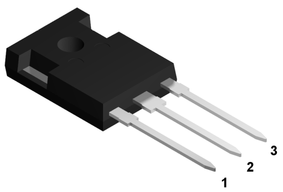
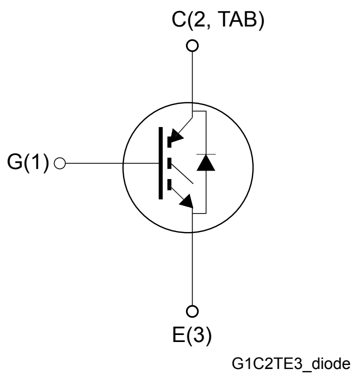
Trench gate field-stop, 650 V, 20 A low-loss M series IGBT in a TO-247 long leads package



TO-247 long leads



Features

- Maximum junction temperature: T_J = 175 °C
- High short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ I_C = 20 A
- Tight parameters distribution
- Low thermal resistance
- Soft and very fast-recovery antiparallel diode

Applications

- Motor control
- UPS
- PFC
- General-purpose inverters

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 the low-loss and the short-circuit functionality is essential.

Product status link
STGWA20M65DF2

Product summary	
Order code	STGWA20M65DF2
Marking	G20M65DF2
Package	TO-247 long leads
Packing	Tube

1 Electrical ratings

Table 1. 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 °C	40	A
I_C	Continuous collector current at T_C = 100 °C	20	A
I_{CP} (1)	Pulsed collector current	80	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	40	A
I_F	Continuous forward current at T_C = 100 °C	20	A
I_{FP} (1)	Pulsed forward current	80	A
P_{TOT}	Total power dissipation at T_C = 25 °C	166	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature range	- 55 to 175	°C

1. *Pulse width limited by maximum junction temperature.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case, IGBT	0.9	°C/W
R_{thJC}	Thermal resistance, junction-to-case, diode	2.08	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	50	°C/W

2 Electrical characteristics

T_C = 25 °C unless otherwise specified

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_C = 250 μA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 20 A		1.55	2.0	V
		V_{GE} = 15 V, I_C = 20 A, T_J = 125 °C		1.95		
		V_{GE} = 15 V, I_C = 20 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 20 A		1.85		V
		I_F = 20 A, T_J = 125 °C		1.65		
		I_F = 20 A, T_J = 175 °C		1.55		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 500 μA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 V			25	μA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ± 20 V			250	nA

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	1688	-	pF
C_{oes}	Output capacitance		-	95	-	
C_{res}	Reverse transfer capacitance		-	35	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 20 A, V_{GE} = 0 to 15 V (see Figure 29. Gate charge test circuit)	-	63	-	nC
Q_{ge}	Gate-emitter charge		-	15	-	
Q_{gc}	Gate-collector charge		-	26	-	

Table 5. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 20 A, V_{GE} = 15 V, R_G = 12 Ω (see Figure 28. Test circuit for inductive load switching)		26	-	ns
t_r	Current rise time			10.8	-	ns
$(di/dt)_{on}$	Turn-on current slope			1409	-	A/µs
$t_{d(off)}$	Turn-off delay time			108	-	ns
t_f	Current fall time			65	-	ns
E_{on}(1)	Turn-on switching energy			0.14	-	mJ
E_{off}(2)	Turn-off switching energy			0.56	-	mJ
E_{ts}	Total switching energy			0.7	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 20 A, V_{GE} = 15 V, R_G = 12 Ω, T_J = 175 °C (see Figure 28. Test circuit for inductive load switching)		28.4	-	ns
t_r	Current rise time			11.2	-	ns
$(di/dt)_{on}$	Turn-on current slope			1393	-	A/µs
$t_{d(off)}$	Turn-off delay time			107	-	ns
t_f	Current fall time			145	-	ns
E_{on}(1)	Turn-on switching energy			0.3	-	mJ
E_{off}(2)	Turn-off switching energy			0.85	-	mJ
E_{ts}	Total switching energy			1.15	-	mJ
t_{sc}	Short-circuit withstand time	V_{CC} = 400 V, V_{GE} = 13 V, T_{Jstart} = 150 °C	10		-	µs
		V_{CC} = 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	6		-	

1. *Including the reverse recovery of the diode.*
2. *Including the tail of the collector current.*

