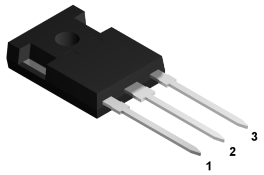
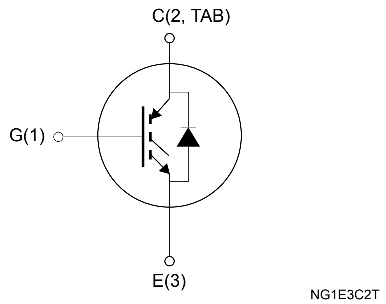
Trench gate field-stop, 650 V, 50 A, high-speed HB2 series IGBT in a TO-247 long leads package



TO-247 long leads



Product status link
STGWA50HP65FB2

Product summary	
Order code	STGWA50HP65FB2
Marking	G50HP65FB2
Package	TO-247 long leads
Packing	Tube

Features

- Maximum junction temperature : T_J = 175 °C
- Low $V_{CE(sat)}$ = 1.55 V(typ.) @ I_C = 50 A
- Co-packaged protection diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient

Applications

- Welding
- Power factor correction

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 diode used for protection purposes only 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	A
I_{CP} (1)(2)	Pulsed collector current	150	A
V_{GE}	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage (t_p ≤ 10 µs)	±30	
I_F	Continuous forward current at T_C = 25 °C	5	A
	Continuous forward current at T_C = 100 °C	5	
I_{FP} (1)(2)	Pulsed forward current	10	A
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	°C

1. *Pulse width is limited by maximum junction temperature.*
2. *Defined by design, not subject to production test.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.55	°C/W
	Thermal resistance junction-case diode	5	
R_{thJA}	Thermal resistance junction-ambient	50	

2 Electrical characteristics

T_C = 25 °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 V, I_C = 1 mA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 50 A		1.55	2	V
		V_{GE} = 15 V, I_C = 50 A, T_J = 125 °C		1.8		
		V_{GE} = 15 V, I_C = 50 A, T_J = 175 °C		1.9		
V_F	Forward on-voltage	I_F = 5 A		2	2.8	V
		I_F = 5 A, T_J = 125 °C		1.85		
		I_F = 5 A, T_J = 175 °C		1.75		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ±20 V			±250	nA

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	2928	-	pF
C_{oes}	Output capacitance		-	162	-	
C_{res}	Reverse transfer capacitance		-	78	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 50 A, V_{GE} = 0 to 15 V (see Figure 27. 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
$t_{d(off)}$	Turn-off delay time	V_{CC} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 4.7 Ω (see Figure 26. Test circuit for inductive load switching)	-	115	-	ns
t_f	Current fall time		-	40	-	ns
E_{off} [(1)]	Turn-off switching energy		-	580	-	μJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 4.7 Ω, T_J = 175 °C (see Figure 26. Test circuit for inductive load switching)	-	135	-	ns
t_f	Current fall time		-	90	-	ns
E_{off} [(1)]	Turn-off switching energy		-	1090	-	μJ

1. *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 = 5 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/μs (see Figure 29. Diode reverse recovery waveform)	-	140	-	ns
Q_{rr}	Reverse recovery charge		-	21	-	nC
I_{rrm}	Reverse recovery current		-	6.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	430	-	A/μs
E_{rr}	Reverse recovery energy		-	1.6	-	μJ
t_{rr}	Reverse recovery time	I_F = 5 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/μs, T_J = 175 °C (see Figure 29. Diode reverse recovery waveform)	-	200	-	ns
Q_{rr}	Reverse recovery charge		-	47.3	-	nC
I_{rrm}	Reverse recovery current		-	9.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	428	-	A/μs
E_{rr}	Reverse recovery energy		-	3.2	-	μJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

