



Hybrid Power Module

Integrated Power Stage for 2.0 hp Motor Drives

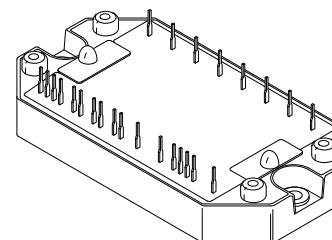
This module integrates a 3-phase input rectifier bridge, 3-phase output inverter and brake transistor/diode in a single convenient package. The output inverter utilizes advanced insulated gate bipolar transistors (IGBT) matched with free-wheeling diodes to give optimal dynamic performance. It has been 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 μ s @ 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

MHPM7B12A120A

Motorola Preferred Device

**12 AMP, 1200 VOLT
HYBRID POWER MODULE**



PLASTIC PACKAGE
CASE 440-01, Style 1

MAXIMUM DEVICE RATINGS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating | Symbol | Value | Unit |
|------------------------------------------------------|-------------|--------------|------------------|
| INPUT RECTIFIER BRIDGE | | | |
| Repetitive Peak Reverse Voltage | V_{RRM} | 1200 | V |
| Average Output Rectified Current (1) | I_O | 12 | A |
| Peak Non-repetitive Surge Current | I_{FSM} | 200 | A |
| OUTPUT INVERTER | | | |
| IGBT Reverse Voltage | V_{CES} | 1200 | V |
| Gate-Emitter Voltage | V_{GES} | ± 20 | V |
| Continuous IGBT Collector Current | I_C | 12 | A |
| Peak IGBT Collector Current – (PW = 1.0 ms) (2) | $I_{C(pk)}$ | 24 | A |
| Continuous Free-Wheeling Diode Current | I_F | 12 | A |
| Peak Free-Wheeling Diode Current – (PW = 1.0 ms) (2) | $I_{F(pk)}$ | 24 | A |
| IGBT Power Dissipation | P_D | 60 | W |
| Free-Wheeling Diode Power Dissipation | P_D | 40 | W |
| IGBT Junction Temperature Range | T_J | - 40 to +125 | $^\circ\text{C}$ |
| Free-Wheeling Diode Junction Temperature Range | T_J | - 40 to +125 | $^\circ\text{C}$ |

(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) ($T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating | Symbol | Value | Unit |
|-----------------------------------------------|-------------|----------|------|
| BRAKE CIRCUIT | | | |
| IGBT Reverse Voltage | V_{CES} | 1200 | V |
| Gate-Emitter Voltage | V_{GES} | ± 20 | V |
| Continuous IGBT Collector Current | I_C | 12 | A |
| Peak IGBT Collector Current (PW = 1.0 ms) (2) | $I_{C(pk)}$ | 24 | A |
| IGBT Power Dissipation | PD | 60 | W |
| Diode Reverse Voltage | V_{RRM} | 1200 | V |
| Continuous Output Diode Current | I_F | 12 | A |
| Peak Output Diode Current (PW = 1.0 ms) (2) | $I_{F(pk)}$ | 24 | 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 | $^\circ\text{C}$ |
| Operating Case Temperature Range | T_C | - 40 to + 90 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | - 40 to +150 | $^\circ\text{C}$ |
| Mounting Torque | – | 6.0 | lb-in |