Table 6. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	I_F = 20 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see Figure 28. Test circuit for inductive load switching)	-	166		ns
Q_{rr}	Reverse recovery charge		-	690		nC
I_{rrm}	Reverse recovery current		-	13.2		A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	769		A/µs
E_{rr}	Reverse recovery energy		-	81		µJ
t_{rr}	Reverse recovery time	I_F = 20 A, V_R = 400 V, V_{GE} = 15 V, T_J = 175 °C, di/dt = 1000 A/µs (see Figure 28. Test circuit for inductive load switching)	-	281		ns
Q_{rr}	Reverse recovery charge		-	2010		nC
I_{rrm}	Reverse recovery current		-	19.6		A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	370		A/µs
E_{rr}	Reverse recovery energy		-	215		µJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

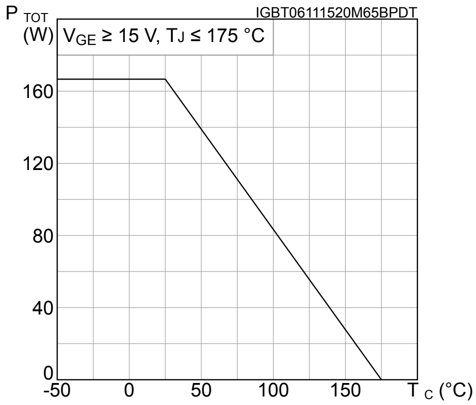


Figure 2. Collector current vs case temperature

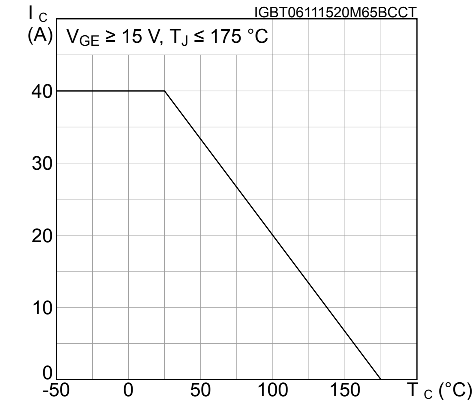


Figure 3. Output characteristics (T_J = 25 °C)

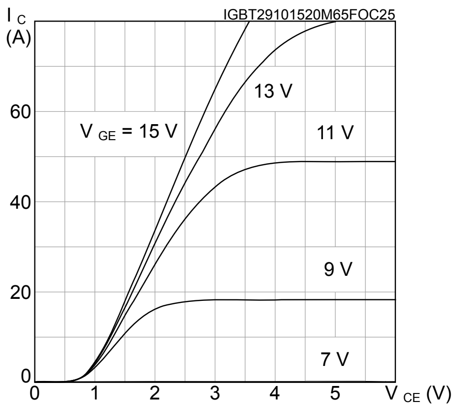


Figure 4. Output characteristics (T_J = 175 °C)

