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

Part Number	Package	Marking
CGD15FB45P1	PCBA	CGD15FB45P1

Applications

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

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_s	Power Supply Voltage	16	V	*Vs 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	±9 (±2)	A	*Rg limited*	
P_{O_AVG}	Ouput power per gate	1.2	W		
F_{Max}	Max. Switching frequency	250	kHz	*Vg=+20/-5, Rg=10Ω*	
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/µs		
W	Weight	223	g		
MTBF	Mean time between failure	1.5	10^6h		
T_{op}	Operating temperature	-35 to 85	ºC		
T_{stg}	Storage temperature	-40 to 85	ºC		

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.) Supply current (max.)		460 780			f=100khz, 25C 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 propogation delay		300		nS	Time from when input pin goes high until driver output goes high	Fig. 3, 4
T_{doff}	Turn off propogation 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		

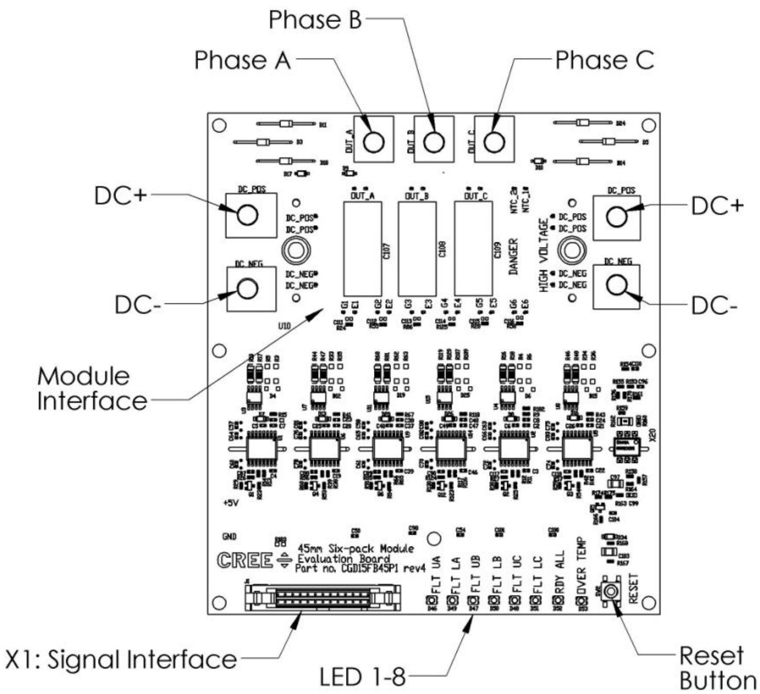


Figure 1. Driver Overview

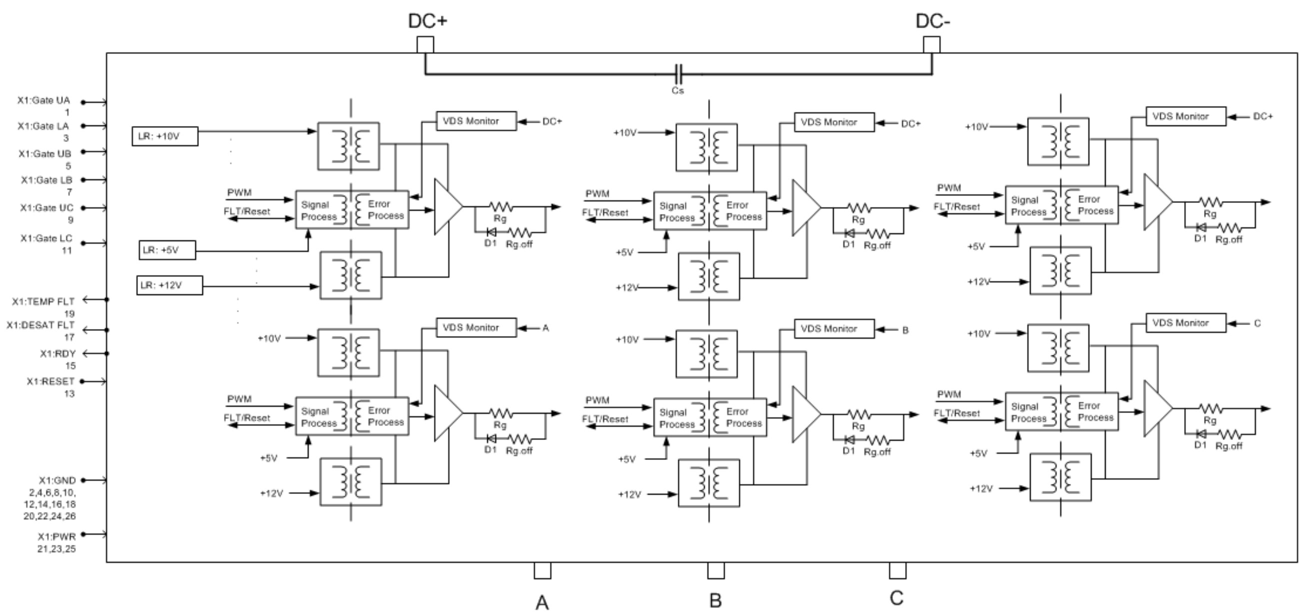


Figure 2. Block Diagram

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		22	
23	PWR In (Vs)	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.

