

## Trench gate field-stop IGBT, HB series 650 V, 40 A high speed in a TO247-4 package

Datasheet - production data

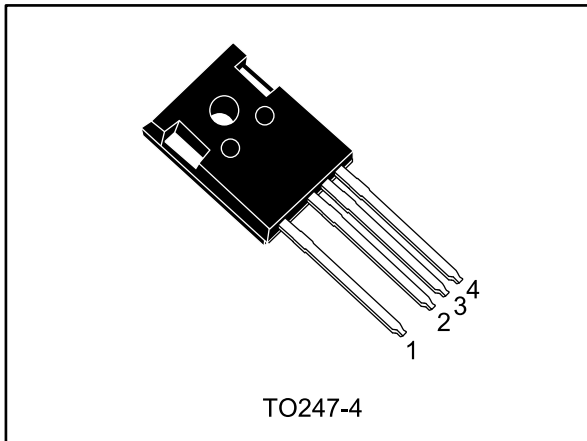
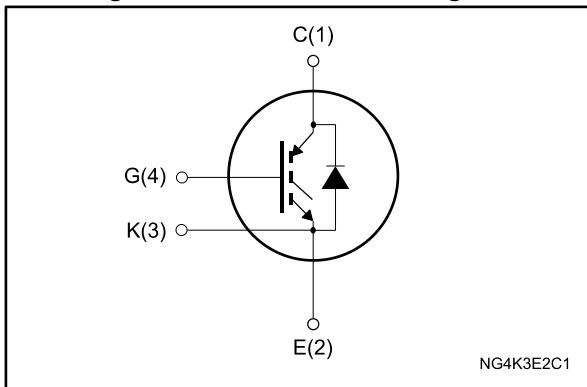


Figure 1: Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ °C}$
- Kelvin pin
- 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. A faster switching event can be achieved by the Kelvin pin, which separates power path from driving signal. 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
STGW40H65DFB-4	G40H65DFB	TO247-4	Tube

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C$	Continuous collector current at $T_C = 25$ °C	80	A
$I_C$	Continuous collector current at $T_C = 100$ °C	40	A
$I_{CP}^{(1)}$	Pulsed collector current	160	A
$V_{GE}$	Gate-emitter voltage	±20	V
$I_F$	Continuous forward current at $T_C = 25$ °C	80	A
$I_F$	Continuous forward current at $T_C = 100$ °C	40	A
$I_{FP}^{(1)}$	Pulsed forward current	160	A
$P_{TOT}$	Total 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	°C

**Notes:**

<sup>(1)</sup>Pulse width is 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	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	50	°C/W

## 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	$V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$			$\pm 250$	$\mu\text{A}$

**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	$V_{CC} = 520\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (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	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\ \Omega$ (see <a href="#">Figure 28: " Test circuit for inductive load switching" )</a> )	-	40	-	ns
$t_r$	Current rise time		-	13	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2553	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time		-	142	-	ns
$t_f$	Current fall time		-	26	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	200	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	410	-	$\mu$ J
$E_{ts}$	Total switching energy		-	610	-	$\mu$ J
$t_{d(on)}$	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> )	-	40	-	ns
$t_r$	Current rise time		-	14.8	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2216	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time		-	148	-	ns
$t_f$	Current fall time		-	61	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	472	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	816	-	$\mu$ J
$E_{ts}$	Total switching energy		-	1288	-	$\mu$ J

**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	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	68	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 28: "Test circuit for inductive load switching"</a> )	-	310	-	ns
$Q_{rr}$	Reverse recovery charge		-	1550	-	nC
$I_{rrm}$	Reverse recovery current		-	10	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	70	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	674	-	$\mu\text{J}$