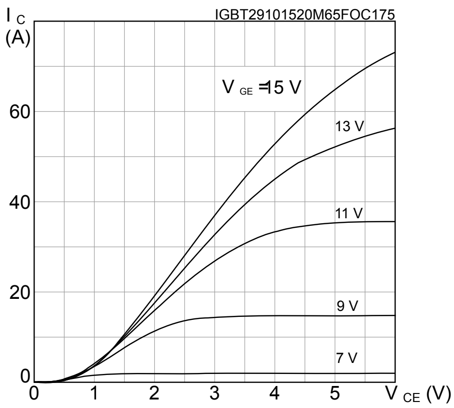


Figure 5. V_{CE}(sat) vs junction temperature

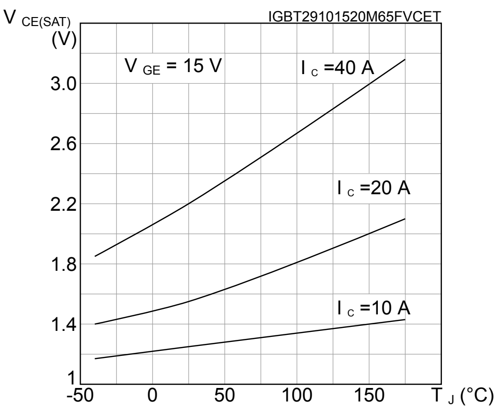


Figure 6. V_{CE}(sat) vs collector current

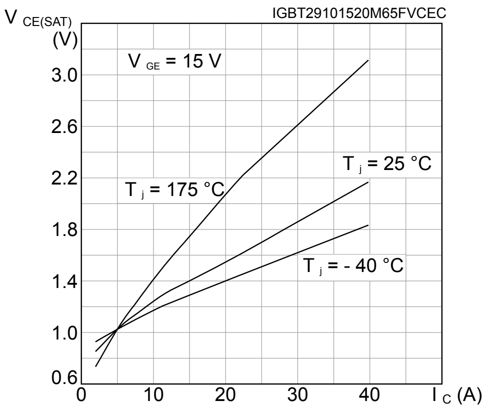


Figure 7. Collector current vs switching frequency

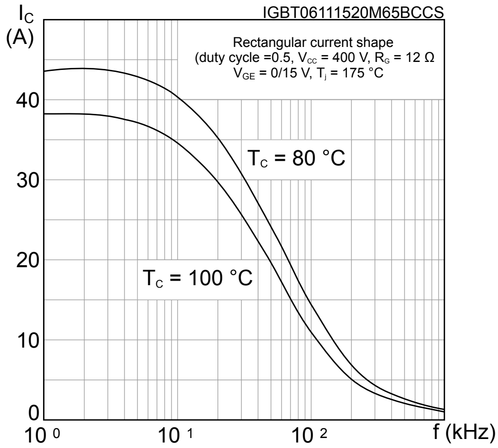


Figure 8. Forward bias safe operating area

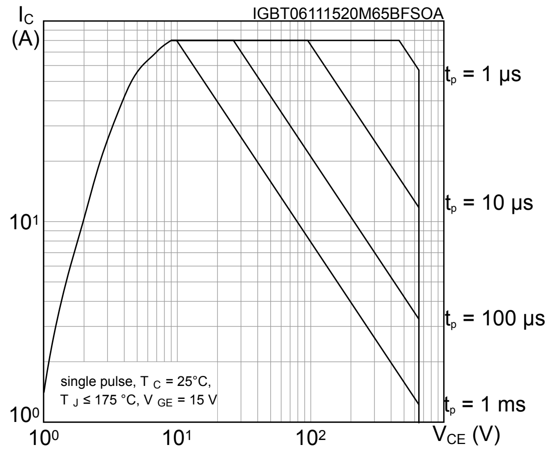


Figure 9. Transfer characteristics

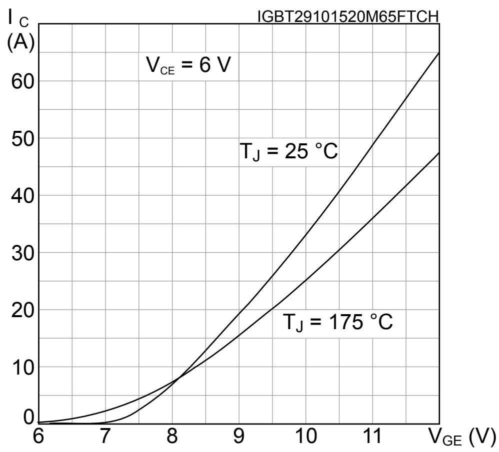


Figure 10. Diode V_F vs forward current

