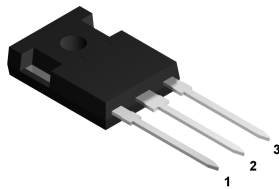
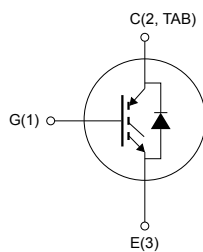


## Trench gate field-stop, 650 V, 50 A, high-speed HB2 series IGBT in a TO-247 long leads package



TO-247 long leads



NG1E3C2T



Product status link

[STGWA50H65DFB2](#)

### Product summary

Order code	STGWA50H65DFB2
Marking	G50H65DFB2
Package	TO-247 long leads
Packing	Tube

### Features

- Maximum junction temperature:  $T_J = 175\text{ °C}$
- Low  $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 50\text{ A}$
- Very fast and soft recovery co-packaged diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive  $V_{CE(sat)}$  temperature coefficient

### Applications

- Welding
- PFC converters - single phase input
- Solar inverters (string and central)
- Uninterruptable power supplies (UPS)
- EV charging - DC fast charging stations

### Description

The newest IGBT 650 V HB2 series represents an evolution of the advanced proprietary trench gate field-stop structure. The performance of the HB2 series is optimized in terms of conduction, thanks to a better  $V_{CE(sat)}$  behavior at low current values, as well as in terms of reduced switching energy. A very fast soft recovery diode is co-packaged in antiparallel with the IGBT. The result is a product specifically designed to maximize efficiency for a wide range of fast applications.

# 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	86	A
	Continuous collector current at $T_C = 100$ °C	53	
$I_{CP}^{(1)}$	Pulsed collector current	150	
$V_{GE}$	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage ( $t_p \leq 10$ μs)	±30	
$I_F$	Continuous forward current at $T_C = 25$ °C	60	A
	Continuous forward current at $T_C = 100$ °C	38	
$I_{FP}$	Pulsed forward current ( $t_p \leq 1$ μs, $T_J < 175$ °C)	150	
$P_{TOT}$	Total power dissipation at $T_C = 25$ °C	272	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	

1. Pulse width is limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.55	°C/W
	Thermal resistance junction-case diode	1.14	
$R_{thJA}$	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	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$		1.55	2	V
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 125\text{ °C}$		1.8		
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 175\text{ °C}$		1.9		
$V_F$	Forward on-voltage	$I_F = 50\text{ A}$		1.85	2.45	V
		$I_F = 50\text{ A}, T_J = 125\text{ °C}$		1.65		
		$I_F = 50\text{ A}, T_J = 175\text{ °C}$		1.45		
$V_{GE(th)}$	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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	2928	-	pF
$C_{oes}$	Output capacitance		-	162	-	
$C_{res}$	Reverse transfer capacitance		-	78	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 50\text{ A}, V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 28. Gate charge test circuit)	-	151	-	nC
$Q_{ge}$	Gate-emitter charge		-	30	-	
$Q_{gc}$	Gate-collector charge		-	63	-	

**Table 5. Switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 4.7\ \Omega$ (see Figure 27. Test circuit for inductive load switching)	-	28	-	ns
$t_r$	Current rise time		-	20	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	910	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off delay time		-	115	-	ns
$t_f$	Current fall time		-	40	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	580	-	$\mu\text{J}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 4.7\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	24	-	ns
$t_r$	Current rise time		-	17	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	1800	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off delay time		-	135	-	ns
$t_f$	Current fall time		-	90	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	1090	-	$\mu\text{J}$

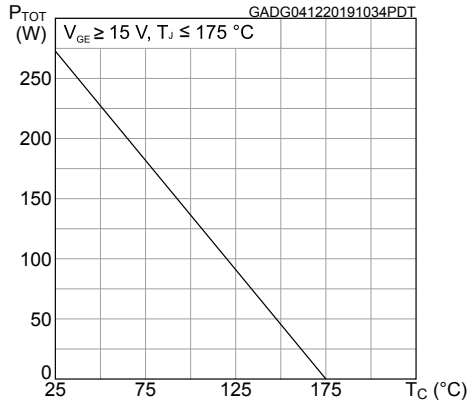
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

