

## Trench gate field-stop IGBT, M series 650 V, 75 A low loss

Datasheet - production data

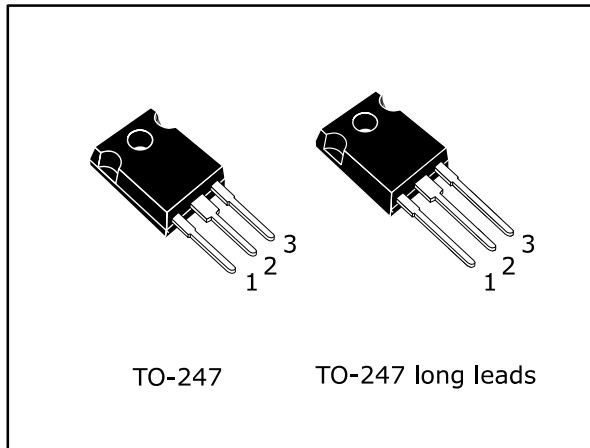
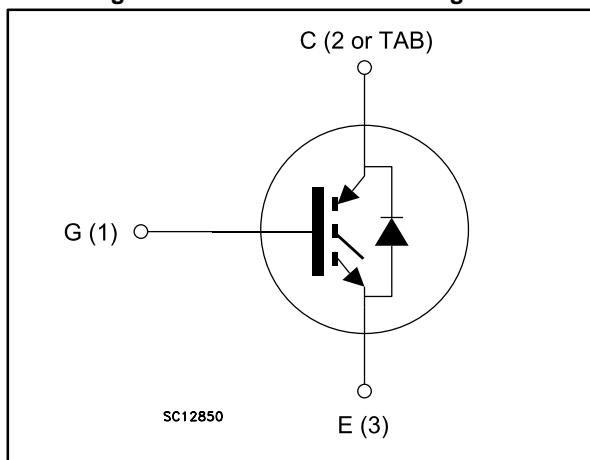


Figure 1: Internal schematic diagram



### Features

- 6  $\mu$ s of short-circuit withstand time
- $V_{CE(sat)} = 1.65$  V (typ.) @  $I_C = 75$  A
- Tight parameter distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

### Applications

- Motor control
- UPS
- PFC

### Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. The devices are part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where low-loss and short-circuit functionality are essential. Furthermore, the positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGW75M65DF2	G75M65DF2	TO-247	Tube
STGWA75M65DF2		TO-247 long leads	

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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
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	120	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	75	A
$I_{CP}^{(2)}$	Pulsed collector current	225	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25\text{ °C}$	120	A
$I_F$	Continuous forward current at $T_C = 100\text{ °C}$	75	A
$I_{FP}^{(2)}$	Pulsed forward current	225	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	468	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature range	- 55 to 175	°C

**Notes:**

(1) Current level is limited by bond wires

(2) Pulse width limited by maximum junction temperature.

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.32	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	0.74	°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	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$		1.65	2.1	V
		$V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$ , $T_J = 125\text{ °C}$		1.95		
		$V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$ , $T_J = 175\text{ °C}$		2.1		
$V_F$	Forward on-voltage	$I_F = 75\text{ A}$		2		V
		$I_F = 75\text{ A}$ , $T_J = 125\text{ °C}$		1.75		
		$I_F = 75\text{ A}$ , $T_J = 175\text{ °C}$		1.6		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 2\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current	$V_{CE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$			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	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	6290	-	pF
$C_{oes}$	Output capacitance		-	390	-	
$C_{res}$	Reverse transfer capacitance		-	136	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 75\text{ A}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 30</a> : "Gate charge test circuit")	-	225	-	nC
$Q_{ge}$	Gate-emitter charge		-	53	-	
$Q_{gc}$	Gate-collector charge		-	87	-	

Table 6: IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 75\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 3.3\ \Omega$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )		47	-	ns
$t_r$	Current rise time			22.4	-	ns
$(di/dt)_{on}$	Turn-on current slope			2680	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time			125	-	ns
$t_f$	Current fall time			93	-	ns
$E_{on(1)}$	Turn-on switching energy			0.69	-	mJ
$E_{off(2)}$	Turn-off switching energy			2.54	-	mJ
$E_{ts}$	Total switching energy			3.23	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 75\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 3.3\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )		48	-	ns
$t_r$	Current rise time			25	-	ns
$(di/dt)_{on}$	Turn-on current slope			2420	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time			125	-	ns
$t_f$	Current fall time			167	-	ns
$E_{on(1)}$	Turn-on switching energy			2.17	-	mJ
$E_{off(2)}$	Turn-off switching energy			3.45	-	mJ
$E_{ts}$	Total switching energy			5.62	-	mJ
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 13\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	10		-	$\mu$ s
		$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	6			

Notes:

