# MHPM7B20A60A

Motorola Preferred Device

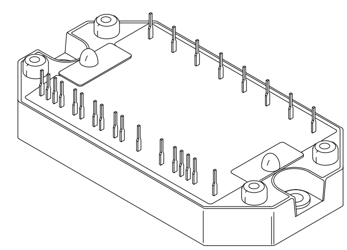
# Hybrid Power Module

## Integrated Power Stage for 2.0 hp Motor Drives

This module integrates a 3–phase input rectifier bridge, 3–phase output inverter and brake transistor/diode in a single convenient package. The output inverter utilizes advanced insulated gate bipolar transistors (IGBT) matched with free–wheeling diodes to give optimal dynamic performance. It has been configured for use as a three–phase motor drive module or for many other power switching applications. The top connector pins have been designed for easy interfacing to the user's control board.

- Short Circuit Rated 10 µs @ 25°C
- Pin-to-Baseplate Isolation Exceeds 2500 Vac (rms)
- Convenient Package Outline
- UL Recognized and Designed to Meet VDE
- Access to Positive and Negative DC Bus

**20 AMP, 600 VOLT**
**HYBRID POWER MODULE**



PLASTIC PACKAGE
**CASE 440-01, Style 1**

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

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| **INPUT RECTIFIER BRIDGE** | | | |
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | 600 | V |
| Average Output Rectified Current (1) | $I_O$ | 20 | A |
| Peak Non-repetitive Surge Current | $I_{FSM}$ | 240 | A |
| **OUTPUT INVERTER** | | | |
| IGBT Reverse Voltage | $V_{CES}$ | 600 | V |
| Gate-Emitter Voltage | $V_{GES}$ | ± 20 | V |
| Continuous IGBT Collector Current | $I_C$ | 20 | A |
| Peak IGBT Collector Current – (PW = 1.0 ms) (2) | $I_{C(pk)}$ | 40 | A |
| Continuous Free-Wheeling Diode Current | $I_F$ | 20 | A |
| Peak Free-Wheeling Diode Current – (PW = 1.0 ms) (2) | $I_{F(pk)}$ | 40 | A |
| IGBT Power Dissipation | $P_D$ | 78 | W |
| Free-Wheeling Diode Power Dissipation | $P_D$ | 39 | W |
| IGBT Junction Temperature Range | $T_J$ | – 40 to +125 | °C |
| Free-Wheeling Diode Junction Temperature Range | $T_J$ | – 40 to +125 | °C |

(1) 1 cycle = 50 or 60 Hz

(2) 1 ms = 1.0% duty cycle

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

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

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| **BRAKE CIRCUIT** | | | |
| IGBT Reverse Voltage | $V_{CES}$ | 600 | V |
| Gate-Emitter Voltage | $V_{GES}$ | ± 20 | V |
| Continuous IGBT Collector Current | $I_C$ | 20 | A |
| Peak IGBT Collector Current (PW = 1.0 ms) (2) | $I_{C(pk)}$ | 40 | A |
| IGBT Power Dissipation | PD | 78 | W |
| Diode Reverse Voltage | $V_{RRM}$ | 600 | V |
| Continuous Output Diode Current | $I_F$ | 20 | A |
| Peak Output Diode Current (PW = 1.0 ms) (2) | $I_{F(pk)}$ | 40 | A |
| **TOTAL MODULE** | | | |
| Isolation Voltage – (47–63 Hz, 1.0 Minute Duration) | $V_{ISO}$ | 2500 | VAC |
| Ambient Operating Temperature Range | $T_A$ | – 40 to + 85 | °C |
| Operating Case Temperature Range | $T_C$ | – 40 to + 90 | °C |
| Storage Temperature Range | $T_{stg}$ | – 40 to +150 | °C |
| Mounting Torque | – | 6.0 | lb–in |

