# MGP15N40CL, MGB15N40CL

Preferred Device

# Ignition IGBT 15 Amps, 410 Volts

## N−Channel TO−220 and $D^2PAK$

ON Semiconductor®

http://onsemi.com

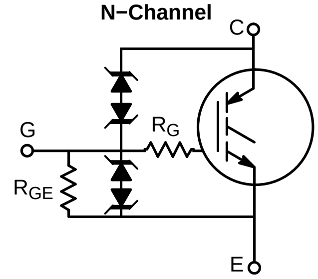
**15 AMPERES**
**410 VOLTS (Clamped)**
**$V_{CE(on)}$ @ 10 A = 1.8 V Max**

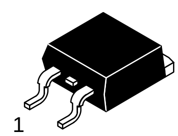
This Logic Level Insulated Gate Bipolar Transistor (IGBT) features monolithic circuitry integrating ESD and Over−Voltage clamped protection for use in inductive coil drivers applications. Primary uses include Ignition, Direct Fuel Injection, or wherever high voltage and high current switching is required.

### Features

- Ideal for Coil−On−Plug, IGBT−On−Coil, or Distributorless Ignition System Applications
- High Pulsed Current Capability up to 50 A
- Gate−Emitter ESD Protection
- Temperature Compensated Gate−Collector Voltage Clamp Limits Stress Applied to Load
- Integrated ESD Diode Protection
- Low Threshold Voltage to Interface Power Loads to Logic or Microprocessor Devices
- Low Saturation Voltage
- Optional Gate Resistor ($R_G$)
- Pb−Free Package is Available

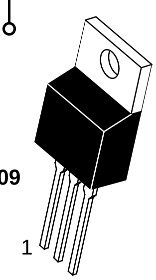
**N−Channel**




**$D^2PAK$**
**CASE 418B**
**STYLE 4**

**TO−220AB**
**CASE 221A−09**
**STYLE 9**

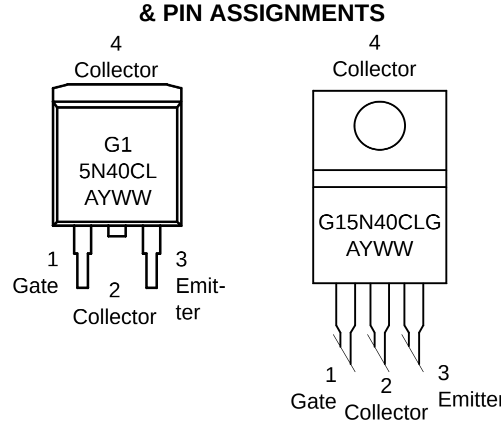



**MAXIMUM RATINGS** (−55°C ≤ $T_J$ ≤ 175°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector−Emitter Voltage | $V_{CES}$ | 440 | $V_{DC}$ |
| Collector−Gate Voltage | $V_{CER}$ | 440 | $V_{DC}$ |
| Gate−Emitter Voltage | $V_{GE}$ | 22 | $V_{DC}$ |
| Collector Current−Continuous @ $T_C$ = 25°C − Pulsed | $I_C$ | 15<br>50 | $A_{DC}$<br>$A_{AC}$ |
| ESD (Human Body Model) R = 1500 Ω, C = 100 pF | ESD | 8.0 | kV |
| ESD (Machine Model) R = 0 Ω, C = 200 pF | ESD | 800 | V |
| Total Power Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 150<br>1.0 | W<br>W/°C |
| Operating and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to 175 | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

**MARKING DIAGRAMS & PIN ASSIGNMENTS**




| | |
|---|---|
| G15N40CL | = Device Code |
| A | = Assembly Location |
| Y | = Year |
| WW | = Work Week |
| G | = Pb−Free Package |

**ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

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

**UNCLAMPED COLLECTOR−TO−EMITTER AVALANCHE CHARACTERISTICS** ($-55°C \le T_J \le 175°C$)

| Characteristic | Symbol | Value | Unit |
|---|---|---|---|
| Single Pulse Collector−to−Emitter Avalanche Energy<br>$V_{CC}$ = 50 V, $V_{GE}$ = 5.0 V, Pk $I_L$ = 17.4 A, L = 2.0 mH, Starting $T_J$ = 25°C<br>$V_{CC}$ = 50 V, $V_{GE}$ = 5.0 V, Pk $I_L$ = 14.2 A, L = 2.0 mH, Starting $T_J$ = 150°C | $E_{AS}$ | <br>300<br>200 | mJ |
| Reverse Avalanche Energy<br>$V_{CC}$ = 100 V, $V_{GE}$ = 20 V, L = 3.0 mH, Pk $I_L$ = 25.8 A, Starting $T_J$ = 25°C | $E_{AS(R)}$ | <br>1000 | mJ |

