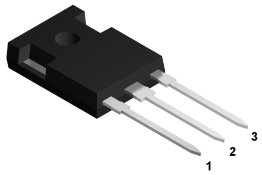
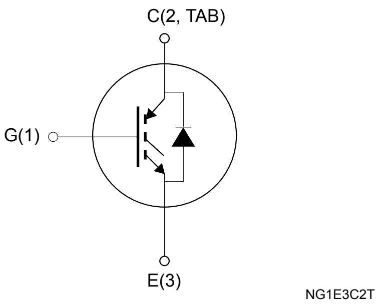
Datasheet

Automotive-grade trench gate field-stop 600 V, 60 A very high speed V series IGBT featuring freewheeling SiC diode



TO-247 long leads



Product status link
STGWA60V60DWFAG

Product summary	
Order code	STGWA60V60DWFAG
Marking	G60V60DWFAG
Package	TO-247 long leads
Packing	Tube

Features

- AEC-Q101 qualified
- Maximum junction temperature: T_J = 175 °C
- $V_{CE(sat)}$ = 1.85 V (typ.) @ I_C = 60 A
- Tail-less switching current
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient
- Silicon carbide diode with no-reverse recovery charge is co-packaged in freewheeling configuration

Applications

- Automotive converters
- Totem-pole power factor correction

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the V series IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Co-packed with the IGBT a silicon carbide diode has been adopted: no recovery is shown at turn-off of the SiC diode and the already minimal capacitive turn-off behavior is independent of temperature. Its high forward surge capability ensures good robustness during transient phases.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	600	V
I_C	Continuous collector current at T_C = 25 °C	80 (1)	A
	Continuous collector current at T_C = 100 °C	60	
I_{CP} (1)	Pulsed collector current (t_p ≤ 1 µs, T_J < 175 C)	240	
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 100 °C	30	A
I_{FRM} (1)	Repetitive peak forward current (T_C = 100 °C, T_J = 175 °C, δ = 0.1)	125	
P_{TOT}	Total power dissipation at T_C = 25 °C	375	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. *Limited by bonding wires.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.4	°C/W
	Thermal resistance junction-case diode	0.9	
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 = 2 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 60 A		1.85	2.3	
		V_{GE} = 15 V, I_C = 60 A, T_J = 125 °C		2.15		
		V_{GE} = 15 V, I_C = 60 A, T_J = 175 °C		2.35		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	
V_F	Forward on-voltage	I_F=30 A		1.45	1.88	
		I_F=30 A, T_J = 125 °C		1.7		
		I_F=30 A, T_J = 175 °C		1.85		
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 600 V			250	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	-	8000	-	pF
C_{oes}	Output capacitance		-	280	-	
C_{res}	Reverse transfer capacitance		-	170	-	
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 60 A, V_{GE} = 0 to 15 V (see Figure 28. Gate charge test circuit)	-	314	-	nC
Q_{ge}	Gate-emitter charge		-	48	-	
Q_{gc}	Gate-collector charge		-	142	-	

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 60 A, V_{GE} = 15 V, R_G = 4.7 Ω (see Figure 27. Test circuit for inductive load switching)		35	-	ns
t_r	Current rise time			20	-	ns
$(di/dt)_{on}$	Turn-on current slope			2834	-	A/µs
$t_{d(off)}$	Turn-off delay time			190	-	ns
t_f	Current fall time			22	-	ns
E_{on} (1)	Turn-on switching energy			1.02	-	mJ
E_{off} (2)	Turn-off switching energy			0.37	-	mJ
E_{ts}	Total switching energy			1.39	-	mJ

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 60 A, V_{GE} = 15 V, R_G = 4.7 Ω, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)		31	-	ns
t_r	Current rise time			24	-	ns
$(di/dt)_{on}$	Turn-on current slope			2263	-	A/μs
$t_{d(off)}$	Turn-off delay time			228	-	ns
t_f	Current fall time			52	-	ns
E_{on} (1)	Turn-on switching energy			0.99	-	mJ
E_{off} (2)	Turn-off switching energy			0.78	-	mJ
E_{ts}	Total switching energy			1.77	-	mJ

