

Universal Gate Drive Prototype Board (BG2J)

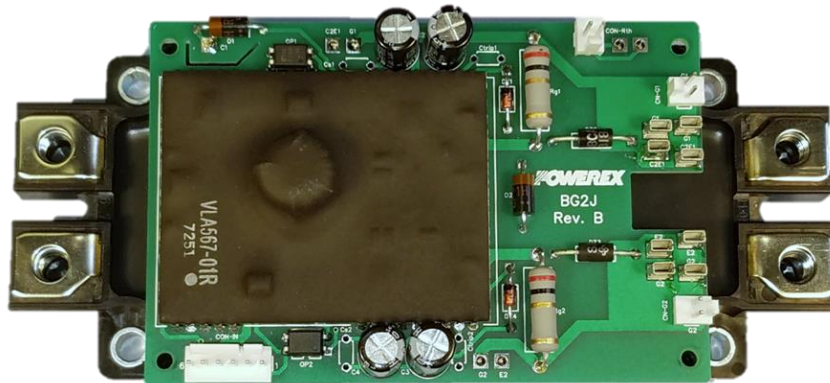


Figure 1 – BG2J Mounted on NX package

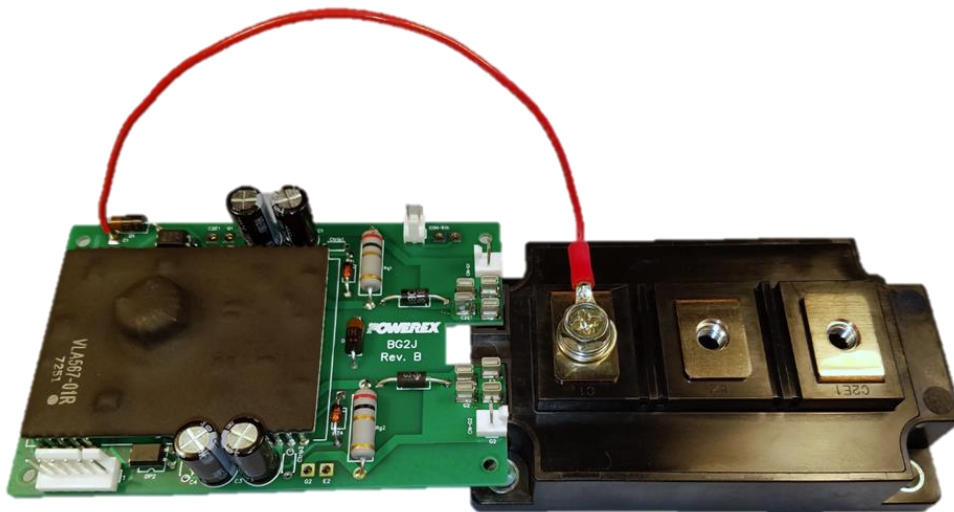


Figure 2 - BG2J Mounted on DY Package

Description: The BG2J is a two-channel gate drive circuit board that utilizes the Powerex VLA567-01R / VLA567-02R dual hybrid gate driver with built-in isolated DC-to-DC converters. The BG2J was designed to provide efficient switching of dual IGBT modules rated up to 1000A / 1200V. The BG2J mounts directly onto NX and DY style packages as shown in Figure 1 and 2 above, either by direct solder or by the use of solderless press fit type connectors. A pair of auxiliary 0.100" two-pin headers makes connection to any module via twisted pair wire possible. The BG2J includes opto-couplers for control signal isolation and isolated fault feedback signal, desaturation detection for short circuit protection, and built-in DC-to-DC converters to provide fully isolated control power for each driving channel.

