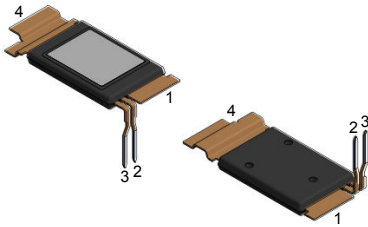
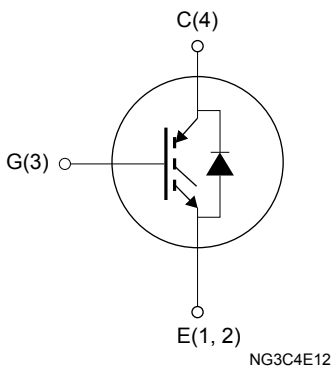



## Automotive-grade trench gate field-stop IGBT 650 V, 200 A in a STPAK package



STPAK



## Features

- AEC-Q101 qualified 
- $V_{CE(sat)} = 1.52$  V (typ.) @  $I_C = 200$  A
- Positive  $V_{CE(sat)}$  temperature coefficient
- Tight parameter distribution
- Low thermal resistance
- Very fast and soft recovery antiparallel diode

## Applications

- Main inverter (electric traction)

## Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. This device represents an optimum compromise in performance to maximize the efficiency of inverter systems where low-loss are essential. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.



## Product status link

[STGST200G65DFAG](#)

## Product summary

Order code	STGST200G65DFAG
Marking	G200G65DFAG
Package	STPAK
Packing	Tray

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25$ °C	285	A
	Continuous collector current at $T_C = 100$ °C	175	
$V_{GE}$	Gate-emitter voltage	±20	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25$ °C	215	A
	Continuous forward current at $T_C = 100$ °C	130	
$P_{TOT}$	Total power dissipation at $T_C = 25$ °C	682	W
$T_{stg}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	°C

1. Limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance, junction-to-case, IGBT	0.22	°C/W
	Thermal resistance, junction-to-case, diode	0.34	

## 2 Electrical characteristics

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

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 200\text{ A}$		1.52	1.80	V
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}, T_J = 175\text{ °C}$		1.75		
$V_F$	Forward on-voltage	$I_F = 150\text{ A}$		1.85	2.32	V
		$I_F = 150\text{ A}, T_J = 175\text{ °C}$		1.47		
		$I_F = 200\text{ A}$		2.00	2.57	
		$I_F = 200\text{ A}, T_J = 175\text{ °C}$		1.65		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$	4.75	5.50	6.25	V
$I_{CES}$	Collector cut-off current	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V},$			10	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$			50	nA
		$V_{CE} = 0\text{ V}, V_{GE} = -20\text{ V}$	-50			

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	14.3	-	nF
$C_{oes}$	Output capacitance		-	0.7	-	nF
$C_{res}$	Reverse transfer capacitance		-	0.4	-	nF
$Q_g$	Total gate charge	$V_{CC} = 400\text{ V}, I_C = 200\text{ A}, V_{GE} = 18\text{ V}$ (see Figure 28. Gate charge test circuit)	-	900	-	nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $V_{GE} = -5\text{ to }+18\text{ V}$ , $R_G = 4.7\ \Omega$ , $I_C = 200\text{ A}$ (see Figure 27. Test circuit for inductive load switching)	-	68.5	-	ns
$t_r$	Current rise time		-	41	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	1.41	-	mJ
$t_{d(off)}$	Turn-off delay time		-	362	-	ns
$t_f$	Current fall time		-	48	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	4.77	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $V_{GE} = -5\text{ to }+18\text{ V}$ , $R_G = 4.7\ \Omega$ , $I_C = 200\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	68	-	ns
$t_r$	Current rise time		-	44	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	2.53	-	mJ
$t_{d(off)}$	Turn-off delay time		-	400	-	ns
$t_f$	Current fall time		-	96	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	7.46	-	mJ

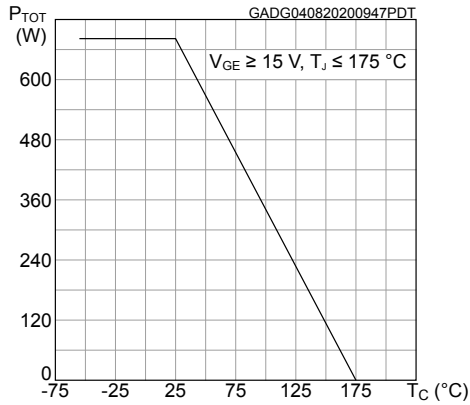
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 6. Diode switching characteristics (inductive load)**