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **INPUT RECTIFIER BRIDGE** | | | | | |
| Reverse Leakage Current ($V_{RRM}$ = 600 V) | $I_R$ | – | 10 | 50 | µA |
| Forward Voltage ($I_F$ = 20 A) | $V_F$ | – | 1.1 | 1.5 | V |
| Thermal Resistance (Each Die) | $R_{\theta JC}$ | – | – | 2.9 | °C/W |
| **OUTPUT INVERTER** | | | | | |
| 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>$T_J$ = 25°C<br>$T_J$ = 125°C | $I_{CES}$ | <br>–<br>– | <br>–<br>– | <br>200<br>1.0 | <br>µA<br>mA |
| 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) | $V_{(BR)CES}$ | 600 | 700 | – | V |
| Collector-Emitter Saturation Voltage ($I_C$ = 20 A, $V_{GE}$ = 15 V) | $V_{CE(SAT)}$ | – | 2.5 | 3.5 | V |
| Input Capacitance ($V_{GE}$ = 0 V, $V_{CE}$ = 10 V, f = 1.0 MHz) | Cies | – | 4400 | – | pF |
| Input Gate Charge ($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V) | $Q_T$ | – | 145 | – | nC |
| Fall Time – Inductive Load<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, RG = 150 Ω) | $t_{fi}$ | – | 250 | 500 | ns |
| Turn-On Energy<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, RG = 150 Ω) | $E_{(on)}$ | – | – | 2.5 | mJ |
| Turn-Off Energy<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, RG = 150 Ω) | $E_{(off)}$ | – | – | 2.5 | mJ |
| Diode Forward Voltage ($I_F$ = 20 A, $V_{GE}$ = 0 V) | $V_F$ | – | 1.3 | 2.0 | V |
| Diode Reverse Recovery Time<br>($I_F$ = 20 A, V = 300 V, dI/dt = 50 A/µs) | $t_{rr}$ | – | 170 | 200 | ns |
| Diode Stored Charge ($I_F$ = 20 A, V = 300 V, di/dt = 50 A/µs) | $Q_{rr}$ | – | 450 | 600 | nC |
| Thermal Resistance – IGBT (Each Die) | $R_{\theta JC}$ | – | – | 1.5 | °C/W |
| Thermal Resistance – Free-Wheeling Diode (Each Die) | $R_{\theta JC}$ | – | – | 2.9 | °C/W |

(2) 1.0 ms = 1.0% duty cycle

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **BRAKE CIRCUIT** | | | | | |
| 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>$T_J$ = 25°C<br>$T_J$ = 125°C | $I_{CES}$ | <br>–<br>– | <br>–<br>– | <br>100<br>2.0 | <br>µA<br>mA |
| 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) | $V_{(BR)CES}$ | 600 | 700 | – | V |
| Collector-Emitter Saturation Voltage ($V_{GE}$ = 15 V, $I_C$ = 20 A) | $V_{CE(SAT)}$ | – | 2.5 | 3.5 | V |
| Input Capacitance ($V_{GE}$ = 0 V, $V_{CE}$ = 25 V, f = 1.0 MHz) | Cies | – | 4400 | – | pF |
| Input Gate Charge ($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V) | $Q_T$ | – | 145 | – | nC |
| Fall Time – Inductive Load<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 150 Ω) | $t_{fi}$ | – | 250 | 500 | ns |
| Turn-On Energy<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 150 Ω) | $E_{(on)}$ | – | – | 2.5 | mJ |
| Turn-Off Energy<br>($V_{CE}$ = 300 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 150 Ω) | $E_{(off)}$ | – | – | 2.5 | mJ |
| Diode Forward Voltage ($I_F$ = 20 A) | $V_F$ | – | 1.3 | 2.0 | V |
| Diode Reverse Leakage Current | $I_R$ | – | – | 50 | µA |
| Thermal Resistance – IGBT | $R_{\theta JC}$ | – | – | 1.5 | °C/W |
| Thermal Resistance – Diode | $R_{\theta JC}$ | – | – | 2.9 | °C/W |

