

Six Channel SiC MOSFET Driver

Gate Driver for 1200V SiC MOSFET Power Module

Features

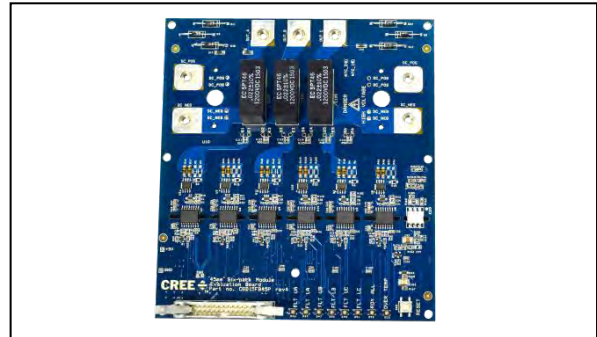
- 6 output channels
- Isolated power supply
- Direct mount low inductance design
- Short circuit protection
- Over temperature protection
- Under voltage protection

For use with Cree Module

- 45mm, six-pack CCS020M12CM2
- 45mm, six-pack CCS050M12CM2

Applications

- Driver for SiC MOSFET modules in two-level, three-phase inverter applications
- DC Bus voltage up to 1000VDC



| Part Number | Package | Marking |
|-------------|---------|-------------|
| CGD15FB45P1 | PCBA | CGD15FB45P1 |

Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit | Test Conditions | Note |
|-------------|---|-----------------|--------------|--------------------------------|------|
| V_s | Power Supply Voltage | 16 | V | V_s ramp rate >50V/sec | |
| V_{IH} | Input signal voltage HIGH | 5 | V | | |
| V_{IL} | Input signal voltage LOW | 0 | V | | |
| $I_{O.pk}$ | Output peak current | $\pm 9 (\pm 2)$ | A | R_g limited | |
| $P_{O.AVG}$ | Output power per gate | 1.2 | W | | |
| F_{Max} | Max. Switching frequency | 250 | kHz | $V_g = +20/-5, R_g = 10\Omega$ | |
| V_{DS} | Max. Drain to source voltage | 1200 | V | | |
| V_{isol} | Input to output isolation voltage | ± 1200 | V | | |
| dv/dt | Rate of change of output to input voltage | 50,000 | V/ μ s | | |
| W | Weight | 223 | g | | |
| MTBF | Mean time between failure | 1.5 | 10^6 h | | |
| T_{op} | Operating temperature | -35 to 85 | $^{\circ}$ C | | |
| T_{stg} | Storage temperature | -40 to 85 | $^{\circ}$ C | | |