**THERMAL CHARACTERISTICS**

| Characteristic | | Symbol | Value | Unit |
|---|---|---|---|---|
| Thermal Resistance, Junction−to−Case | | $R_{\theta JC}$ | 1.0 | °C/W |
| Thermal Resistance, Junction−to−Ambient | TO−220<br>$D^2$PAK (Note 1) | $R_{\theta JA}$<br>$R_{\theta JA}$ | 62.5<br>50 | |
| Maximum Lead Temperature for Soldering Purposes, 1/8″ from case for 5 seconds | | $T_L$ | 275 | °C |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Collector−Emitter Clamp Voltage | $BV_{CES}$ | $I_C$ = 2.0 mA | $T_J$ = −40°C to 150°C | 380 | 410 | 440 | $V_{DC}$ |
| | | $I_C$ = 10 mA | $T_J$ = −40°C to 150°C | 390 | 420 | 450 | |
| Zero Gate Voltage Collector Current | $I_{CES}$ | $V_{CE}$ = 350 V, $V_{GE}$ = 0 V | $T_J$ = 25°C | − | 1.5 | 20 | μ$A_{DC}$ |
| | | | $T_J$ = 150°C | − | 10 | 40* | |
| | | | $T_J$ = −40°C | − | 0.7 | 1.5 | |
| Reverse Collector−Emitter Leakage Current | $I_{ECS}$ | $V_{CE}$ = −24 V | $T_J$ = 25°C | − | 0.35 | 1.0 | mA |
| | | | $T_J$ = 150°C | − | 8.0 | 15* | |
| | | | $T_J$ = −40°C | − | 0.05 | 0.5 | |
| Reverse Collector−Emitter Clamp Voltage | $B_{VCES(R)}$ | $I_C$ = −75 mA | $T_J$ = 25°C | 25 | 33 | 50 | $V_{DC}$ |
| | | | $T_J$ = 150°C | 25 | 36 | 50 | |
| | | | $T_J$ = −40°C | 25 | 30 | 50 | |
| Gate−Emitter Clamp Voltage | $BV_{GES}$ | $I_G$ = 5.0 mA | $T_J$ = −40°C to 150°C | 17 | 20 | 22 | $V_{DC}$ |
| Gate−Emitter Leakage Current | $I_{GES}$ | $V_{GE}$ = 10 V | $T_J$ = −40°C to 150°C | 384 | 600 | 1000 | μ$A_{DC}$ |
| Gate Resistor (Optional) | $R_G$ | − | $T_J$ = −40°C to 150°C | − | 70 | − | Ω |
| Gate Emitter Resistor | $R_{GE}$ | − | $T_J$ = −40°C to 150°C | 10 | 16 | 26 | kΩ |
| **ON CHARACTERISTICS** (Note 2) | | | | | | | |
| Gate Threshold Voltage | $V_{GE(th)}$ | $I_C$ = 1.0 mA, $V_{GE}$ = $V_{CE}$ | $T_J$ = 25°C | 1.4 | 1.7 | 2.0 | $V_{DC}$ |
| | | | $T_J$ = 150°C | 0.75 | 1.1 | 1.4 | |
| | | | $T_J$ = −40°C | 1.6 | 1.9 | 2.1* | |
| Threshold Temperature Coefficient (Neg) | − | − | − | − | 4.4 | − | mV/°C |
| Collector−to−Emitter On−Voltage | $V_{CE(on)}$ | $I_C$ = 6.0 A, $V_{GE}$ = 4.0 V | $T_J$ = 25°C | 1.0 | 1.3 | 1.6 | $V_{DC}$ |
| | | | $T_J$ = 150°C | 0.9 | 1.2 | 1.5 | |
| | | | $T_J$ = −40°C | 1.1 | 1.4 | 1.7* | |
| | | $I_C$ = 10 A, $V_{GE}$  4.0 V | $T_J$ = 25°C | 1.3 | 1.6 | 1.9 | |
| | | | $T_J$ = 150°C | 1.2 | 1.5 | 1.8 | |
| | | | $T_J$ = −40°C | 1.3 | 1.6 | 1.9* | |
| | | $I_C$ = 15 A, $V_{GE}$ = 4.0 V | $T_J$ = 25°C | 1.6 | 1.95 | 2.25 | |
| | | | $T_J$ = 150°C | 1.7 | 2.0 | 2.3* | |
| | | | $T_J$ = −40°C | 1.6 | 1.9 | 2.2 | |

1. When surface mounted to an FR4 board using the minimum recommended pad size.
2. Pulse Test: Pulse Width $\le$ 300 μS, Duty Cycle $\le$ 2%.

*Maximum Value of Characteristic across Temperature Range.

**ELECTRICAL CHARACTERISTICS (continued)**

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **ON CHARACTERISTICS (continued)** (Note 3) | | | | | | | |
| Collector−to−Emitter On−Voltage | $V_{CE(on)}$ | $I_C$ = 20 A, $V_{GE}$ = 4.0 V | $T_J$ = 25°C | 1.9 | 2.2 | 2.5 | $V_{DC}$ |
| | | | $T_J$ = 150°C | 2.1 | 2.4 | 2.7* | |
| | | | $T_J$ = −40°C | 1.85 | 2.15 | 2.45 | |
| | | $I_C$ = 25 A, $V_{GE}$ = 4.0 V | $T_J$ = 25°C | 2.1 | 2.5 | 2.9 | |
| | | | $T_J$ = 150°C | 2.5 | 2.9 | 3.3* | |
| | | | $T_J$ = −40°C | 2.0 | 2.4 | 2.8 | |
| Collector−to−Emitter On−Voltage | $V_{CE(on)}$ | $I_C$ = 10 A, $V_{GE}$ = 4.5 V | $T_J$ = 150°C | − | 1.5 | 1.8 | $V_{DC}$ |
| Forward Transconductance | gfs | $V_{CE}$ = 5.0 V, $I_C$ = 6.0 A | $T_J$ = −40°C to 150°C | 8.0 | 15 | 25 | Mhos |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{CC}$ = 25 V, $V_{GE}$ = 0 V f = 1.0 MHz | $T_J$ = −40°C to 150°C | − | 1000 | 1300 | pF |
| Output Capacitance | $C_{OSS}$ | | | − | 100 | 130 | |
| Transfer Capacitance | $C_{RSS}$ | | | − | 5.0 | 8.0 | |
| **SWITCHING CHARACTERISTICS** (Note 3) | | | | | | | |
| Turn−Off Delay Time (Inductive) | $t_{d(off)}$ | $V_{CC}$ = 300 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, L = 300 μH | $T_J$ = 25°C | − | 4.0 | 10 | μSec |
| | | | $T_J$ = 150°C | − | 4.5 | 10 | |
| Fall Time (Inductive) | $t_f$ | $V_{CC}$ = 300 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, L = 300 μH | $T_J$ = 25°C | − | 7.0 | 10 | |
| | | | $T_J$ = 150°C | − | 10 | 15* | |
| Turn−Off Delay Time (Resistive) | $t_{d(off)}$ | $V_{CC}$ = 300 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, $R_L$ = 46 Ω, | $T_J$ = 25°C | − | 4.0 | 10 | μSec |
| | | | $T_J$ = 150°C | − | 4.5 | 10 | |
| Fall Time (Resistive) | $t_f$ | $V_{CC}$ = 300 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, $R_L$ = 46 Ω, | $T_J$ = 25°C | − | 13 | 20 | |
| | | | $T_J$ = 150°C | − | 16 | 20 | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CC}$ = 10 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, $R_L$ = 1.5 Ω | $T_J$ = 25°C | − | 1.0 | 1.5 | μSec |
| | | | $T_J$ = 150°C | − | 1.0 | 1.5 | |
| Rise Time | $t_r$ | $V_{CC}$ = 10 V, $I_C$ = 6.5 A $R_G$ = 1.0 kΩ, $R_L$ = 1.5 Ω | $T_J$ = 25°C | − | 4.5 | 6.0 | |
| | | | $T_J$ = 150°C | − | 5.0 | 6.0 | |