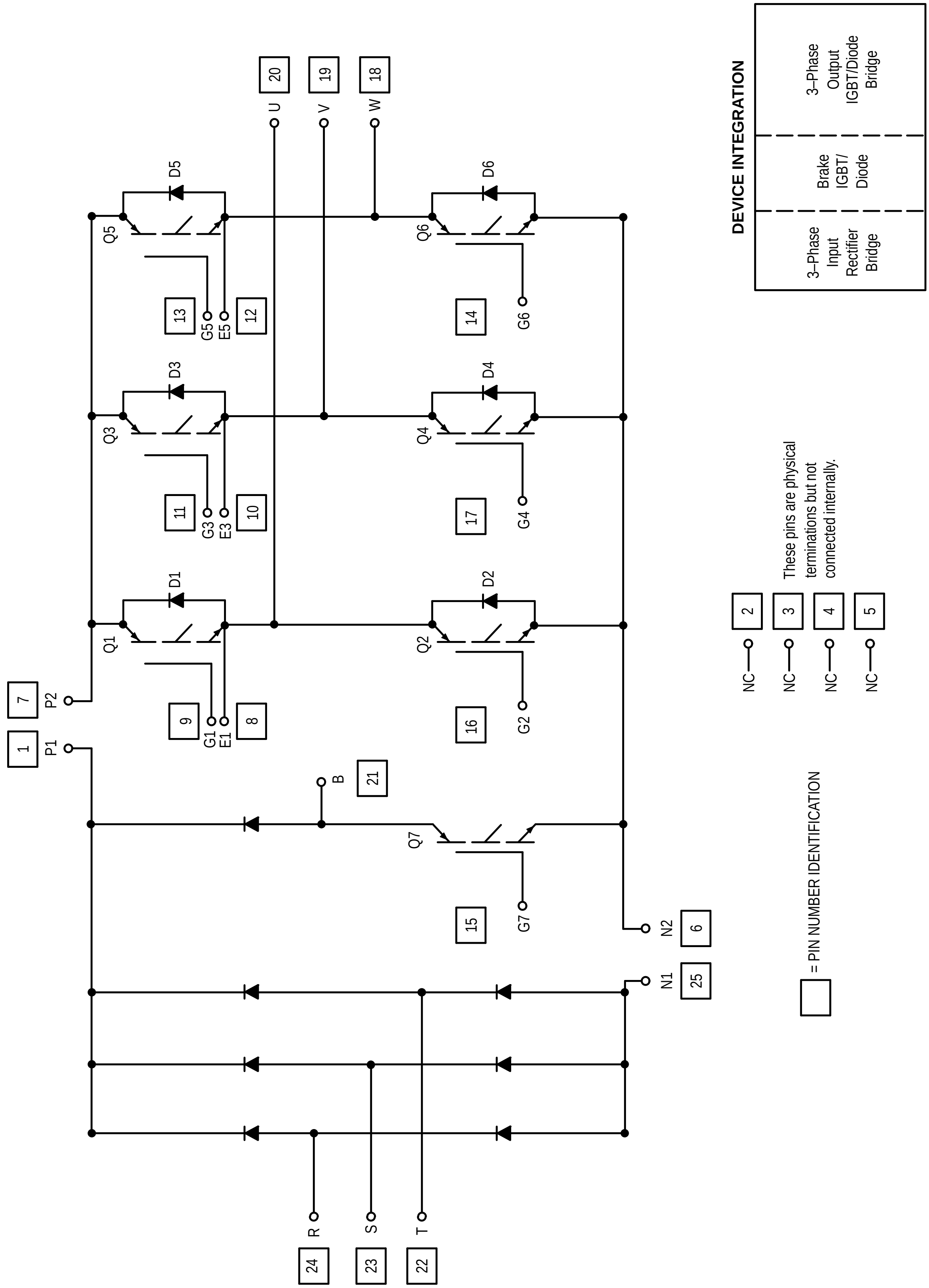



Figure 1. Integrated Power Stage Schematic

## Typical Characteristics

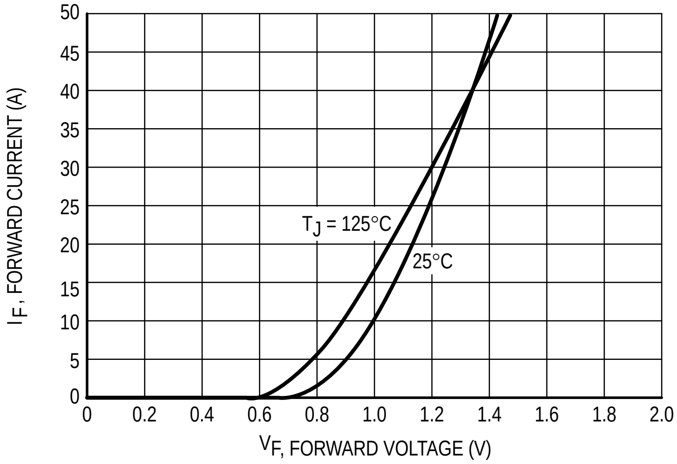



**Figure 2. Input Bridge Forward Current $I_F$ versus Forward Voltage $V_F$**

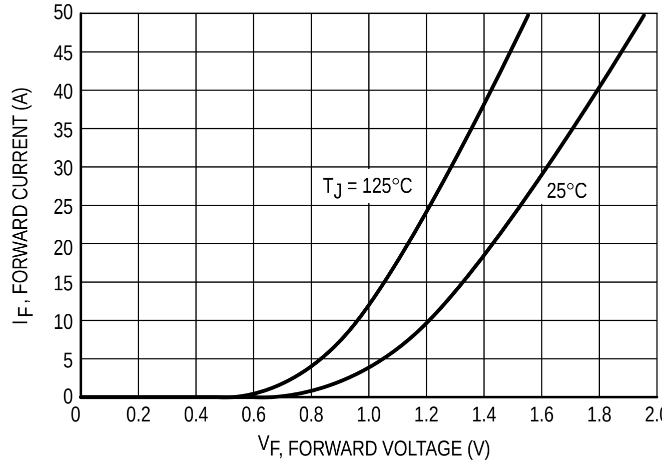



**Figure 3. Output Inverter Forward Current $I_F$ versus Forward Voltage $V_F$**

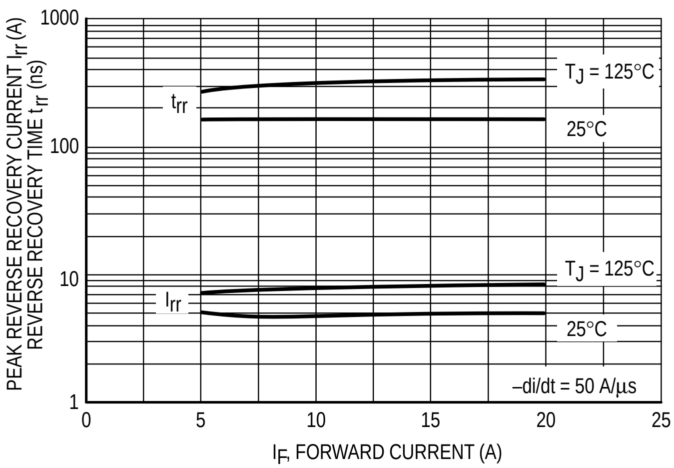



**Figure 4. Output Inverter Reverse Recovery $t_{rr}$, $I_{rr}$ versus Forward Current $I_F$**

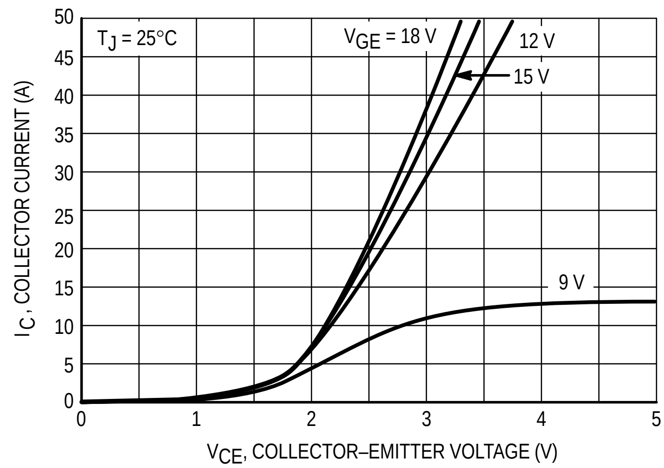



