# International TOR Rectifier

### PRELIMINARY

## IRPT1065A

### POW RTRAIN<sup>TM</sup>

### **Power Module for 1 hp Motor Drives**

- 1 hp (0.75 kW) power output
   Industrial rating at 150% overload for 1 minute
- · 180-240V AC single-phase input, 50/60 Hz
- · Single-phase rectifier bridge
- · 3-phase, short circuit rated, ultrafast IGBT inverter
- · HEXFRED ultrafast soft recovery freewheeling diodes
- · Brake IGBT and diode
- Low inductance (current sense) shunts in positive and negative DC rail
- · NTC temperature sensor
- · Pin-to-baseplate isolation 2500V rms
- · Easy-to-mount two-screw package
- · Case temperature range -25°C to 125°C operational

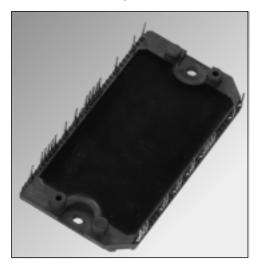


Figure 1. IRPT1065A Power Module

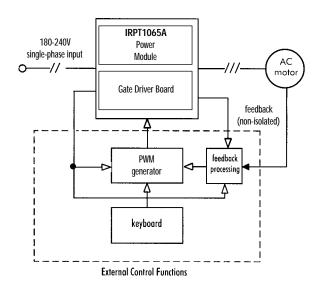


Figure 2. The IRPT1065A power module within a motor control system

### **IRPT1065A**



#### The IRPT1065A Power Module

The IRPT1065A power module, shown in figure 1, is a chip and wire epoxy encapsulated module. It houses input rectifiers, brake IGBT and freewheeling diode, output inverter, current sense shunts and NTC thermistor. The single-phase input bridge rectifiers are rated at 800V. The inverter section uses 600V, short circuit rated, ultrafast IGBTs and ultrafast freewheeling diodes. Current sensing is achieved through 75 m $\Omega$  low inductance shunts provided in the positive and negative DC bus rail. The NTC thermistor provides temperature sensing capability. The lead spacing on the power module meets UL840 pollution level 3 requirements.

The power circuit and layout within the module are carefully designed to minimize inductance in the power path, to reduce noise during inverter operation and to improve the inverter efficiency. The driver board required to run the inverter can be soldered to the power module pins, thus minimizing assembly and alignment. The power module is designed to be mounted to a heat sink with two screw mount positions, in order to insure good thermal contact between the module substrate and the heat sink.



