ACPL-4800

Wolfspeed(CREE) SiC MOSFET Gate Driver

Reference Manual

Introduction

Silicon Carbide (SiC) power semiconductors are rapidly emerging into the commercial market, delivering several benefits over conventional Silicon-based power semiconductors. SiC MOSFETs can improve overall system efficiency significantly, and the higher switching capability can reduce the overall system size and costs. The technical benefits coupled with lower costs have increased the fast adoption of SiC power semiconductors in applications like industrial motor control, induction heating, industrial power supplies, and renewable energy.

Broadcom optocouplers, which are used extensively with Silicon-based semiconductors like IPM, IGBT and Power MOSFETs, can also be used for SiC operations. Optocouplers are used to provide reinforced galvanic insulation between the control circuits from the high voltages and the power semiconductors. The ability to reject high common mode noise (CMR) will prevent erroneous driving of the SiC power semiconductors during high frequency switching.

This reference design will describe the basic operation of using IPM Interface optcoupler ACPL-4800 for the Wolfspeed (CREE) SiC MOSFET isolated Gate Driver. Detailed operations, board configurations, schematic, and BOM can be found in Wolfspeed (Cree) *SiC MOSFET Isolated Gate Driver* Application Note.

Figure 1 shows the top and bottom views of the enhanced gate driver. The enhanced creep distance is accomplished with the groove in the printed circuit card.

Gate Driver Board Features and Operations

The schematic for the gate driver is shown in Figure 2. The circuit consists of a Broadcom optocoupler (U1), two isolated DC-DC converters (X2 and X3), and a current buffer (U2).

The Broadcom ACPL-4800 has high common mode transient immunity (30kV/µs min.) and can operate from 4.5 V to 20 V. It can provide isolation certified by UL1577 for up to V_{ISO} 3750 V_{RMS}/min and IEC 60747-5-5 for working voltage, V_{IORM} up to 630 V_{PEAK}. A +10 V to +12 V pulse is applied to the input LED of the ACPL-4800 via split resistors network R3 and R6 to control the gate driver's output. The ACPL-4800 fast-speed optocoupler contains a GaAsP LED and photo detector with built-in Schmitt trigger to provide logic-compatible waveforms, eliminating the need for additional wave shaping. The totem pole output eliminates the need for a pull-up resistor and allows for direct drive of the current buffer.

Power is provided by isolated DC-DC converters; one for the positive bias and the other for negative bias. X2 and X3 are both from the Recom RP series of 1 watt unregulated isolated DC-DC converters. As shown in the schematic, the outputs of the converters are series connected and the common connection is referenced to the source terminal. Therefore, V_{CC} determines the gate pulse positive voltage and $-V_{EE}$ determines the negative gate pulse voltage. The $-V_{EE}$ node is used as the ground reference for the ACPL-4800 and the current buffer. An emitter follower consisting of Q1 and D1 has been added to limit ACPL-4800's V_{CC} below 20 V operation.

The current buffer, the Clare/IXYS IXDN609SI, can provide 35 V output swing and up to 9 A of current with a typical output resistance of 0.8 Ω. Gate resistors, R2, R4, R5, R9–R15, and diode D2 can be populated to provide optimum turn-on and turn-off performance. To minimize stray inductance, capacitors C8–C10 are located very close to the source output pin and the gate driver to provide very tight coupling between the source output terminal and the $-V_{EE}$ node.