**Figure 5. Output Inverter Collector Currrent $I_C$ versus Collector–Emitter Voltage $V_{CE}$**

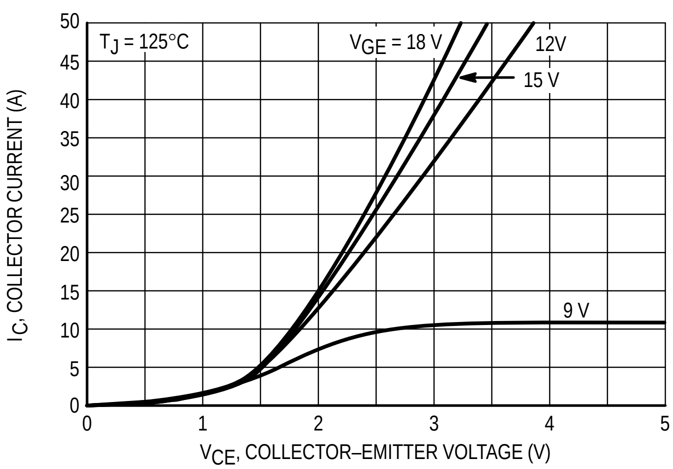



**Figure 6. Ouput Inverter Collector Current $I_C$ versus Collector–Emitter Voltage $V_{CE}$**

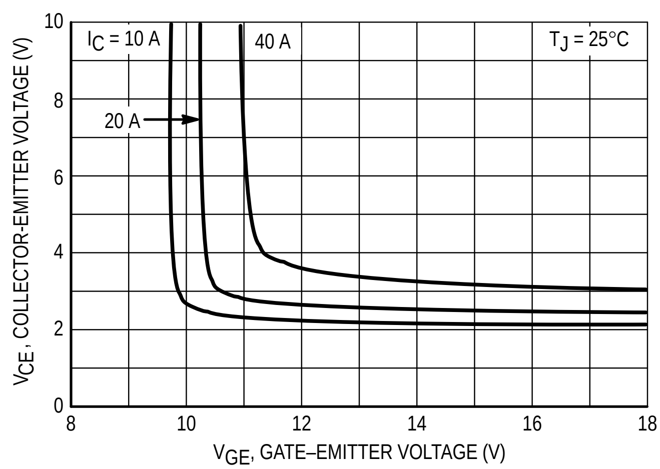



**Figure 7. Inverter Collector–Emitter Voltage $V_{CE}$ versus Gate–Emitter Voltage $V_{GE}$**

## Typical Characteristics

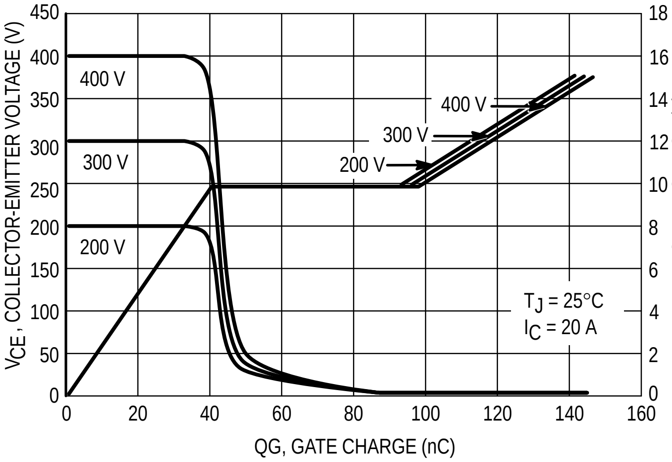