3. Pulse Test: Pulse Width ≤ 300 μS, Duty Cycle ≤ 2%.
*Maximum Value of Characteristic across Temperature Range.

## TYPICAL ELECTRICAL CHARACTERISTICS (unless otherwise noted)

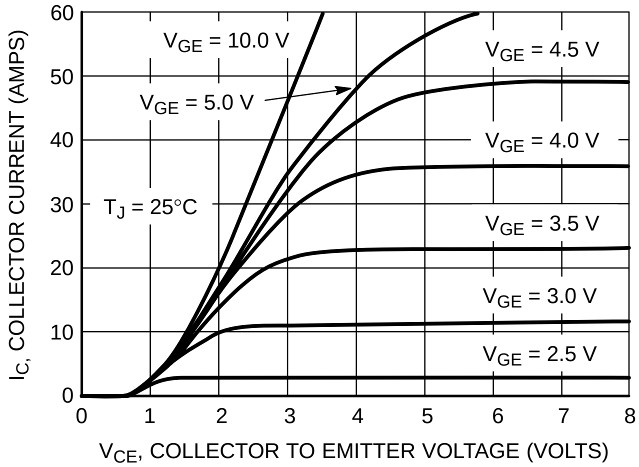



**Figure 1. Output Characteristics**

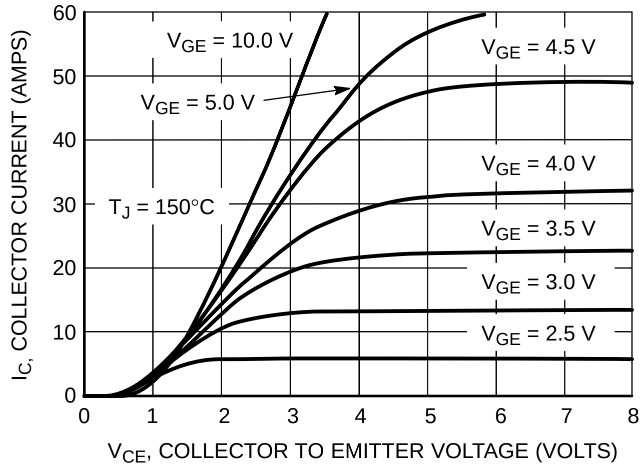



**Figure 2. Output Characteristics**

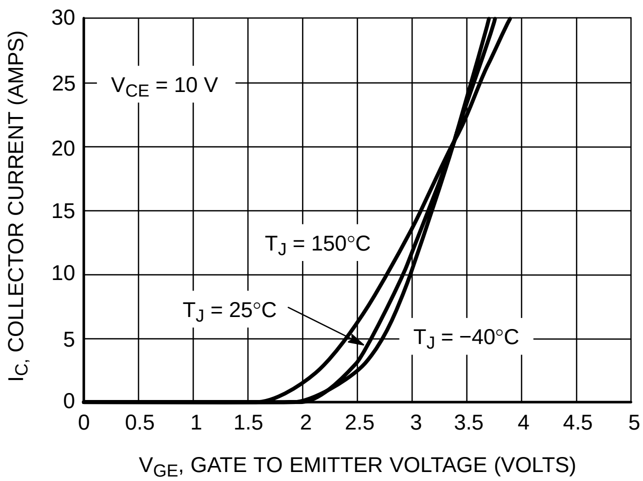



**Figure 3. Transfer Characteristics**

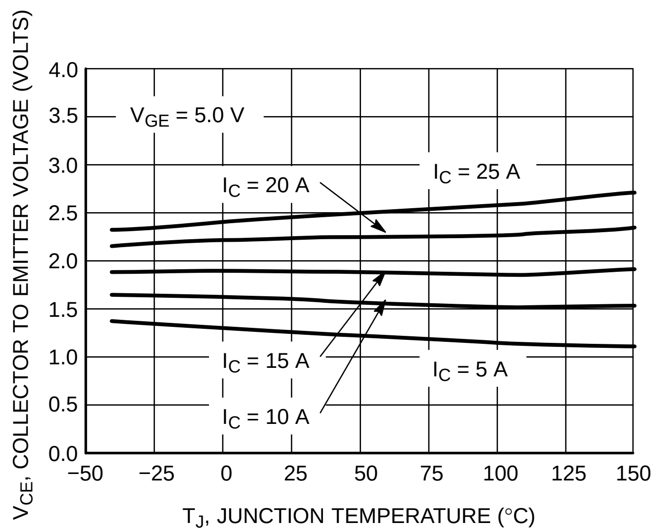