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

Table 6. SiC diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	I_F = 60 A, V_R = 400 V, V_{GE} = 15 V, dI_F/dt = 2570 A/μs (see Figure 27. Test circuit for inductive load switching)	-	200	-	ns
Q_{rr}	Reverse recovery charge		-	282	-	nC
I_{rrm}	Reverse recovery current		-	8.5	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	30	-	A/μs
E_{rr}	Reverse recovery energy		-	87	-	μJ
t_{rr}	Reverse recovery time	I_F = 60 A, V_R = 400 V, V_{GE} = 15 V, dI_F/dt = 2570 A/μs, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)	-	400	-	ns
Q_{rr}	Reverse recovery charge		-	700	-	nC
I_{rrm}	Reverse recovery current		-	11	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	19	-	A/μs
E_{rr}	Reverse recovery energy		-	225	-	μJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

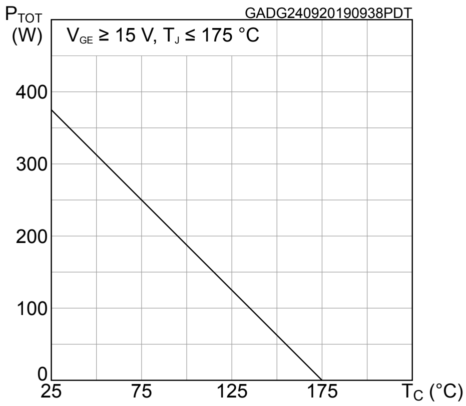


Figure 2. Collector current vs case temperature

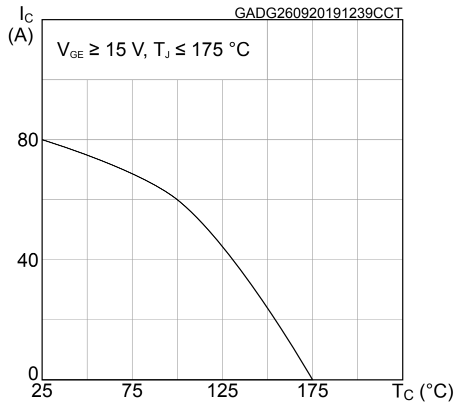


Figure 3. Output characteristics (T_J = 25 °C)

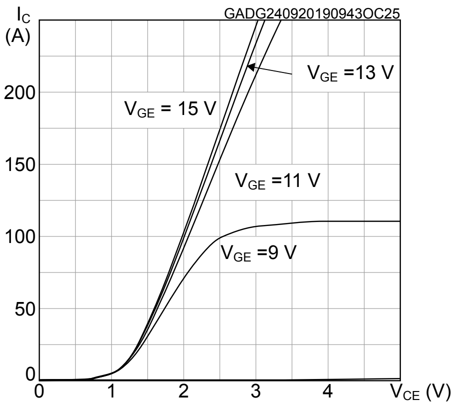


Figure 4. Output characteristics (T_J = 175 °C)