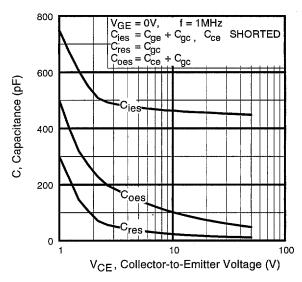
### **Specifications**

Output PowerVoltage $0 \cdot 230V \text{ rms}$ defined by external PWM controlNominal motor hp (kW)1 hp (0.75 kW) nominal full load power 150% overload for 1 minute $V_{\text{in}} = 220V \text{ AC}, f_{\text{pwm}} = 4 \text{ kHz}, f_{\text{o}} = 60 \text{ Hz},$ Nominal motor current4.4A rms nominal full load CURRENT 6.6A rms 150% overload for 1 minute $T_{\text{A}} = 40^{\circ}\text{C}, R_{\text{thSA}} = 1.16^{\circ}\text{C/W}$ DC linkDC link voltage425V maximumBrakeCurrent7.9ASensor $T_{\text{emp}}$ sense resistance $T_{\text{NTC}} = 25^{\circ}\text{C}$ 3.1kOhms $\pm 5\%$ $T_{\text{NTC}} = 100^{\circ}\text{C}$ Current sense $T_{\text{5mOhms}} \pm 5\%$ $T_{\text{SHUNT}} = 25^{\circ}\text{C}$ Protection $T_{\text{SHUNT}} = 25^{\circ}\text{C}$	PARAMETERS	VALUES	CONDITIONS
Frequency   50/60 Hz   10.12A rms @ nominal output   T <sub>A</sub> = 40°C, R <sub>msA</sub> = 1.16°C/W   I <sub>rsM</sub>   150A   10 ms half-cycle, non-repetitive surge   Output Power   Voltage   0 · 230V rms   defined by external PWM control   Nominal motor hp (kW)   1 hp (0.75 kW) nominal full load power   150% overload for 1 minute   T <sub>A</sub> = 40°C, R <sub>msA</sub> = 4 kHz,   f <sub>o</sub> = 60 Hz,   T <sub>A</sub> = 40°C, R <sub>msA</sub> = 1.16°C/W   T <sub></sub>	Input Power		
Current 10.12A rms @ nominal output $T_A = 40^{\circ}\text{C}$ , $R_{IhSA} = 1.16^{\circ}\text{C/W}$ $I_{FSM}$ 150A 10 ms half-cycle, non-repetitive surge $Output Power$ Voltage $0 \cdot 230\text{V rms}$ defined by external PWM control Nominal motor hp (kW) 1 hp (0.75 kW) nominal full load power 150% overload for 1 minute 150% overload for	Voltage	220V, -15%, +10%, 1-phase	
Seminarian   150A   10 ms half-cycle, non-repetitive surge	Frequency	50/60 Hz	
Output PowerVoltage $0 \cdot 230V \text{ rms}$ defined by external PVM controlNominal motor hp (kW)1 hp (0.75 kW) nominal full load power 150% overload for 1 minute $V_{\text{in}} = 220V \text{ AC}, f_{\text{pwm}} = 4 \text{ kHz}, f_{0} = 60 \text{ Hz},$ Nominal motor current4.4A rms nominal full load CURRENT 6.6A rms 150% overload for 1 minute $T_{\text{A}} = 40^{\circ}\text{C}, R_{\text{inSA}} = 1.16^{\circ}\text{C/W}$ DC LinkDC link voltage425V maximumBrakeCurrent7.9ACurrent7.9A $0 \text{ T}_{\text{NTC}} = 25^{\circ}\text{ C}$ 3.1kOhms $\pm 10\%$ $0 \text{ T}_{\text{NTC}} = 100^{\circ}\text{ C}$ Current sense75mOhms $\pm 5\%$ $0 \text{ T}_{\text{SHUNT}} = 25^{\circ}\text{ C}$ Protection $0 \text{ T}_{\text{ISBT}} = 100^{\circ}\text{ C}$ IGBT short circuit time $0 \text{ T}_{\text{ID}} = 100^{\circ}\text{ C}$ Recommended short circuit-shuldown current $0 \text{ T}_{\text{A}} = 100^{\circ}\text{ C}$ Gate Drive $0 \text{ T}_{\text{C}} = 15V$ , refer figure 4bQG $0 \text{ T}_{\text{C}} = 15V$ , refer figure 4bRecommended gate driverIR2132J (refer figure 9)Module	Current	10.12A rms @ nominal output	$T_A = 40^{\circ}C$ , $R_{thSA} = 1.16^{\circ}C/W$
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	I <sub>FSM</sub>	150A	10 ms half-cycle, non-repetitive surge
Nominal motor hp (kW)	Output Power		
	Voltage	0 - 230V rms	defined by external PWM control
