



ON Semiconductor®

## FGB3040CS

### EcoSPARK® 300mJ, 400V, N-Channel Current Sensing Ignition IGBT

#### General Description

The FGB3040CS is an Ignition IGBT that offers outstanding SCIS capability along with a ratiometric emitter current sensing capability. This sensing is based on a emitter active area ratio of 200:1. The output is provided through a fourth (sense) lead. This signal provides a current level that is proportional to the main collector to emitter current. The effective ratio as measured on the sense lead is a function of the sense output, the collector current and the gate to emitter drive voltage.



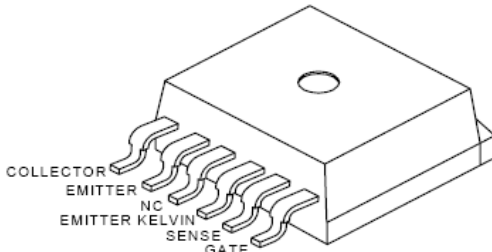
#### Applications

- Smart Automotive Ignition Coil Driver Circuits
- ECU Based Systems
- Distributorless Based Systems
- Coil on Plug Based Systems

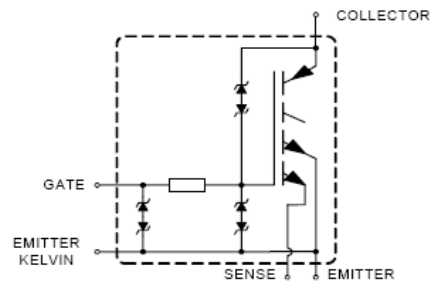
#### Features

- SCIS Energy = 300mJ at  $T_J = 25^\circ\text{C}$
- Logic Level Gate Drive
- Qualified to AEC Q101
- RoHS Compliant

#### Package



#### Symbol



#### Device Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Ratings	Units
$BV_{CER}$	Collector to Emitter Breakdown Voltage ( $I_C = 2\text{mA}$ )	430	V
$BV_{ECS}$	Emitter to Collector Breakdown Voltage ( $I_C = 1\text{mA}$ ) (Reverse Battery Condition)	24	V
$E_{SCIS25}$	Self Clamping Inductive Switching Energy (at starting $T_J = 25^\circ\text{C}$ )	300	mJ
$E_{SCIS150}$	Self Clamping Inductive Switching Energy (at starting $T_J = 150^\circ\text{C}$ )	170	mJ
$I_{C25}$	Continuous Collector Current, at $V_{GE} = 4.0\text{V}$ , $T_C = 25^\circ\text{C}$	21	A
$I_{C110}$	Continuous Collector Current, at $V_{GE} = 4.0\text{V}$ , $T_C = 110^\circ\text{C}$	19	A
$V_{GEM}$	Maximum Continuous Gate to Emitter Voltage	$\pm 10$	V
$P_D$	Power Dissipation, at $T_C = 25^\circ\text{C}$	150	W
	Power Dissipation Derating, for $T_C > 25^\circ\text{C}$	1	W/ $^\circ\text{C}$
$T_J$	Operating Junction Temperature Range	-40 to 175	$^\circ\text{C}$
$T_{STG}$	Storage Junction Temperature Range	-40 to 175	$^\circ\text{C}$
$T_L$	Max. Lead Temp. for Soldering (at 1.6mm from case for 10sec)	300	$^\circ\text{C}$
$T_{PKG}$	Max. Package Temp. for Soldering (Package Body for 10 sec)	260	$^\circ\text{C}$
ESD	Electrostatic Discharge Voltage, HBM model (100pfd, 1500 ohms)	4	kV

## Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
3040CS	FGB3040CS	TO-263 6 Lead	300mm	24mm	800
3040CS	FGB3040CS	TO-263 6 Lead	Tube	N/A	50

## Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
--------	-----------	-----------------	-----	-----	-----	-------