## 2.1 Electrical characteristics (curves)

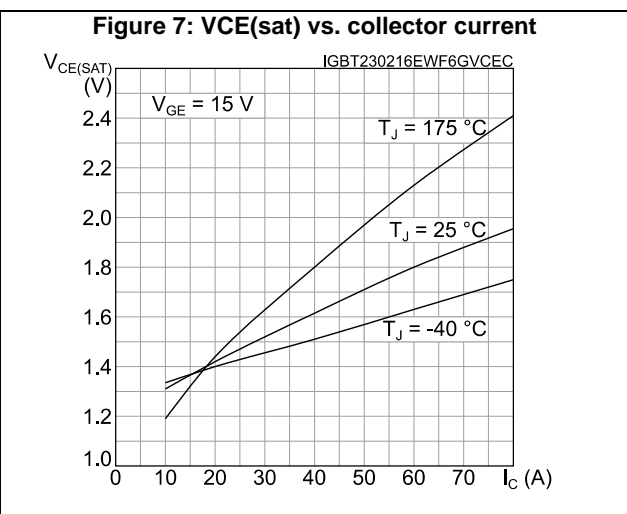
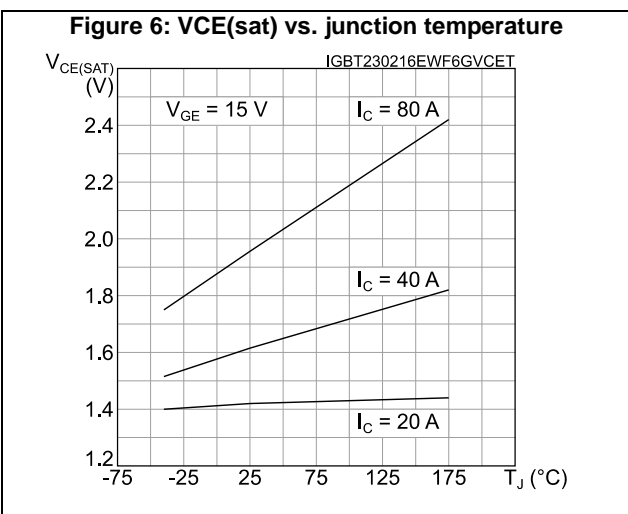
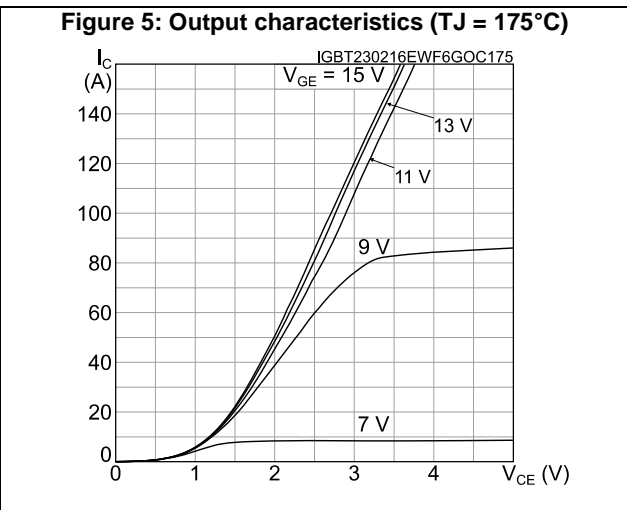
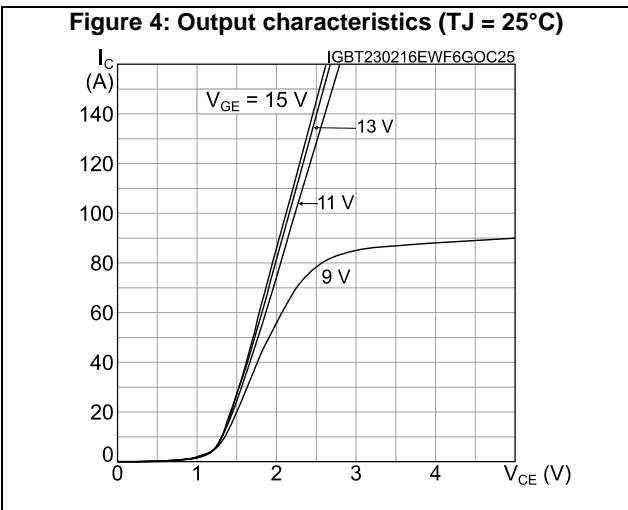
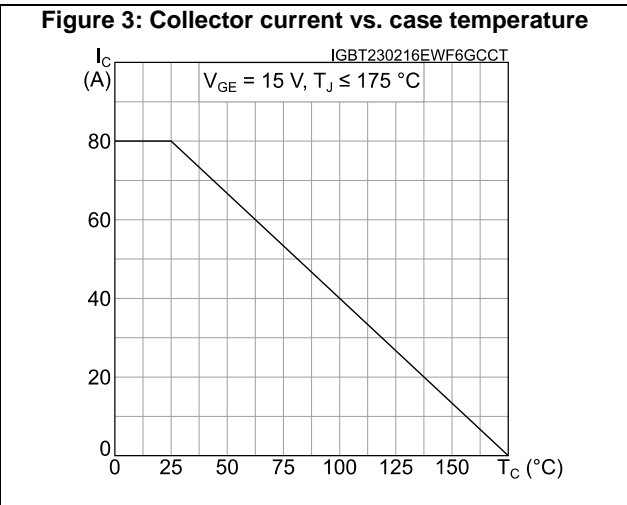
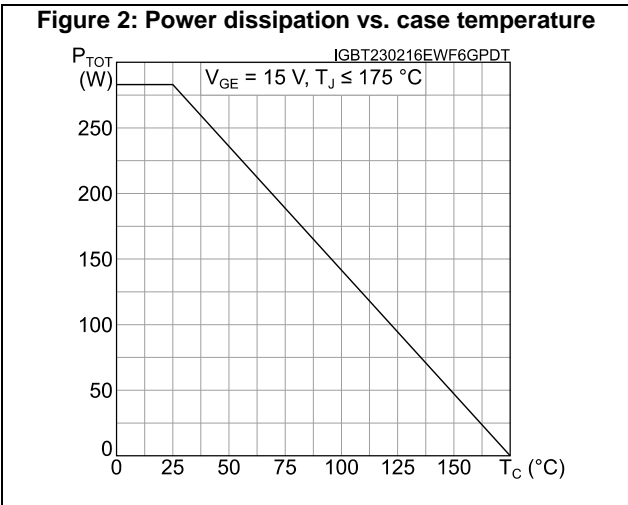