**Figure 8. Gate–to-Emitter Voltage versus Gate Charge**

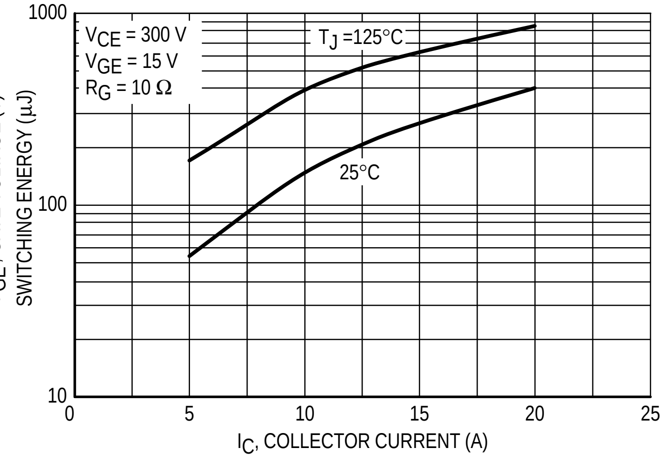



**Figure 9. Inverter Switching Energy $E_{(off)}$ versus Collector Current $I_C$**

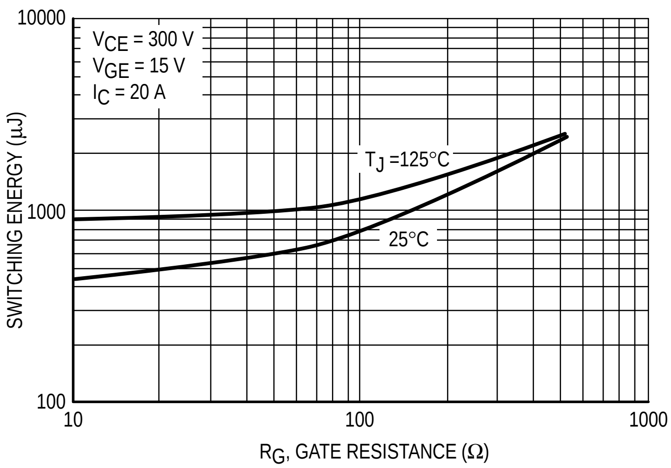



**Figure 10. Inverter Switching Energy $E_{(off)}$ versus Gate Resistance $R_G$**

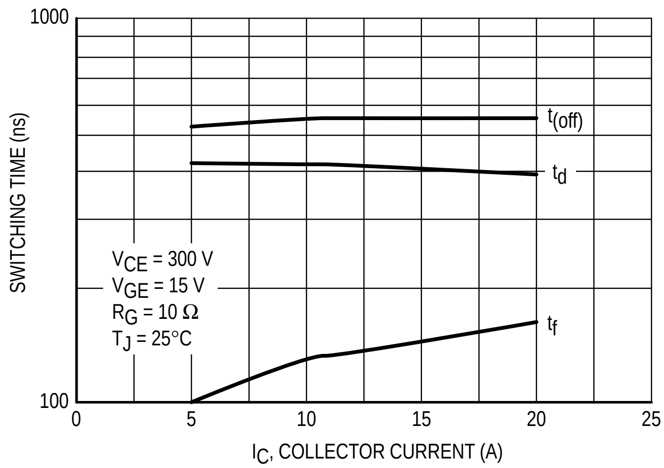



**Figure 11. Inverter Switching Time $t_d$, $t_f$, $t_{(off)}$ versus Collector Current $I_C$**

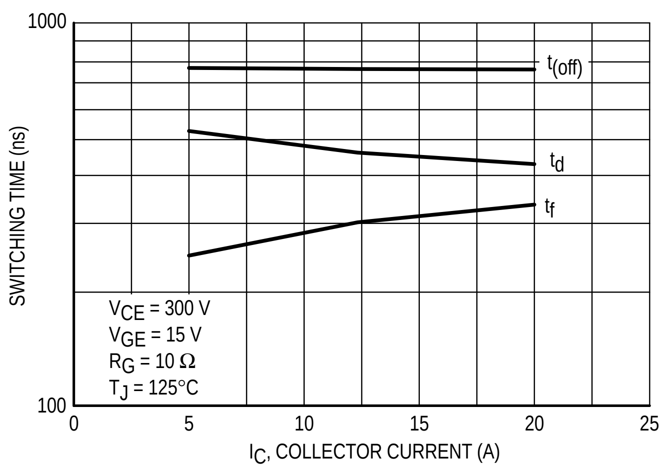



