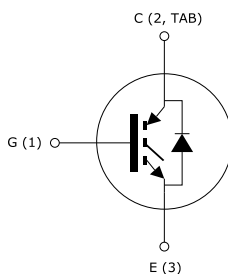


## Trench gate field-stop 650 V, 40 A high speed HB series IGBT



TO-247 long leads



## Features

- Maximum junction temperature:  $T_J = 175\text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- Low saturation voltage:  $V_{CE(sat)} = 1.6\text{ V (typ.) @ } I_C = 40\text{ A}$
- 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	$\pm 20$	V
	Transient gate-emitter voltage	$\pm 30$	
$I_F$	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

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

**Table 3. Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$		1.6	2	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 125\text{ °C}$		1.7		
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175\text{ °C}$		1.8		
$V_F$	Forward on-voltage	$I_F = 40\text{ A}$		1.7	2.45	V
		$I_F = 40\text{ A}, T_J = 125\text{ °C}$		1.4		
		$I_F = 40\text{ A}, T_J = 175\text{ °C}$		1.3		
$V_{GE(th)}$	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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	5412	-	pF
$C_{oes}$	Output capacitance		-	198	-	
$C_{res}$	Reverse transfer capacitance		-	107	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 40\text{ A},$	-	210	-	nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 0\text{ to }15\text{ V}$	-	39	-	
$Q_{gc}$	Gate-collector charge	(see Figure 28. Gate charge test circuit)	-	82	-	

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\ \Omega$ (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/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time				142	-	ns
$t_f$	Current fall time				27	-	
$E_{on}^{(1)}$	Turn-on switching energy				498	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy				363	-	
$E_{ts}$	Total switching energy			861	-		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$ (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/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time				141	-	ns
$t_f$	Current fall time				61	-	
$E_{on}^{(1)}$	Turn-on switching energy				1417	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy				764	-	
$E_{ts}$	Total switching energy			2181	-		

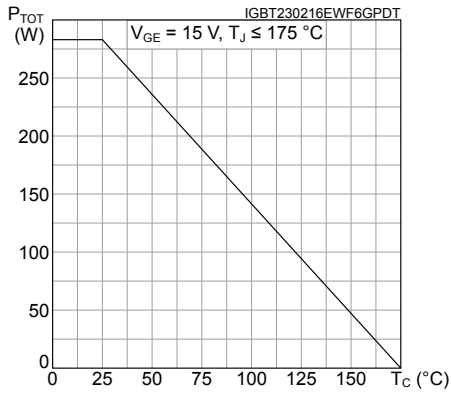
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

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

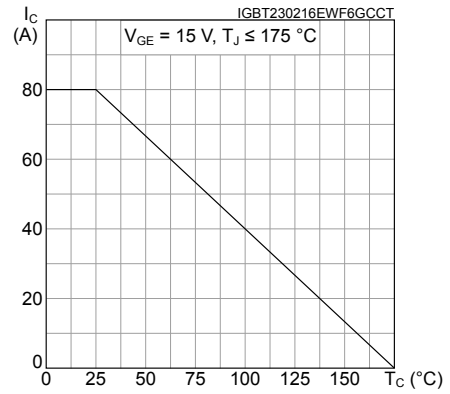
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 27. Test circuit for inductive load switching)	-	62	-	ns	
$Q_{rr}$	Reverse recovery charge			-	99	-	nC
$I_{rrm}$	Reverse recovery current			-	3.3	-	A
$dI_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$			-	187	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy			-	68	-	$\mu$ J
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ di/ $dt = 100\text{ A}/\mu\text{s}$ (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/ $\mu$ s
$E_{rr}$	Reverse recovery energy			-	674	-	$\mu$ J

## 2.1 Electrical characteristics (curves)

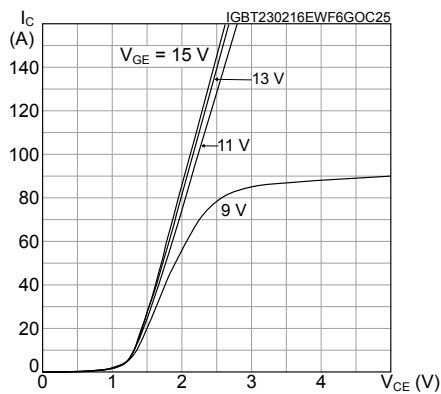
**Figure 1. Power dissipation vs case temperature**