**Figure 4. Collector−to−Emitter Saturation Voltage vs. Junction Temperature**

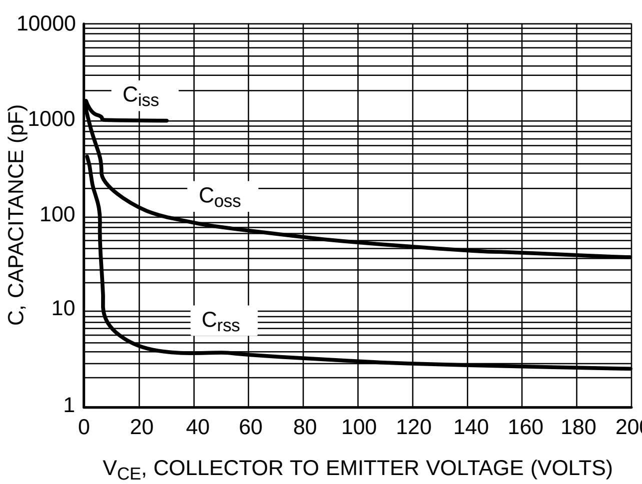



**Figure 5. Capacitance Variation**

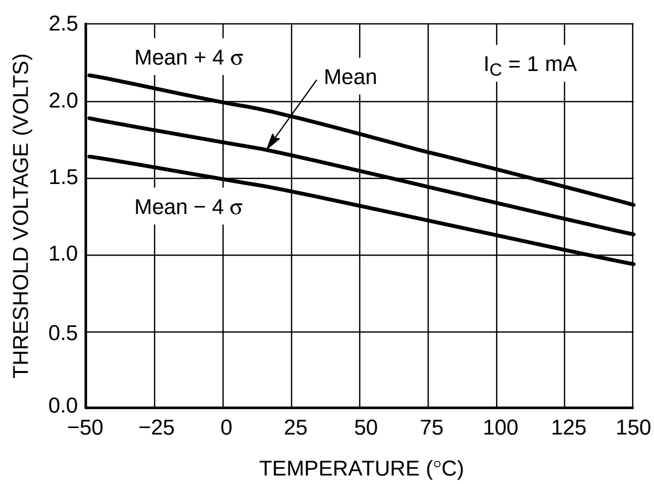



**Figure 6. Threshold Voltage vs. Temperature**

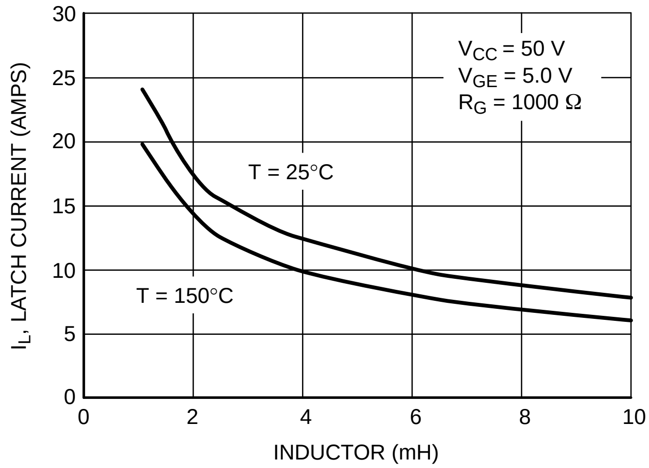



**Figure 7. Minimum Open Secondary Latch Current vs. Inductor**

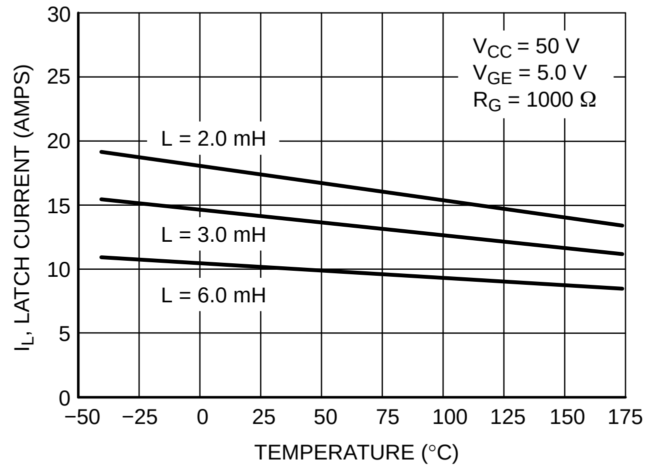



**Figure 8. Minimum Open Secondary Latch Current vs. Temperature**

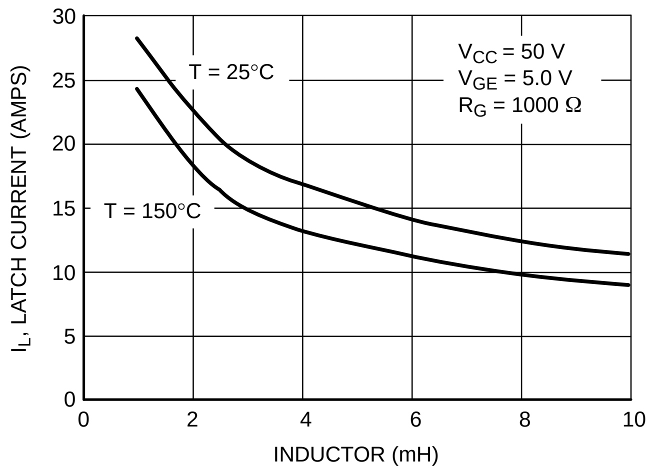



**Figure 9. Typical Open Secondary Latch Current vs. Inductor**

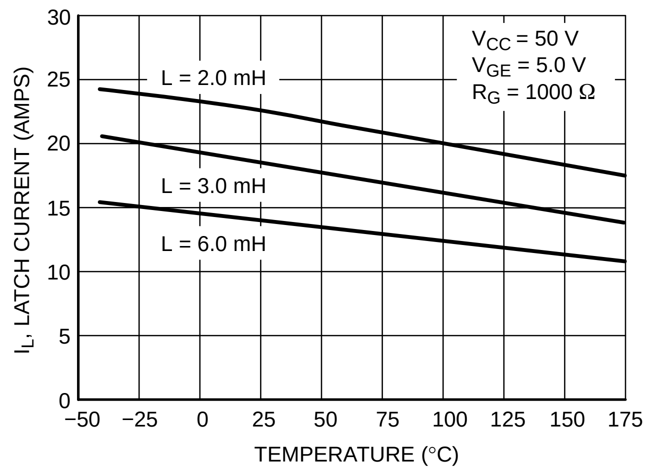