Specifications:

- $\pm 8A$ peak output current
- 2500VRMS isolation for 1 minute
- Standard MTA 0.100" connectors
- Operates from a single +15Vdc or +24Vdc control supply
- +15.5V/-8V typical gate drive voltage
- Adjustable short circuit protection
- Adjustable fall time after short circuit

Applications:

Gate driver for Mitsubishi 7th Gen "T" Series dual IGBT Modules:

- Direct solder or solderless connection to NX style modules via Honda connectors
- Direct solder or solderless connection to DY style packages via Zierick connector
- Auxiliary twisted pair to connect to other style modules

*See Table 2 for compatible IGBT module list

Ordering Information*:

- BG2J-15V is a kit with a bare BG2J board, one VLA567-01R gate drive IC (15V Input), four Honda connectors, and four Zierick connectors.
 - BG2J-24V is a kit with a bare BG2J board, one VLA567-02R gate drive IC (24V Input), four Honda connectors, and four Zierick connectors.
- * The user is required to order the necessary components and connectors contained in the parts list herein to complete assembly. The kit contains a bare board, U1, four pieces of NX solderless Honda connectors, and four pieces of DY solderless Zierick connectors. Through-hole components were selected to make hand assembly easy. Gate resistor values should be selected based on IGBT module selected. Consult the IGBT module data sheet for the range of acceptable gate resistors. For detailed gate resistor selection guidance, see the [Driving IGBT Modules](http://www.pwr.com/pwr/app/Driving%20IGBT%20Modules.pdf) Application Note. (<http://www.pwr.com/pwr/app/Driving%20IGBT%20Modules.pdf>)

Circuit Explanation:

The BG2J is a basic two-channel gate drive board designed around the recommended application circuit for the Powerex VLA567-01R/02R core IGBT gate driver with built-in DC-to-DC converters.

A functional block diagram of the VLA567-01R/02R is shown for reference in Figure 3. This gate drive is optimized for use with Powerex 600V and 1200V dual IGBT modules rated up to 1000A. The driver uses 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. The gate driver includes a desaturation detection circuit to provide protection against short circuit conditions. For additional detailed information on the characteristics and operation of the gate driver please refer to the VLA567-01R/02R [datasheet](#).

