SiC MOSFET Power Module Gate Driver

碳化硅 MOSFET 功率模块门级驱动

AZ-SiC-EVB-PMGD01

About this document

Scope and purpose

This application note provides an overview of the evaluation board AZ-SiC-EVB-PMGD01 including its main features, key specification, pin assignments and mechanical dimensions.

AZ-SiC-EVB-PMGD01 is a complete SiC power module gate drive board that can be used to drive and protect power modules with half-bridge configuration, the supported bus voltage is up to 1700V. It includes one input voltage monitoring circuit, two isolated power supply boards, two gate drive circuits and an on-board EMI filter. In combination with control boards or equipment that are capable of output pulse width modulation (PWM) signal, the gate drive board features and demonstrates AZ Power's SiC MOSFET power modules for most power electronic applications.

The evaluation board AZ-SiC-EVB-PMGD01 was developed to support customers to speed up their product development during their initial hardware design. The gate drive module is designed to support the high switching frequency operation of the SiC power module.

Intended audience

This application note is intended for power electronic engineers who want to:

1, evaluate the performance of AZ Power 's SiC power devices.

2, speed up product development during initial design with existing gate driving circuits.

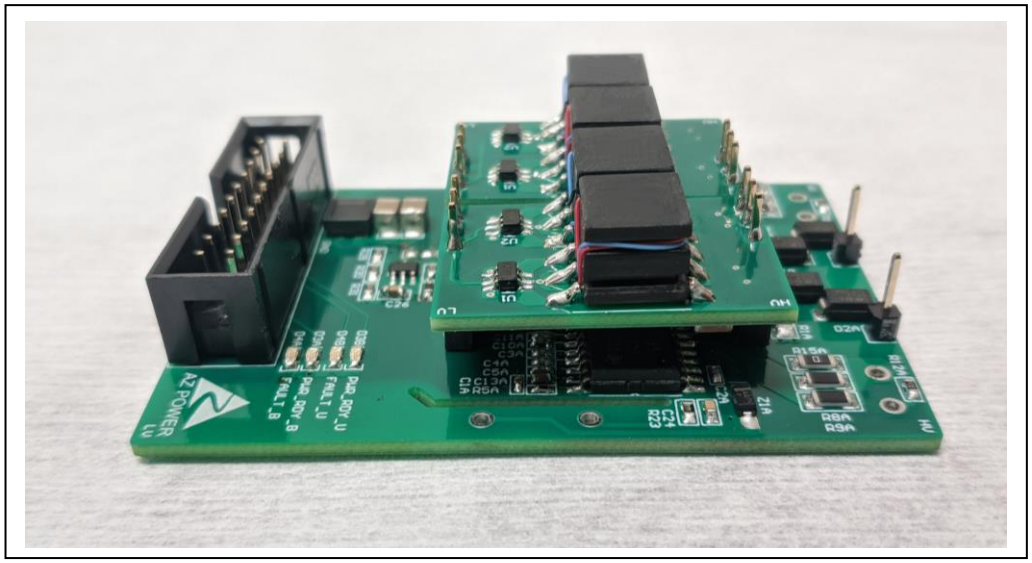


Table of Contents

1. Safety Precautions

	CAUTION: DURING THE OPERATION OF THE BOARD DO NOT TOUCH THE EVALUATION BOARD WHEN IT IS POWERED BY ANY EXTERNAL POWER SOURCE. AND NEVER LEAVE THE EVALUATION BOARD UNATTENDED. THERE MAY HAVE VERY HIGH VOLTAGE PRESENTS ON THE EVALUATION BOARD.

	CAUTION: BEFORE OPERATING THE BOARD THE EVALUATION BOARD MAY PRESENTS HIGH VOLTAGE DURING OPERATION. THE ELECTRONIC COMPONENTS WILL BE CHARGED BY EXTERNAL POWER SUPPLIES. BEFORE OPERATING THE BOARD, WAIT FOR 2 SECONDS TO ALLOW THE POWER SUPPLIES TO FULLY CHARGE ALL THE CAPACITORS AND GET THE WHOLE SYSTEM READY FOR OPERATION.