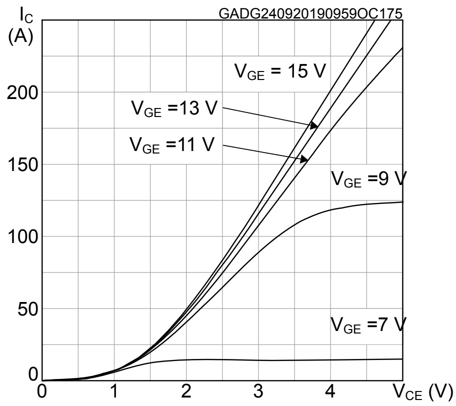


Figure 5. $V_{CE(sat)}$ vs junction temperature

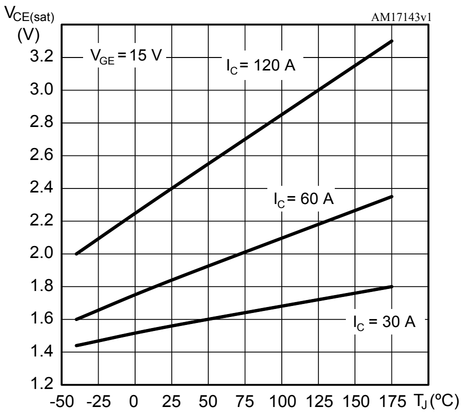


Figure 6. $V_{CE(sat)}$ vs collector current

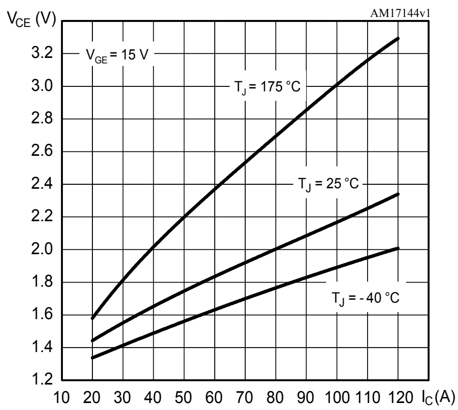


Figure 7. Collector current vs. switching frequency

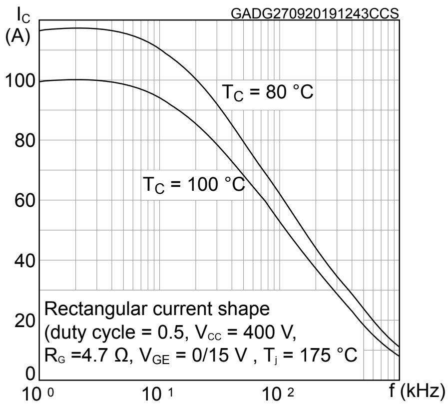


Figure 8. Forward bias safe operating area

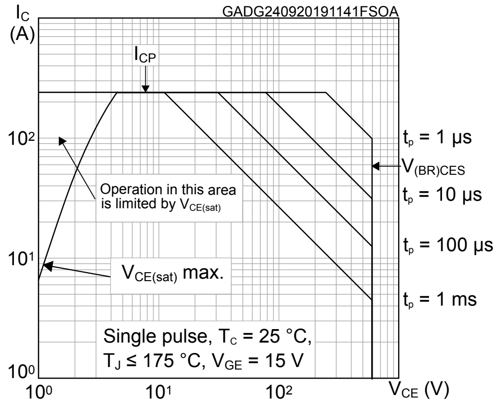


Figure 9. Transfer characteristics

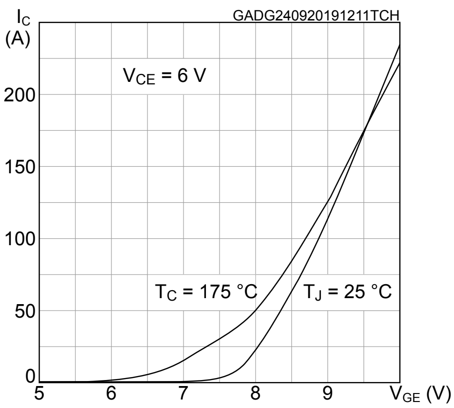


Figure 10. Diode V_F vs forward current

