

## BG2C – Universal Gate Drive Prototype Board



**Description:** The BG2C is a two channel gate drive circuit designed for use with high frequency optimized IGBT modules. The BG2C utilizes Powerex VLA507 or VLA513 hybrid gate drivers and VLA106 series DC to DC converters to provide efficient switching of modules rated up to 300A. The hybrid gate drivers include high speed opto-couplers with typical propagation delay times as short as 200ns for control signal isolation. The hybrid DC to DC converters provide fully isolated control power for each driving channel.

### Features:

- 3A or 5A Peak Output Current
- 2500VRMS isolation for control power and signals
- Standard AMP MTA .100" input/output connectors
- Operates from a single 15 VDC or 24 VDC supply
- Wide output voltage swing +15V/-8V
- Low parts count – Only 17 parts for two channels
- Compact Size 2.7" x 2.4" (69mm x 61mm)

### Applications:

BG2C is designed for use with Powerex NFH Series and CM\*\*\*DUS-12F high frequency IGBT modules.

- Use **VLA106-15242** DC to DC converter for operation with 15 VDC control power
- Use **VLA106-24242** DC to DC converter for operation with 24 VDC control power

**Ordering Information:** **BG2C-3015** is a kit with a bare BG2C board, two VLA507 and two VLA106-15242s  
**BG2C-5015** is a kit with a bare BG2C board, two VLA513 and two VLA106-15242s

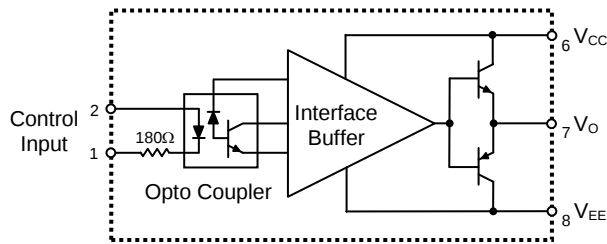
### BG2C Application Guide

| Gate Driver Part Number | Peak Drive Current ( $I_{OP}$ ) | Minimum $R_G$ | Typical Application* (IGBT Module Rating) | DC/DC Converter                                                                    |
|-------------------------|---------------------------------|---------------|-------------------------------------------|------------------------------------------------------------------------------------|
| <b>VLA507</b>           | +/- 3A                          | 3.9 $\Omega$  | Up to 100A                                | <b>VLA106-15242</b><br>for 15 VDC input<br><b>VLA106-24242</b><br>for 24 VDC input |
| <b>VLA513</b>           | +/- 5A                          | 2.0 $\Omega$  | Up to 300A                                |                                                                                    |

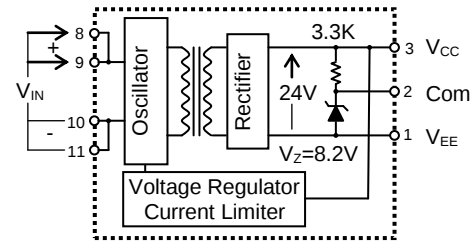
\* Compatible IGBT module depends on voltage rating, switching frequency and selected  $R_G$ . Refer to Powerex application notes for details.

Note: For high frequency applications using modules with current ratings larger than 300A the Powerex VLA502-01 driver is recommended

**Figure 1: VLA507/VLA513 Block Diagram**



**Figure 2: VLA106-15242, VLA106-24242 Block Diagram**

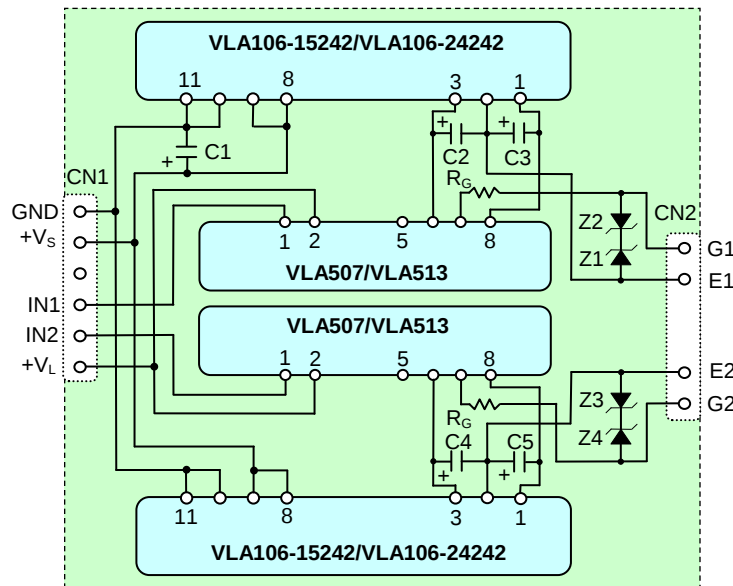


**Circuit Explanation:** The BG2C is a basic two channel gate driver designed around the recommended application circuits for the Powerex VLA507 and VLA513 hybrid IGBT gate drivers in combination with either VLA106-15242 or VLA106-24242 isolated DC to DC converters.

