

Trench gate field-stop IGBT, M series 650 V, 50 A low loss

Datasheet - production data

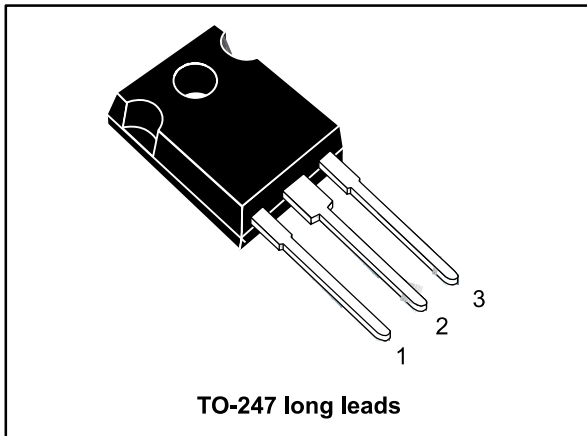
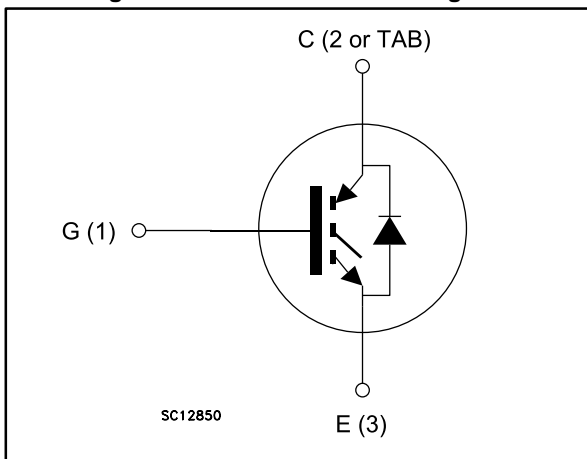


Figure 1: Internal schematic diagram



Features

- 6 μ s of minimum short-circuit withstand time
- $V_{CE(sat)} = 1.65$ V (typ.) @ $I_C = 50$ A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

Applications

- Motor control
- UPS
- PFC

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is 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
STGWA50M65DF2	G50M65DF2	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
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	80	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	50	A
$I_{CP}^{(2)}$	Pulsed collector current	150	A
V_{GE}	Gate-emitter voltage	± 20	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25\text{ °C}$	80	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	50	A
$I_{FP}^{(2)}$	Pulsed forward current	150	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	375	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	0.4	°C/W
R_{thJC}	Thermal resistance junction-case diode	0.96	°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	$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$		1.65	2.1	V
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 125\text{ °C}$		1.95		
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 175\text{ °C}$		2.1		
V_F	Forward on-voltage	$I_F = 50\text{ A}$		1.85		V
		$I_F = 50\text{ A}$, $T_J = 125\text{ °C}$		1.65		
		$I_F = 50\text{ A}$, $T_J = 175\text{ °C}$		1.55		
$V_{GE(th)}$	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	μA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	4200	-	pF
C_{oes}	Output capacitance		-	252	-	
C_{res}	Reverse transfer capacitance		-	88	-	
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$ (see Figure 30 : "Gate charge test circuit")	-	150	-	nC
Q_{ge}	Gate-emitter charge		-	32	-	
Q_{gc}	Gate-collector charge		-	62	-	