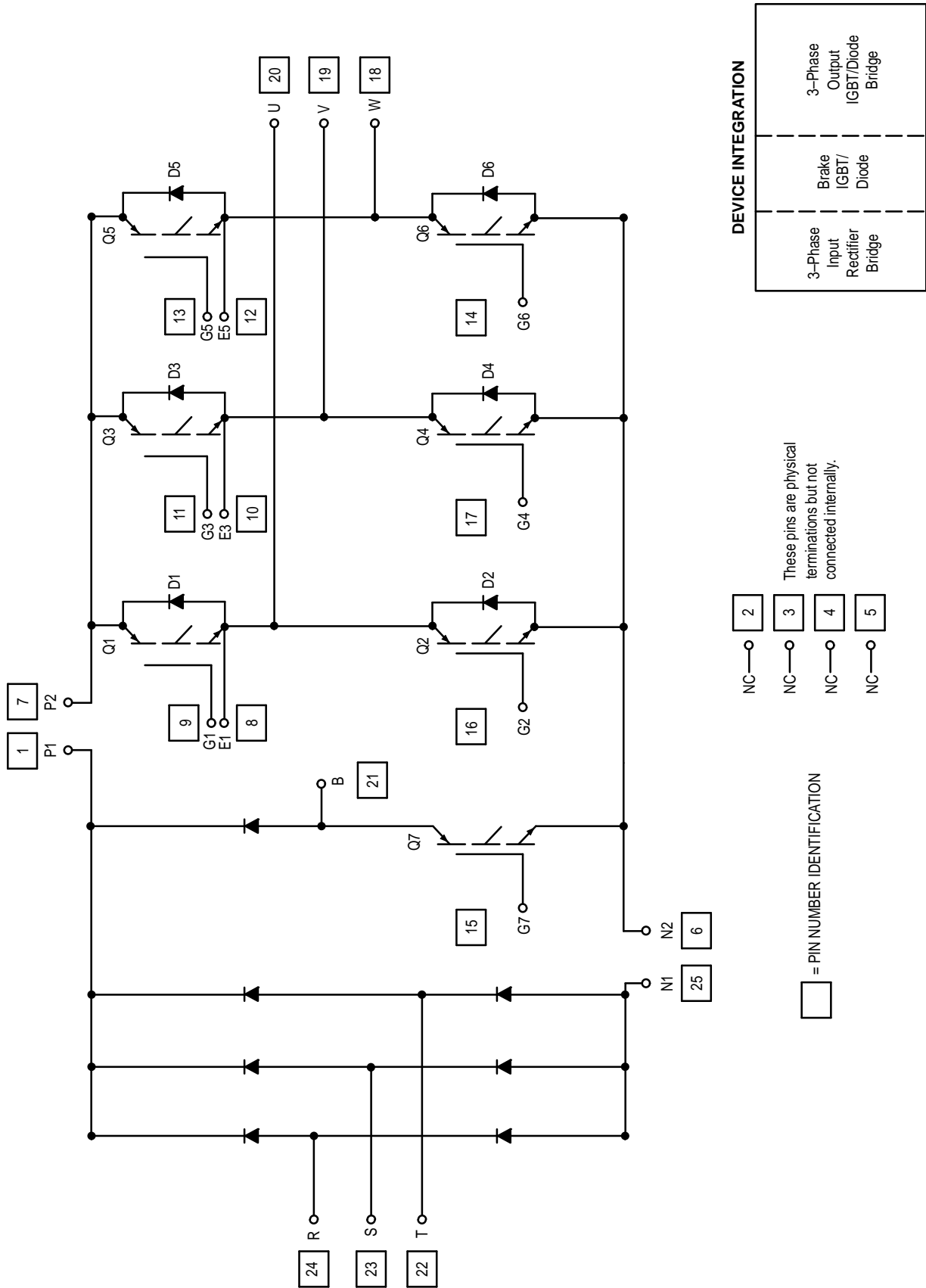
ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|--------|------------|---------------------|
| INPUT RECTIFIER BRIDGE | | | | | |
| Reverse Leakage Current ($V_{RRM} = 1200\text{ V}$) | I_R | – | 10 | 50 | μA |
| Forward Voltage ($I_F = 12\text{ A}$) | V_F | – | 1.03 | 1.5 | V |
| Thermal Resistance (Each Die) | $R_{\theta JC}$ | – | – | 2.9 | $^\circ\text{C/W}$ |
| OUTPUT INVERTER | | | | | |
| Gate-Emitter Leakage Current ($V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$) | I_{GES} | – | – | ± 20 | μA |
| Collector-Emitter Leakage Current ($V_{CE} = 1200\text{ V}$, $V_{GE} = 0\text{ V}$) $T_J = 25^\circ\text{C}$ $T_J = 125^\circ\text{C}$ | I_{CES} | – – | – – | 100 2.0 | μA mA |
| Gate-Emitter Threshold Voltage ($V_{CE} = V_{GE}$, $I_C = 1.0\text{ mA}$) | $V_{GE(th)}$ | 4.0 | 6.0 | 8.0 | V |
| Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $V_{GE} = 0$) | $V_{(BR)CES}$ | 1200 | 1300 | – | V |
| Collector-Emitter Saturation Voltage ($I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$) | $V_{CE(SAT)}$ | – | 2.4 | 3.5 | V |
| Input Capacitance ($V_{GE} = 0\text{ V}$, $V_{CE} = 10\text{ V}$, $f = 1.0\text{ MHz}$) | C_{ies} | – | 1800 | – | pF |
| Input Gate Charge ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$) | Q_T | – | 65 | – | nC |
| Fall Time – Inductive Load ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | t_{fi} | – | 300 | 500 | ns |
| Turn-On Energy ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | $E_{(on)}$ | – | – | 2.0 | mJ |
| Turn-Off Energy ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | $E_{(off)}$ | – | – | 2.0 | mJ |
| Diode Forward Voltage ($I_F = 12\text{ A}$, $V_{GE} = 0\text{ V}$) | V_F | – | 1.7 | 2.2 | V |
| Diode Reverse Recovery Time ($I_F = 12\text{ A}$, $V = 600\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$) | t_{rr} | – | 160 | 200 | ns |
| Diode Stored Charge ($I_F = 12\text{ A}$, $V = 600\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$) | Q_{rr} | – | 800 | 950 | nC |
| Thermal Resistance – IGBT (Each Die) | $R_{\theta JC}$ | – | – | 1.7 | $^\circ\text{C/W}$ |
| Thermal Resistance – Free-Wheeling Diode (Each Die) | $R_{\theta JC}$ | – | – | 2.7 | $^\circ\text{C/W}$ |