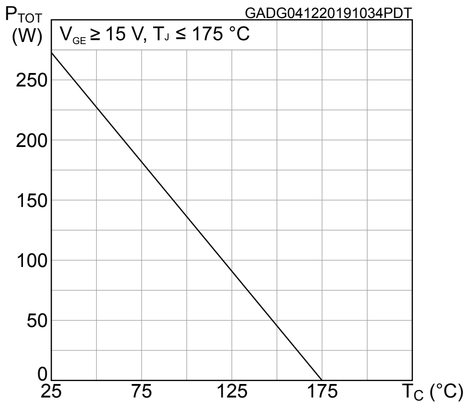


Figure 2. Collector current vs case temperature

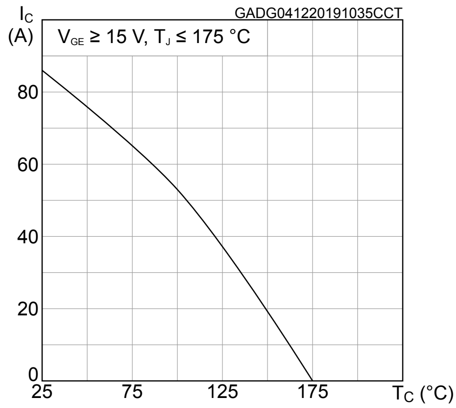


Figure 3. Output characteristics (T_J = 25 °C)

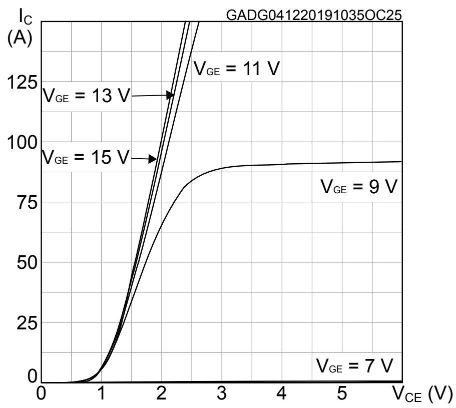


Figure 4. Output characteristics (T_J = 175 °C)