Characteristics

| Symbol | Parameter | Value | | | Unit | Test Conditions | Notes |
|----------------------|--|-------|------|------|------|---|-----------|
| | | Min | Typ | Max | | | |
| V _S | Supply voltage | 14 | 15.0 | 16 | V | | |
| V _i | Input signal voltage on/off | | 5/0 | | V | | |
| I _{SO} | Supply current (no load) | | 230 | | mA | 25C | |
| | Supply current (max.) | | 460 | | | f=100kHz, 25C | |
| | Supply current (max.) | | 780 | | | f=250kHz, 25C | |
| V _{IT+} | Input threshold voltage HIGH | 3.5 | | | V | | |
| V _{IT-} | Input threshold voltage LOW | | | 1.5 | V | | |
| R _{in} | Input resistance | | 48 | | kΩ | | |
| C _{io} | Coupling capacitance | | 30 | | pf | | |
| T _{don} | Turn on propagation delay | | 300 | | nS | Time from when input pin goes high until driver output goes high | Fig. 3, 4 |
| T _{doff} | Turn off propagation delay | | 300 | | nS | Time from when input pin goes low until driver output goes low | Fig. 3, 4 |
| T _{Rout} | Output voltage rise time | | 65 | | nS | V _{OUT} time from 10% to 90% with R _G = 0ohms, C _{LOAD} = 40,000pf | Fig. 5 |
| T _{Fout} | Output voltage fall time | | 50 | | nS | V _{OUT} time from 90% to 10% with R _G = 0ohms, C _{LOAD} = 40,000pf | Fig. 5 |
| R _{GON} | Turn-on gate resistor | | 10 | | Ω | | |
| R _{GOFF} | Turn-off gate resistor | | 10 | | Ω | | |
| V _{GATEON} | Gate voltage at turn-on | | +20 | | V | | |
| V _{GATEOFF} | Gate voltage at turn-off | | -5 | | V | | |
| T _{SC} | Short Circuit Response Time | | 2.34 | | μS | Total time from when short circuit current begins flowing until it is interrupted | |
| V _{DS,TRIP} | V _{DS} monitoring threshold | | 4.7 | | V | V _{DS} value that causes the driver to trip on overcurrent | |
| T _{FLT_DLY} | Fault Delay Time | | 425 | | nS | Time from when desat pin=9V until the gate output begins turning off | |
| T _{FLT_SIG} | Transmission delay of fault state | | | 2.25 | μS | Time delay from desat pin=9V until fault status pin is pulled low | |
| T _{err} | Pulse width for resetting fault | 800 | | | nS | Time reset pin must be held low to reset driver | |
| | Test voltage (60Hz/1min), Primary to secondary | | 4000 | | V | | |
| | Test voltage (60Hz/1min), Secondary to secondary | | 4000 | | V | | |
| | Creepage distance, Primary to secondary | | 9.0 | | mm | | |
| | Creepage distance, Secondary to secondary | | 7.0 | | mm | | |
| | Clearance distance, Primary to secondary | | 6.0 | | mm | | |
| | Clearance distance, Secondary to secondary | | 7.0 | | mm | | |