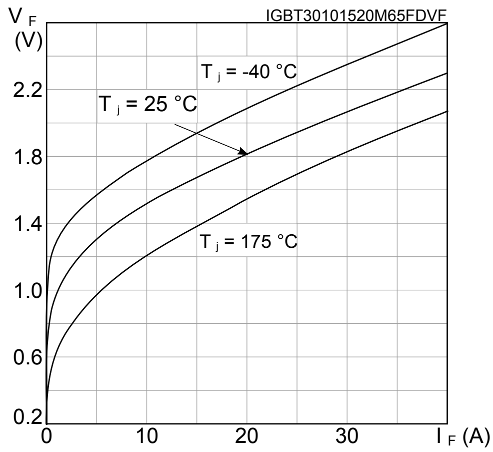


Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

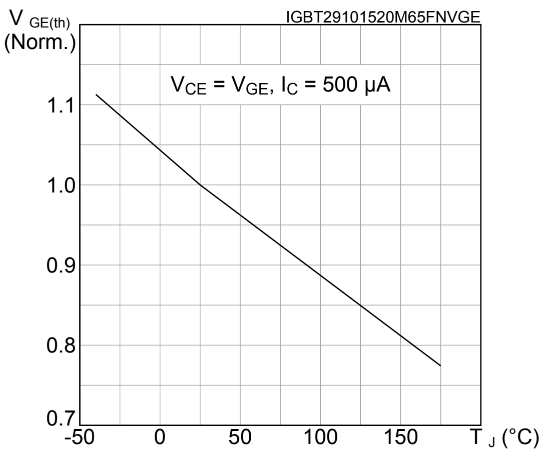


Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature

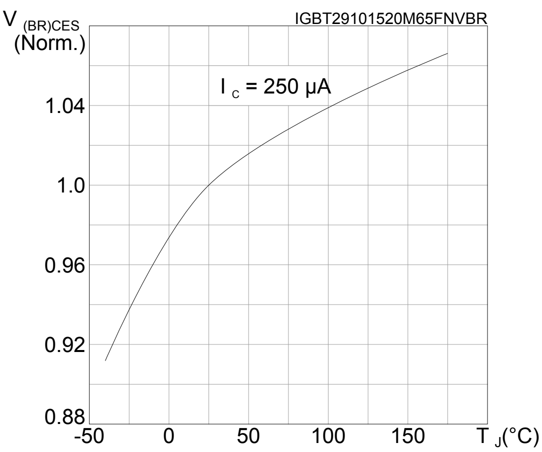


Figure 13. Capacitance variations

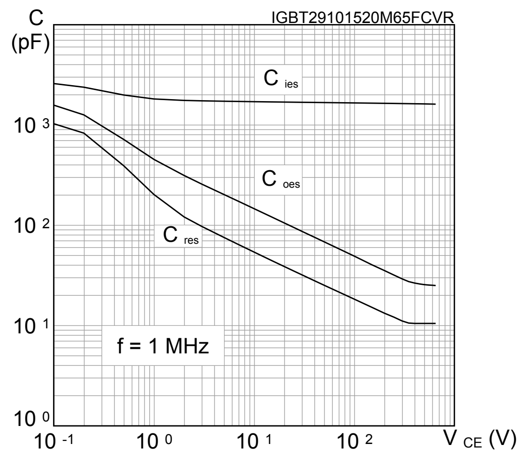


Figure 14. Gate charge vs gate-emitter voltage

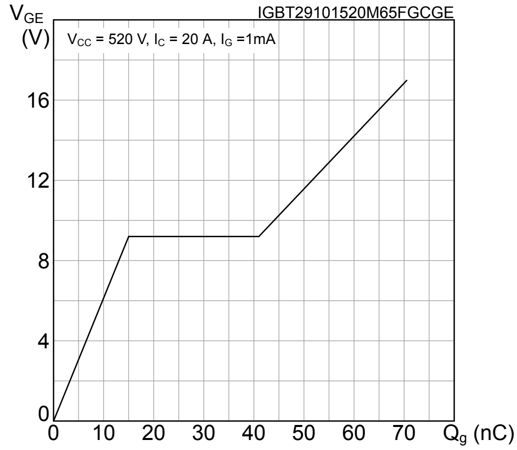


Figure 15. Switching energy vs collector current

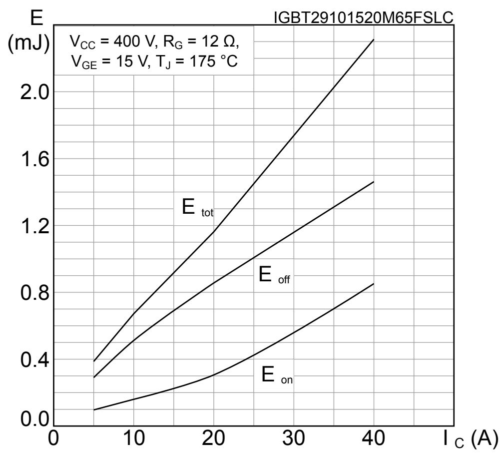


Figure 16. Switching energy vs gate resistance

