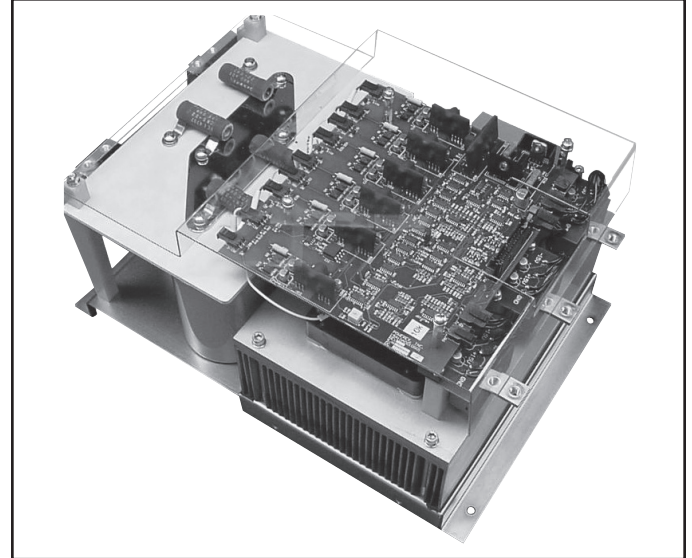
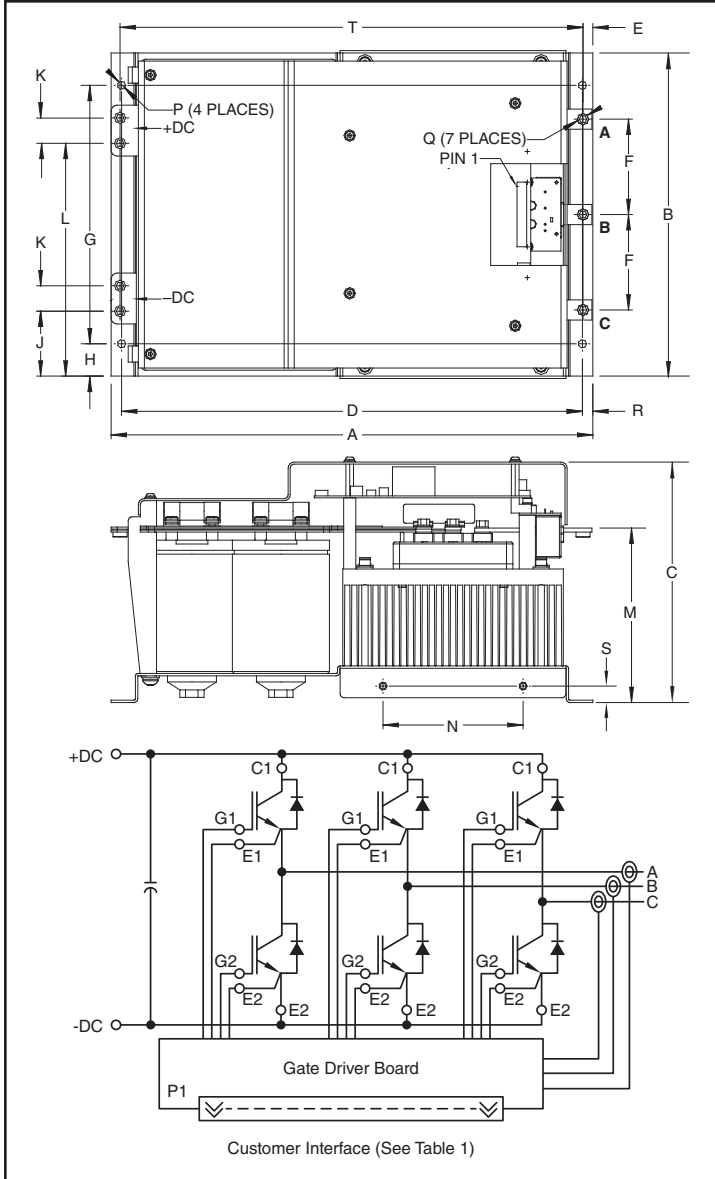


### 3-Phase POW-R-PAK™ IGBT Assembly 400 Amperes/600 Volts



#### Description:

The Powerex POW-R-PAK™ is a configurable IGBT based power assembly that may be used as a converter, chopper, half or full bridge, or three phase inverter for motor control, power supply, UPS or other power conversion applications.

The power assembly is mounted on a forced air-cooled heatsink and features state-of-the-art Powerex IGBTs with low conduction and low switching losses for high efficiency operation. The POW-R-PAK™ includes a low inductance laminated bus structure, optically isolated gate drive interfaces, isolated gate drive power supplies, and a DC-link capacitor bank. The control board provides a simple user interface along with built-in protection features including overvoltage, undervoltage lockout, overcurrent, overtemperature, and short circuit detection.