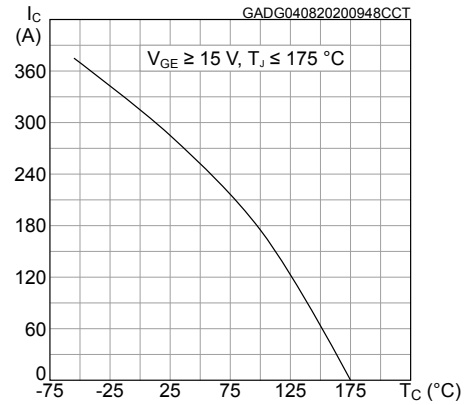
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{rm}$	Reverse recovery current	$V_{CC} = 400\text{ V}$ , $V_{GE} = -5\text{ to }+18\text{ V}$ , $R_G = 4.7\ \Omega$ , $di/dt = 4318\text{ A}/\mu\text{s}$ , $I_C = 200\text{ A}$ (see Figure 27. Test circuit for inductive load switching)	-	101	-	A
$t_{rr}$	Reverse recovery time		-	164	-	ns
$Q_{rr}$	Reverse recovery charge		-	6.3	-	$\mu\text{C}$
$E_{rr}$	Reverse recovery energy		-	2	-	mJ
$I_{rm}$	Reverse recovery current	$V_{CC} = 400\text{ V}$ , $V_{GE} = -5\text{ to }+18\text{ V}$ , $R_G = 4.7\ \Omega$ , $di/dt = 4513\text{ A}/\mu\text{s}$ , $I_C = 200\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	198	-	A
$t_{rr}$	Reverse recovery time		-	300	-	ns
$Q_{rr}$	Reverse recovery charge		-	22	-	$\mu\text{C}$
$E_{rr}$	Reverse recovery energy		-	7.1	-	mJ

## 2.1 Electrical characteristics (curves)

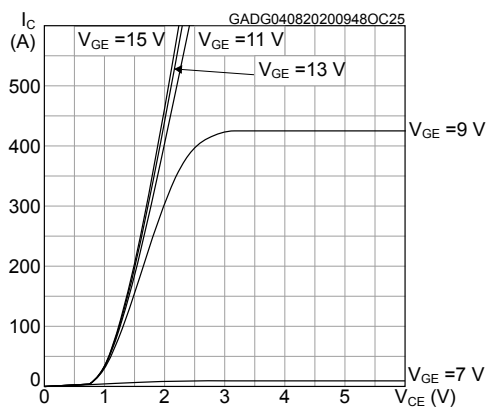
**Figure 1. Power dissipation vs case temperature**



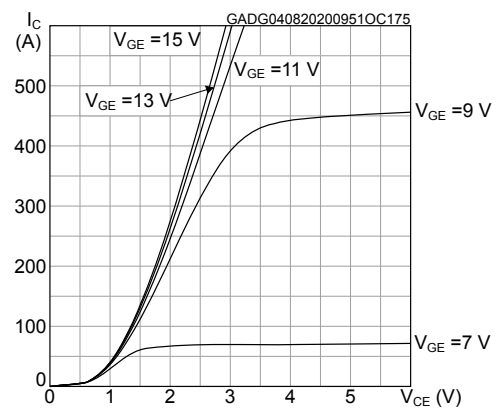
**Figure 2. Collector current vs case temperature**



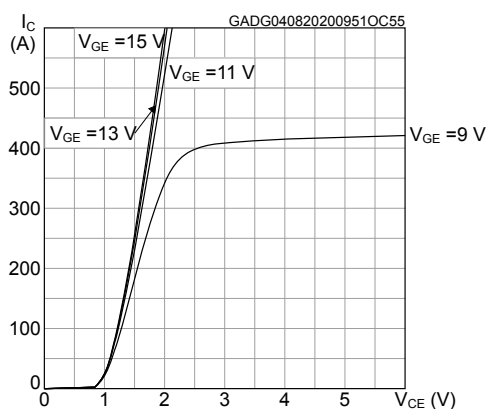
**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**