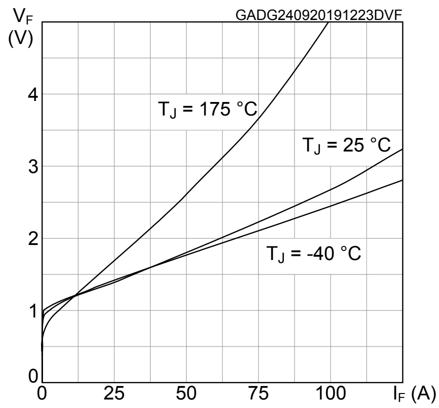


Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

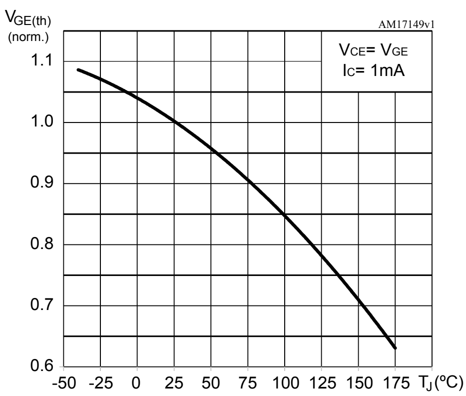


Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature

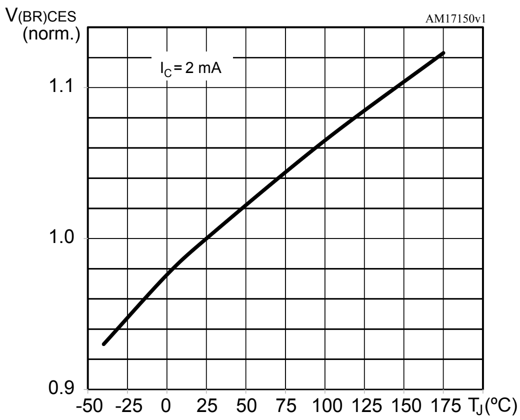


Figure 13. Capacitance variations

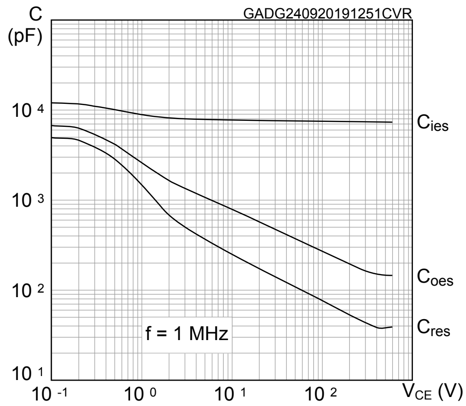


Figure 14. Gate charge vs gate-emitter voltage

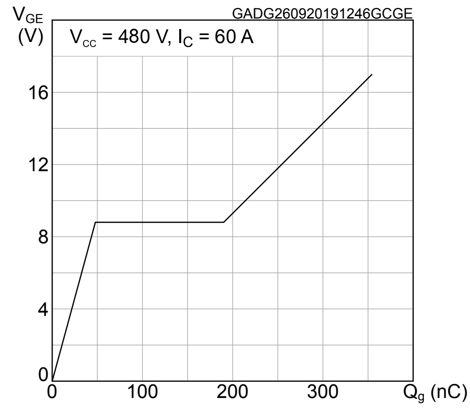


Figure 15. Switching energy vs collector current

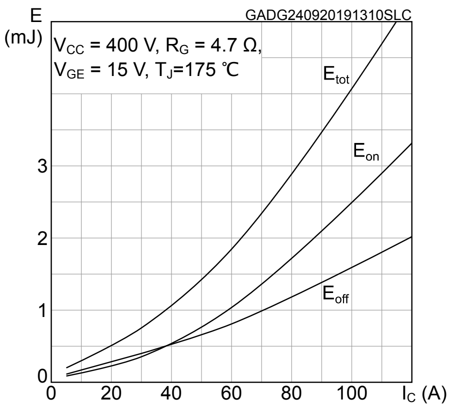