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

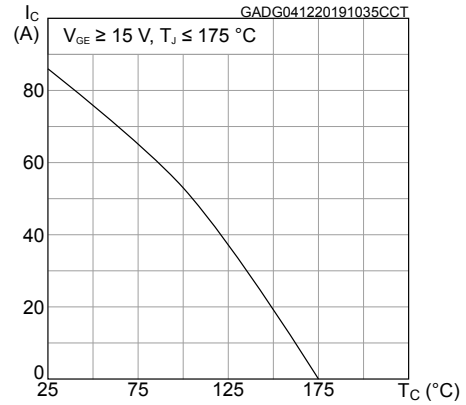
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 50\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 30. Diode reverse recovery waveform)	-	92	-	ns
$Q_{rr}$	Reverse recovery charge		-	673	-	nC
$I_{rrm}$	Reverse recovery current		-	20.9	-	A
$di_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	675	-	$\text{A}/\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	138	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 50\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 30. Diode reverse recovery waveform)	-	209	-	ns
$Q_{rr}$	Reverse recovery charge		-	3500	-	nC
$I_{rrm}$	Reverse recovery current		-	45.8	-	A
$di_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	600	-	$\text{A}/\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	841	-	$\mu\text{J}$

## 2.1 Electrical characteristics (curves)

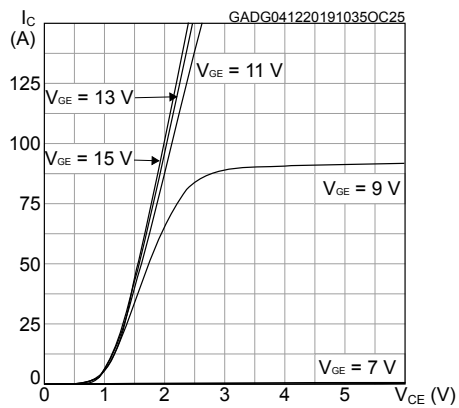
**Figure 1. Power dissipation vs case temperature**



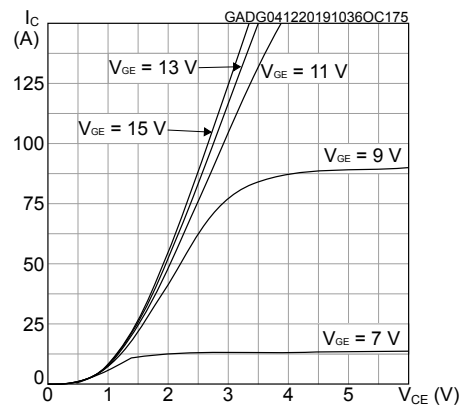
**Figure 2. Collector current vs case temperature**



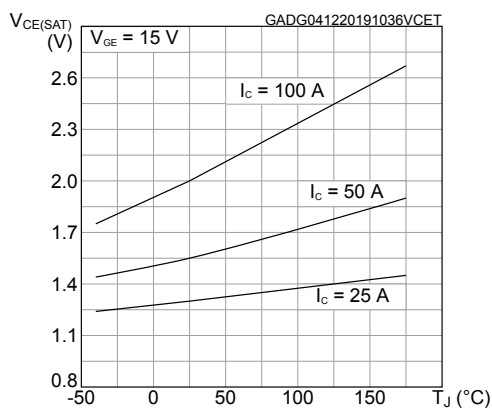
**Figure 3. Output characteristics ( $T_J = 25 \text{ }^\circ\text{C}$ )**