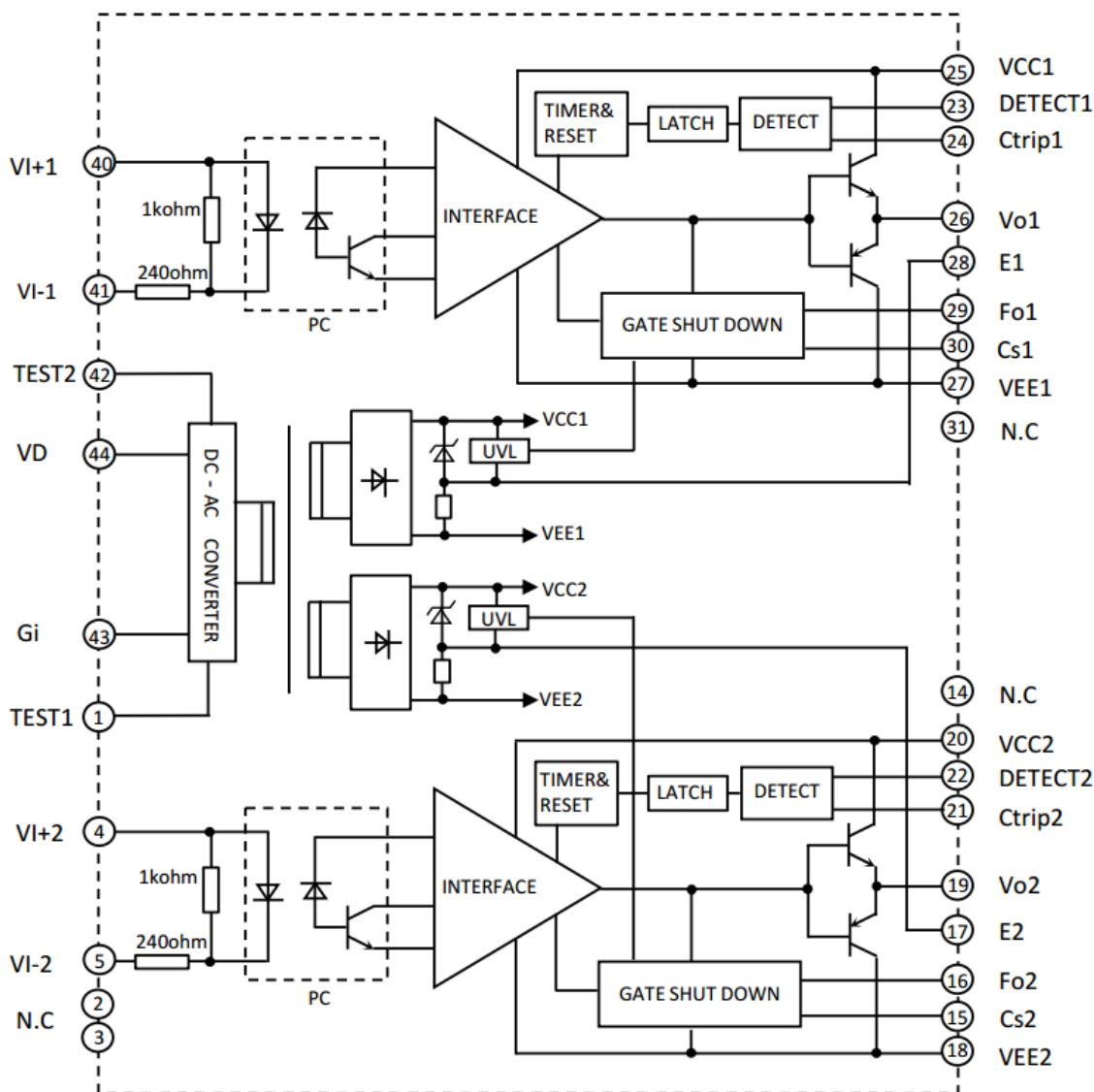


Figure 3 – VLA567-01R / VLA567-02R Functional Block Diagram

Reference	Type	Description	Manufacturer Part Number	Manufacturer	Quantity
C1-C4	Capacitor	CAP ALUM 120UF 20% 50V RADIAL	UHE1H121MPD1TD	NICHICON	4
Ctrip1-Ctrip2	Capacitor	0-350PF (47PF TYPICAL) C0G 50V	FK28	TDK CORPORATION	2
Cs1-Cs2	Capacitor	0-650PF C0G 50V	FK28	TDK CORPORATION	2
CON-IN	Connector	CONN HEADER 6POS .100 VERT TIN	22-23-2061	MOLEX, LLC	1
CN-G1, CN-G2, CON-Rth	Connector	CONN HEADER 2POS .100 VERT TIN	22-23-2021	MOLEX, LLC	3
CON-IN	Connector	CONN HOUS 6POS .100 W/RAMP/RIB	22-01-3067	MOLEX, LLC	1
CN-G1, CN-G2, CON-Rth	Connector	CONN HOUS 2POS .100 W/RAMP/RIB	22-01-3027	MOLEX, LLC	3
CON-IN, CON-Rth, CN-G1, CN-G2, CON-Rth	Connector	CONN TERM FEMALE 22-30AWG TIN CRIMP	08-50-0114	MOLEX, LLC	12
U4/U5 - DY: G1, G2, C2E1, E2	Connector	PRESS FIT BOX RECEPTACLE	1266	ZIERICK	4
NX: G1/C2E1, G2/E2, C1, Rth	Connector	POWER MODULE SOCKET; 2-PIN; 3.81MM	PZAB-2SFY+	HONDA TSUHIN KOGYO CO.	4
D1-D2	Diode	DIODE GEN PURP 2KV 100MA AXIAL	RP 1HV1	SANKEN (VA)	2
U1	Hybrid IC	IGBT MODULE DRIVER CORE	VLA567-01R / -02R	ISAHAYA ELECTRONICS	1
OP1-OP2	Optocoupler	OPTOISOLATOR 5KV TRANS 4DIP	PS2501-1-L-A	CEL	2
Rg1-Rg2	Resistor	RES 2 OHM 2W 5% AXIAL	RSF200JB-73-2R	YAGEO	2
R1-R5	Resistor	RES 4.7K OHM 1/4W 5% AXIAL	CF14JT4K70	STACKPOLE ELECTRONICS INC	5
DZ1, DZ4	Zener Diode	DIODE ZENER 30V 1W DO41	1N4751ATR	FAIRCHILD SEMICONDUCTOR	2
DZ2, DZ3	TVS Diode	TVS DIODE 18VWM 29.2VC DO204AC	SA18CA-E3/54	VISHAY SEMICONDUCTOR	2

