

# MGP15N40CL, MGB15N40CL

Preferred Device

## Ignition IGBT 15 Amps, 410 Volts

### N-Channel TO-220 and D<sup>2</sup>PAK

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

#### MAXIMUM RATINGS ( $-55^{\circ}\text{C} \leq T_J \leq 175^{\circ}\text{C}$ 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 @ $T_C = 25^{\circ}\text{C}$ - Pulsed	$I_C$	15 50	$A_{DC}$ $A_{AC}$
ESD (Human Body Model) $R = 1500 \Omega$ , $C = 100 \text{ pF}$	ESD	8.0	kV
ESD (Machine Model) $R = 0 \Omega$ , $C = 200 \text{ pF}$	ESD	800	V
Total Power Dissipation @ $T_C = 25^{\circ}\text{C}$ Derate above $25^{\circ}\text{C}$	$P_D$	150 1.0	W $W/^{\circ}\text{C}$
Operating and Storage Temperature Range	$T_J, T_{stg}$	-55 to 175	$^{\circ}\text{C}$

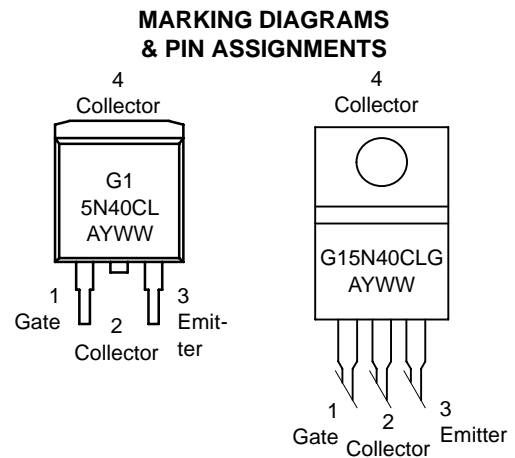
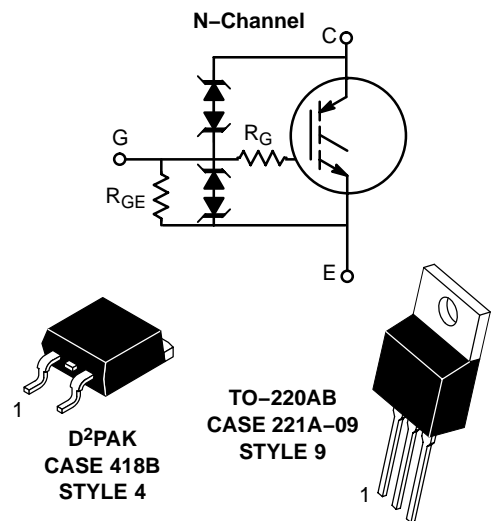
Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur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



ON Semiconductor®

<http://onsemi.com>

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



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.

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## UNCLAMPED COLLECTOR-TO-EMITTER AVALANCHE CHARACTERISTICS ( $-55^{\circ}\text{C} \leq T_J \leq 175^{\circ}\text{C}$ )

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

## THERMAL CHARACTERISTICS

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

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Clamp Voltage	$BV_{CES}$	$I_C = 2.0\text{ mA}$	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	380	410	440	$V_{DC}$
		$I_C = 10\text{ mA}$	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	390	420	450	
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{CE} = 350\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_J = 25^{\circ}\text{C}$	-	1.5	20	$\mu\text{A}_{DC}$
			$T_J = 150^{\circ}\text{C}$	-	10	40*	
			$T_J = -40^{\circ}\text{C}$	-	0.7	1.5	
Reverse Collector-Emitter Leakage Current	$I_{ECS}$	$V_{CE} = -24\text{ V}$	$T_J = 25^{\circ}\text{C}$	-	0.35	1.0	mA
			$T_J = 150^{\circ}\text{C}$	-	8.0	15*	
			$T_J = -40^{\circ}\text{C}$	-	0.05	0.5	
Reverse Collector-Emitter Clamp Voltage	$BV_{CES(R)}$	$I_C = -75\text{ mA}$	$T_J = 25^{\circ}\text{C}$	25	33	50	$V_{DC}$
			$T_J = 150^{\circ}\text{C}$	25	36	50	
			$T_J = -40^{\circ}\text{C}$	25	30	50	
Gate-Emitter Clamp Voltage	$BV_{GES}$	$I_G = 5.0\text{ mA}$	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	17	20	22	$V_{DC}$
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = 10\text{ V}$	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	384	600	1000	$\mu\text{A}_{DC}$
Gate Resistor (Optional)	$R_G$	-	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	-	70	-	$\Omega$
Gate Emitter Resistor	$R_{GE}$	-	$T_J = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$	10	16	26	$k\Omega$

