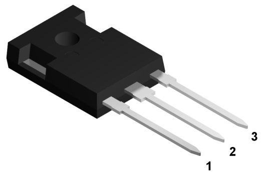
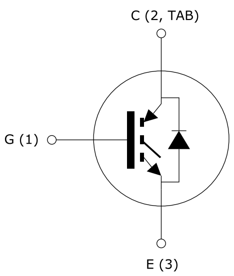
Trench gate field-stop 650 V, 40 A high speed HB series IGBT



TO-247 long leads



Features

- Maximum junction temperature: T_J = 175 °C
- High speed switching series
- Minimized tail current
- Low saturation voltage: $V_{CE(sat)}$ = 1.6 V (typ.) @ I_C = 40 A
- Tight parameter distribution
- Safe paralleling
- Positive $V_{CE(sat)}$ temperature coefficient
- Low thermal resistance
- Very fast soft recovery antiparallel diode

Applications

- Photovoltaic inverters
- High frequency converters

Description

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

Product status link
STGWA40H65DFB

Product summary	
Order code	STGWA40H65DFB
Marking	G40H65DFB
Package	TO-247 long leads
Packing	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	160	A
V_{GE}	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage	±30	
I_F	Continuous forward current at T_C = 25 °C	80	A
	Continuous forward current at T_C = 100 °C	40	
I_{FP} (1)	Pulsed forward current	160	A
P_{TOT}	Total power dissipation at T_C = 25 °C	283	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	0.53	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.14	
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	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 40 A		1.6	2	V
		V_{GE} = 15 V, I_C = 40 A, T_J = 125 °C		1.7		
		V_{GE} = 15 V, I_C = 40 A, T_J = 175 °C		1.8		
V_F	Forward on-voltage	I_F = 40 A		1.7	2.45	V
		I_F = 40 A, T_J = 125 °C		1.4		
		I_F = 40 A, T_J = 175 °C		1.3		
$V_{GE(th)}$	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	-	5412	-	pF
C_{oes}	Output capacitance		-	198	-	
C_{res}	Reverse transfer capacitance		-	107	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 40 A, V_{GE} = 0 to 15 V (see Figure 28. Gate charge test circuit)	-	210	-	nC
Q_{ge}	Gate-emitter charge		-	39	-	
Q_{gc}	Gate-collector charge		-	82	-	

Table 5. IGBT 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 = 40 A, V_{GE} = 15 V, R_G = 5 Ω (see Figure 27. Test circuit for inductive load switching)		40	-	ns
t_r	Current rise time			13	-	
$(di/dt)_{on}$	Turn-on current slope			2413	-	A/μs
$t_{d(off)}$	Turn-off-delay time			142	-	ns
t_f	Current fall time			27	-	
E_{on} (1)	Turn-on switching energy			498	-	μJ
E_{off} (2)	Turn-off switching energy			363	-	
E_{ts}	Total switching energy			861	-	
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 40 A, V_{GE} = 15 V, R_G = 5 Ω, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)		38	-	ns
t_r	Current rise time			14	-	
$(di/dt)_{on}$	Turn-on current slope			2186	-	A/μs
$t_{d(off)}$	Turn-off-delay time			141	-	ns
t_f	Current fall time			61	-	
E_{on} (1)	Turn-on switching energy			1417	-	μJ
E_{off} (2)	Turn-off switching energy			764	-	
E_{ts}	Total switching energy			2181	-	

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 = 40 A, V_R = 400 V, V_{GE} = 15 V di/dt = 100 A/μs (see Figure 27. Test circuit for inductive load switching)	-	62	-	ns
Q_{rr}	Reverse recovery charge		-	99	-	nC
I_{rrm}	Reverse recovery current		-	3.3	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	187	-	A/μs
E_{rr}	Reverse recovery energy		-	68	-	μJ
t_{rr}	Reverse recovery time	I_F = 40 A, V_R = 400 V, V_{GE} = 15 V, T_J = 175 °C di/dt = 100 A/μs (see Figure 27. Test circuit for inductive load switching)	-	310	-	ns
Q_{rr}	Reverse recovery charge		-	1550	-	nC
I_{rrm}	Reverse recovery current		-	10	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	70	-	A/μs
E_{rr}	Reverse recovery energy		-	674	-	μJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

