*Preliminary Data Sheet*

# Hybrid Power Module

## Integrated Power Stage for 230 VAC Motor Drives

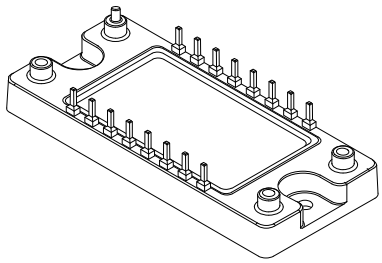
**MHPM6B10A60D**
**MHPM6B20A60D**

**Motorola Preferred Devices**

**10, 20 AMP, 600 V**
**HYBRID POWER MODULES**

These modules integrate a 3–phase inverter in a single convenient package. They are designed for 1.0 and 2.0 hp motor drive applications. The inverter incorporates advanced insulated gate bipolar transistors (IGBT) matched with free–wheeling diodes to give optimum performance. The top connector pins are designed for easy interfacing to the user's control board.

- Short Circuit Rated 10 μs @ 125°C
- Pin-to-Baseplate Isolation Exceeds 2500 Vac (rms)
- Compact Package Outline
- Access to Positive and Negative DC Bus
- UL Recognized



PRELIMINARY

**MAXIMUM DEVICE RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Rating | | Symbol | Value | Unit |
|---|---|---|---|---|
| IGBT Reverse Voltage | | $V_{CES}$ | 600 | V |
| Gate-Emitter Voltage | | $V_{GES}$ | ± 20 | V |
| Continuous IGBT Collector Current | 10A60<br>20A60 | $I_{Cmax}$ | 10<br>20 | A |
| Peak Repetitive IGBT Collector Current (1) | 10A60<br>20A60 | $I_{C(pk)}$ | 20<br>40 | A |
| Continuous Diode Current | 10A60<br>20A60 | $I_{Fmax}$ | 10<br>20 | A |
| Peak Repetitive Diode Current (1) | 10A60<br>20A60 | $I_{F(pk)}$ | 20<br>40 | A |
| IGBT Power Dissipation ($T_C$ = 25°C) | 10A60<br>20A60 | $P_D$ | 52<br>78 | W |
| Diode Power Dissipation ($T_C$ = 25°C) | 10A60<br>20A60 | $P_D$ | 19<br>38 | W |
| IGBT Power Dissipation ($T_C$ = 95°C) | 10A60<br>20A60 | $P_D$ | 23<br>34 | W |
| Diode Power Dissipation ($T_C$ = 95°C) | 10A60<br>20A60 | $P_D$ | 8.3<br>17 | W |
| Junction Temperature Range | | $T_J$ | – 40 to +150 | °C |
| Short Circuit Duration ($V_{CC}$ = 300 V, $T_J$ = 125°C) | | $t_{sc}$ | 10 | μsec |
| Isolation Voltage | | $V_{ISO}$ | 2500 | V |
| Operating Case Temperature Range | | $T_C$ | – 40 to +95 | °C |
| Storage Temperature Range | | $T_{stg}$ | – 40 to +125 | °C |
| Mounting Torque — Heat Sink Mounting Holes (#8 or M4 screws) | | — | 12 | in–lb |

(1) 1.0 ms = 1.0% duty cycle

This document contains information on a product under development. Motorola reserves the right to change or discontinue this product without notice.

**Preferred** devices are Motorola recommended choices for future use and best overall value.

REV 2

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**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Gate-Emitter Leakage Current ($V_{CE}$ = 0 V, $V_{GE}$ = ± 20 V) | $I_{GES}$ | — | — | ± 20 | μA |
| Collector-Emitter Leakage Current ($V_{CE}$ = 600 V, $V_{GE}$ = 0 V)<br>$T_J$ = 125°C | $I_{CES}$ | — | 6.0<br>2000 | 100 | μA |
| Gate-Emitter Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 1.0 mA) | $V_{GE(th)}$ | 4.0 | 6.0 | 8.0 | V |
| Collector-Emitter Breakdown Voltage ($I_C$ = 10 mA, $V_{GE}$ = 0 V) | $V_{(BR)CES}$ | 600 | — | — | V |
| Collector-Emitter Saturation Voltage ($I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V)<br>$T_J$ = 125°C | $V_{CE(SAT)}$ | —<br>— | 2.35<br>2.31 | 3.5<br>— | V |
| Diode Forward Voltage ($I_F$ = $I_{Fmax}$, $V_{GE}$ = 0 V)<br>$T_J$ = 125°C | $V_F$ | —<br>— | 1.23<br>1.12 | 2.0<br>— | V |
| Input Capacitance ($V_{CE}$ = 10 V, $V_{GE}$ = 0 V, f = 1.0 Mhz)<br>10A60<br>20A60 | $C_{ies}$ | <br>—<br>— | <br>2300<br>4400 | <br>—<br>— | pF |
| Input Gate Charge ($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V)<br>10A60<br>20A60 | $Q_T$ | <br>—<br>— | <br>75<br>135 | <br>—<br>— | nC |