**Figure 4. Output characteristics ( $T_J = 175 \text{ }^\circ\text{C}$ )**



**Figure 5.  $V_{CE(sat)}$  vs junction temperature**



**Figure 6.  $V_{CE(sat)}$  vs collector current**

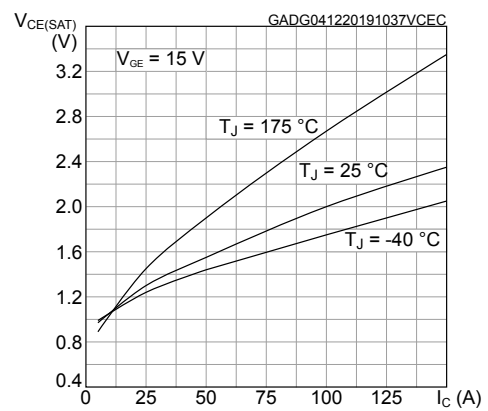


Figure 7. Collector current vs switching frequency

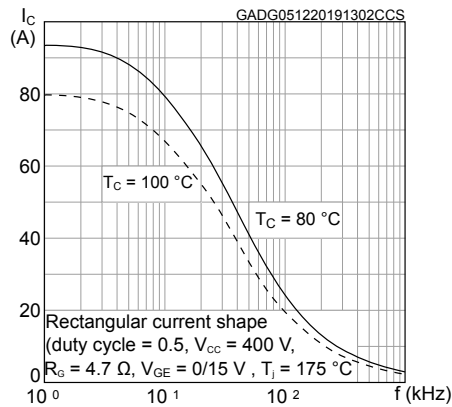


Figure 8. Forward bias safe operating area

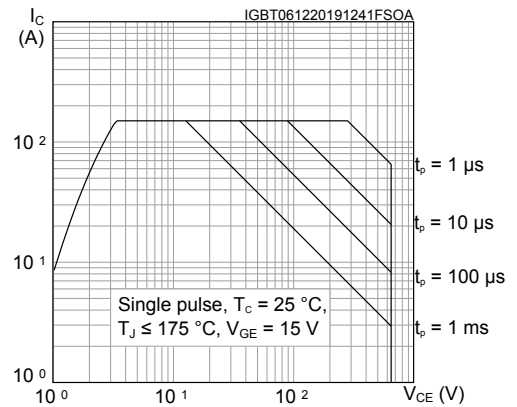


Figure 9. Transfer characteristics

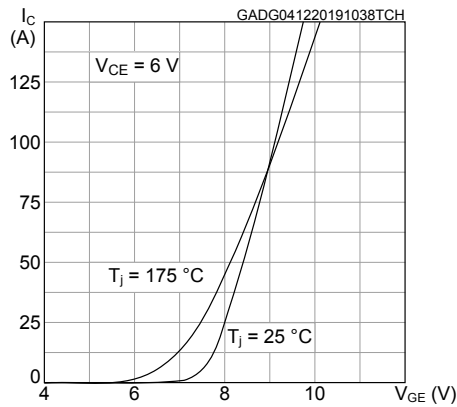


Figure 10. Diode VF vs forward current