**Figure 10. Typical Open Secondary Latch Current vs. Temperature**

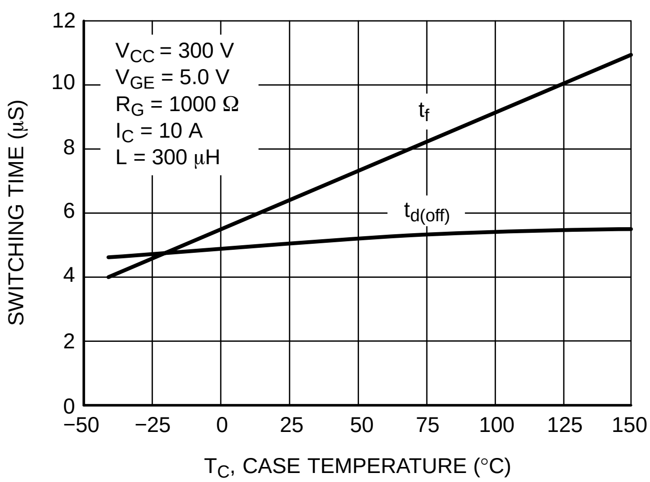



**Figure 11. Switching Speed vs. Case Temperature**

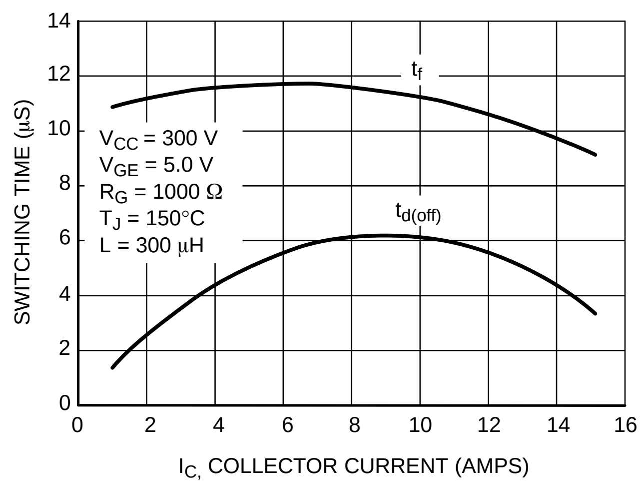



**Figure 12. Switching Speed vs. Collector Current**

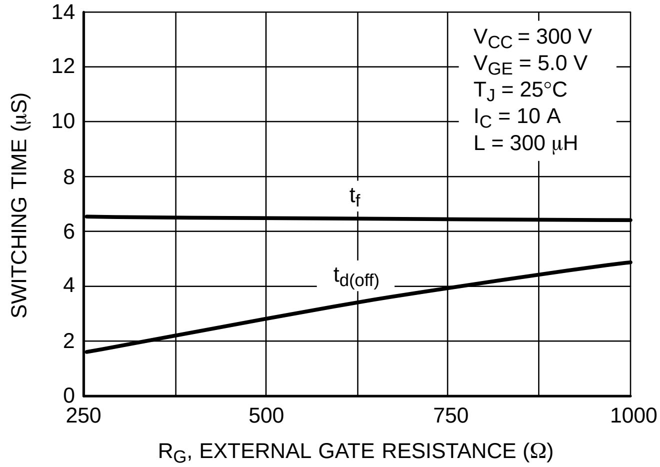



**Figure 13. Switching Speed vs. External Gate Resistance**

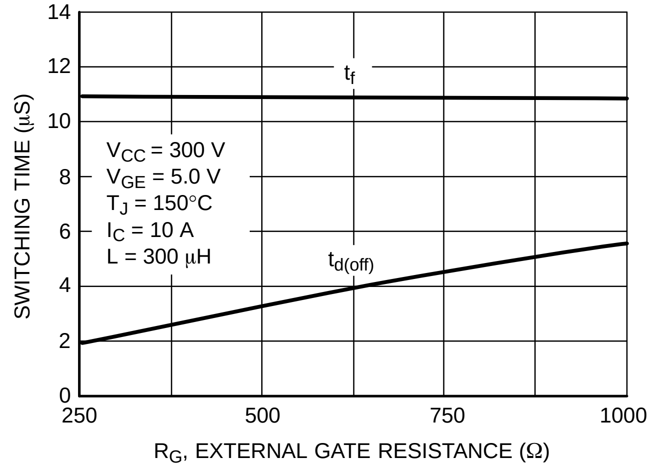



**Figure 14. Switching Speed vs. External Gate Resistance**

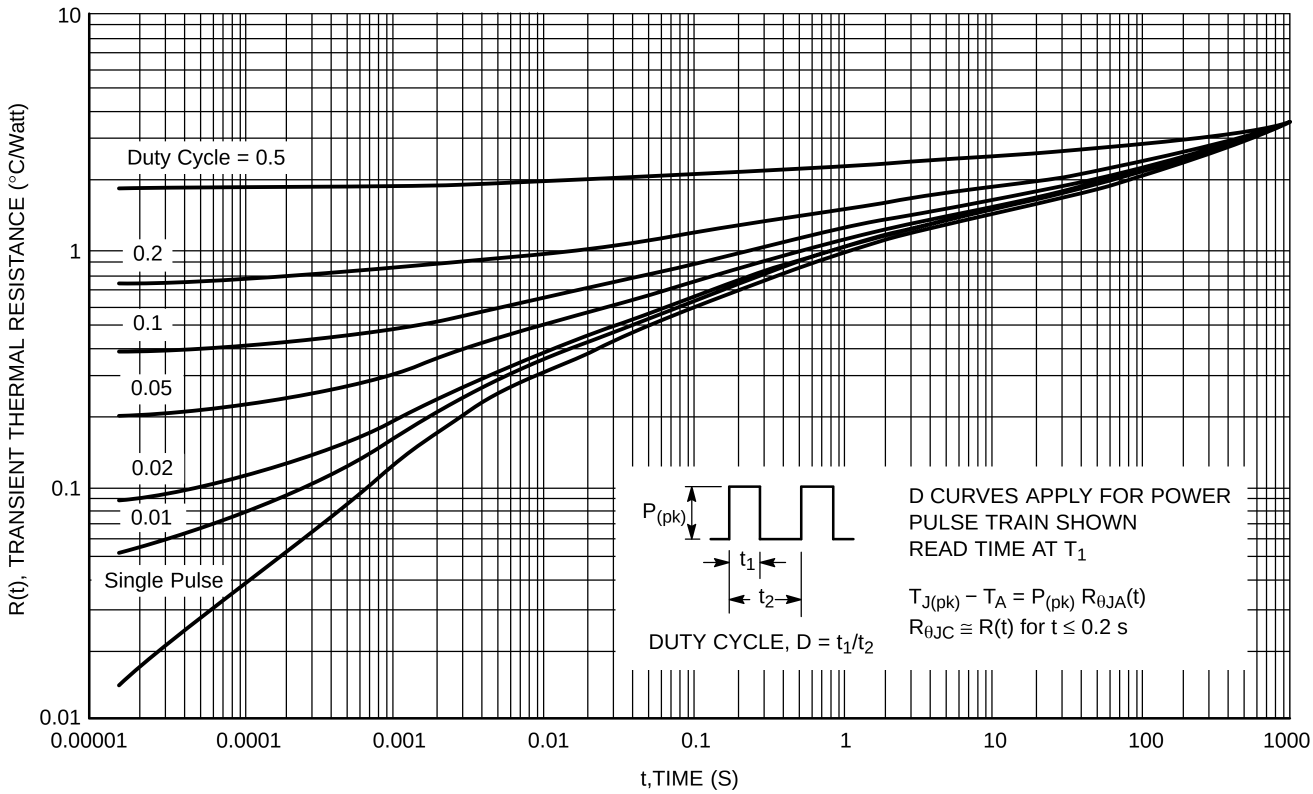



**Figure 15. Transient Thermal Resistance (Non−normalized Junction−to−Ambient mounted on fixture in Figure 16)**

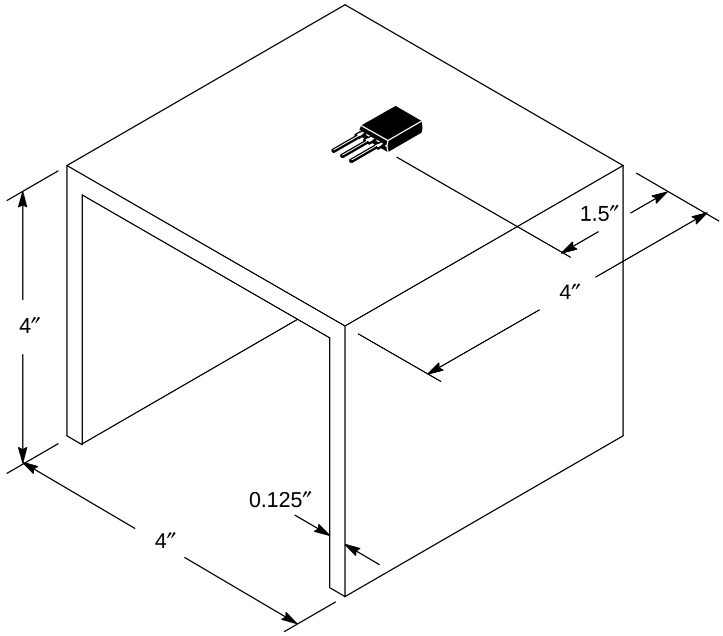



**Figure 16. Test Fixture for Transient Thermal Curve**
**(48 square inches of 1/8″ thick aluminum)**

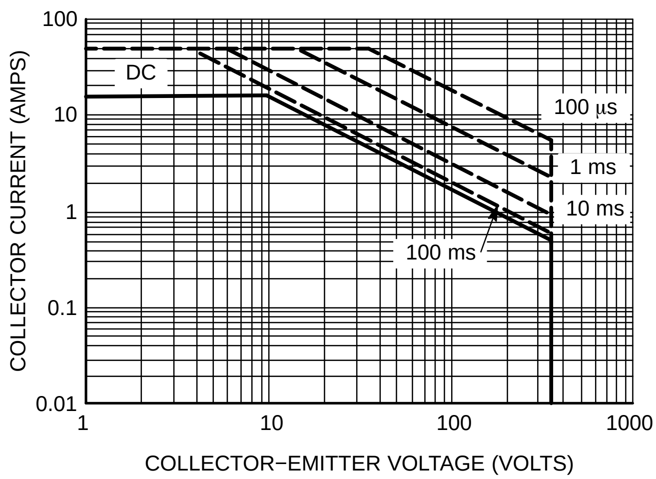



**Figure 17. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_C$ = 25°C)**

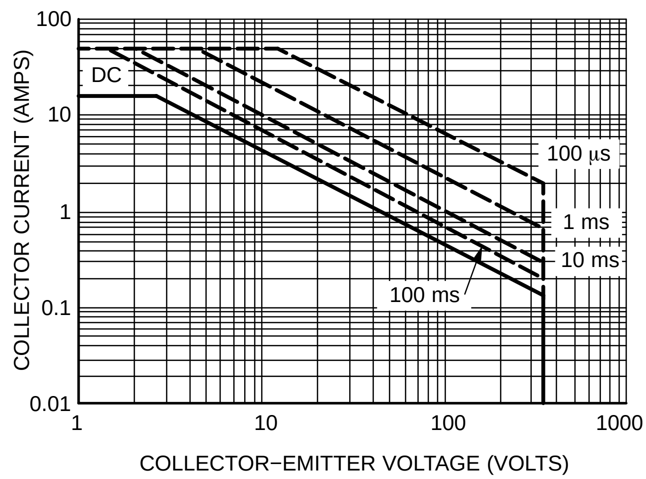



**Figure 18. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_C$ = 125°C)**

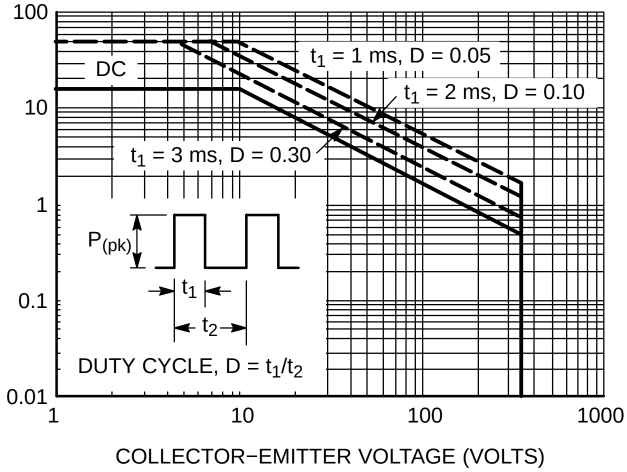



**Figure 19. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C$ = 25°C)**

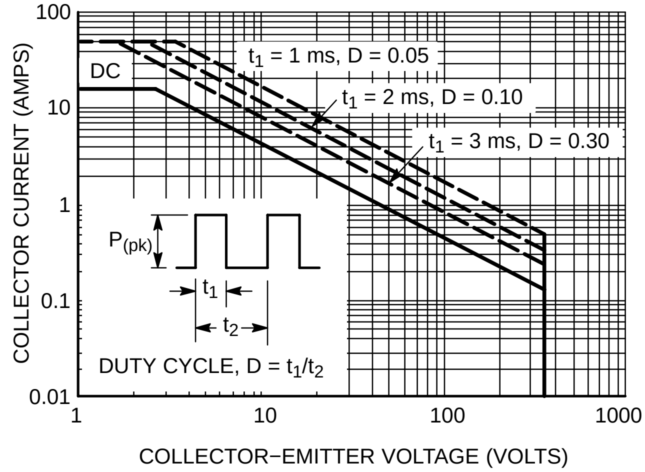



**Figure 20. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C$ = 125°C)**

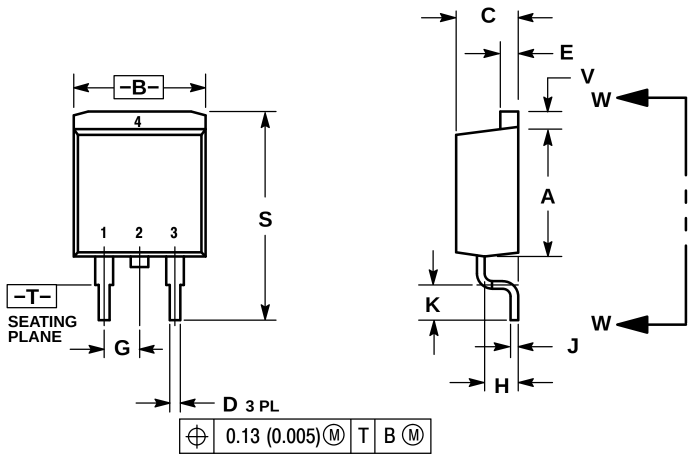
## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| MGP15N40CL | TO−220AB | 50 Units / Rail |
| MGP15N40CLG | TO−220AB (Pb−Free) | |
| MGB15N40CLT4 | D2PAK | 800 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## PACKAGE DIMENSIONS