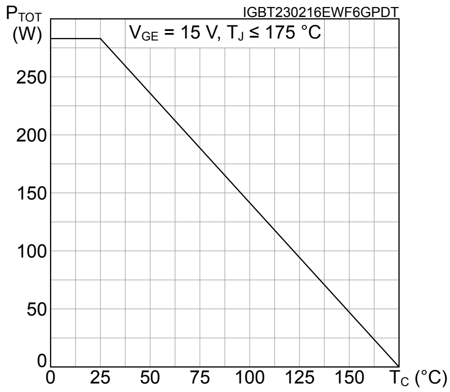


Figure 2. Collector current vs case temperature

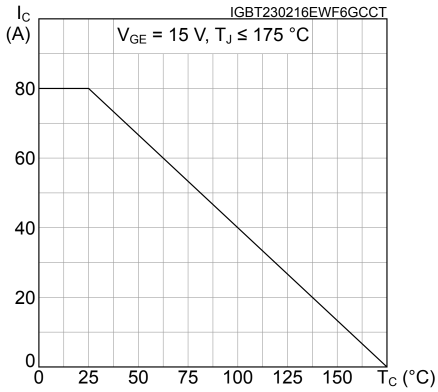


Figure 3. Output characteristics (T_J = 25 °C)

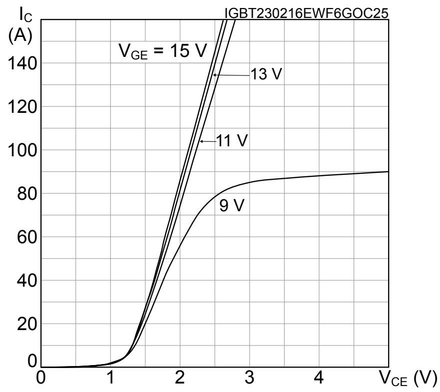


Figure 4. Output characteristics (T_J = 175 °C)