Depending on application characteristics, the POW-R-PAK™ is suitable for operation with DC bus voltages up to 400VDC and switching frequencies below 20kHz.

#### Features:

- ☐ High performance IGBT inverter bridge
- ☐ Integrated gate drive with fault monitoring and protection
- ☐ System status / troubleshooting LEDs to verify or monitor proper operation
- ☐ Isolated gate drive power supplies
- ☐ Low inductance laminated bus
- ☐ Output current measurement and feedback
- ☐ Superior short circuit detection & shoot through prevention

#### Outline Drawing and Circuit Diagram

| Dim. | Inches | mm    |
|------|--------|-------|
| A    | 14.9   | 378.4 |
| B    | 10.15  | 257.8 |
| C    | 7.4    | 193.0 |
| D    | 14.25  | 362.0 |
| E    | 0.3    | 7.7   |
| F    | 2.95   | 75.0  |
| G    | 8.0    | 203.2 |
| H    | 1.0    | 25.4  |
| J    | 2.01   | 51.0  |

| Dim. | Inches     | mm       |
|------|------------|----------|
| K    | 0.79       | 20.0     |
| L    | 7.20       | 183.0    |
| M    | 5.4        | 137.2    |
| N    | 4.33       | 110.0    |
| P    | 0.256 Dia. | 6.5 Dia. |
| Q    | M6 Metric  | M6       |
| R    | 0.32       | 8.2      |
| S    | 0.51       | 12.9     |
| T    | 14.32      | 363.6    |



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PP400T060-ND  
3-Phase POW-R-PAK™ IGBT Assembly  
400 Amperes/600 Volts

## Absolute Maximum Ratings, $T_j = 25^\circ\text{C}$ unless otherwise specified

### Module

| Characteristics                               | Symbol           | Rating      | Units            |
|-----------------------------------------------|------------------|-------------|------------------|
| IGBT Junction Temperature                     | $T_j$            | -40 to +150 | $^\circ\text{C}$ |
| Storage Temperature                           | $T_{\text{stg}}$ | -40 to +65  | $^\circ\text{C}$ |
| Operating Temperature                         | $T_{\text{op}}$  | -20 to +60  | $^\circ\text{C}$ |
| Voltage Applied to DC Terminals               | $V_{\text{CC}}$  | 400         | Volts            |
| Isolation Voltage, Main Terminals to Heatsink | $V_{\text{iso}}$ | 2500        | Volts            |

### IGBT Part

| Characteristics                                                       | Symbol          | Rating | Units   |
|-----------------------------------------------------------------------|-----------------|--------|---------|
| Collector Current (DC, $T_C = 87^\circ\text{C}$ )                     | $I_C$           | 400    | Amperes |
| Peak Collector Current                                                | $I_{\text{CM}}$ | 800    | Amperes |
| Emitter Current ( $T_C = 25^\circ\text{C}$ )                          | $I_E$           | 400    | Amperes |
| Peak Emitter Current                                                  | $I_{\text{EM}}$ | 800    | Amperes |
| Maximum Collector Dissipation ( $T_j < 150^\circ\text{C}$ per Module) | $P_C$           | 2710   | Watts   |

### Interface Board

| Characteristics                     | Symbol | Rating | Units |
|-------------------------------------|--------|--------|-------|
| Unregulated +24V Power Supply Input | —      | 30     | Volts |
| IGBT Command Signal Input Voltage   | —      | 20     | Volts |
| Fault Output Supply Voltage         | —      | 30     | Volts |
| Fault Output Current                | —      | 50     | mA    |



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## Electrical Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

### IGBT Part

| Characteristics                      | Symbol        | Test Conditions                                                                              | Min. | Typ. | Max. | Units         |
|--------------------------------------|---------------|----------------------------------------------------------------------------------------------|------|------|------|---------------|
| Collector Cutoff Current             | $I_{CES}$     | $V_{CE} = V_{CES}$ , $V_{GE} = 0V$                                                           | —    | —    | 1.0  | mA            |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = 400A$ , $T_j = 25^\circ\text{C}$                                                      | —    | 2.1  | 3.0  | Volts         |
|                                      |               | $I_C = 400A$ , $T_j = 125^\circ\text{C}$                                                     | —    | 2.4  | —    | Volts         |
| Emitter-Collector Voltage            | $V_{EC}$      | $I_E = 400A$                                                                                 | —    | —    | 3.8  | Volts         |
| Turn-on Delay Time                   | $t_{d(on)}$   | $V_{CC} = 600V$ , $I_C = 400A$ , $V_{GE} = \pm 15V$ ,<br>$R_G = 0.78\Omega$ , Inductive Load | —    | —    | 550  | Ns            |
| Rise Time                            | $t_r$         |                                                                                              | —    | —    | 180  | Ns            |
| Turn-off Delay Time                  | $t_{d(off)}$  |                                                                                              | —    | —    | 600  | Ns            |
| Fall Time                            | $t_f$         |                                                                                              | —    | —    | 350  | Ns            |
| Diode Reverse Recovery Time          | $t_{rr}$      | $I_E = 400A$                                                                                 | —    | —    | 250  | Ns            |
| Diode Reverse Recovery Charge        | $Q_{rr}$      | $I_E = 400A$                                                                                 | —    | 16.0 | —    | $\mu\text{C}$ |