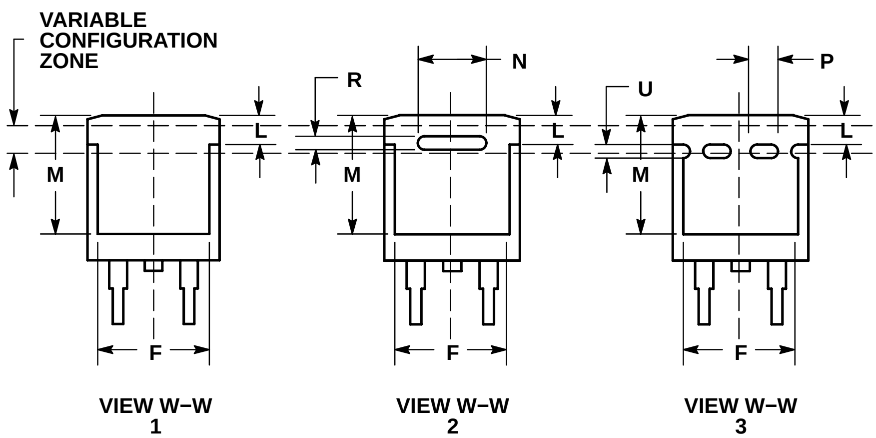
**$D^2$PAK 3**
CASE 418B−04
ISSUE J



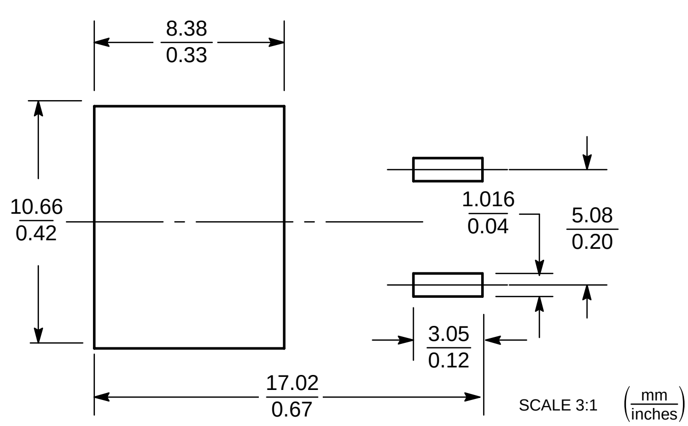

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 418B−01 THRU 418B−03 OBSOLETE, NEW STANDARD 418B−04.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.340 | 0.380 | 8.64 | 9.65 |
| B | 0.380 | 0.405 | 9.65 | 10.29 |
| C | 0.160 | 0.190 | 4.06 | 4.83 |
| D | 0.020 | 0.035 | 0.51 | 0.89 |
| E | 0.045 | 0.055 | 1.14 | 1.40 |
| F | 0.310 | 0.350 | 7.87 | 8.89 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.080 | 0.110 | 2.03 | 2.79 |
| J | 0.018 | 0.025 | 0.46 | 0.64 |
| K | 0.090 | 0.110 | 2.29 | 2.79 |
| L | 0.052 | 0.072 | 1.32 | 1.83 |
| M | 0.280 | 0.320 | 7.11 | 8.13 |
| N | 0.197 REF | | 5.00 REF | |
| P | 0.079 REF | | 2.00 REF | |
| R | 0.039 REF | | 0.99 REF | |
| S | 0.575 | 0.625 | 14.60 | 15.88 |
| V | 0.045 | 0.055 | 1.14 | 1.40 |

STYLE 4:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR



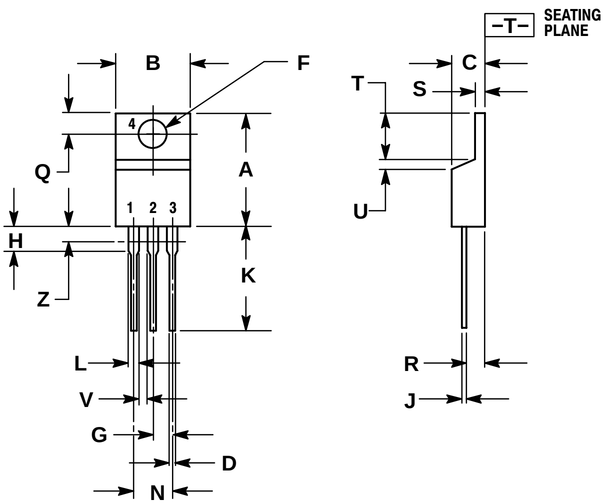

### SOLDERING FOOTPRINT*




*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## PACKAGE DIMENSIONS

**TO−220 THREE−LEAD**
**TO−220AB**
CASE 221A−09
ISSUE AA




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.570 | 0.620 | 14.48 | 15.75 |
| B | 0.380 | 0.405 | 9.66 | 10.28 |
| C | 0.160 | 0.190 | 4.07 | 4.82 |
| D | 0.025 | 0.035 | 0.64 | 0.88 |
| F | 0.142 | 0.147 | 3.61 | 3.73 |
| G | 0.095 | 0.105 | 2.42 | 2.66 |
| H | 0.110 | 0.155 | 2.80 | 3.93 |
| J | 0.018 | 0.025 | 0.46 | 0.64 |
| K | 0.500 | 0.562 | 12.70 | 14.27 |
| L | 0.045 | 0.060 | 1.15 | 1.52 |
| N | 0.190 | 0.210 | 4.83 | 5.33 |
| Q | 0.100 | 0.120 | 2.54 | 3.04 |
| R | 0.080 | 0.110 | 2.04 | 2.79 |
| S | 0.045 | 0.055 | 1.15 | 1.39 |
| T | 0.235 | 0.255 | 5.97 | 6.47 |
| U | 0.000 | 0.050 | 0.00 | 1.27 |
| V | 0.045 | --- | 1.15 | --- |
| Z | --- | 0.080 | --- | 2.04 |

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2. COLLECTOR
3. EMITTER
4. COLLECTOR



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