### Off State Characteristics

BV <sub>CER</sub>	Collector to Emitter Breakdown Voltage	I <sub>CE</sub> = 2mA, V <sub>GE</sub> = 0, R <sub>GE</sub> = 1KΩ, See Fig. 17 T <sub>J</sub> = -40 to 150°C		370	410	430	V
BV <sub>CES</sub>	Collector to Emitter Breakdown Voltage	I <sub>CE</sub> = 10mA, V <sub>GE</sub> = 0V R <sub>GE</sub> = 0, See Fig. 17 T <sub>J</sub> = -40 to 150°C		390	430	450	V
BV <sub>ECS</sub>	Emitter to Collector Breakdown Voltage	I <sub>CE</sub> = -75mA, V <sub>GE</sub> = 0V, T <sub>C</sub> = 25°C		30	-	-	V
BV <sub>GES</sub>	Gate to Emitter Breakdown Voltage	I <sub>GES</sub> = ±2mA		±12	±14	-	V
I <sub>GEO</sub>	Gate to Emitter Leakage Current	V <sub>GE</sub> = ±10V		-	-	±9	μA
I <sub>CES</sub>	Collector to Emitter Leakage Current	V <sub>CES</sub> = 250V, See Fig. 13	T <sub>C</sub> = 25°C	-	-	25	μA
			T <sub>C</sub> = 150°C	-	-	1	mA
I <sub>ECS</sub>	Emitter to Collector Leakage Current	V <sub>EC</sub> = 24V, See Fig. 13	T <sub>C</sub> = 25°C	-	-	1	mA
			T <sub>C</sub> = 150°C	-	-	40	
R <sub>1</sub>	Series Gate Resistance			-	100	-	Ω

### On State Characteristics

$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_{CE} = 6\text{A}$ , $V_{GE} = 4\text{V}$	$T_C = 25^\circ\text{C}$ See Fig. 5	-	1.3	1.6	V
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_{CE} = 10\text{A}$ , $V_{GE} = 4.5\text{V}$	$T_C = 150^\circ\text{C}$ See Fig. 6	-	1.6	1.85	V
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_{CE} = 15\text{A}$ , $V_{GE} = 4.5\text{V}$	$T_C = 150^\circ\text{C}$	-	1.8	2.35	V
$I_{CE(ON)}$	Collector to Emitter On State Current	$V_{CE} = 5\text{V}$ , $V_{GE} = 5\text{V}$		-	37	-	A

### Dynamic Characteristics

Q <sub>G(ON)</sub>	Gate Charge	I <sub>CE</sub> = 10A, V <sub>CE</sub> = 12V, V <sub>GE</sub> = 5V, See Fig. 16		-	15	-	nC
V <sub>GE(TH)</sub>	Gate to Emitter Threshold Voltage	I <sub>CE</sub> = 1mA, V <sub>CE</sub> = V <sub>GE</sub> See Fig. 12	T <sub>C</sub> = 25°C	1.3	1.6	2.2	V
			T <sub>C</sub> = 150°C	0.75	1.1	1.8	
V <sub>GEP</sub>	Gate to Emitter Plateau Voltage	I <sub>CE</sub> = 10A, V <sub>CE</sub> = 12V		-	3.0	-	V
β <sub>AREA</sub>	Emitter Sense Area Ratio	Sense Area/Total Area		-	1/200	-	-
β <sub>5Ω</sub>	Emitter Current Sense Ratio	I <sub>CE</sub> = 8.0A, V <sub>GE</sub> = 5V, R <sub>SENSE</sub> = 5 Ω		-	230	-	-
β <sub>20Ω</sub>	Emitter Current Sense Ratio	I <sub>CE</sub> = 9.0A, V <sub>GE</sub> = 5V, R <sub>SENSE</sub> = 20 Ω		550	640	765	-

### Switching Characteristics

$t_{d(ON)R}$	Current Turn-On Delay Time-Resistive	$V_{CE} = 14\text{V}$ , $R_L = 1\Omega$ $V_{GE} = 5\text{V}$ , $R_G = 1\text{k}\Omega$ $T_J = 25^\circ\text{C}$ , See Fig. 14	-	0.6	4	$\mu\text{s}$
$t_{rR}$	Current Rise Time-Resistive		-	1.5	7	$\mu\text{s}$
$t_{d(OFF)L}$	Current Turn-Off Delay Time-Inductive	$V_{CE} = 300\text{V}$ , $L = 500\mu\text{H}$ , $V_{GE} = 5\text{V}$ , $R_G = 1\text{k}\Omega$ $T_J = 25^\circ\text{C}$ , See Fig. 14	-	4.7	15	$\mu\text{s}$
$t_{fL}$	Current Fall Time-Inductive		-	2.6	15	$\mu\text{s}$
SCIS	Self Clamped inductive Switching	$T_J = 25^\circ\text{C}$ , $L = 3.0\text{mH}$ , $I_{CE} = 14.2\text{A}$ , $R_G = 1\text{k}\Omega$ , $V_{GE} = 5\text{V}$ , See Fig. 3&4	-	-	300	mJ

### Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance Junction to Case	All Packages	-	-	1.0	$^\circ\text{C/W}$
-----------------	-------------------------------------	--------------	---	---	-----	--------------------

## Typical Performance Curves

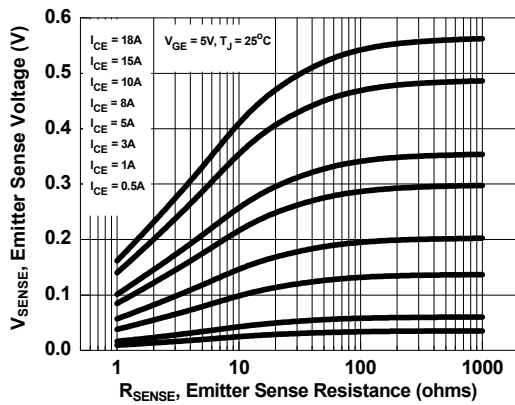


Figure 1. Emitter Sense Voltage vs. Emitter Sense Resistance

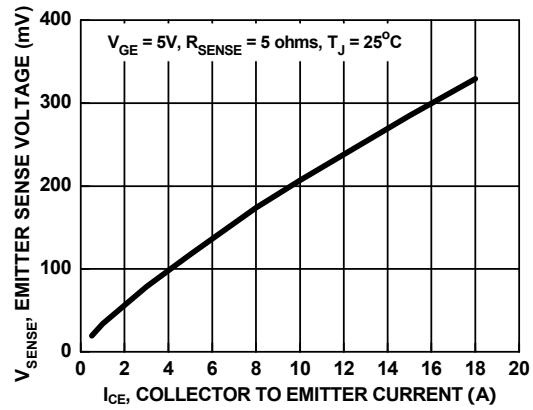


Figure 2. Emitter Sense Voltage vs. Collector to Emitter Current

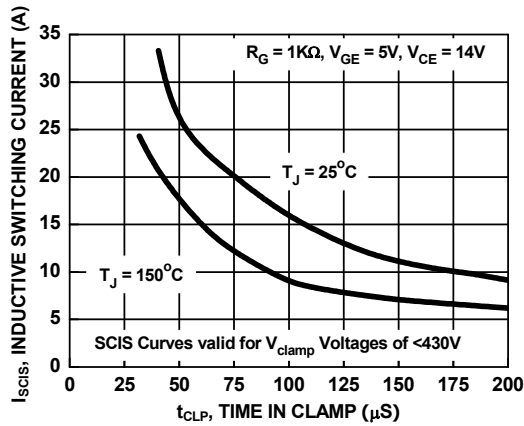