**Figure 12. Inverter Switching Time $t_d$, $t_f$, $t_{(off)}$ versus Collector Current $I_C$**

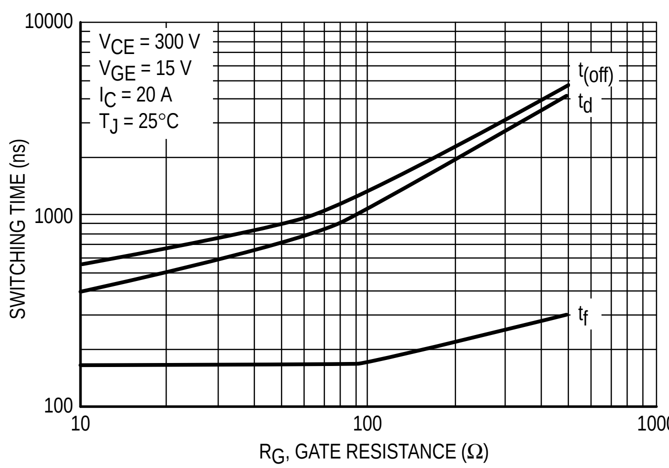



**Figure 13. Inverter Switching Time $t_d$,$t_f$, $t_{(off)}$ versus Gate Resistance $R_G$**

## Typical Characteristics

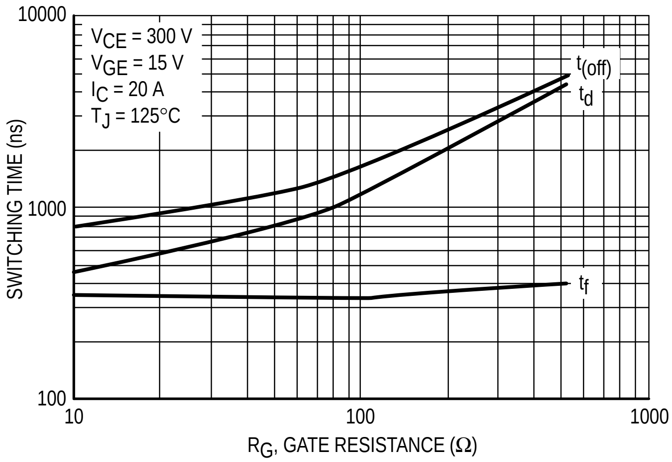



**Figure 14. Inverter Switching Time $t_d$, $t_f$, $t_{(off)}$ versus Gate Resistance $R_G$**

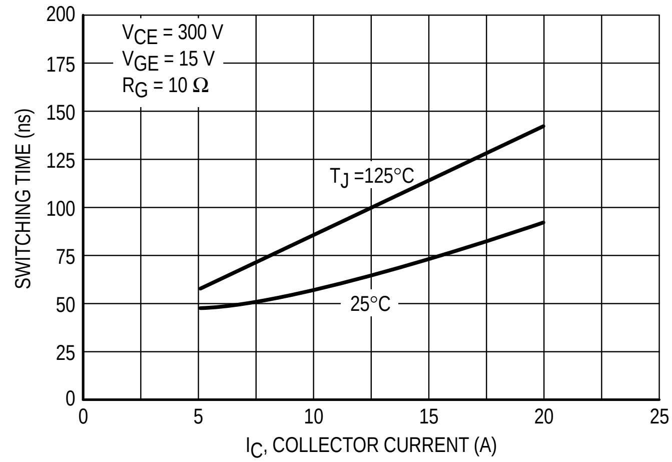