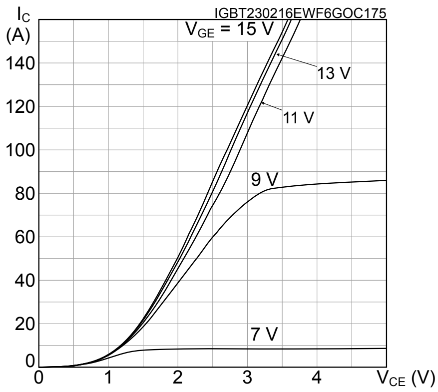


Figure 5. $V_{CE(sat)}$ vs junction temperature

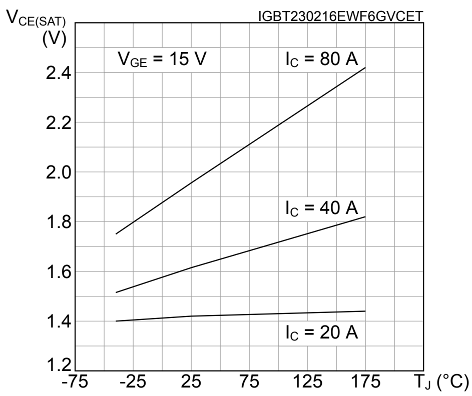


Figure 6. $V_{CE(sat)}$ vs collector current

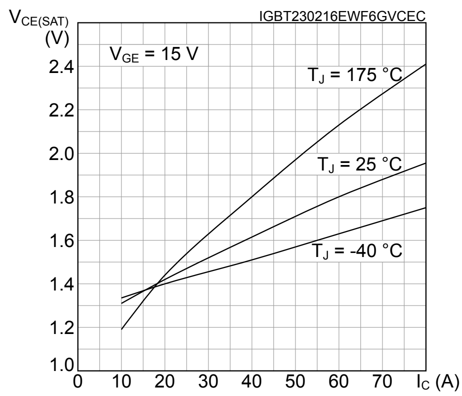


Figure 7. Collector current vs switching frequency

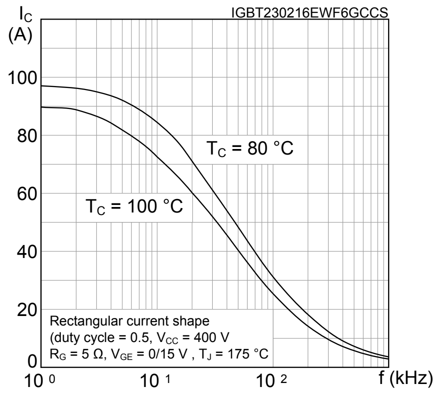


Figure 8. Forward bias safe operating area

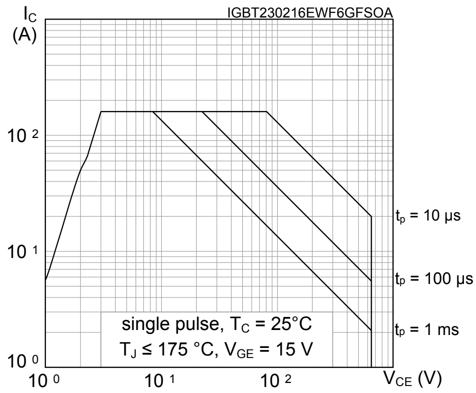


Figure 9. Transfer characteristics

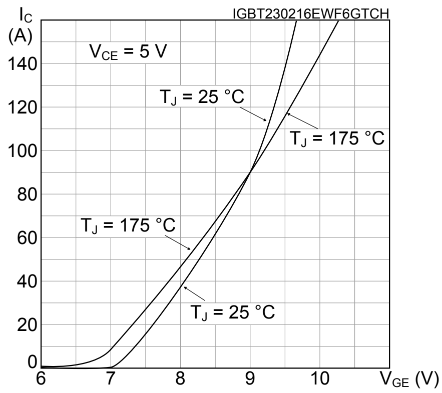


Figure 10. Diode V_F vs forward current

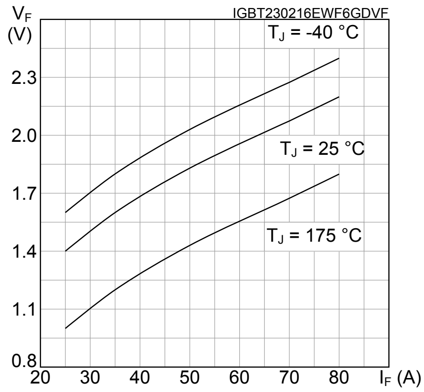


Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