Nominal motor current  4.4A rms nominal full load CURRENT 6.6A rms 150% overload for 1 minute  DC Link  DC link voltage 425V maximum  Brake  Current 7.9A  Sensor  Temp. sense resistance 50kOhms $\pm 5\%$ @ $T_{NTC} = 25^{\circ}C$ 3.1kOhms $\pm 10\%$ @ $T_{NTC} = 100^{\circ}C$ Current sense 75mOhms $\pm 5\%$ @ $T_{SHUNT} = 25^{\circ}C$ Protection  IGBT short circuit time 10 $\mu$ s DC bus = 425V, $V_{GE} = 15V$ , line to line shutdown current Gate Drive  QG 34 nC (typical) $V_{GE} = 15V$ , refer figure 4b  Recommended gate driver Module	Nominal motor hp (kW)	1 hp (0.75 kW) nominal full load power	V <sub>in</sub> = 220V AC, f <sub>pwm</sub> = 4 kHz,
6.6A rms 150% overload for 1 minute         DC Link         DC link voltage       425V maximum         Brake       7.9A         Current       7.9A         Sensor       © T <sub>NTC</sub> = 25°C         3.1kOhms ±5%       © T <sub>NTC</sub> = 100°C         Current sense       75mOhms ±5%       © T <sub>SHUNT</sub> = 25°C         Protection         IGBT short circuit time       10 μs       DC bus = 425V, V <sub>GE</sub> = 15V, line to line sequence and short circuit shutdown current         Gate Drive       QG       34 nC (typical)       V <sub>GE</sub> = 15V, refer figure 4b         Recommended gate driver       IR2132J (refer figure 9)         Module       IR2132J (refer figure 9)	• • •	150% overload for 1 minute	f <sub>o</sub> = 60 Hz,
DC link voltage  Brake  Current  7.9A  Sensor  Temp. sense resistance  50kOhms ±5%  3.1kOhms ±10%  Current sense  75mOhms ±5%  © T <sub>NTC</sub> = 25°C  75mOhms ±5%  © T <sub>SHUNT</sub> = 25°C  Protection  IGBT short circuit time  Recommended short circuit-shutdown current  Gate Drive  Q <sub>G</sub> Recommended gate driver  Module  425V maximum  7.9A  © T <sub>NTC</sub> = 25°C  © T <sub>NTC</sub> = 100°C  © T <sub>SHUNT</sub> = 25°C  PDC bus = 425V, V <sub>GE</sub> = 15V, line to line so the second part of the	Nominal motor current		$T_A = 40$ °C, $R_{thSA} = 1.16$ °C/W
BrakeCurrent7.9ASensor $\odot$ Tomp. sense resistance $\odot$ SokOhms $\pm$ 5% $\odot$ Tomp. $\odot$ Compared to $\odot$ Courrent sense $\odot$ Tomp. $\odot$ Courrent sense $\odot$ DC bus = 425V, VGE = 15V, line to line senseRecommended short circuit-shutdown current sense $\odot$ Courrent sense $\odot$ DC bus = 425V, VGE = 15V, line to line senseGate Drive $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ DC bus = 425V, VGE = 15V, line to line senseGate Drive $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ Courrent senseGate Drive $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ Courrent sense $\odot$ Courrent senseQG34 nC (typical) $\odot$ Courrent sense $\odot$ Courrent senseQG34	DC Link		
Current 7.9A  Sensor  Temp. sense resistance 50kOhms $\pm 5\%$ @ $T_{NTC} = 25^{\circ}C$ 3.1kOhms $\pm 10\%$ @ $T_{NTC} = 100^{\circ}C$ Current sense 75mOhms $\pm 5\%$ @ $T_{SHUNT} = 25^{\circ}C$ Protection  IGBT short circuit time 10 $\mu$ s DC bus = 425V, $V_{GE} = 15V$ , line to line secommended short circuit-shutdown current Qate Drive  QG 34 nC (typical) $V_{GE} = 15V$ , refer figure 4b  Recommended gate driver IR2132J (refer figure 9)  Module	DC link voltage	425V maximum	
Sensor50kOhms $\pm 5\%$ @ $T_{NTC} = 25^{\circ}C$ Temp. sense resistance $50kOhms \pm 5\%$ @ $T_{NTC} = 100^{\circ}C$ Current sense $75mOhms \pm 5\%$ @ $T_{SHUNT} = 25^{\circ}C$ ProtectionIGBT short circuit time $10 \mu s$ DC bus = $425V$ , $V_{GE} = 15V$ , line to line $s$ Recommended short circuit-shutdown current $20A peak$ Gate DriveQG34 nC (typical) $V_{GE} = 15V$ , refer figure $4b$ Recommended gate driverIR2132J (refer figure $9$ )	Brake		