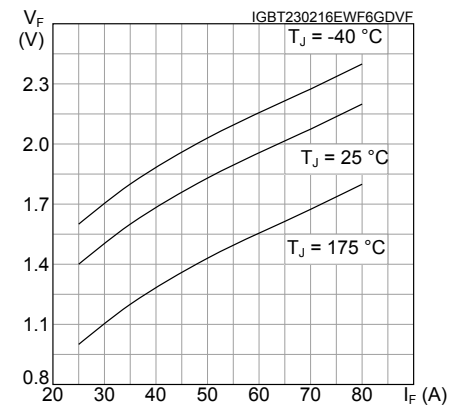


Figure 11. Normalized VGE(th) vs junction temperature

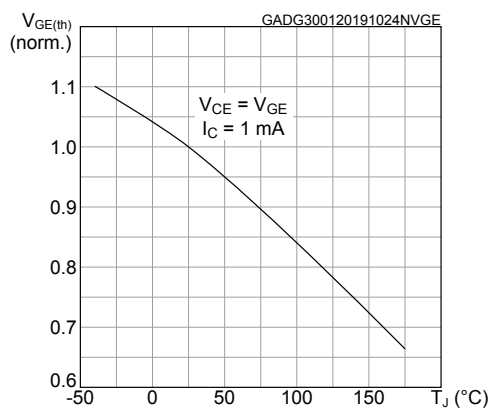
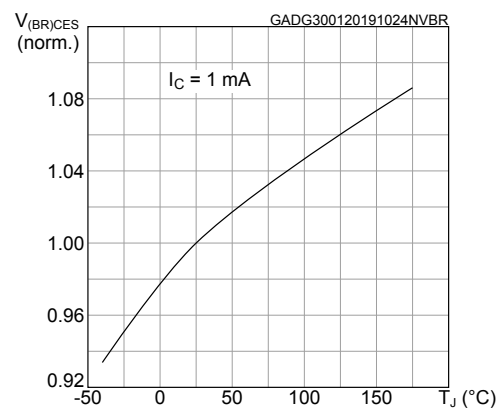
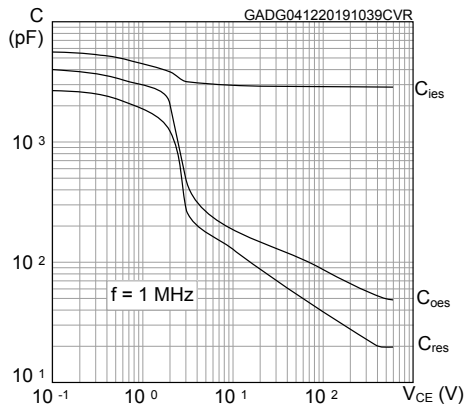


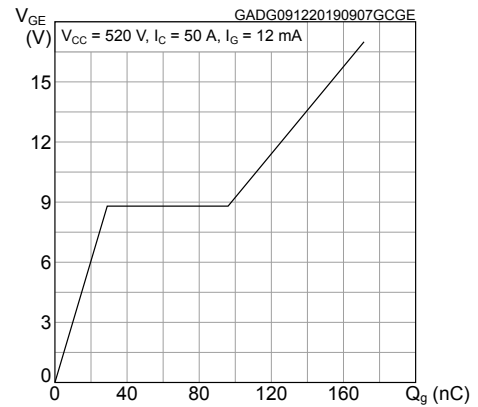
Figure 12. Normalized V(BR)CES vs junction temperature



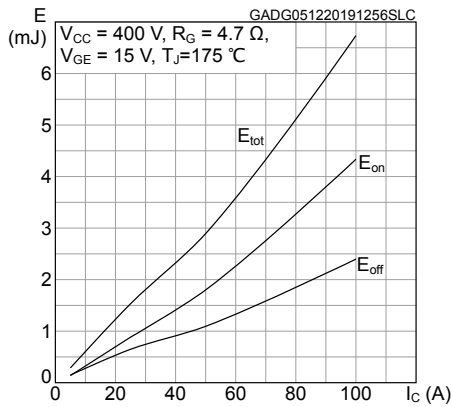
**Figure 13. Capacitance variations**



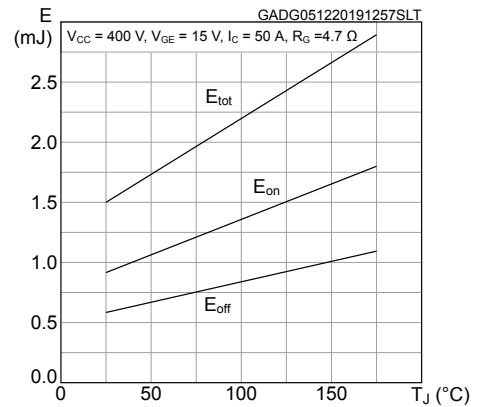
**Figure 14. Gate charge vs gate-emitter voltage**