Figure 8: Collector current vs. switching frequency

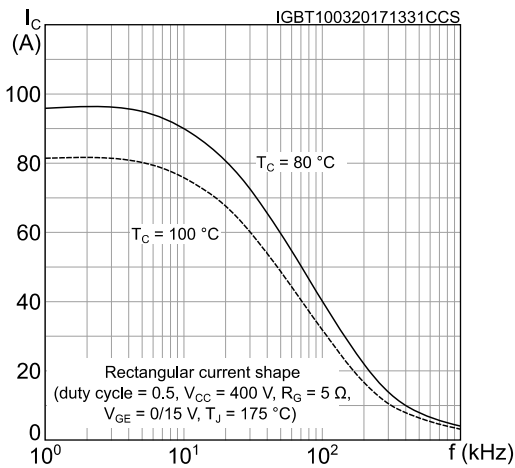


Figure 9: Forward bias safe operating area

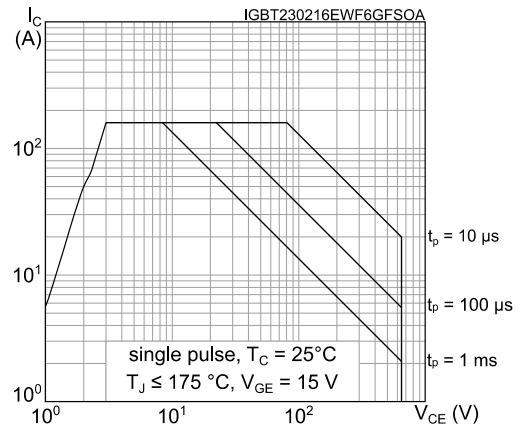


Figure 10: Transfer characteristics

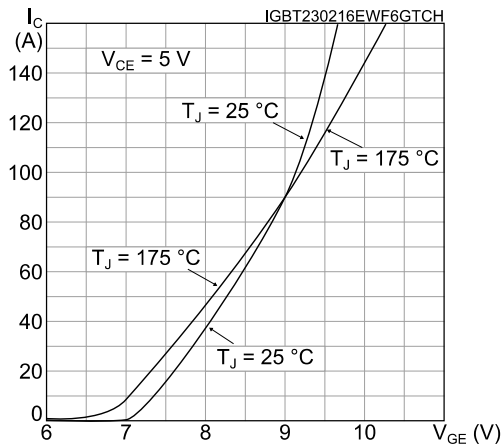


Figure 11: Diode VF vs. forward current

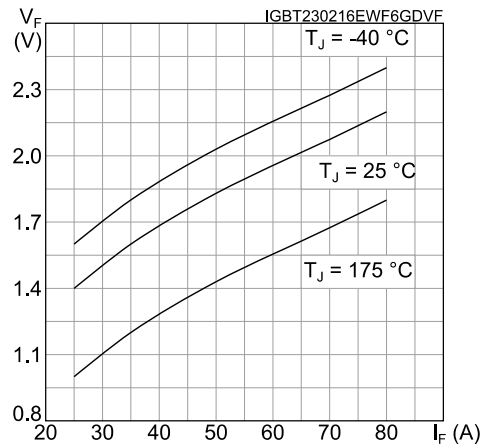


Figure 12: Normalized V<sub>GE(th)</sub> vs junction temperature

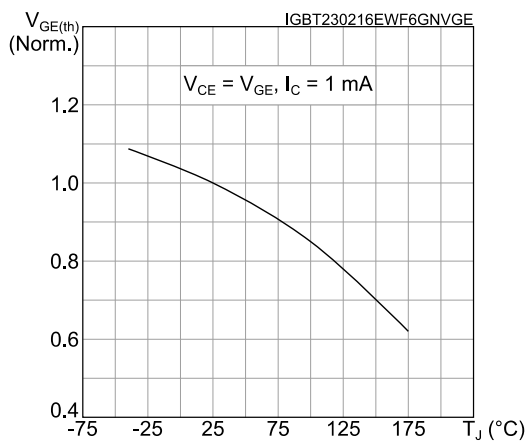
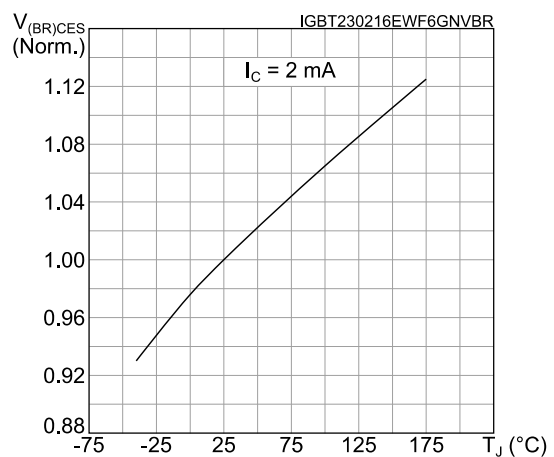
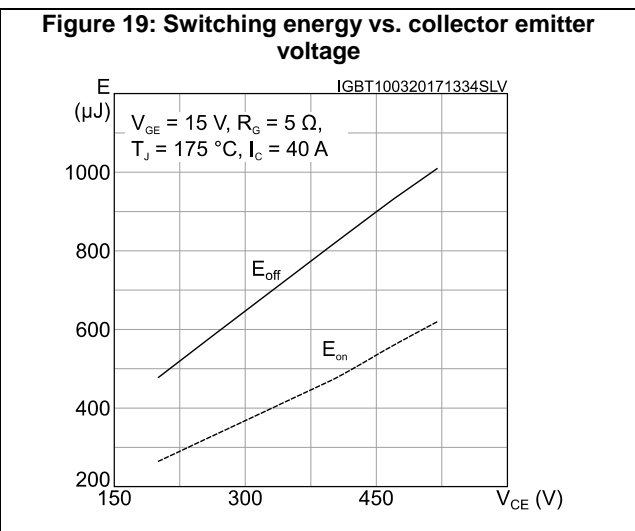
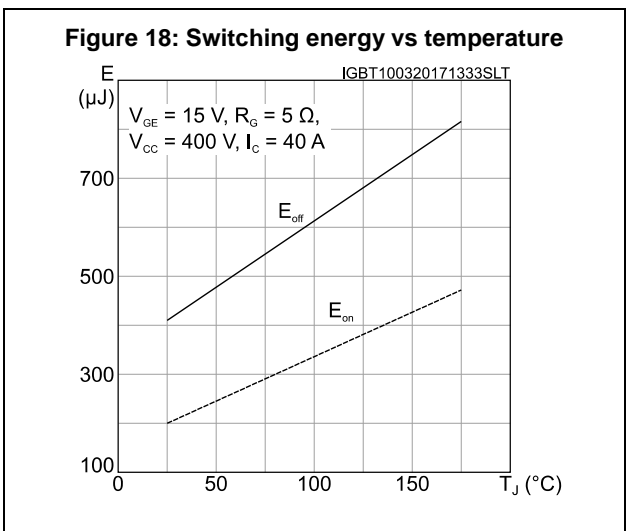
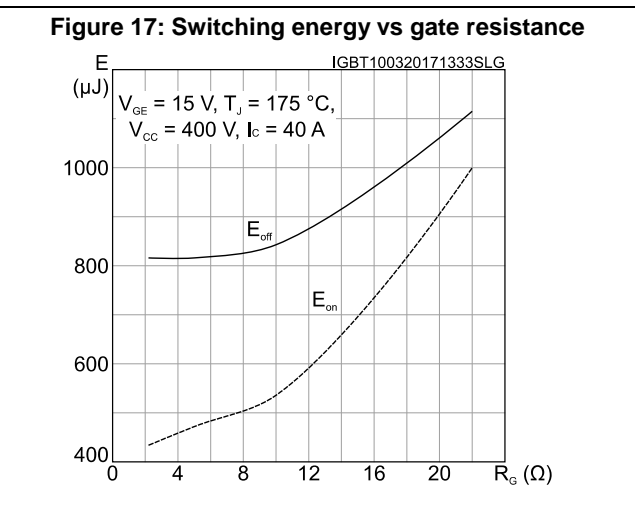
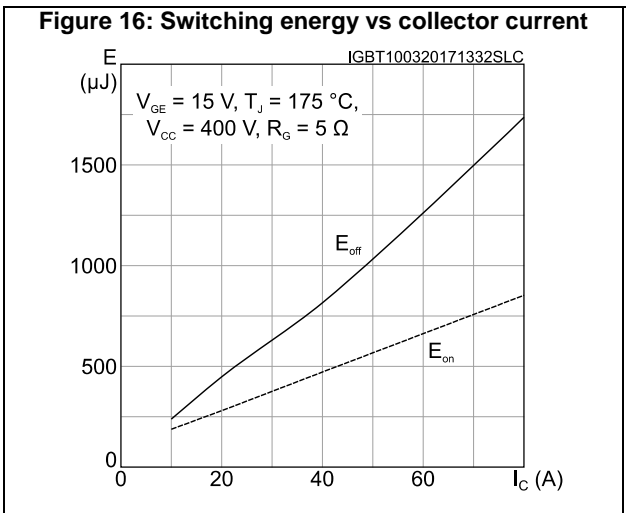
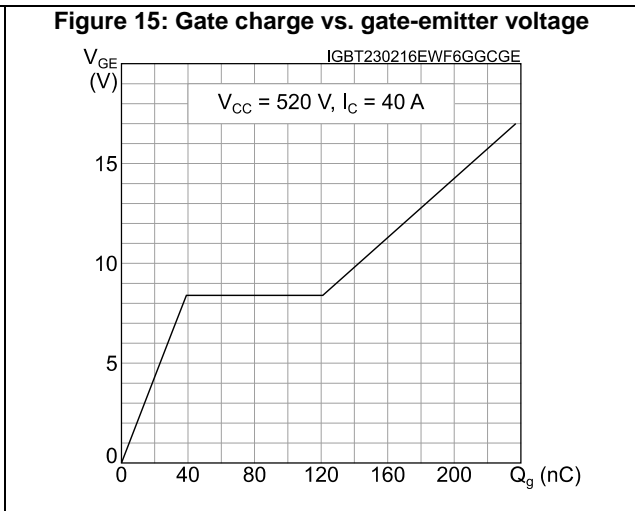
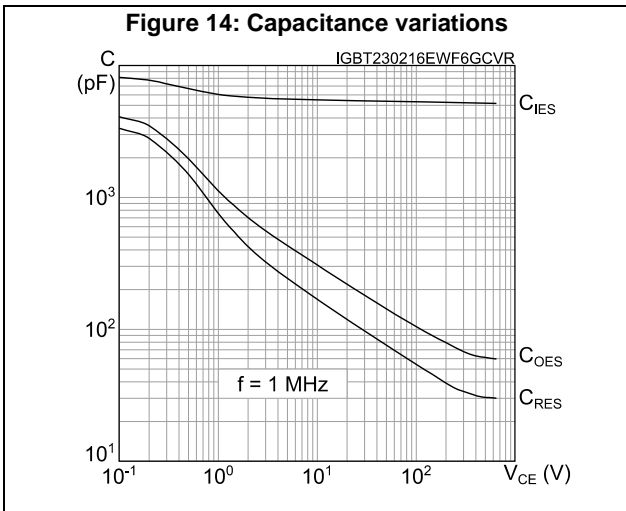


Figure 13: Normalized V<sub>(BR)CES</sub> vs. junction temperature







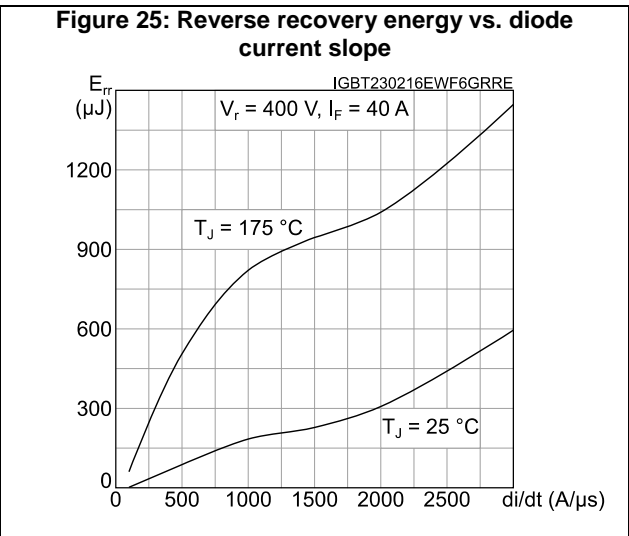
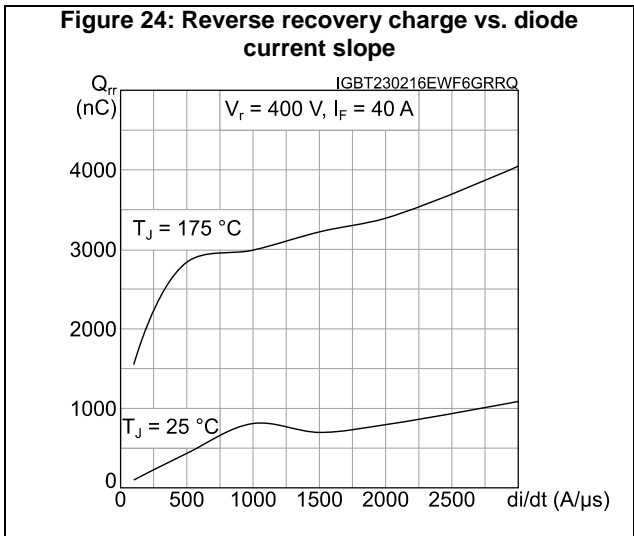