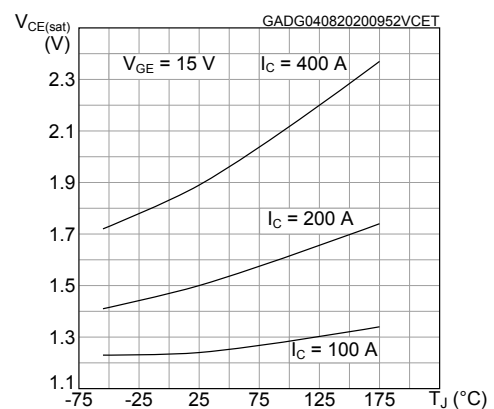
**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**



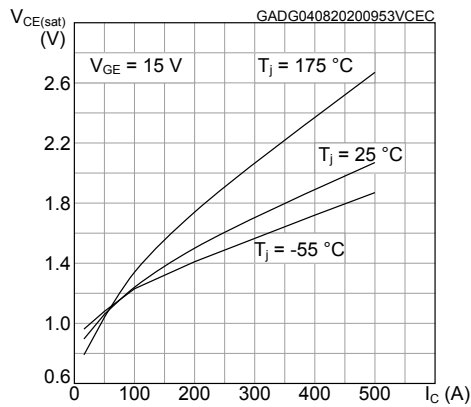
**Figure 5. Output characteristics (T<sub>J</sub> = -55 °C)**



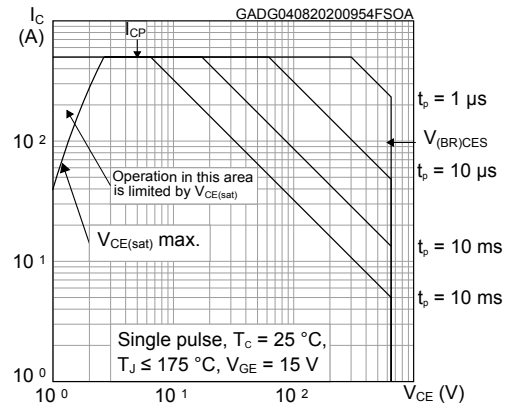
**Figure 6. V<sub>CE(sat)</sub> vs junction temperature**



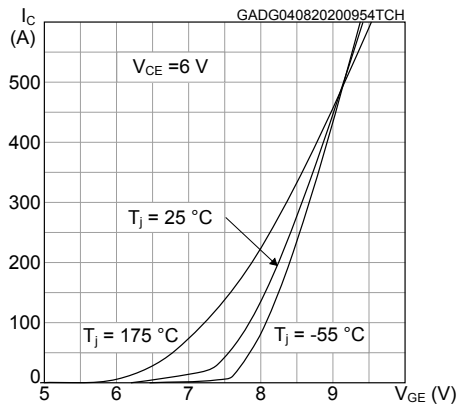
**Figure 7.  $V_{CE(sat)}$  vs collector current**



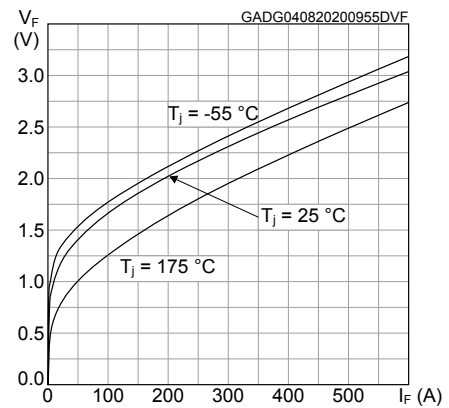
**Figure 8. Forward bias safe operating area**