### ON CHARACTERISTICS (Note 2)

Gate Threshold Voltage	$V_{GE(th)}$	$I_C = 1.0\text{ mA}$ , $V_{GE} = V_{CE}$	$T_J = 25^{\circ}\text{C}$	1.4	1.7	2.0	$V_{DC}$
			$T_J = 150^{\circ}\text{C}$	0.75	1.1	1.4	
			$T_J = -40^{\circ}\text{C}$	1.6	1.9	2.1*	
Threshold Temperature Coefficient (Neg)	-	-	-	-	4.4	-	$\text{mV}/^{\circ}\text{C}$
Collector-to-Emitter On-Voltage	$V_{CE(on)}$	$I_C = 6.0\text{ A}$ , $V_{GE} = 4.0\text{ V}$	$T_J = 25^{\circ}\text{C}$	1.0	1.3	1.6	$V_{DC}$
			$T_J = 150^{\circ}\text{C}$	0.9	1.2	1.5	
			$T_J = -40^{\circ}\text{C}$	1.1	1.4	1.7*	
		$I_C = 10\text{ A}$ , $V_{GE} = 4.0\text{ V}$	$T_J = 25^{\circ}\text{C}$	1.3	1.6	1.9	
			$T_J = 150^{\circ}\text{C}$	1.2	1.5	1.8	
			$T_J = -40^{\circ}\text{C}$	1.3	1.6	1.9*	
		$I_C = 15\text{ A}$ , $V_{GE} = 4.0\text{ V}$	$T_J = 25^{\circ}\text{C}$	1.6	1.95	2.25	
			$T_J = 150^{\circ}\text{C}$	1.7	2.0	2.3*	
			$T_J = -40^{\circ}\text{C}$	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  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

\*Maximum Value of Characteristic across Temperature Range.

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## ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
<b>ON CHARACTERISTICS (continued)</b> (Note 3)							
Collector-to-Emitter On-Voltage	$V_{CE(on)}$	$I_C = 20\text{ A}$ , $V_{GE} = 4.0\text{ V}$	$T_J = 25^\circ\text{C}$	1.9	2.2	2.5	$V_{DC}$
			$T_J = 150^\circ\text{C}$	2.1	2.4	2.7*	
			$T_J = -40^\circ\text{C}$	1.85	2.15	2.45	
		$I_C = 25\text{ A}$ , $V_{GE} = 4.0\text{ V}$	$T_J = 25^\circ\text{C}$	2.1	2.5	2.9	
			$T_J = 150^\circ\text{C}$	2.5	2.9	3.3*	
			$T_J = -40^\circ\text{C}$	2.0	2.4	2.8	
Collector-to-Emitter On-Voltage	$V_{CE(on)}$	$I_C = 10\text{ A}$ , $V_{GE} = 4.5\text{ V}$	$T_J = 150^\circ\text{C}$	–	1.5	1.8	$V_{DC}$
Forward Transconductance	gfs	$V_{CE} = 5.0\text{ V}$ , $I_C = 6.0\text{ A}$	$T_J = -40^\circ\text{C}$ to $150^\circ\text{C}$	8.0	15	25	Mhos

## DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{ISS}$	$V_{CC} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$ $f = 1.0\text{ MHz}$	$T_J = -40^\circ\text{C}$ to $150^\circ\text{C}$	–	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)	$t_{d(off)}$	$V_{CC} = 300\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $L = 300\text{ }\mu\text{H}$	$T_J = 25^\circ\text{C}$	–	4.0	10	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	4.5	10	
Fall Time (Inductive)	$t_f$	$V_{CC} = 300\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $L = 300\text{ }\mu\text{H}$	$T_J = 25^\circ\text{C}$	–	7.0	10	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	10	15*	
Turn-Off Delay Time (Resistive)	$t_{d(off)}$	$V_{CC} = 300\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $R_L = 46\text{ }\Omega$	$T_J = 25^\circ\text{C}$	–	4.0	10	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	4.5	10	
Fall Time (Resistive)	$t_f$	$V_{CC} = 300\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $R_L = 46\text{ }\Omega$	$T_J = 25^\circ\text{C}$	–	13	20	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	16	20	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 10\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $R_L = 1.5\text{ }\Omega$	$T_J = 25^\circ\text{C}$	–	1.0	1.5	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	1.0	1.5	
Rise Time	$t_r$	$V_{CC} = 10\text{ V}$ , $I_C = 6.5\text{ A}$ $R_G = 1.0\text{ k}\Omega$ , $R_L = 1.5\text{ }\Omega$	$T_J = 25^\circ\text{C}$	–	4.5	6.0	$\mu\text{Sec}$
			$T_J = 150^\circ\text{C}$	–	5.0	6.0	

3. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

\*Maximum Value of Characteristic across Temperature Range.