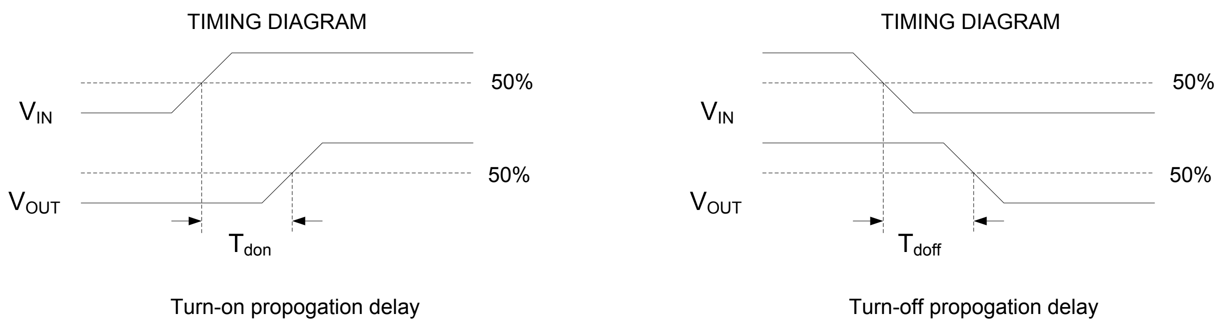


Figure 3. Propagation Delays

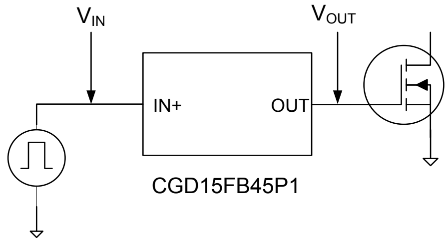


Figure 4. Propagation Delay Test Circuit

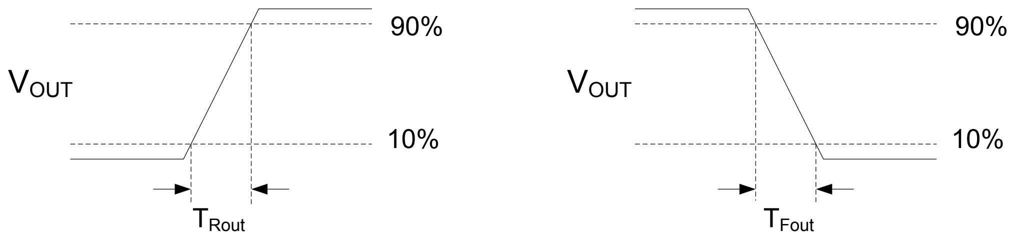


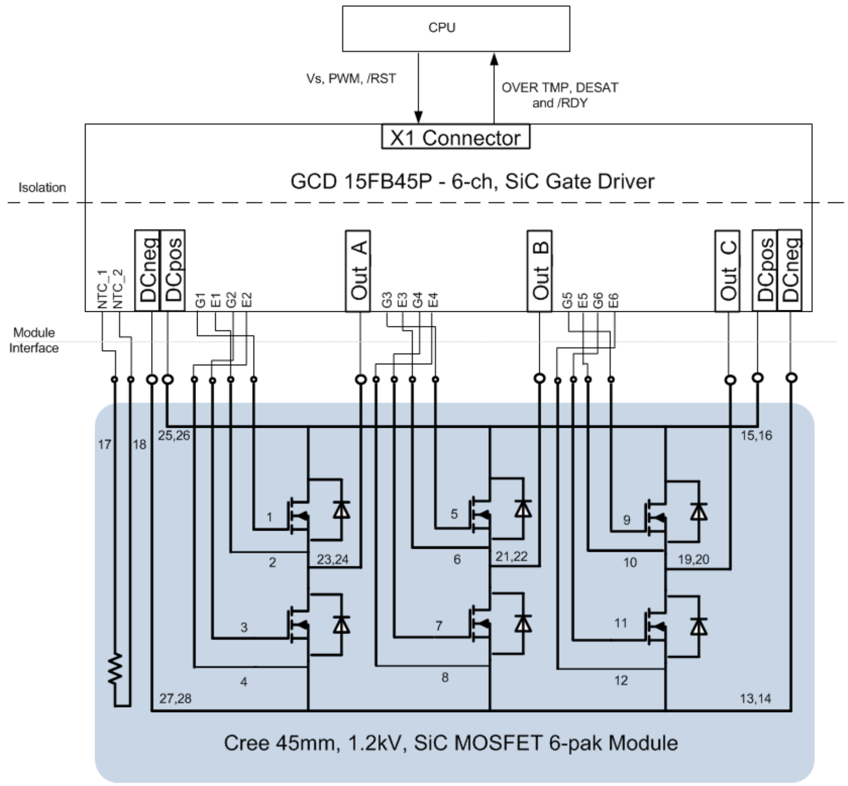
Figure 5. Output Voltage Rise and Fall Times

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 260ºC 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.