Table 6: IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 6.8\ \Omega$ (see Figure 29: "Test circuit for inductive load switching")		42	-	ns
t_r	Current rise time			21	-	ns
$(di/dt)_{on}$	Turn-on current slope			1942	-	A/ μ s
$t_{d(off)}$	Turn-off-delay time			130	-	ns
t_f	Current fall time			104	-	ns
$E_{on}^{(1)}$	Turn-on switching energy			0.88	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy			1.57	-	mJ
E_{ts}	Total switching energy			2.45	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 6.8\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29: "Test circuit for inductive load switching")		42	-	ns
t_r	Current rise time			24	-	ns
$(di/dt)_{on}$	Turn-on current slope			1700	-	A/ μ s
$t_{d(off)}$	Turn-off-delay time			131	-	ns
t_f	Current fall time			184	-	ns
$E_{on}^{(1)}$	Turn-on switching energy			1.97	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy			2.22	-	mJ
E_{ts}	Total switching energy			4.19	-	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		-	μ 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	$I_F = 50\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$ (see Figure 29: "Test circuit for inductive load switching") $di/dt = 1000\text{ A}/\mu\text{s}$	-	162	-	ns
Q_{rr}	Reverse recovery charge		-	1.37	-	μC
I_{rrm}	Reverse recovery current		-	19	-	A
di_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	420	-	$\text{A}/\mu\text{s}$
E_{rr}	Reverse recovery energy		-	192	-	μJ
t_{rr}	Reverse recovery time	$I_F = 50\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29: "Test circuit for inductive load switching") $di/dt = 1000\text{ A}/\mu\text{s}$	-	262	-	ns
Q_{rr}	Reverse recovery charge		-	5.1	-	μC
I_{rrm}	Reverse recovery current		-	34	-	A
di_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	160	-	$\text{A}/\mu\text{s}$
E_{rr}	Reverse recovery energy		-	676	-	μJ

2.2 Electrical characteristics (curves)

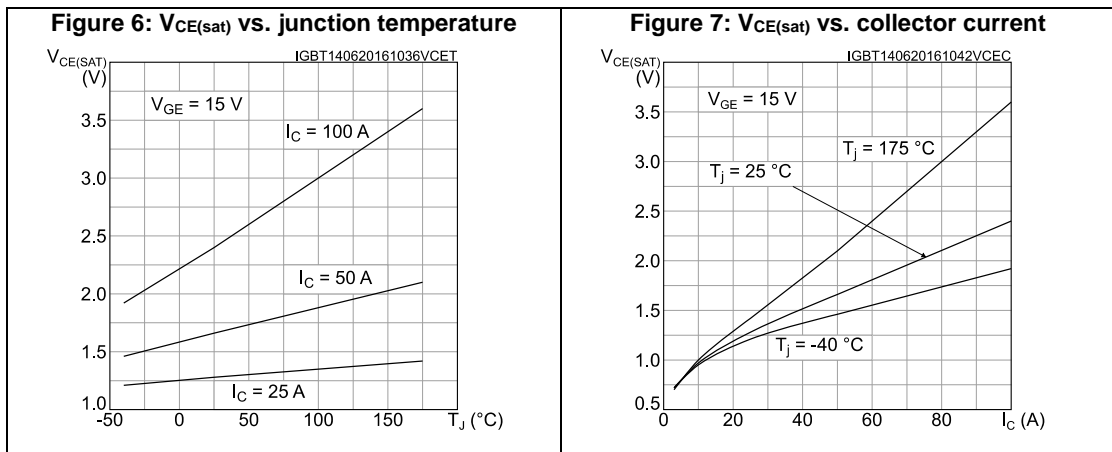
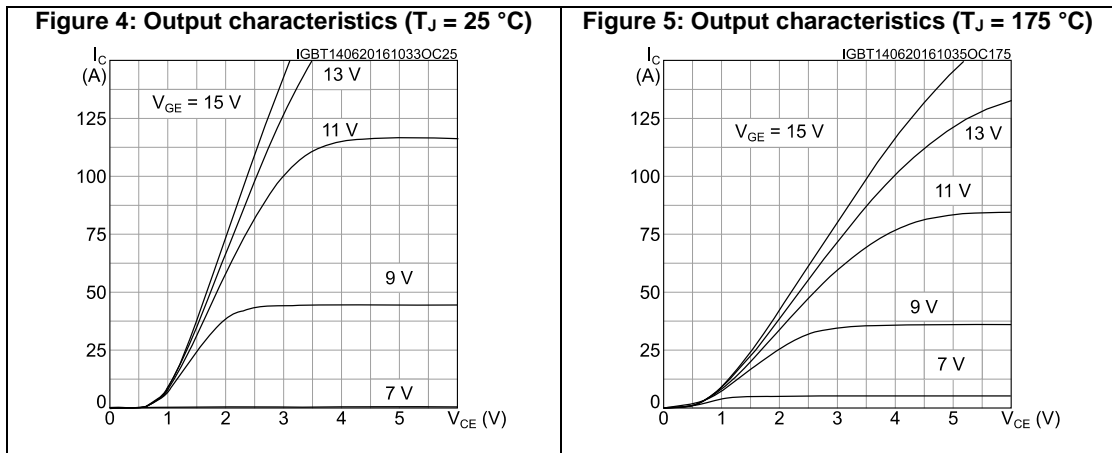
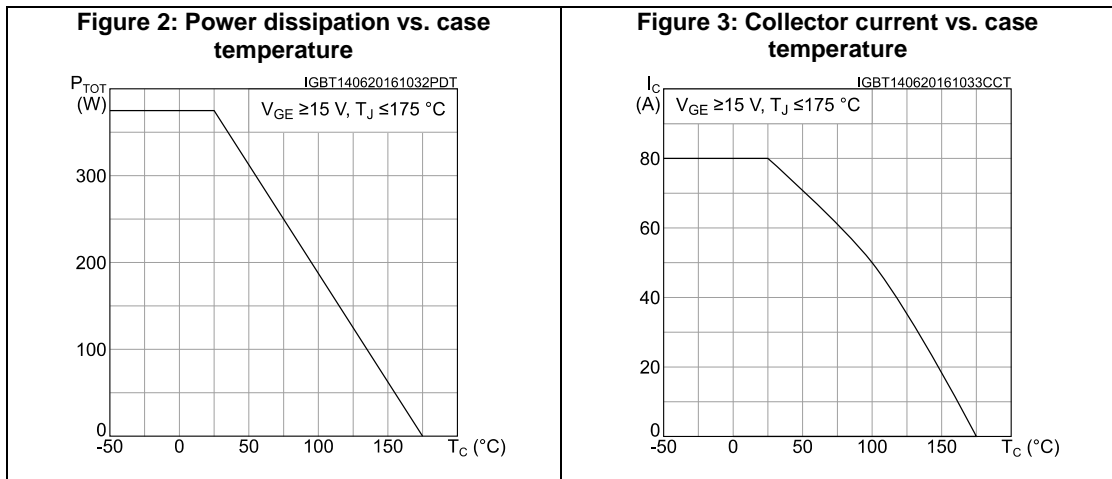