### Interface Board

| Characteristics                       | Min. | Typ. | Max. | Units         |
|---------------------------------------|------|------|------|---------------|
| Unregulated +24V Power Supply Input   | 20   | 24   | 30   | Volts         |
| Power Supply Current Consumption      | —    | —    | 800  | mA            |
| IGBT Command Signal ON Threshold      | 12   | 15   | —    | Volts         |
| IGBT Command Signal OFF Threshold     | —    | 0    | 2    | Volts         |
| IGBT Command Signal Input Impedance   | —    | 10   | —    | k $\Omega$    |
| IGBT Command Signal Input Capacitance | —    | 1    | —    | nF            |
| Dead Time                             | —    | 3.0  | —    | $\mu\text{s}$ |

### Feedback Signal and Fault Characteristics

| Characteristics                   | Min. | Typ.                    | Max. | Units            |
|-----------------------------------|------|-------------------------|------|------------------|
| Output Over Current Trip          | —    | 625                     | —    | Amperes          |
| Heatsink Over Temperature Trip    | —    | 95                      | —    | $^\circ\text{C}$ |
| Bus Over Voltage Trip             | —    | 460                     | —    | Volts            |
| Power Supply Under Voltage Trip   | —    | 18.9                    | —    | Volts            |
| Fault Reset Time                  | —    | 9                       | —    | $\mu\text{s}$    |
| Heatsink Temperature Feedback     | —    | 0.1 V/ $^\circ\text{C}$ | —    | Volts            |
| Output Current Feedback (Bipolar) | —    | $\pm 0.016$ V/Amp       | —    | Volts            |
| DC Link Feedback                  | —    | 0.01 V/V                | —    | Volts            |



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400 Amperes/600 Volts

## Electrical Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

### Other Electrical Component Specifications

| Characteristics                                                            | Min. | Typ.      | Max. | Units                   |
|----------------------------------------------------------------------------|------|-----------|------|-------------------------|
| <b>DC Link Capacitor Bank</b>                                              |      |           |      |                         |
| Total Nominal Capacitance                                                  | —    | 13,800    | —    | $\mu\text{F}$           |
| Nominal Ripple Current Rating per Capacitor (@ $85^\circ\text{C}$ , 120Hz) | —    | 11.6      | —    | $\text{A}_{\text{RMS}}$ |
| Nominal Total Voltage Rating                                               | —    | 500       | —    | Volts                   |
| Minimum Life @ Nominal Ripple Current ( $80^\circ\text{C}$ )               | —    | 10        | —    | khrs                    |
| <b>Output Current Sensor</b>                                               |      |           |      |                         |
| Primary Current Measuring Range                                            | —    | $\pm 500$ | —    | Amperes                 |
| Accuracy (@ $I_{\text{PN}}$ , $25^\circ\text{C}$ )                         | —    | $< \pm 1$ | —    | %                       |
| Linearity Error                                                            | —    | $< \pm 1$ | —    | %                       |
| Response Time                                                              | —    | $< 5$     | —    | $\mu\text{s}$           |
| Bandwidth (-3 dB)                                                          | DC   | —         | 25   | kHz                     |

## Thermal Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

| Characteristics                           | Symbol                | Test Conditions      | Min. | Typ.  | Max.  | Units              |
|-------------------------------------------|-----------------------|----------------------|------|-------|-------|--------------------|
| IGBT Thermal Resistance, Junction-to-Case | $R_{\text{th(j-c)Q}}$ | Per IGBT, 1/2 Module | —    | —     | 0.046 | $^\circ\text{C/W}$ |
| FWD Thermal Resistance, Junction-to-Case  | $R_{\text{th(j-c)D}}$ | Per FWD, 1/2 Module  | —    | —     | 0.085 | $^\circ\text{C/W}$ |
| Contact Thermal Resistance                | $R_{\text{th(c-f)}}$  | Per 1/2 Module       | —    | 0.02  | —     | $^\circ\text{C/W}$ |
| Heatsink Thermal Resistance               | $R_{\text{th(f-a)}}$  | 286 CFM Airflow      | —    | 0.037 | —     | $^\circ\text{C/W}$ |

