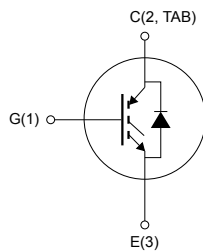


## Trench gate field-stop 650 V, 40 A, soft-switching IH series IGBT in a TO-247 long leads package



TO-247 long leads



NG1E3C2T

### Features

- Designed for soft commutation only
- Maximum junction temperature:  $T_J = 175\text{ °C}$
- $V_{CE(sat)} = 1.5\text{ V (typ.) @ } I_C = 40\text{ A}$
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Low drop voltage freewheeling co-packaged diode
- Positive  $V_{CE(sat)}$  temperature coefficient

### Applications

- Induction heating
- Resonant converters
- Microwave ovens

### Description

The newest IGBT 650 V soft-switching IH series has been developed using an advanced proprietary trench gate field-stop structure, whose performance is optimized both in conduction and switching losses for soft commutation. A freewheeling diode with a low drop forward voltage is included. The result is a product specifically designed to maximize efficiency for any resonant and soft-switching applications.

#### Product status link

[STGWA40IH65DF](#)

#### Product summary

<b>Order code</b>	STGWA40IH65DF
<b>Marking</b>	G40IH65DF
<b>Package</b>	TO-247 long leads
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C$	Continuous collector current at $T_C = 25$ °C	80	A
	Continuous collector current at $T_C = 100$ °C	40	
$I_{CP}^{(1)}$	Pulsed collector current	120	A
$V_{GE}$	Gate-emitter voltage	±20	V
$I_F$	Continuous forward current at $T_C = 25$ °C	40	A
	Continuous forward current at $T_C = 100$ °C	20	
$I_{FP}^{(1)}$	Pulsed forward current	120	
$P_{TOT}$	Total power dissipation at $T_C = 25$ °C	238	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature range	- 55 to 175	

1. Pulse width limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.63	°C/W
	Thermal resistance junction-case diode	2.08	
$R_{thJA}$	Thermal resistance junction-ambient	50	

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 3. Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$		1.50	2.00	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 125\text{ °C}$		1.75		
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175\text{ °C}$		1.90		
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$		1.85	2.65	V
		$I_F = 20\text{ A}, T_J = 125\text{ °C}$		1.60		
		$I_F = 20\text{ A}, T_J = 175\text{ °C}$		1.55		
		$I_F = 40\text{ A}$		2.30		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$			$\pm 250$	nA

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	2210	-	pF
$C_{oes}$	Output capacitance		-	105	-	
$C_{res}$	Reverse transfer capacitance		-	63	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 40\text{ A}, V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 23. Gate charge test circuit)	-	114	-	nC
$Q_{ge}$	Gate-emitter charge		-	21	-	
$Q_{gc}$	Gate-collector charge		-	49	-	

**Table 5. IGBT switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$ , $I_C = 40\text{ A}$ ,	-	210	-	ns
$t_f$	Current fall time	$V_{GE} = 15\text{ V}$ , $R_G = 22\ \Omega$ (see Figure 21. Test circuit for inductive load switching)	-	12.5	-	
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$ , $I_C = 40\text{ A}$ ,	-	216	-	ns
$t_f$	Current fall time	$V_{GE} = 15\text{ V}$ , $R_G = 22\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 21. Test circuit for inductive load switching)	-	47	-	ns