Figure 3. Self Clamped Inductive Switching Current vs. Time in Clamp

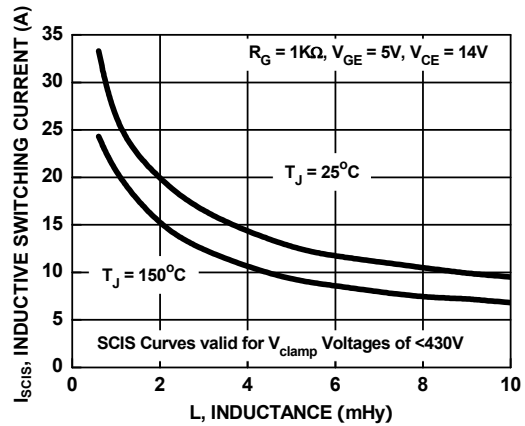


Figure 4. Self Clamped Inductive Switching Current vs. Inductance

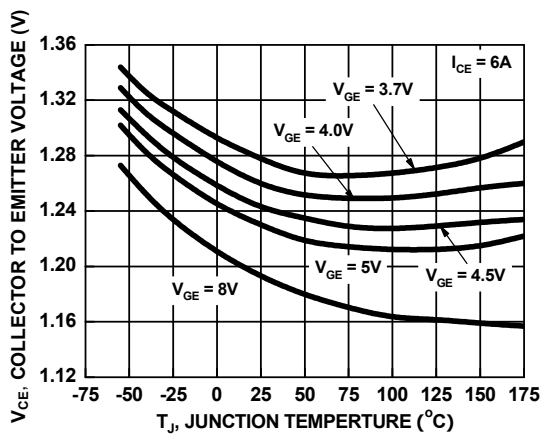


Figure 5. Collector to Emitter On-State Voltage vs. Junction Temperature

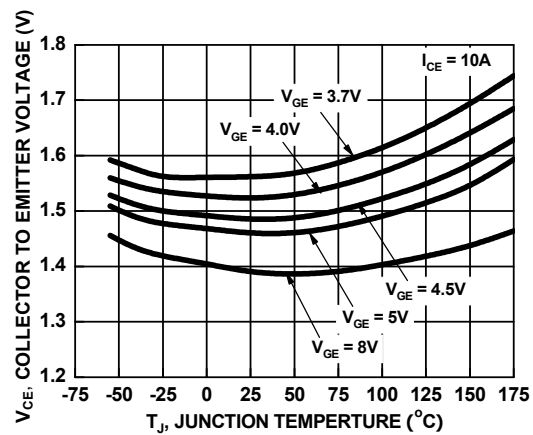


Figure 6. Collector to Emitter On-State Voltage vs. Junction Temperature

## Typical Performance Curves (Continued)

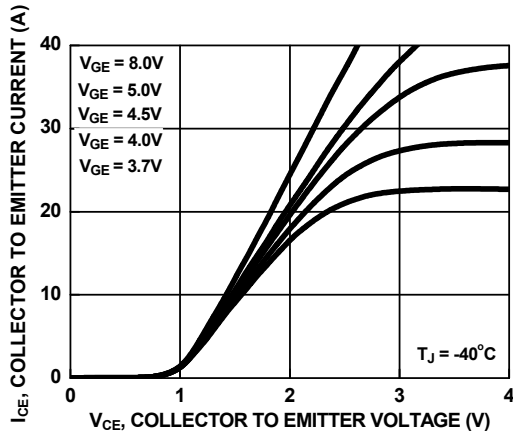


Figure 7. Collector to Emitter On-State Voltage vs. Collector Current