## Mechanical Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

| Characteristics                         | Min. | Typ. | Max. | Units |
|-----------------------------------------|------|------|------|-------|
| Mounting Torque, Output Power Terminals | —    | 75   | 90   | in-lb |
| Mounting Torque, DC Bus Terminals       | —    | 130  | 150  | in-lb |
| Weight                                  | —    | 39   | —    | lb    |

## Relevant Standards

UL508C: Power Conversion Equipment

EN50178: Electronic Equipment for Use in Power Installations



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#### PP400T060-ND

#### 3-Phase POW-R-PAK™ IGBT Assembly

400 Amperes/600 Volts

### Interface Board Signal Definitions (Table 1)

| Pin | Signal Name                   | Description                                                                                                                                  |
|-----|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Shield                        | Internally Connected to PGND                                                                                                                 |
| 2   | Gate 1 Neg.                   | 0-15V Signal Controlling, Lower IGBT, HIGH = IGBT on                                                                                         |
| 3   | Leg 1 Error <sup>1</sup>      | Open Collector Output, External Pull-up Resistor Required<br>LOW = No Error; HIGH = Phase A Over Current or Short Circuit OR Power Supply UV |
| 4   | Gate 1 Pos.                   | 0-15V Signal Controlling, Upper IGBT, HIGH = IGBT on                                                                                         |
| 5   | Gate 2 Neg.                   | 0-15V Signal Controlling, Lower IGBT, HIGH = IGBT on                                                                                         |
| 6   | Leg 2 Error <sup>1</sup>      | Open Collector Output, External Pull-up Resistor Required<br>LOW = No Error; HIGH = Phase A Over Current or Short Circuit OR Power Supply UV |
| 7   | Gate 2 Pos.                   | 0-15V Signal Controlling, Upper IGBT, HIGH = IGBT on                                                                                         |
| 8   | Gate 3 Neg.                   | 0-15V Signal Controlling, Lower IGBT, HIGH = IGBT on                                                                                         |
| 9   | Leg 3 Error <sup>1</sup>      | Open Collector Output, External Pull-up Resistor Required<br>LOW = No Error; HIGH = Phase A Over Current or Short Circuit OR Power Supply UV |
| 10  | Gate 3 Pos.                   | 0-15V Signal Controlling, Upper IGBT, HIGH = IGBT on                                                                                         |
| 11  | Over Temperature <sup>1</sup> | Open Collector Output, External Pull-up Resistor Required<br>LOW = No Error; HIGH = Heatsink OT                                              |
| 12  | External Fault Reset          | Active Low: Must be High for Operation; Low for 10microseconds to Reset Faults <sup>3</sup>                                                  |
| 13  | DC Link Voltage               | Analog Voltage Feedback of DC Link Voltage                                                                                                   |
| 14  | 24 VDC Input Power            | 20-30 VDC Input Power Supply                                                                                                                 |
| 15  | 24 VDC Input Power            | 20-30 VDC Input Power Supply                                                                                                                 |
| 16  | N/C                           | No Connect - Do Not Ground                                                                                                                   |
| 17  | N/C                           | No Connect - Do Not Ground                                                                                                                   |
| 18  | PGND                          | Ground Reference for 24 VDC Power Supply                                                                                                     |
| 19  | PGND                          | Ground Reference for 24 VDC Power Supply                                                                                                     |
| 20  | Heatsink Temperature          | Analog Voltage Representation of Heatsink Temperature                                                                                        |
| 21  | AGND <sup>2</sup>             | Tied to Pins 10 and 11                                                                                                                       |
| 22  | I <sub>OUT</sub> Phase A      | Analog Voltage Representation of Output Current                                                                                              |
| 23  | AGND <sup>2</sup>             | Tied to Pins 10 and 11                                                                                                                       |
| 24  | I <sub>OUT</sub> Phase B      | Analog Voltage Representation of Output Current                                                                                              |
| 25  | AGND <sup>2</sup>             | Tied to Pins 10 and 11                                                                                                                       |
| 25  | I <sub>OUT</sub> Phase C      | Analog Voltage Representation of Output Current                                                                                              |

1. Open collectors can be pulled up to 30V max. and sink 50mA continuous.

2. AGND signals to be used for analog feedback signals (i.e. twisted pair with I<sub>OUT</sub> Phase A).

3. On the board is a jumper that enables fault reset by bringing all leg control signals low for 10 microseconds (default).

### Interface Board Connector

| Description                       | Symbol | Type                                    | Manufacturer                |
|-----------------------------------|--------|-----------------------------------------|-----------------------------|
| Gate Drive Board Interface Header | P1     | 0.100" x 0.100" Latching Header, 26 Pin | 3M# 3429-6002 or Equivalent |
| Recommended Mating Socket         | —      | 0.100" x 0.100" IDC Socket, 26 Pin      | 3M# 3499-7600 or Equivalent |
| Recommended Strain Relief         | —      | Plastic Strain Relief                   | 3M# 3448-3026 or Equivalent |