Figure 16. Switching energy vs temperature

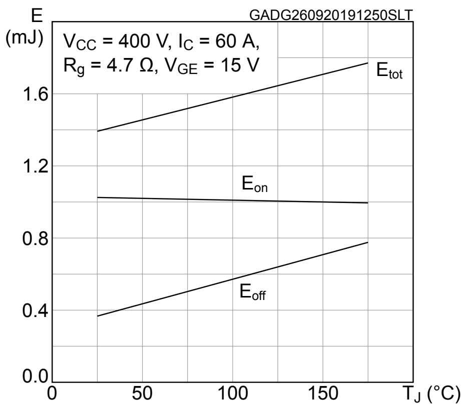


Figure 17. Switching energy vs collector emitter voltage

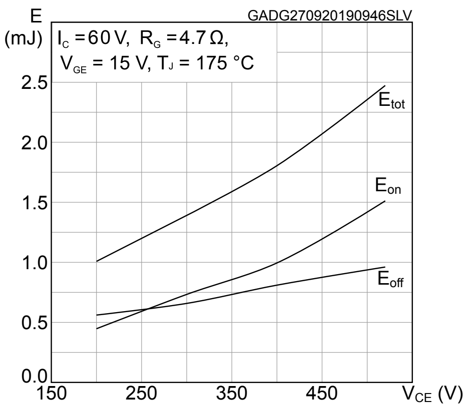


Figure 18. Switching energy vs gate resistance

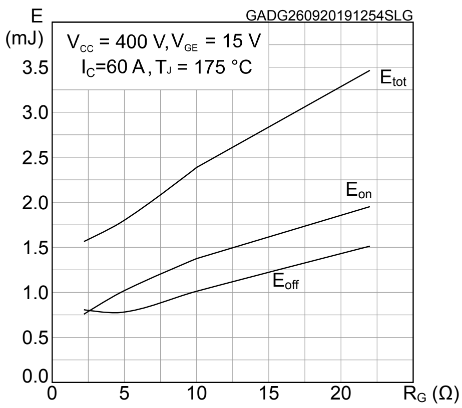


Figure 19. Switching times vs collector current

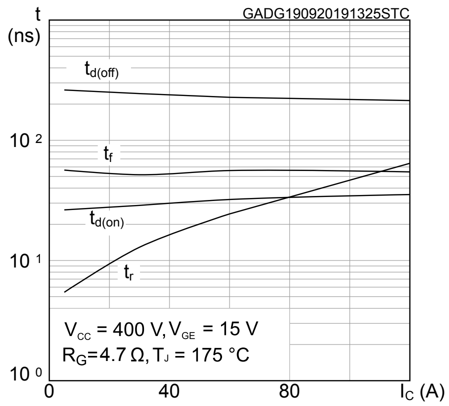


Figure 20. Switching times vs gate resistance

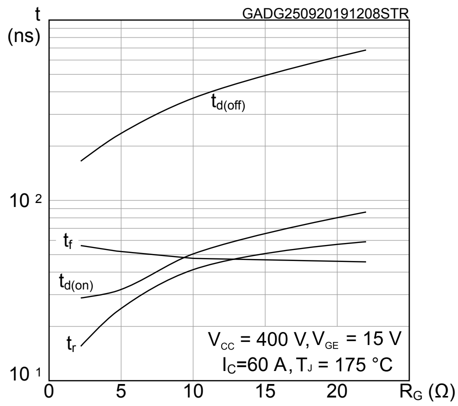