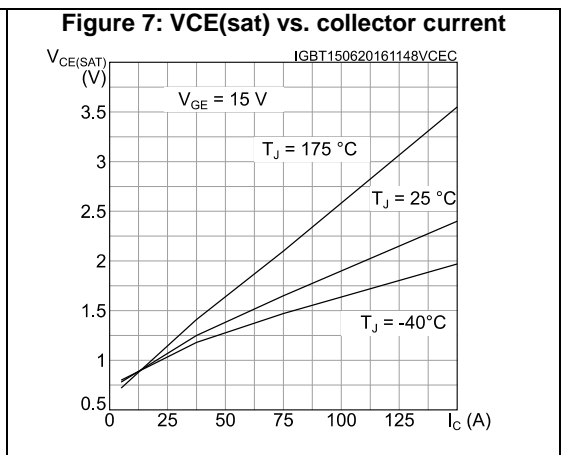
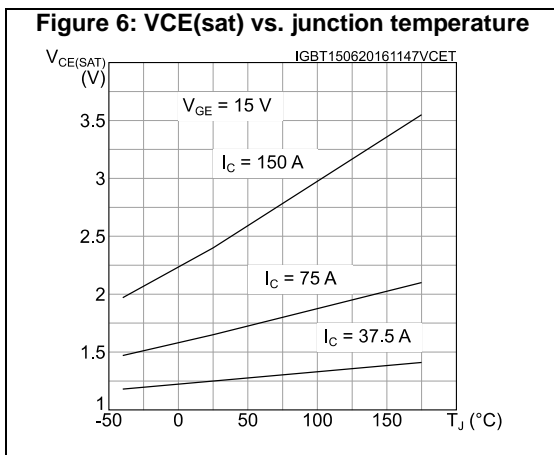
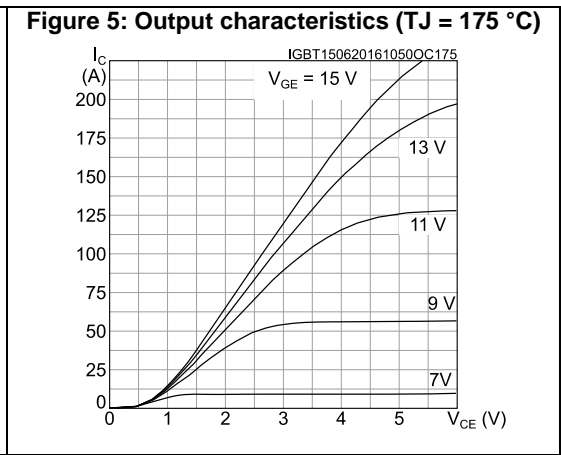
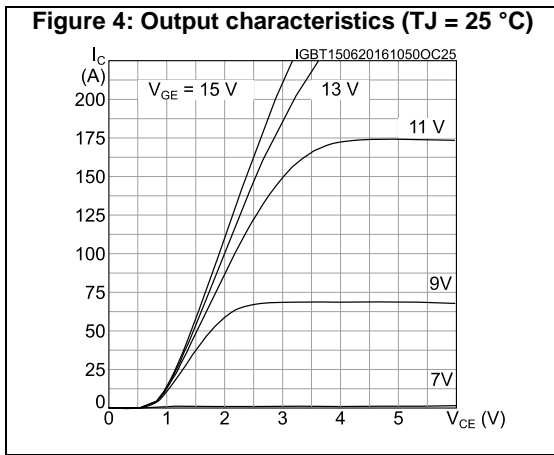
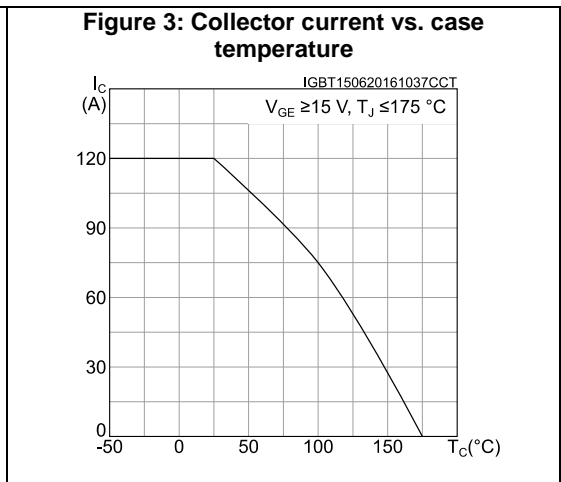
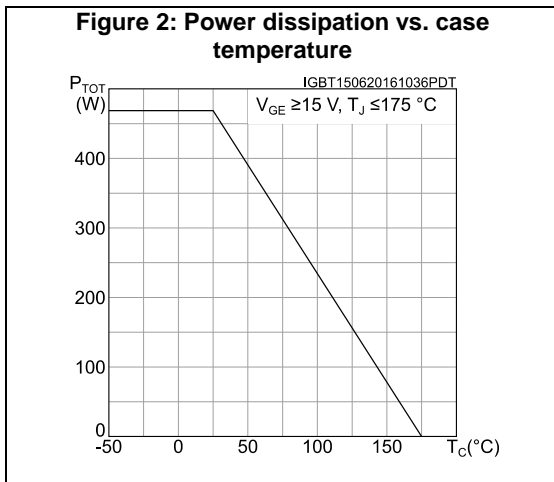
(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

