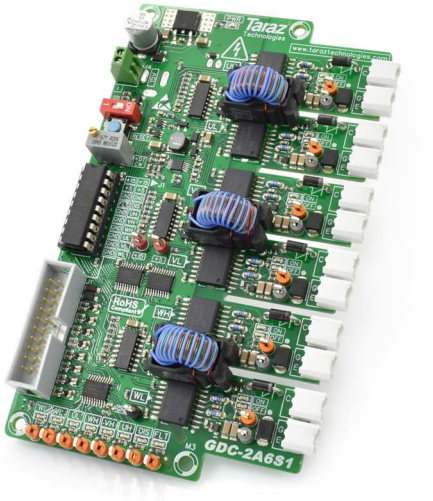
GDC-2A6S1

High CMR Isolated 6SW 2A Smart Gate Drive Module For SiC FETs



Applications

- 6 Switch Isolated SiC/IGBT/MOSFET Gate Driver
- AC & Brushless DC Motor Drives
- 3 Phase PFC Rectifiers
- R&D Inverters

Compliance

- ROHS

Features

- Best Cost to Performance Ratio in the Market.
- Suitable for 1200V SiC FET, IGBTs & MOSFETs up-to 120A.
- 2A Peak Gate Drive Current.
- 3000 V_{RMS} Input to Output Isolation.
- Short-Circuit Protection Through Desaturation Detection.
- Active Miller Protection.
- Output UVLO Protection.
- Output Clamping Protection.
- Isolated Fault Feedback.
- Soft Turnoff in Case of Fault.
- Fault Latch Shutdown.
- Configurable PWM/Dual Inputs.
- Configurable Dead-Time.
- 100KV/us Minimum Common Mode Rejection (CMR).
- Very Low Propagation Delay of 110ns (Maximum) for High Frequency Operation.
- Input & Output Indication LEDs for Visual Feedback.
- Input & Output Test points for easy testing.
- Built-in 5V Regulator for Powering up External Control Circuitry.

Description

The GDC-2A6S1 is high performance fully isolated SiC/IGBT/MOSFET gate drive module for 6 Switches. It is specially designed for fastest inverter prototyping in research and educational environments. The drive use's Texas Instrument's ISO5852 smart and high performance gate driver IC, and feature's dead time generation logic, fault latch logic, input and output indication LEDs, test points and built in 5V regulator which could be used to power up external control circuitry.

But the most notable feature of this module is that it detects short circuit condition using desaturation detection and can safely turn off the switch and give the controller an isolated fault feedback signal. Another major feature of GDC series is very high common mode immunity of 100 kV/us. Due to very high switching speeds of SiC FETs, high immunity is required for proper operation of the gate driver module.

This product can be ordered with different output voltages suitable for different available SiC FETs in the market. Available options are +20/-5, +18/0, +15/0, +15/-5 & +15/-15.

Revision History Table

Version	Release Date	Changes
1.0	19/06/2019	First Version Released
1.1	3/09/2019	Application information updated

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Table of Contents

Ratings & Characteristics

*All ratings are given at Vs=15V and 25°C ambient temperature unless otherwise specified.

Absolute Maximum Ratings	Test Conditions/ Note	Value	Unit
Supply Voltage (V_S)		18	V
Input Signal Voltage HIGH		5.5	V
Input Signal Voltage LOW		0	V
Output Peak Current ($I_{out(PEAK)}$)	Using Rg<10Ω	2	A
Output Power (P_{out})	Per Channel	1	W
Active Miller Clamp Current		1.6	A
Maximum Working Insulation Voltage	Vpeak	1200	V
Input to Output Isolation	AC RMS	3000	V
J1 5V Output Current (I_{OUT5V})	Supply for external circuit	180	mA
Operating Temperature	I_{OUT5V} = 0	-25 to +70	℃
Storage Temperature		-25 to +85	℃

Recommended Operating Conditions	Test Conditions/ Note	Minimum	Typical	Max	Unit
Supply Voltage (Vs)		13	15	17	V
Supply Current			100	300	mA
Operating temperature	I_{OUT5V} = 0	-10	-	70	℃
Input Signal Voltage On/Off	3.3V control signals possible		5/0		V

Ratings & Characteristics (Continued)

*All ratings are given at Vs=15V and 25°C ambient temperature unless otherwise specified.