	CAUTION: AFTER POWERING DOWN THE BOARD THE EVALUATION BOARD MAY PRESENTS HIGH VOLTAGE DURING OPERATION. THE ELECTRONIC COMPONENTS WILL BE CHARGED BY EXTERNAL POWER SUPPLIES. BEFORE WORKING ON THE EVALUATION BOARD, ALLOW THE ELECTRONIC COMPONENTS TO DISCHARGING FOR 10 SECONDS.

	CAUTION: MEASUREMENT WHEN MEASUREMENT EQUIPMENT ARE ABOUT TO CONNECT TO THE EVALUATION BOARD, USE HIGH-VOLTAGE DIFFERENTIAL PROBES. IF PASSIVE PROBES ARE INTENDED TO BE USED FOR MEASUREMENT, CONSULT POWER ELECTRONICS PROFESSIONALS FIRST. DO NOT CONNECT THE PROBE WHEN THE EVALUATION BOARD IS POWERED BY POWER SOURCE.

	CAUTION: CONSEQUENCES PLEASE MAKE SURE THAT ALL MENTIONED SAFTY PROCEDURES ARE FOLLOWED WHEN USING THE EVALUATION BOARD. FAILED TO FOLLOW THE INSTRUCTIONS MAY LEAD TO: • DEATH • HEAT BURN • SERIES INJURY • ELECTROCUTION • ELECTRICAL SHOCK • ELECTRICAL BURN

2. Introduction

The AZ-SiC-EVB-PMGD01 evaluation board is designed for general SiC power module driving purposes and evaluating the performance of AZ Power's SiC power modules.

The gate drive board is intended for use with any control boards or signal generators that are capable of outputting PWM signals. This evaluation board can be easily interfaced to the appropriate motherboard via interface pin connectors.

This evaluation board is specially designed for AZ Power's SiC power modules based on ultra-fast gate drive ICs. The evaluation board includes a pin connector for connecting the 5V power supply, PWM signal input and different kinds of feedback signals, multiple through-hole pads for connecting the gate, drain and source of the MOSFET.

The AZ-SiC-EVB-PMGD01 evaluation board is available via regular AZ Power distribution partners as well as on AZ Power's website. The features of this board are described in the design feature chapter of this document. The remaining paragraphs provide information enabling customers to modify and qualify the design for production according to their own specific requirements.

Environmental conditions were considered in the design of the AZ-SiC-EVB-PMGD01. The design was tested as described in this document, but not qualified in terms of safety requirements, manufacturing and operation over the entire operating temperature range or lifetime. The boards provided by AZ Power are subject to functional testing only.

Evaluation boards are not subject to the same procedures as regular products regarding returned material analysis, process change notification and product discontinuation. Evaluation boards are intended to be used under laboratory conditions and by trained specialists only.

The system overview of the AZ-SiC-EVB-PMGD01 is depicted in Figure 1. This evaluation board includes EMI filter, isolated DC/DC power supply, input voltage monitoring circuit and isolated gate driver IC. All the important control signals can be measured and observed via test points (if there are any) on the evaluation board. The hardware circuit regarding adjusting MOSFET turn-on/turn-off speed can be implemented by changing the resistance value of the gate resistors.

The signal circuitry of the evaluation board is fully isolated from the power circuitry by using the isolated power supply and isolated gate drive IC. The design supports 5.7kV$_{RMS}$ reinforced isolation to ensure the gate drive evaluation board can meet the safety regulations of different applications.