Figure 21. Reverse recovery current vs diode current slope

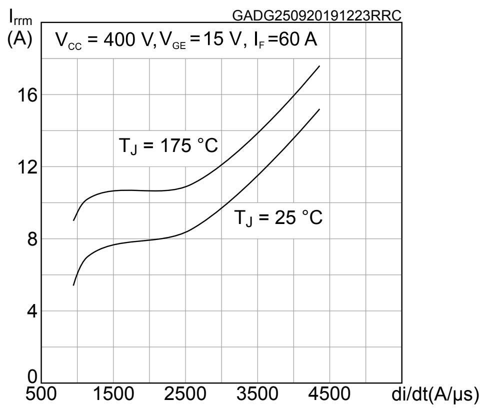


Figure 22. Reverse recovery time vs diode current slope

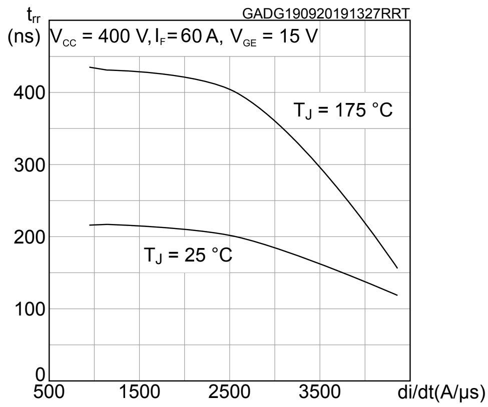


Figure 23. Reverse recovery charge vs diode current slope

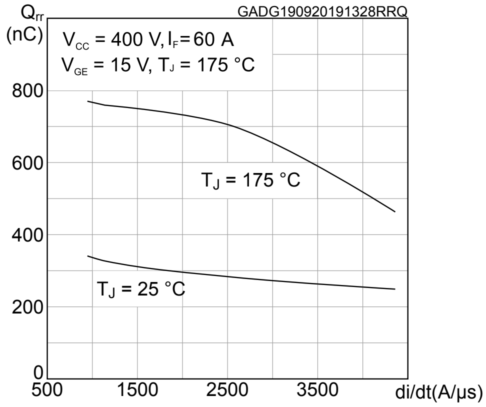


Figure 24. Reverse recovery energy vs diode current slope

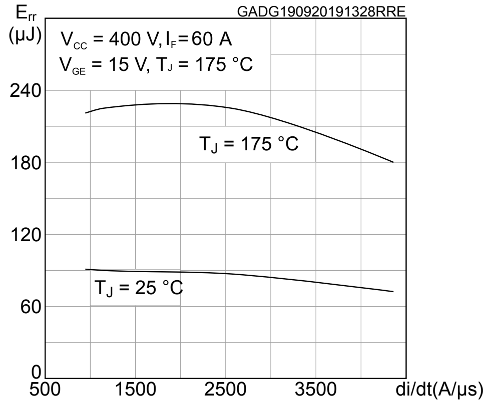


Figure 25. **Thermal impedance for IGBT**

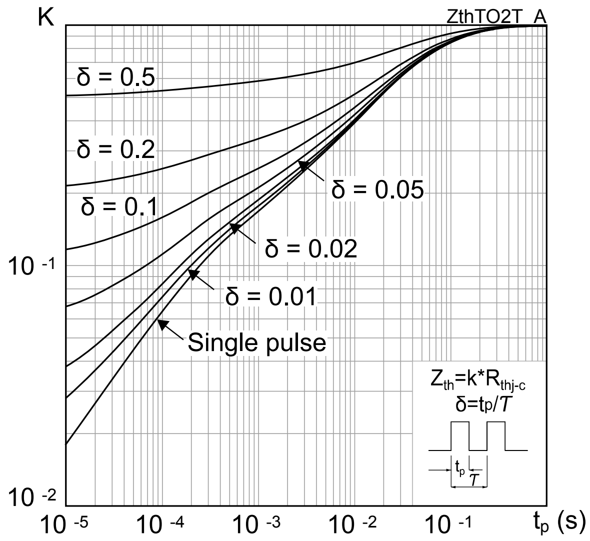
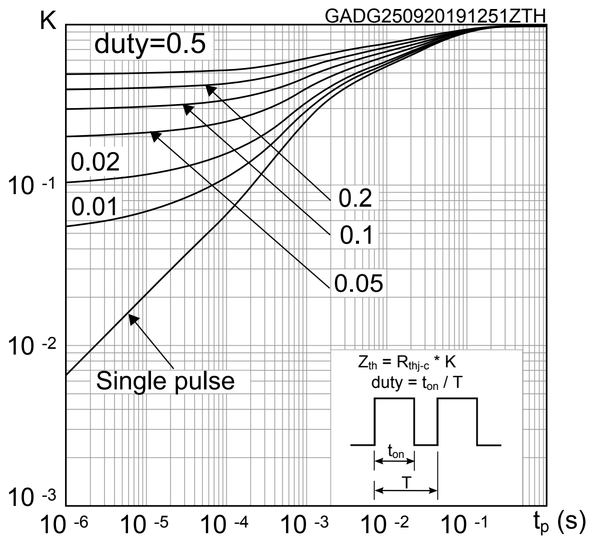