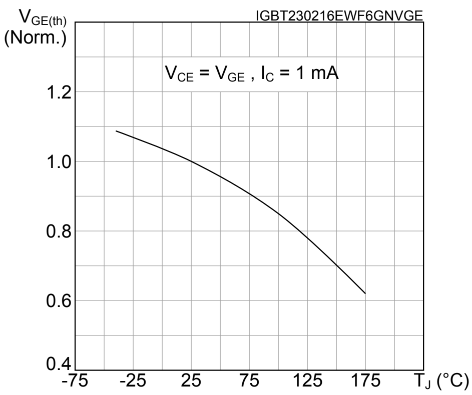


Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature

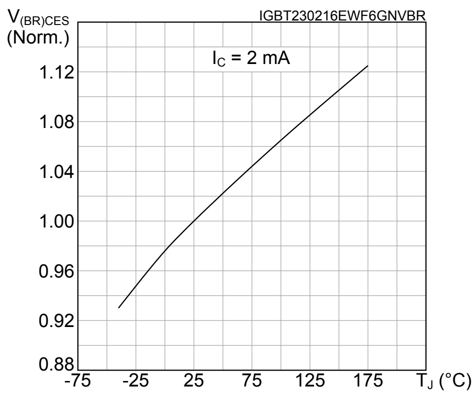


Figure 13. Capacitance variations

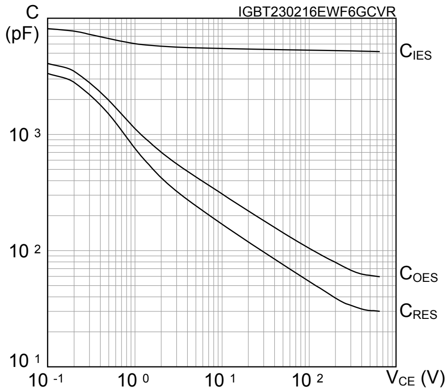


Figure 14. Gate charge vs gate-emitter voltage

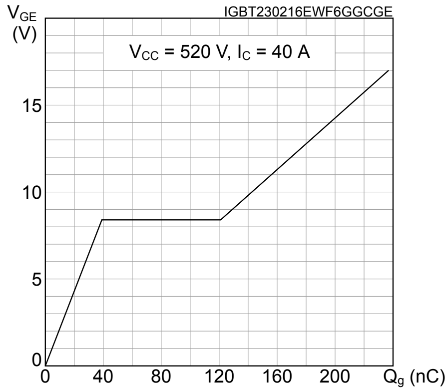


Figure 15. Switching energy vs collector current

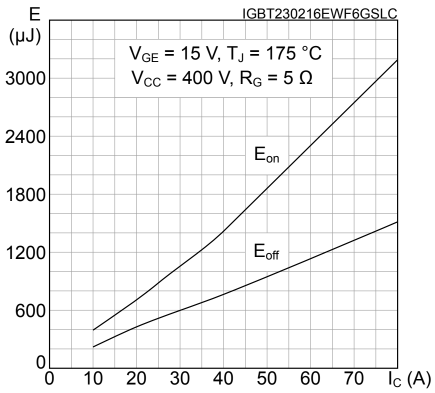


Figure 16. Switching energy vs gate resistance

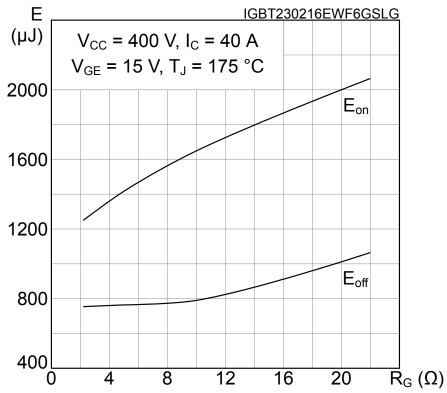


Figure 17. Switching energy vs temperature

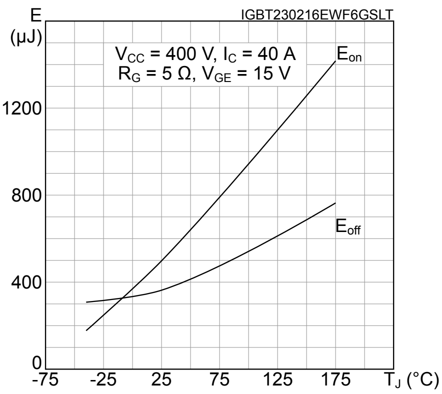