Temp. sense resistance $50 \text{kOhms} \pm 5\%$ $@ T_{NTC} = 25 ^{\circ}\text{C}$ $3.1 \text{kOhms} \pm 10\%$ $@ T_{NTC} = 100 ^{\circ}\text{C}$ Current sense $75 \text{mOhms} \pm 5\%$ $@ T_{SHUNT} = 25 ^{\circ}\text{C}$ Protection $$10 \text{ µs}$$ DC bus = 425V, $V_{GE} = 15 \text{V}$ , line to line sequence and the second short circuit shutdown current $$Gate\ Drive$$ QG $$34\ \text{nC}\ (typical)$$ $$V_{GE} = 15 \text{V}$$ , refer figure 4b $$Module$$ $$Module$$		7.9A	
$3.1 \text{kOhms} \pm 10\% \qquad \qquad @ \text{T}_{\text{NIC}} = 100^{\circ}\text{C}$ Current sense $75 \text{mOhms} \pm 5\% \qquad \qquad @ \text{T}_{\text{SHUNT}} = 25^{\circ}\text{C}$ Protection  IGBT short circuit time $10  \mu \text{s} \qquad \qquad DC \text{ bus} = 425\text{V}, \text{ V}_{\text{GE}} = 15\text{V}, \text{ line to line s}$ Recommended short circuit-shutdown current $Gate \text{ Drive}$ $Q_{\text{G}} \qquad \qquad 34 \text{ nC (typical)} \qquad \qquad V_{\text{GE}} = 15\text{V}, \text{ refer figure 4b}$ Recommended gate driver $IR2132J \text{ (refer figure 9)}$ $Module$	Sensor		
Current sense 75mOhms $\pm 5\%$ @ $T_{SHUNT} = 25^{\circ}C$ Protection  IGBT short circuit time 10 $\mu$ s DC bus = 425V, $V_{GE} = 15$ V, line to line sent the short circuit shutdown current Gate Drive  QG 34 nC (typical) $V_{GE} = 15$ V, refer figure 4b  Recommended gate driver IR2132J (refer figure 9)	Temp. sense resistance	50kOhms ±5%	@ T <sub>NTC</sub> = 25°C
Protection  IGBT short circuit time Recommended short circuit shutdown current $Gate \ Drive$ QG  A 4 nC (typical)  Recommended gate driver  IR2132J (refer figure 9)  Module  DC bus = 425V, V <sub>GE</sub> = 15V, line to line so the province of		3.1kOhms ±10%	@ T <sub>NTC</sub> = 100°C
IGBT short circuit time  Recommended short circuit- shutdown current $O(S)$	Current sense	75mOhms ±5%	@ T <sub>SHUNT</sub> = 25°C
Recommended short circuit- shutdown current  Gate Drive  Q <sub>G</sub> 34 nC (typical)  Recommended gate driver  IR2132J (refer figure 9)  Module	Protection		
shutdown current  Gate Drive  Q <sub>G</sub> 34 nC (typical) V <sub>GE</sub> = 15V, refer figure 4b  Recommended gate driver IR2132J (refer figure 9)  Module	IGBT short circuit time	10 μs	DC bus = 425V, $V_{GE}$ = 15V, line to line short
Gate Drive  Q <sub>G</sub> 34 nC (typical) V <sub>GE</sub> = 15V, refer figure 4b  Recommended gate driver IR2132J (refer figure 9)  Module		20A peak	
$Q_G$ 34 nC (typical) $V_{GE}$ = 15V, refer figure 4b Recommended gate driver IR2132J (refer figure 9)			
Recommended gate driver IR2132J (refer figure 9)  Module	Gate Drive		
Module	9	, ,	V <sub>GE</sub> = 15V, refer figure 4b
	•	IR2132J (refer figure 9)	
Isolation voltage 2500V rms pin to baseplate, 60 Hz, 1 minute	Module		
	Isolation voltage	2500V rms	pin to baseplate, 60 Hz, 1 minute
Operating case temperature -25°C to 125°C 95% RH max. (non-condensing)	Operating case temperature	-25°C to 125°C	95% RH max. (non-condensing)
Mounting torque 1 Nm M4 screw type	Mounting torque	1 Nm	M4 screw type
Storage temperature range -40°C to 125°C	Storage temperature range	-40°C to 125°C	
Soldering temperature for 10 sec. 260°C maximum at the pins (.06" from case)	Soldering temperature for 10 sec.	260°C maximum	at the pins (.06" from case)