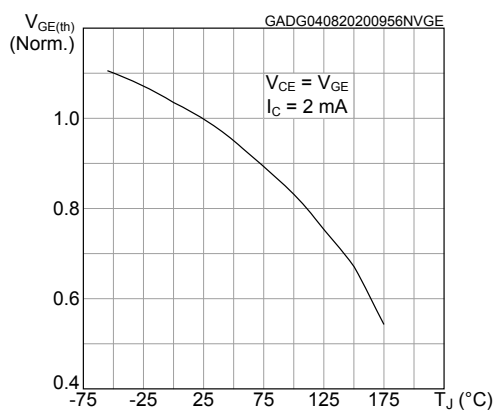
**Figure 9. Transfer characteristics**



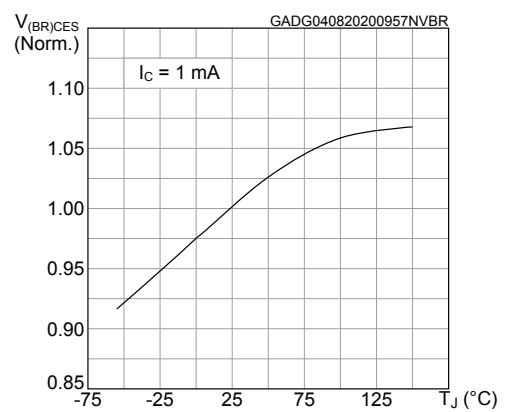
**Figure 10. Diode  $V_F$  vs forward current**



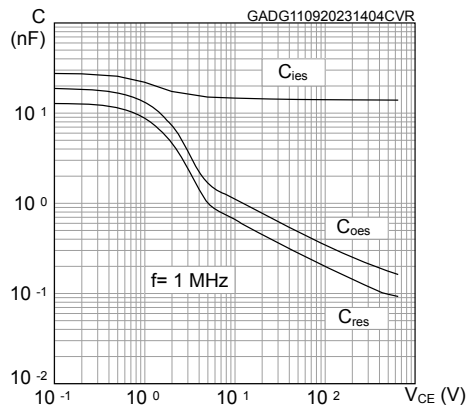
**Figure 11. Normalized  $V_{GE(th)}$  vs junction temperature**



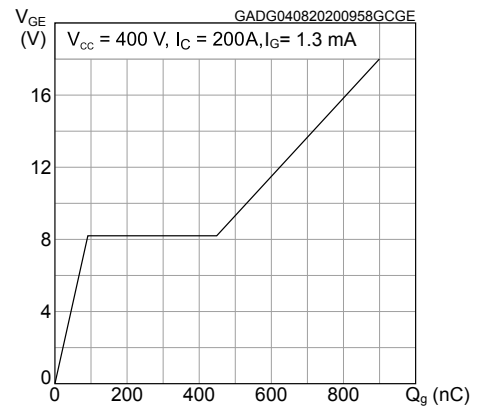
**Figure 12. Normalized  $V_{(BR)CES}$  vs junction temperature**



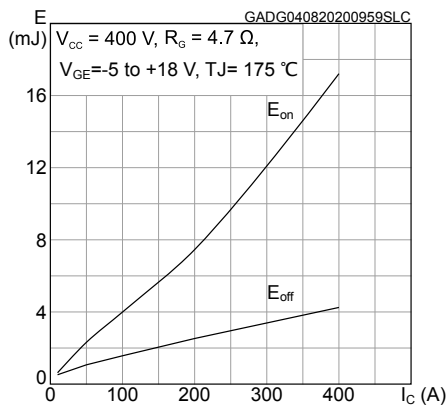
**Figure 13. Capacitance variations**



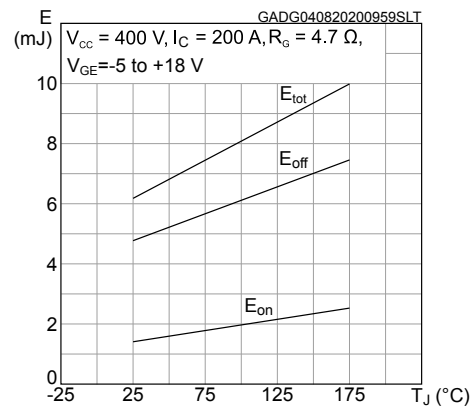
**Figure 14. Gate charge vs gate-emitter voltage**



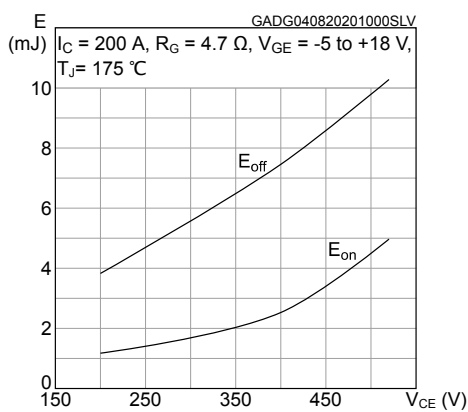
**Figure 15. Switching energy vs collector current**