**INDUCTIVE SWITCHING CHARACTERISTICS** ($T_J$ = 25°C)

| | | | | | |
|---|---|---|---|---|---|
| Recommended Gate Resistor | | | | | Ω |
| Turn–On | 10A60 | $R_{G(on)}$ | — | 180 | — | |
| | 20A60 | | — | 47 | — | |
| Turn–Off | | $R_{G(off)}$ | — | 20 | — | |
| Turn-On Delay Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_{d(on)}$ | | | | ns |
| | 10A60 | | — | 375 | — | |
| | 20A60 | | — | 215 | — | |
| Rise Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_r$ | | | | ns |
| | 10A60 | | — | 160 | — | |
| | 20A60 | | — | 125 | — | |
| Turn–Off Delay Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_{d(off)}$ | — | 219 | — | ns |
| Fall Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_f$ | — | 210 | 500 | ns |
| Turn-On Energy<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $E_{(on)}$ | | | | mJ |
| | 10A60 | | — | 0.85 | 1.0 | |
| | 20A60 | | — | 1.6 | 2.0 | |
| Turn-Off Energy<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $E_{(off)}$ | | | | mJ |
| | 10A60 | | — | 0.13 | 1.0 | |
| | 20A60 | | — | 0.3 | 2.0 | |
| Diode Reverse Recovery Time<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | | $t_{rr}$ | — | 150 | — | ns |
| Peak Reverse Recovery Current<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | 10A60 | $I_{rrm}$ | — | 6.8 | — | A |
| | 20A60 | | — | 12 | — | |
| Diode Stored Charge<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | 10A60 | $Q_{rr}$ | — | 560 | — | nC |
| | 20A60 | | — | 1060 | — | |

**INDUCTIVE SWITCHING CHARACTERISTICS** ($T_J$ = 125°C)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Turn–On Delay Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_{d(on)}$ | | | | ns |
| | 10A60 | | — | 335 | — | |
| | 20A60 | | — | 200 | — | |
| Rise Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_r$ | | | | ns |
| | 10A60 | | — | 160 | — | |
| | 20A60 | | — | 125 | — | |
| Turn–Off Delay Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_{d(off)}$ | — | 230 | — | ns |
| Fall Time<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $t_f$ | — | 460 | — | ns |
| Turn–On Energy<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $E_{(on)}$ | | | | mJ |
| | 10A60 | | — | 1.2 | — | |
| | 20A60 | | — | 2.2 | — | |
| Turn–Off Energy<br>($V_{CE}$ = 300 V, $I_C$ = $I_{Cmax}$, $V_{GE}$ = 15 V, $R_G$ as specified) | | $E_{(off)}$ | | | | mJ |
| | 10A60 | | — | 0.44 | — | |
| | 20A60 | | — | 0.82 | — | |
| Diode Reverse Recovery Time<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | | $t_{rr}$ | — | 240 | — | ns |
| Peak Reverse Recovery Current<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | 10A60 | $I_{rrm}$ | — | 10 | — | A |
| | 20A60 | | — | 18 | — | |
| Diode Stored Charge<br>($I_F$ = $I_{Fmax}$, V = 300 V, $R_G$ as specified) | 10A60 | $Q_{rr}$ | — | 1330 | — | nC |
| | 20A60 | | — | 2400 | — | |

**THERMAL CHARACTERISTICS** (Each Die)

| | | | | | | |
|---|---|---|---|---|---|---|
| Thermal Resistance — IGBT | 10A60 | $R_{\theta JC}$ | — | 1.94 | 2.43 | °C/W |
| | 20A60 | | — | 1.28 | 1.60 | |
| Thermal Resistance — Free–Wheeling Diode | 10A60 | $R_{\theta JC}$ | — | 5.28 | 6.60 | °C/W |
| | 20A60 | | — | 2.61 | 3.26 | |