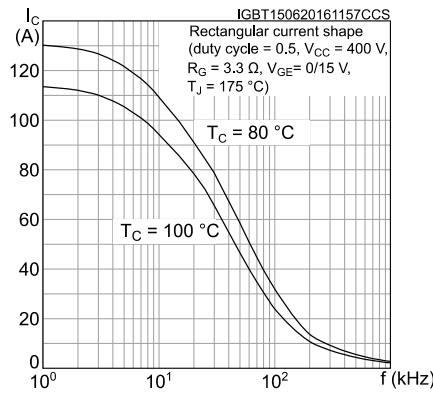
Table 7: Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 75\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) $di/dt = 1000\text{ A}/\mu\text{s}$	-	165	-	ns
$Q_{rr}$	Reverse recovery charge		-	1.72	-	$\mu$ C
$I_{rrm}$	Reverse recovery current		-	25	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	750	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	289	-	$\mu$ J
$t_{rr}$	Reverse recovery time	$I_F = 75\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) $di/dt = 1000\text{ A}/\mu\text{s}$	-	256	-	ns
$Q_{rr}$	Reverse recovery charge		-	6.85	-	$\mu$ C
$I_{rrm}$	Reverse recovery current		-	48	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	300	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	1033	-	$\mu$ J

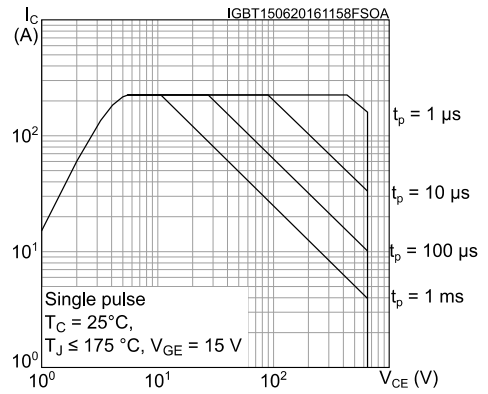
2.1 Electrical characteristics(curves)



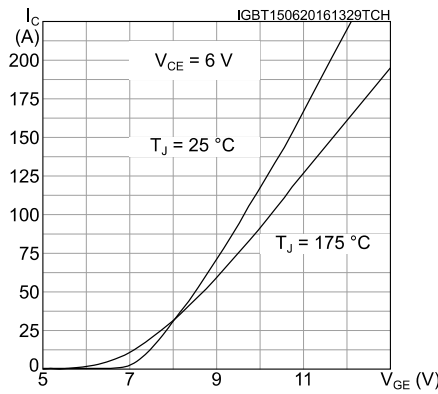
**Figure 8: Collector current vs. switching frequency**



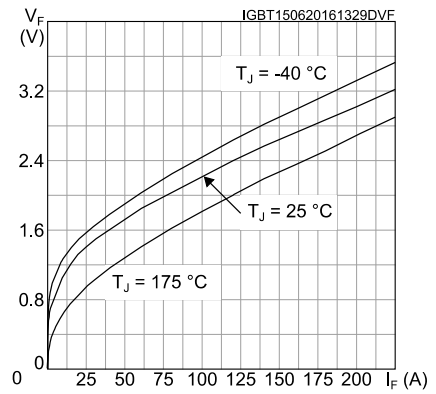
**Figure 9: Forward bias safe operating area**



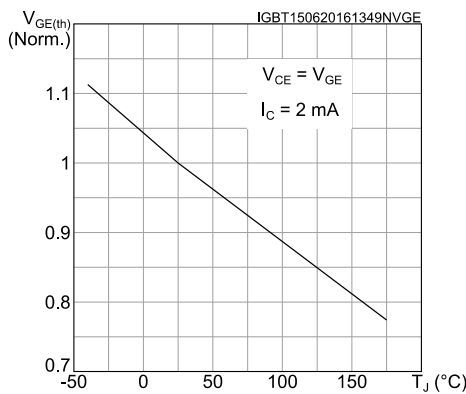
**Figure 10: Transfer characteristics**



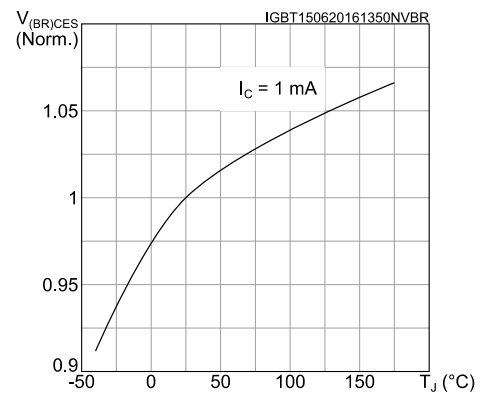
**Figure 11: Diode VF vs. forward current**