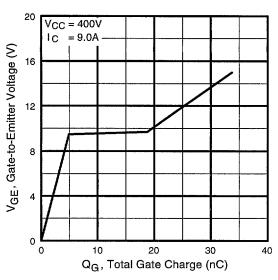
### **IRPT1065A**

International

TOR Rectifier



**Figure 4a.** Typical Capacitance vs Collector-to-Emitter Voltage



**Figure 4b.** Typical Gate Charge vs Gate-to-Emitter Voltage

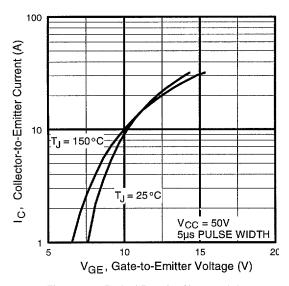
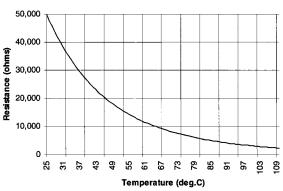


Figure 4c. Typical Transfer Characteristics



**Figure 5.** Nominal R-T Characteristics of the NTC Thermistor

## **Mounting Procedure Mounting**

- Connect the driver board and the IRPT1065A power module.
- 2. Remove all particles and grit from the heat sink and power substrate.
- 3. Spread a .004" to .005" layer of silicone grease on the heat sink, covering the entire area that the power substrate will occupy. Recommended heat sink flatners is .001 inch/inch and Total Indicator Readout (TIR) of .003 inch below substrate.
- 4. Place the power substrate onto the heat sink with the mounting holes aligned and press it firmly into the silicone grease.
- 5. Place the 2 M4 mounting screws through the PCB and power module and into the heat sink and tighten the screws to 1 Nm torque.

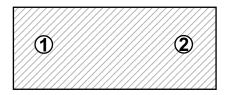


Figure 6. Power Module Mounting Screw Sequence

#### **Power Connections**

The power module pin designation, function and other details can be obtained from the package outline in Figure 7 and circuit diagram in Figure 8. Single phase input connections made to pins S and T and inverter output connections are made to pins U, V and W. Positive rectifier output and positive inverter bus are brought out to pins RP and P respectively in order to provide DC bus capacitor soft charging implementation option. The current shunt terminals are connected to pins IS1, IS2 and IS3, IS4 on the positive and negative DC rails respectively.

# Functional Information Heat Sink Requirements

Figures 3a-3b show the thermal resistance of the heat sink required for various output power levels and Pulse-Width-Modulated (PWM) switching frequencies. Maximum total losses of the unit are also shown. This data is based on the following key operating conditions:

- The maximum continuous combined losses of the rectifier and inverter occur at full pulse-width-modulation. These maximum losses set the maximum continuous operating temperature of the heat sink.
- The maximum combined losses of the rectifier and inverter at full pulse-width-modulation under overload set the incremental temperature rise of the heat sink during overload.
- The minimum output frequency at which full load current is to be delivered sets the peak IGBT junction temperature.
- At low output frequency, IGBT junction temperature tends to follow the instantaneous fluctuations of the output current. Thus, peak junction temperature rise increases as output frequency decreases.

### **Over Temperature Protection**

Over temperature can be detected using the NTC thermistor included in the power module for thermal sensing. Protection circuit that initiates a shutdown if the temperature of the IMS substrate exceeds a set level can be implemented. The nominal resistance vs. temperature characteristic of the thermistor is given in Figure 5.