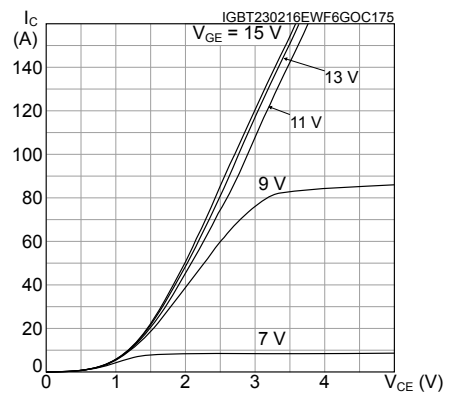
**Figure 2. Collector current vs case temperature**



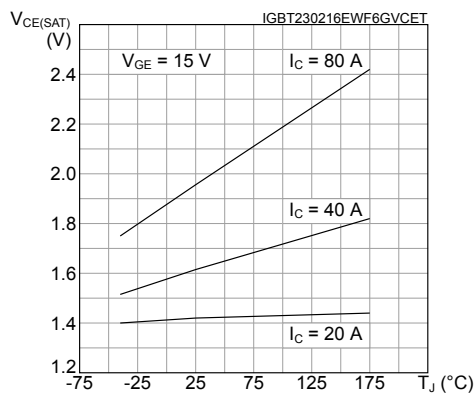
**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**



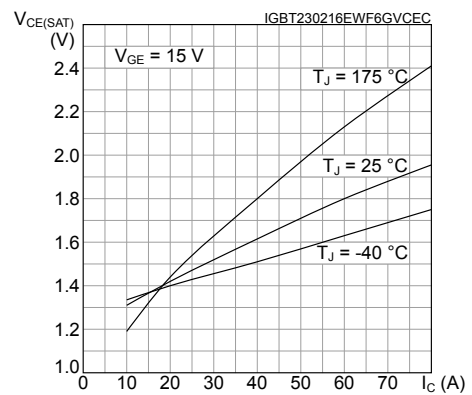
**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**



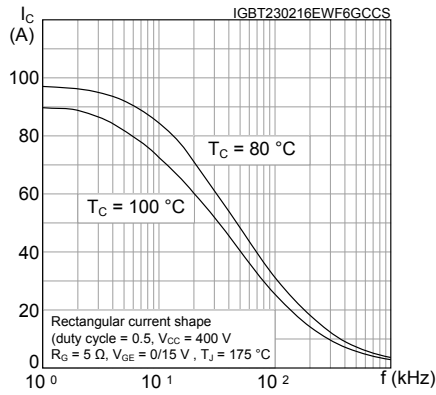
**Figure 5. V<sub>CE(sat)</sub> vs junction temperature**



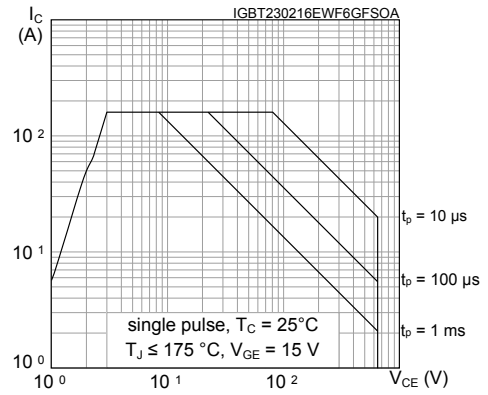
**Figure 6. V<sub>CE(sat)</sub> vs collector current**



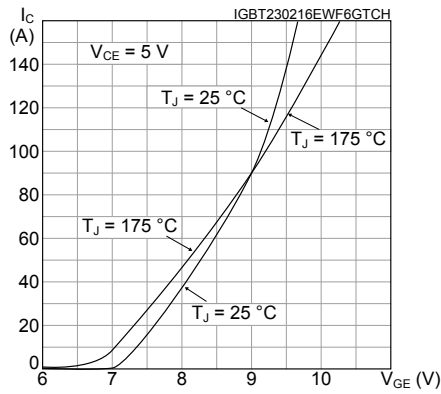
**Figure 7. Collector current vs switching frequency**



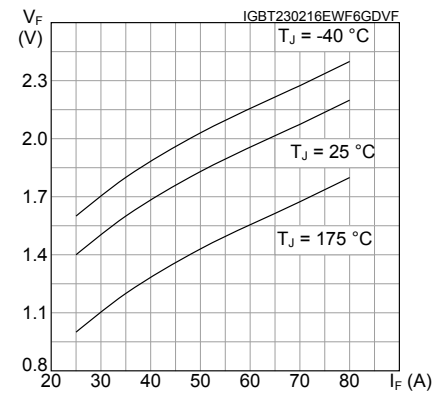
**Figure 8. Forward bias safe operating area**