## TYPICAL CHARACTERISTICS

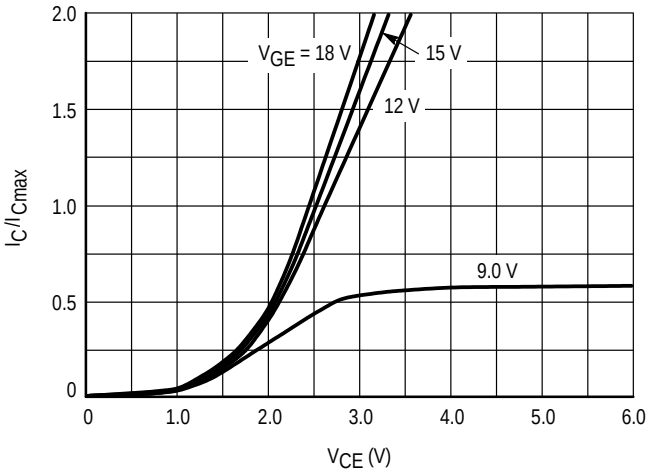



**Figure 1. Normalized $I_C$ versus $V_{CE}$, $T_J$ = 25°C**

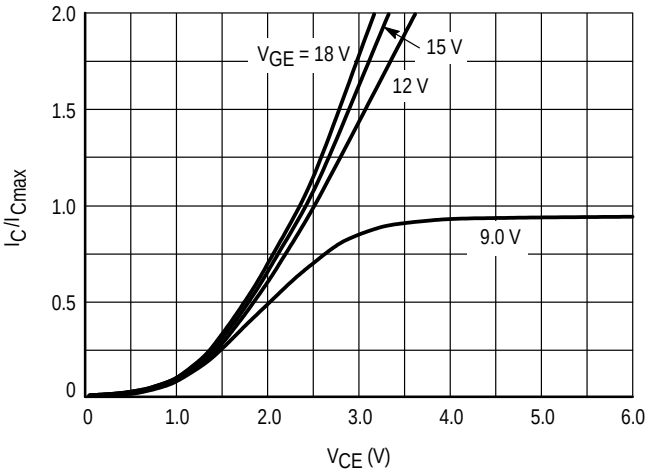



**Figure 2. Normalized $I_C$ versus $V_{CE}$, $T_J$ = 125°C**

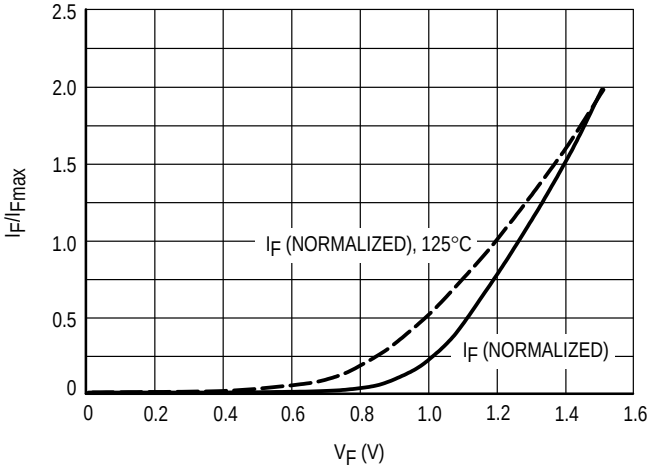



**Figure 3. $I_F$ versus $V_F$**

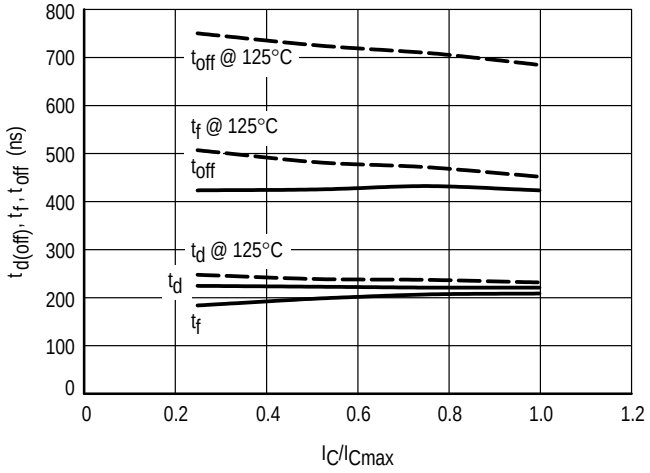



**Figure 4. $t_{d(off)}$, $t_f$, $t_{off}$ versus Normalized $I_C$**

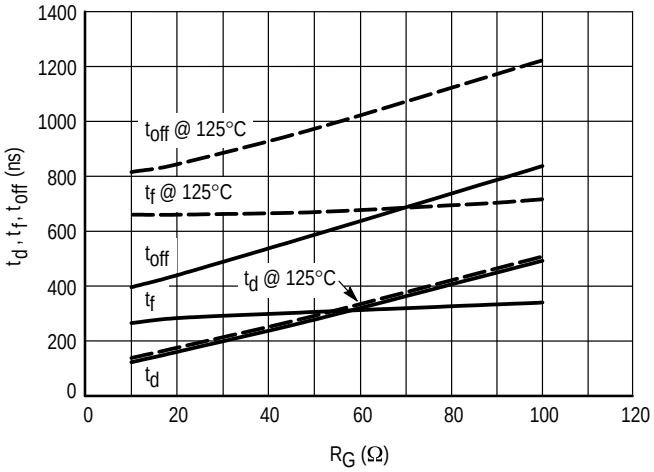



**Figure 5. $t_{d(off)}$, $t_f$, $t_{off}$, versus $R_G$**

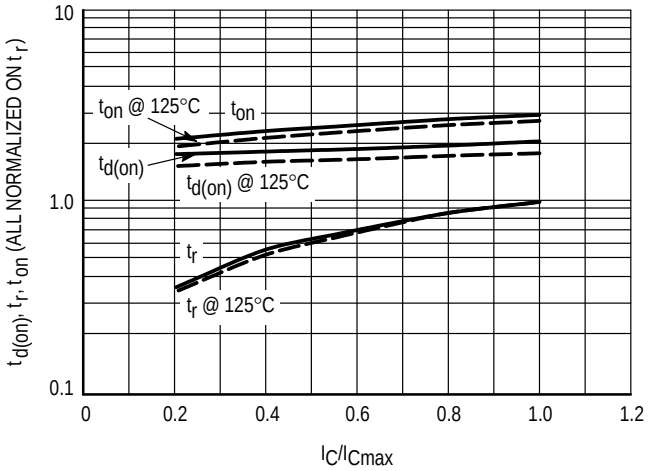



**Figure 6. $t_{d(on)}$, $t_r$, $t_{on}$ versus $I_C$**

## TYPICAL CHARACTERISTICS

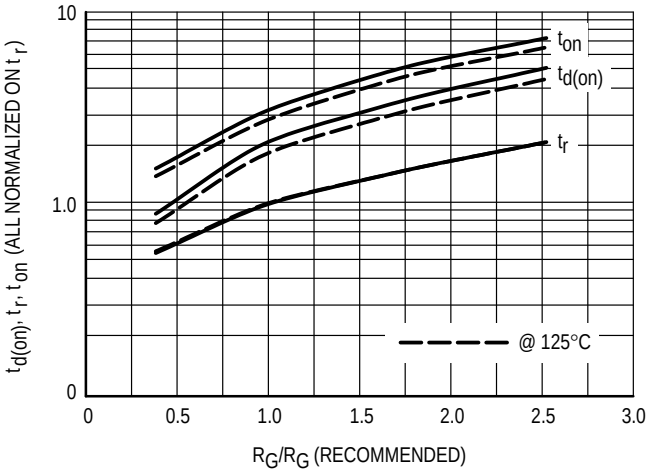



**Figure 7. $t_{d(on)}$, $t_r$, $t_{on}$ versus Normalized $R_G$**

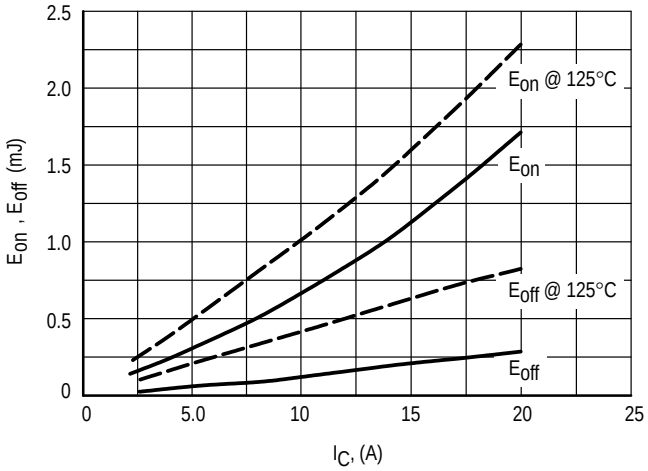



**Figure 8. $E_{on}$, $E_{off}$ versus $I_C$**

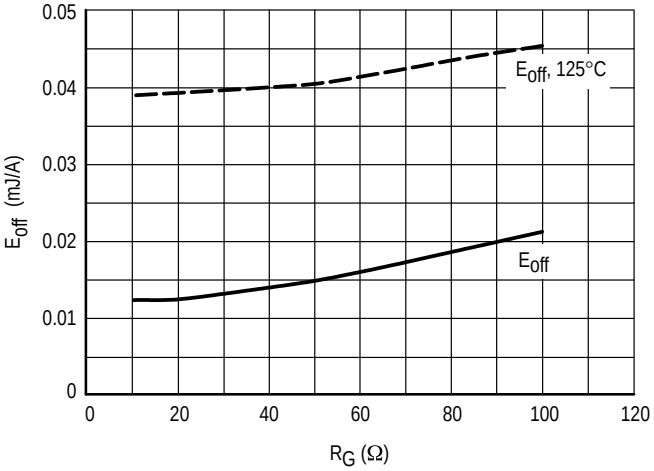



**Figure 9. $E_{off}$ versus $R_{G(off)}$ at Rated $I_C$**

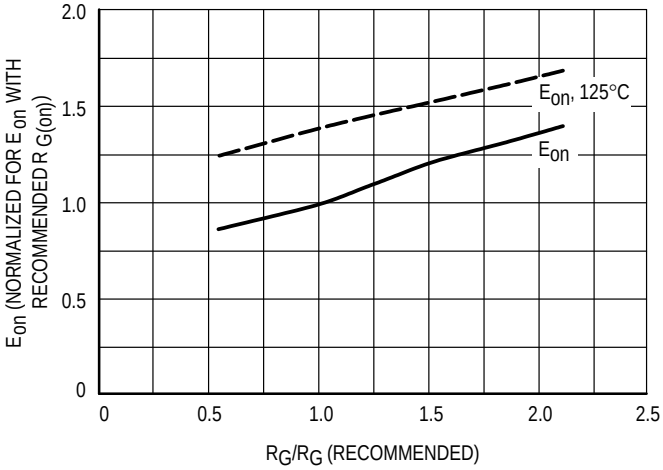



**Figure 10. Normalized $E_{on}$ versus Normalized $R_{G(on)}$**

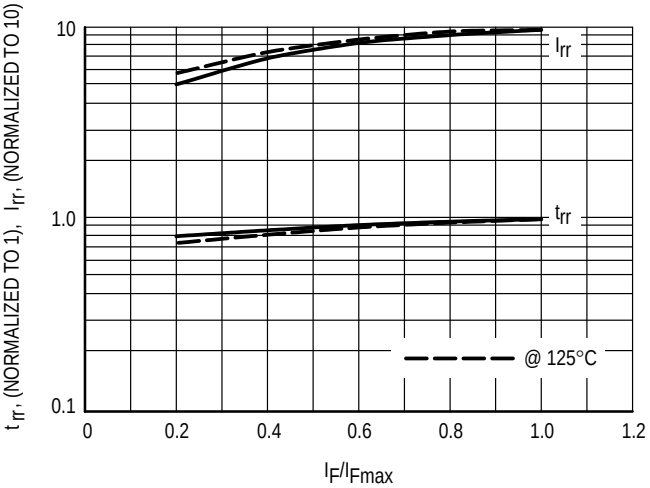



**Figure 11. $t_{rr}$, $I_{rr}$ versus $I_F$**

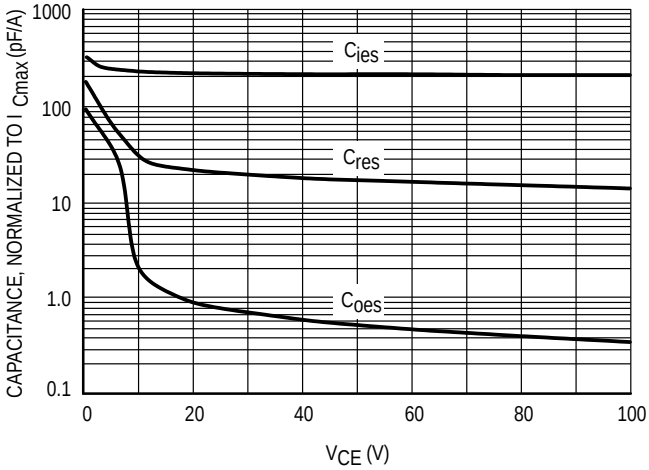



**Figure 12. Capacitance Variation**

## TYPICAL CHARACTERISTICS

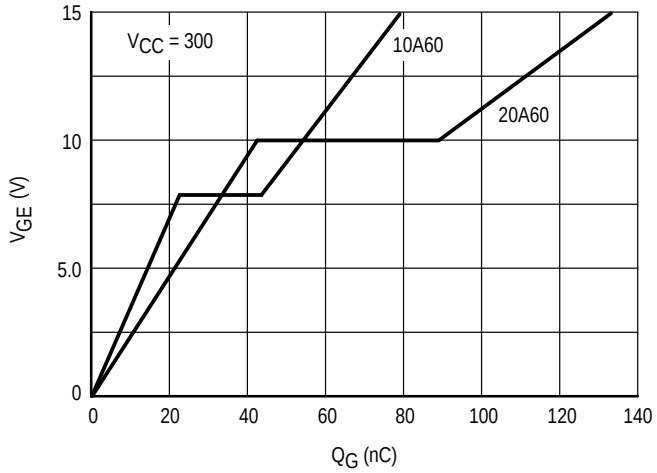



**Figure 13. $V_{GE}$ versus $Q_G$**

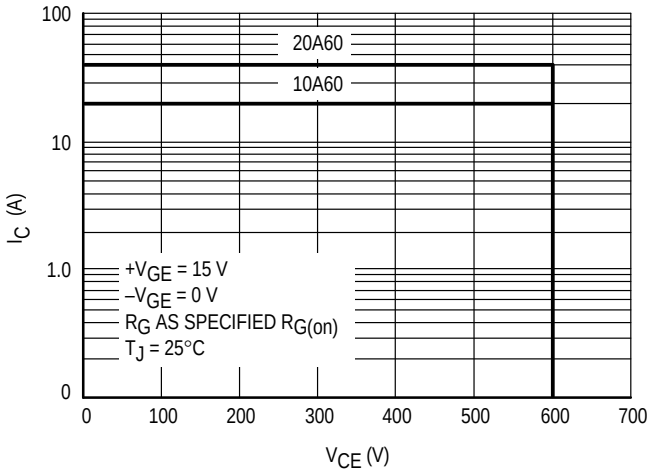