Figure 18. Switching energy vs collector emitter voltage

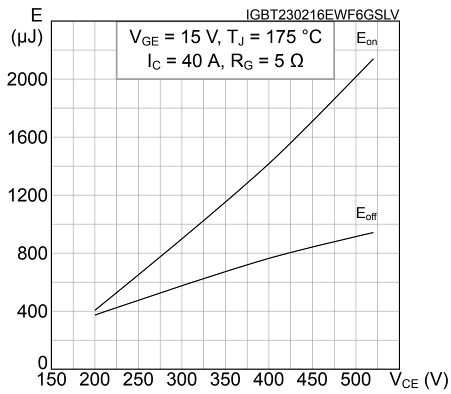


Figure 19. Switching times vs collector current

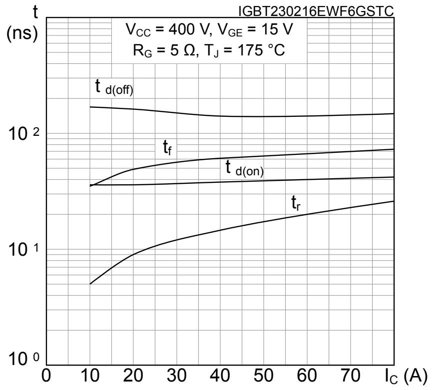


Figure 20. Switching times vs gate resistance

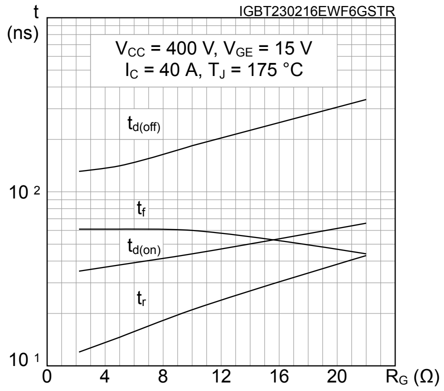


Figure 21. Reverse recovery current vs diode current slope

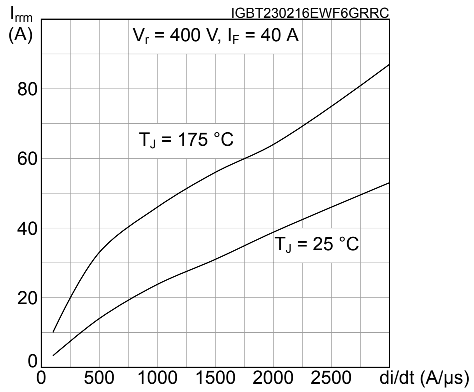


Figure 22. Reverse recovery time vs diode current slope

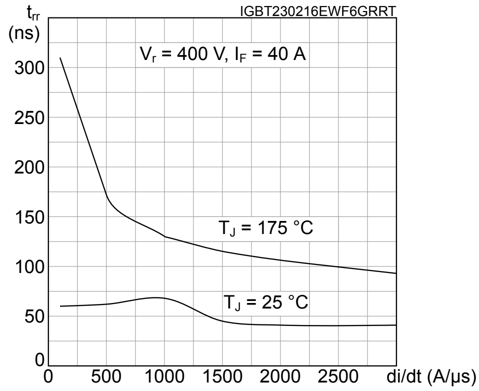


Figure 23. Reverse recovery charge vs diode current slope

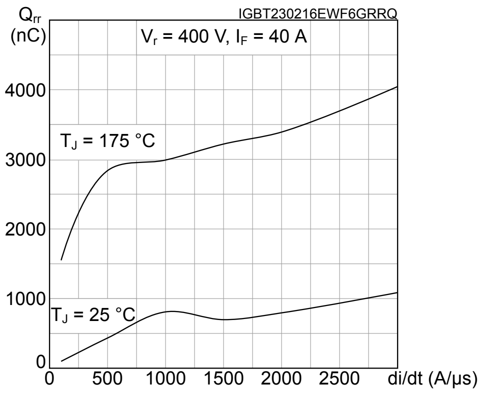
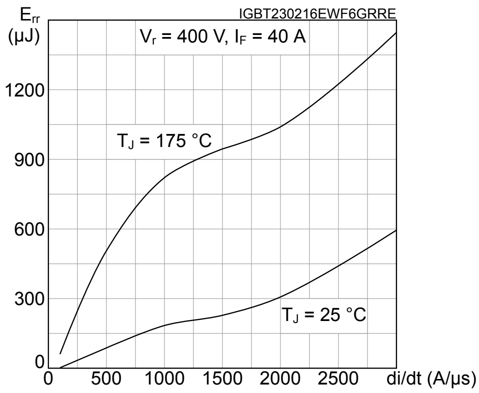