*Ctrip and Cs are required only in certain applications. See VLA567-01R/02R datasheet for selection guidance.
Note - All parts excluding U1 must be purchased separately.

Table 1: BG2J Parts List

The board will normally be operated with two input voltage sources, VL and Vs. A 5V logic source (VL) provides drive for the high speed opto-couplers inside the hybrid gate driver and pull-up voltage for the fault signal isolation optos OP1 and OP2. A control power supply (Vs) provides power for the gate driver and is connected to the primary side of the DC-to-DC converters across Pins 43 and 44. The Vs source is decoupled internally a low impedance electrolytic capacitor and therefore an external decoupling capacitor is not required to provide a stable, well-filtered DC source. The built-in DC-to-DC converters provide isolated gate drive power which consists of +16.8V (VCC), and -8.5 (VEE). The gate drive power supplies are decoupled using the low impedance electrolytic capacitors C1, C2, C3, and C4. 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 120µF low impedance capacitors used on the BG2J are sized to supply 8A gate pulses at a 20kHz 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 hybrid gate driver amplifies the control input signal and produces high current gate drive at Pins 19 and 26. The gate drive current is adjusted by selecting the appropriate series gate resistance (Rg). Rg 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 Rg see the [“Driving IGBT Modules”](#) application note. Protection against gate voltage surges is provided by DZ2 and DZ3. These TVS diodes also help to control short circuit currents by shunting miller current away from the gate.

Short circuit protection is provided by means of desaturation detection. For details on the operation of this circuit consult the VLA567-01R/02R [datasheet](#). The collector voltage of each IGBT is detected through the high voltage blocking diodes D1 and D2. The blocking voltage of the diodes must be equal to or greater than the VCES rating of the IGBT. **External connection from C1 of the power module to the anode of D1 is required for the DY packages for operation of the desaturation detector.** DZ1 and DZ4 protect the gate driver’s detect input (Pins 22 and 23) from voltage surges during reverse recovery of the high voltage blocking diodes. The capacitors Ctrip1 and Ctrip2 are used to adjust the driver’s protection circuit trip time. The driver’s default settings are sufficient for many applications so it may be possible to omit these capacitors. For details on the use of Ctrip1 and Ctrip2, consult the VLA567-01R/02R [datasheet](#).

If the gate driver's short circuit protection is activated, it immediately shuts down the gate drive and pulls the fault output pin low. Current flows from Vcc and through the LED in the fault isolation opto (OP1, OP2) causing the transistor in the fault isolation opto to turn on and pull the fault signal line (FO) at Pin 4 of CON-IN low. This opto-isolated signal can now be used by the controller to detect the fault condition.

The capacitors Cs1 and Cs2 are used to increase the IGBT turn off fall time after the activation of the short circuit shutdown. Increasing the fall time has the effect of reducing the peak surge voltage generated during a high current shutdown. The driver's default settings are sufficient for many applications so it may be possible to omit these capacitors. For details on the use of Cs1 and Cs2, consult the VLA567-01R/02R [datasheet](#).

Interface Circuit Requirements:

A typical interface circuit for the BG2J is shown in Figure 5.