(2) 1.0 ms = 1.0% duty cycle

ELECTRICAL CHARACTERISTICS (continued) ($T_J = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|--------|------------|------------------------------|
| BRAKE CIRCUIT | | | | | |
| Gate-Emitter Leakage Current ($V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$) | I_{GES} | – | – | ± 20 | μA |
| Collector-Emitter Leakage Current ($V_{CE} = 1200\text{ V}$, $V_{GE} = 0\text{ V}$) $T_J = 25^\circ\text{C}$ $T_J = 125^\circ\text{C}$ | I_{CES} | – – | – – | 100 2.0 | μA mA |
| Gate-Emitter Threshold Voltage ($V_{CE} = V_{GE}$, $I_C = 10\text{ mA}$) | $V_{GE(th)}$ | 4.0 | 6.0 | 8.0 | V |
| Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $V_{GE} = 0$) | $V_{(BR)CES}$ | 1200 | 1300 | – | V |
| Collector-Emitter Saturation Voltage ($V_{GE} = 15\text{ V}$, $I_C = 12\text{ A}$) | $V_{CE(SAT)}$ | – | 2.4 | 3.5 | V |
| Input Capacitance ($V_{GE} = 0\text{ V}$, $V_{CE} = 10\text{ V}$, $f = 1.0\text{ MHz}$) | C_{ies} | – | 1800 | – | pF |
| Input Gate Charge ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$) | Q_T | – | 65 | – | nC |
| Fall Time – Inductive Load ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | t_{fi} | – | 300 | 500 | ns |
| Turn-On Energy ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | $E_{(on)}$ | – | – | 2.0 | mJ |
| Turn-Off Energy ($V_{CE} = 600\text{ V}$, $I_C = 12\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 150\ \Omega$) | $E_{(off)}$ | – | – | 2.0 | mJ |
| Diode Forward Voltage ($I_F = 12\text{ A}$) | V_F | – | 1.7 | 2.2 | V |
| Diode Reverse Leakage Current | I_R | – | – | 50 | μA |
| Thermal Resistance – IGBT | $R_{\theta JC}$ | – | – | 1.7 | $^\circ\text{C/W}$ |
| Thermal Resistance – Diode | $R_{\theta JC}$ | – | – | 2.7 | $^\circ\text{C/W}$ |



DEVICE INTEGRATION

| | | |
|--------------------------------|------------------|----------------------------------|
| 3-Phase Input Rectifier Bridge | Brake IGBT/Diode | 3-Phase Output IGBT/Diode Bridge |
|--------------------------------|------------------|----------------------------------|

- 2 NC
 - 3 NC
 - 4 NC
 - 5 NC
- These pins are physical terminations but not connected internally.

[] = PIN NUMBER IDENTIFICATION

Figure 1. Integrated Power Stage Schematic

Typical Characteristics

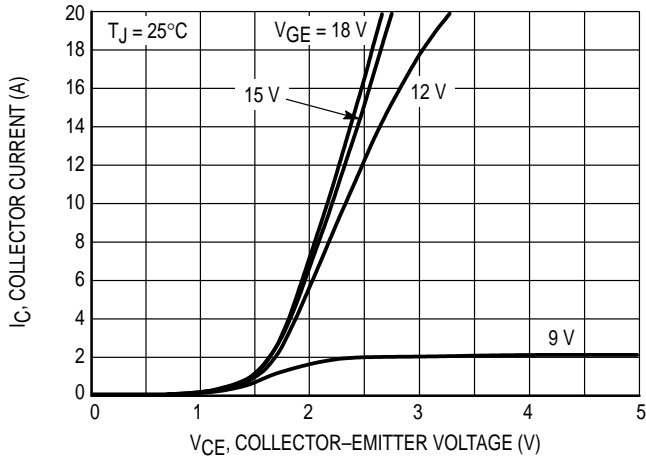


Figure 2. Output Inverter Collector Current I_C versus Collector-Emitter Voltage V_{CE}