Figure 8: Collector current vs. switching frequency

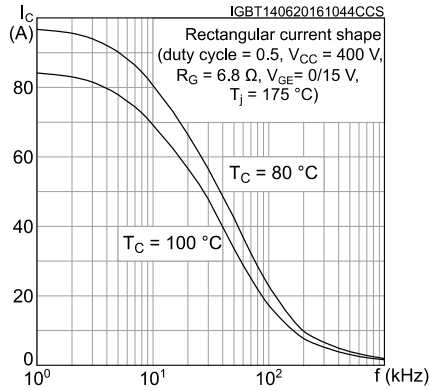


Figure 9: Forward bias safe operating area

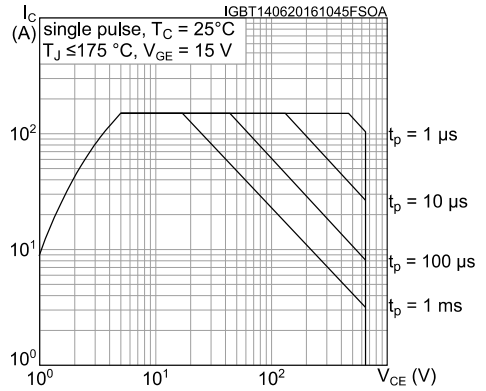


Figure 10: Transfer characteristics

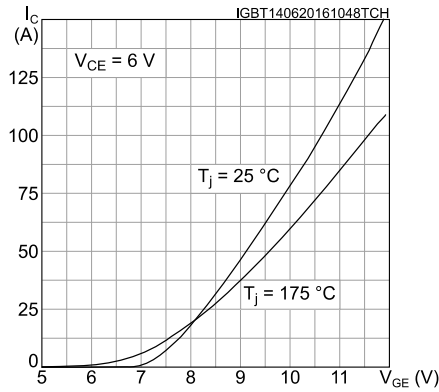


Figure 11: Diode V_F vs. forward current

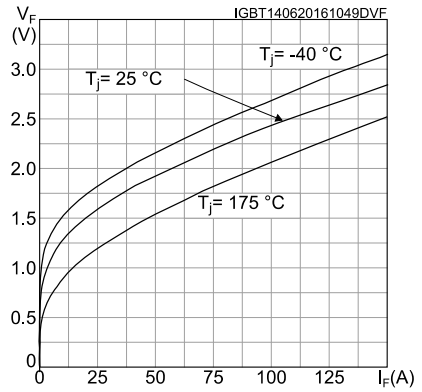


Figure 12: Normalized V_{GE(th)} vs. junction temperature

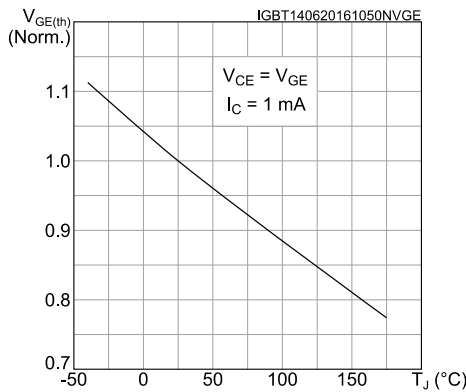


Figure 13: Normalized V_{(BR)CES} vs. junction temperature