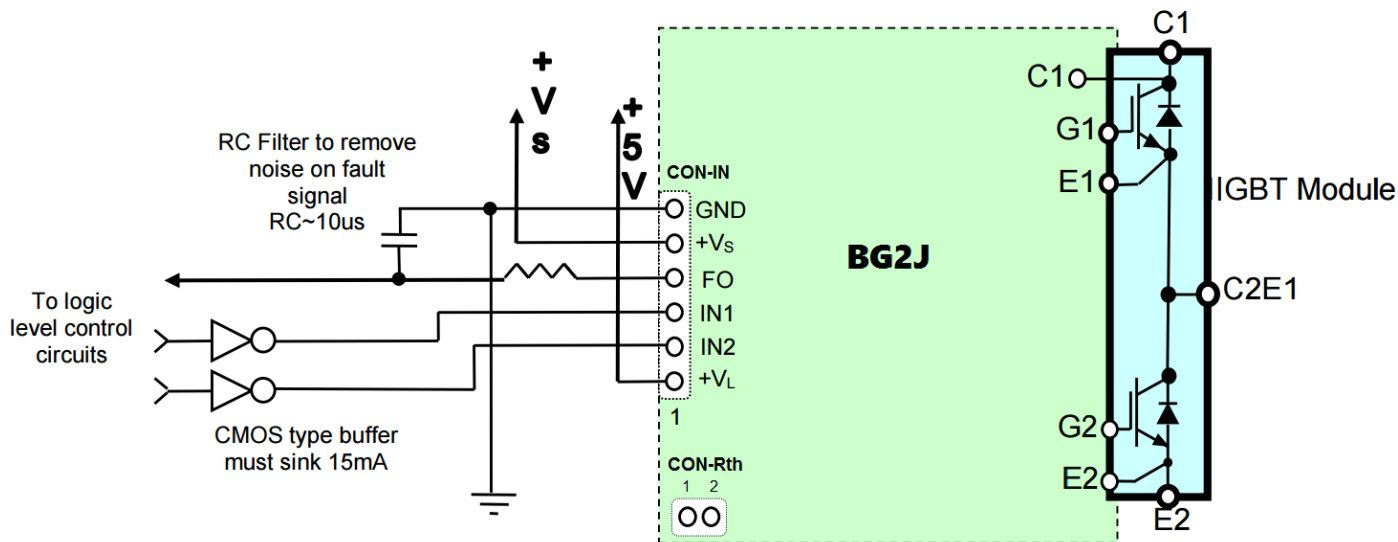


Figure 5: BG2J External Wiring Diagram

A single control power supply (+Vs) is connected to Pin 5 of CON-IN with its common at Pin 6. This supply provides all of the gate drive power for both channels. The current drawn from the +Vs 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 +Vs supply using the load current versus input current specification on the VLA567-01R/02R [datasheet](#).

A 5V logic supply is connected at Pin 1 of CON-IN and shares the same common at Pin 6 of CON-IN as the 15V/24V control supply. The 5V supply is directly connected to Pins 4 and 40 of the VLA567-01R/02R, which are internally connected to the respective anode of the LED in the high-speed opto-coupler. The 5V supply is also used to pull the output side of the fault isolation opto-couplers high.