Characteristics	Test Conditions/ Note	Minimum	Typical	Max	Unit
Logic High Input Threshold		2.0	-	-	V
Logic Low Input Threshold		-	-	0.8	V
Output Voltage (+20/-5 option)	V_S = 15V, 20mA $I_{out(AVG)}$	-5		20	V
Output Voltage (+18/0 option)	V_S = 15V, 20mA $I_{out(AVG)}$	0		18	V
Output Voltage (+15/0 option)	V_S = 15V, 20mA $I_{out(AVG)}$	0		15	V
Output Voltage (+15/-5 option)	V_S = 15V, 20mA $I_{out(AVG)}$	-5		15	V
Output Voltage (+15/-15 option)	V_S = 15V, 20mA $I_{out(AVG)}$	-15		15	V
Output UVLO Threshold	UVLO + UVLO -	12 9.5		13 11	V
Output Clamp Threshold	Of Bi-directional TVS @ 1mA	22.2	-	24.5	V
Fault Output Voltage	Active LOW	-	-	0.8	V
Input Impedance	All inputs have 22 kΩ pull-down resistors	-	22	-	kΩ
Internal Gate to Emitter Resistance		-	6.2	-	kΩ
Duty Cycle Range		0	-	100	%
Configurable Dead-time	Using DT-ADJ	0.58	-	9.28	us
Propagation Delay	R_g=10Ω, C_g=10nF, f=10kHz, Duty Cycle = 50%		76	110	ns
Output Rise and Fall Time	R_g=10Ω, C_g=10nF, f=10kHz, Duty Cycle = 50%	12	20	37	ns
DESAT Threshold		8.3	9	9.5	V
Common Mode Rejection (CMR)	At V_{CM}=1500V	100	120		kV/us
Weight		-	59	-	g
Dimensions (Bare)	Width x Length x Depth		74 x 127 x 22.14		mm

Block Diagram

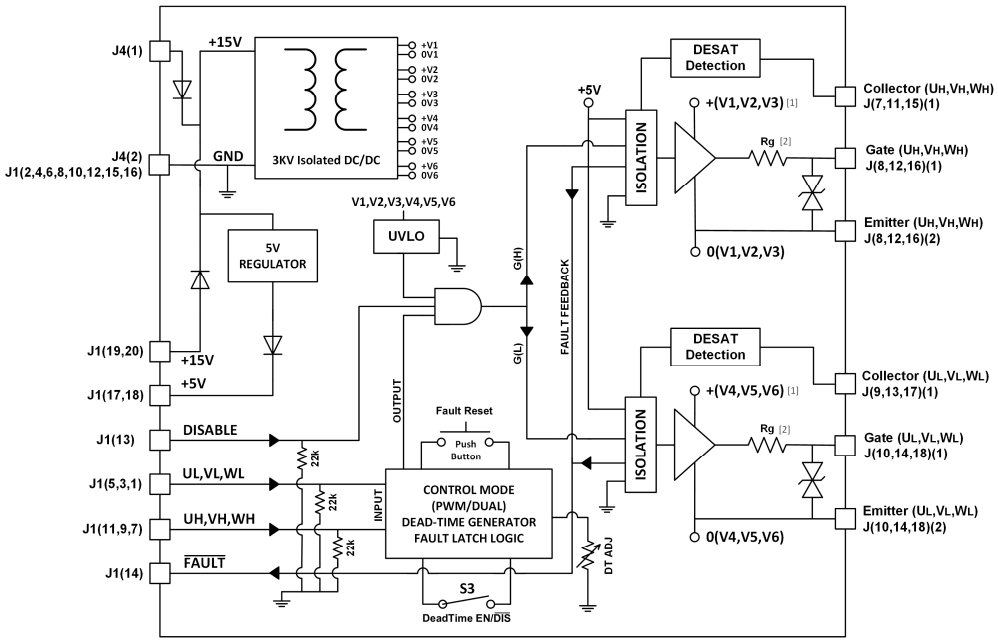
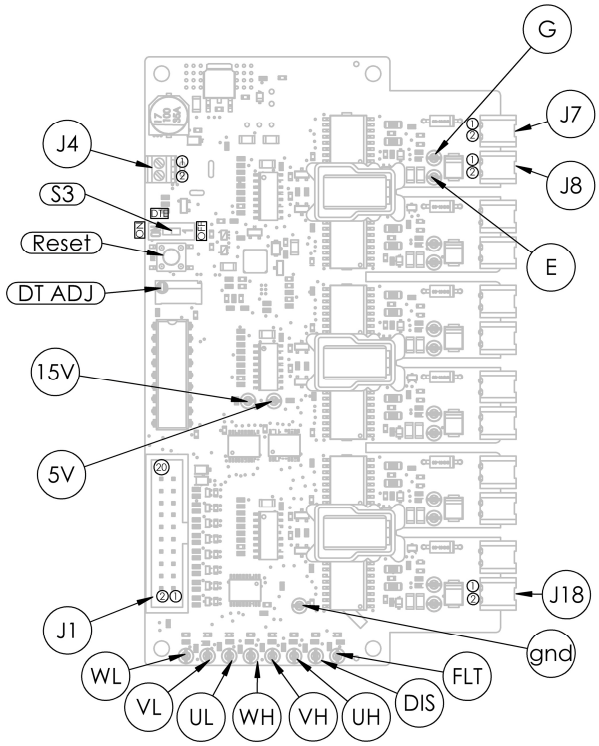