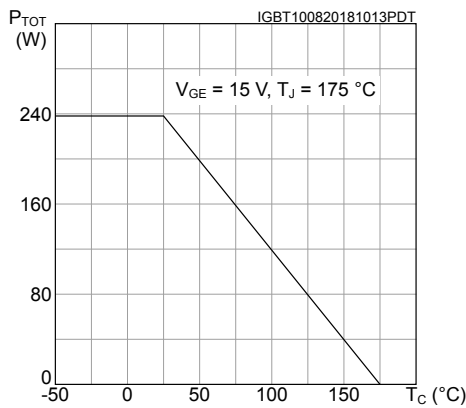
**Table 6. IGBT switching characteristics (capacitive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{off}^{(1)}$	Turn-off switching energy	$V_{CC} = 320\text{ V}$ , $R_G = 10\ \Omega$ , $I_C = 40\text{ A}$ , $L = 100\ \mu\text{H}$ , $C_{snub} = 22\text{ nF}$ (see Figure 22. Test circuit for snubbed inductive load switching)	-	190	-	$\mu\text{J}$
		$V_{CC} = 320\text{ V}$ , $R_G = 10\ \Omega$ , $I_C = 40\text{ A}$ , $L = 100\ \mu\text{H}$ , $C_{snub} = 22\text{ nF}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 22. Test circuit for snubbed inductive load switching)	-	385	-	

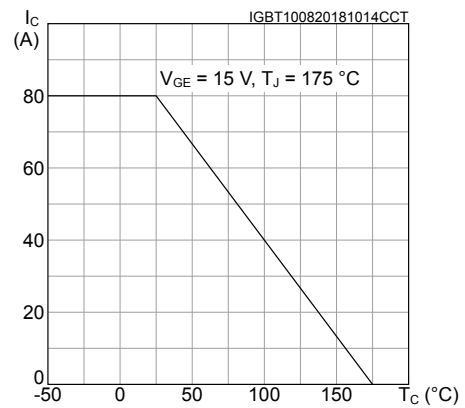
1. Including the tail of the collector current.

## 2.1 Electrical characteristics (curves)

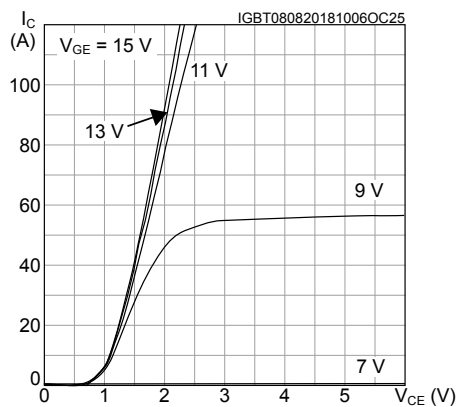
**Figure 1. Power dissipation vs case temperature**



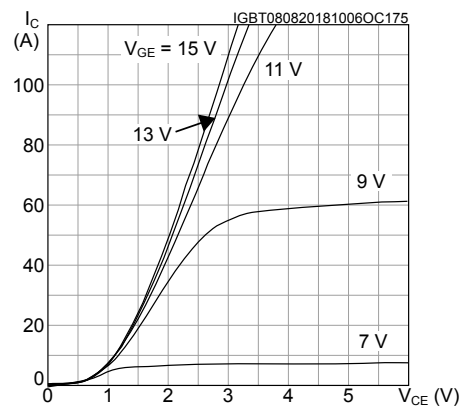
**Figure 2. Collector current vs case temperature**



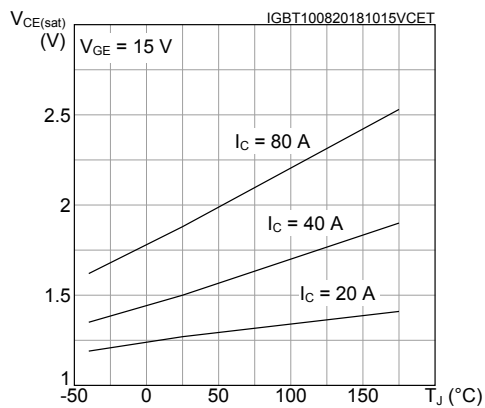
**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**