### **Voltage Rise During Braking**

The motor will feed energy back to the DC link during regenerative braking, forcing the DC bus voltage to rise above the level defined by the input line voltage. Deceleration of the motor must be controlled by appropriate PWM control to keep the DC bus voltage within the rated maximum value.

**NOTE:** Dimensions are in inches (millimeters)

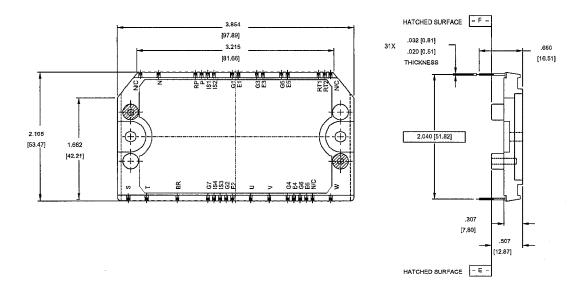


Figure 7a. Power Module Package Outline

**NOTE:** Dimensions are in inches (millimeters)

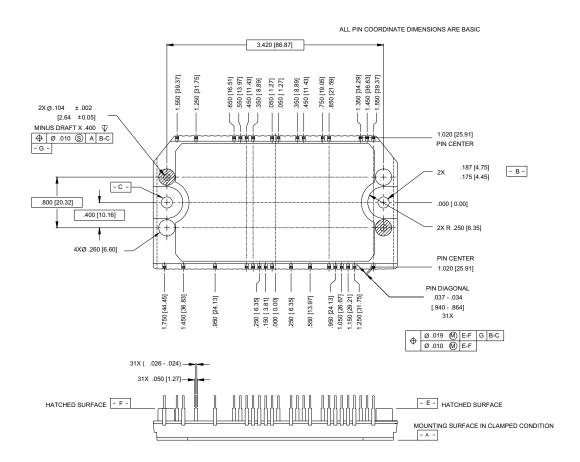


Figure 7b. Power Module Package Outline

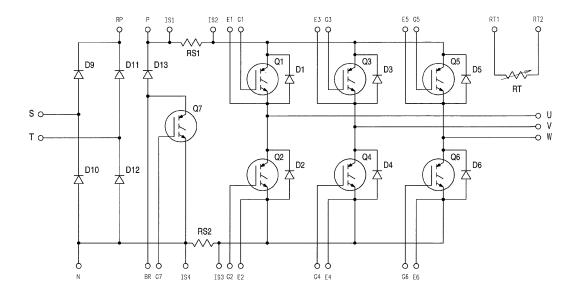


Figure 8. Power Module Circuit Diagram

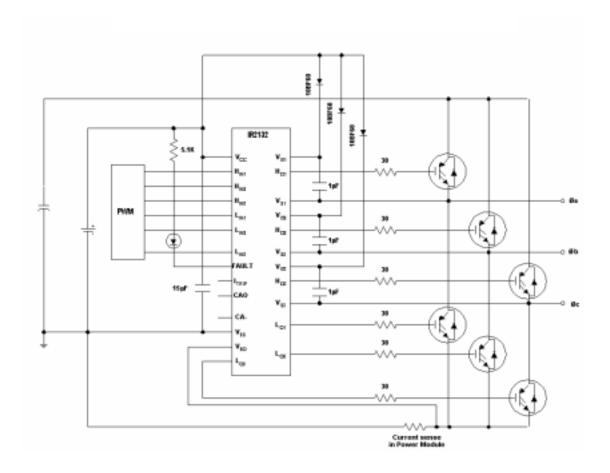


Figure 9. Recommended Gate Drive Circuit

### Part Number Identification and Ordering Instructions

### **IRPT1065A Power Module**

Chip and wire epoxy encapsulated module with 800V input rectifiers, 600V short-circuit rated, ultra-fast IGBT inverter with

ultra-fast freewheeling diodes, temperature sensing NTC thermistor and current-sensing low-inductance shunts.

**IRPT1065A** 

International

TOR Rectifier

# International TOR Rectifier

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