Figure 1: Block Diagram

Notes:

1) All drivers are powered by isolated (floating) voltage sources.
2) The default gate resistor is 10Ω and user can control the gate turn on and off by changing Rg to lower value for faster switching, or higher value to minimize ringing. However, the minimum value to be used should be greater than or equal to SiC/IGBT/MOSFET datasheet recommended value for reliable operation.
3) In case of PWM mode, control signals will be generated from UH, VH & WH. User don't have to supply the UL, VL & WL signals.

Pin Description



Name	Connector (Pin No.)	Description
UH, VH, WH	J1(11,9,7)	Non-inverting logic input terminal for HIGH side gate.
UL, VL, WL	J1(5,3,1)	Non-inverting logic input terminal for LOW side gate. (Dual mode only)
GND	J4(2), J1(2,4,6,8,10,12,15,16)	Ground
+15V	J4(1), J1(19,20)	+15V supply voltage (Vs) for the module. It can be supplied either from J4 or J1.
+5V	J1(17,18)	+5V supply output from the module to power up the external circuit.
DISABLE	J1(13)	Input disable signal, active high will drive all outputs to LOW.
$\overline{\text{FLT}}$	J1(14)	Fault feedback output, active low. When a fault condition occurs, this pin will move into low state.
Collector	J(7,9,11,13,15,17)(1)	Output to SiC/IGBT/MOSFET collector terminal (must be connected).
NC	J(7,9,11,13,15,17)(2)	This pin is not connected.
Gate	J(8,10,12,14,16,18)(1)	Output to SiC/IGBT/MOSFET gate terminal.
Emitter	J(8,10,12,14,16,18)(2)	Output to SiC/IGBT/MOSFET emitter terminal.
Reset	Push Button	Once fault is triggered, it can either be reset with the reset push button, or by disabling the module using J1.13 and re-enable it after minimum 10us delay.
PWM / Dual	S3	Operation mode can be selected by turning dead-time ON (PWM mode) or OFF (Dual mode). If position 1 of switch S3 is at ON state then PWM mode is selected. Conversely, at OFF state, Dual Mode is selected.
Dead-Time Adjust	DT-ADJ	Duration of Dead-time can be adjusted by DT-ADJ potentiometer.