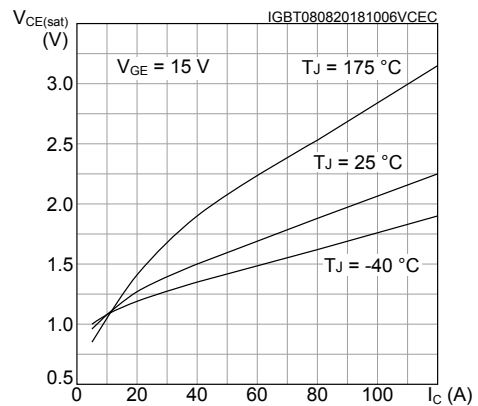
**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**



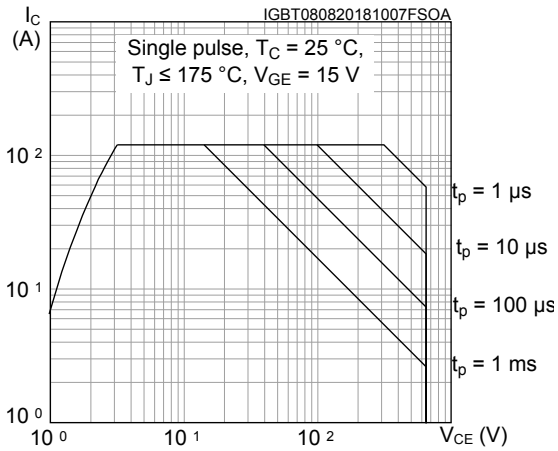
**Figure 5. V<sub>CE(sat)</sub> vs junction temperature**



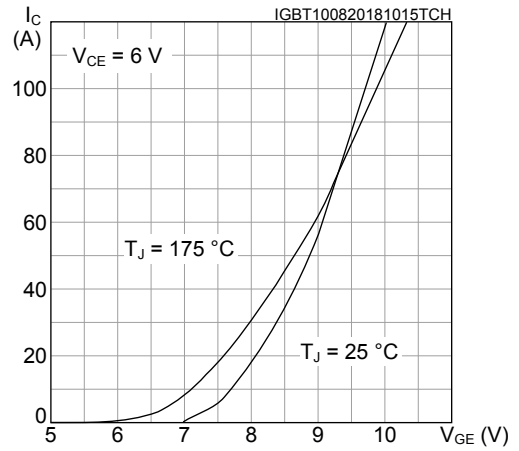
**Figure 6. V<sub>CE(sat)</sub> vs collector current**



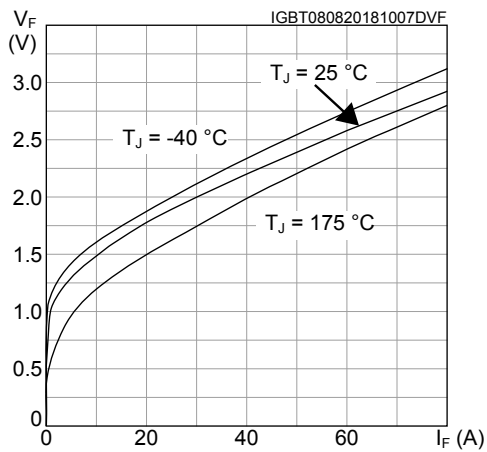
**Figure 7. Forward bias safe operating area**