**Figure 14. Reverse Biased Safe operating Area**

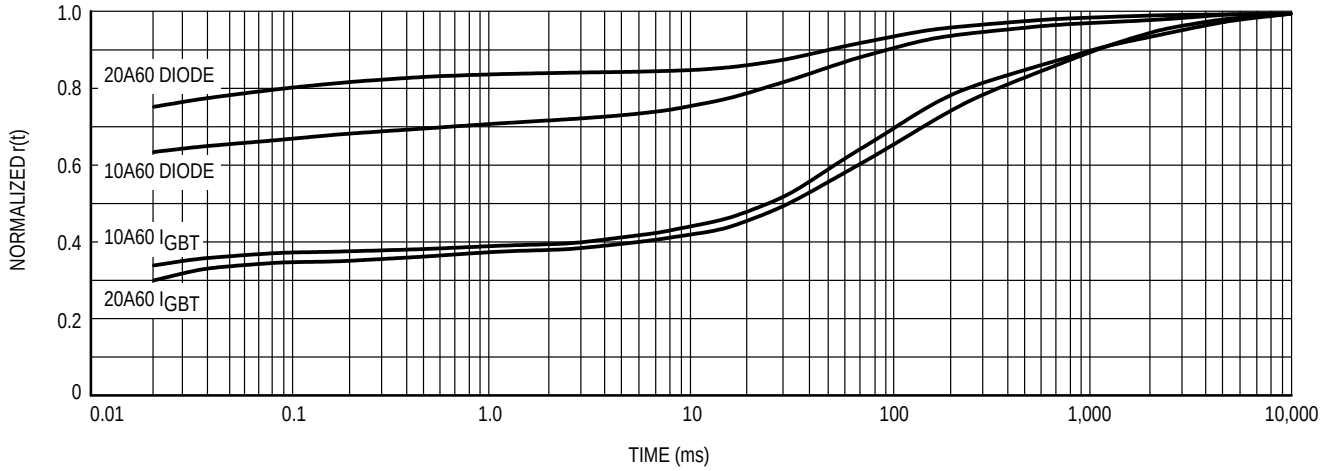



**Figure 15. Normalized Transient Thermal Resistance**

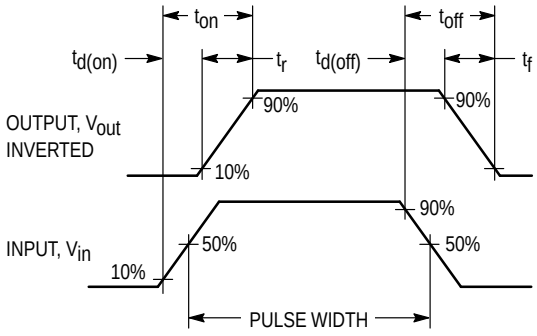



**Figure 16. Switching Waveforms**

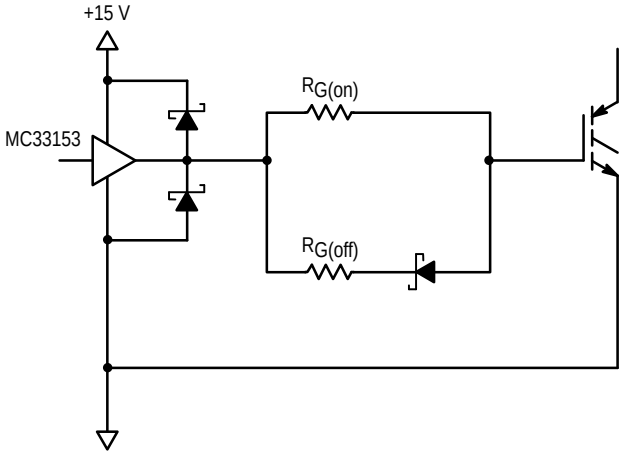



**Figure 17. Typical Gate Drive Circuit**

## APPLICATION INFORMATION

These modules are designed to be used as the power stage of a three–phase AC induction motor drive. They may be used for up to 230 VAC applications. Switching frequencies up to 10 kHz have been considered in the design.

Gate resistance recommendations have been listed. Separate turn–on and turn–off resistors are listed, to be used in a circuit resembling Figure 17. All switching characteristics are given based on following these recommendations, but appropriate graphs are shown for operation with different gate resistance. In order to equalize across the two different module ratings, a normalization process was used. Actual typical values are listed in the second section of this specification sheet, “Electrical Specifications,” but many of the graphs are given in normalized units.

The first three graphs, the DC characteristics, are normalized for current. The devices are designed to operate the same at rated maximum current (10 and 20 A). The curves extend to $I_{Cpk}$, the maximum allowable instantaneous current.