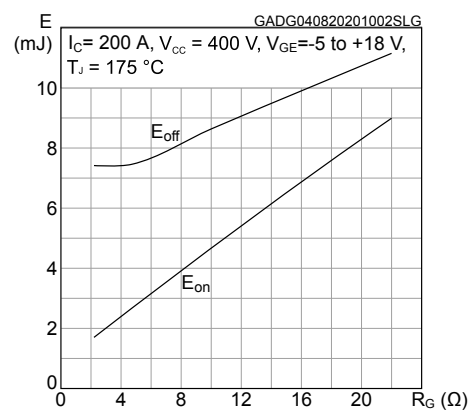
**Figure 16. Switching energy vs temperature**



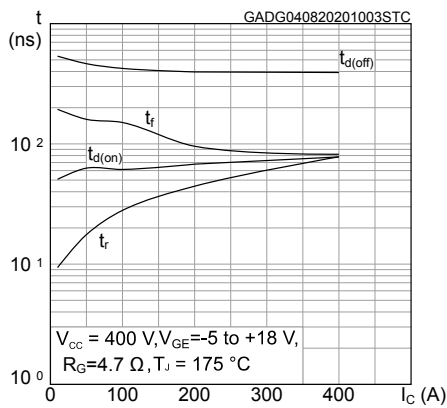
**Figure 17. Switching energy vs collector emitter voltage**



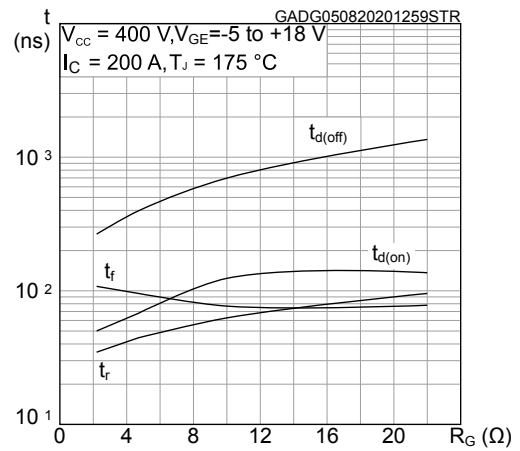
**Figure 18. Switching energy vs gate resistance**



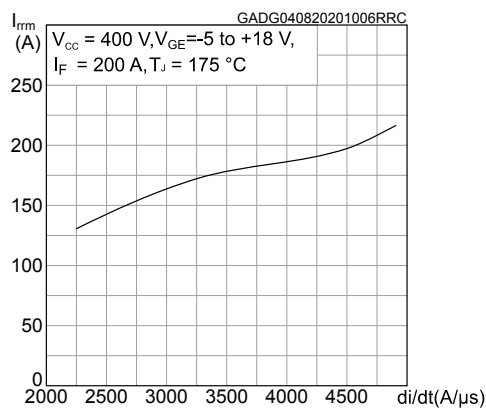
**Figure 19. Switching times vs collector current**



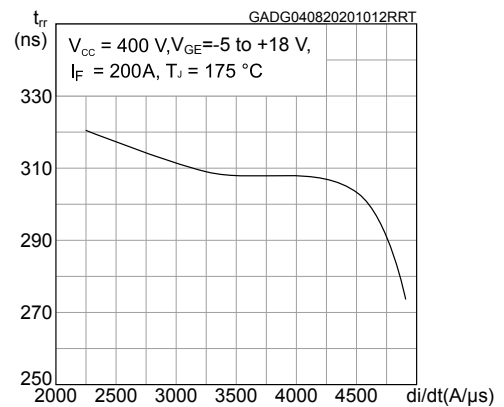
**Figure 20. Switching times vs gate resistance**