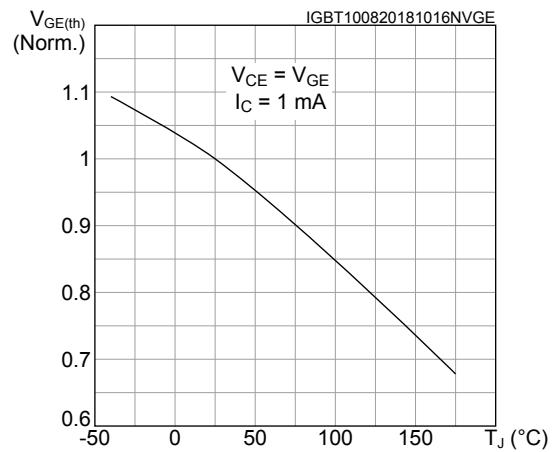
**Figure 8. Transfer characteristics**



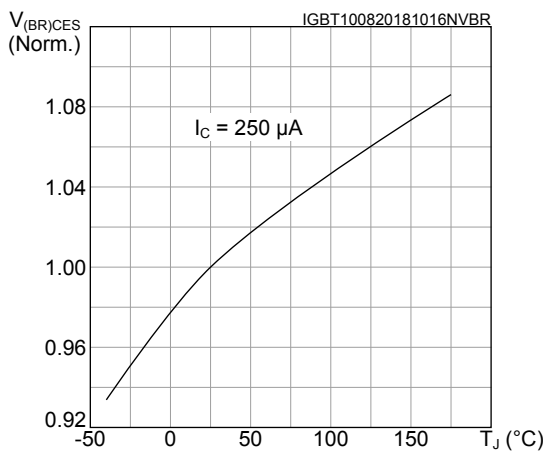
**Figure 9. Diode V\_F vs forward current**



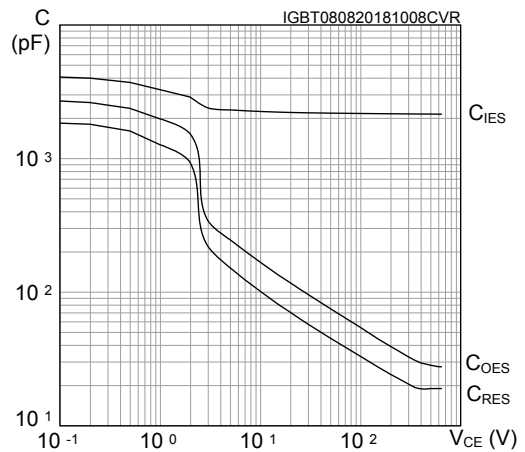
**Figure 10. Normalized V\_GE(th) vs junction temperature**



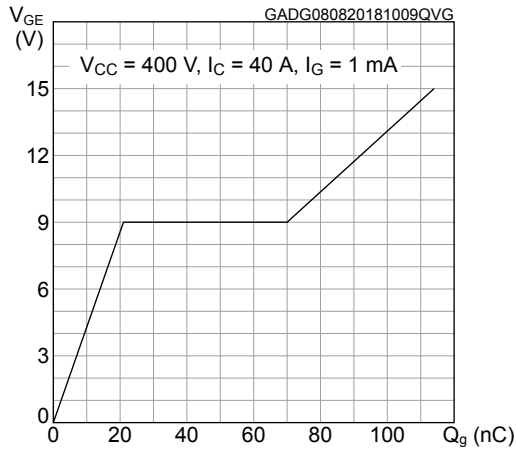
**Figure 11. Normalized V\_(BR)CES vs junction temperature**



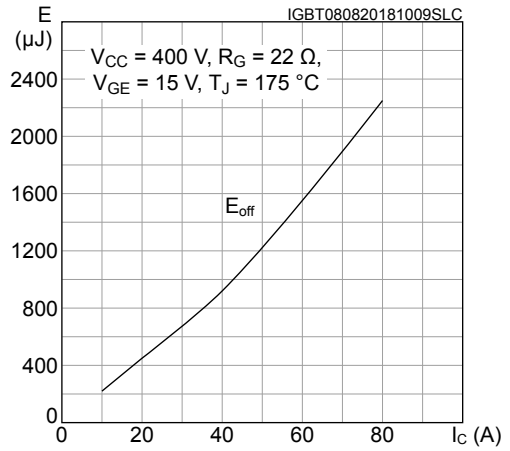
**Figure 12. Capacitance variations**



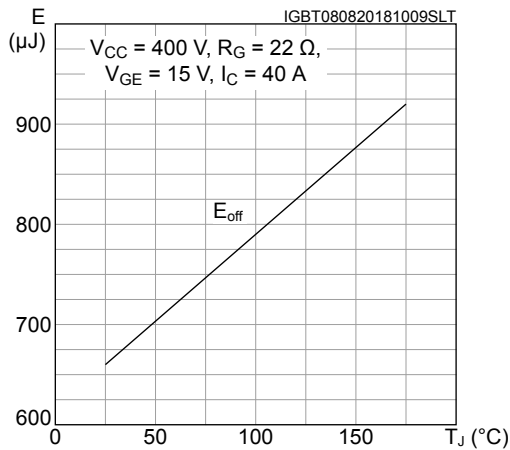
**Figure 13. Gate charge vs gate-emitter voltage**