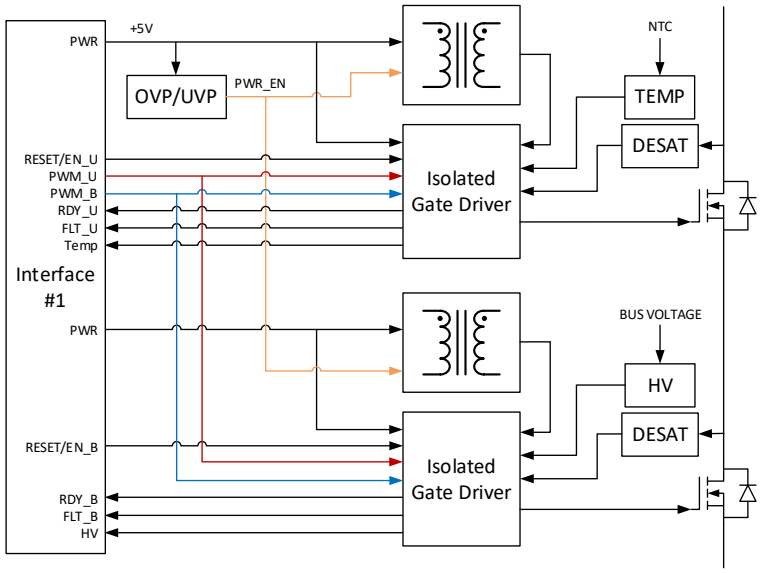


Figure 1. The system overview of the AZ-SiC-EVB-PMGD01 evaluation board

3. Design features

AZ-SiC-EVB-PMGD01 is a compact, dual-channel gate drive board for SiC MOSFET gate driving purposes, which is designed to evaluate the performance of AZ Power's SiC power module. By connecting to an appropriate motherboard that has a compatible interface, it demonstrates AZ Power's silicon carbide power device technology.

The features of the evaluation board:

- 10A peak current source/sink capability, with active miller clamp function
- Split source/sink drive path for MOSFET turn-on and turn-off
- ＋17V/-5V drive voltage with ＋5V input supply
- 2W isolated power supply with OVLO and UVLO for each switching device
- PWM interlock function
- Desat short-circuit sensing and soft turn-off upon short circuit detection
- Fault feedback with reset function
- 5.7kV$_{RMS}$ reinforced isolation between the signal circuitry and the power circuitry
- Isolated temperature and DC-link voltage sensing
- High noise-immune design, CMTI ＞150 V/ns
- On-board EMI filter
- Measurement test points compatible with standard oscilloscope probes
- RoHS compliant

3.1. Electrical Characteristics

Parameters	Min	Typ	Max
Primary Side Power Supply			
Primary supply voltage (VCC)	4.5 V	5V	6 V
VCC Rising OVLO Threshold		5.9 V	
VCC Rising UVLO Threshold		4.9 V	
VCC Falling OVLO Threshold		5.6 V	
VCC Falling UVLO Threshold		4.5 V	
Drive (VCC = 5V)			
Positive Drive Voltage	16V	17V	18V
Negative Drive Voltage	-6V	-5V	-4.5V
Peak Output Current – Source*			10A
Peak Output Current – Sink*			10A
Output Power Per Gate			2 W
Signals			
Input Logic Threshold - High			0.7 x VCC
Input Logic Threshold - Low	0.7 x VCC		
Input Logic Hysteresis		0.1 x VCC	
Propagation Delay		90 ns	
Input Glitch Filter		40 ns	
Isolated Sensing (VCC = 5V)			
DC-Link Voltage	160 V		1440 V
Feedback Signals (Temp, DC Voltage)	0.5 V		4.4 V
Switching Frequency			
Maximum Switching Frequency f_{max}		500 kHz	
System Environment			
Ambient Temperature	0 °C		105 °C
PCB Information			
Material	FR4		
Dimension	43.4 mm x 63.9 mm		

*Actual peak output current will be affected by the turn-on and turn-off gate resistor values.

3.2. Functional Groups

The next two figures illustrate the functional groups on the top and bottom sides of the evaluation board. And a third figure shows the side view of the evaluation board. The functional groups are explained in Table 1.