**Figure 12: Normalized V\_{GE(th)} vs. junction temperature**



**Figure 13: Normalized V\_{(BR)CES} vs. junction temperature**



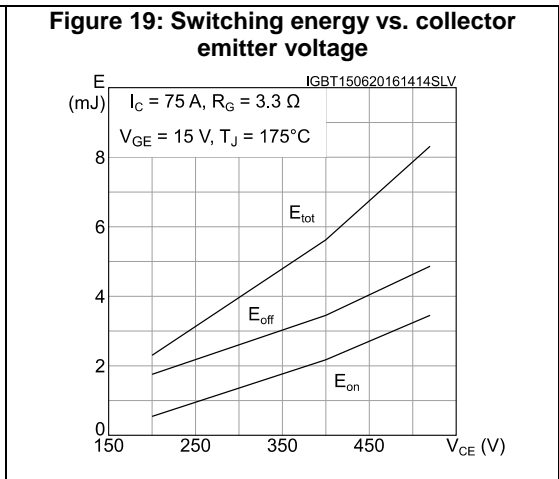
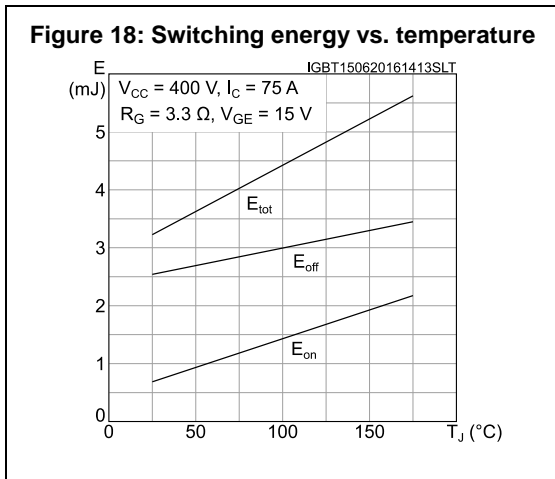
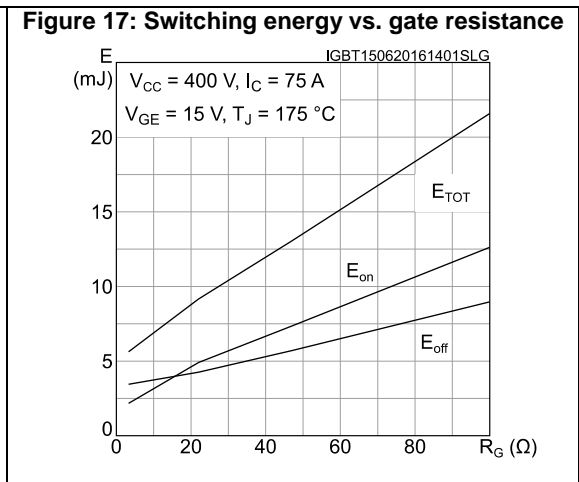
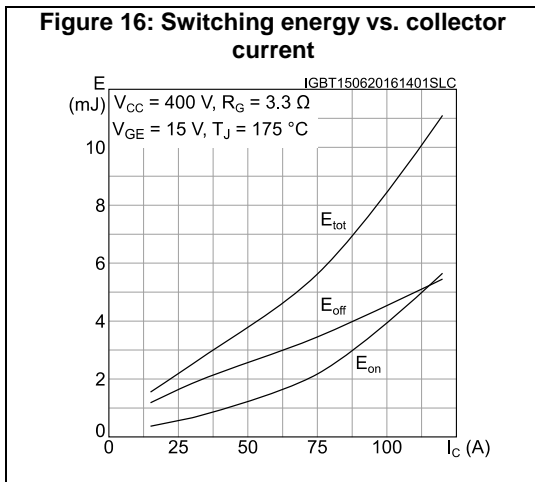
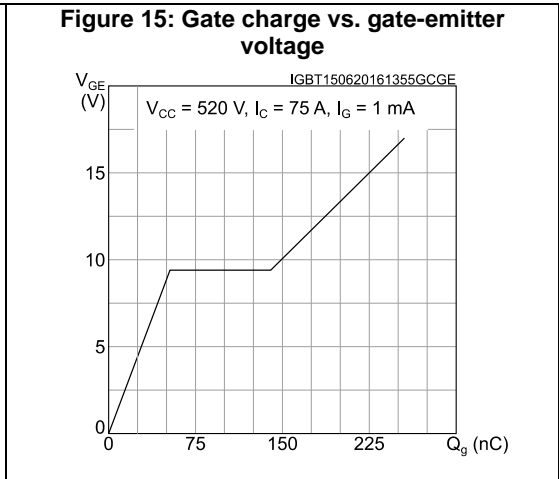
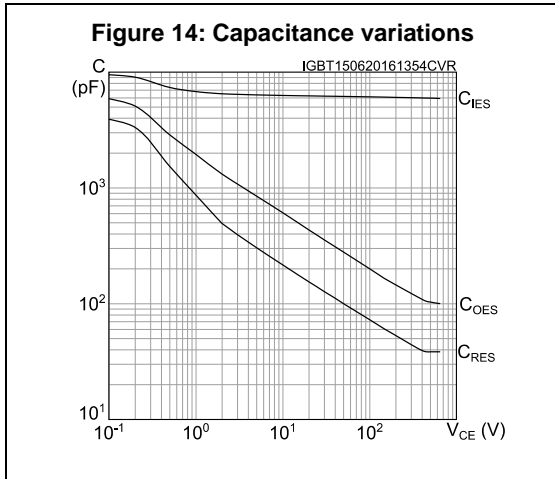