The next graph, turn–off times versus current, is again normalized to the rated maximum current. The following graph, turn–off times versus $R_{G(off)}$, is intentionally not normalized, as both modules behave similarly during turn–off.

Turn–on times have been normalized. Again, the graph showing variation due to current has been normalized for rated maximum current. The graph showing variation due to gate resistance normalizes against the recommended $R_{G(on)}$ for each module. In addition, the times are normalized to $t_r$ at the appropriate temperature. For example, $t_{d(on)}$ for a 10 A module operating at 125°C at 4.0 A can be found by multiplying the typical $t_r$ for a 10 A module at 125°C (160 ns) by the value shown on the graph at a normalized current of 0.4 (1.6) to get 256 ns. The most salient features demonstrated by these graphs are the general trends: rise time is a larger fraction of total turn–on time at 125°C, and in general, larger gate resistance results in slower switching.

Graphs of switching energies follow a similar structure. The first of these graphs, showing variation due to current, is not normalized, as any of these devices operating within its limits follows the same trend. $E_{off}$ does not need to be normalized to show variation with $R_{G(off)}$, as both are specified with the same nominal resistance. $E_{on}$, however, has been appropriately normalized. Gate resistance has been normalized to the specified $R_{G(on)}$. In order to show the effect of elevated temperature, all energies were normalized to $E_{on}$ at 25°C using the recommended $R_{G(on)}$.

Reverse recovery characteristics are also normalized. $I_F$ is normalized to rated maximum current. $I_{rrm}$ is normalized so that at maximum current at either 25°C or 125°C, the graph indicates “10”, while $t_{rr}$ is normalized to be “1” at maximum current at either temperature.

Capacitance values are normalized for $I_{Cmax}$. Due to poor scaling, gate charge and thermal characteristics are shown separately for each module.

Many issues must be considered when doing PCB layout. Figure 19 shows the footprint of a module, allowing for reasonable tolerances. A polarizing post is provided near pin 1 to ensure that the module is properly inserted during final assembly. When laying out traces, two issues are of primary importance: current carrying capacity and voltage clearance. Many techniques may be used to maximize both, including using traces on both sides of the PCB to double total copper thickness, providing cut–outs in high–current traces near high–voltage pins, and even removing portions of the board to increase “over–the–surface” creepage distance. Some additional advantage may be gained by potting the entire board assembly in a good dielectric. Consult appropriate regulatory standards, such as UL 840, for more details on high–voltage creepage and clearance.