Figure 24. Reverse recovery energy vs diode current slope



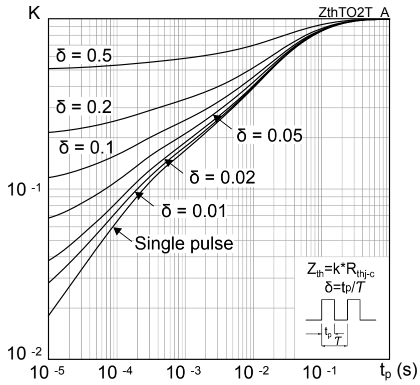


Figure 25. Thermal impedance for IGBT

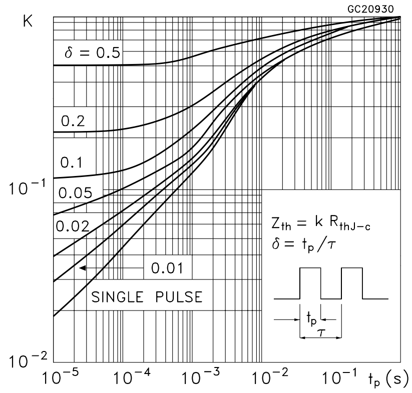


Figure 26. Thermal impedance for diode

3 Test circuits

Figure 27. Test circuit for inductive load switching

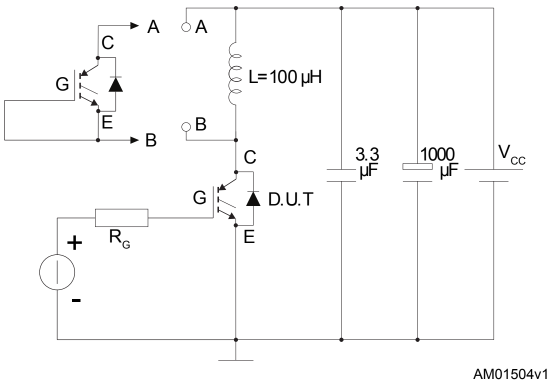


Figure 28. Gate charge test circuit

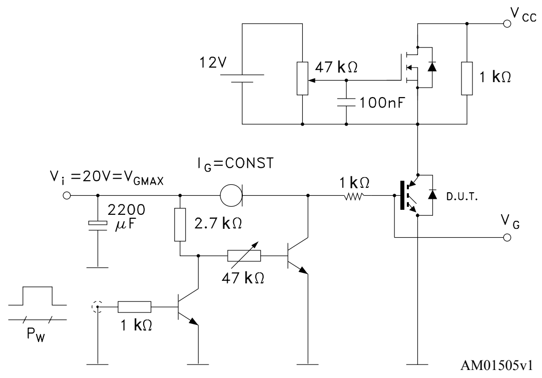


Figure 29. Switching waveform

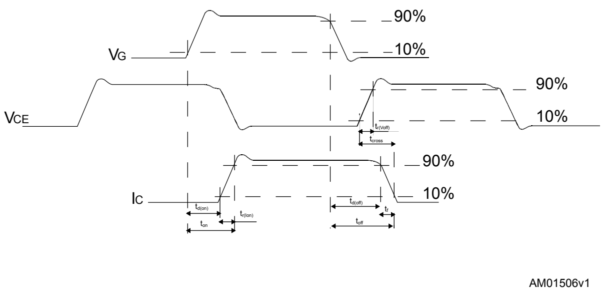
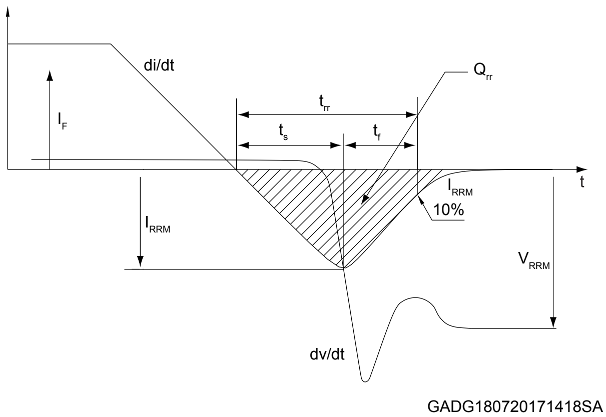