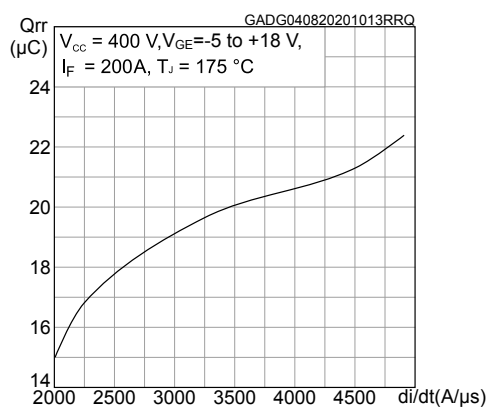
**Figure 21. Reverse recovery current vs diode current slope**



**Figure 22. Reverse recovery time vs diode current slope**



**Figure 23. Reverse recovery charge vs diode current slope**



**Figure 24. Reverse recovery energy vs diode current slope**

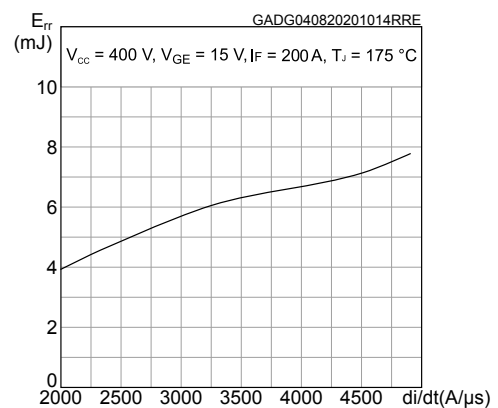




Figure 25. Normalized thermal impedance for IGBT

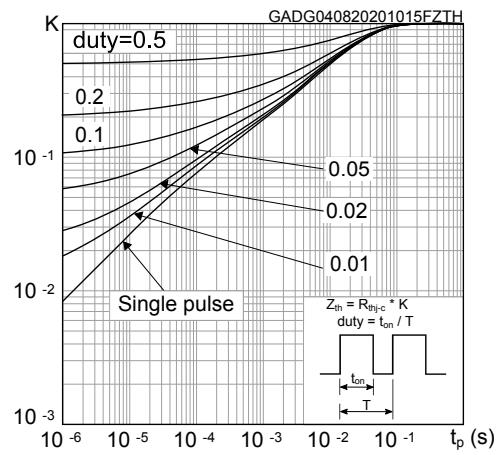
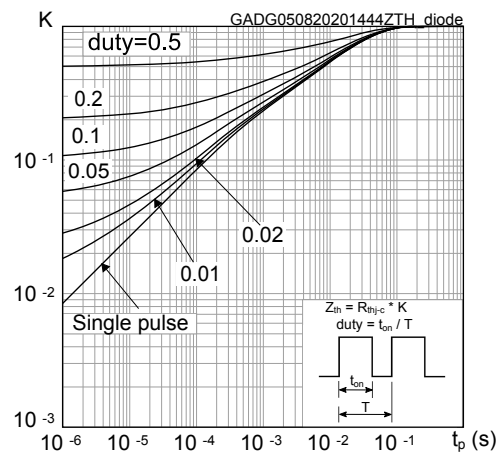
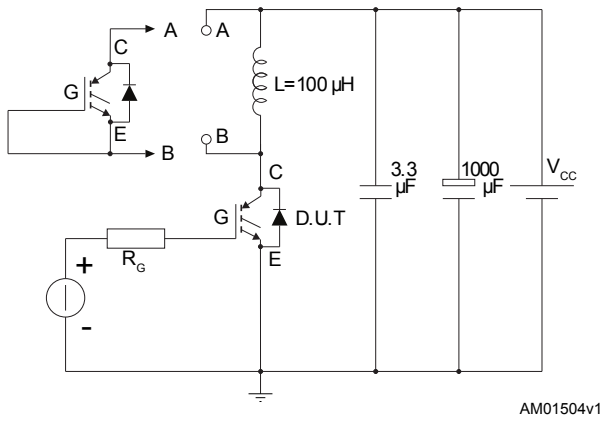
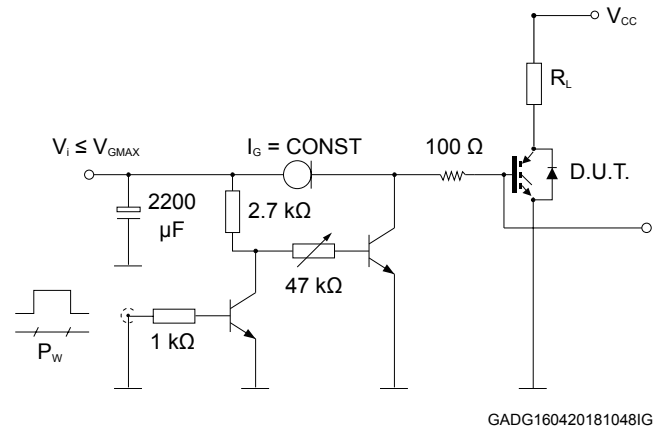
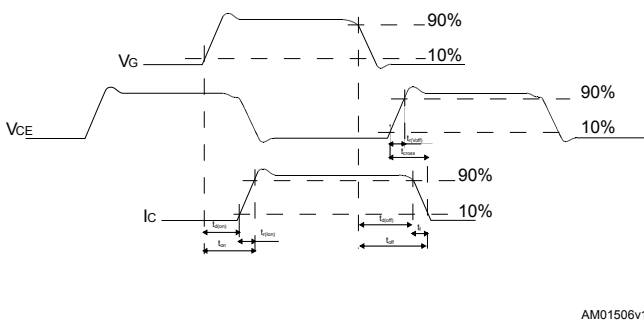
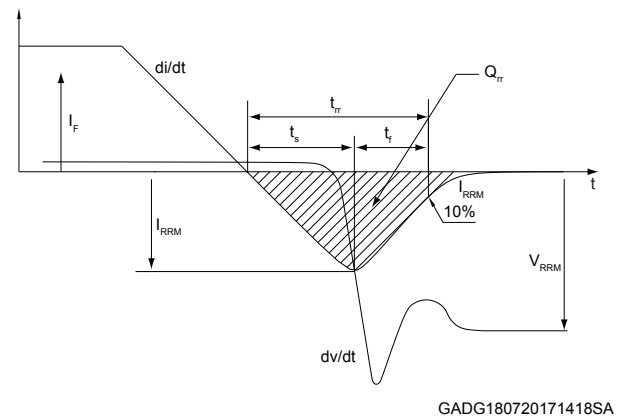