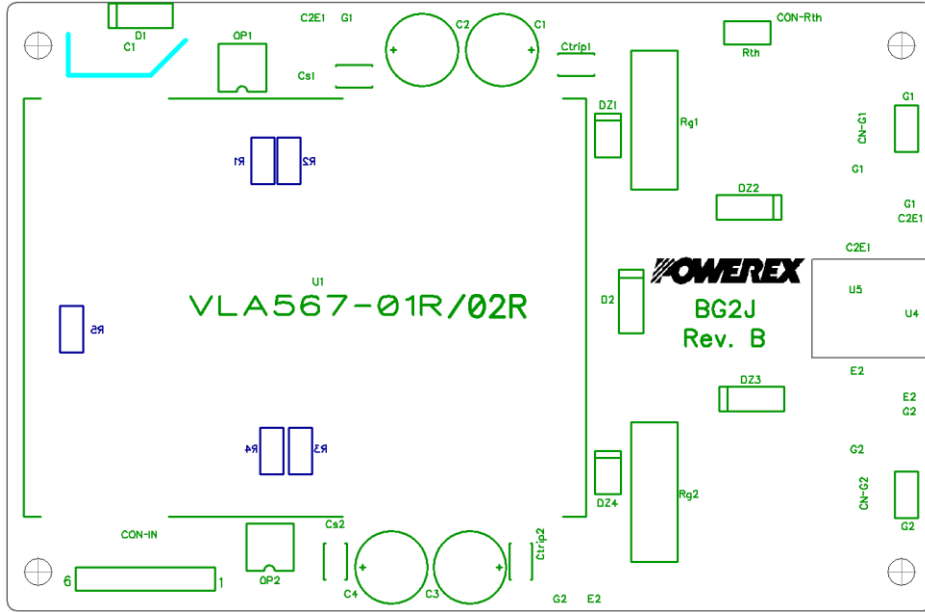
The control signal interface is designed for use with standard 5V CMOS logic. The control input signals at Pins 2 and 3 of connector CON-IN are used to turn the IGBTs on and off. These signals are active low which means that the gate driver output will be high (IGBT on) when they are pulled low. These control pins are connected directly to Pins 5 and 41 of the driver which are connected internally through a 240Ω limiting resistor to the cathode of the LED in the high speed opto-coupler (see Figure 3). When the control signal is pulled low, current flows from the 5V logic supply through the LED to turn on the gate driver's output. 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.

The fault signal line on Pin 4 of CON-IN is active low, which means that a fault condition will be indicated by a low level signal. During normal operation, Pin 4 is pulled high to the +Vl supply by the 4.7kΩ resistor R5. If either half of the hybrid gate driver detects a short circuit condition its fault isolation opto (OP1, OP2) will turn on and pull Pin 4 of CON-IN low. When a fault is detected, the gate driver disables the output and produces a fault signal for a minimum of 1ms. Any signal on the fault line that is significantly shorter than 1ms cannot be a legitimate fault, so it should be

ignored. Therefore, for a robust noise immune design, it is recommended that an RC filter with a time constant of approximately $10\mu\text{s}$ be added between Pin 4 and the controller as shown in Figure 5.

Printed Circuit Layout:

Figures 6, 7, and 8 show the layout of the BG2J two channel gate driver board. The compact 101.5mm x 66.5mm circuit board with few components demonstrates the advantage of using the VLA567-01R/02R. 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 of each output channel. The third island is connected to logic interface common at Pin 6 of CON-IN. This layout provides shielding to help prevent undesirable coupling of noise between the control side and the gate drive channels.