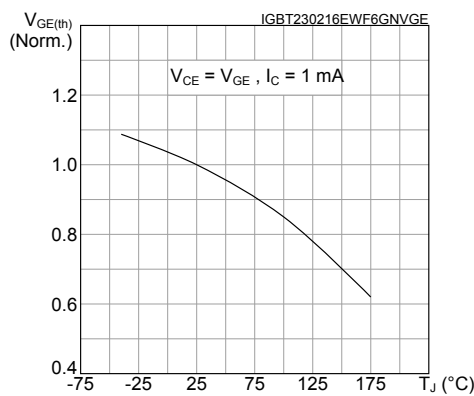
**Figure 9. Transfer characteristics**



**Figure 10. Diode Vf vs forward current**



**Figure 11. Normalized VGE(th) vs junction temperature**



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

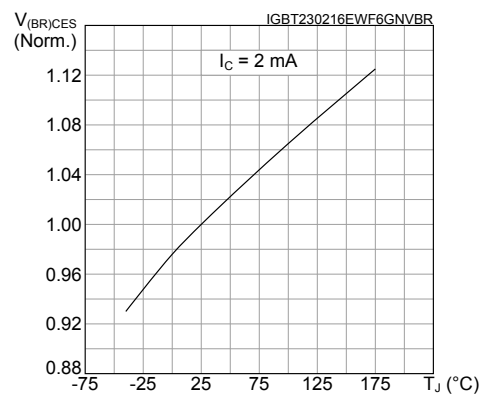


Figure 13. Capacitance variations

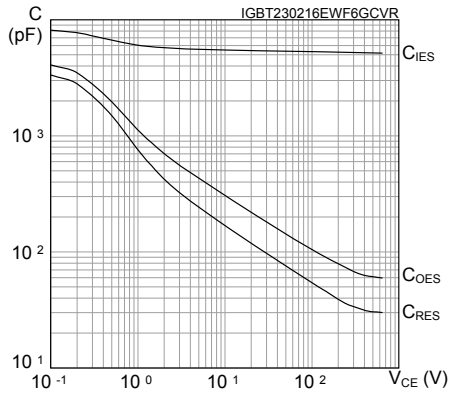


Figure 14. Gate charge vs gate-emitter voltage

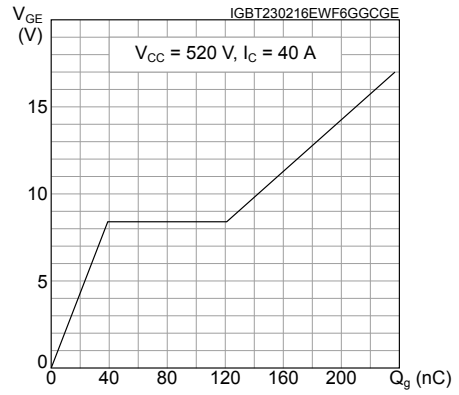


Figure 15. Switching energy vs collector current

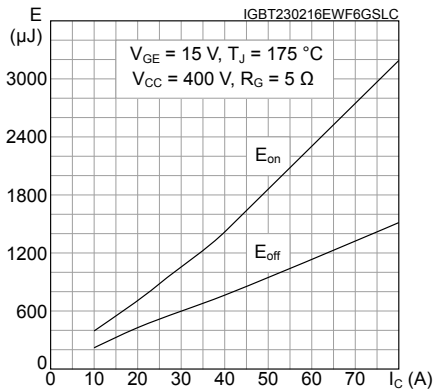


Figure 16. Switching energy vs gate resistance