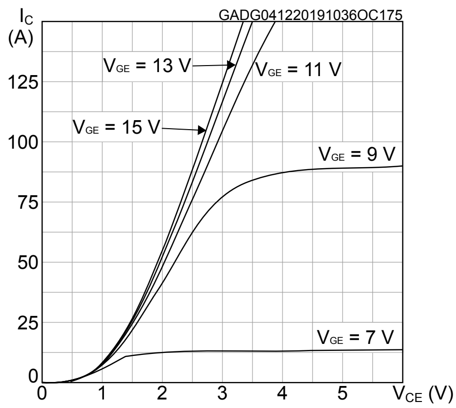


Figure 5. $V_{CE(sat)}$ vs junction temperature

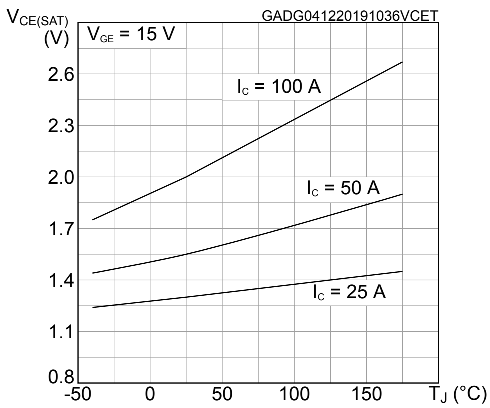


Figure 6. $V_{CE(sat)}$ vs collector current

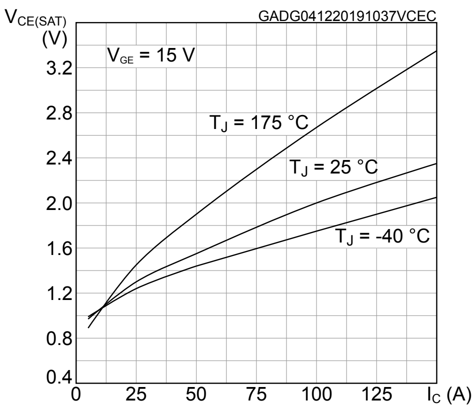


Figure 7. Forward bias safe operating area

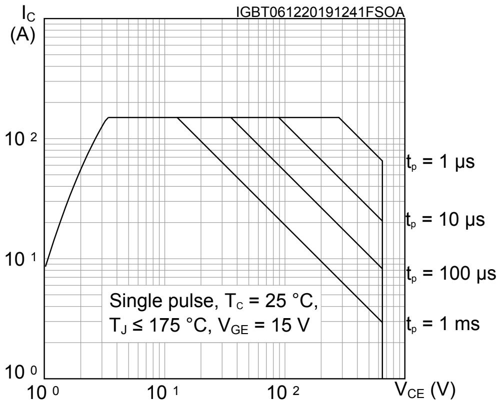


Figure 8. Transfer characteristics

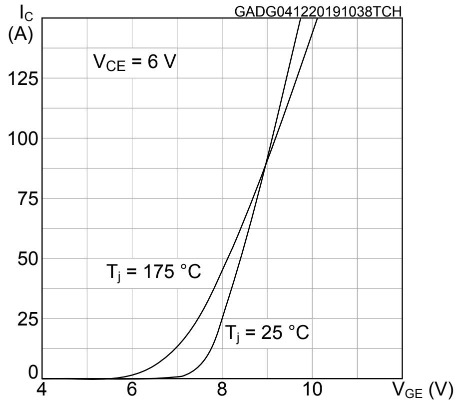


Figure 9. Diode V_F vs forward current

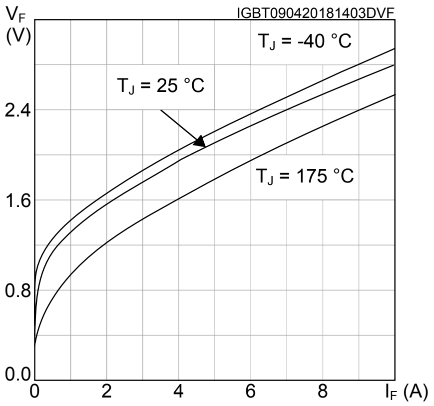