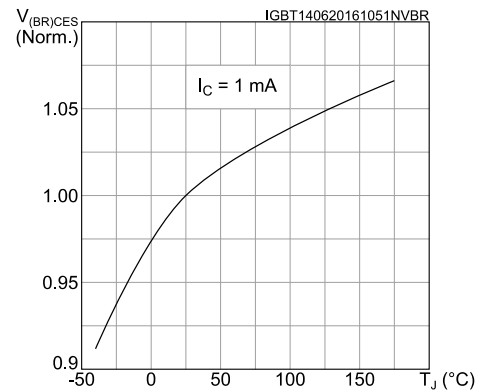


Figure 14: Capacitance variations

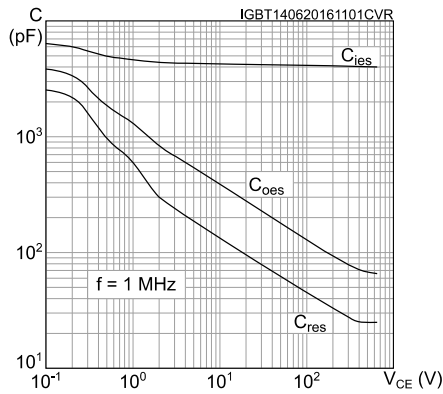


Figure 15: Gate charge vs. gate-emitter voltage

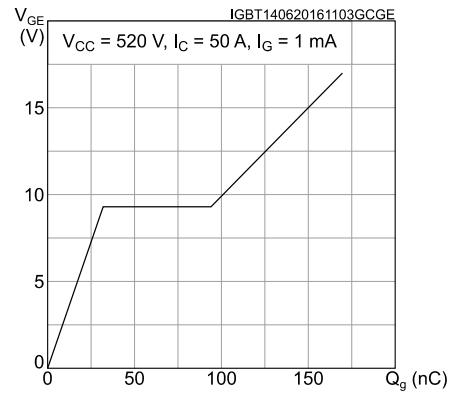


Figure 16: Switching energy vs. collector current

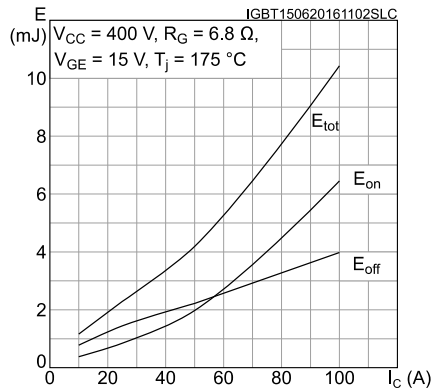


Figure 17: Switching energy vs. gate resistance

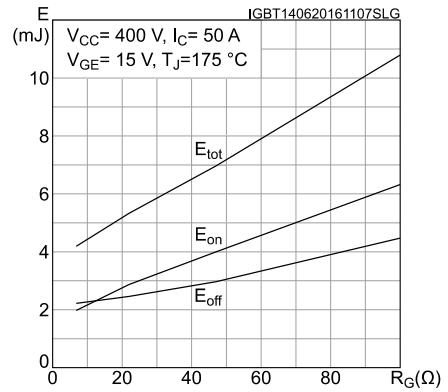


Figure 18: Switching energy vs. temperature

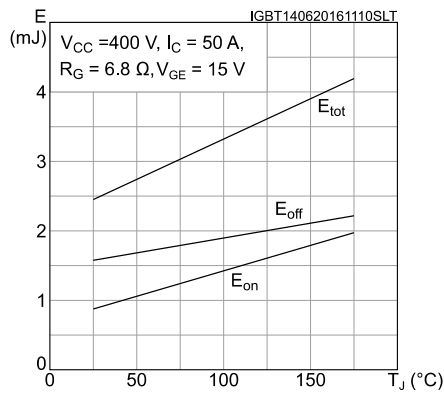


Figure 19: Switching energy vs. collector emitter voltage