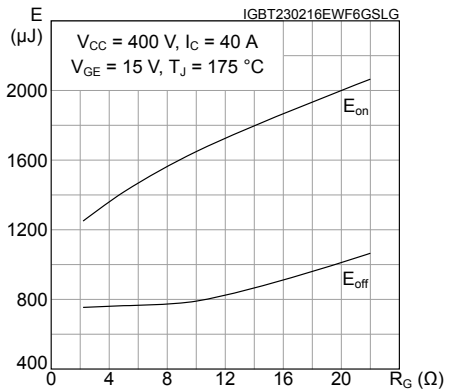


Figure 17. Switching energy vs temperature

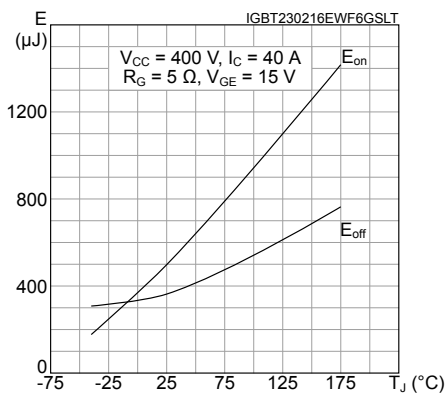
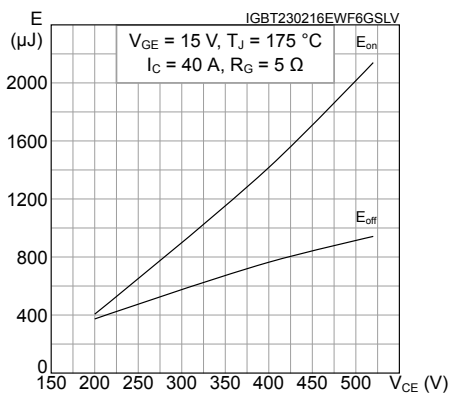
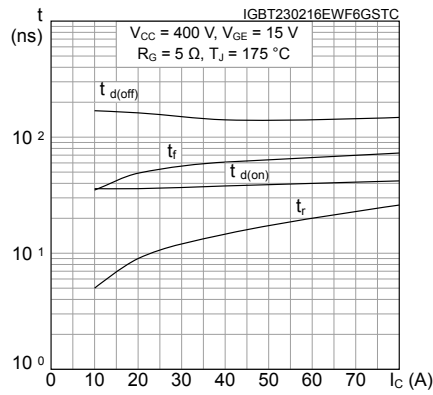


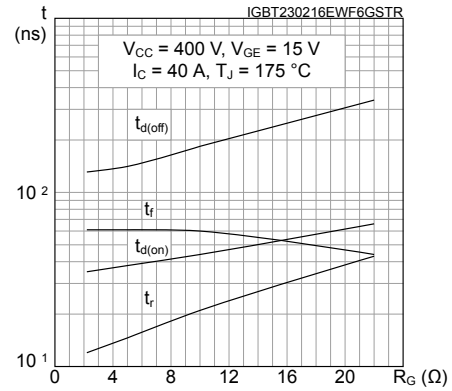
Figure 18. Switching energy vs collector emitter voltage



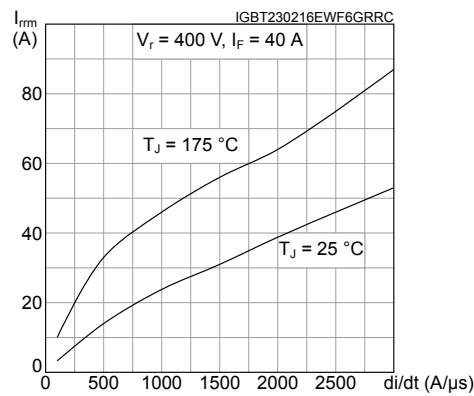
**Figure 19. Switching times vs collector current**



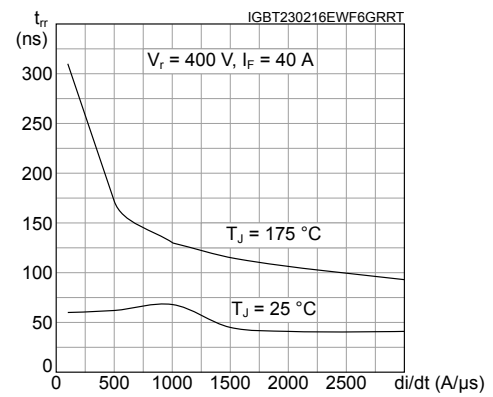
**Figure 20. Switching times vs gate resistance**



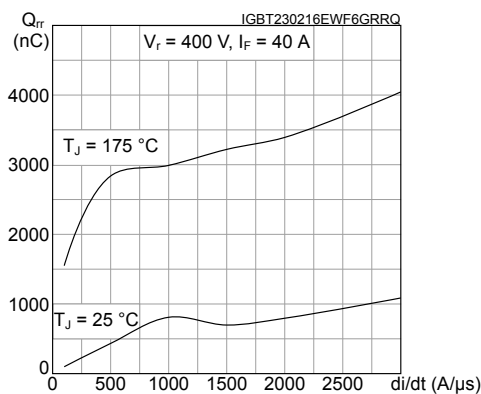
**Figure 21. Reverse recovery current vs diode current slope**



**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**

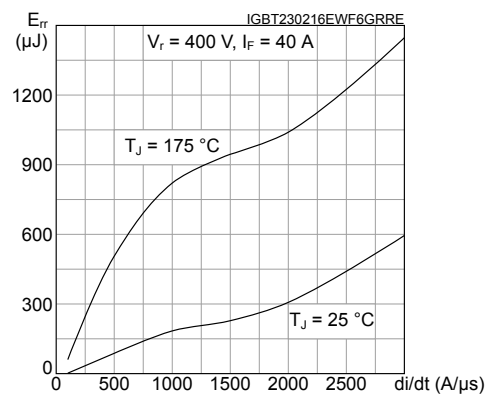




Figure 25. Thermal impedance for IGBT

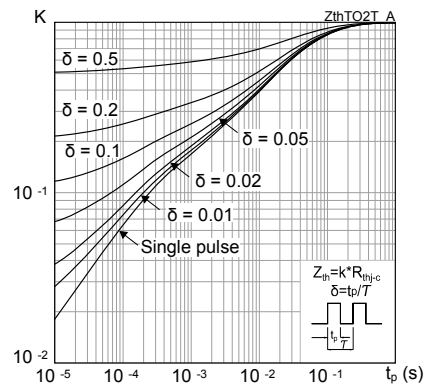
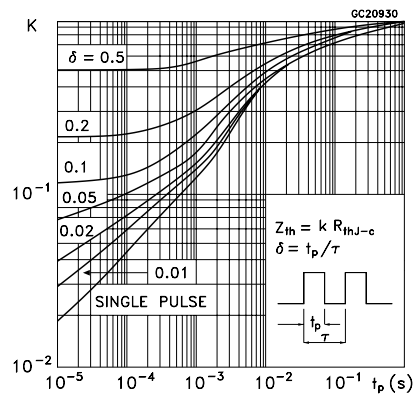
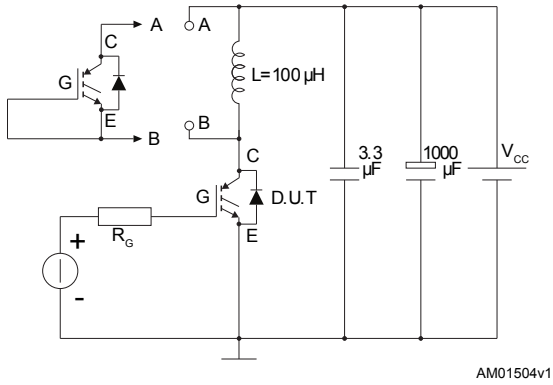


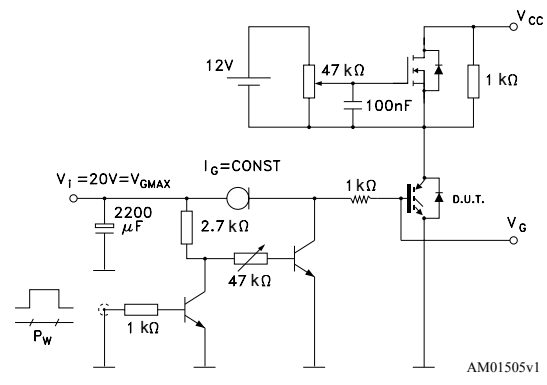
Figure 26. Thermal impedance for diode



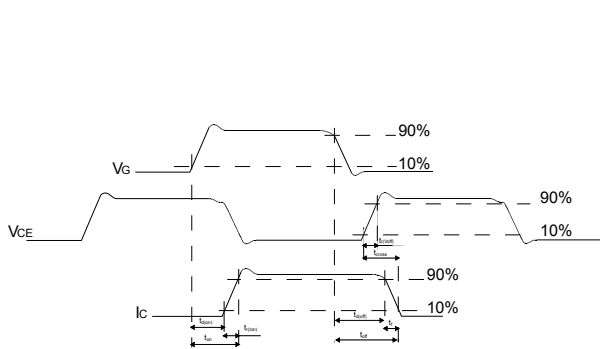
### 3 Test circuits

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


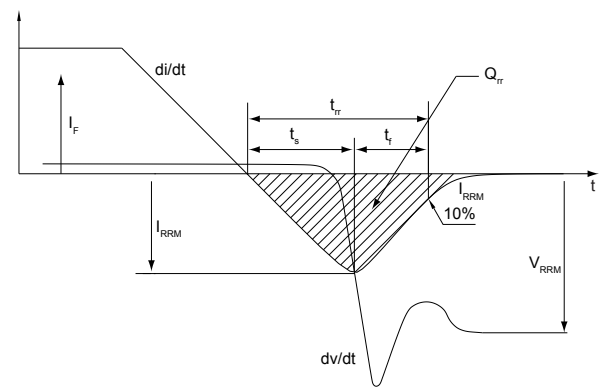
AM01504v1

**Figure 28. Gate charge test circuit**


AM01505v1

**Figure 29. Switching waveform**


AM01506v1

**Figure 30. Diode reverse recovery waveform**


GADG180720171418SA

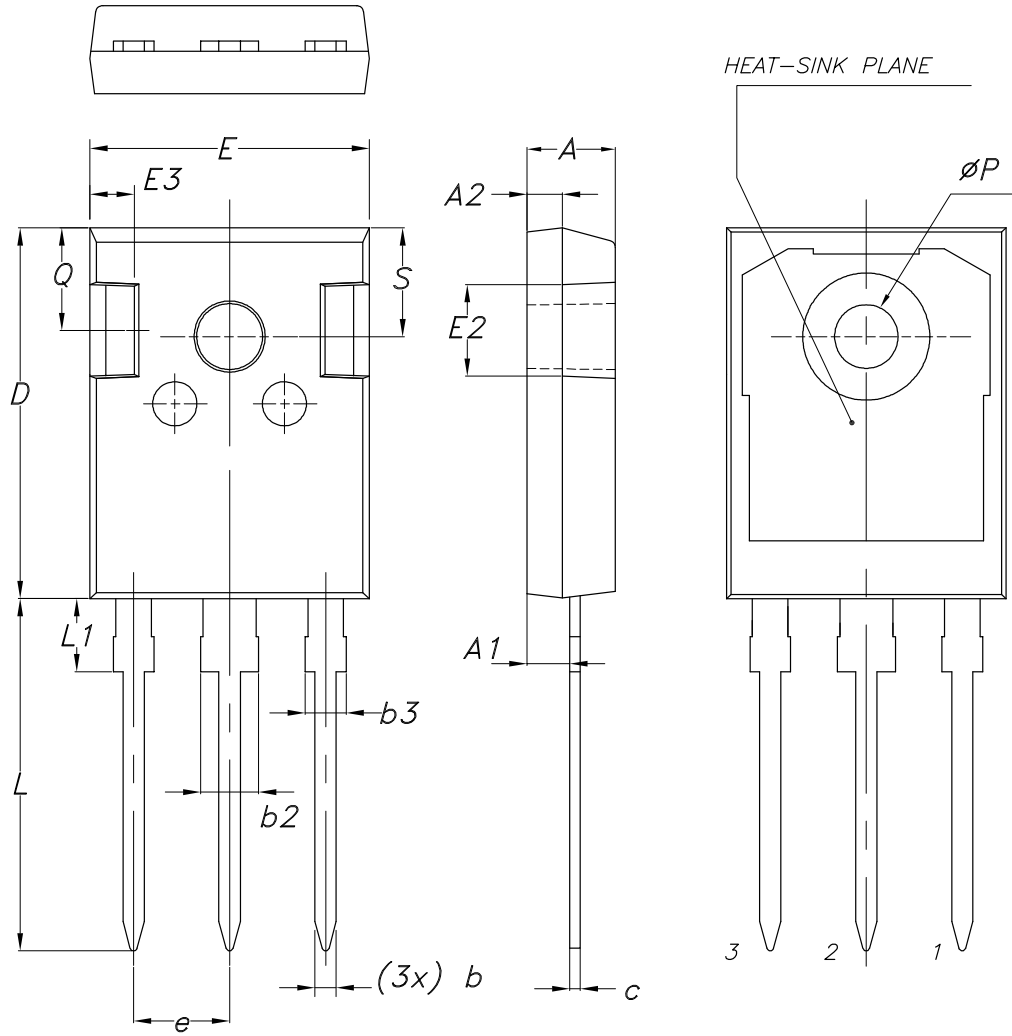
## **4** Package information

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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 TO-247 long leads package information

Figure 31. TO-247 long leads package outline



8463846\_2\_F

**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 <a href="#">Table 1. Absolute maximum ratings</a> . Minor text changes.

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