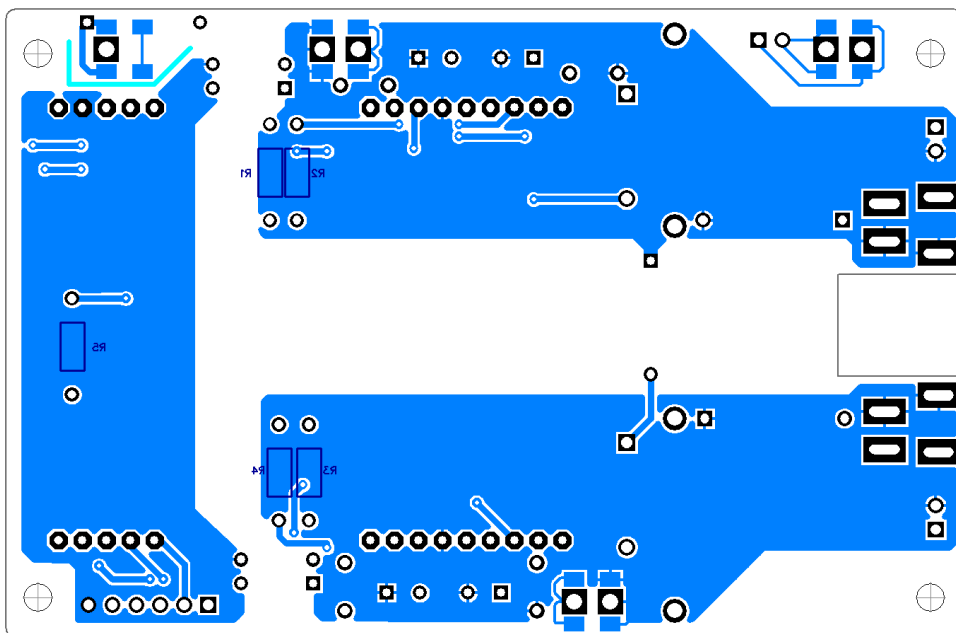


Figure 8: PCB Pattern Layout (Bottom Copper Only)

Table 2: BG2J Compatible Modules

Current [A]	"DY" Style Modules		"DX" Style Modules	
	650V	1200V	650V	1200V
100	CM100DY-13T	CM100DY-24T	-	-
150	CM150DY-13T	CM150DY-24T	-	-
200/225	CM200DY-13T	CM200DY-24T	-	CM225DX-24T / T1 / S1
300	CM300DY-13T	CM300DY-24T / S	CM300DX-13T	CM300DX-24T / T1 / S1
400/450	CM400DY-13T	CM450DY-24T / S	CM450DX-13T	CM450DX-24T / T1 / S1
600	CM600DY-13T	CM600DY-24T / S	CM600DX-13T	CM600DX-24T / T1 / S1
800	-	-	-	CM800DX-24T1
1000	-	-	-	CM1000DX-24T^

Connection Type
 - "DX" - Direct solder or solderless connection to DX style modules via Honda connectors
 - "DY" - Direct solder or solderless connection to DY style packages via Zierick connector
 - ^Other - Auxiliary twisted pair to connect to other style modules