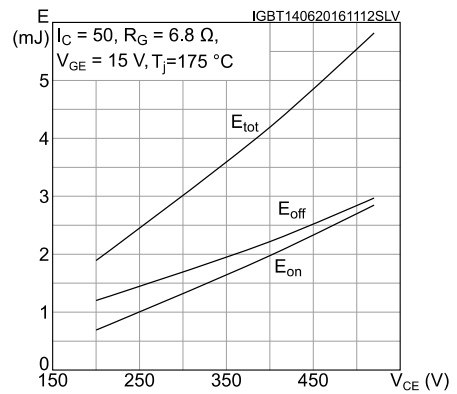


Figure 20: Short-circuit time and current vs. V_{GE}

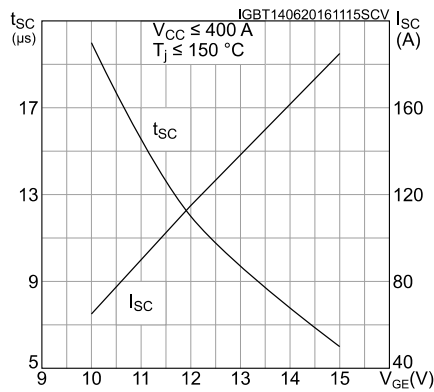


Figure 21: Switching times vs. collector current

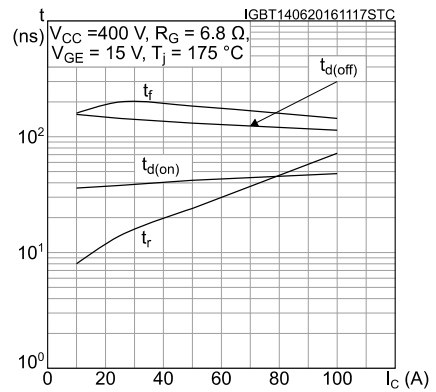


Figure 22: Switching times vs. gate resistance

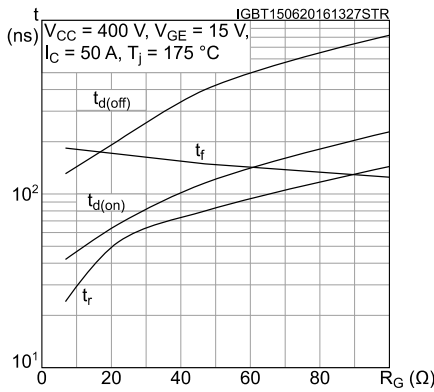


Figure 23: Reverse recovery current vs. diode current slope

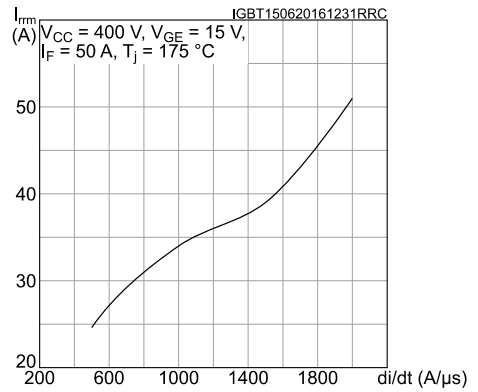


Figure 24: Reverse recovery time vs. diode current slope