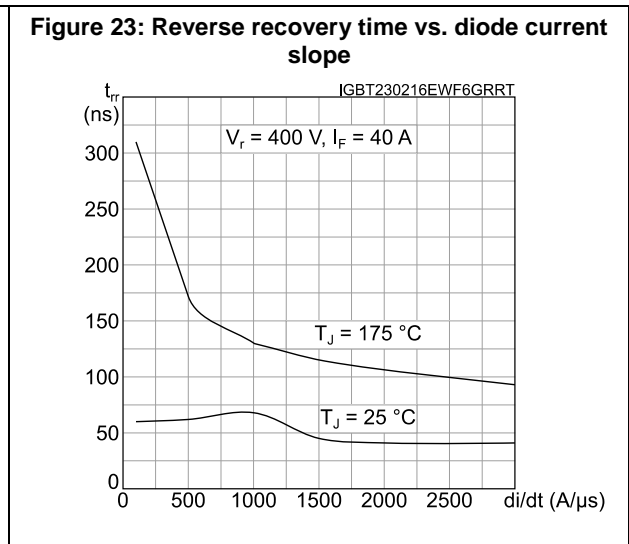
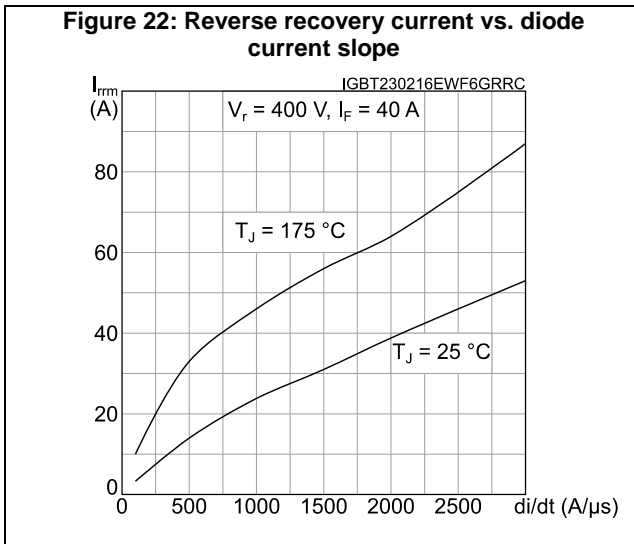
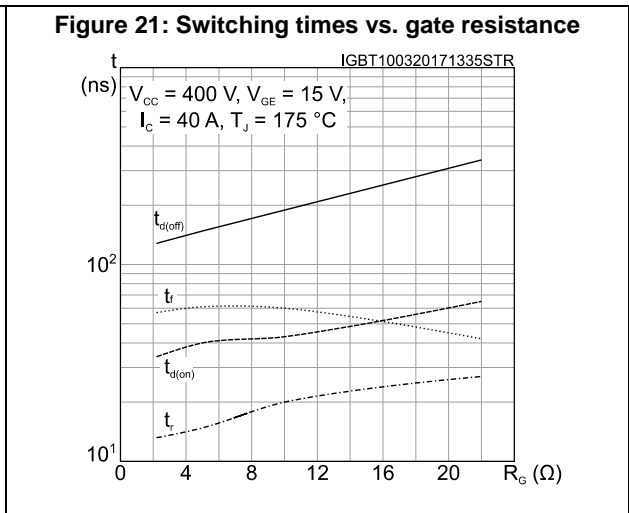
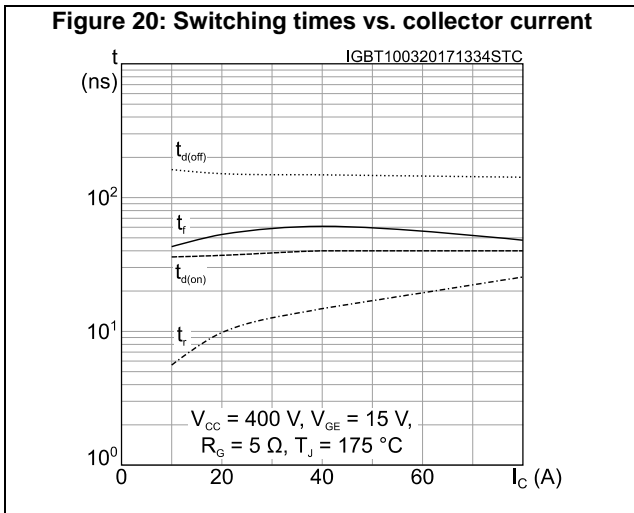