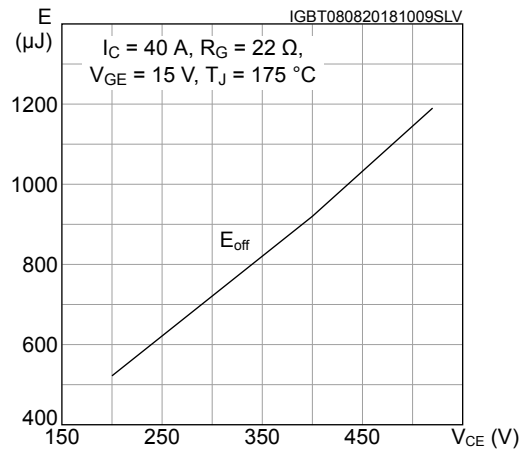
**Figure 14. Switching energy vs collector current**



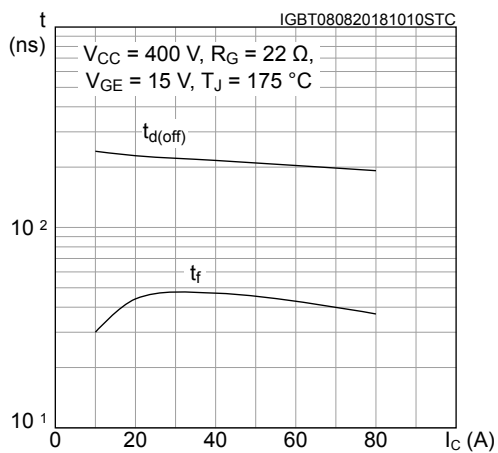
**Figure 15. Switching energy vs temperature**