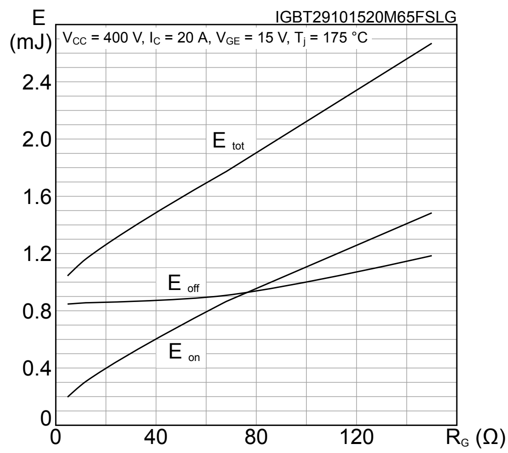


Figure 17. Switching energy vs temperature

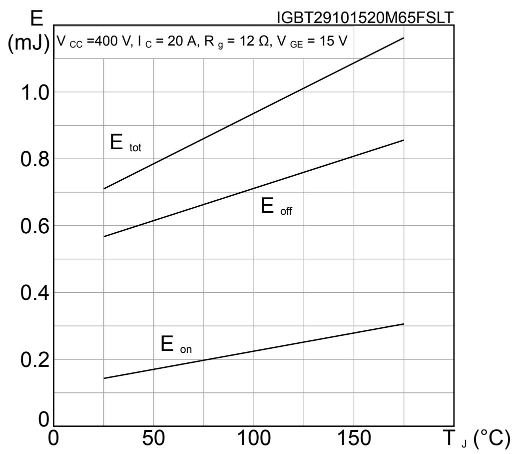


Figure 18. Switching energy vs collector emitter voltage

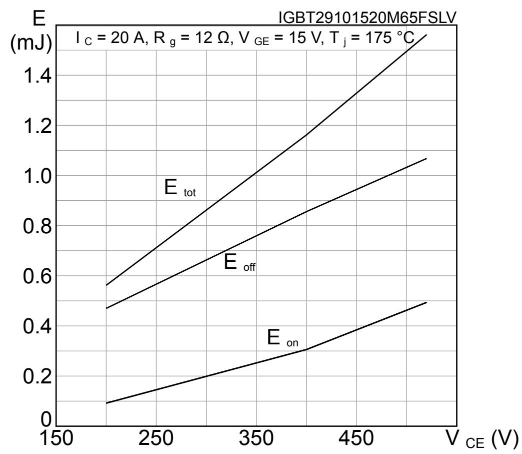


Figure 19. Short-circuit time and current vs V_{GE}

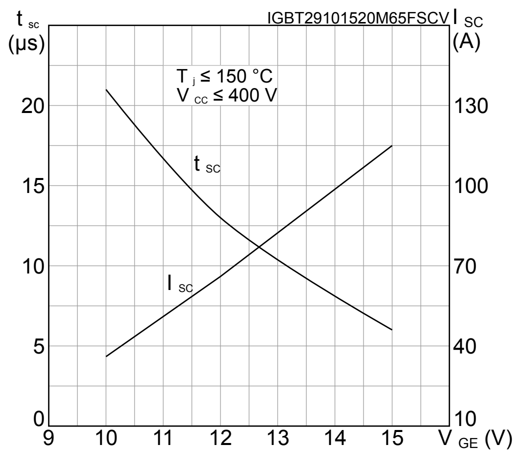


Figure 20. Switching times vs collector current

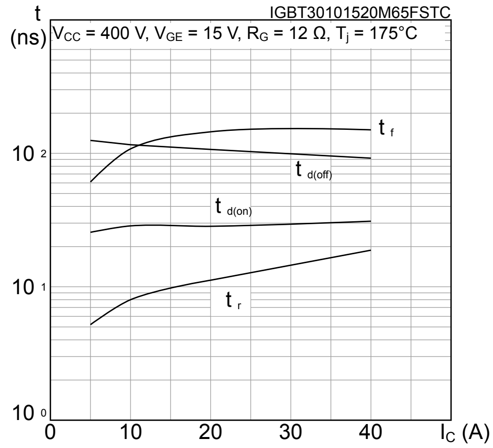


Figure 21. Switching times vs gate resistance

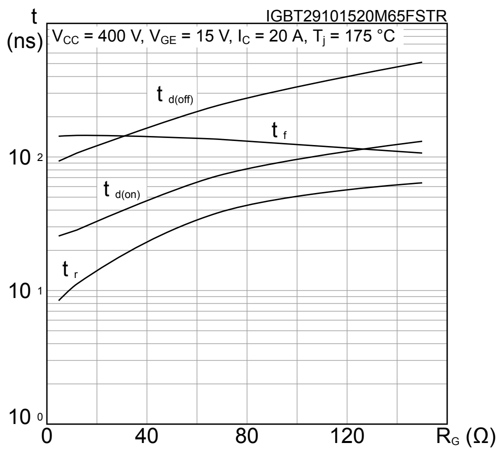