Figure 26: Thermal impedance for IGBT

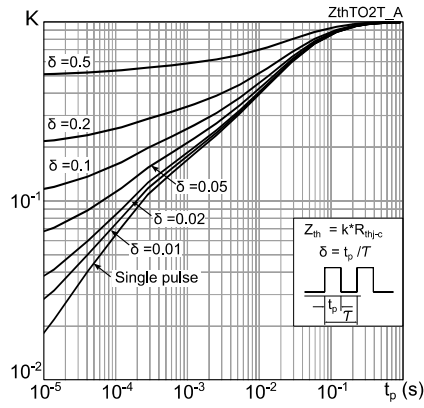
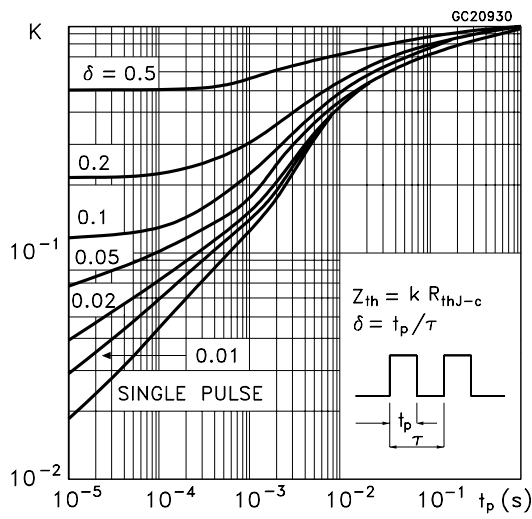
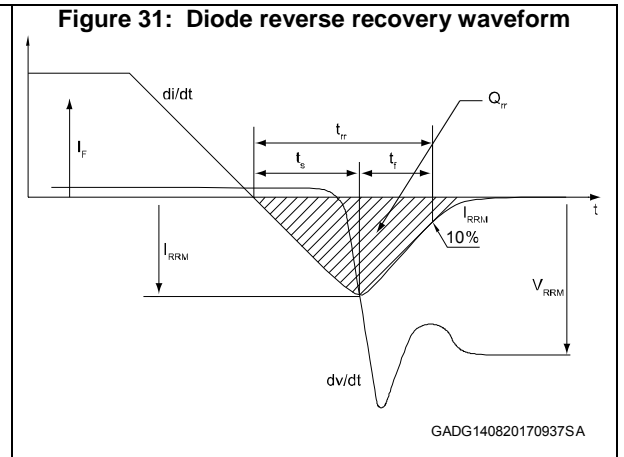
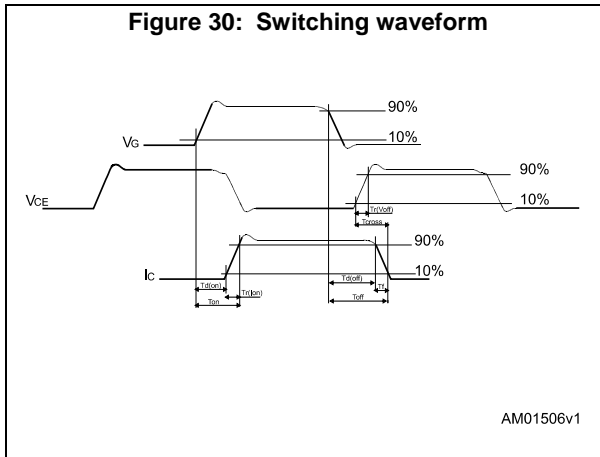
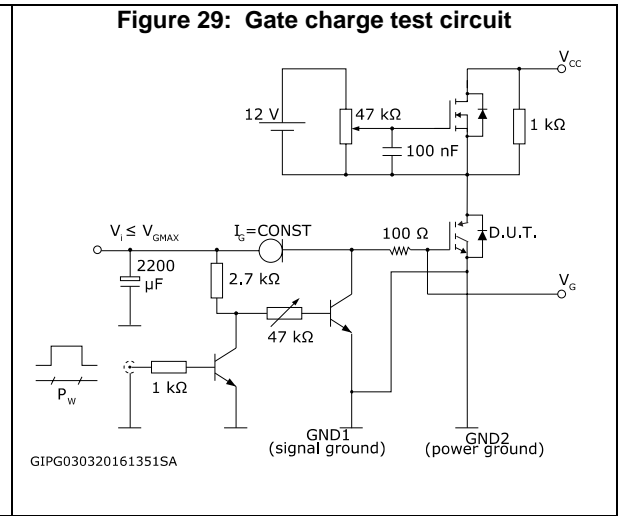
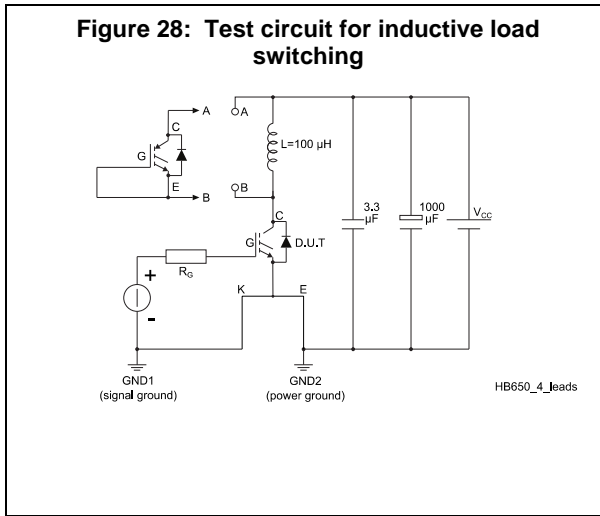