**Figure 16. Switching energy vs collector emitter voltage**



**Figure 17. Switching times vs collector current**



**Figure 18. Switching energy vs snubber capacitance**

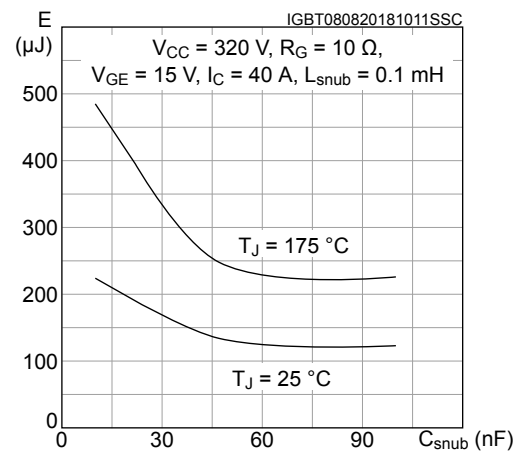


Figure 19. Thermal impedance for IGBT

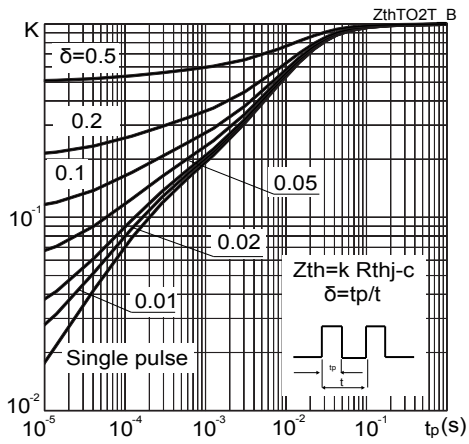
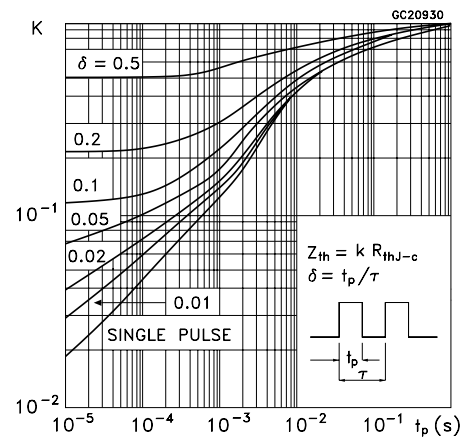
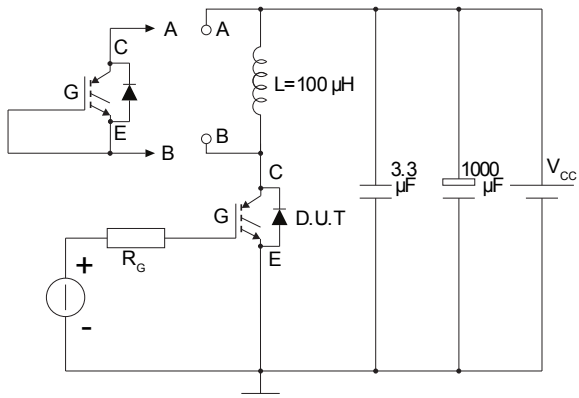
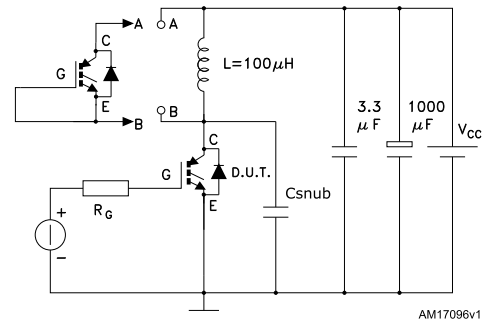
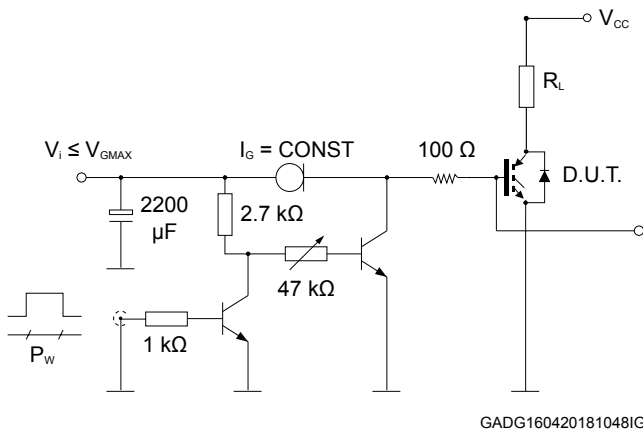
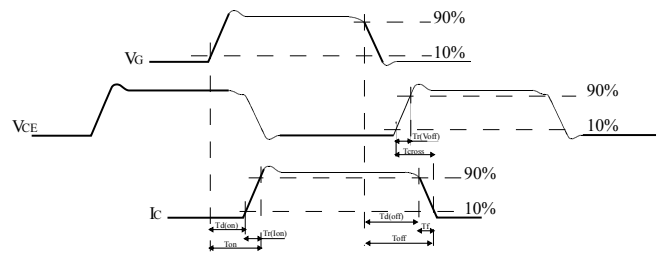