Figure 22. Reverse recovery current vs diode current slope

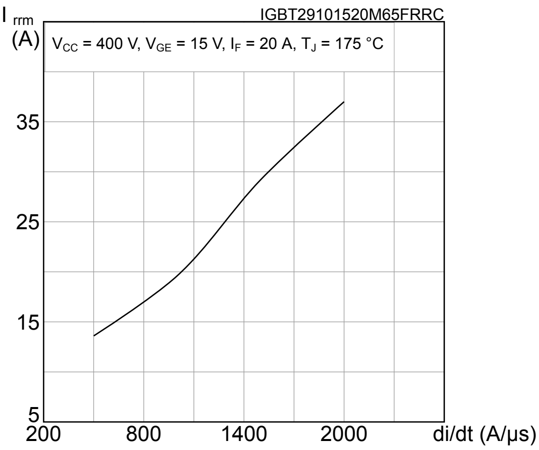


Figure 23. Reverse recovery time vs diode current slope

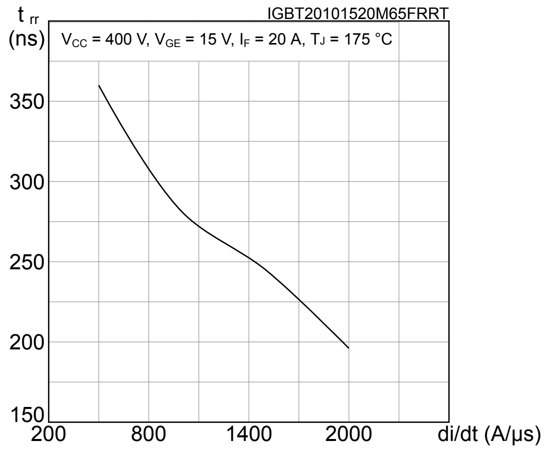


Figure 24. Reverse recovery charge vs diode current slope

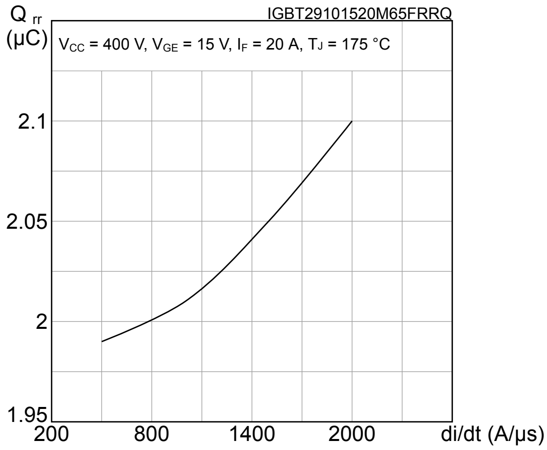


Figure 25. Reverse recovery energy vs diode current slope

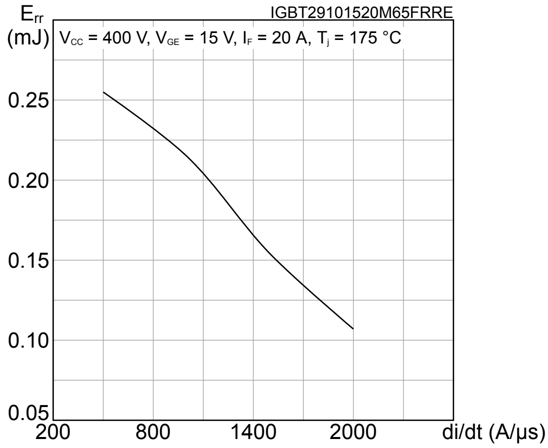


Figure 26. Thermal impedance for IGBT

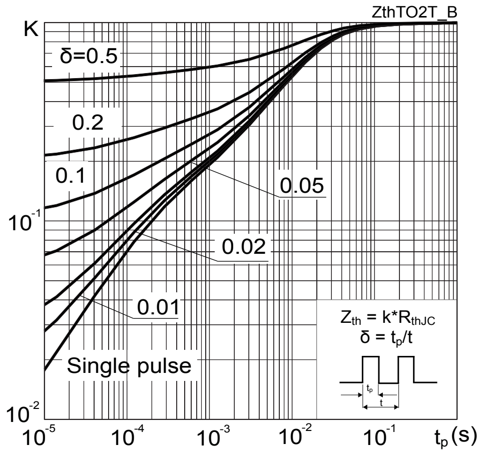
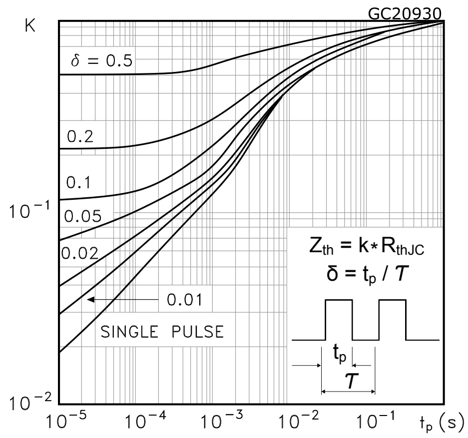