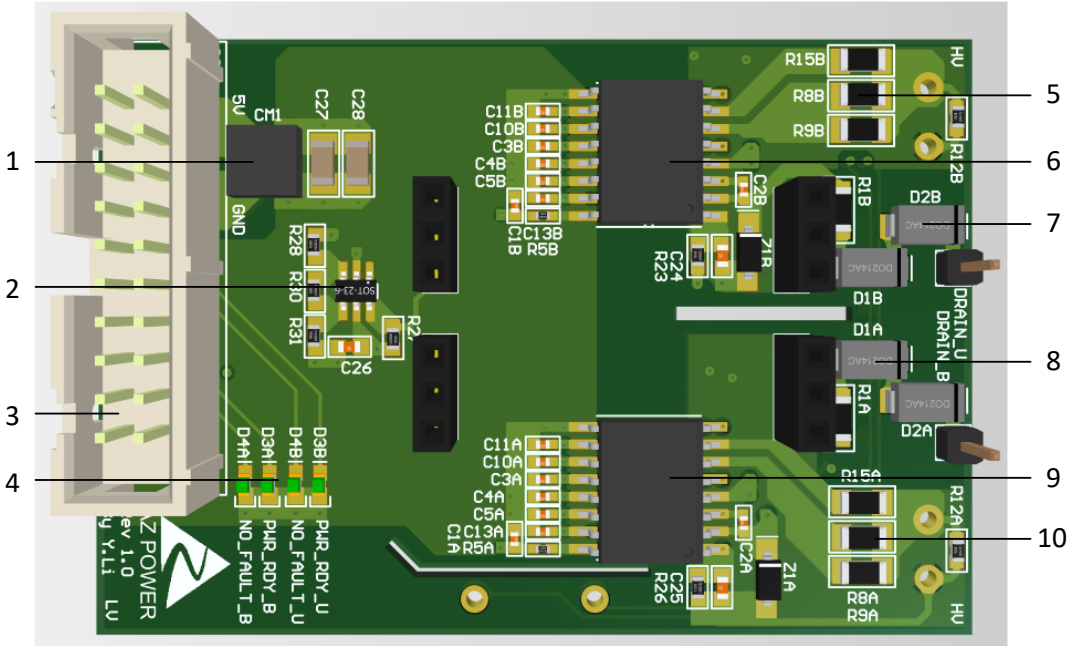


Figure 2. The top view of the AZ-SiC-EVB-PMGD01 evaluation board

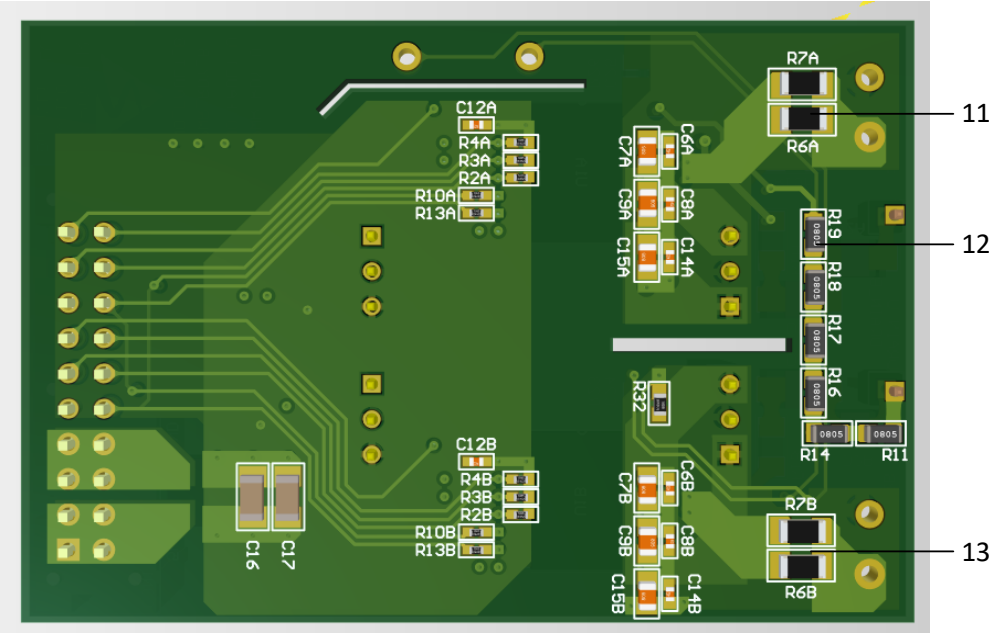


Figure 3. The bottom view of the AZ-SiC-EVB-PMGD01 evaluation board

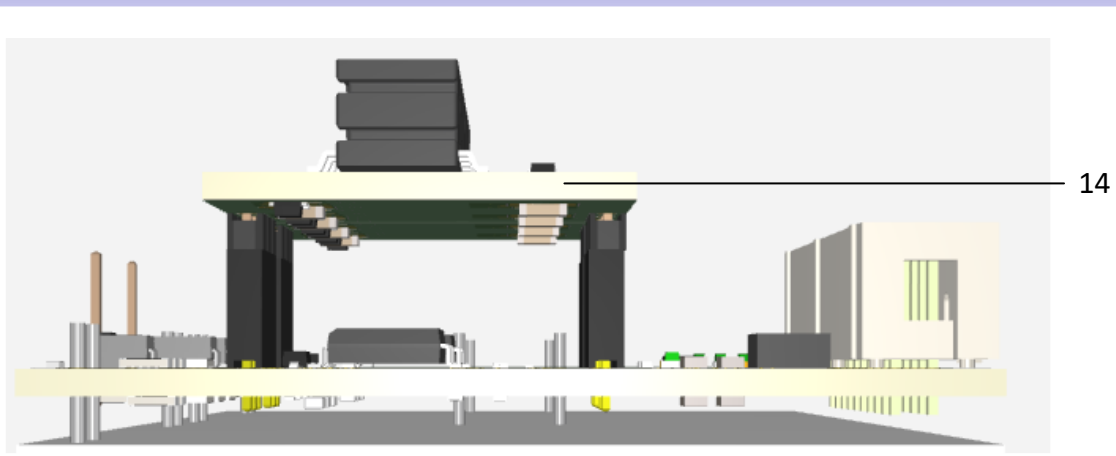


Figure 4. The side view of the AZ-SiC-EVB-PMGD01 evaluation board

Table 1. Functional Groups of The Evaluation Board

Number	Functional Groups
1	On-board common mode EMI filter
2	Input voltage monitoring circuit for VCC OVLO and UVLO
3	20 pin user interfaces
4	Fault status and power indicator
5	Upper switch gate resistors
6	Upper switch isolated gate drive IC
7	Upper switch DESAT circuit
8	Bottom switch DESAT circuit
9	Bottom switch isolated gate drive IC
10	Bottom switch gate resistors
11	Bottom switch gate resistors
12	Bus voltage conditioning circuit
13	Upper switch gate resistors
14	Isolated power supply board