**Figure 15. Inverter Switching Time $t_r$ versus Collector Current $I_C$**

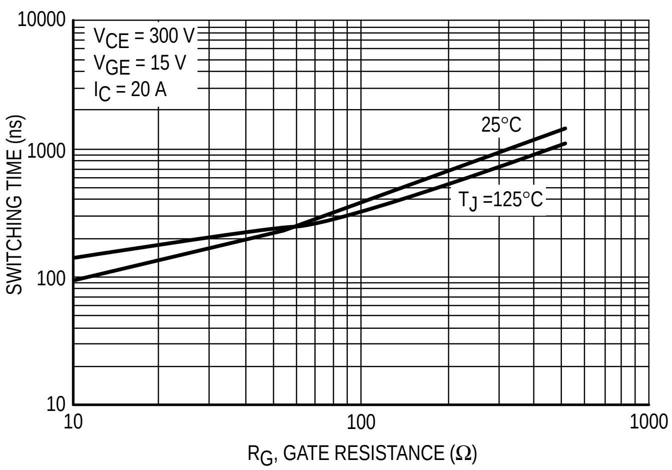



**Figure 16. Inverter Switching Time $t_r$ versus Gate Resistance $R_G$**

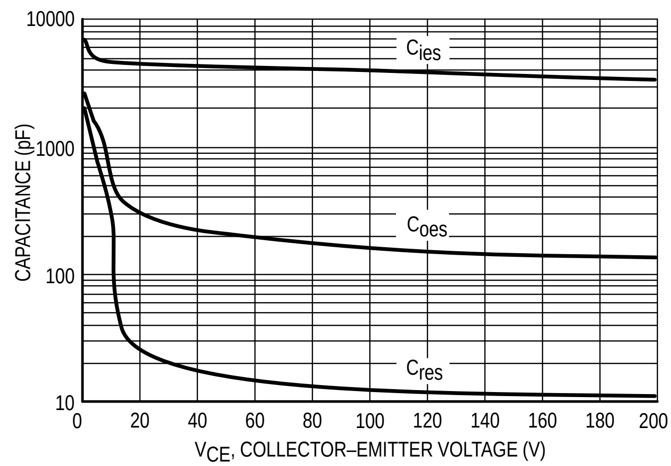



**Figure 17. Output Inverter Capacitance versus Collector Voltage $V_{CE}$**

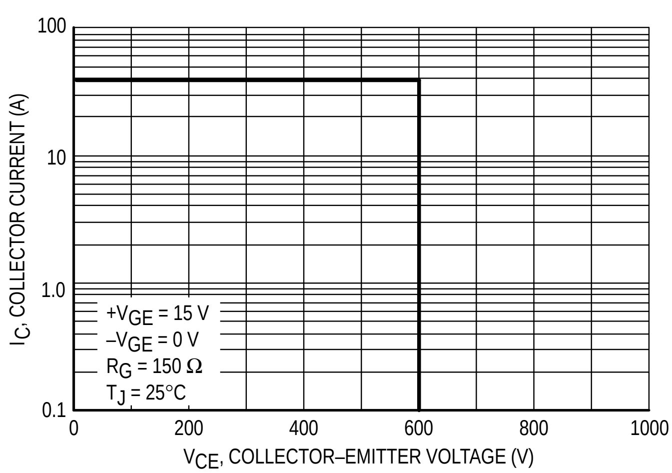



**Figure 18. Output Inverter Reversed Biased Safe Operating Area**

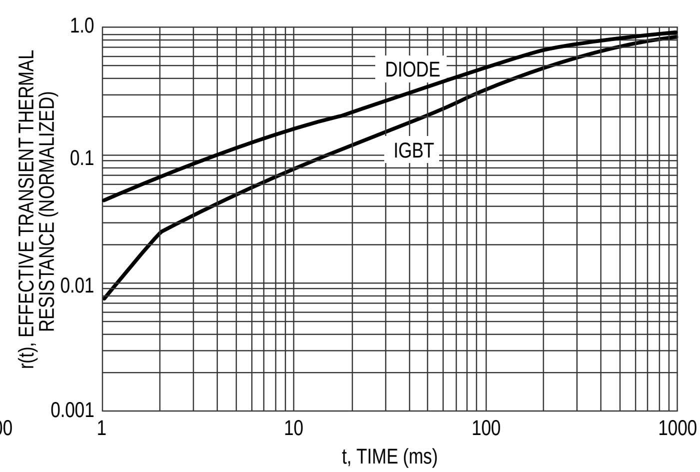
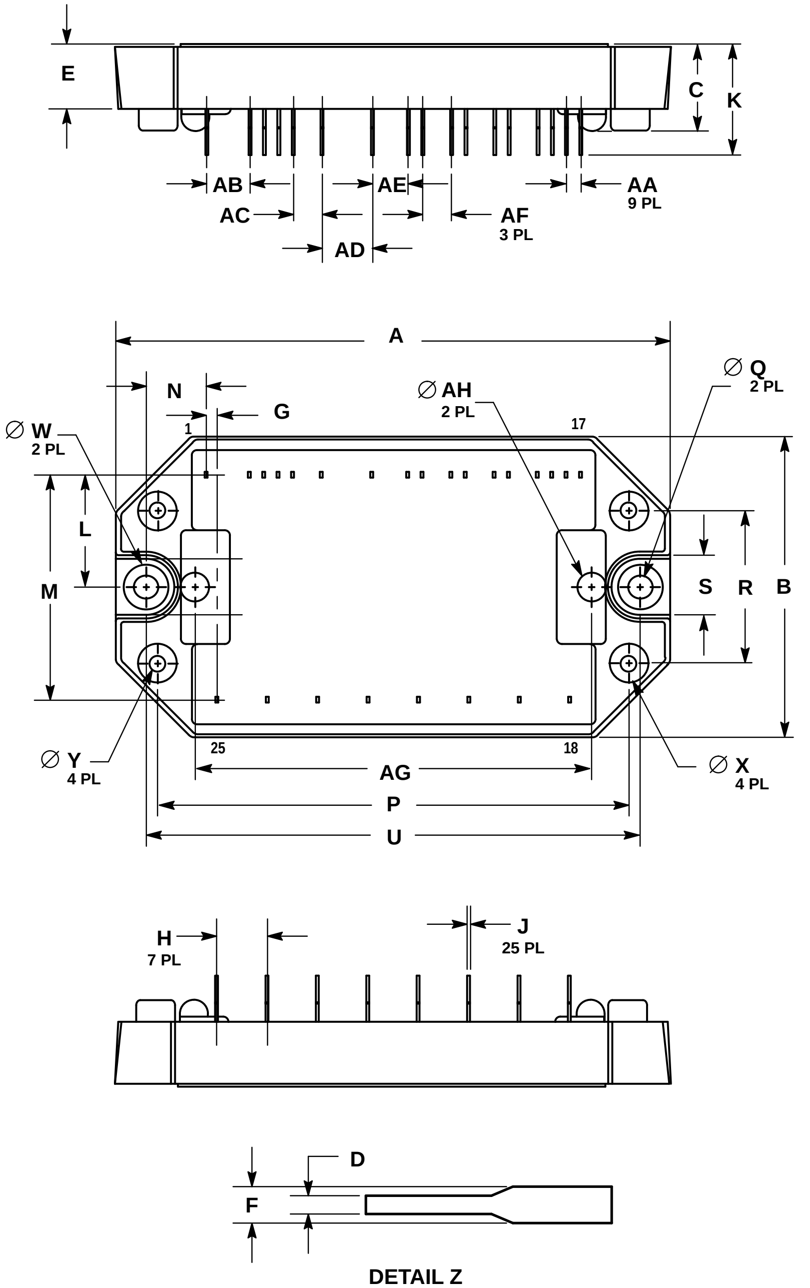
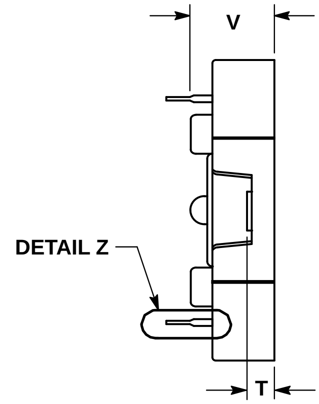