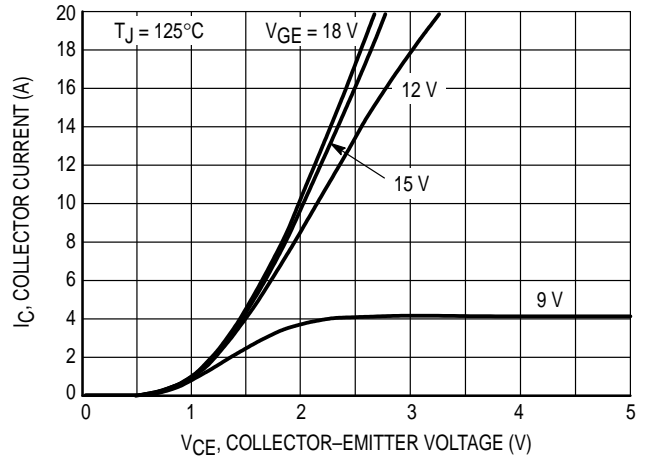


Figure 3. Output Inverter Collector Current I_C versus Collector-Emitter Voltage V_{CE}

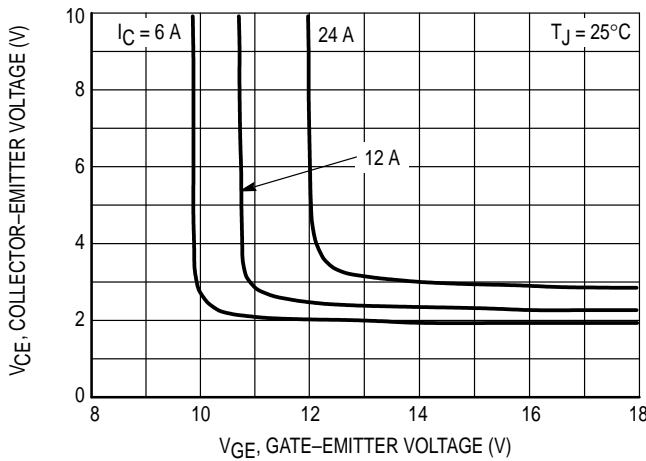


Figure 4. Inverter Collector-Emitter Voltage V_{CE} versus Gate-Emitter Voltage V_{GE}

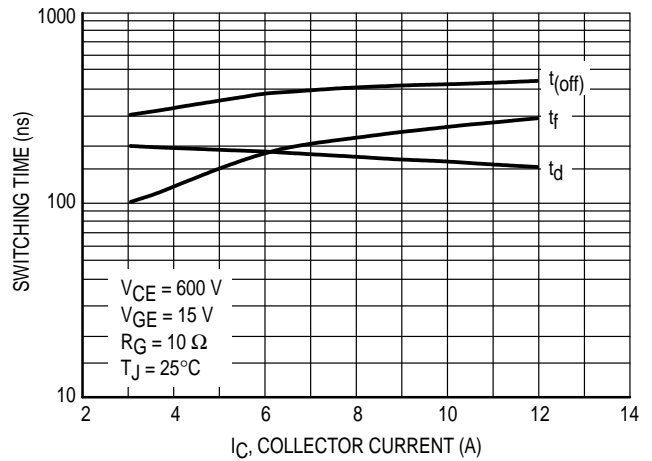


Figure 5. Inverter Switching Time t_d , t_f , $t_{(off)}$ versus Collector Current I_C

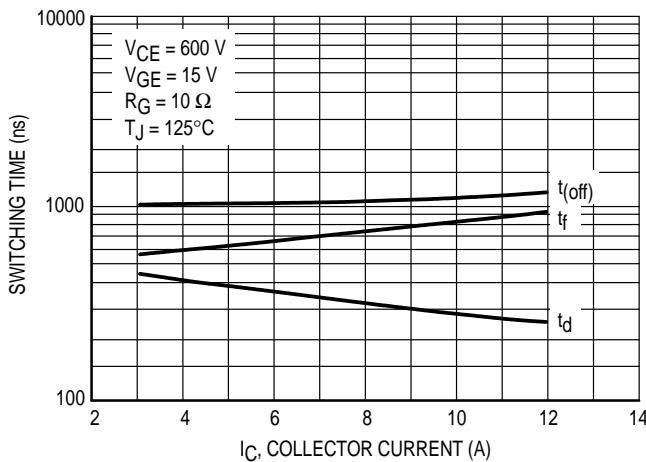


Figure 6. Inverter Switching Time t_d , t_f , $t_{(off)}$ versus Collector Current I_C