3.3. Connector Interface Pin Assignment

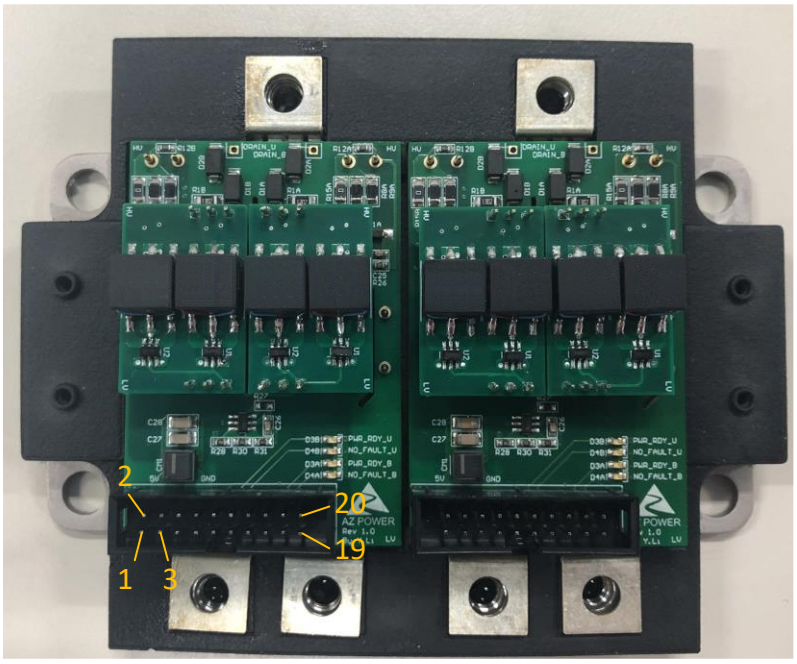


Figure 5. The interface of the AZ-SiC-EVB-PMGD01 evaluation board

Table 2. Connector Interface Pin Arrangement

Pin #	Signal	Pin #	Signal
1, 2, 3, 4	VCC – +5V Supply Voltage	14	Upper Device Reset/Enable Signal
5, 6, 7, 8	GND – Supply Voltage Ground	16	Bottom Device PWM Signal
9, 15	AGND – Signal Ground	17	Bottom Device Fault Feedback Signal
10	Upper Device PWM Signal	18	Bottom Device Power Ready Feedback
11	Upper Device Fault Feedback Signal	19	DC-link Voltage Feedback
12	Upper Device Power Ready Feedback	20	Bottom Device Reset/Enable Signal
13	Module Temperature Feedback		

3.4. Power Module Interface Pin Assignment

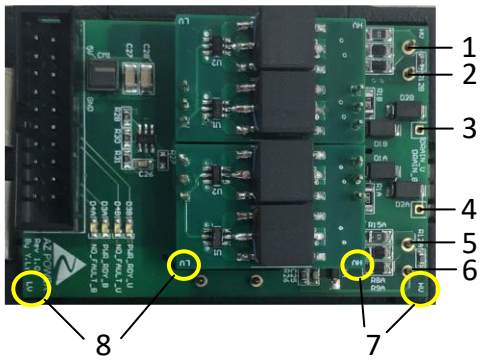


Figure 6. The mechanical dimension of the AZ-SiC-EVB-PMGD01 evaluation board

Table 3. Power Module Interface Arrangement

Pin #	Signal
1	Upper Device Gate
2	Upper Device Source
3	Upper Device Drain
4	Bottom Device Drain
5	Bottom Device Gate
6	Bottom Device Source
7	High Voltage Side Marker
8	Low Voltage Side Marker

3.5. Isolated Sensing Functions

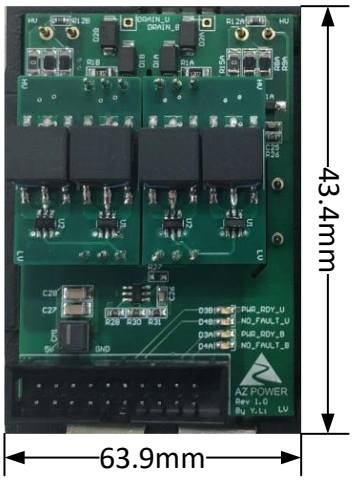
DC-link voltage sensing:

$$V_{FB\_DC} = VCC \times (1 - 6.243 \times 10^{-4} \times V_{DC\_LINK})$$

Power module temperature sensing:

$$V_{FB\_TEMP} = VCC \times (1 - 4 \times 10^{-5} \times R_{NTC})$$

3.6. Mechanical Dimensions



4. Revision History

Document version	Description of change
1.0	Initial version

This Product has not been designed or tested for use in, and is not intended for use in, applications implanted into the human body nor in applications in which failure of the product could lead to death, personal injury or property damage, including but not limited to equipment used in the operation of nuclear facilities, life-support machines, systems, or air-traffic control systems.

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, AZ Power Inc. disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

AZ Power Inc.
Providing A to Z Power Solutions

5601 W SLAUSON AVE 190
CULVER CITY, CA 90230
WWW.AZPE.COM