Figure 10. Normalized $V_{GE(th)}$ vs junction temperature

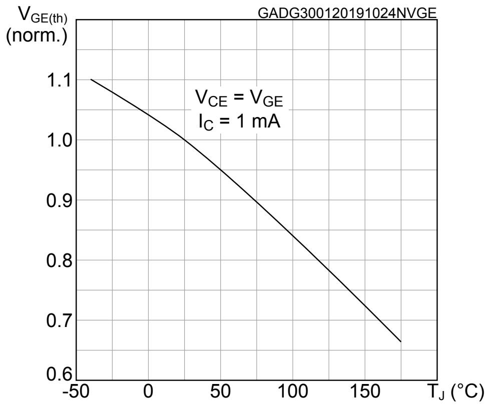


Figure 11. Normalized $V_{(BR)CES}$ vs junction temperature

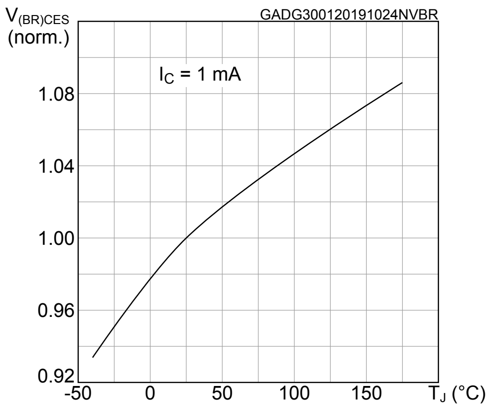


Figure 12. Capacitance variations

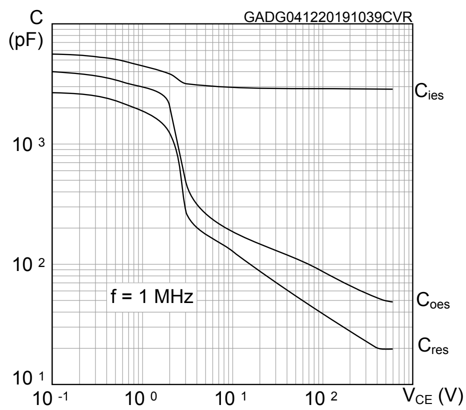


Figure 13. Gate charge vs gate-emitter voltage

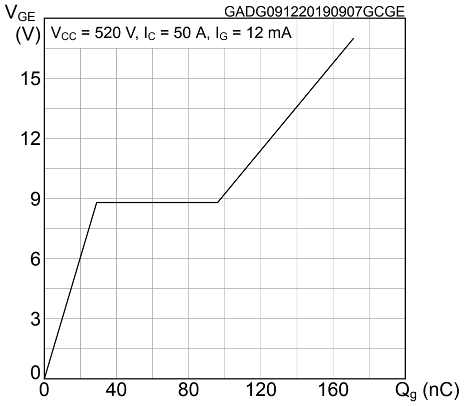


Figure 14. Switching energy vs collector current

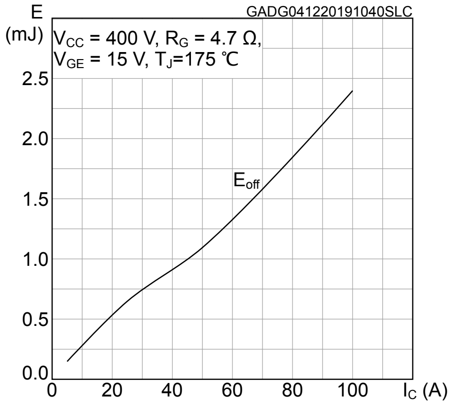


Figure 15. Switching energy vs temperature