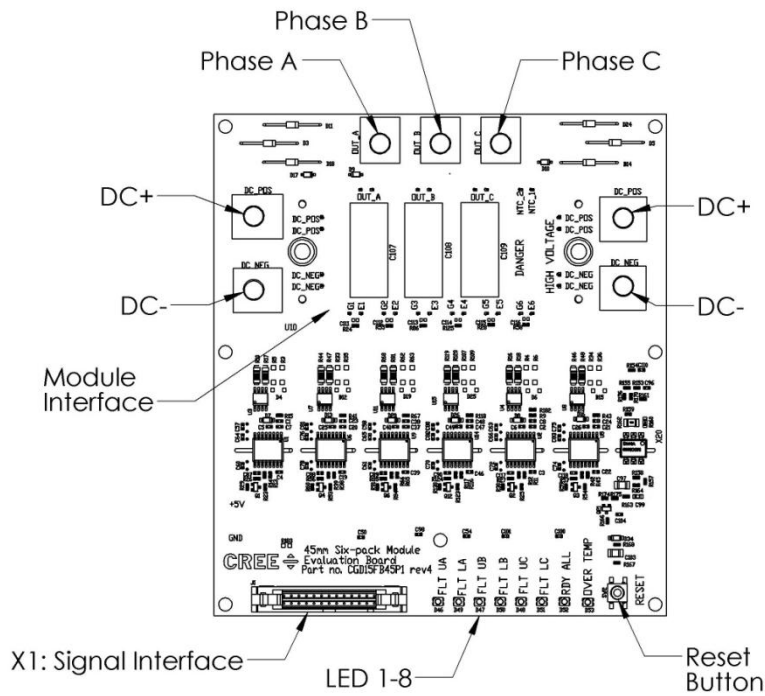


Figure 1. Driver Overview

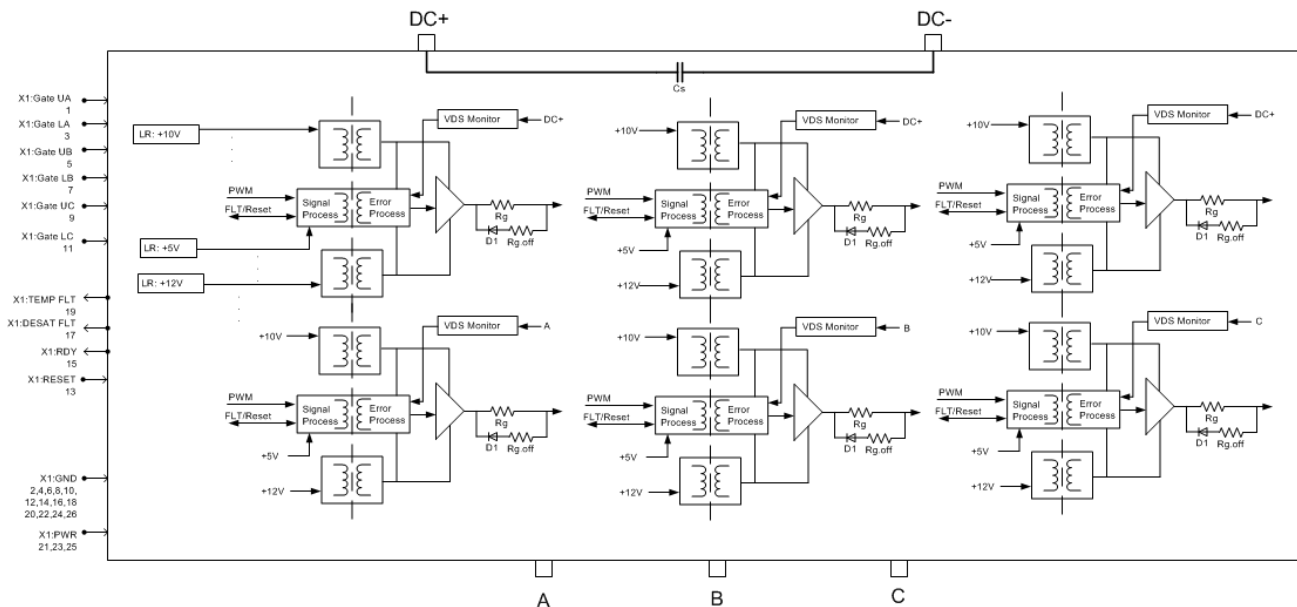


Figure 2. Block Diagram

Note: Default gate resistor for Rg is 10Ω for gate ON and OFF. The user can control the gate turn ON and OFF speed by changing Rg to a lower value and gain better MOSFET switching efficiency. The user can also control the Gate turn-ON and OFF speed independently by populating Rg.off and D1. Cs is made up of 3x 2.2nF, 1.2kV film capacitors.

X1 – Signal interface

| | | | |
|----|------------------------------|----|--------|
| 1 | PWM_Upper_A (5V Logic) | 2 | COMMON |
| 3 | PWM_Lower_A (5V Logic) | 4 | |
| 5 | PWM_Upper_B (5V Logic) | 6 | |
| 7 | PWM_Lower_B (5V Logic) | 8 | |
| 9 | PWM_Upper_C (5V Logic) | 10 | |
| 11 | PWM_Lower_C (5V Logic) | 12 | |
| 13 | /RST (normally hi) | 14 | |
| 15 | RDY (normally hi) | 16 | |
| 17 | DESAT_FAULT (normally low) | 18 | |
| 19 | OVER_TEMP_FLT (normally low) | 20 | |
| 21 | PWR_In (Vs) | 22 | |
| 23 | | 24 | |
| 25 | | 26 | |

| LED Status Indicators | | | |
|-----------------------|--|-----------|---|
| L1 | RED led, illuminated when Phase A upper switch has a desat fault. | L2 | RED led, illuminated when Phase A lower switch has a desat fault. |
| L3 | RED led, illuminated when Phase B upper switch has a desat fault. | L4 | RED led, illuminated when Phase B lower switch has a desat fault. |
| L5 | RED led, illuminated when Phase C upper switch has a desat fault. | L6 | RED led, illuminated when Phase C lower switch has a desat fault. |
| L7 | GREEN led, illuminated when power is present and all faults are clear. | L8 | RED led, illuminated when there is an over temp fault. |