Application Information

Typical Application Circuit

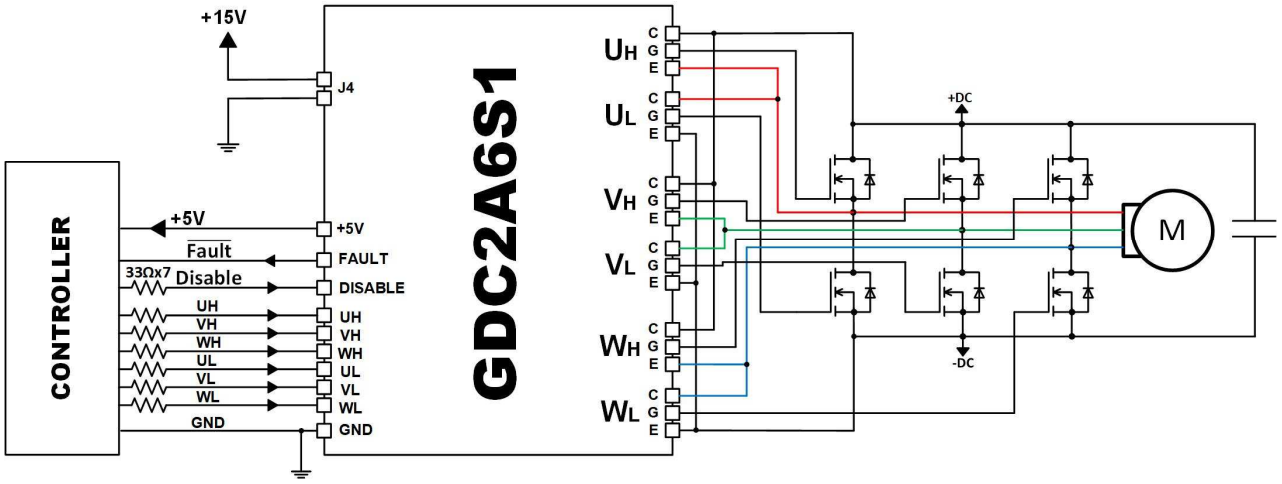


Figure 2: Typical application circuit

Operation Requirements

For proper operation of the gate drive module, certain requirements need to be fulfilled. First, the module need to be supplied with +15V voltage source through J4 or J1 connectors. Second, **all switches need to be connected including collector terminals**, failure to do so will latch the fault circuitry and module will become un-operational. Last, control signals need to be given to the module with recommended 33 Ohm transmission resistors to avoid ringing and noise. Disable signal must be in low state, while Fault signal can be monitored for feedback.

Power Supply & Configuration (J1 & J4)

Supply voltage (+15V) is provided through J4 terminal block. It can also be supplied from J1 (pins 19, 20). Moreover, user can utilize 5V supply from J1 (pins 17, 18) to power external control circuit.

Output Connection (J7-J18)

Output connectors from J7 to J18 should be directly connected to power switches accordingly. Please note that voltage difference between the collector and rest of output is high, and hence proper wiring and insulation must be used. Gate and emitter wires are recommended to be in twisted pairs in case of free hanging connectors and must be as short as possible.

Fault Latch Reset

Fault output pin (J1.14) indicates fault condition at any switch and is active LOW. Once fault is detected, the output will be muted for 5µs (minimum). Any input signal will be ignored during this mute period to allow driver to completely soft shut-down the switch.

Fault will be triggered by either desaturation detection or wiring disconnection. Once fault is triggered, it can either be reset with the push button, or by disabling the module using J1.13 (Disable) and re-enable it after minimum 10us delay. The module will resume operation after fault is cleared.

Application Information (Continued)

Operation Modes (S3)

User can select to use this gate driver as PWM or Dual input mode using S3. All gate driver modules are pre-configured in PWM mode by default. In PWM mode (S3 ON State), UL, VL and WL signals are generated by dead-time generation logic. The user has to connect only UH, VH and WH signals to Input. In Dual mode (S3 OFF State), all channels are independently controlled through respective signals, this is required for some topologies where shoot-through is needed such as Z-Source Inverter.

Configurable Dead Time (DT ADJ) in PWM Mode

User can configure the internal dead time using DT ADJ potentiometer. The duration of dead time delay DT can be calculated as per equation 1.

$$DT \approx 0.39579\ x\ RDT$$

Equation 1.

Where: DT= dead time (µs), and RDT= on board dead time programming trimmer (kΩ), which varies from 1k to 21kΩ, changing dead time from 0.39579µs to 8.3µs. By default, the module is configured at 2.2µs dead time. If dead time need to be adjusted, it must be done with switches high voltage power supply in OFF condition.

Selecting Appropriate Output Voltage for SiC Devices

Due to variety of available SiC devices in the market, gate drive voltage requirements of each SiC device varies greatly, choosing the correct voltage is important for reliable operation of the switch and gate driver. Following are examples of different series SiC devices with recommended gate drive voltages.

SiC Series	Manufacturer	Output Voltage	Also Use for
C3M	Cree	+15V/-5V	IGBTs & MOSFETs
C2M	Cree	+20V/-5V	
SCT	Rohm	+18V/0V	