Figure 30. Diode reverse recovery waveform



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

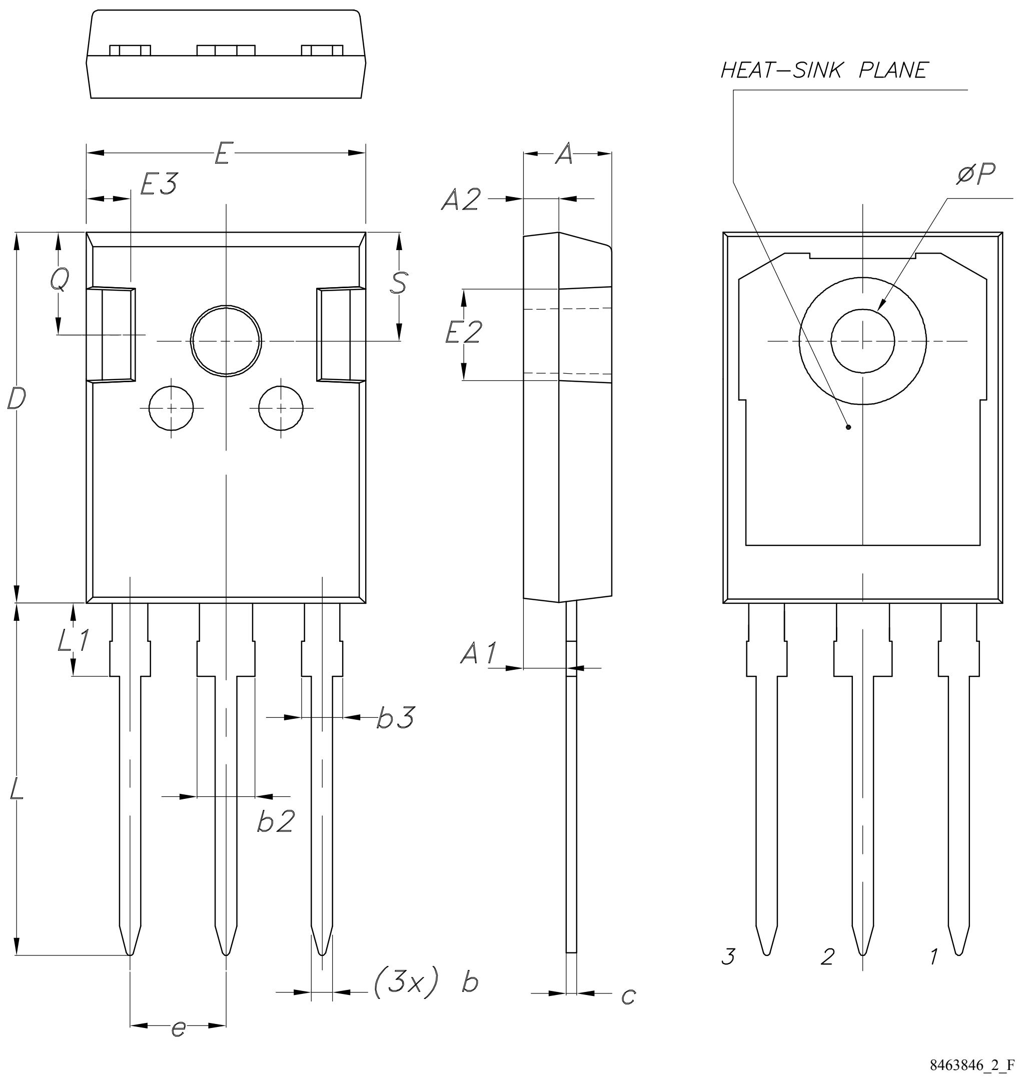


Table 7. TO-247 long leads package mechanical data

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	Revision	Changes
06-Jun-2016	1	Initial version. Part number previously included in datasheet DocID024363.
24-Jun-2019	2	Modified Table 1. Absolute maximum ratings. Minor text changes.

Contents