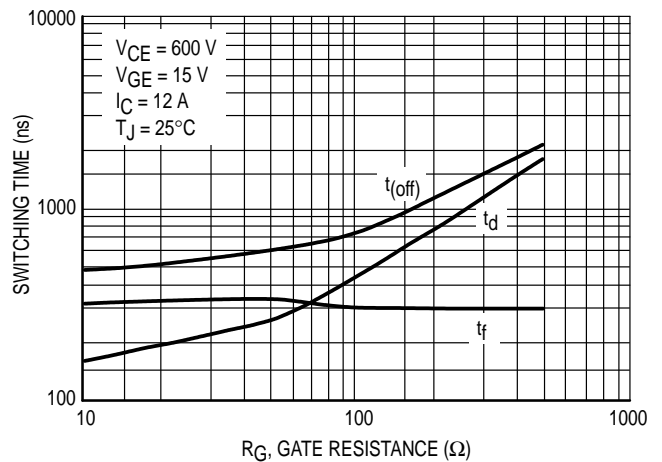


Figure 7. Inverter Switching Time t_d , t_f , $t_{(off)}$ versus Gate Resistance R_G

Typical Characteristics

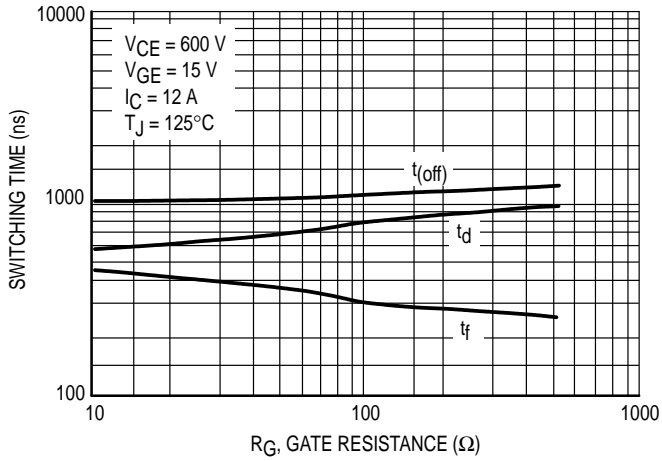


Figure 8. Inverter Switching Time t_d , t_f , $t_{(off)}$ versus Gate Resistance R_G