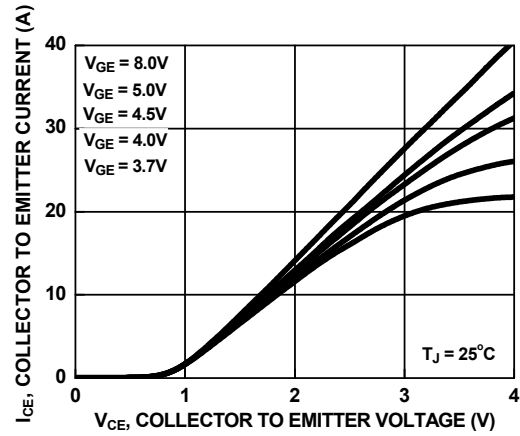


Figure 8. Collector to Emitter On-State Voltage vs. Collector Current

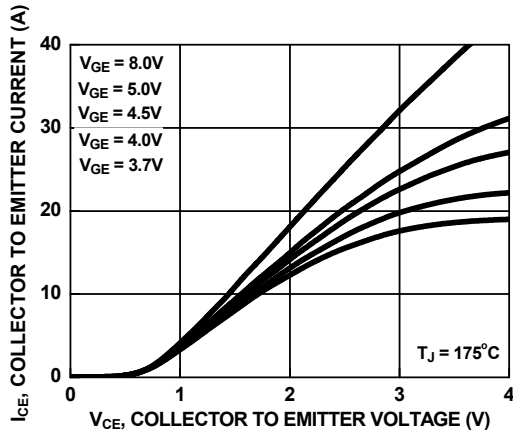


Figure 9. Collector to Emitter On-State Voltage vs. Collector Current

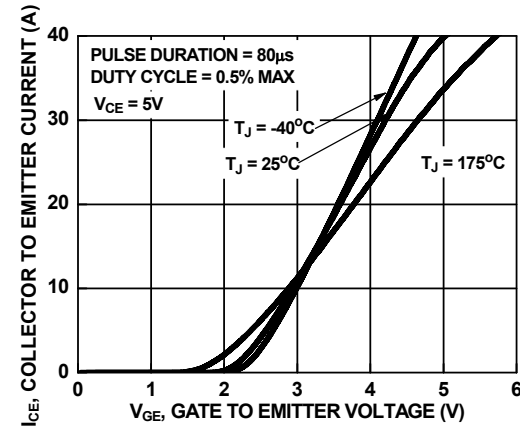


Figure 10. Transfer Characteristics

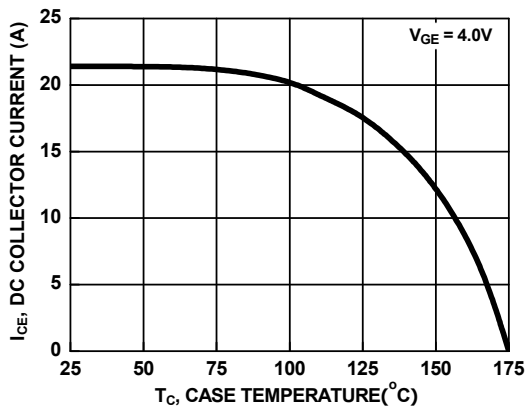


Figure 11. DC Collector Current vs. Case Temperature

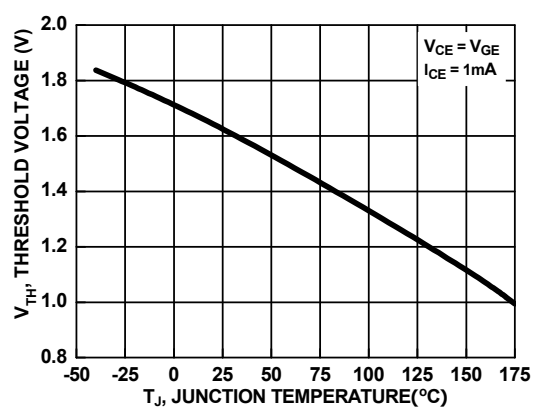


Figure 12. Threshold Voltage vs. Junction Temperature