**Figure 19. Transient Thermal Resistance**

## PACKAGE DIMENSIONS




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. LEAD LOCATION DIMENSIONS (ie: M, B. AA...) ARE TO THE CENTER OF THE LEAD.

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 97.54 | 98.55 | 3.840 | 3.880 |
| B | 52.45 | 53.47 | 2.065 | 2.105 |
| C | 14.60 | 15.88 | 0.575 | 0.625 |
| D | 0.43 | 0.84 | 0.017 | 0.033 |
| E | 10.80 | 12.06 | 0.425 | 0.475 |
| F | 0.94 | 1.35 | 0.037 | 0.053 |
| G | 1.60 | 2.21 | 0.063 | 0.087 |
| H | 8.58 | 9.19 | 0.338 | 0.362 |
| J | 0.30 | 0.71 | 0.012 | 0.028 |
| K | 18.80 | 20.57 | 0.74 | 0.81 |
| L | 19.30 | 20.32 | 0.760 | 0.800 |
| M | 38.99 | 40.26 | 1.535 | 1.585 |
| N | 9.78 | 11.05 | 0.385 | 0.435 |
| P | 82.55 | 83.57 | 3.250 | 3.290 |
| Q | 4.01 | 4.62 | 0.158 | 0.182 |
| R | 26.42 | 27.43 | 1.040 | 1.080 |
| S | 12.06 | 12.95 | 0.475 | 0.515 |
| T | 4.32 | 5.33 | 0.170 | 0.210 |
| U | 86.36 | 87.38 | 3.400 | 3.440 |
| V | 14.22 | 15.24 | 0.560 | 0.600 |
| W | 7.62 | 8.13 | 0.300 | 0.320 |
| X | 6.55 | 7.16 | 0.258 | 0.282 |
| Y | 2.49 | 3.10 | 0.098 | 0.122 |
| AA | 2.24 | 2.84 | 0.088 | 0.112 |
| AB | 7.32 | 7.92 | 0.288 | 0.312 |
| AC | 4.78 | 5.38 | 0.188 | 0.212 |
| AD | 8.58 | 9.19 | 0.338 | 0.362 |
| AE | 6.05 | 6.65 | 0.238 | 0.262 |
| AF | 4.78 | 5.38 | 0.188 | 0.212 |
| AG | 69.34 | 70.36 | 2.730 | 2.770 |
| AH | —— | 5.08 | —— | 0.200 |

STYLE 1:

| | | | | |
|---|---|---|---|---|
| PIN 1. P1 | PIN 6. N2 | PIN 11. G3 | PIN 16. G2 | PIN 21. B |
| 2. T– | 7. P2 | 12. K5 | 17. G4 | 22. T |
| 3. T+ | 8. K1 | 13. G5 | 18. W | 23. S |
| 4. I+ | 9. G1 | 14. G6 | 19. V | 24. R |
| 5. I– | 10. K3 | 15. G7 | 20. U | 25. N1 |

**CASE 440-01**
**ISSUE O**

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