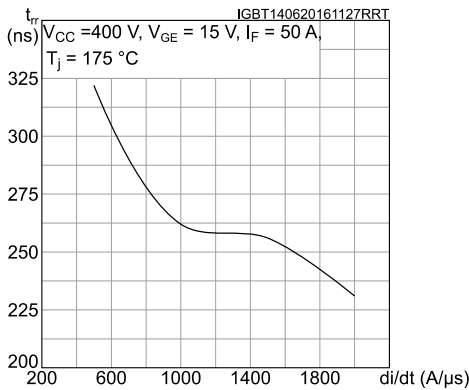


Figure 25: Reverse recovery charge vs. diode current slope

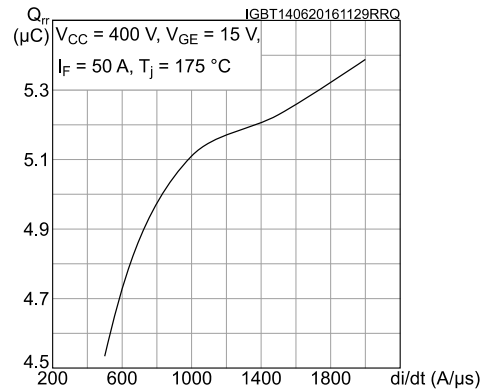


Figure 26: Reverse recovery energy vs. diode current slope

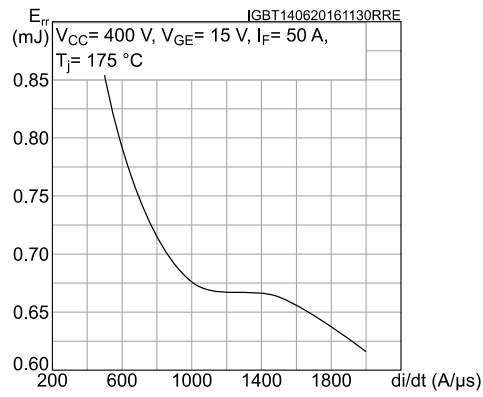


Figure 27: Thermal impedance for IGBT

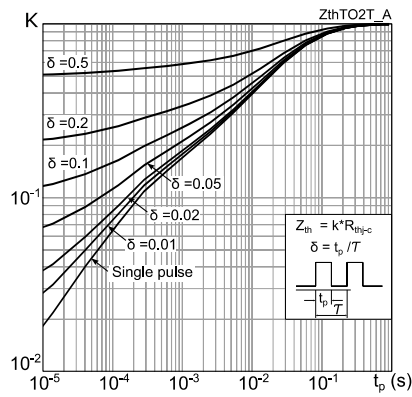
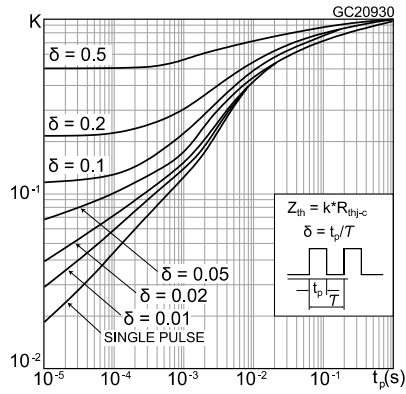
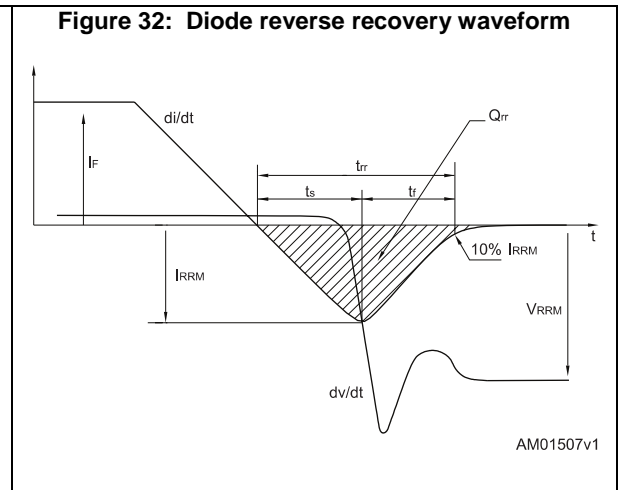
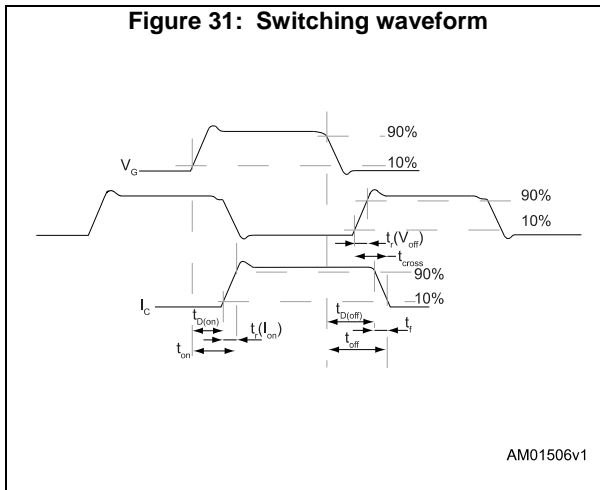
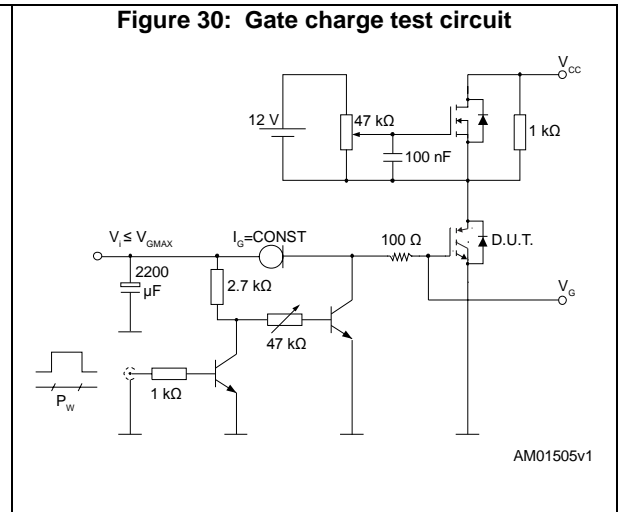
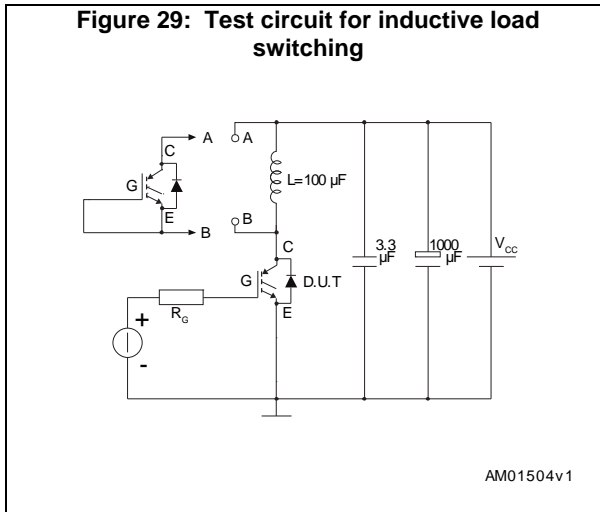