Figure 26. Normalized thermal impedance for diode



### 3 Test circuits

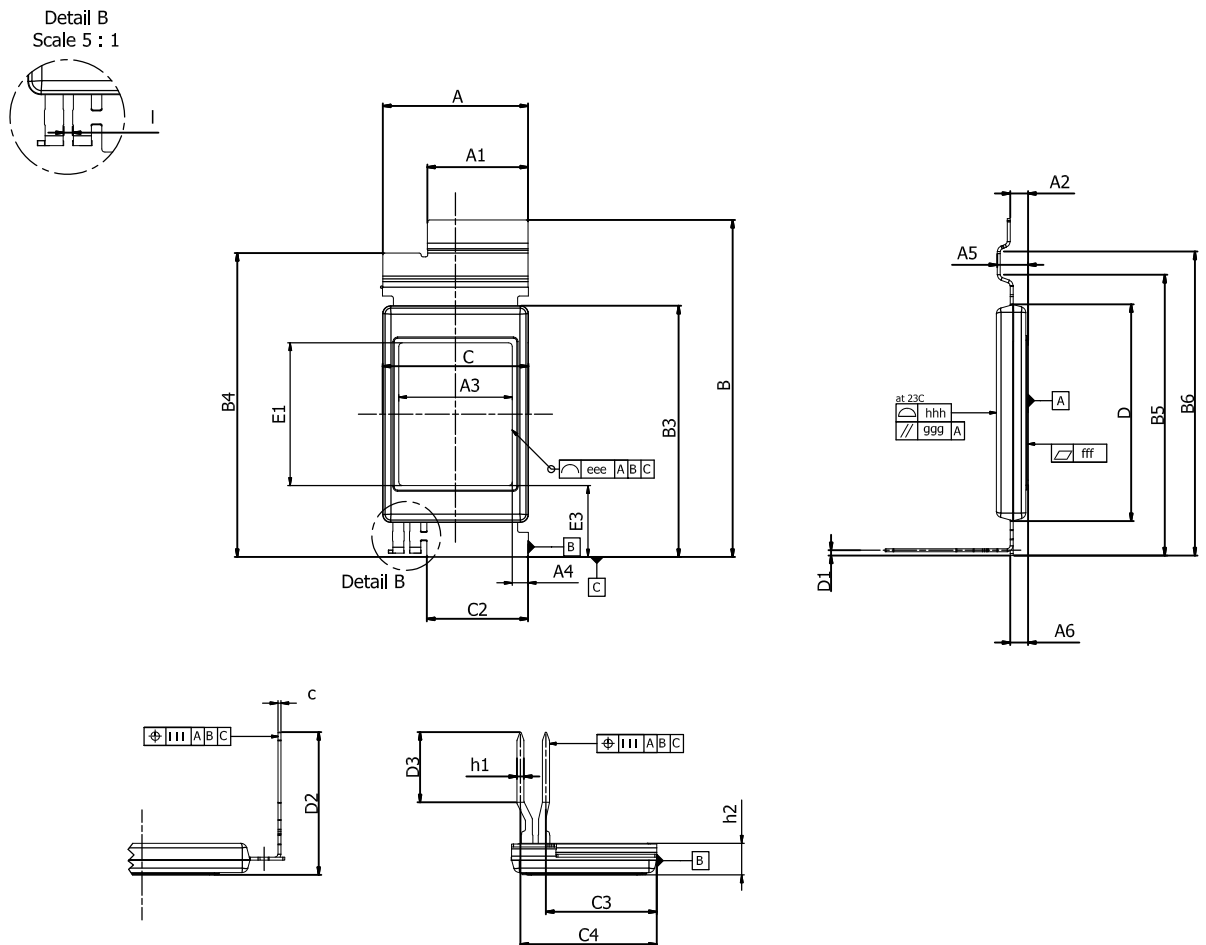
**Figure 27. Test circuit for inductive load switching**