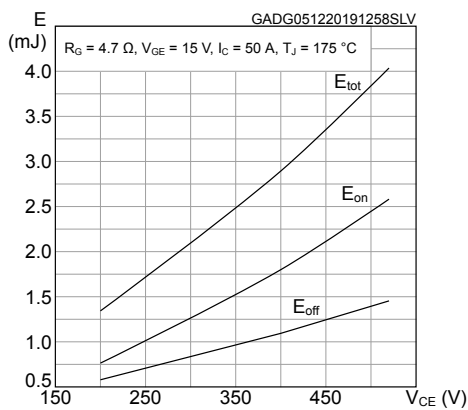
**Figure 15. Switching energy vs collector current**



**Figure 16. Switching energy vs temperature**



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



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

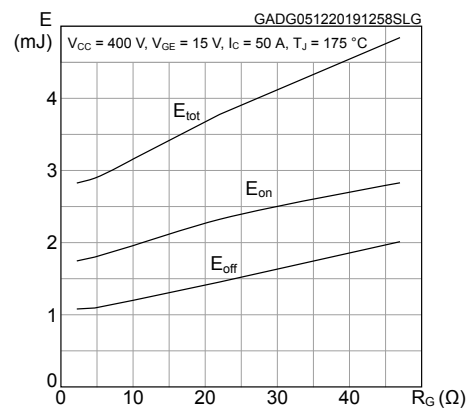


Figure 19. Switching times vs collector current

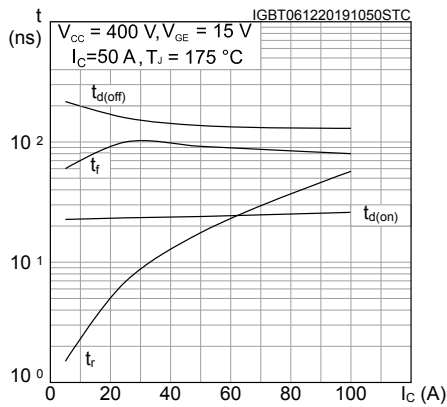