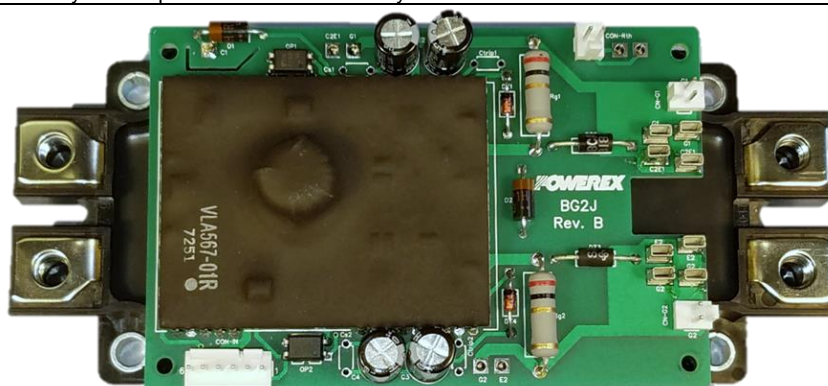


Figure 9 – BG2J Mounted on NX package

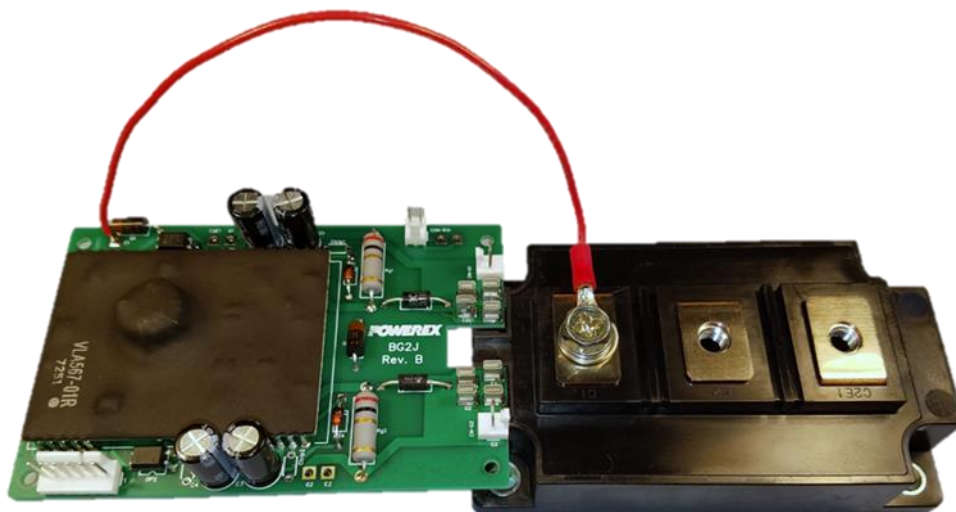


Figure 10 - BG2J Mounted on DY Package*

* External connection from C1 of the power module to the anode of D1 is required for the DY packages for operation of the desaturation detector.

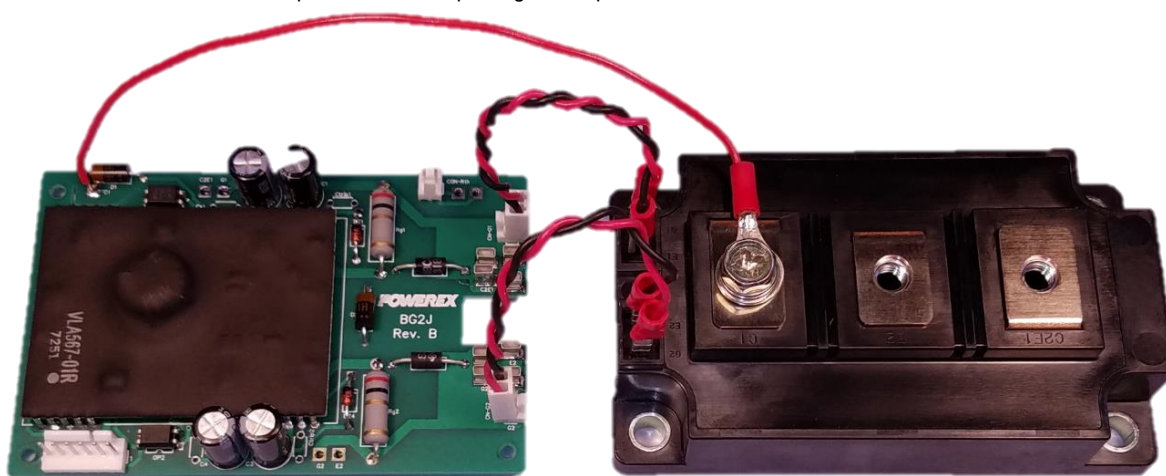


Figure 11 – BG2J Connected to “Other” Modules via Twisted Pair*

* External connection from C1 of the power module to the anode of D1 is required for “Other” packages for operation of the desaturation detector.

Additional Information:

Detailed information about the operation and electrical characteristics of the VLA567-01R/02R can be found on the individual device datasheets and in the Driving IGBT Modules [Application Note](#). All of these documents are available on the Powerex website at www.pwr.com.

For applications using higher current IGBT modules refer to the application notes for the VLA552-01R hybrid gate driver IC or the VLA553-01R/02R board. For applications using high frequency optimized NFH series IGBT modules refer to the VLA513-01 or VLA502-01 datasheet.

For design assistance with any of the products covered in this application note contact your local Powerex sales representative or Powerex application engineering at (724) 925-7272.

The BG2J board was designed for the purpose of evaluating and verifying the VLA567-01R/02R performance; reliability of the board is not considered. General environment was assumed for parts selection. Care should be taken when selecting parts for the specific application environment and conditions.

Please take precaution to avoid electric shock. We assume no responsibility for damage occurring while using the BG2J board.

Keep safety first in your circuit designs!

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