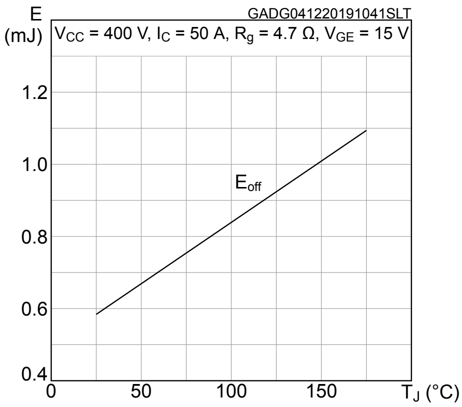


Figure 16. Switching energy vs collector emitter voltage

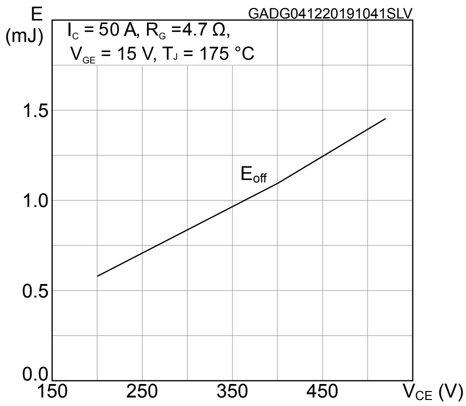


Figure 17. Switching energy vs gate resistance

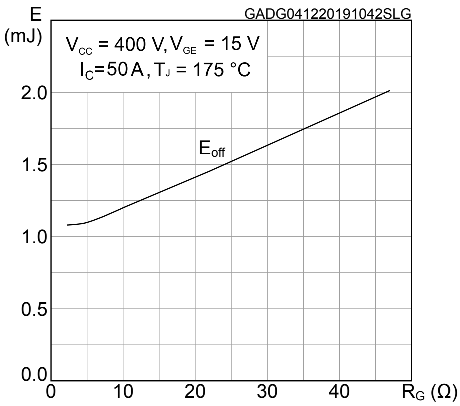


Figure 18. Switching times vs collector current

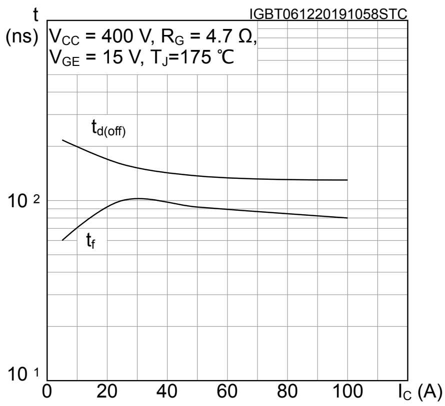


Figure 19. **Switching times vs gate resistance**

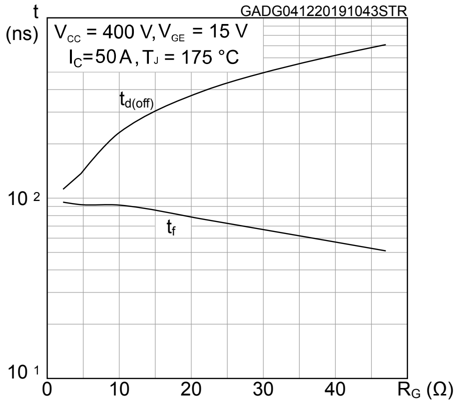


Figure 20. **Reverse recovery current vs diode current slope**