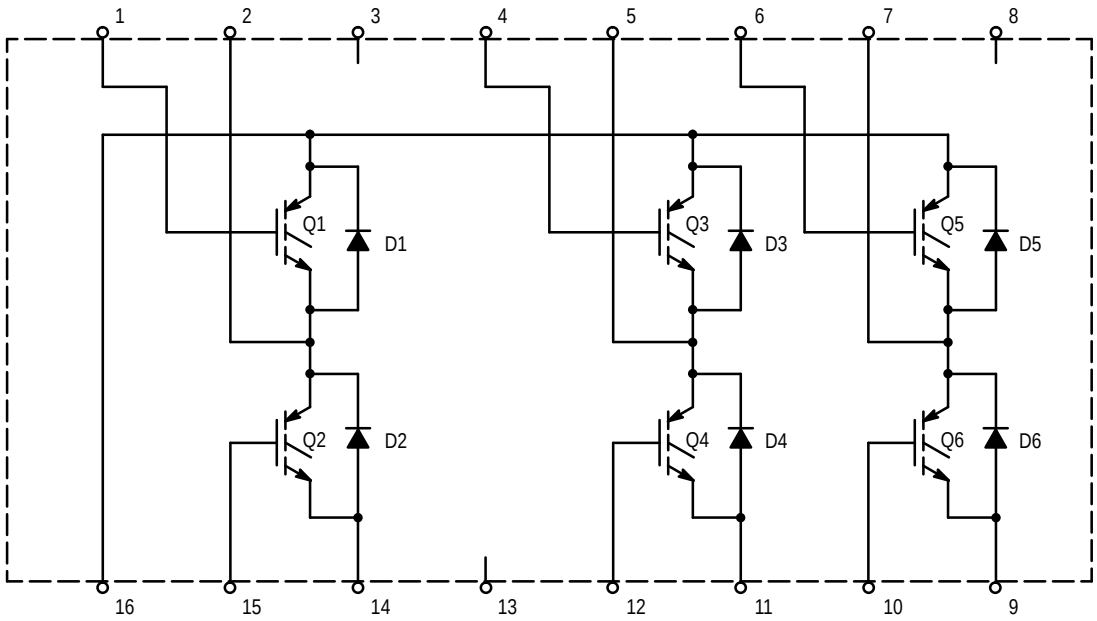



**Figure 18. Schematic of Internal Circuit, Showing Package Pin–Out**

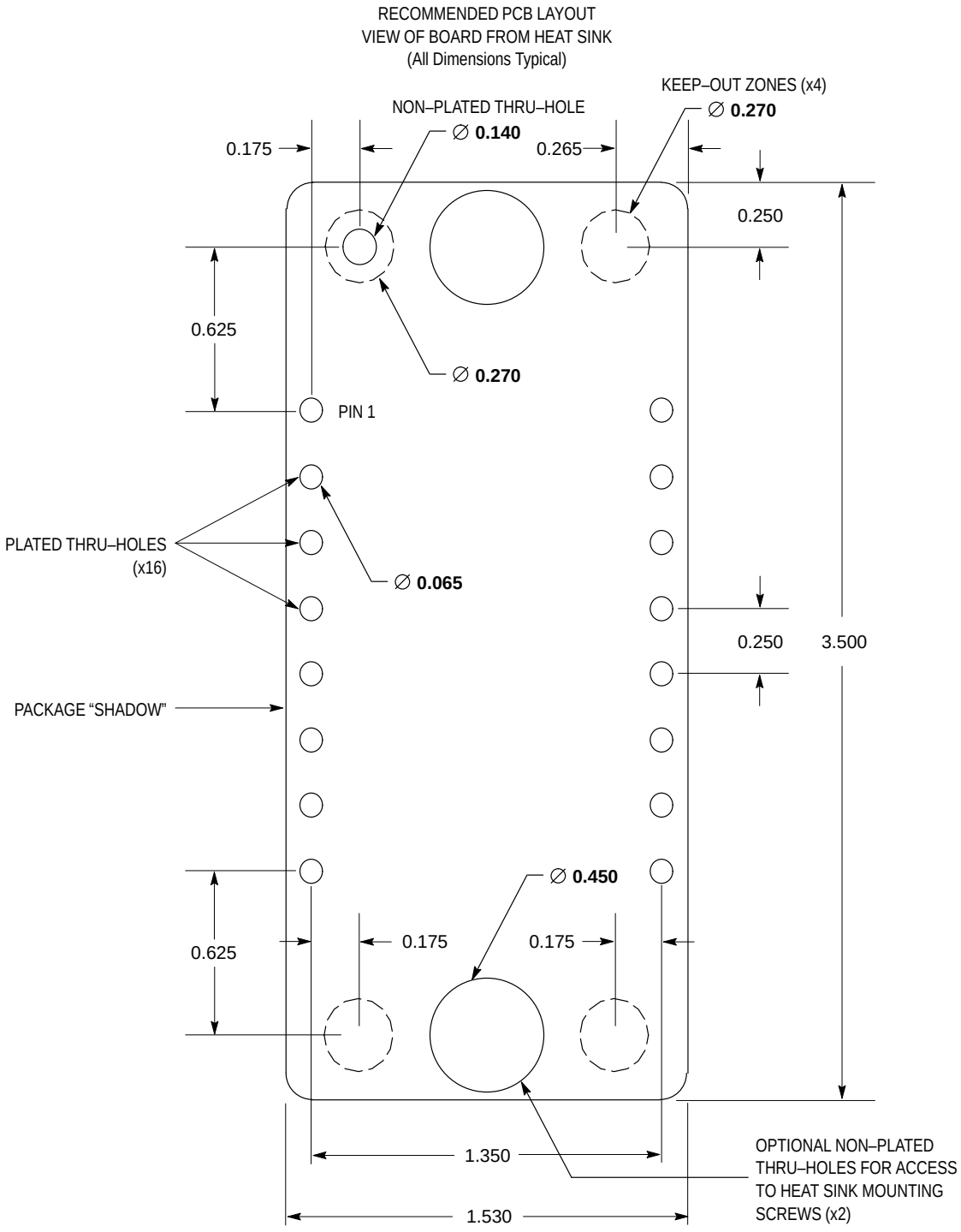
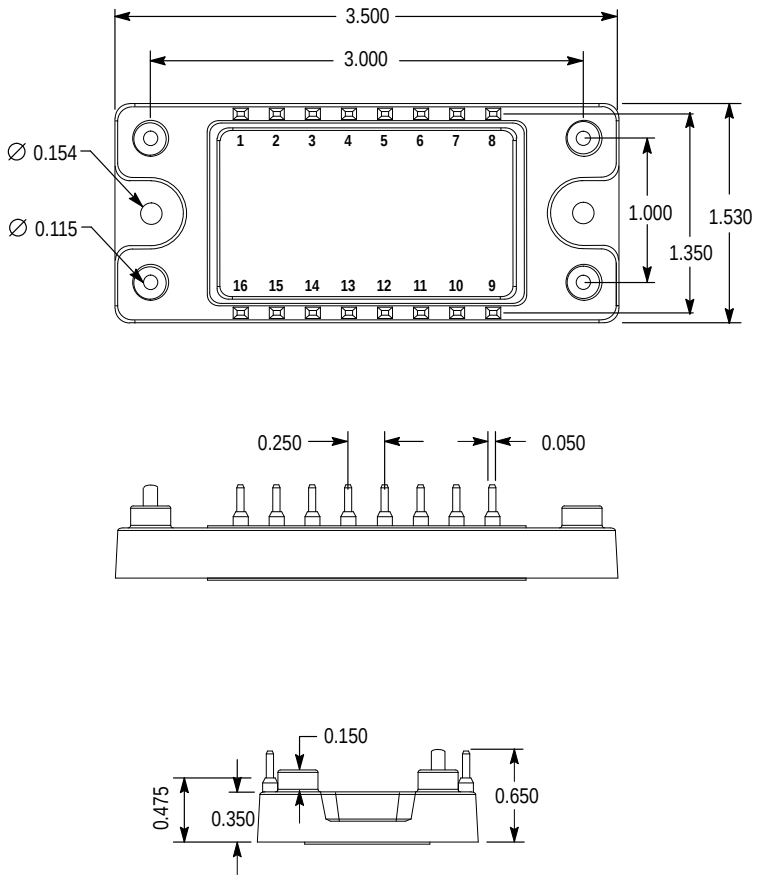



**Figure 19. Package Footprint**

NOTES:
1. Package is symmetrical, except for a polarizing plastic post near pin 1, indicated by a non–plated thru–hole in the footprint.
2. Dimension of plated thru–holes indicates finished hole size after plating.
3. Access holes for mounting screws may or may not be necessary depending on assembly plan for finished product.

## PACKAGE DIMENSIONS




**PRELIMINARY**

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Живое партнерство

**ООО «ЛайфЭлектроникс»** **“LifeElectronics” LLC**

*ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703*

*Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.*

*С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров*

*Мы предлагаем:*

- *Конкурентоспособные цены и скидки постоянным клиентам.*
- *Специальные условия для постоянных клиентов.*
- *Подбор аналогов.*
- *Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.*

- *Приемлемые сроки поставки, возможна ускоренная поставка.*
- *Доставку товара в любую точку России и стран СНГ.*
- *Комплексную поставку.*
- *Работу по проектам и поставку образцов.*
- *Формирование склада под заказчика.*

- *Сертификаты соответствия на поставляемую продукцию (по желанию клиента).*
- *Тестирование поставляемой продукции.*
- *Поставку компонентов, требующих военную и космическую приемку.*
- *Входной контроль качества.*
- *Наличие сертификата ISO.*

*В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.*

*Конструкторский отдел помогает осуществить:*

- *Регистрацию проекта у производителя компонентов.*
- *Техническую поддержку проекта.*
- *Защиту от снятия компонента с производства.*
- *Оценку стоимости проекта по компонентам.*
- *Изготовление тестовой платы монтаж и пусконаладочные работы.*

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***www.lifeelectronics.ru***