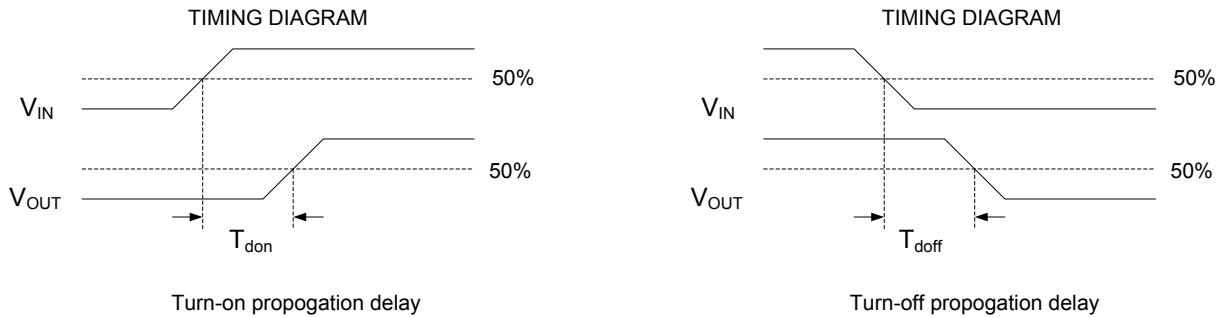


Figure 3. Propagation Delays

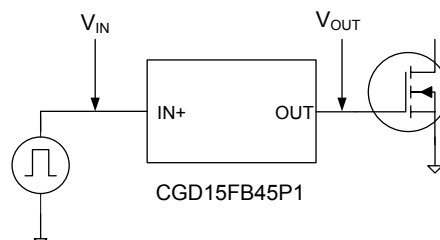


Figure 4. Propagation Delay Test Circuit

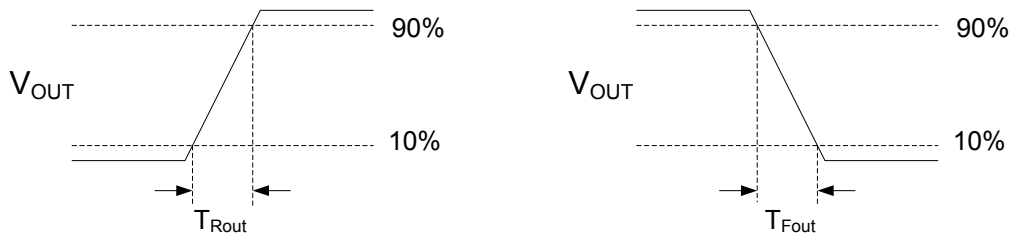


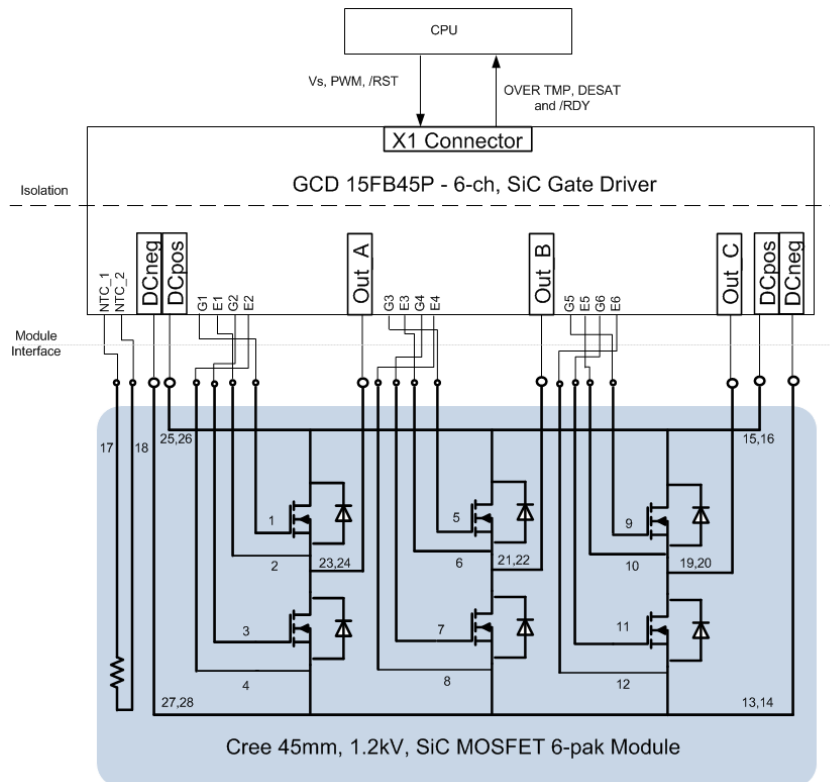
Figure 5. Output Voltage Rise and Fall Times

Fault Handling

Each of the six gate drive channels is protected by a desaturation (desat) circuit. In the event of a short circuit, the voltage across the MOSFET (V_{DS}) rises until it hits a threshold which causes the desat circuit to drive all six gate drive channels to their off state. Pin 17 of the X1 signal connector toggles high when a desat event occurs. There will also be a red LED (L1-L6) illuminated for the gate drive channel(s) that activated the desaturation protection. Once the fault is cleared, the circuit can be reset with the onboard reset button or remotely by driving pin 13 of the X1 connector to common.

There is an overtemperature protection circuit that turns off all the gates in the event an overtemperature is detected. The overtemperature circuit reads the value of the six pack module's onboard temperature sensor. When the sensor reaches a value corresponding to 115°C, the overtemperature circuit is activated and all six gate drive channels are driven to their low state. Pin 19 of the X1 connector is toggled high when an overtemperature fault occurs.

Typical Application



Mechanical Instructions

Designed to directly mount to Cree 45 mm style power modules, the 6-ch gate driver also has several other mounting holes to secure the assembly.

Attach the gate driver board to the power module via the 4x Module screw holes (see diagram below) using the recommended hardware in Table 1. Then solder the 28x solder pins via the solder pin holes to electrically connect the driver board to the power module. The soldering tip must not exceed 260°C and contact with the solder per pin must not exceed 10 seconds. The solder joints should be in accordance with IPC A 610 Rev D (or later) – Class 3 to ensure an optimal connection between the module and gate driver board.

The module plus driver board assembly must be further supported by securing the assembly to standoffs via the 7x Mounting holes shown in the figure below.