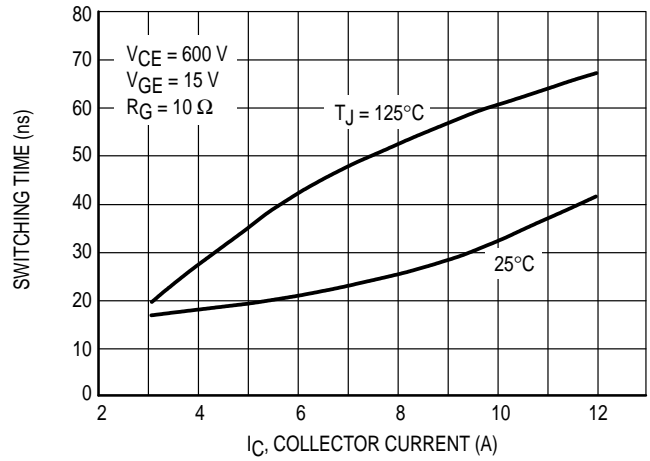


Figure 9. Inverter Switching Time t_r versus Collector Current I_C

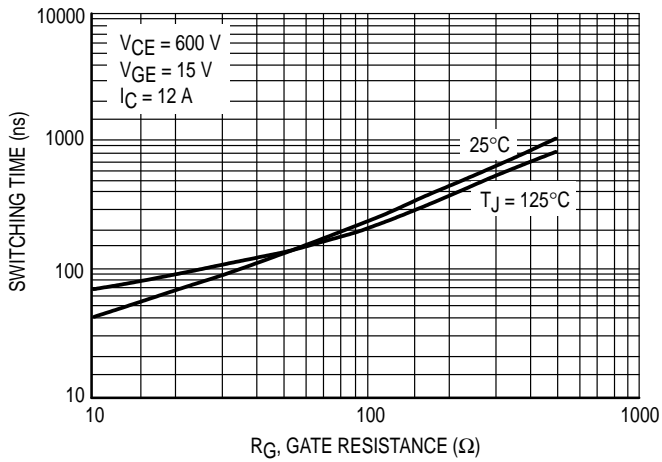


Figure 10. Inverter Switching Time t_r versus Gate Resistance R_G

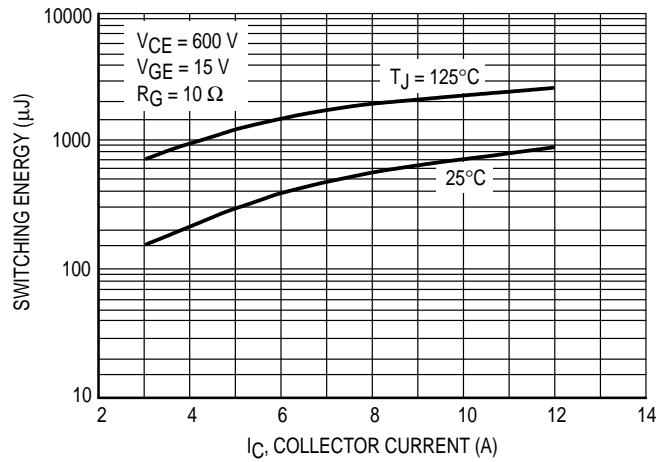


Figure 11. Inverter Switching Energy $E_{(off)}$ versus Collector Current I_C

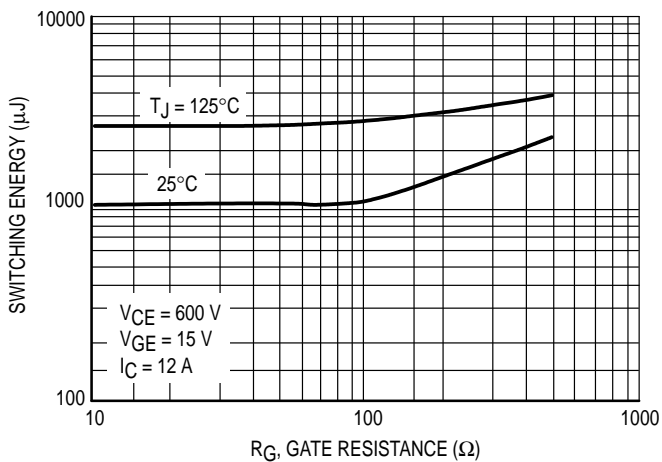


Figure 12. Inverter Switching Energy $E_{(off)}$ versus Gate Resistance R_G

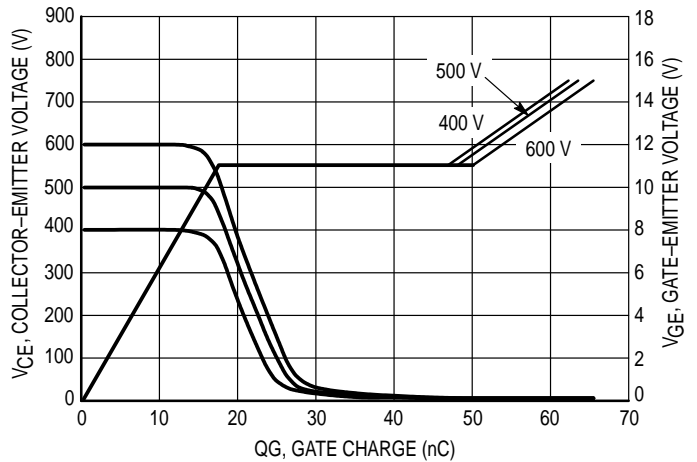