Figure 20. Switching times vs gate resistance

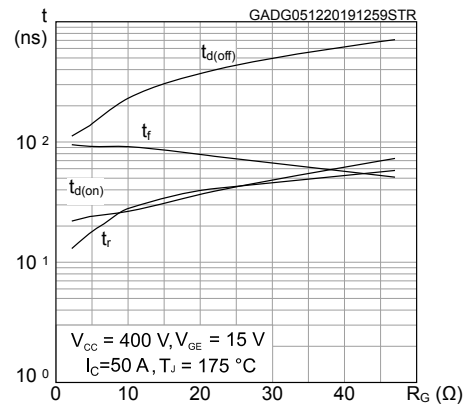


Figure 21. Reverse recovery current vs diode current slope

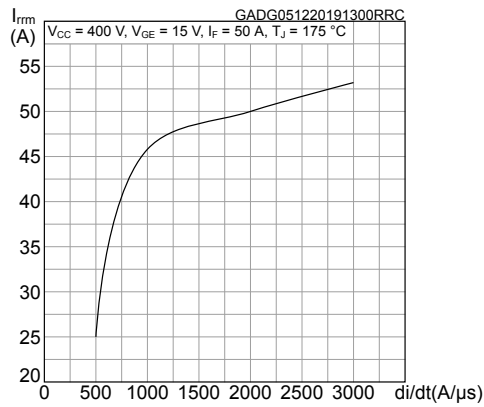


Figure 22. Reverse recovery time vs diode current slope

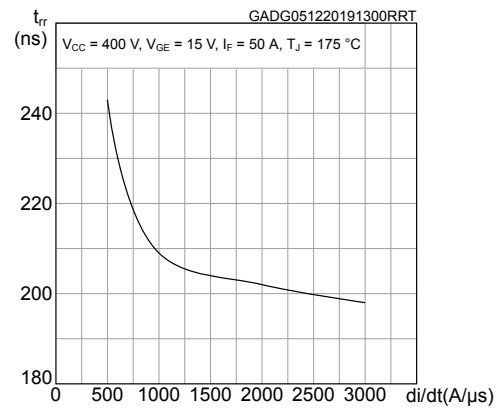


Figure 23. Reverse recovery charge vs diode current slope

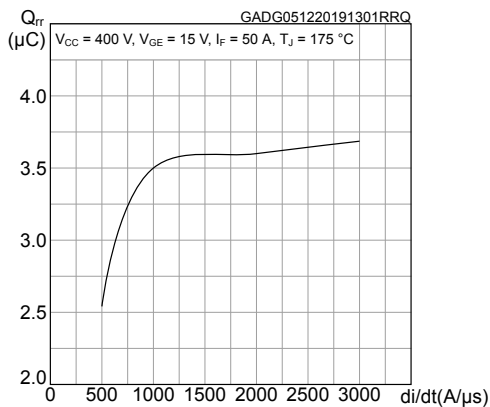