## Typical Performance Curves (Continued)

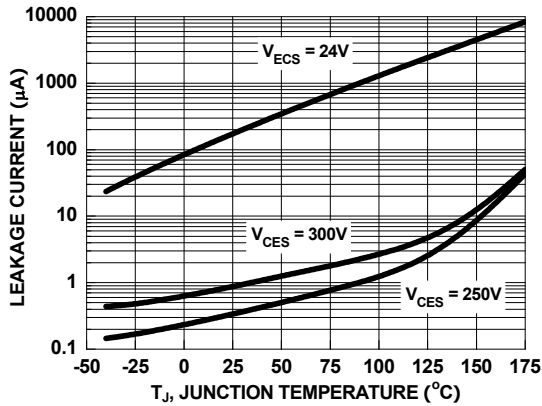


Figure 13. Leakage Current vs. Junction Temperature

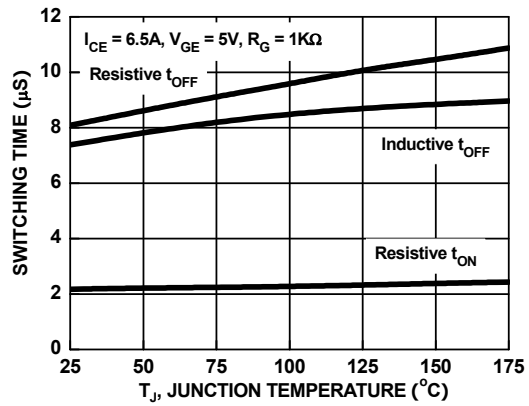


Figure 14. Switching Time vs. Junction Temperature

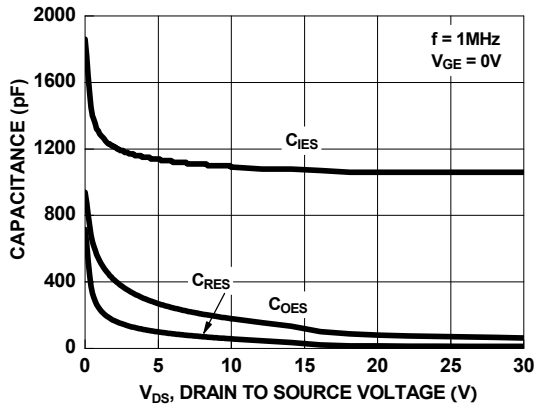


Figure 15. Capacitance vs. Collector to Emitter Voltage

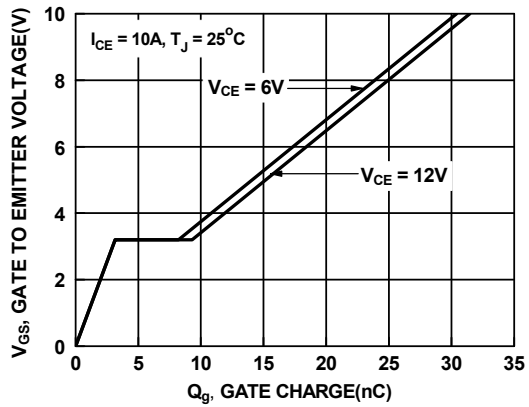


Figure 16. Gate Charge

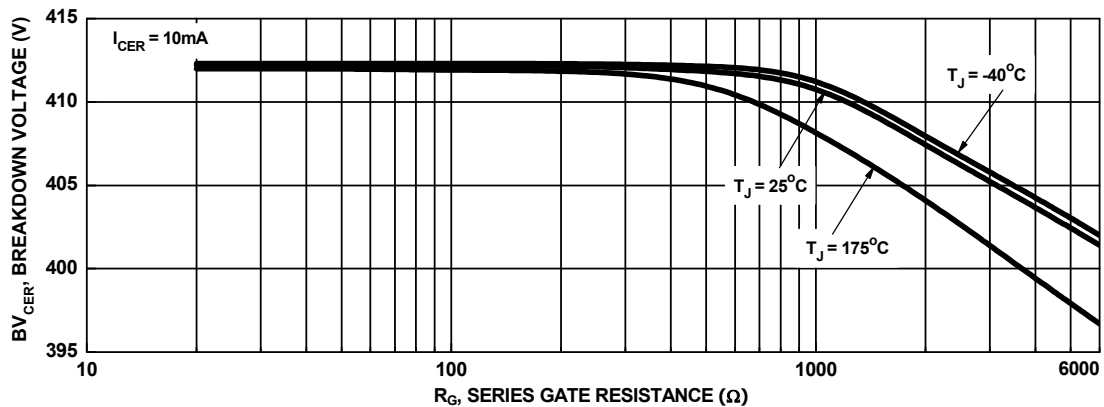


Figure 17. Breakdown Voltage vs. Series Gate Resistance