Figure 13. Gate-to-Emitter Voltage versus Gate Charge

Typical Characteristics

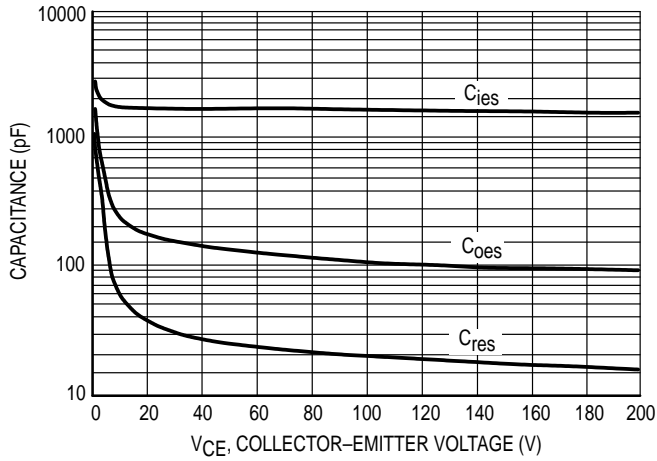


Figure 14. Output Inverter Capacitance versus Collector Voltage V_{CE}

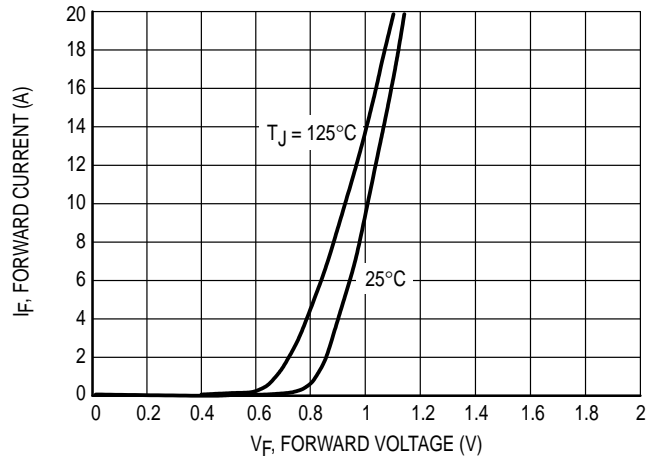


Figure 15. Input Bridge Forward Current I_F versus Forward Voltage V_F

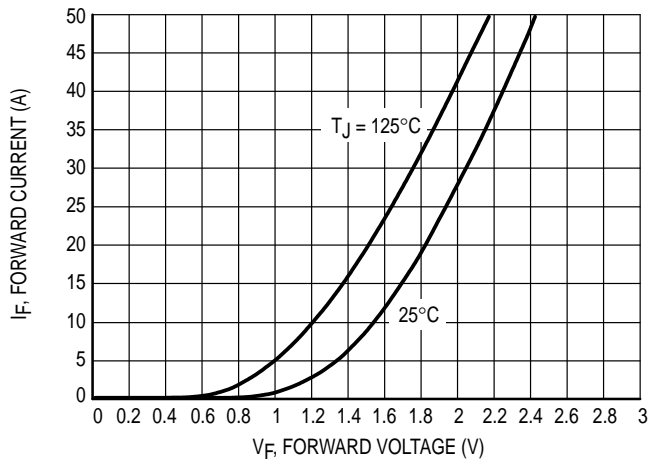


Figure 16. Output Inverter Forward Current I_F versus Forward Voltage V_F

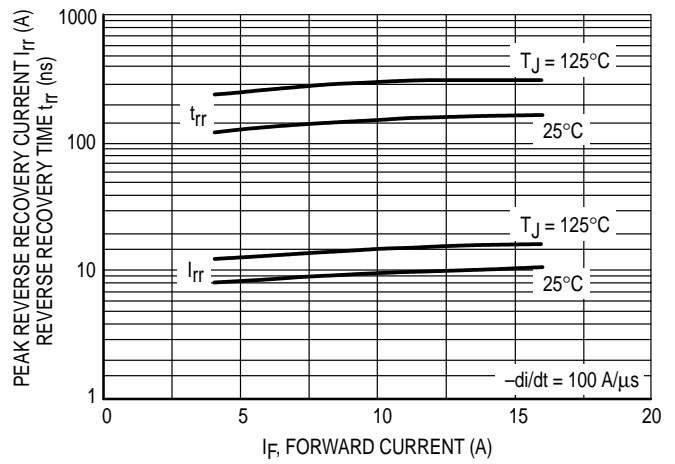


Figure 17. Output Inverter Reverse Recovery t_{rr} , I_{rr} versus Forward Current I_F