Figure 20: Short-circuit time and current vs. V<sub>GE</sub>

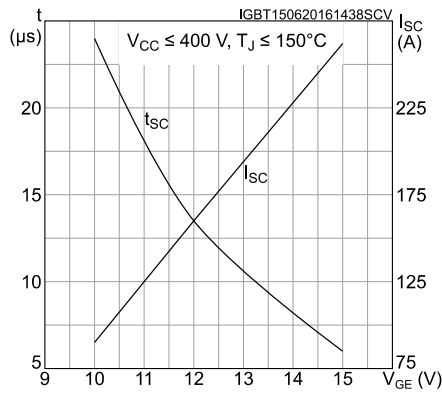


Figure 21: Switching times vs. collector current

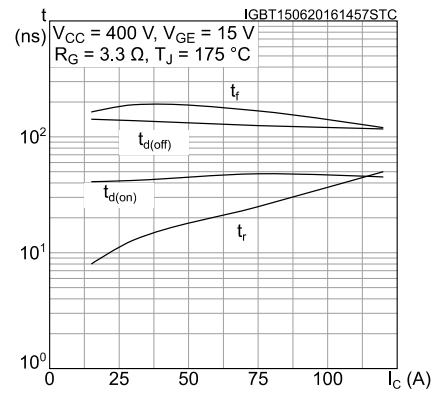


Figure 22: Switching times vs. gate resistance

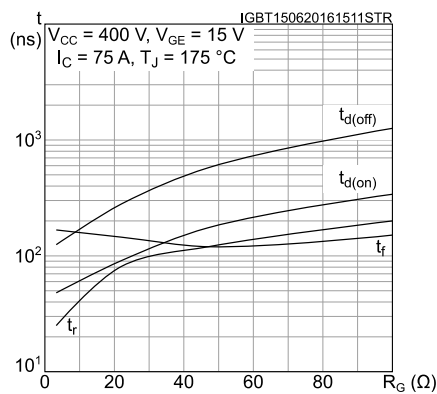


Figure 23: Reverse recovery current vs. diode current slope

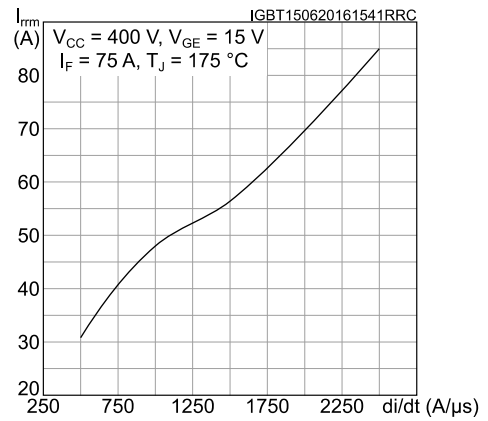