## Typical Performance Curves

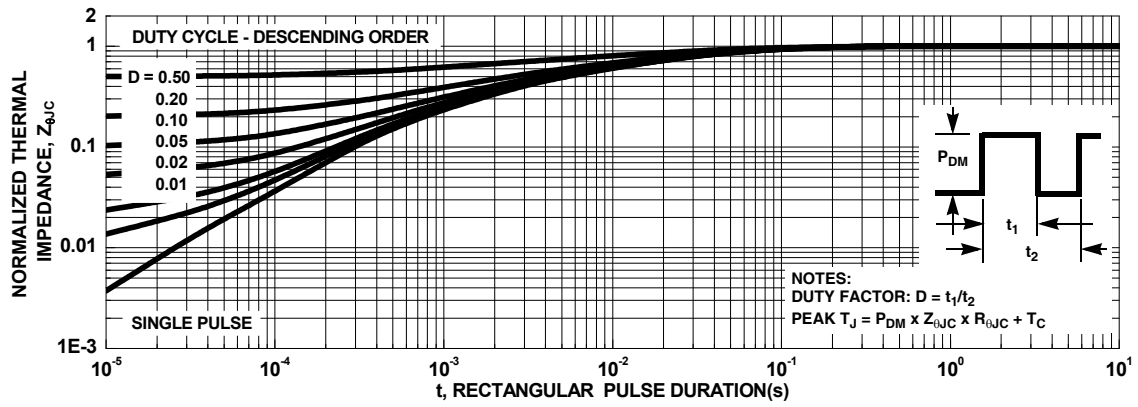


Figure 18. IGBT Normalized Transient Thermal Impedance, Junction to Case

## Test Circuit and Waveforms

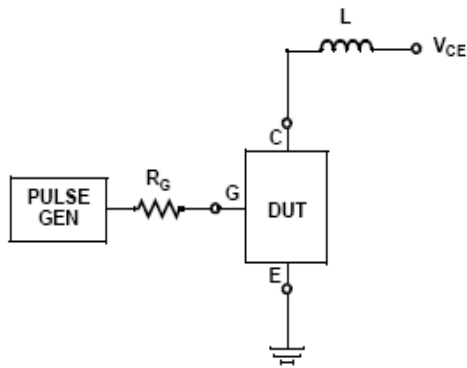


Figure 19. Inductive Switching Test Circuit

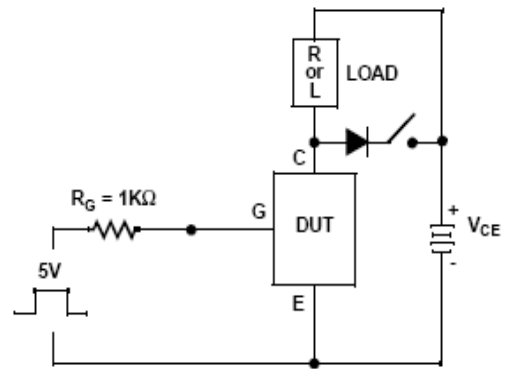


Figure 20.  $t_{ON}$  and  $t_{OFF}$  Switching Test Circuit

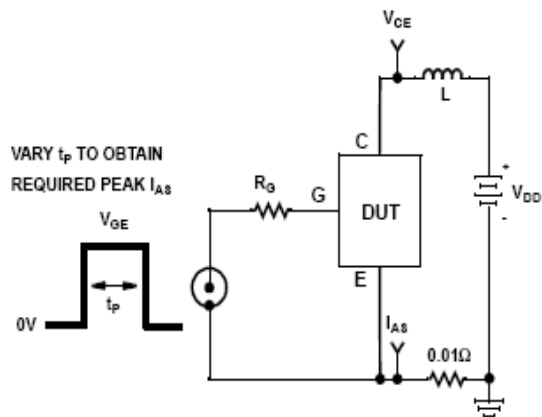


Figure 21. Energy Test Circuit

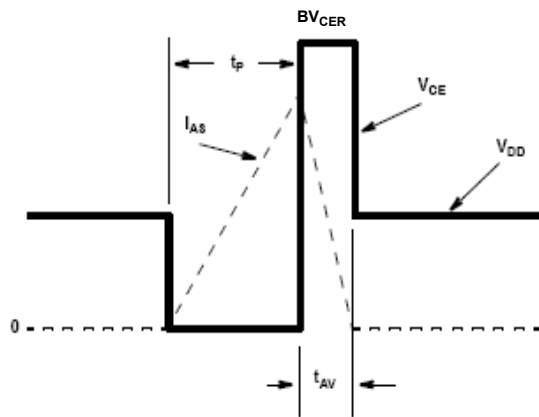
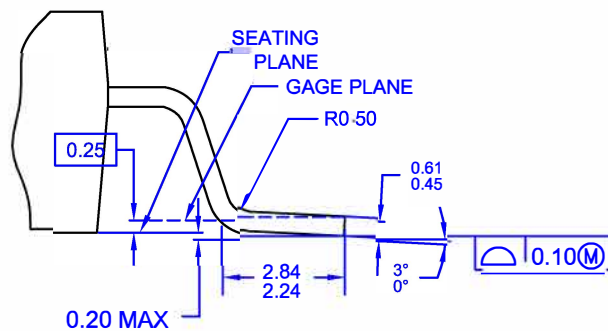