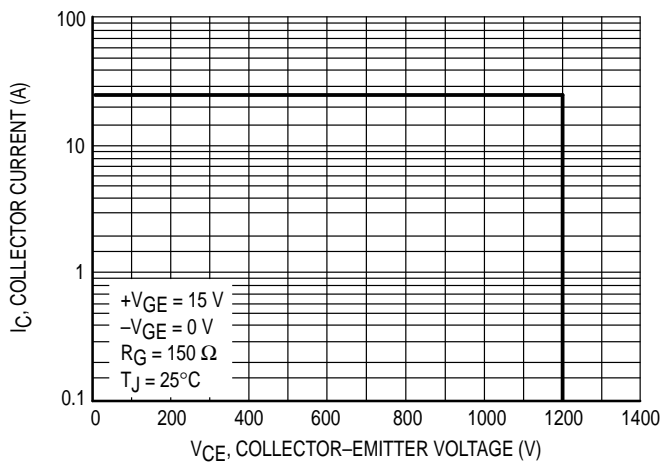


Figure 18. Output Inverter Reversed Biased Safe Operating Area

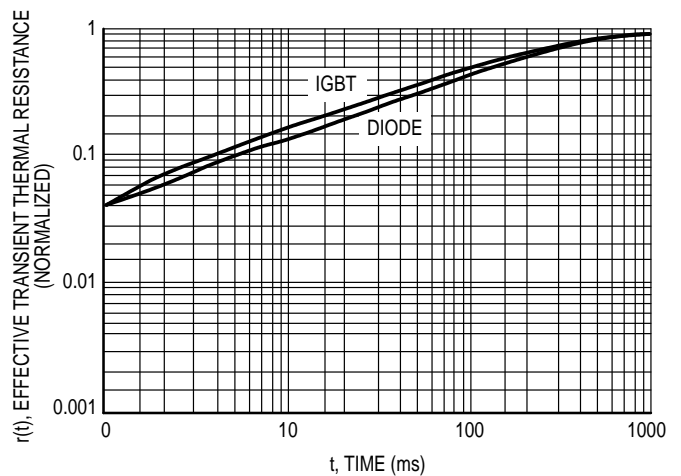
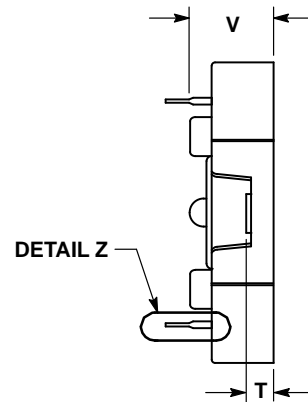
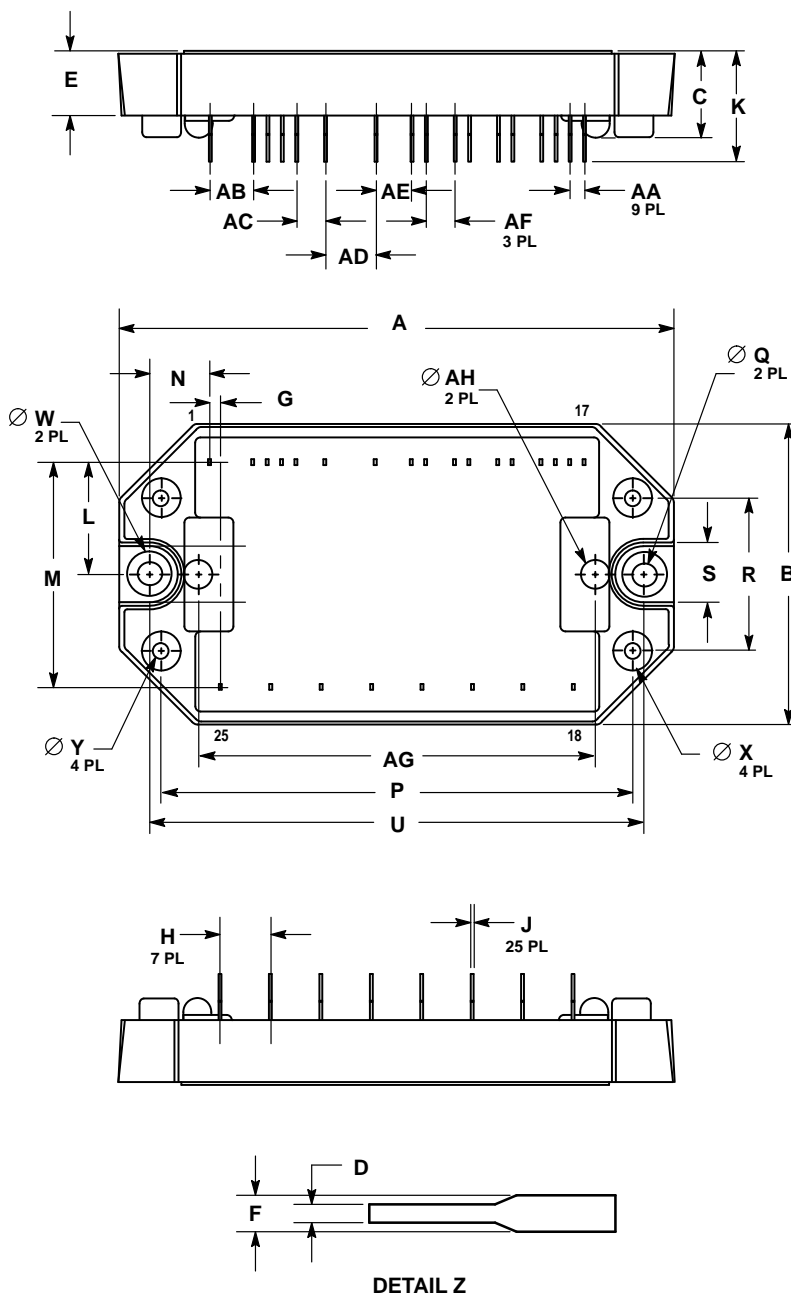


Figure 19. Transient Thermal Resistance

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 0**

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