

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

Datasheet - production data

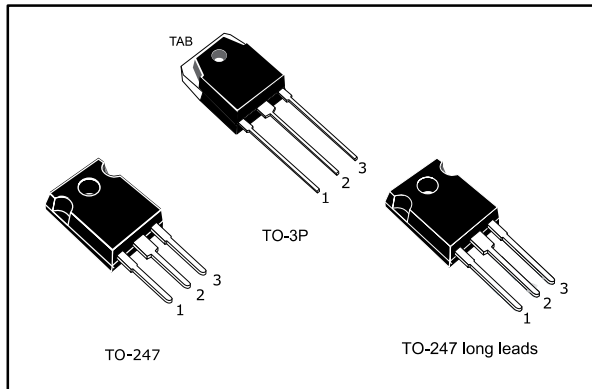
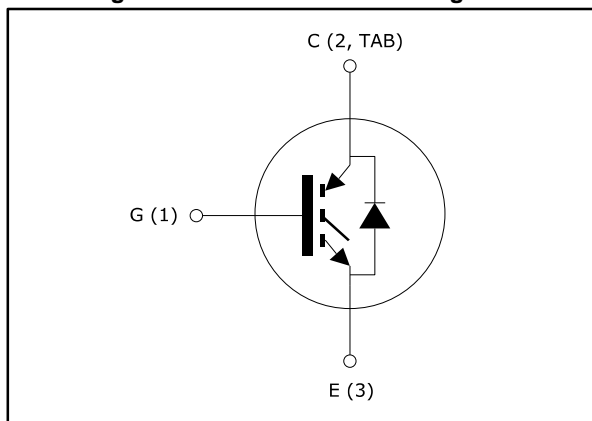


Figure 1: Internal schematic diagram



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

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the new HB series of IGBTs, which represent 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
STGW40H65DFB	GW40H65DFB	TO-247	Tube
STGWA40H65DFB	G40H65DFB	TO-247 long leads	
STGWT40H65DFB	GWT40H65DFB	TO-3P	

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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	± 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:

(1)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	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 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 Figure 29 : "Gate charge test circuit")	-	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 Figure 28: "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	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 5\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 28: "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	-		

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 Figure 28: "Test circuit for inductive load switching")	-	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/ μs
E_{rr}	Reverse recovery energy			-	68	-	μJ
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 28: "Test circuit for inductive load switching")	-	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/ μs
E_{rr}	Reverse recovery energy			-	674	-	μJ

2.1 Electrical characteristics (curves)

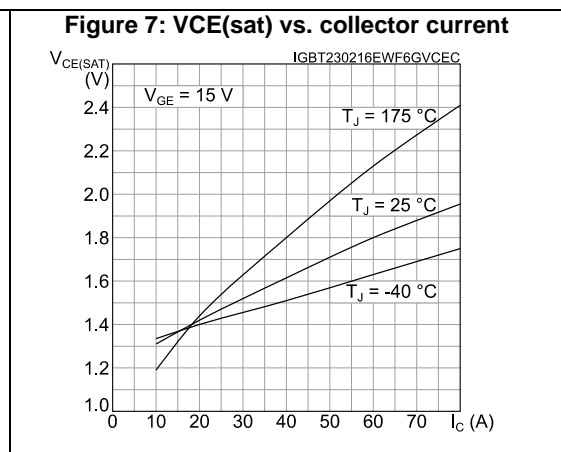
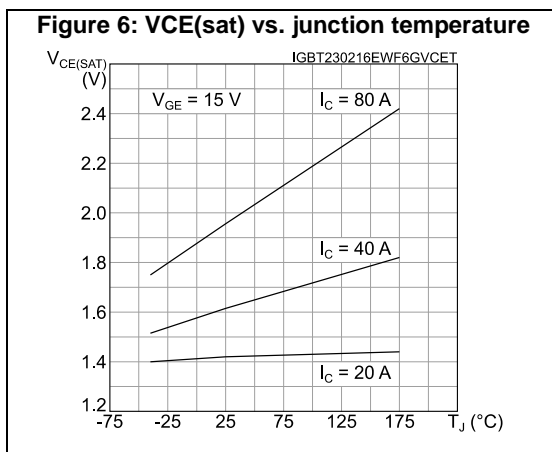
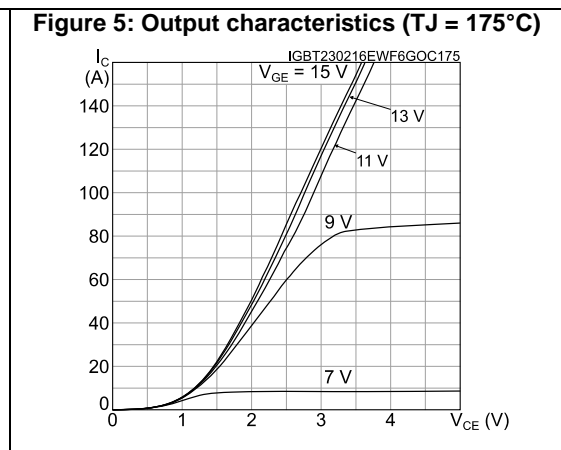
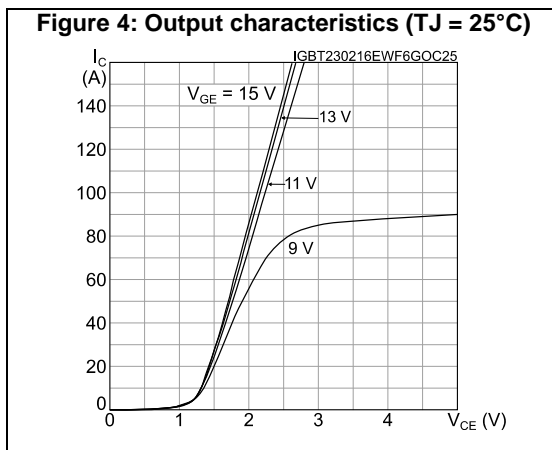
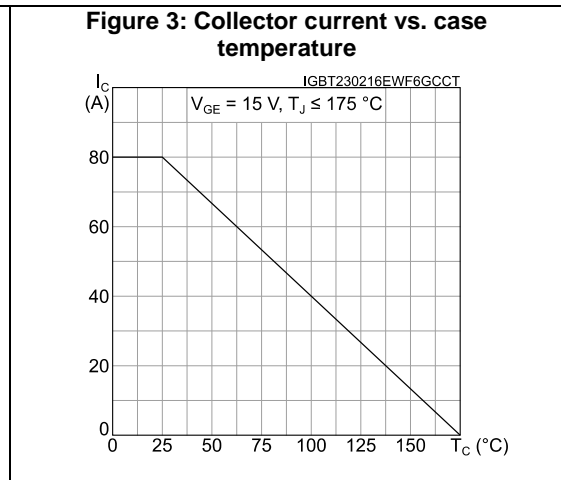
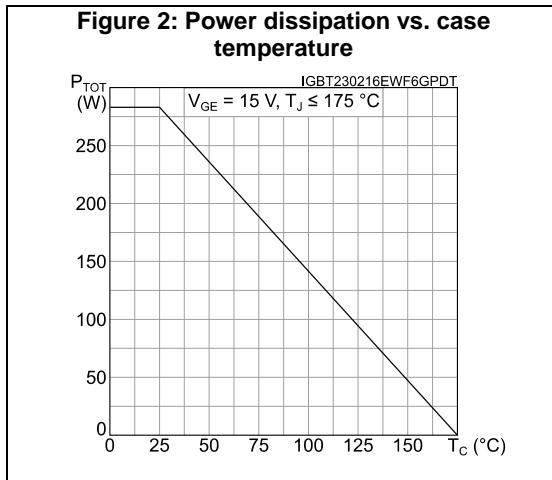


Figure 8: Collector current vs. switching frequency

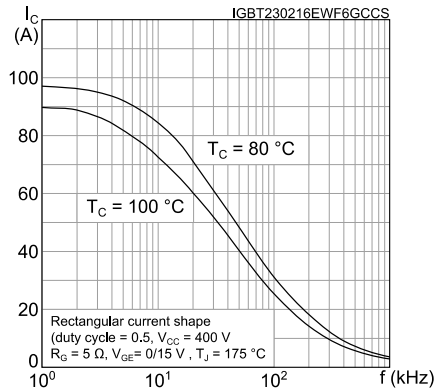


Figure 9: Forward bias safe operating area

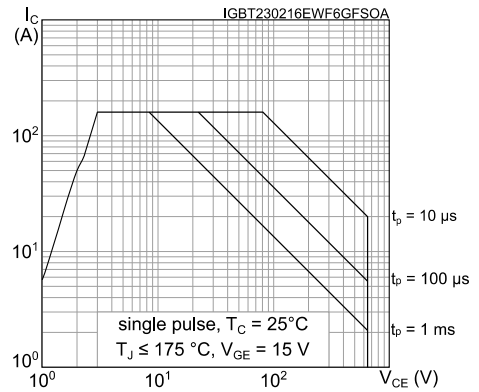


Figure 10: Transfer characteristics

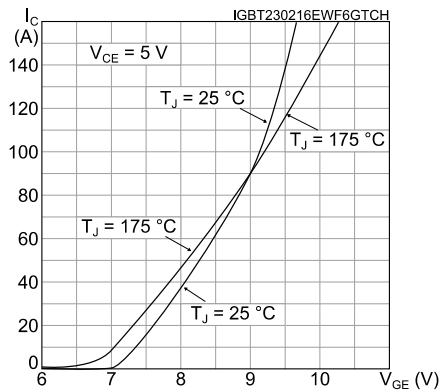


Figure 11: Diode VF vs. forward current

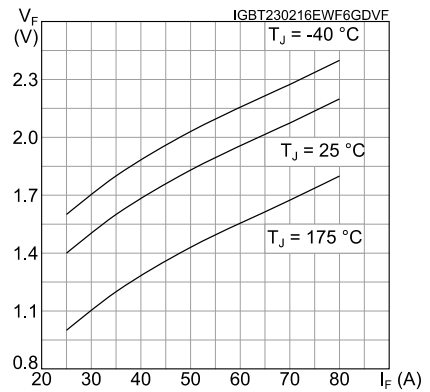


Figure 12: Normalized VGE(th) vs junction temperature

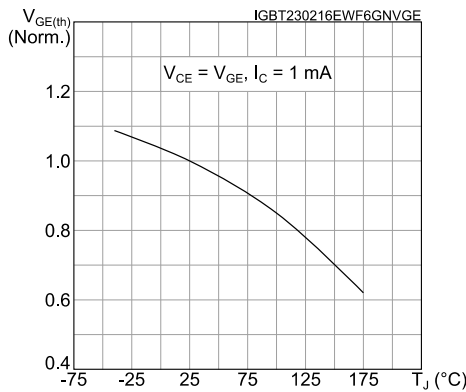
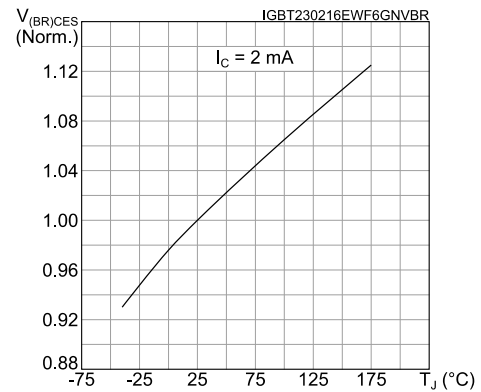


Figure 13: Normalized V(BR)CES vs. junction temperature



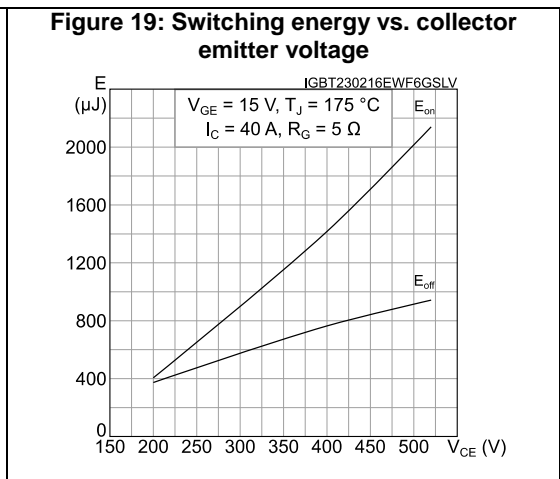
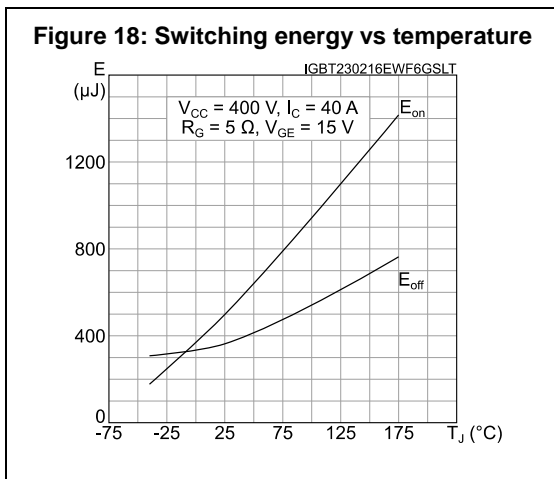
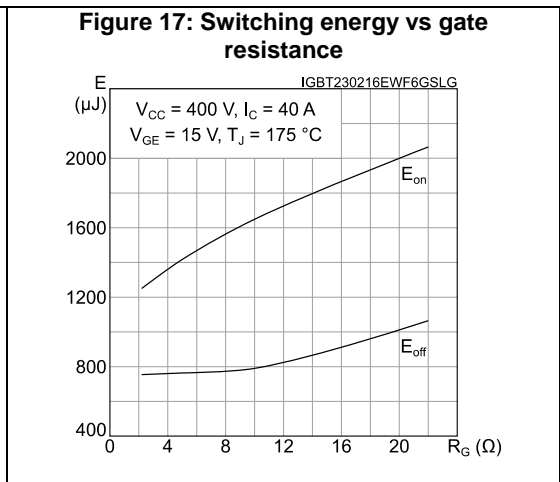
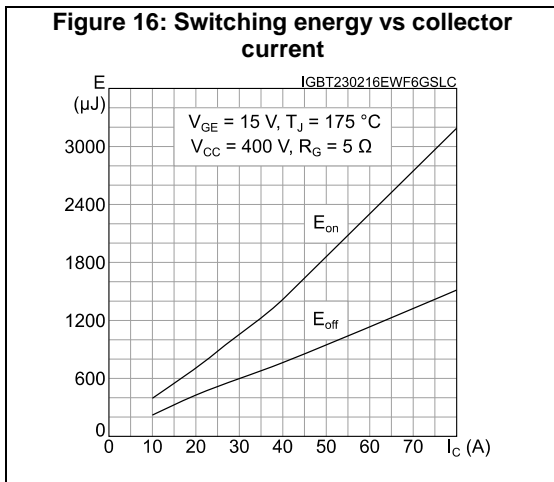
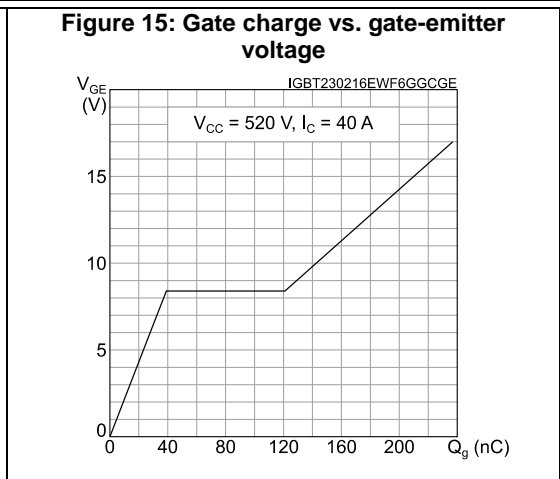
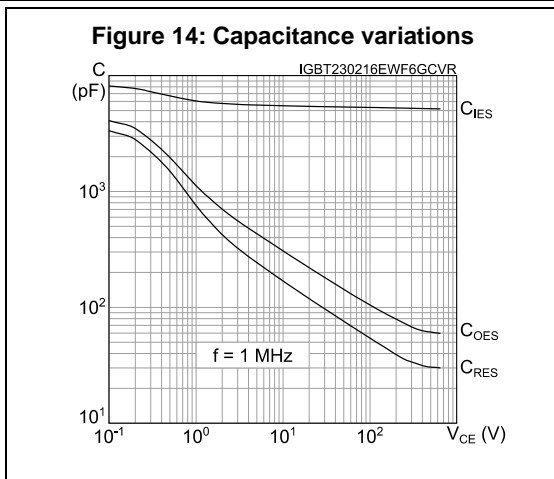


Figure 20: Switching times vs. collector current

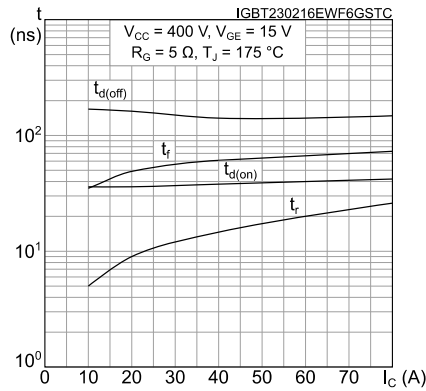


Figure 21: Switching times vs. gate resistance

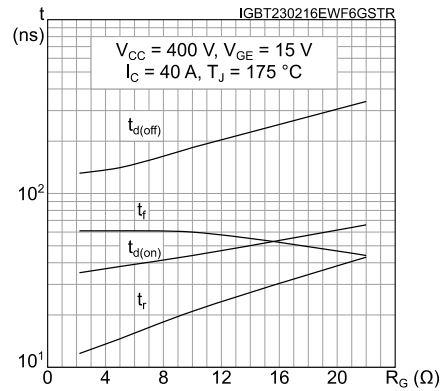


Figure 22: Reverse recovery current vs. diode current slope

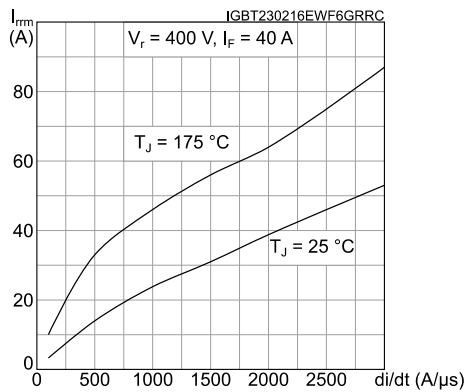


Figure 23: Reverse recovery time vs. diode current slope

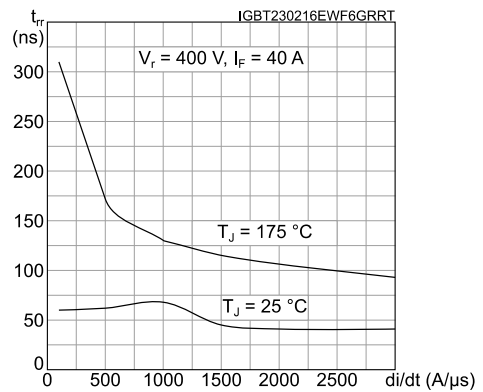


Figure 24: Reverse recovery charge vs. diode current slope

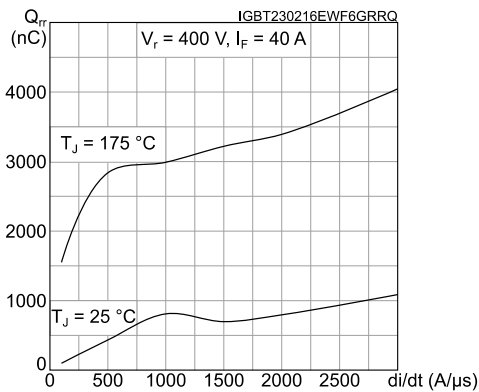
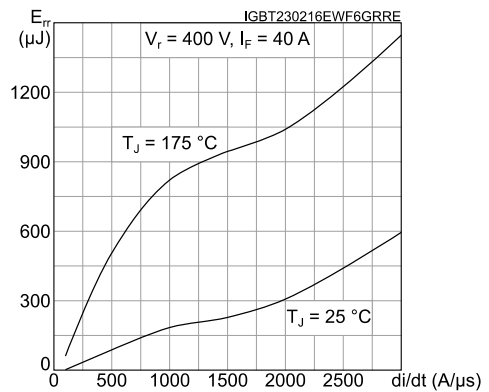
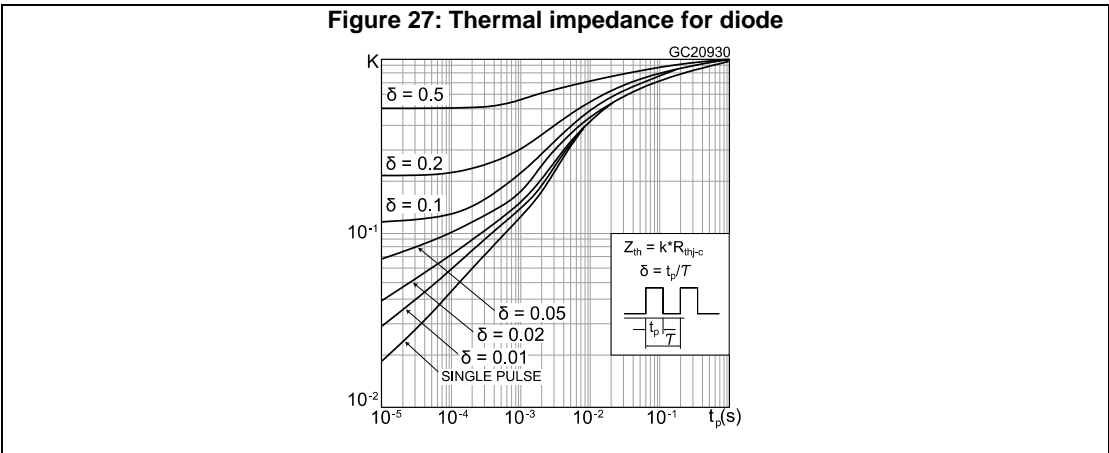
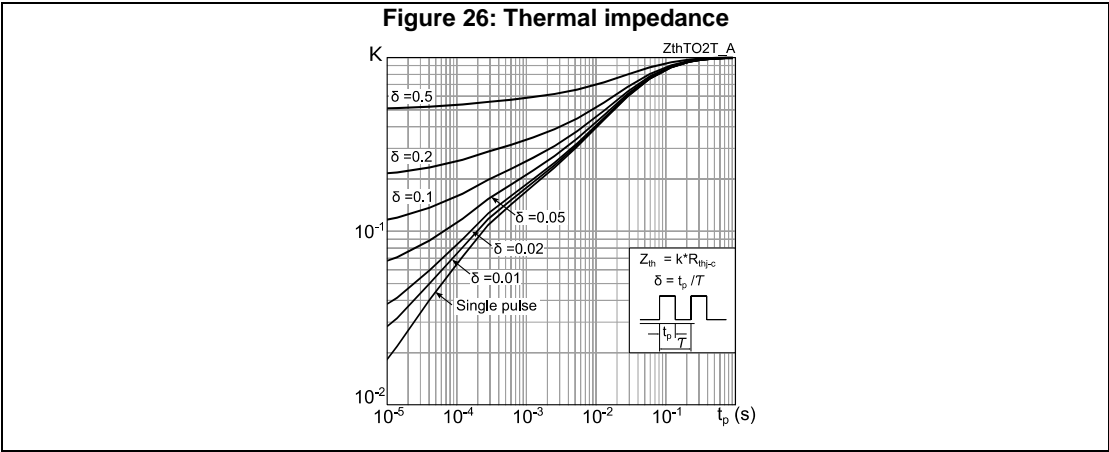


Figure 25: Reverse recovery energy vs. diode current slope





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. ECOPACK® is an ST trademark.

4.1 TO-247 package information

Figure 32: TO-247 package outline

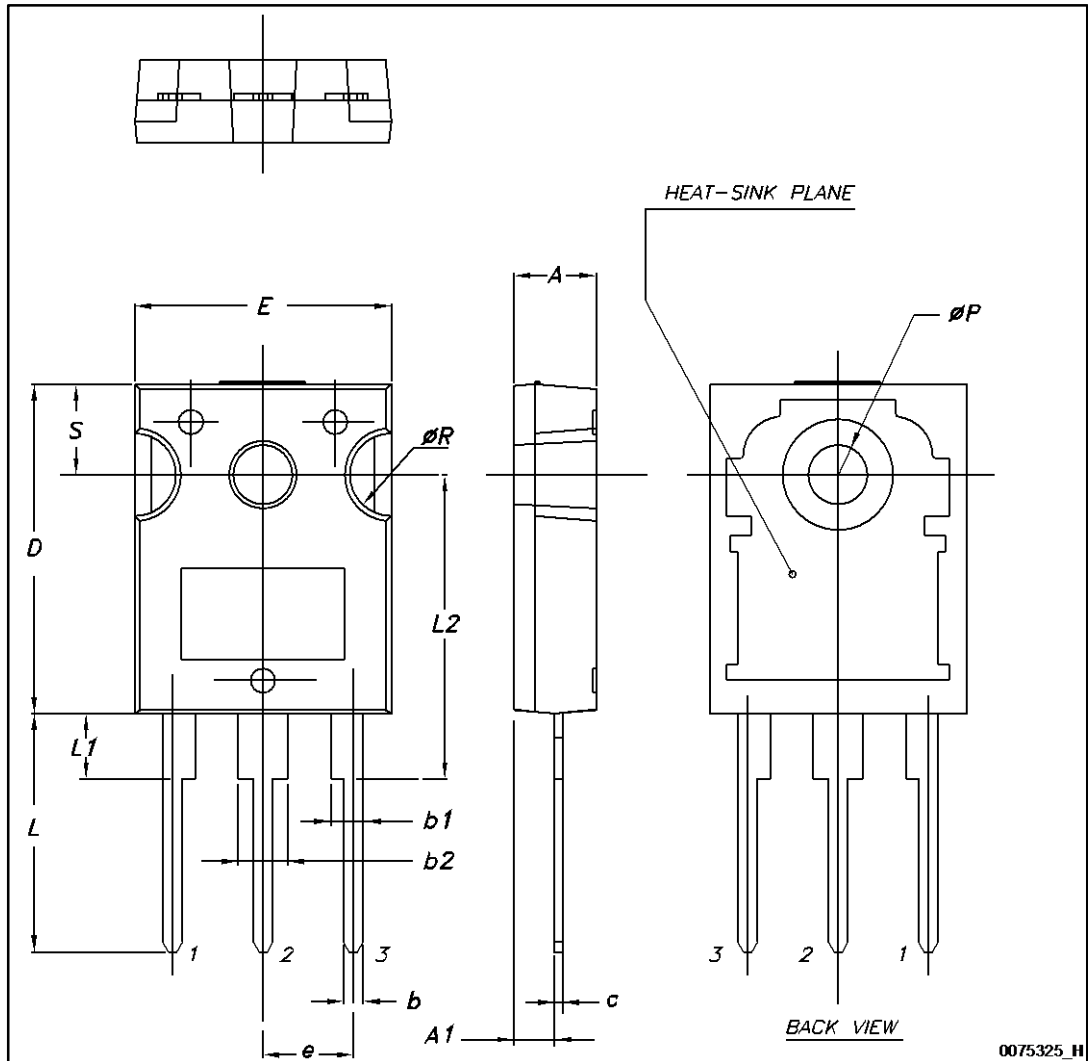
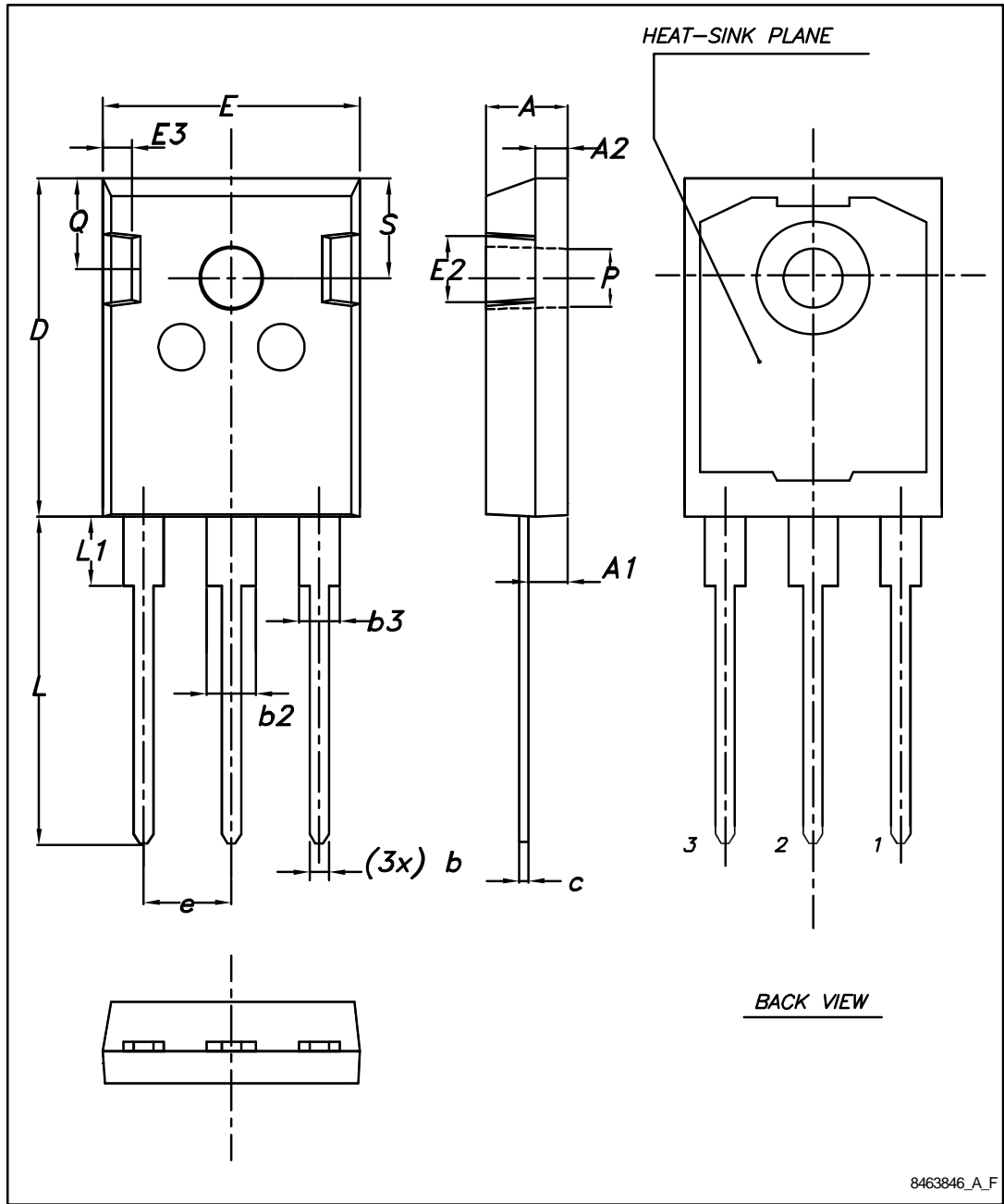


Table 8: TO-247 package mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

4.2 TO-247 long leads package information

Figure 33: TO-247 long leads package outline



8463846_A_F

Table 9: 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

4.3 TO-3P package information

Figure 34: TO-3P package outline

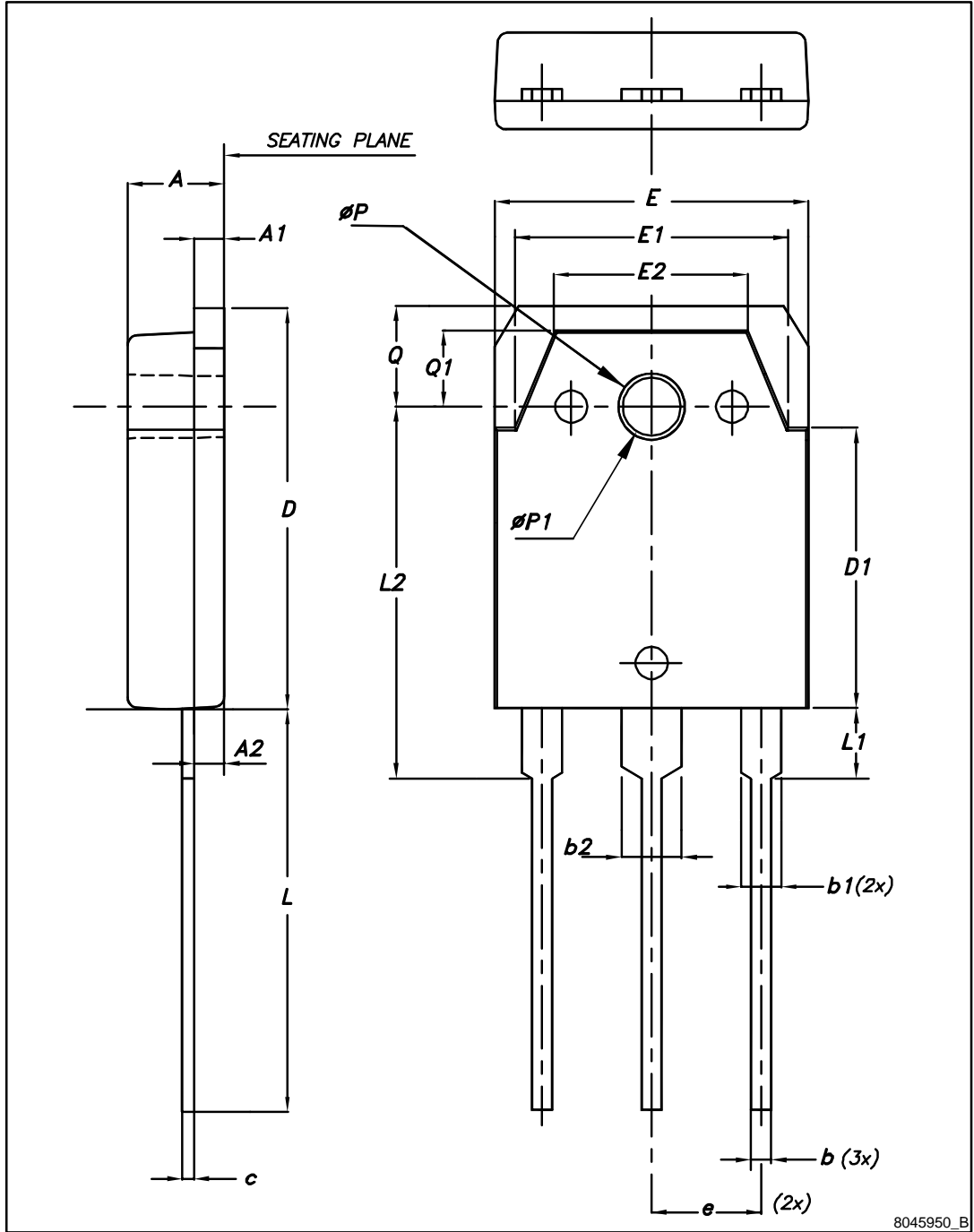


Table 10: TO-3P package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.80	5.00
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1.00	1.20
b1	1.80	2.00	2.20
b2	2.80	3.00	3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1	13.70	13.90	14.10
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	9.40	9.60	9.90
e	5.15	5.45	5.75
L	19.80	20.00	20.20
L1	3.30	3.50	3.70
L2	18.20	18.40	18.60
ØP	3.30	3.40	3.50
ØP1	3.10	3.20	3.30
Q	4.80	5.00	5.20
Q1	3.60	3.80	4

5 Revision history

Table 11: Document revision history

Date	Revision	Changes
12-Mar-2013	1	Initial release.
09-Sep-2013	2	<ul style="list-style-type: none"> – Modified: VCE(sat) values in cover page – Modified: VCE(sat), VF and VGE(th) typical and max values in Table 4 – Modified: entire typical values in Table 5, 6 and 7 – Minor text changes – Added: Section 2.1: Electrical characteristics (curves)
11-Sep-2013	3	– Updated TSTG value in Table 2: Absolute maximum ratings.
23-Sep-2013	4	– Updated units in Table 6: IGBT switching characteristics (inductive load).
31-Oct-2013	5	Updated VCE(sat) in Table 4: Static characteristics.
24-Feb-2014	6	Updated title and description in cover page.
23-Feb-2016	7	<p>Throughout document:</p> <ul style="list-style-type: none"> - added TO-247 long leads package details - text and formatting changes <p>In Section 1: "Electrical ratings":</p> <ul style="list-style-type: none"> - updated Table 2: "Absolute maximum ratings" <p>In Section 2: "Electrical characteristics":</p> <ul style="list-style-type: none"> - updated Table 4: "Static characteristics", Table 6: "IGBT switching characteristics (inductive load)" and Table 7: "Diode switching characteristics (inductive load)" <p>Updated Section 2.1: "Electrical characteristics (curves)"</p> <p>Updated Section 4: "Package mechanical data"</p>

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