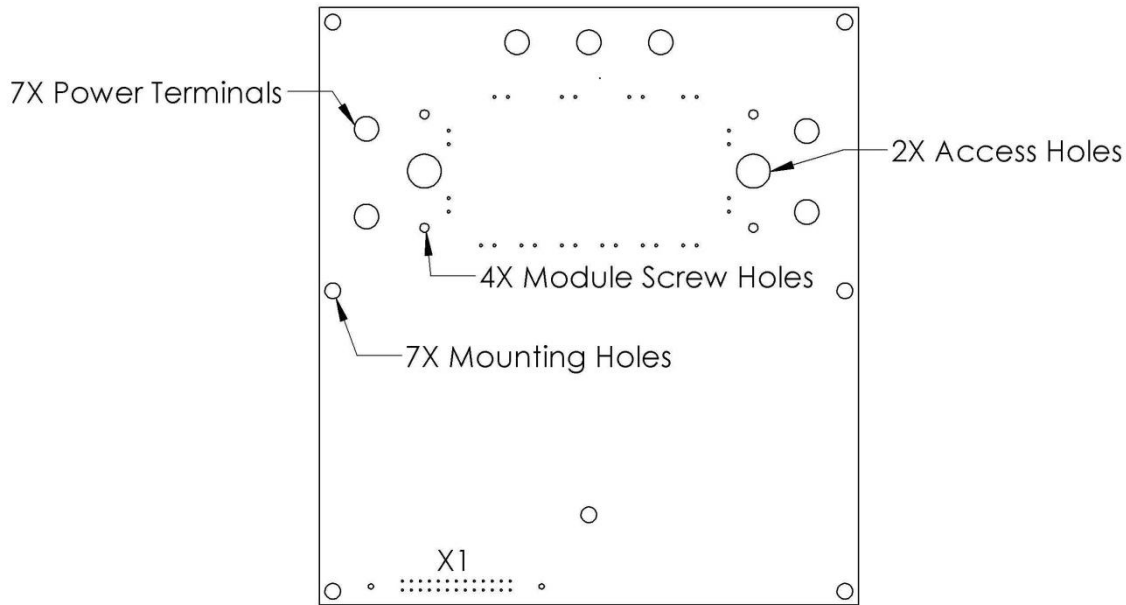
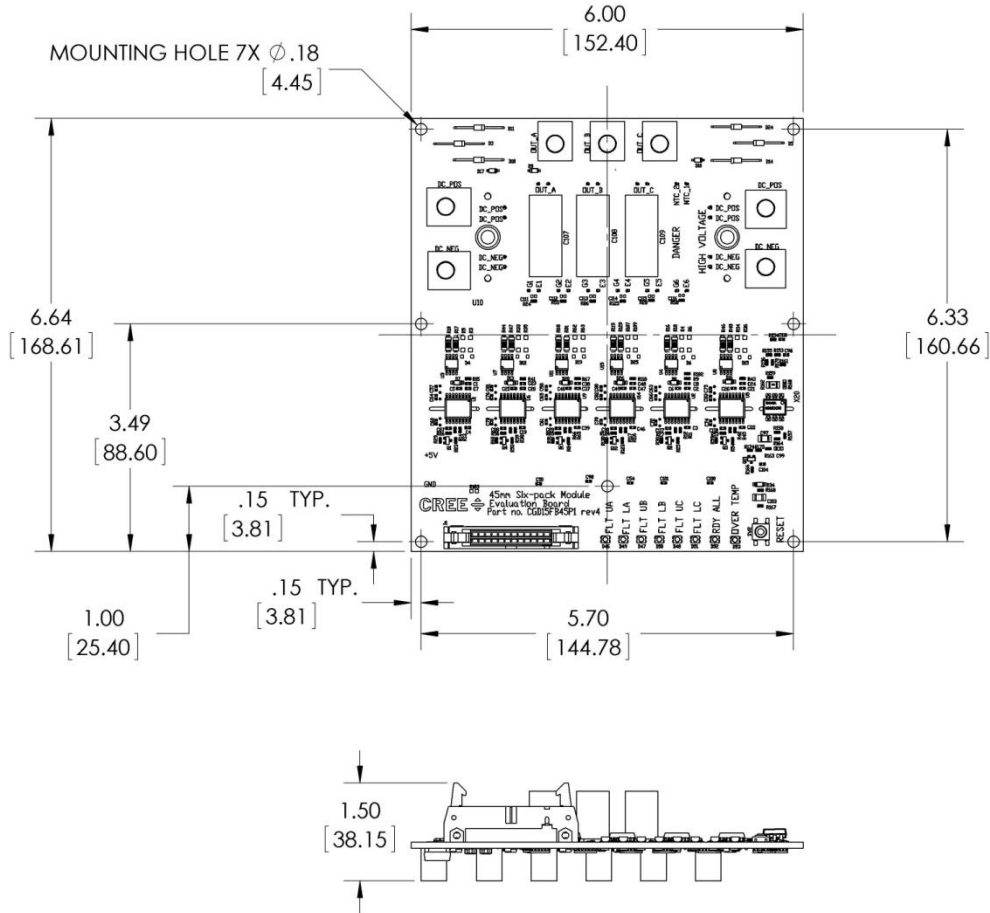


Table 1 Hardware List

| Ref | Description | Hardware | Locations | Torque |
|--------------------|---|--|-----------|--------|
| Module screw holes | 2.5mm clearance holes for mounting screws to secure the module to the printed circuit board assembly. | M2.5 x 4mm | 4x | 0.5 Nm |
| Mounting holes | 4.3mm clearance holes for screws to secure the circuit assembly to stand-offs for additional support. | 6-32 x 5/6" Zinc Plated pan head screw /w internal tooth washer. | 9x | 0.9 Nm |
| Access holes | 10mm clearance hole to provide access to the screw that secure the module to the heatsink. | n/a | 2x | n/a |
| Solder pin holes | 1.6mm plated holes for solder pins from power module. | Solder pins from power module | 28x | n/a |
| Power terminals | 6mm holes to secure power cables. | 1/4" or 6mm hardware | 7x | |

Mechanical Drawing (units in Inches) [mm]



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, cardiac defibrillators or similar emergency medical equipment, aircraft navigation or communication or control systems or air traffic control systems.

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