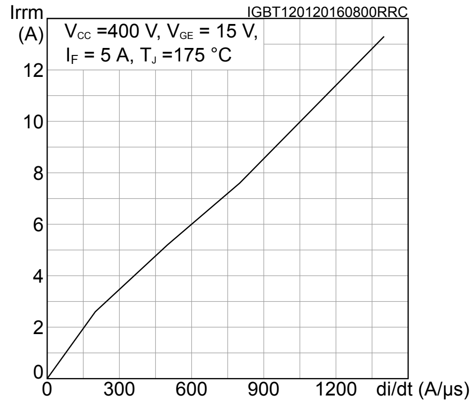


Figure 21. **Reverse recovery time vs diode current slope**

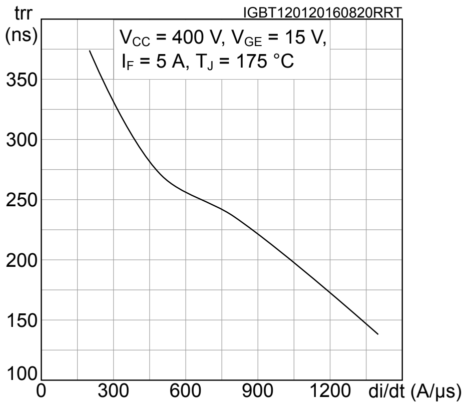


Figure 22. **Reverse recovery charge vs diode current slope**

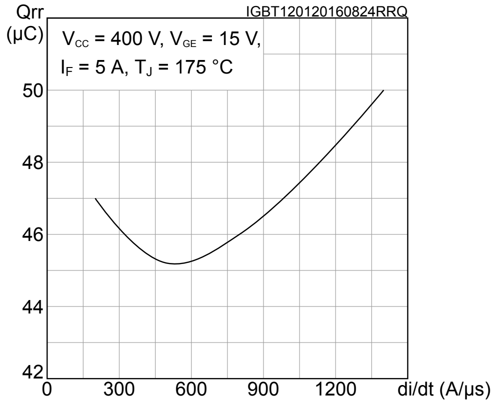


Figure 23. **Reverse recovery energy vs diode current slope**

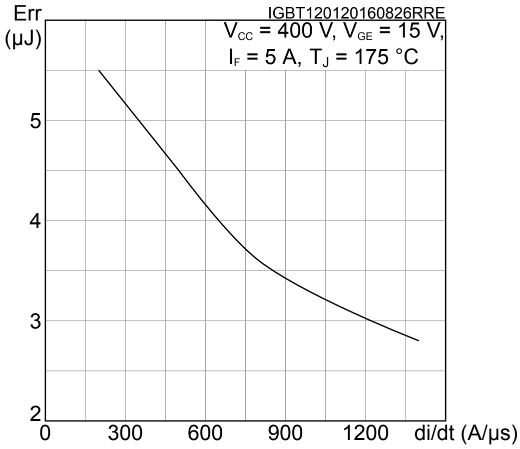


Figure 24. Thermal impedance for IGBT

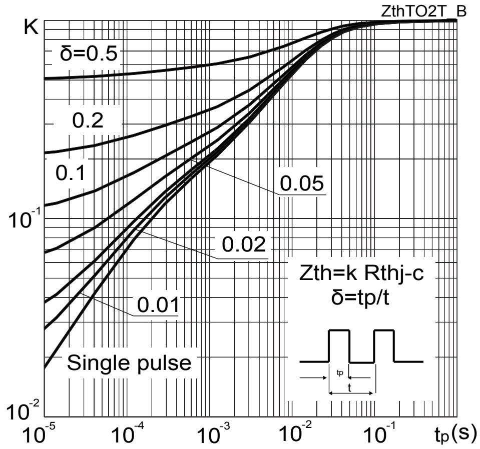
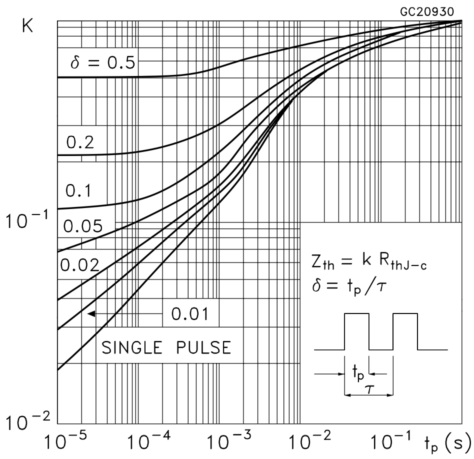