Figure 26. **Thermal impedance for diode**



3 Test circuits

Figure 27. Test circuit for inductive load switching

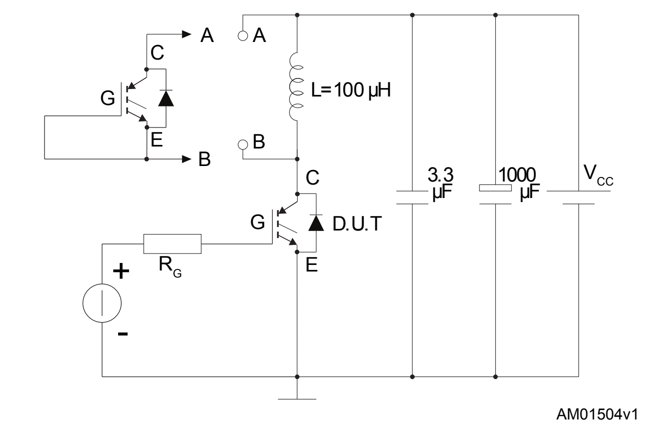


Figure 28. Gate charge test circuit

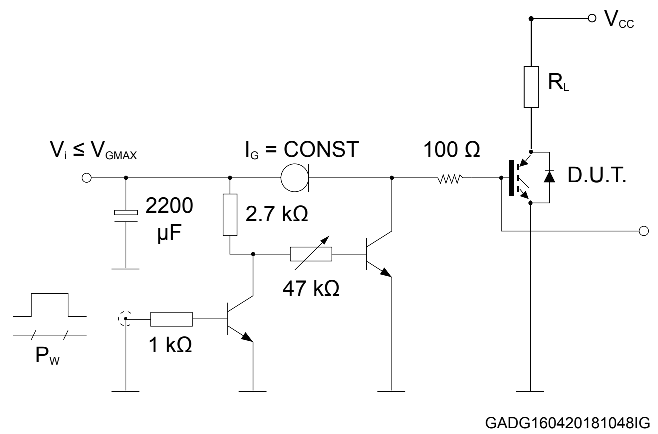


Figure 29. Switching waveform

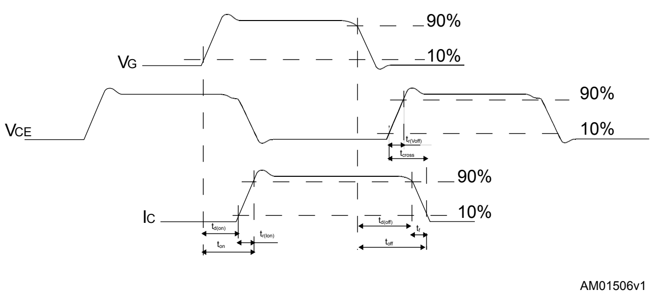
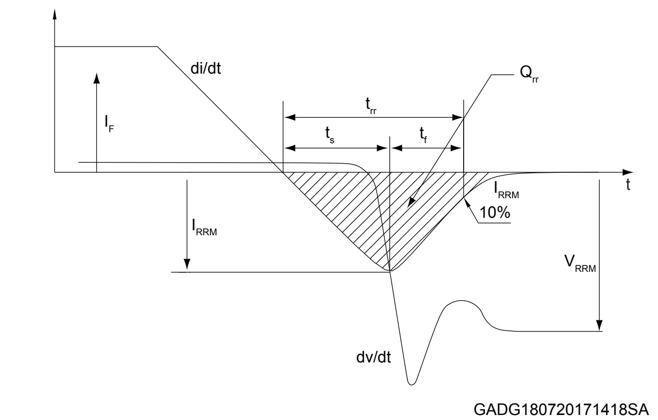