Figure 1 SiC MOSFET Isolated Gate Driver

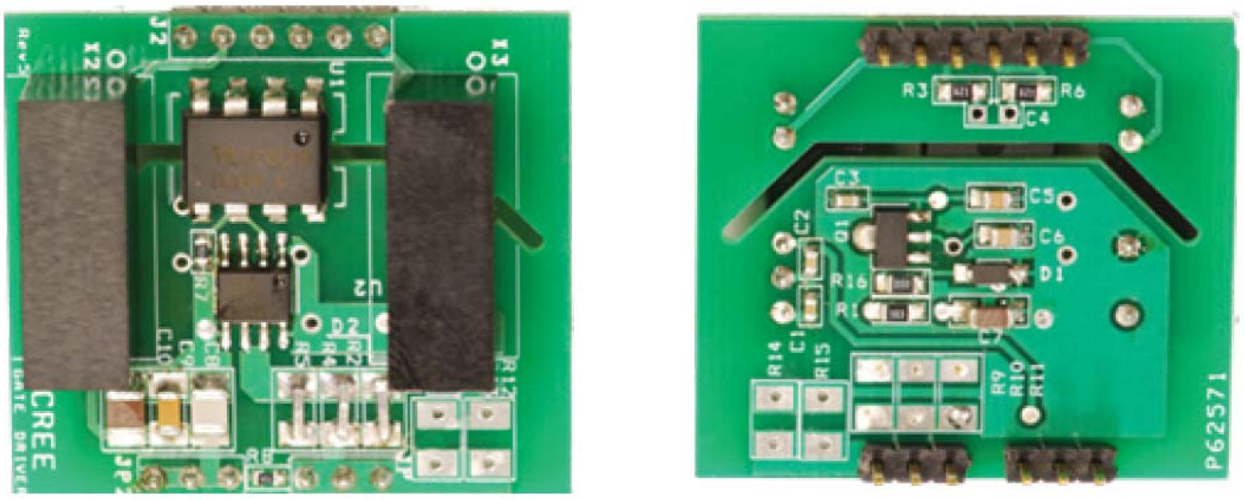
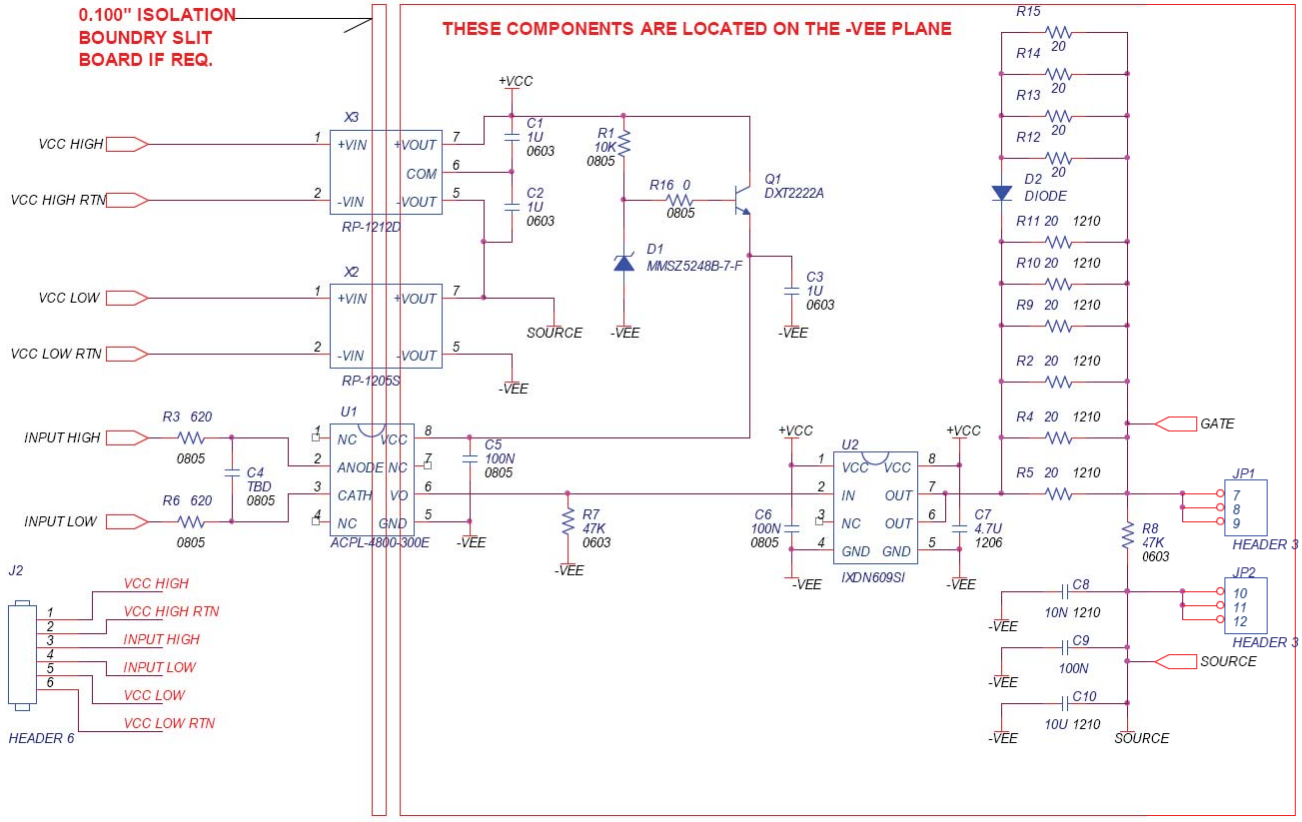


Figure 2 Schematic of the Gate Driver Board



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