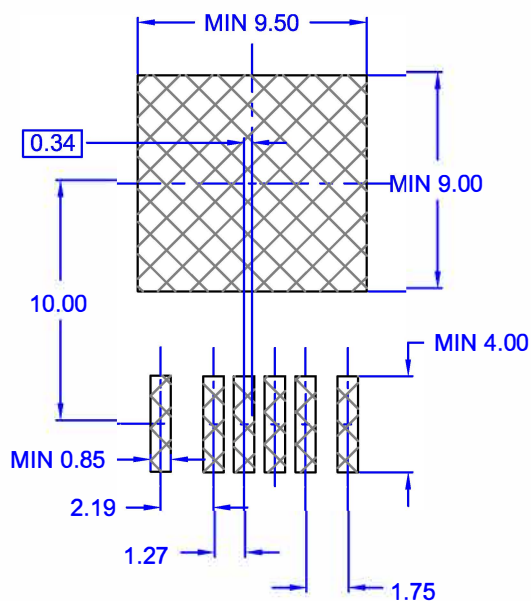
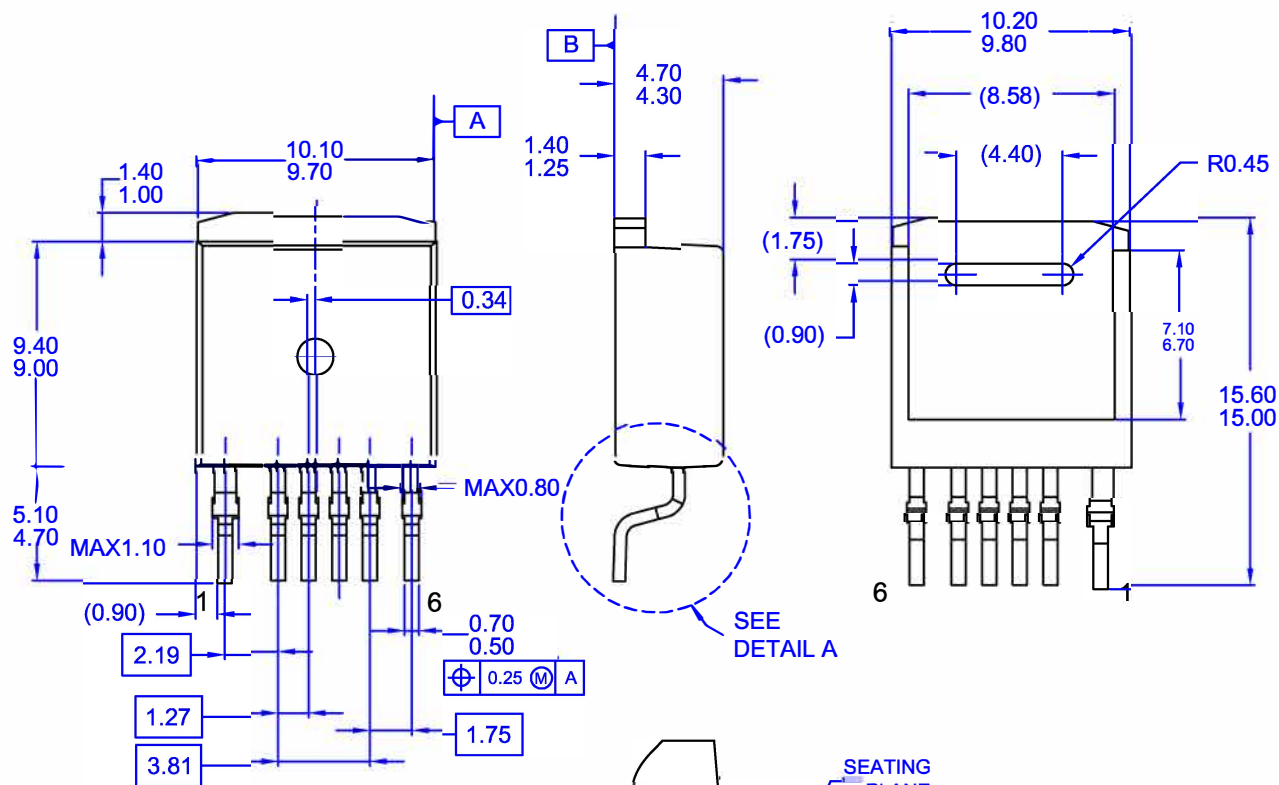


Figure 22. Energy Waveforms



DETAIL A, ROTATED 90°  
SCALE: 2X

- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE DOES NOT COMPLY TO ANY CURRENT PACKAGING STANDARD.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
  - D) DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
  - E) DRAWING FILENAME AND REVISION: MKT-TO263A06REV6



ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)

**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative