

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

Datasheet - production data

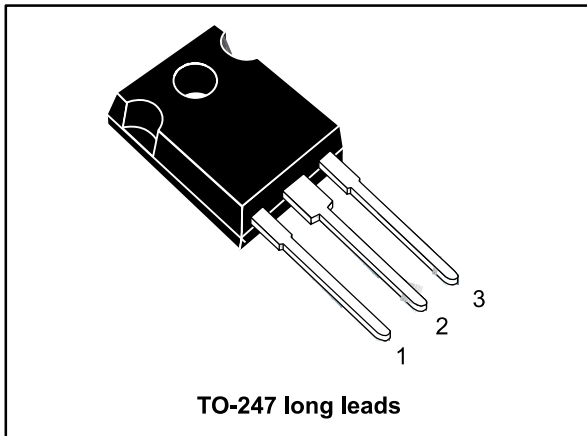
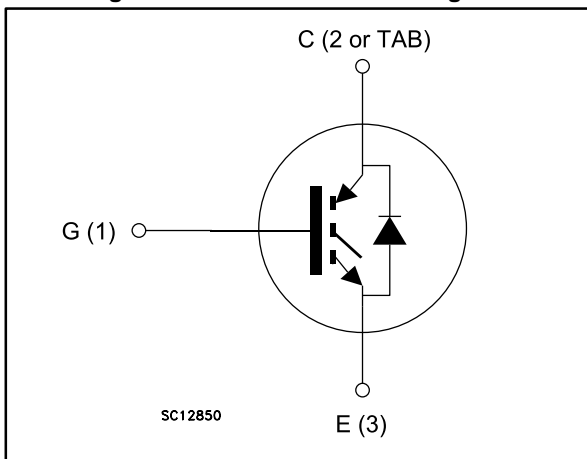


Figure 1: Internal schematic diagram



### 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
- 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.

Table 1: Device summary

Order code	Marking	Package	Packing
STGWA40H65DFB	G40H65DFB	TO-247 long leads	Tube

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	650	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	80	A
	Continuous collector current at $T_C = 100\text{ °C}$	40	
$I_{CP}^{(1)}$	Pulsed collector current	160	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current at $T_C = 25\text{ °C}$	80	A
	Continuous forward current at $T_C = 100\text{ °C}$	40	
$I_{FP}^{(1)}$	Pulsed forward current	160	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	283	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature range	- 55 to 175	

**Notes:**

<sup>(1)</sup>Pulse width limited by maximum junction temperature.

**Table 3: 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 4: 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 5: 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	$V_{CC} = 520\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 29: "Gate charge test circuit"</a> )	-	210	-	nC
$Q_{ge}$	Gate-emitter charge		-	39	-	
$Q_{gc}$	Gate-collector charge		-	82	-	

**Table 6: IGBT switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\text{ }\Omega$ (see <a href="#">Figure 28: "Test circuit for inductive load switching"</a> )		40	-	ns
$t_r$	Current rise time			13	-	
$(di/dt)_{on}$	Turn-on current slope			2413	-	A/ $\mu\text{s}$
$t_{d(off)}$	Turn-off-delay time			142	-	ns
$t_f$	Current fall time			27	-	

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy			498	-	$\mu\text{J}$
$E_{off}^{(2)}$	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 <a href="#">Figure 28: "Test circuit for inductive load switching"</a> )		38	-	ns
$t_r$	Current rise time			14	-	
$(di/dt)_{on}$	Turn-on current slope			2186	-	$\text{A}/\mu\text{s}$
$t_{d(off)}$	Turn-off-delay time			141	-	ns
$t_f$	Current fall time			61	-	
$E_{on}^{(1)}$	Turn-on switching energy			1417	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching energy			764	-	
$E_{ts}$	Total switching energy			2181	-	

**Notes:**

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

**Table 7: Diode switching characteristics (inductive load)**

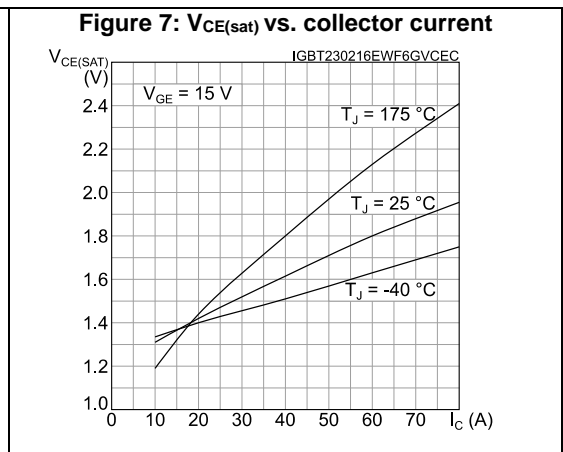
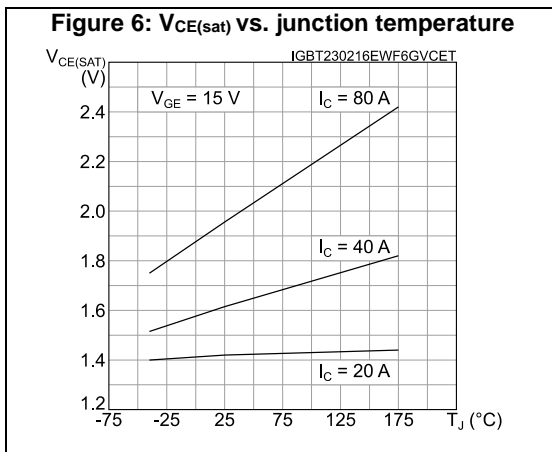
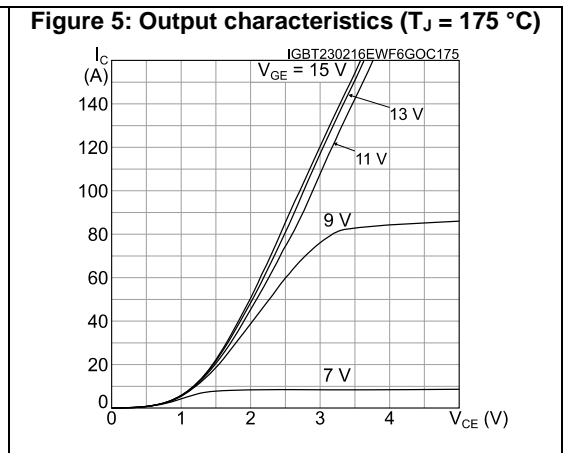
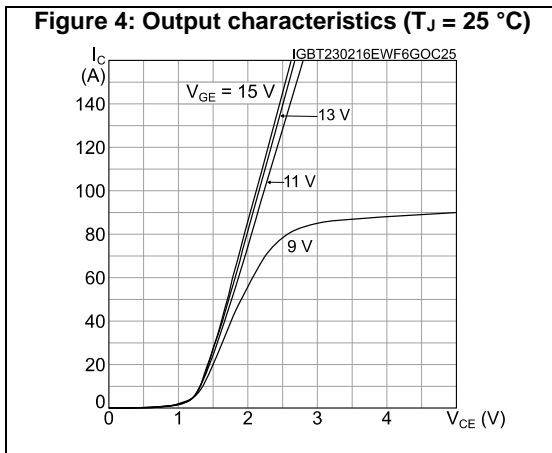
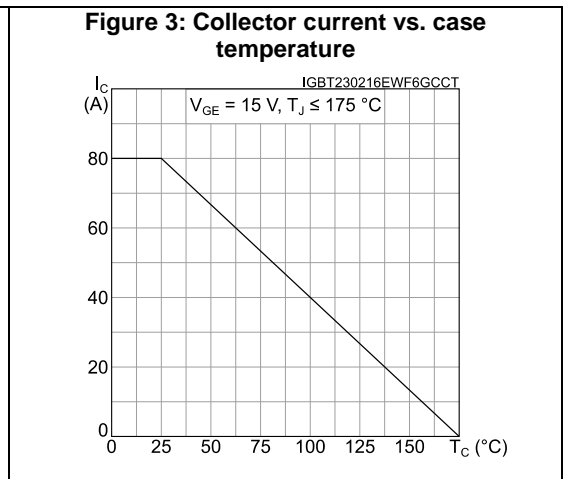
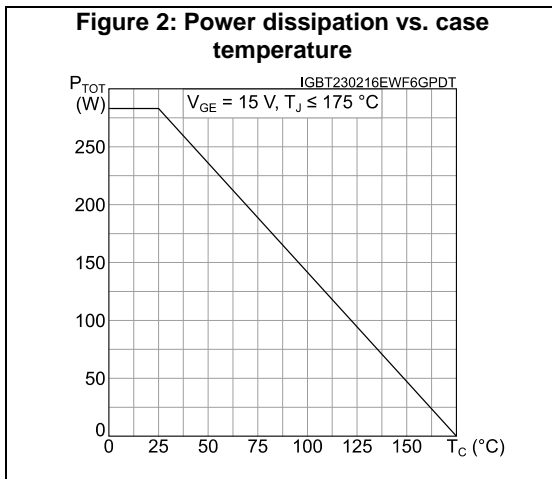
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 28: "Test circuit for inductive load switching"</a> )	-	62	-	ns
$Q_{rr}$	Reverse recovery charge		-	99	-	nC
$I_{rrm}$	Reverse recovery current		-	3.3	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	187	-	$\text{A}/\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	68	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	310	-	ns

Electrical characteristics

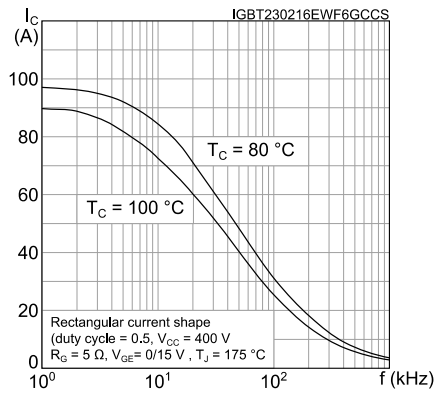
STGWA40H65DFB

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$Q_{rr}$	Reverse recovery charge	(see <i>Figure 28: "Test circuit for inductive load switching"</i> )	-	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

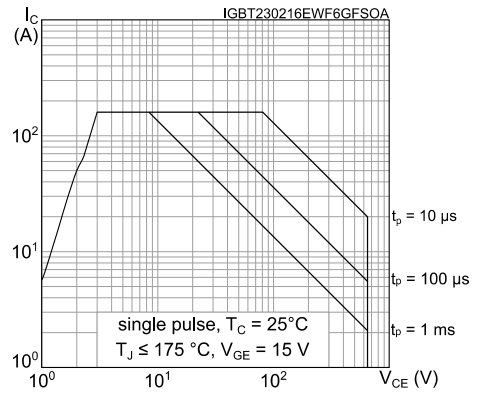
2.1 Electrical characteristics (curves)



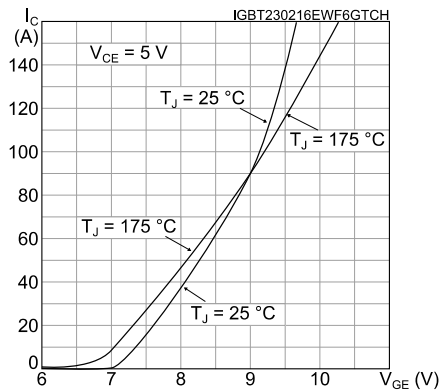
**Figure 8: Collector current vs. switching frequency**



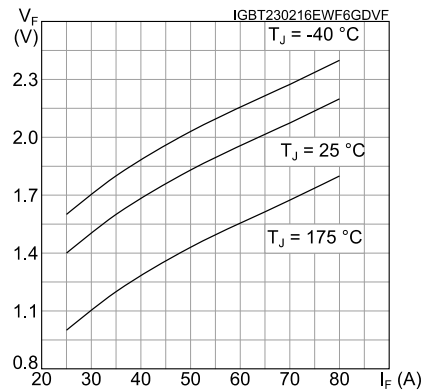
**Figure 9: Forward bias safe operating area**



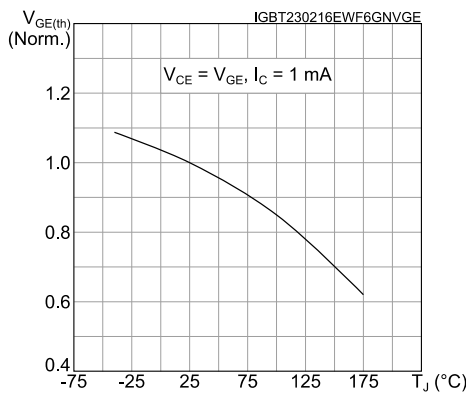
**Figure 10: Transfer characteristics**



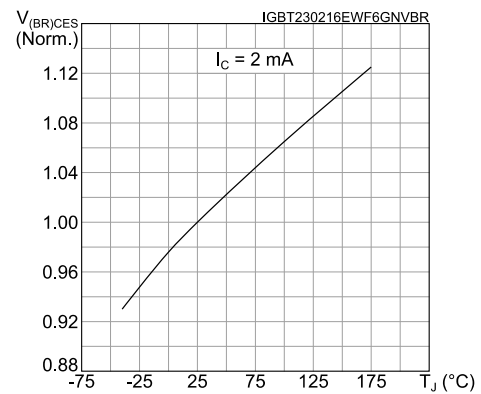
**Figure 11: Diode Vf vs. forward current**



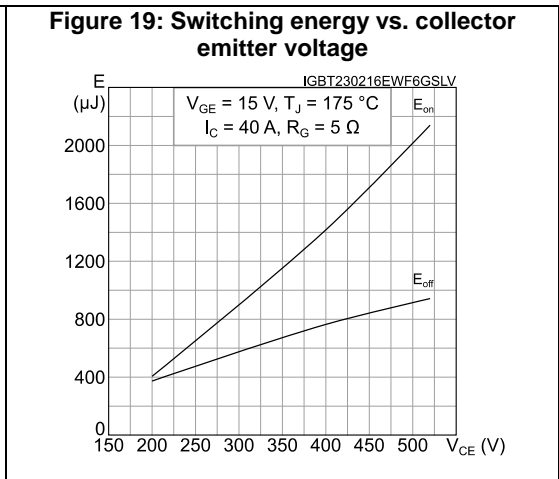
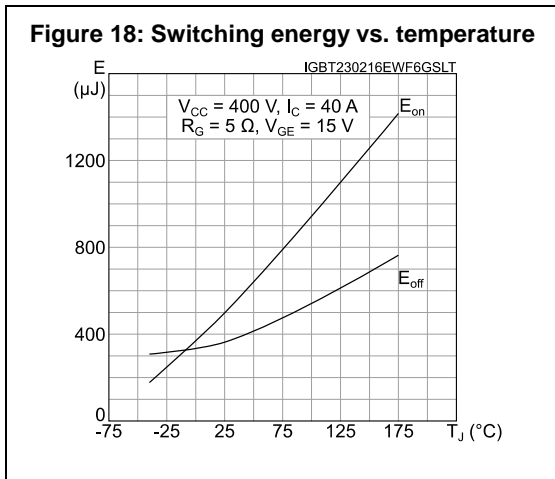
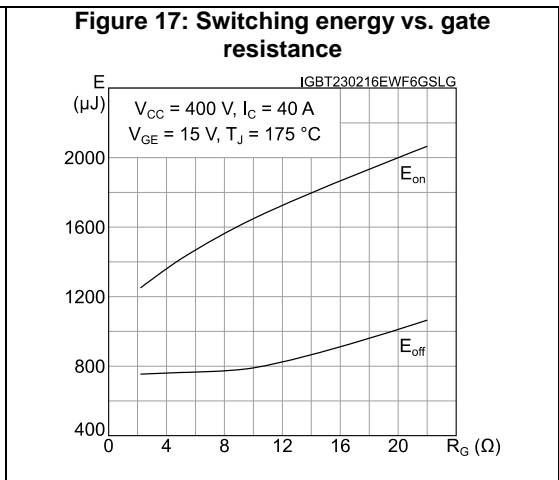
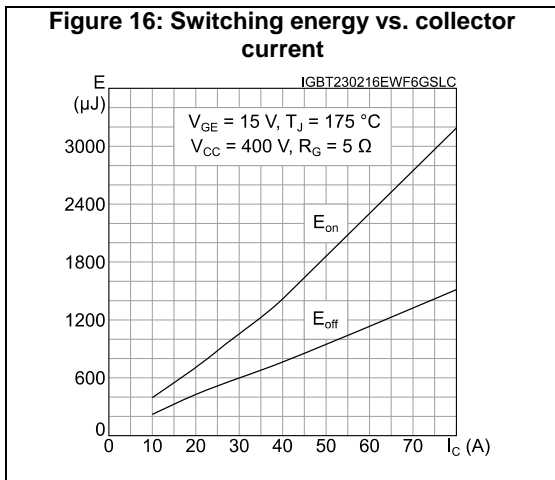
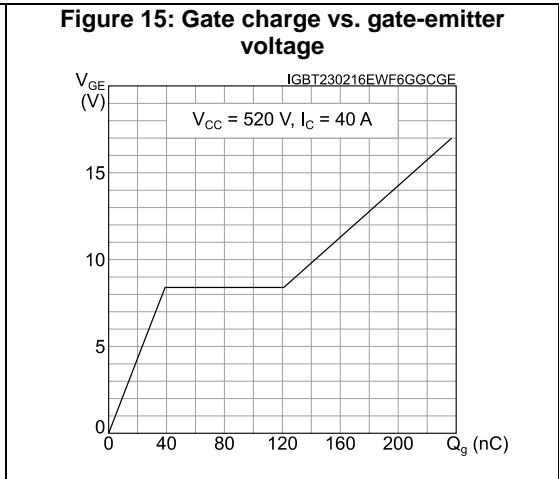
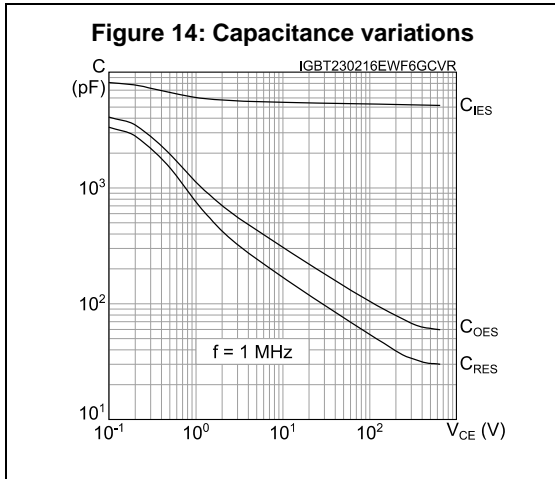
**Figure 12: Normalized VGE(th) vs. junction temperature**



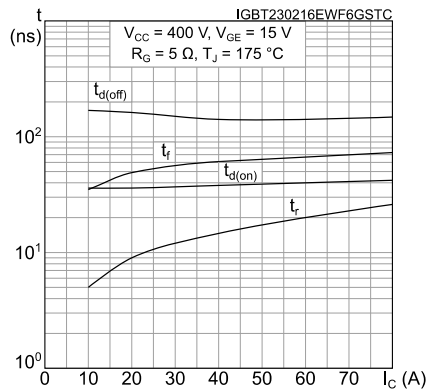
**Figure 13: Normalized V(BR)CES vs. junction temperature**



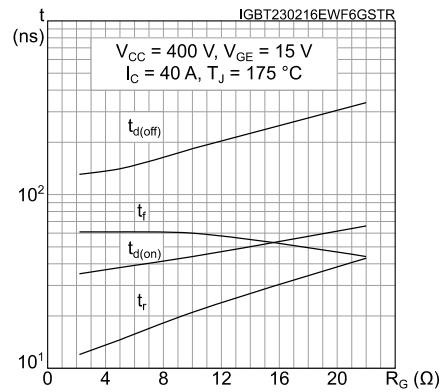




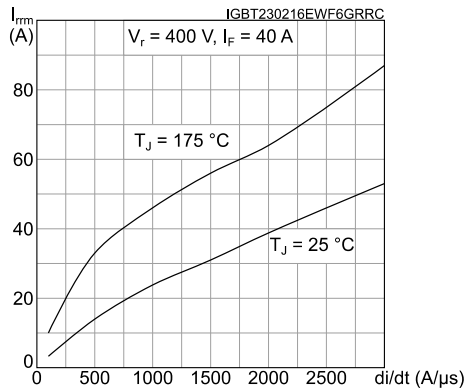
**Figure 20: Switching times vs. collector current**



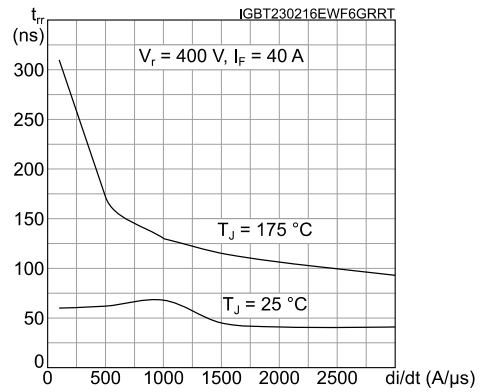
**Figure 21: Switching times vs. gate resistance**



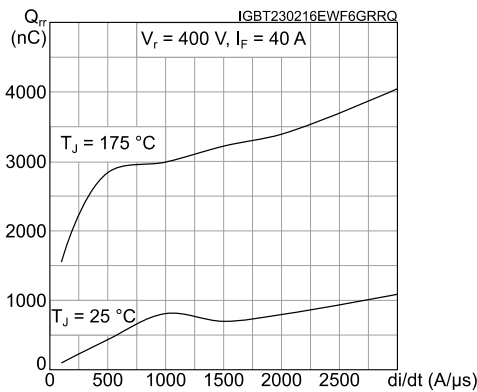
**Figure 22: Reverse recovery current vs. diode current slope**



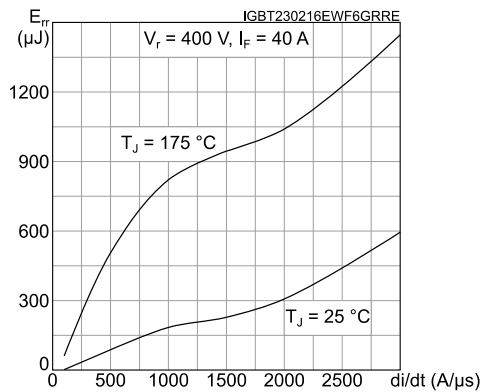
**Figure 23: Reverse recovery time vs. diode current slope**

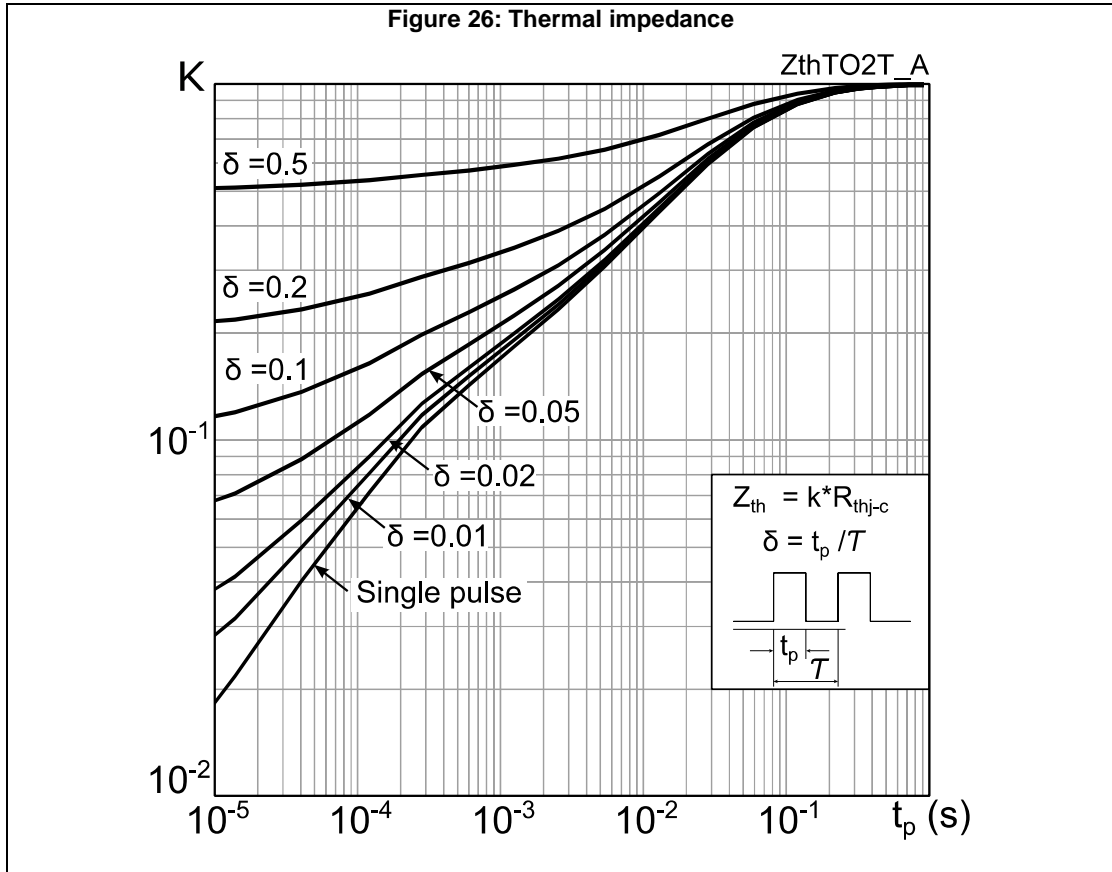


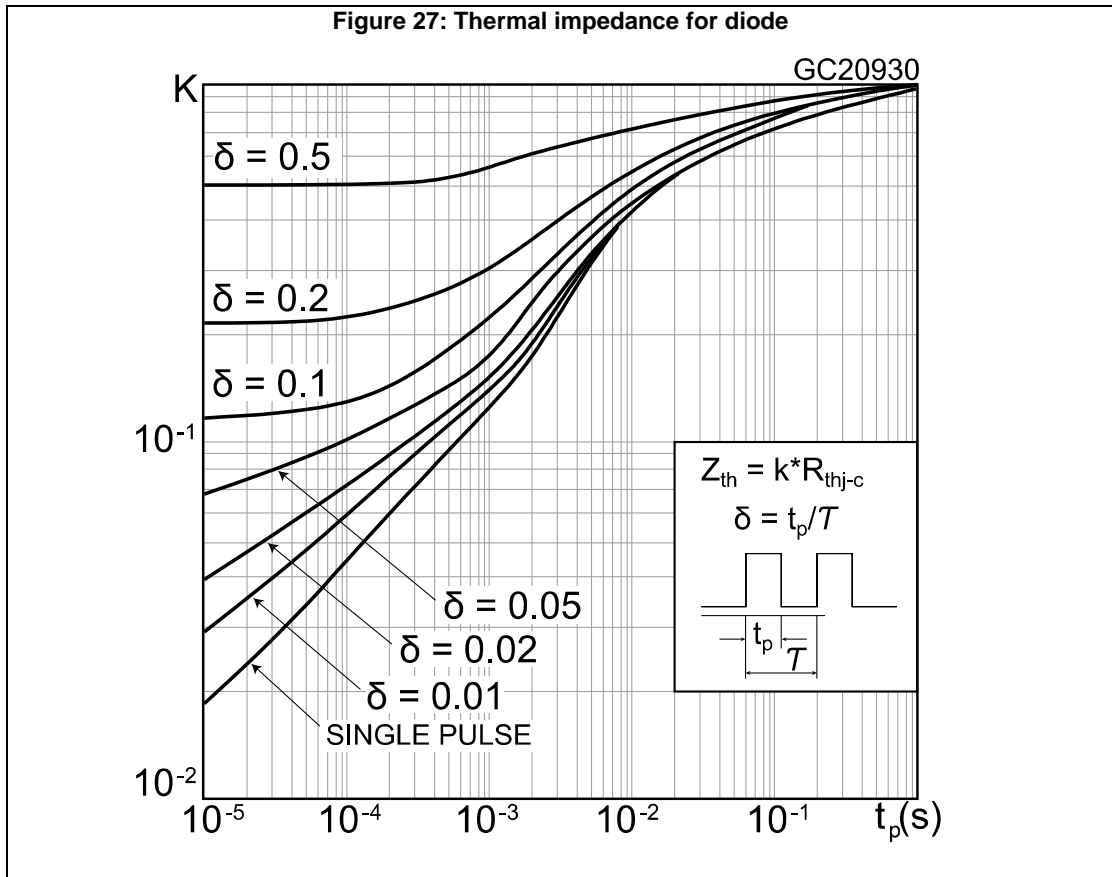
**Figure 24: Reverse recovery charge vs. diode current slope**



**Figure 25: Reverse recovery energy vs. diode current slope**

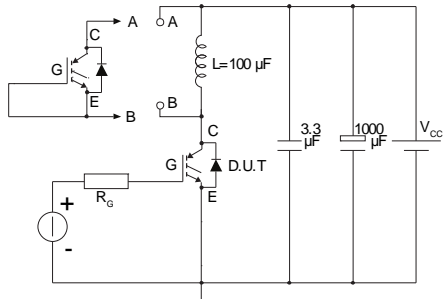






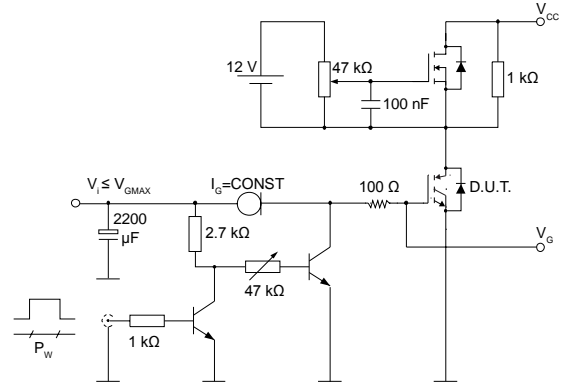
### 3 Test circuits

**Figure 28: Test circuit for inductive load switching**



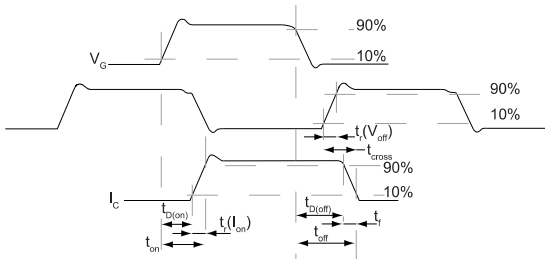
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**Figure 29: Gate charge test circuit**



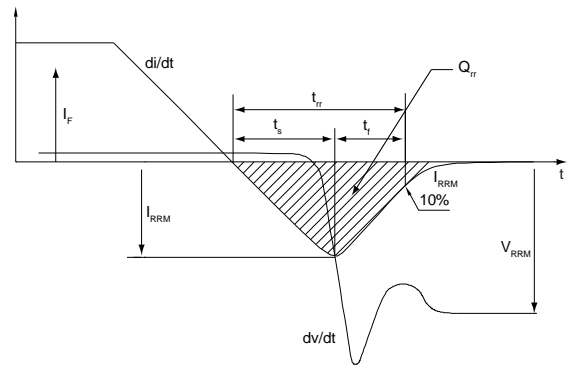
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**Figure 30: Switching waveform**



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**Figure 31: Diode reverse recovery waveform**



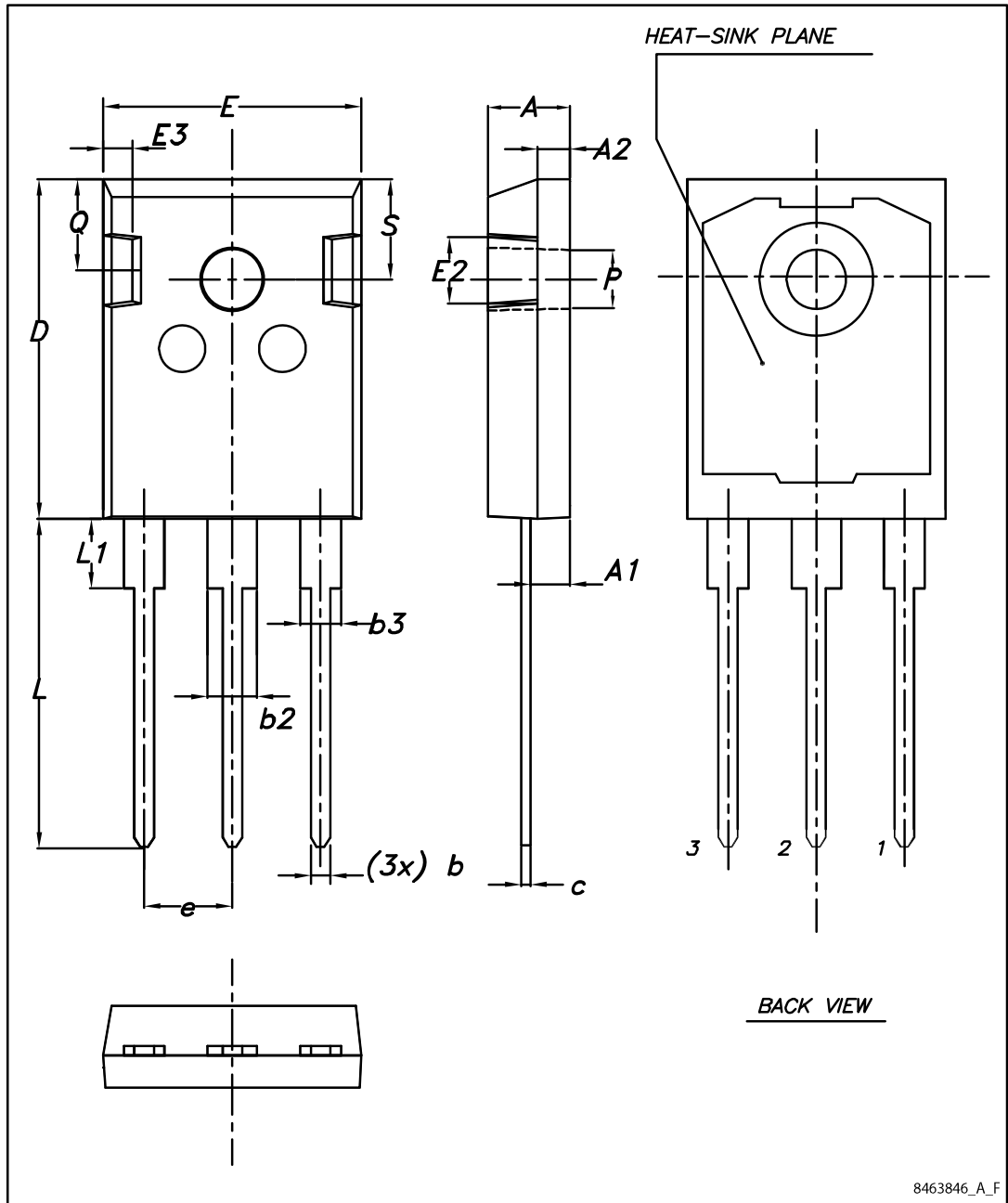
AM01507v1

## 4 Package mechanical data

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 lead package information

Figure 32: TO-247 long lead package outline



8463846\_A\_F

Table 8: TO-247 long lead 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

## 5 Revision history

**Table 9: Document revision history**

Date	Revision	Changes
06-Jun-2016	1	Initial version. Part number previously included in datasheet DocID024363.



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