Figure 24: Reverse recovery time vs. diode current slope

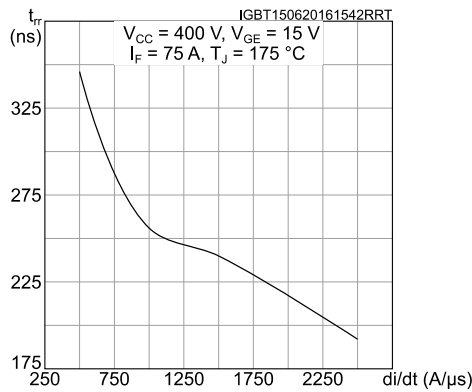


Figure 25: Reverse recovery charge vs. diode current slope

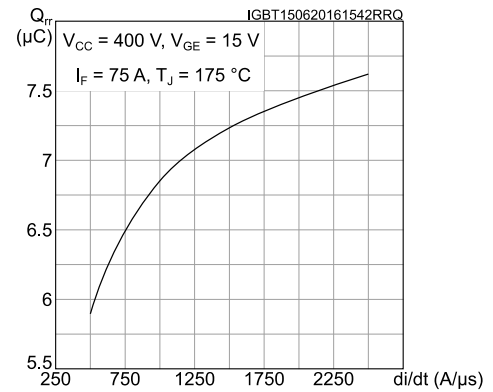


Figure 26: Reverse recovery energy vs. diode current slope

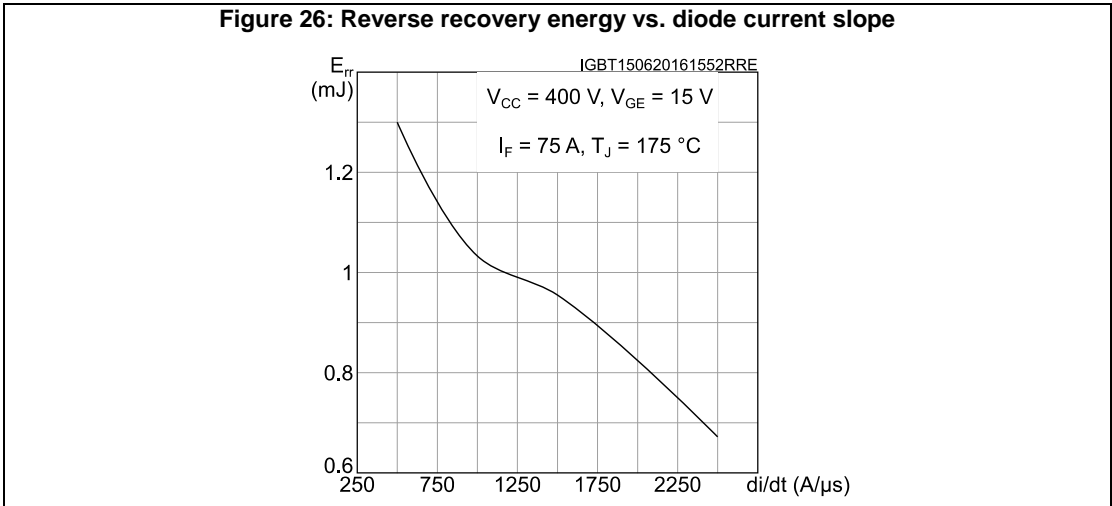


Figure 27: Thermal impedance for IGBT

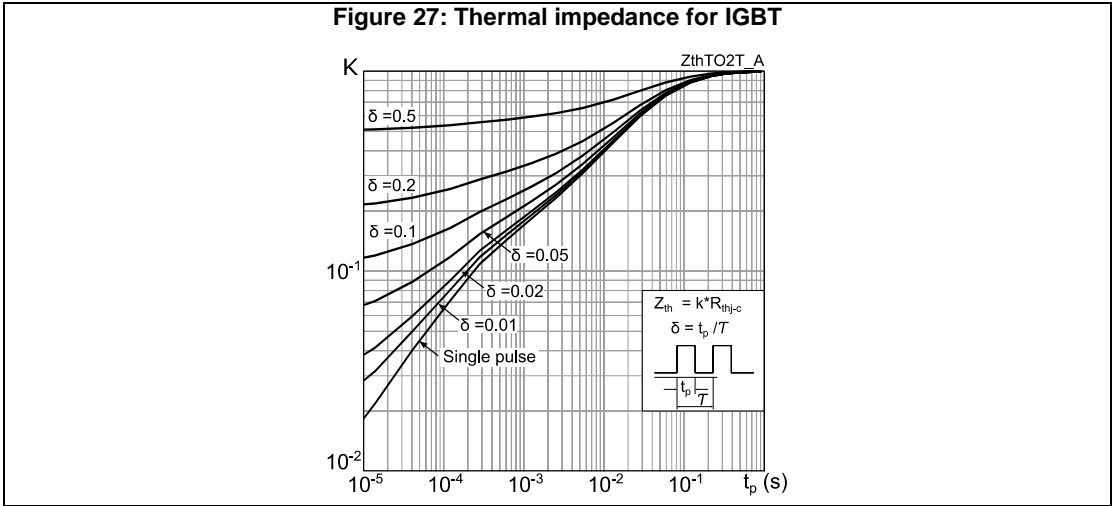
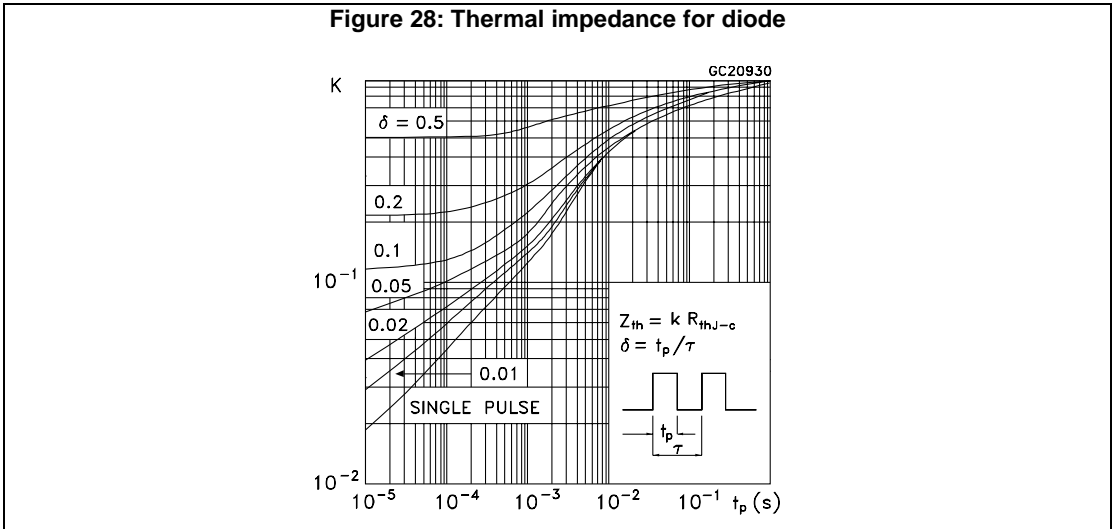