Figure 20. Thermal impedance for diode





### 3 Test circuits

**Figure 21. Test circuit for inductive load switching**

**Figure 22. Test circuit for snubbed inductive load switching**

**Figure 23. Gate charge test circuit**

**Figure 24. Switching waveform**


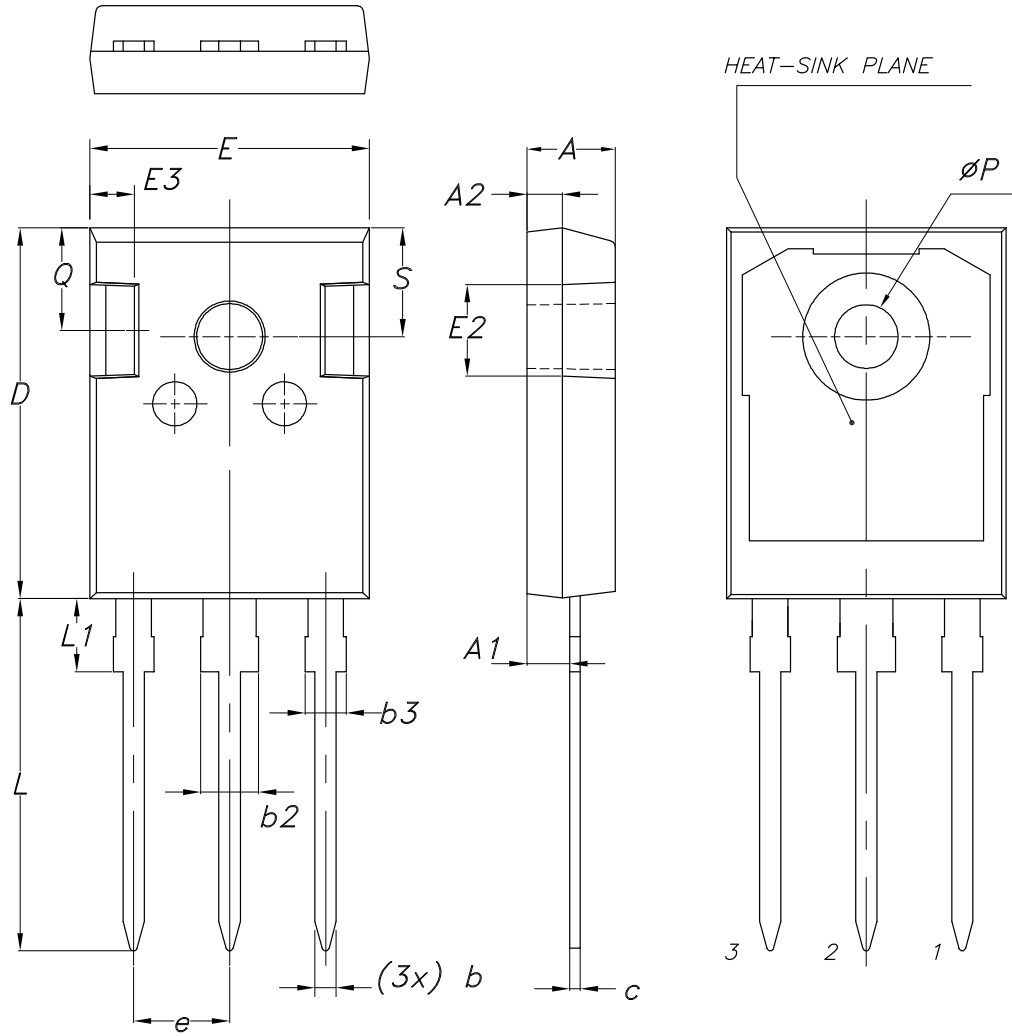
## **4 Package information**

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In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO-247 long leads package information

Figure 25. TO-247 long leads package outline



8463846\_2\_F

**Table 7. TO-247 long leads package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25

## Revision history

**Table 8. Document revision history**

Date	Revision	Changes
02-Sep-2016	1	First release.
10-Aug-2018	2	Updated features on cover page. Updated <i>Section 1 Electrical ratings</i> and <i>Section 2 Electrical characteristics</i> . Added <i>Section 2.1 Electrical characteristics (curves)</i> . Minor text changes.
24-Sep-2018	3	Updated schematic on cover page. Updated <a href="#">Section 2.1 Electrical characteristics (curves)</a> . Minor text changes

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