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## TYPICAL ELECTRICAL CHARACTERISTICS (unless otherwise noted)

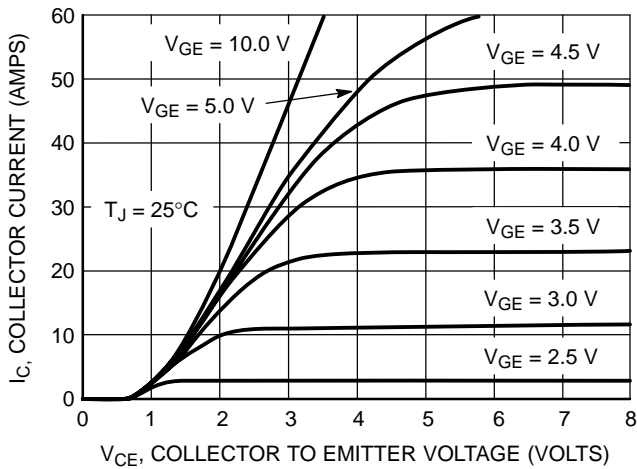


Figure 1. Output Characteristics

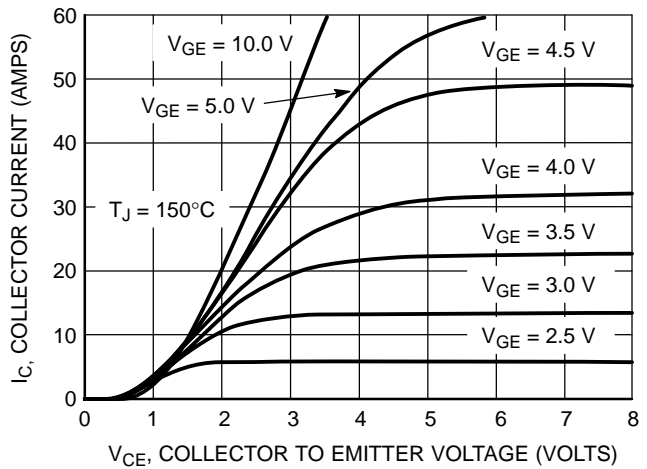


Figure 2. Output Characteristics

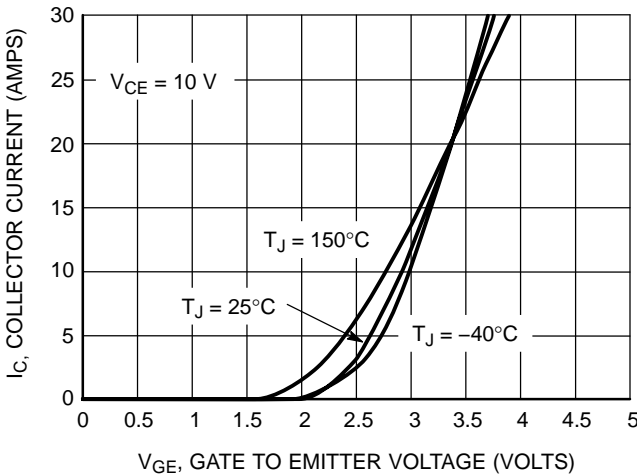


Figure 3. Transfer Characteristics

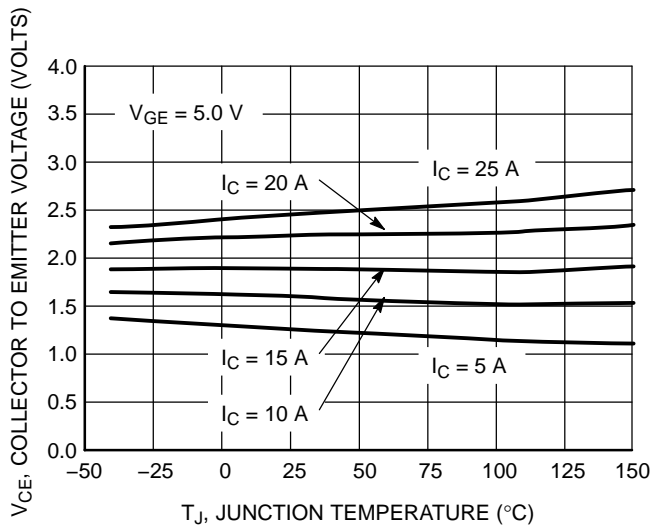


Figure 4. Collector-to-Emitter Saturation Voltage vs. Junction Temperature

