/applinote/ic/sensor/rohm-evk-sw_ug-e.pdf

3.3. Shutdown routine

- Turn off/disconnect the load.
- Disconnect the AC voltage supply.
- **Wait at least 3 minutes** for the DC bus to completely discharge. Before touching the board, always check by other means that the circuit is fully discharged.

Note: For a faster discharge time, we recommend connecting a 1-kΩ dummy load at the DC output connector. In this case, DC voltage will drop from 400 V to 0 V within ~10 seconds.

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.
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- 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.
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