A functional block diagram of the VLA507/513 hybrid gate drivers is shown for reference in Figure 1. These gate drivers are optimized for use with Powerex NFH series and CM\*\*DUS-12F IGBT modules. The drivers use a high speed open collector type opto-coupler to provide 2500VRMS isolation of control signals. The output stage is designed to provide high current gate drive with the appropriate on and off-state bias voltages for large IGBT modules. For additional detailed information on the characteristics and operation of these gate drivers please refer to the individual device data sheets.

Figure 2 shows a block diagram of the VLA106-15242 and VLA106-24242 hybrid DC to DC converters. These two devices are identical except that VLA106-15242 is designed to operate from a 15 VDC input and the VLA106-24242 is designed to operate from a 24 VDC input. These DC to DC converters use a transformer to provide 2500VRMS isolation for gate drive power. The converter's regulated 24VDC output is split using a resistor and zener diode to provide +15.8V and -8.2V for the hybrid gate driver. For additional detailed information on the operation of the hybrid DC to DC converters please see the individual device data sheets.

**Figure 3: BG2C Schematic and Component Selection**

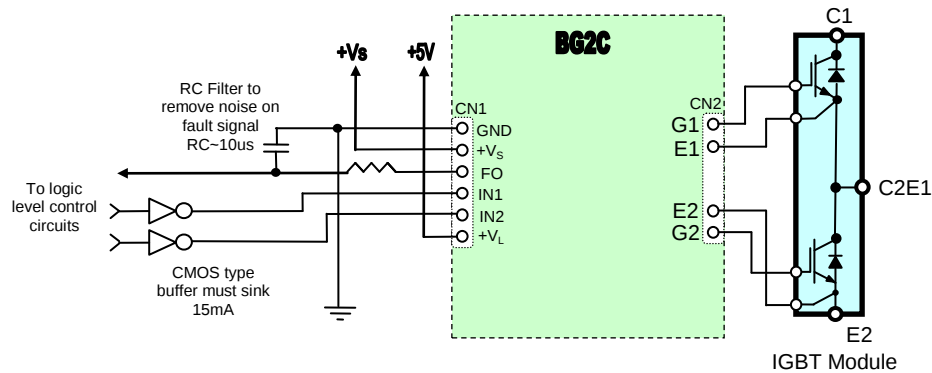


### Component Selection:

| Designation        | Typical Value | Description                                       | Example: Mfg./PN       |
|--------------------|---------------|---------------------------------------------------|------------------------|
| Z1, Z2, Z3, Z4     | 16V, 1W       | Gate Voltage Surge Protection                     | 1N4745                 |
| C1, C2, C3, C4, C5 | 390μF, 35V    | Power supply filter – Electrolytic, low Impedance | Panasonic EEU-FC1V391S |
| CN1, CN2**         | MTA .100"     | Input and gate connections                        | AMP 640457-6           |

\*\* Recommended mating connector AMP CST-100 Housing P/N 770602-6 with crimp contact 770666-2.

**Figure 4: BG2C External Wiring Diagram**



A complete schematic and component selection guide for the BG2C is shown in Figure 3. The board will normally be operated with two input voltage sources. A 5V logic source ( $+V_L$ ) provides drive for the high speed opto-couplers inside the hybrid gate drivers. A control power supply ( $+V_S$ ) provides power for the gate driver and is connected to the primary side of the DC to DC converters at pins 8, 9 and 10, 11. The  $+V_S$  source is decoupled with a low impedance electrolytic capacitor C1. The capacitor is connected close to the input pins of the DC to DC converters to provide a stable, well-filtered DC source. A 390 $\mu$ F capacitor was selected for C1 to provide the required ripple current and filtering assuming a maximum driven load and a significant distance to the main filter capacitor of the  $+V_S$  supply. These capacitors will be larger than necessary if the driven load is smaller or the  $V_S$  supply main filter capacitors are nearby. The DC to DC converters provide isolated gate drive power which consists of +15.8V ( $V_{CC}$ ) at pin 3 and -8.2 ( $V_{EE}$ ) at pin 1 with respect to common at pin 2. The gate drive power supplies are decoupled using the low impedance electrolytic capacitors C2, C3, C4, and C5. It is very important that these capacitors have low enough impedance and sufficient ripple current capability to provide the required high current gate drive pulses. The 390 $\mu$ F low impedance capacitors used on the BG2C are sized to supply 5A gate pulses at a 60 KHz rate. If the application is operating at lower frequency or lower peak current it may be possible to reduce the size of these capacitors.