Input & Output Indication LEDs, Test Points

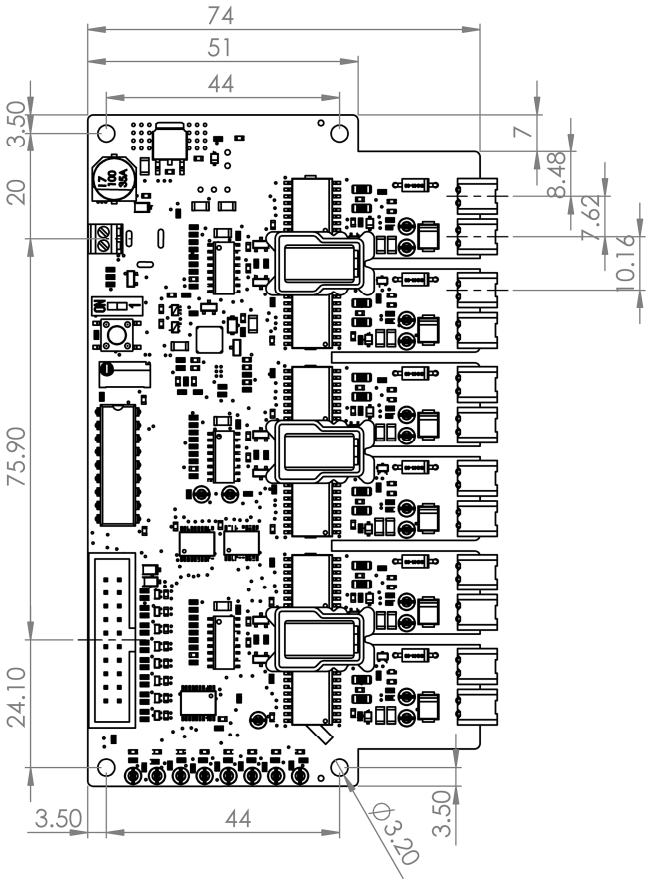
LEDs are provided on input and output signals for instant user feedback. Input side LEDs are yellow colored. While output LEDs are independent for ON (Orange) state and OFF (Yellow) state so user can have feedback of high frequency PWM signals as well. Separate LEDs also indicate DISABLE (Orange), FAULT (RED) and Power state (Green).

The module also has input and output test points for easy debugging. This is very helpful feature for educational and research use. Test points are available on all inputs, Disable, Fault, Power (+15V, +5V, GND) and Gate, Emitter of all outputs.

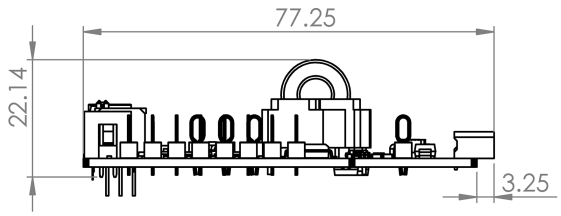
Mounting and Safety

Since output side may carry dangerous high voltage, it is not safe to touch the circuit in operation. User must consider proper clearance of heat sink, metal enclosure, stray metallic objects near output side, and cover module and inverter with proper insulated casing. Care must be taken with mounting since mounting holes are close to outputs.

Mechanical Drawing



TOP VIEW

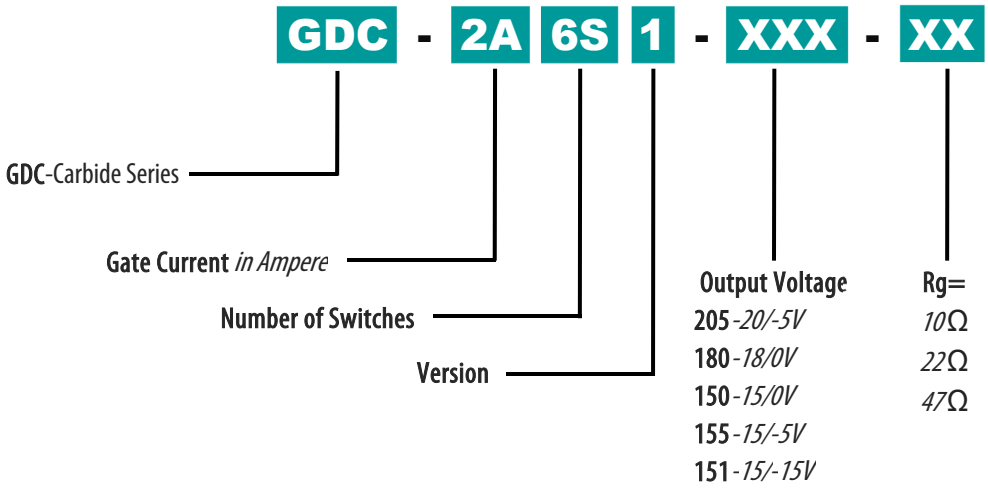


SIDE VIEW

Notes:

* All dimensions are in mm.

Ordering Information



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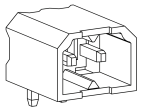
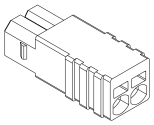
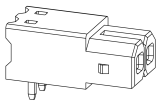
Output Connectors



Output Connector (PCB):
1814841



Plug (Wire to Plug):
1704853



Plug (PCB to PCB): Not Supplied
1814980

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www.taraztechnologies.com
Address: 21-X, 2nd Floor, DHA Business Avenue, DHA Phase 1, Bahria Expressway, Rawalpindi 46000, Pakistan
Phone: +92 (51) 5400335
Fax: +92 (51) 5400155
E-Mail: info@taraztechnologies.com

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