Figure 25. Thermal impedance for diode



3 Test circuits

Figure 26. Test circuit for inductive load switching

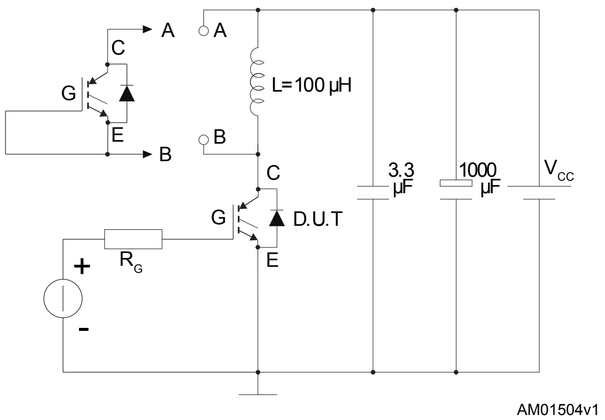


Figure 27. Gate charge test circuit

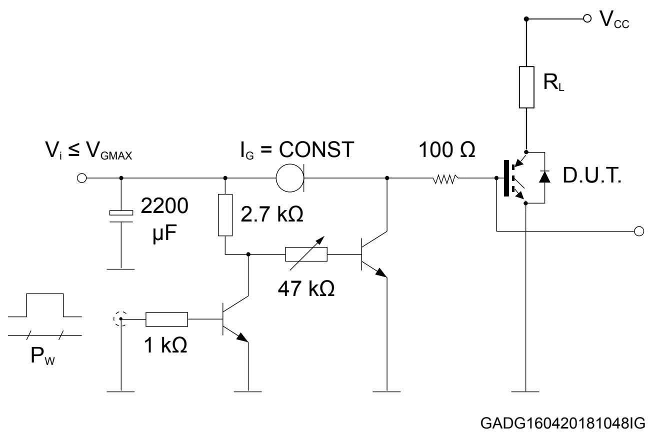


Figure 28. Switching waveform

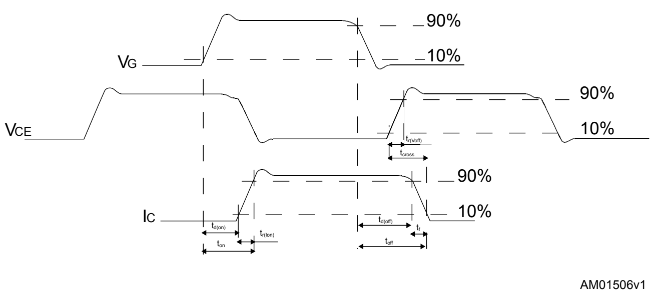
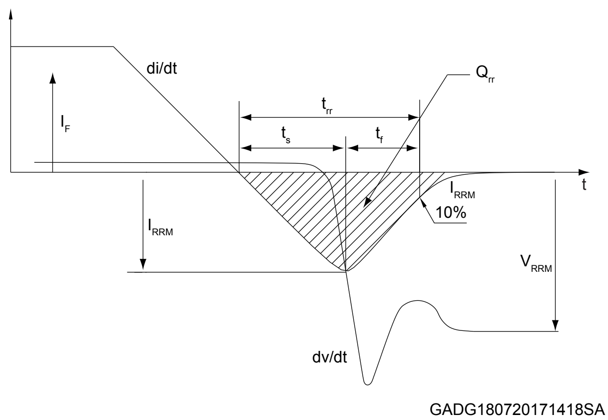


Figure 29. Diode reverse recovery waveform



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. ECOPACK is an ST trademark.

4.1 TO-247 long leads package information

Figure 30. TO-247 long leads package outline

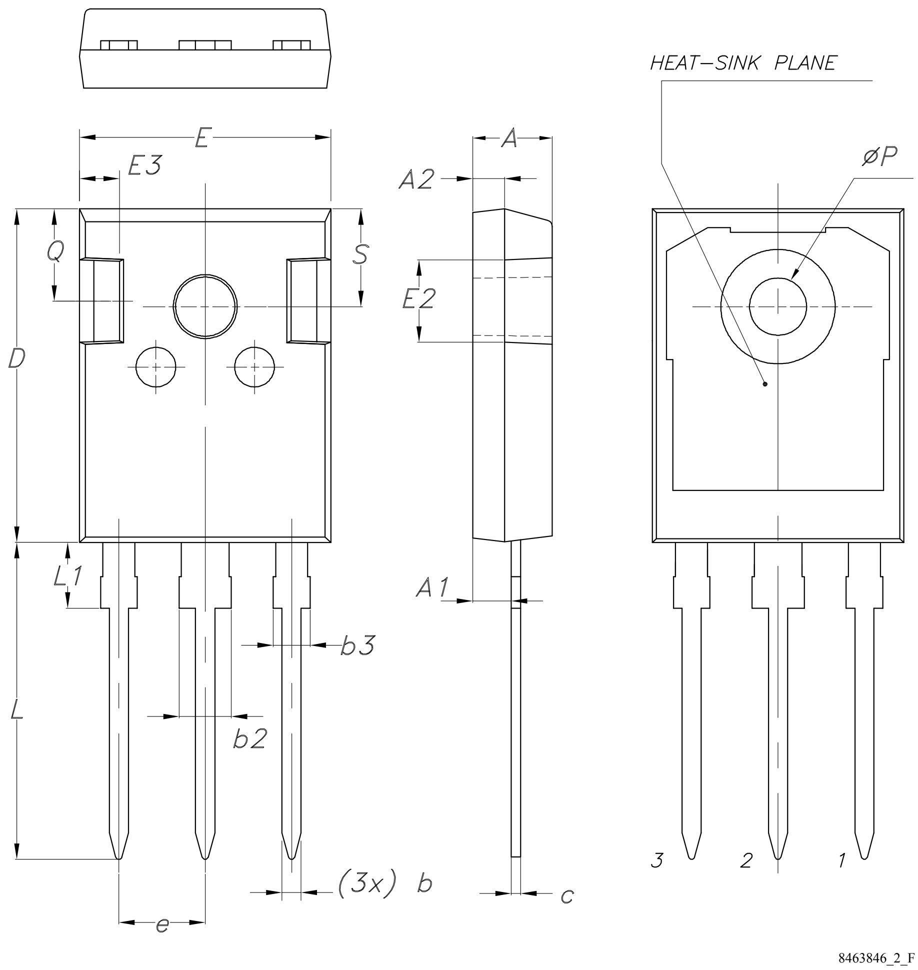


Table 7. TO-247 long leads package mechanical data

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	Version	Changes
05-Dec-2019	1	First release.

Contents