Figure 28: Thermal impedance for diode



3 Test circuits



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 Package information

Figure 33: TO-247 long lead package outline

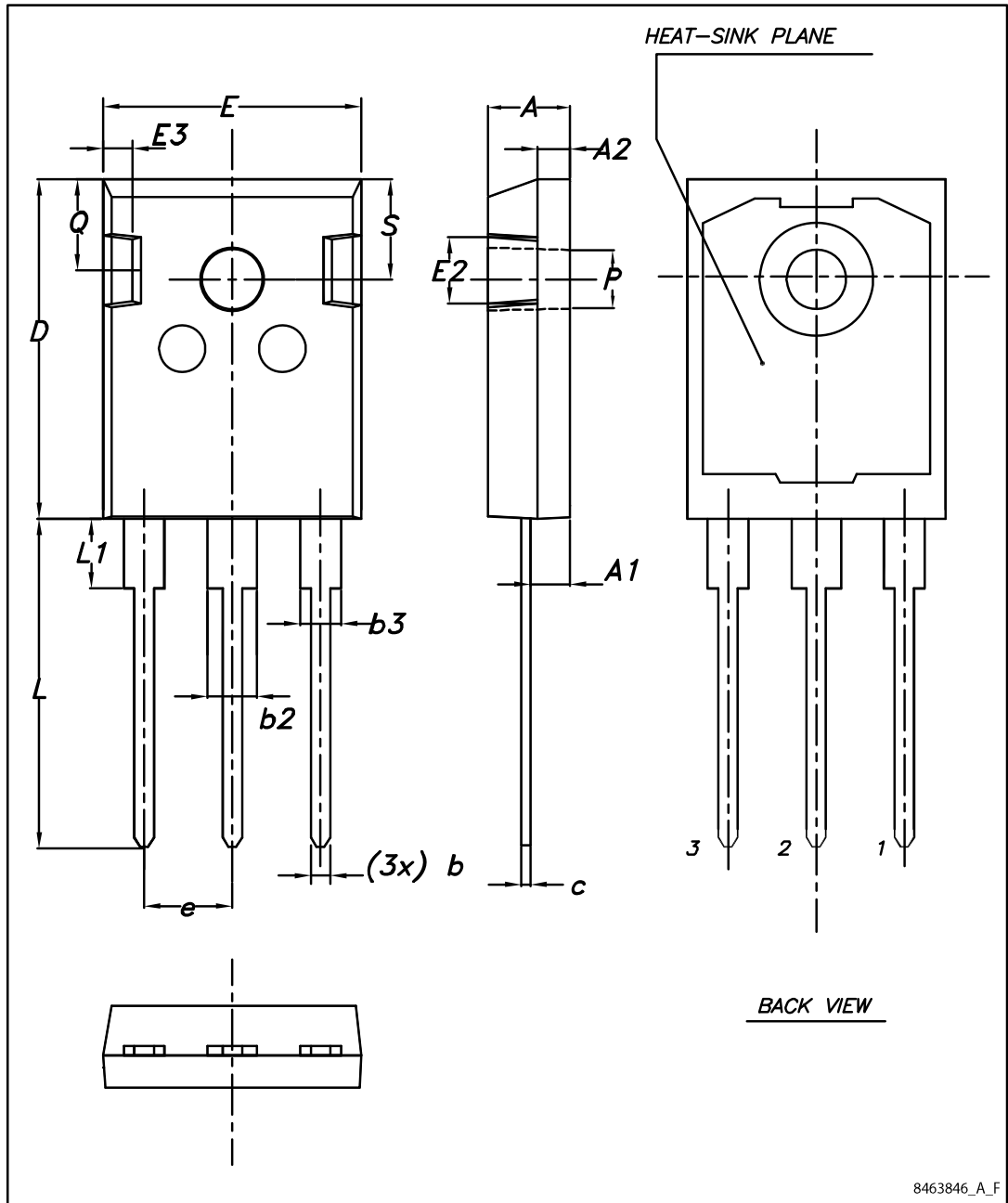


Table 8: TO-247 long lead package mechanical data

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
27-Nov-2015	1	First release.
14-Jun-2016	2	Modified: features and applications in cover page Modified: <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Static characteristics"</i> , <i>Table 5: "Dynamic characteristics"</i> , <i>Table 6: "IGBT switching characteristics (inductive load)"</i> , <i>Table 7: "Diode switching characteristics (inductive load)"</i> Added: <i>Section 2.1: "Electrical characteristics (curves)"</i> Minor text changes

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