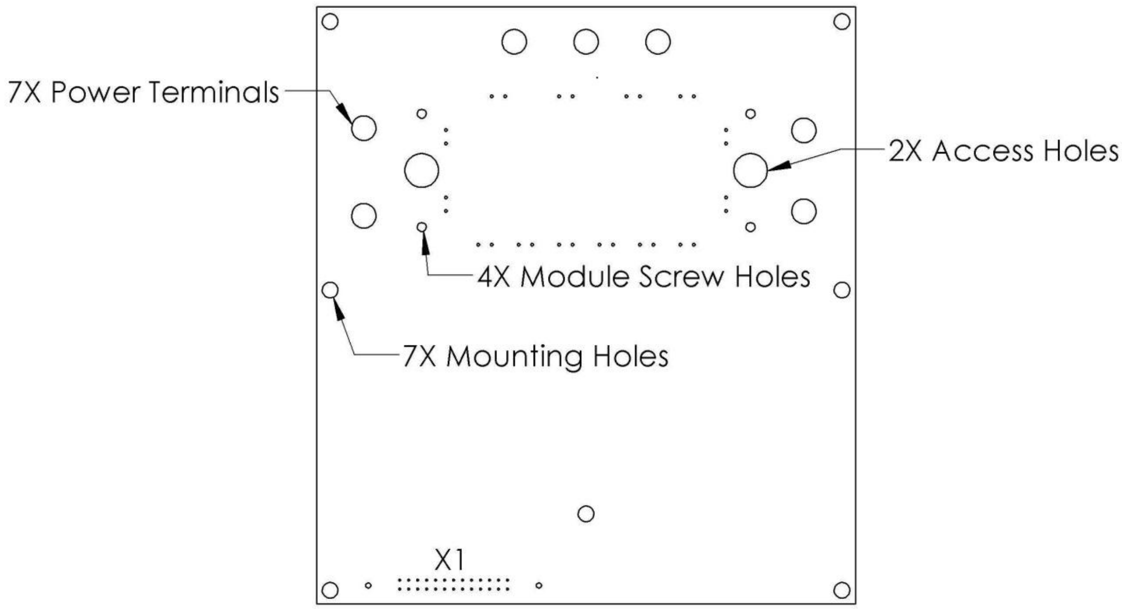
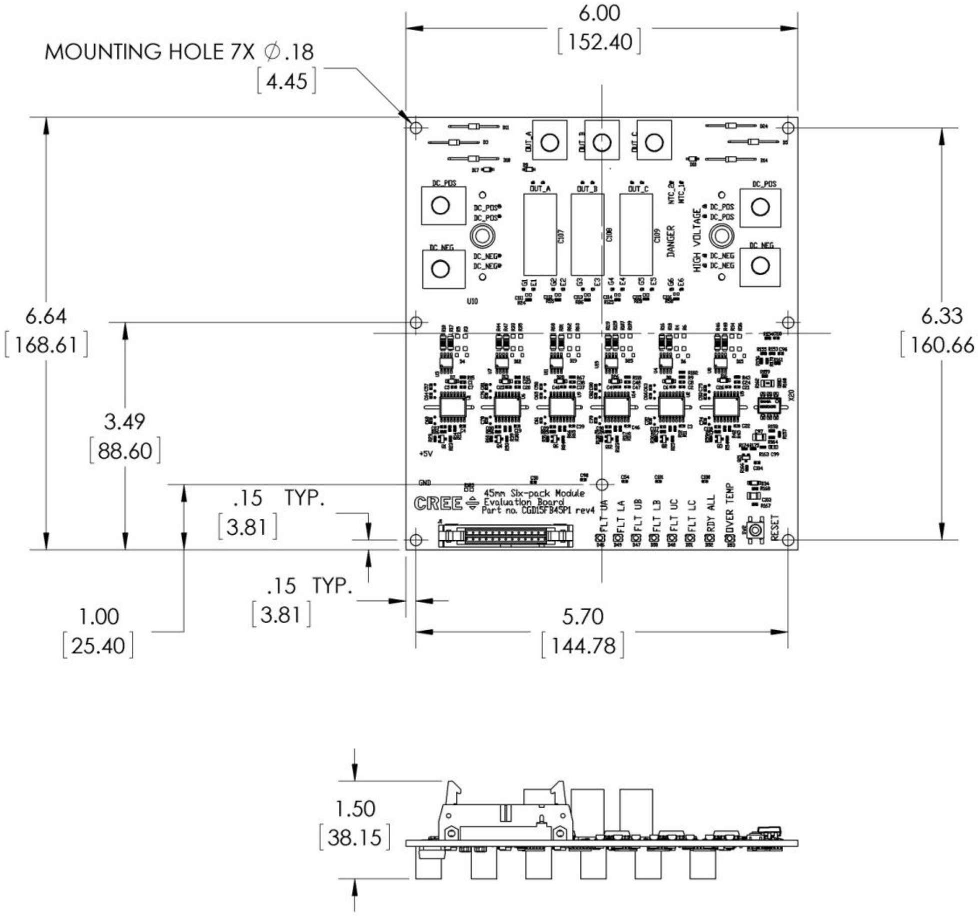


Table 1 Hardware List

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.	¼” or 6mm hardware	7x	

Mechanical Drawing (units in Inches) [mm]



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