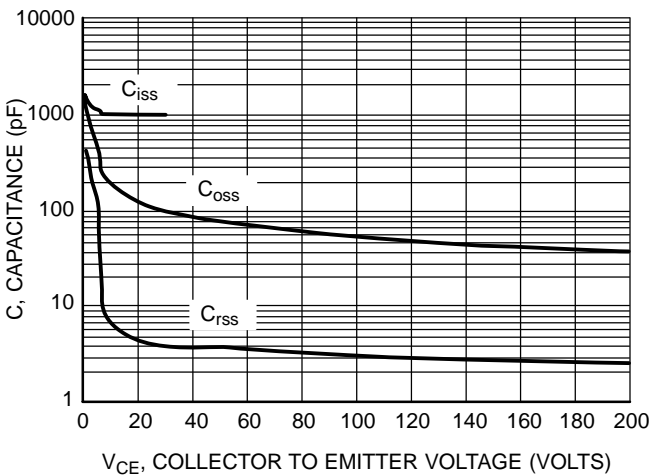


Figure 5. Capacitance Variation

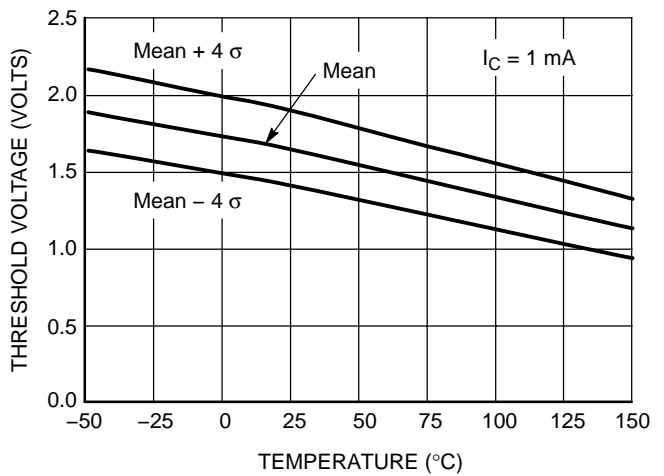
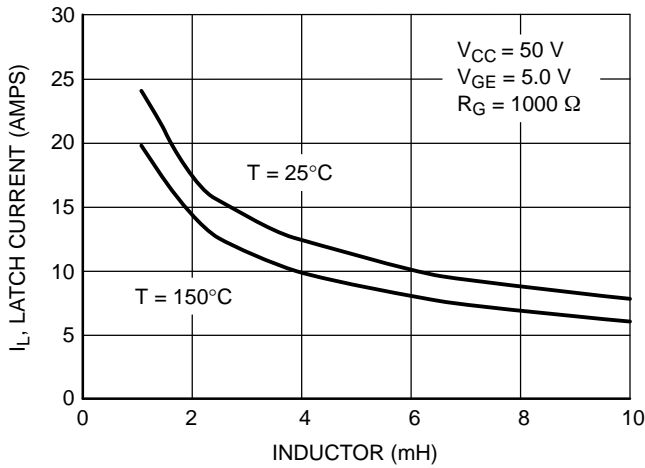
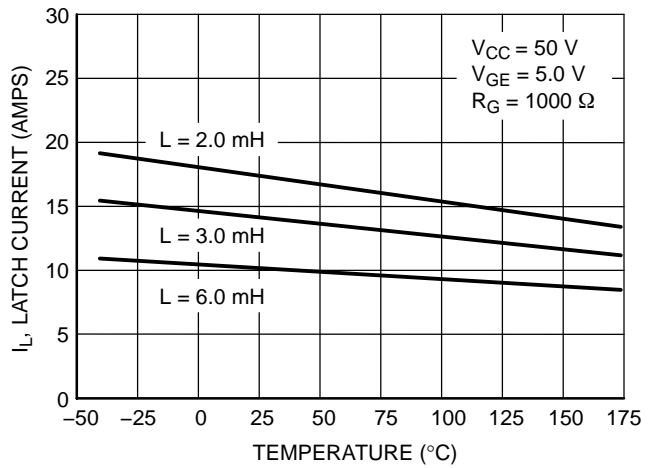


Figure 6. Threshold Voltage vs. Temperature

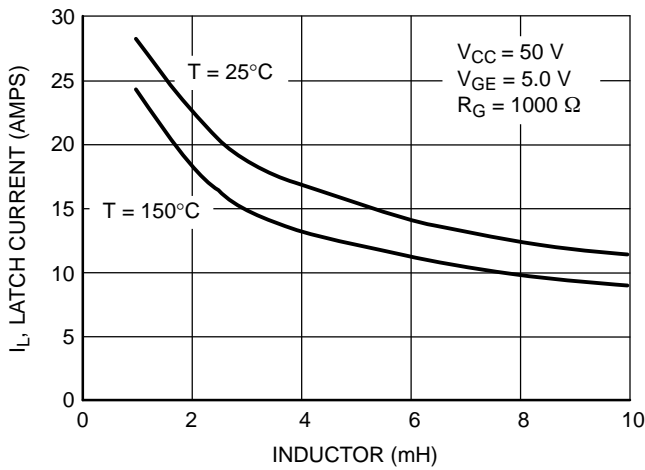
# MGP15N40CL, MGB15N40CL



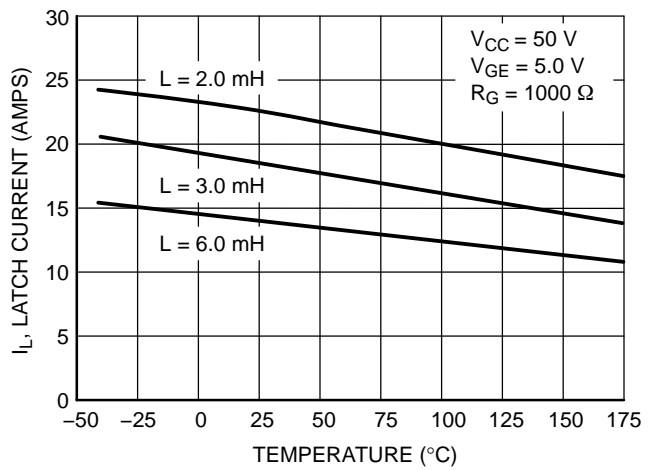
**Figure 7. Minimum Open Secondary Latch Current vs. Inductor**



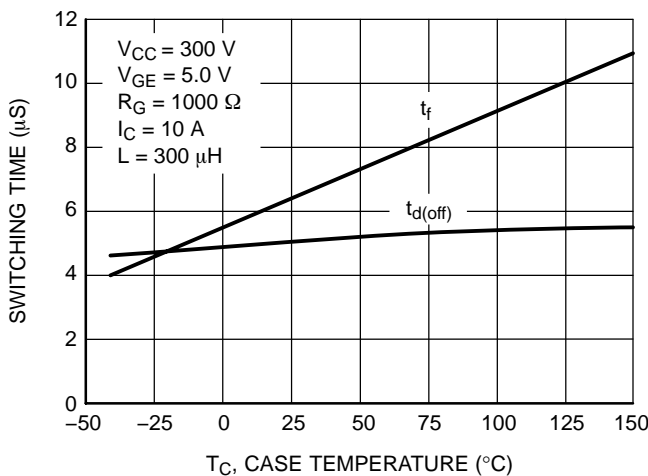
**Figure 8. Minimum Open Secondary Latch Current vs. Temperature**



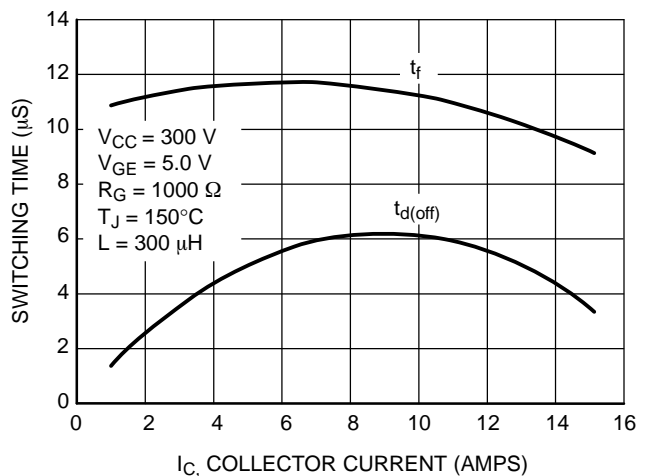
**Figure 9. Typical Open Secondary Latch Current vs. Inductor**



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

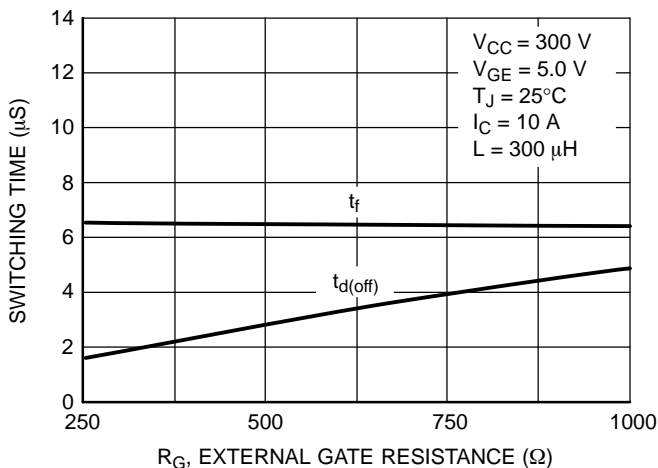


**Figure 11. Switching Speed vs. Case Temperature**

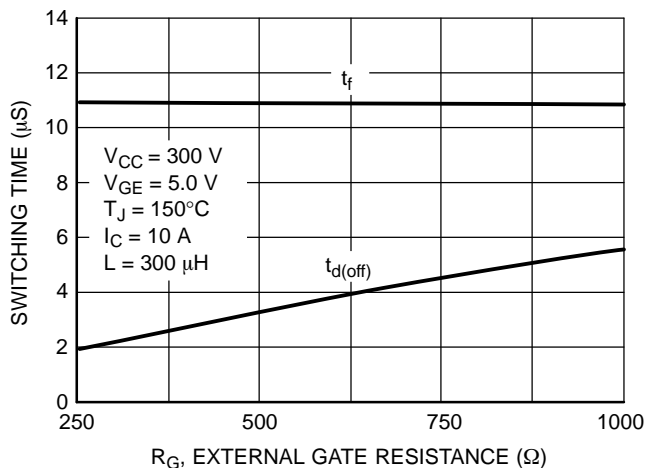


**Figure 12. Switching Speed vs. Collector Current**

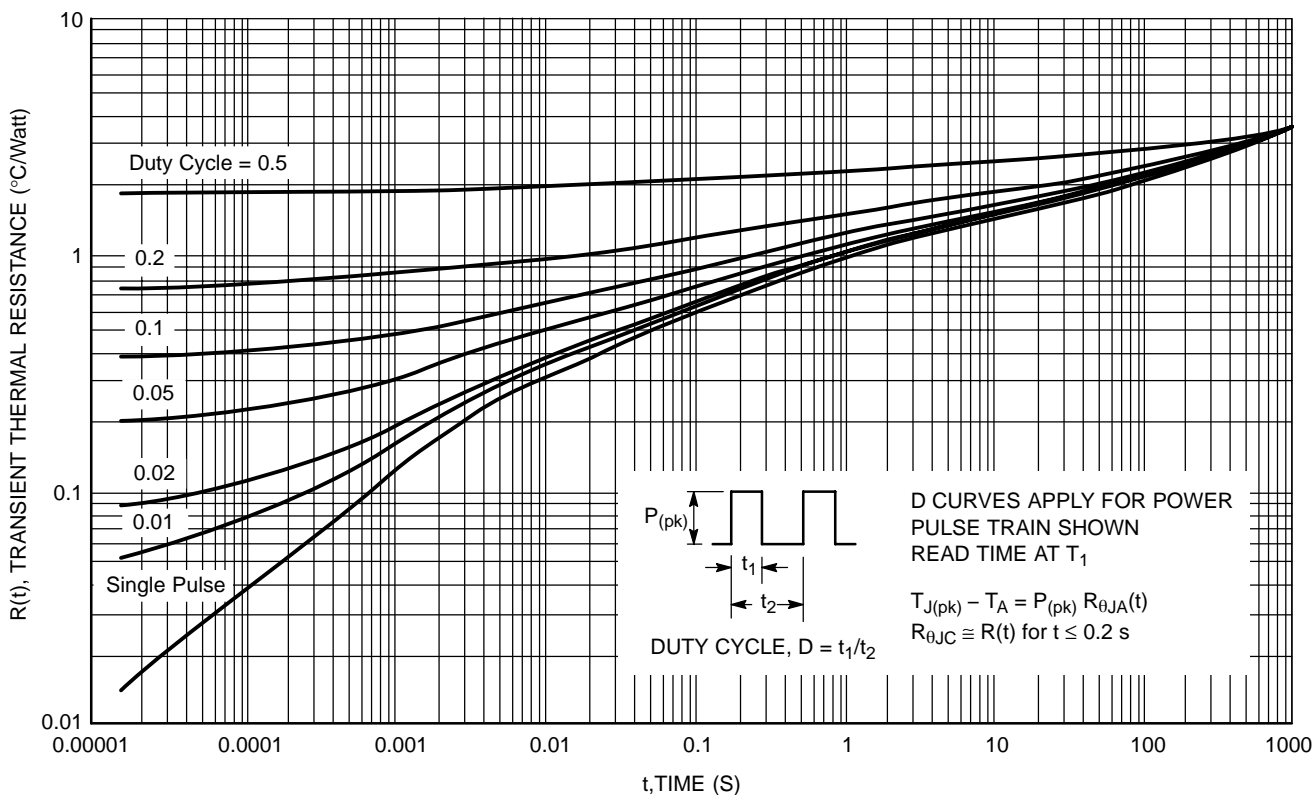
# MGP15N40CL, MGB15N40CL



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

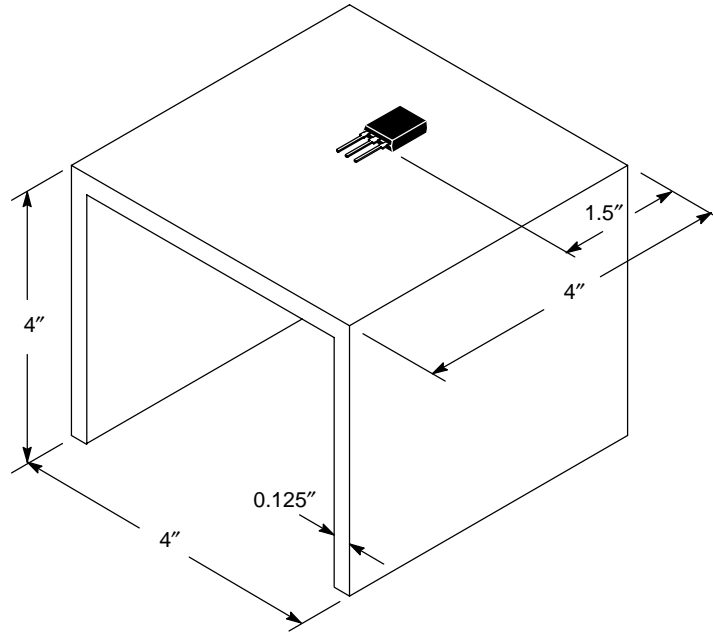


**Figure 14. Switching Speed vs. External Gate Resistance**

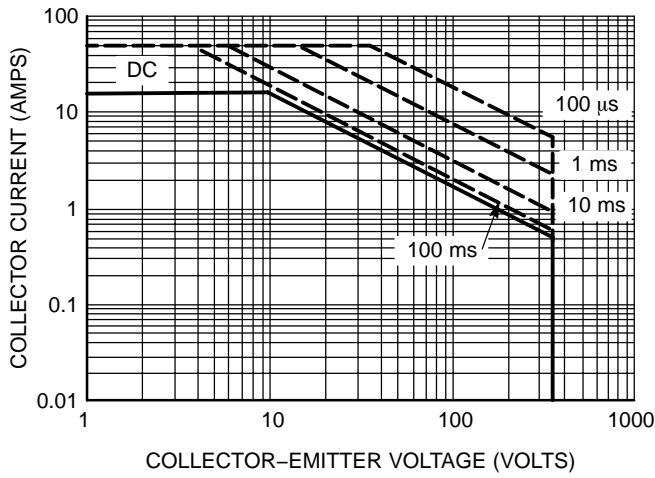


**Figure 15. Transient Thermal Resistance (Non-normalized Junction-to-Ambient mounted on fixture in Figure 16)**

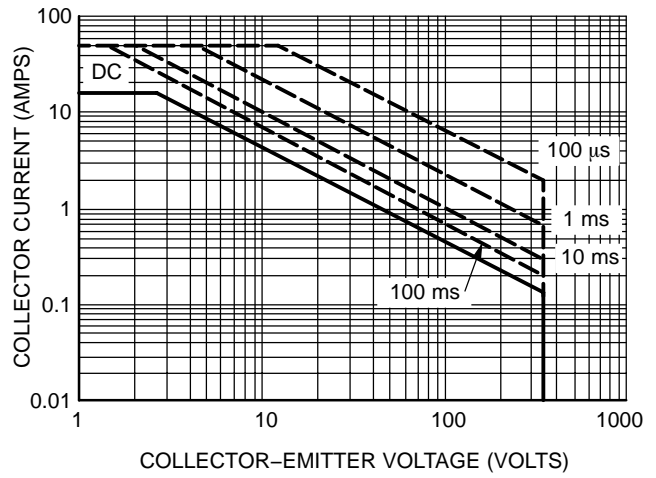
# MGP15N40CL, MGB15N40CL



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

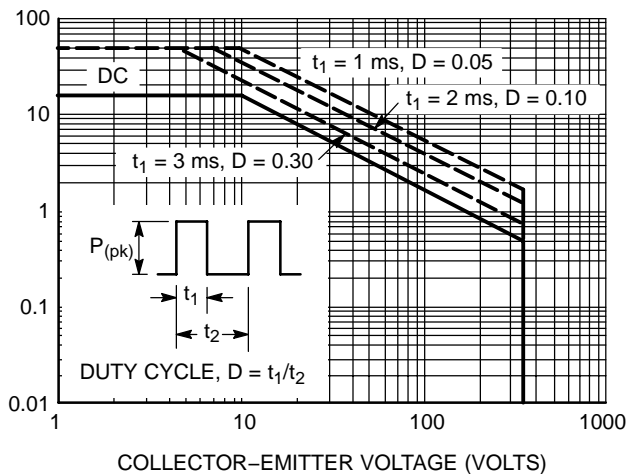


**Figure 17. Single Pulse Safe Operating Area  
(Mounted on an Infinite Heatsink at  $T_C = 25^\circ\text{C}$ )**

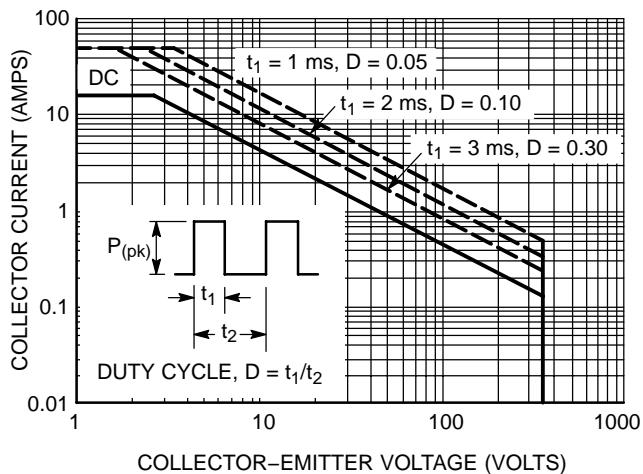


**Figure 18. Single Pulse Safe Operating Area  
(Mounted on an Infinite Heatsink at  $T_C = 125^\circ\text{C}$ )**

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**Figure 19. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at  $T_C = 25^\circ\text{C}$ )**



**Figure 20. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at  $T_C = 125^\circ\text{C}$ )**

## ORDERING INFORMATION

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

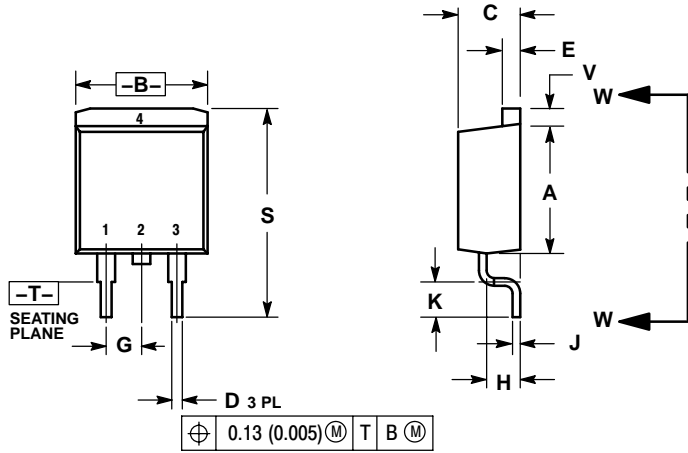
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



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## PACKAGE DIMENSIONS

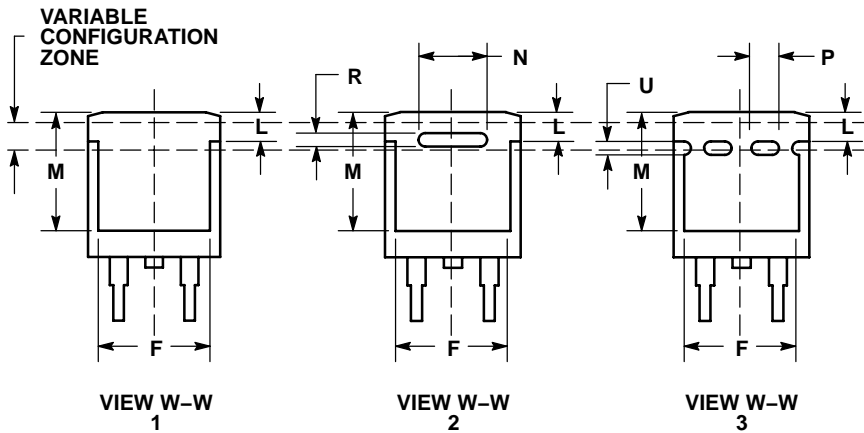
D<sup>2</sup>PAK 3  
CASE 418B-04  
ISSUE J



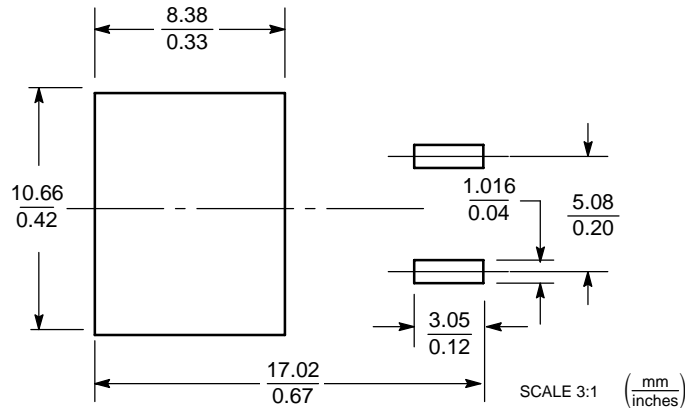
- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.  
3. 418B-01 THRU 418B-03 OBSOLETE, NEW STANDARD 418B-04.

DIM	INCHES		MILLIMETERS	
	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\*

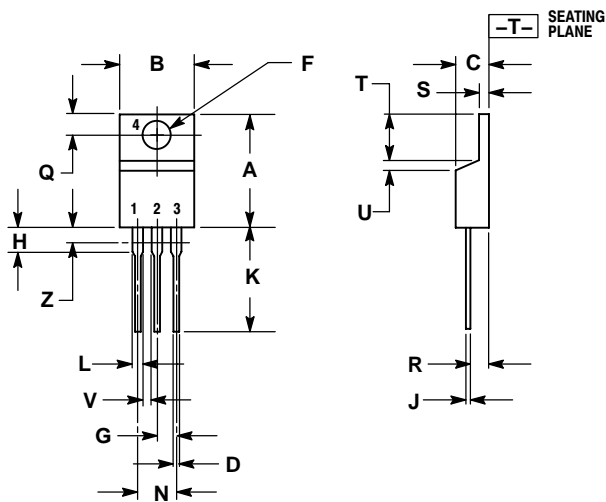


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# MGP15N40CL, MGB15N40CL

## 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.

DIM	INCHES		MILLIMETERS	
	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

- STYLE 9:
1. GATE
  2. COLLECTOR
  3. EMITTER
  4. COLLECTOR

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