Figure 28: Thermal impedance for diode





## 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 TO-247 package information

Figure 33: TO-247 package outline

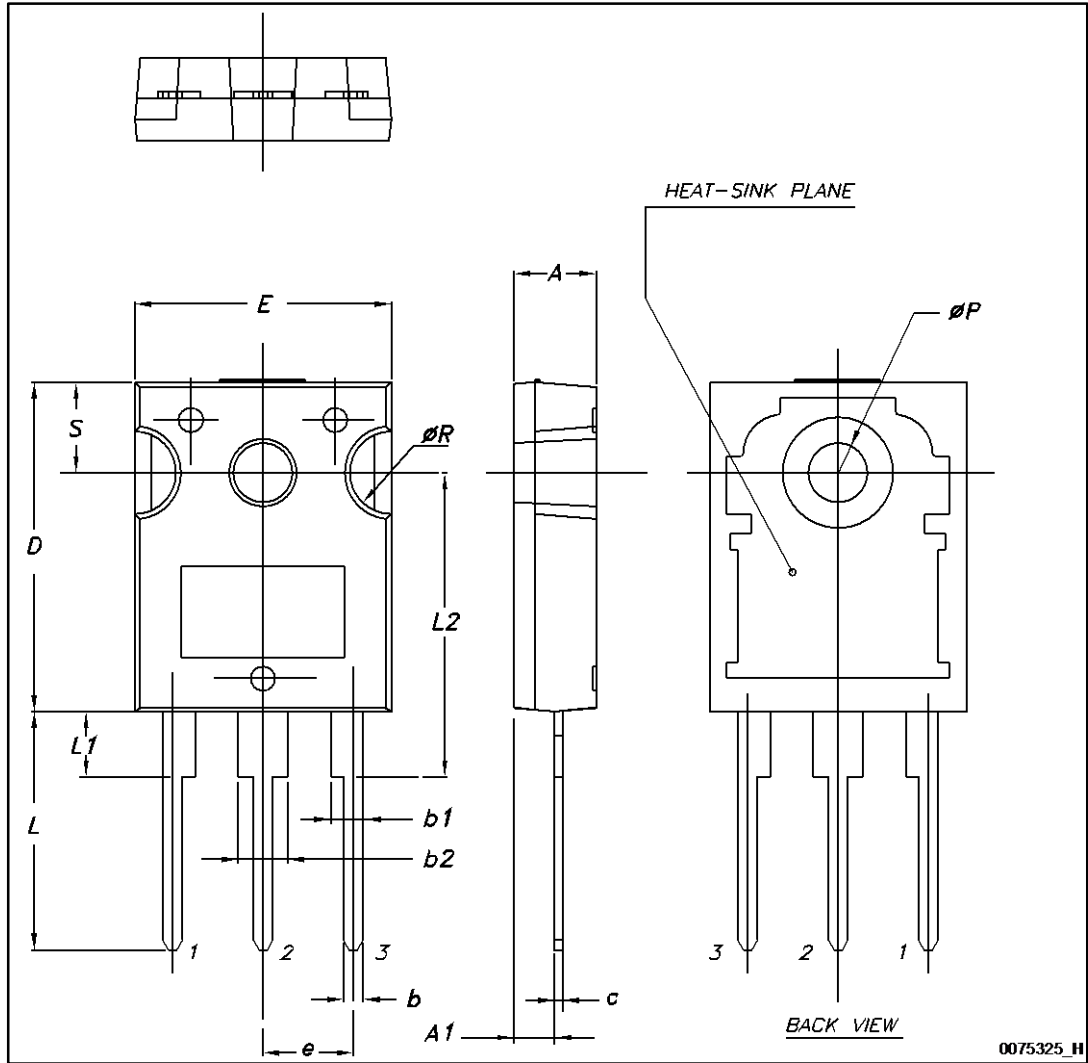
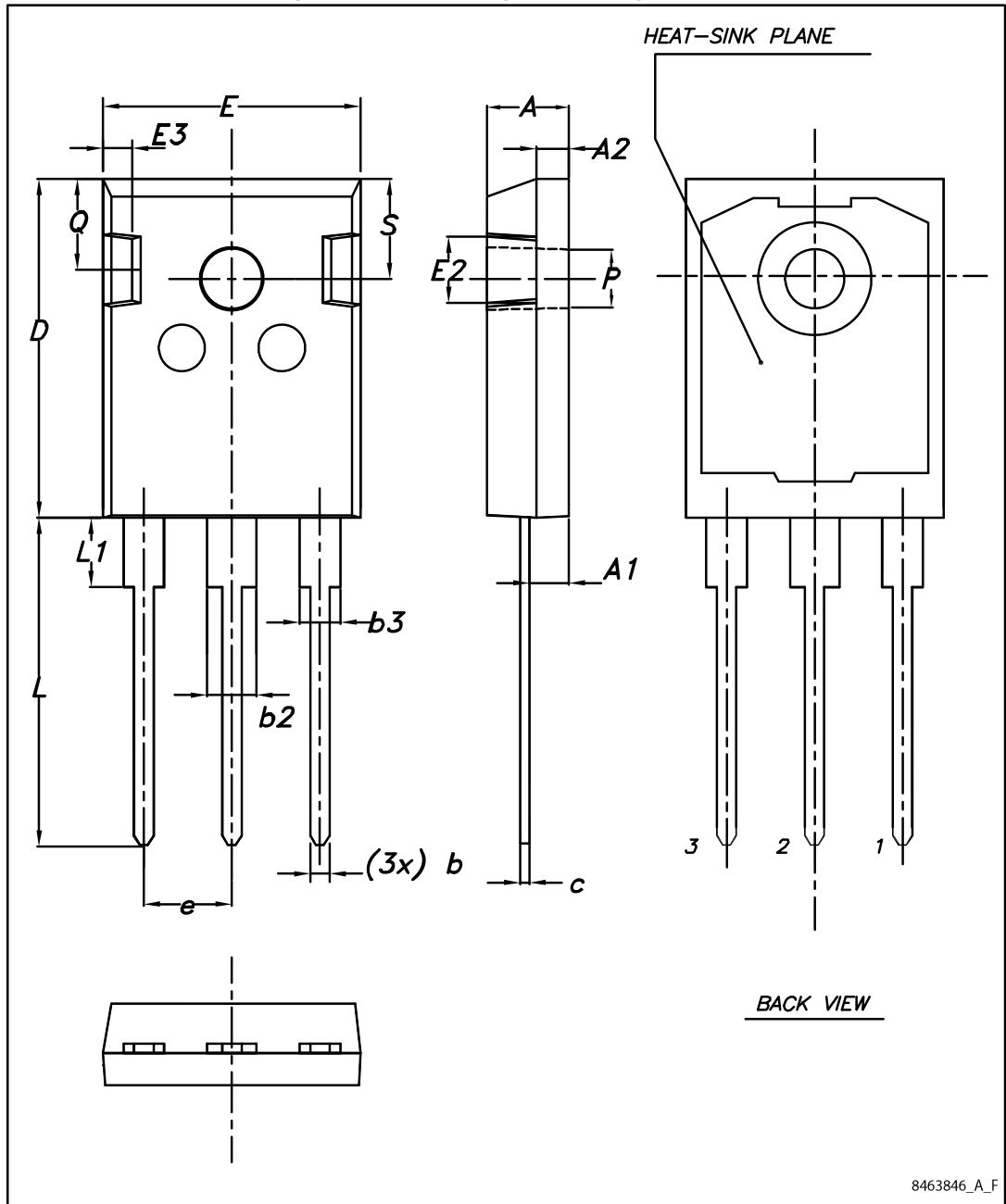


Table 8: TO-247 package mechanical data

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 34: TO-247 long lead package outline



8463846\_A\_F

Table 9: 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 10: Document revision history

Date	Revision	Changes
02-Dec-2015	1	First release.
15-Jun-2016	2	Inserted device in TO-247 and document updated accordingly. Inserted <a href="#">Section 2.1: "Electrical characteristics(curves)"</a> . Document status promoted from preliminary to production data. Minor text changes.



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