**Figure 28. Gate charge test circuit**

**Figure 29. Switching waveform**

**Figure 30. Diode reverse recovery waveform**


## 4 Package information

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 STPAK package information

Figure 31. STPAK package outline



DM00305987\_10

**Table 7. STPAK package mechanical data**

Ref.	Dimensions			Notes
	mm			
	Min.	Typ.	Max.	
A	18.60	18.80	19.00	
A1	12.85	13.05	13.25	
A2	2.00	2.30	2.60	
A3	14.20	14.70	15.20	Exposed Pad
A4	1.55	2.05	2.55	
A5	3.80	4.00	4.20	
A6	2.10	2.30	2.50	
B	43.40	43.70	44.00	
B3	32.20	32.50	32.80	
B4	39.10	39.40	39.70	
B5	36.07	36.37	36.67	
B6	39.07	39.37	39.67	
c	0.34	0.39	0.44	
C		18.55	19.10	Encompass both large and small cav.
C2	12.90	13.10	13.30	
C3		14.35		
C4		17.65		
D	27.90	28.10	28.30	
D1		0.69		
D2	18.00 (18.50)	18.50 (19.00)	19.00 (19.50)	Refer to the values in brackets for the longer pins type
D3	8.60 (9.10)	9.10 (9.60)	9.60 (10.10)	Refer to the values in brackets for the longer pins type
E1	18.00	18.50	19.00	Exposed pad
E3	8.75	9.25	9.75	
h1	0.85	0.90	0.95	x2 - Pins width
h2	4.00	4.10	4.20	
l	0.60	0.70	0.80	
eee	0.50			
fff	0.10 at 23 °C – 0.05 at 220 °C			Convex with center higher than edges
ggg	0.05			
hhh	0.10			
iii	0.60			

## Revision history

**Table 8. Document revision history**

Date	Revision	Changes
10-Dec-2021	1	Initial release.
13-Nov-2023	2	Updated <a href="#">Applications</a> on cover page. Updated <a href="#">Figure 13. Capacitance variations</a> . Updated <a href="#">Section 4.1 STPAK package information</a> . Minor text changes.

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## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>2</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>3</b>
<b>2.1</b>	<b>Electrical characteristics (curves)</b> .....	<b>5</b>
<b>3</b>	<b>Test circuits</b> .....	<b>10</b>
<b>4</b>	<b>Package information</b> .....	<b>11</b>
<b>4.1</b>	<b>STPAK package information</b> .....	<b>11</b>
	<b>Revision history</b> .....	<b>13</b>

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