Figure 27: Thermal impedance for diode



### 3 Test circuits



## 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO247-4 package information

Figure 32: TO247-4 package outline

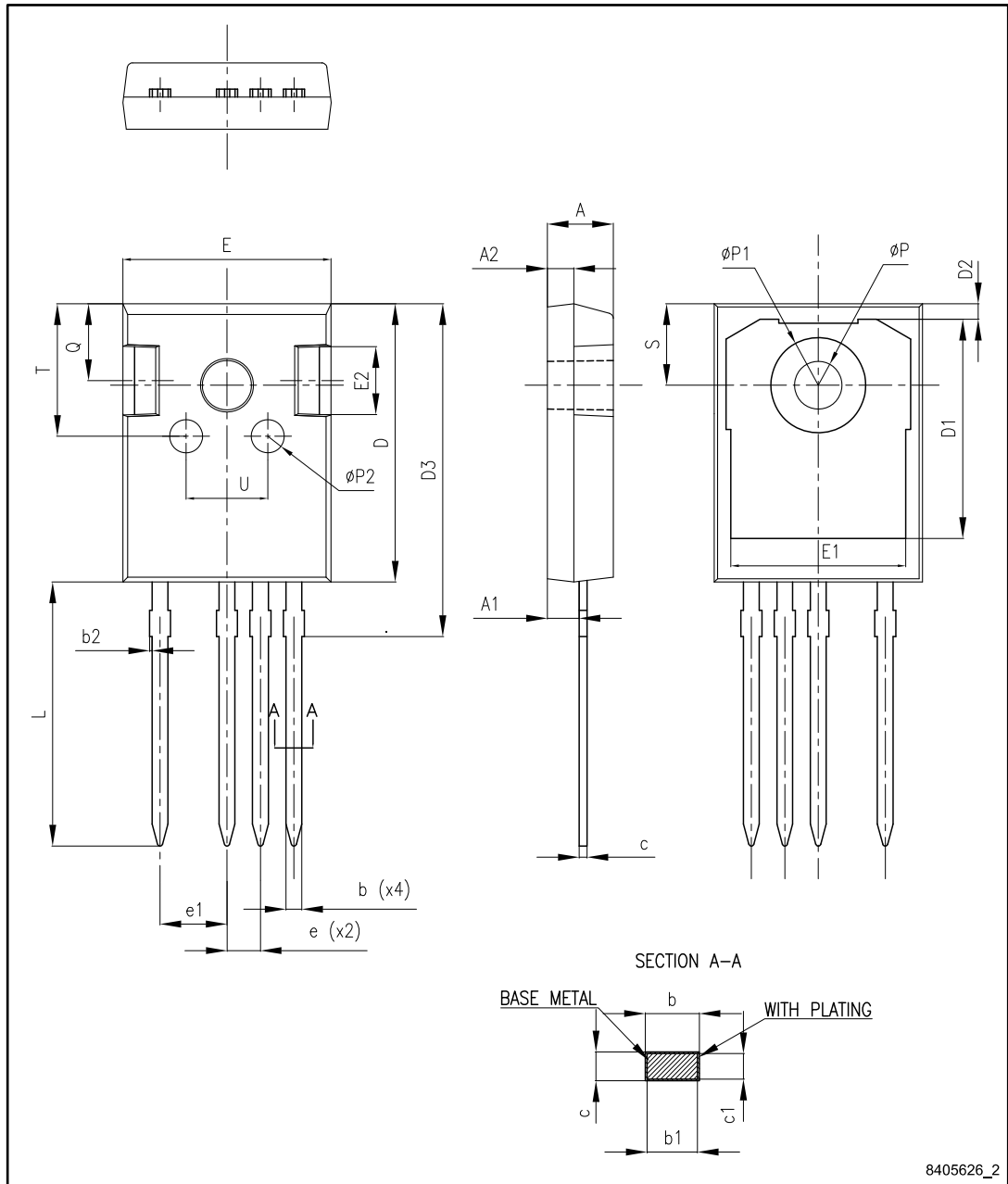


Table 8: TO247-4 mechanical data

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		1.29
b1	1.15	1.20	1.25
b2	0		0.20
c	0.59		0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.20	1.35
D3	24.97	25.12	25.27
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	2.44	2.54	2.64
e1	4.98	5.08	5.18
L	19.80	19.92	20.10
P	3.50	3.60	3.70
P1			7.40
P2	2.40	2.50	2.60
Q	5.60		6.00
S		6.15	
T	9.80		10.20
U	6.00		6.40

## 5 Revision history

**Table 9: Document revision history**

Date	Revision	Changes
04-Mar-2016	1	First release
13-Mar-2017	2	Updated Table 6: "IGBT switching characteristics (inductive load)". Updated Section 2.1: "Electrical characteristics (curves)". Minor text changes
17-Aug-2017	3	Updated title in cover page. Updated <i>Table 7: "Diode switching characteristics (inductive load)"</i> . Updated <i>Section 4.1: "TO247-4 package information"</i> Minor text changes.

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