Figure 24. Reverse recovery energy vs diode current slope

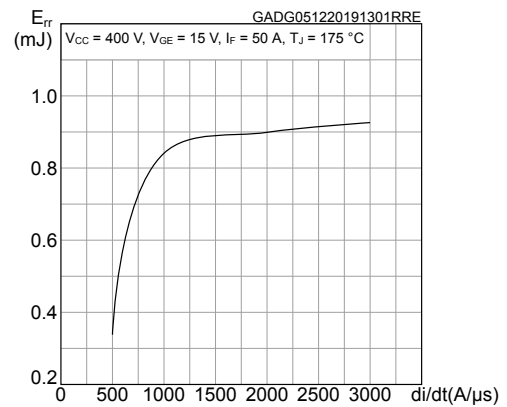




Figure 25. Thermal impedance for IGBT

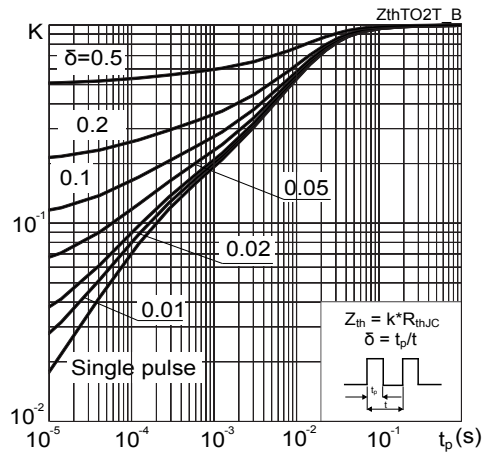
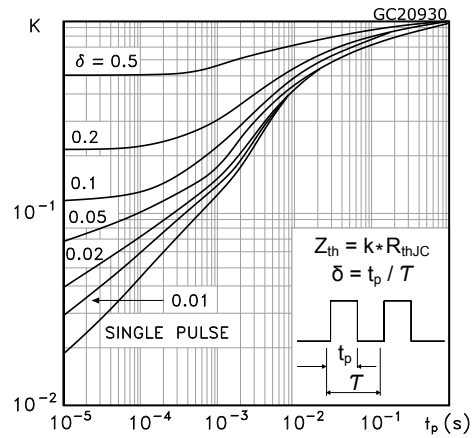
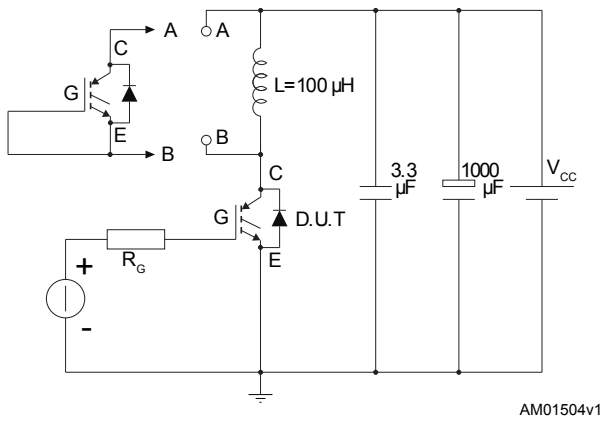
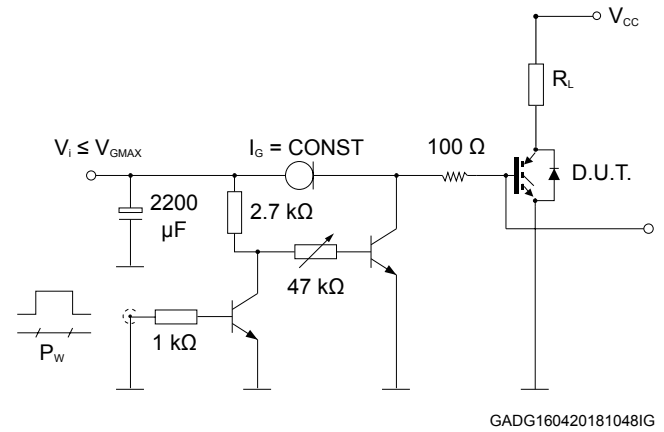
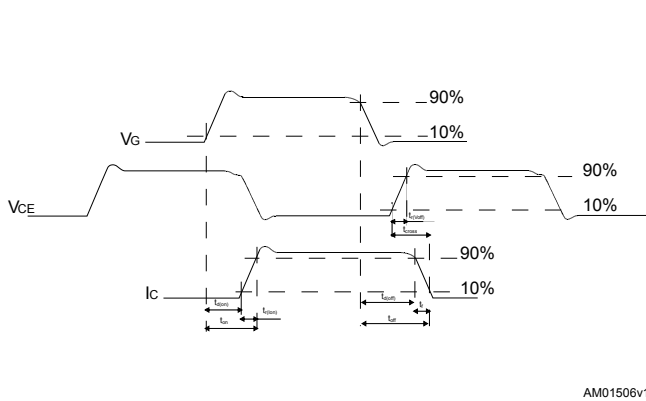
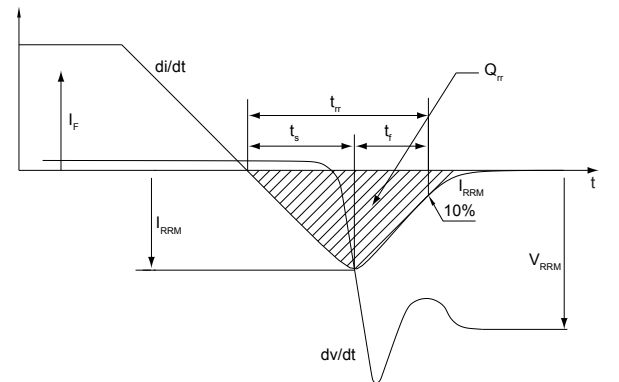