The isolated  $V_{EE}$  and  $V_{CC}$  supplies provided by the DC to DC converters are connected to the hybrid gate drivers at pins 6 and 8 to provide gate drive power. The hybrid gate driver amplifies the control input signal and produces high current gate drive at pin 7. The gate drive current is adjusted by selecting the appropriate series gate resistance ( $R_G$ ).  $R_G$  will normally be adjusted to provide suitable drive for the module being used considering dynamic performance, losses and switching noise. For more information on selecting  $R_G$  see Powerex IGBT module application notes. Protection against gate voltage surges is provided by Z1, Z2, Z3, and Z4. These zener diodes also help to control short circuit currents by shunting miller current away from the gate.

**Interface Circuit Requirements:** A typical interface circuit for the BG2C is shown in Figure 4. A single control power supply ( $+V_S$ ) is connected to pin 5 of CN1 with its common at pin 6. This supply provides all of the gate drive power for both channels via the hybrid DC to DC converters. The current drawn from the  $+V_S$  supply will vary from less than 100mA to more than 500mA depending on the switching frequency and size of IGBT being driven. Consult the hybrid gate driver application notes for details on determining the required supply current for the gate driver. The gate driver supply current can then be converted into current drawn from the  $+V_S$  supply using the efficiency specification on the DC to DC converter data sheet.

A 5V logic supply is connected at pin 1 of CN1 and shares the same common at pin 6 of CN1 as the 15V control supply. The 5V supply is directly connected to pin 2 of the hybrid gate driver which is internally connected to the anode of the LED in the high speed opto coupler.

The control signal interface is designed for use with standard 5V CMOS logic. The control input signals at pins 2 and 3 of connector CN1 are used to turn the IGBTs on and off. These signals are active low which means that the gate driver output will be high (IGBT on) when they are pulled low. These control pins are connected directly to pin 1 of the hybrid gate driver which is connected internally through a 180 $\Omega$  limiting resistor to the cathode of the LED in the high speed opto coupler (see figure 1). When the control signal is pulled low, current flows from the 5V logic supply through the LED to turn the gate driver's output on. The control pins must be pulled low with a buffer that is capable of sinking at least 16mA in order to turn on the high speed opto coupler inside the hybrid gate driver. A CMOS buffer that actively pulls its output high in the off state (74HC04 or similar)

is recommended for maintaining good common mode noise immunity. Open collector drive that allows IN1 and IN2 to float will degrade common mode noise immunity and is therefore not recommended.

**Printed Circuit Layout:** Figure 5 shows the layout of the BG2C two channel gate driver board. The compact 2.7" x 2.4" circuit board with only 17 components clearly demonstrates the advantage of using hybrid gate drivers and DC to DC converters. One important feature is the use of three ground plane islands for the regions of the PCB having high voltage differences. Two of the islands are tied to the IGBT emitter/circuit common (Pin 2 of the DC to DC converters) of each output channel. The third island is connected to logic interface common at pin 6 of CN1. This layout provides shielding to help prevent undesirable coupling of noise between the control side and the gate drive channels.

**Additional Information:** Detailed information about the operation and electrical characteristics of the VLA507 and VLA513 hybrid gate drivers can be found on the individual device data sheets. Electrical characteristics such as input voltage range, efficiency, and output voltage regulation of the VLA106-15242 and VLA106-24242 DC to DC converters can also be found on the individual device data sheets. Information about calculating gate drive current and selection of series gate resistors ( $R_g$ ) can be found in the general IGBT module and gate drive application notes. For applications using higher current IGBT modules refer to the application notes for the VLA502-01 hybrid gate driver and BG2A reference design. All of these documents are available on the Powerex website at [www.pwr.com](http://www.pwr.com). For design assistance with any of the products covered in this application note contact Powerex at (724) 925-7272 and request application engineering. For product pricing and availability call the Power Line: 1-800-451-1415.

**Figure 5: BG2C Printed Circuit Board Layout**