Figure 30. Diode reverse recovery waveform



4 Package information

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 31. **TO-247 long leads package outline**

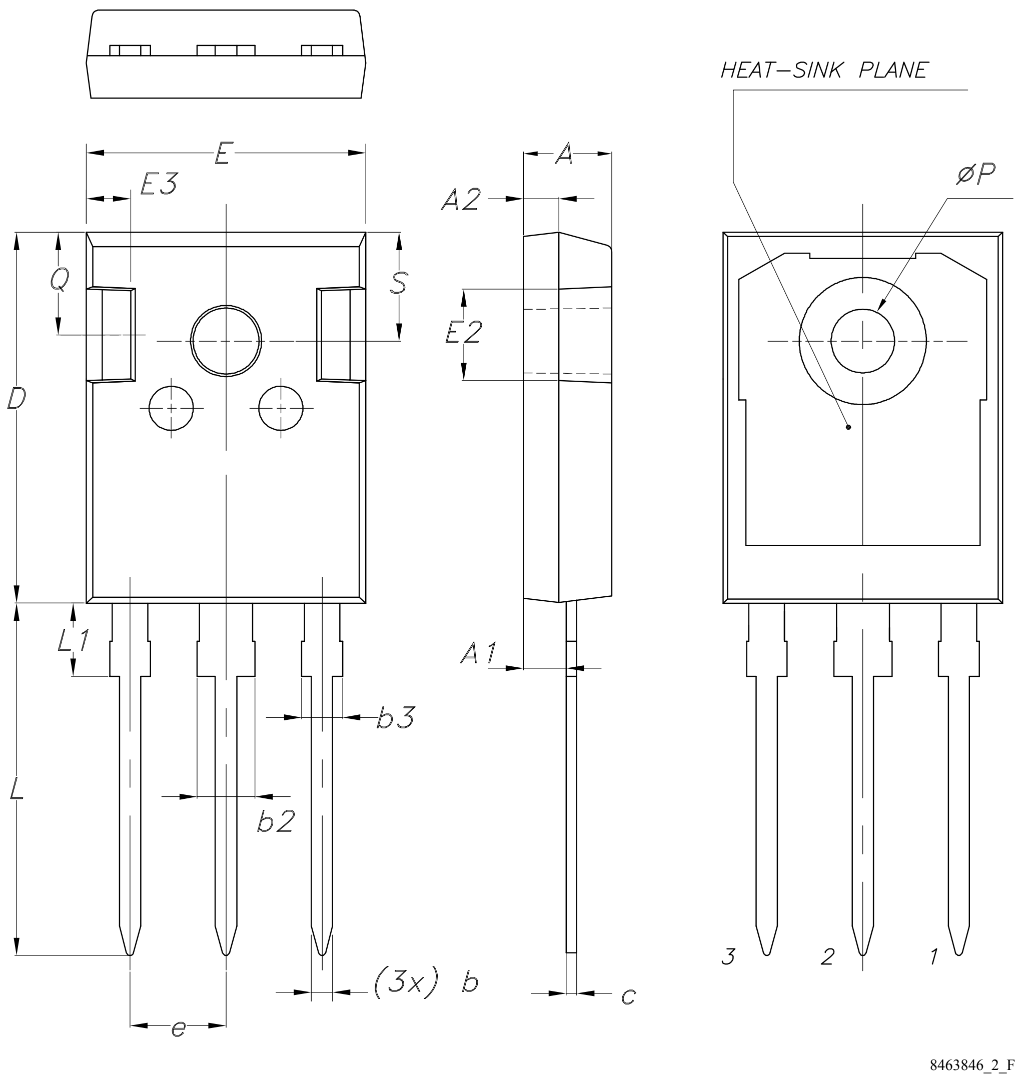


Table 7. TO-247 long leads package mechanical data

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
01-Oct-2019	1	First release.
23-Oct-2019	2	Modified Table 3. Static characteristics.

Contents