Figure 26. Thermal impedance for diode



### 3 Test circuits

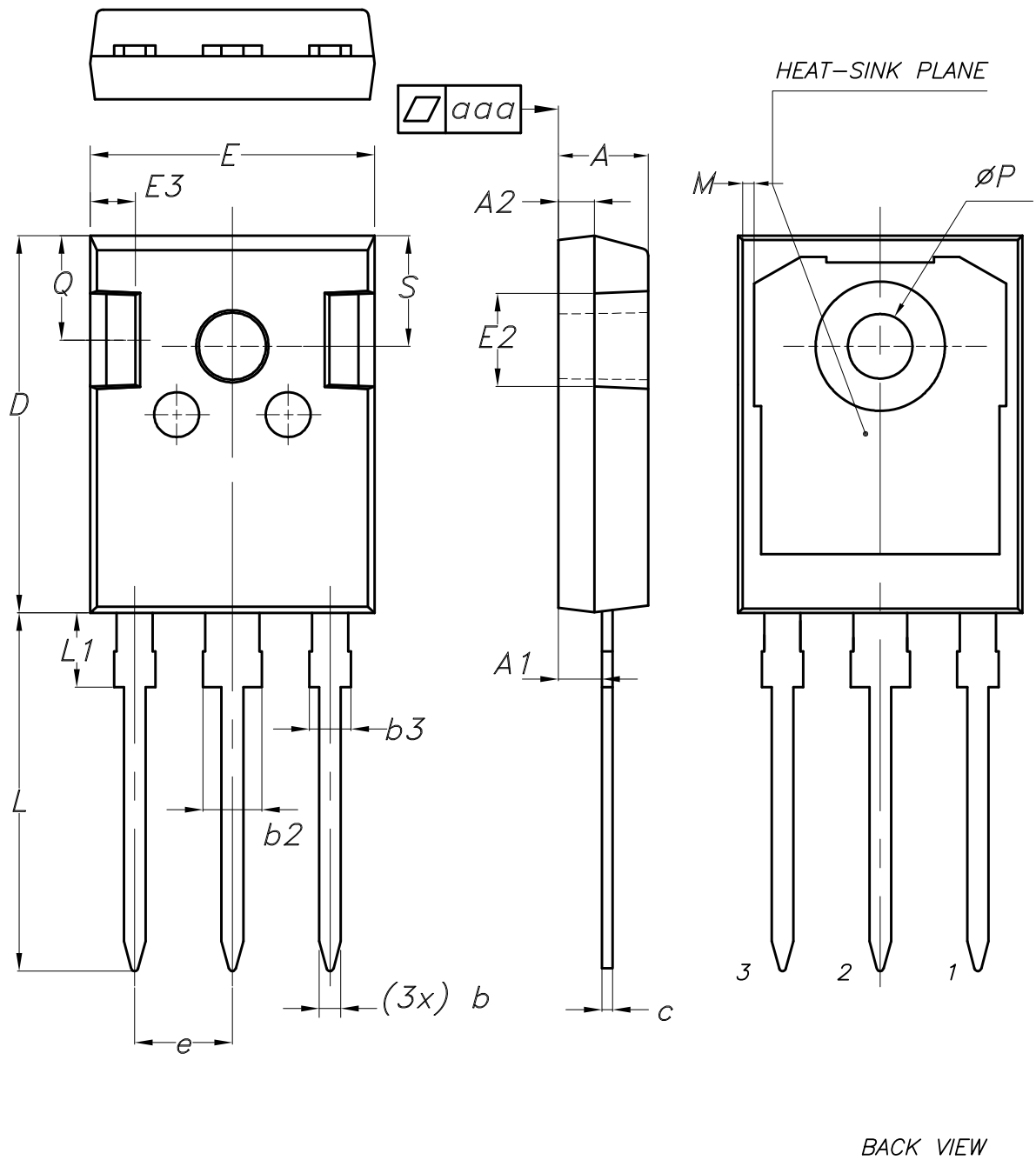
**Figure 27. Test circuit for inductive load switching**

**Figure 28. Gate charge test circuit**

**Figure 29. Switching waveform**

**Figure 30. Diode reverse recovery waveform**


## 4 Package information

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 31. TO-247 long leads package outline



BACK VIEW

8463846\_5

**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
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

## Revision history

**Table 8. Document revision history**

Date	Version	Changes
09-Dec-2019	1	First release.
11-Oct-2024	2	Updated <a href="#">Section 4.1</a> : TO-247 long leads package information. Minor text changes.

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