Figure 27. Thermal impedance for diode



3 Test circuits

Figure 28. Test circuit for inductive load switching

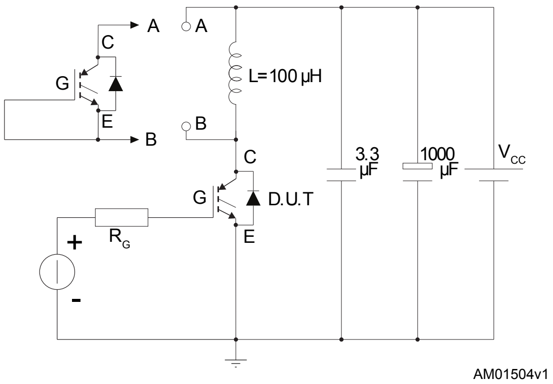


Figure 29. Gate charge test circuit

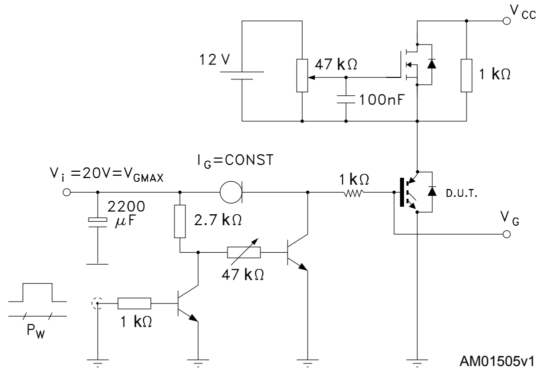


Figure 30. Switching waveform

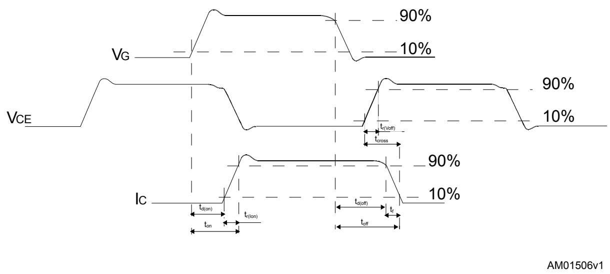
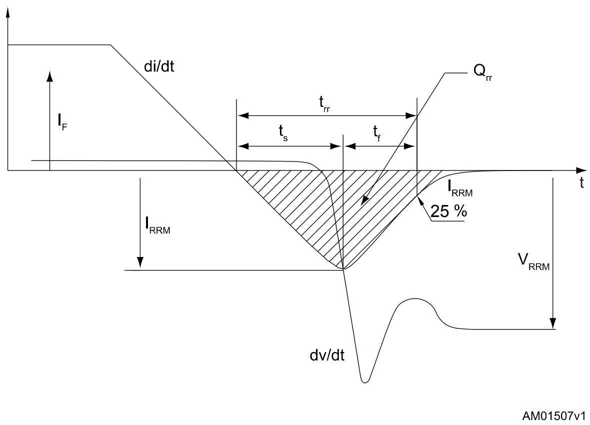


Figure 31. Diode reverse recovery waveform



4 Package information

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 long leads package information

Figure 32. TO-247 long leads package outline

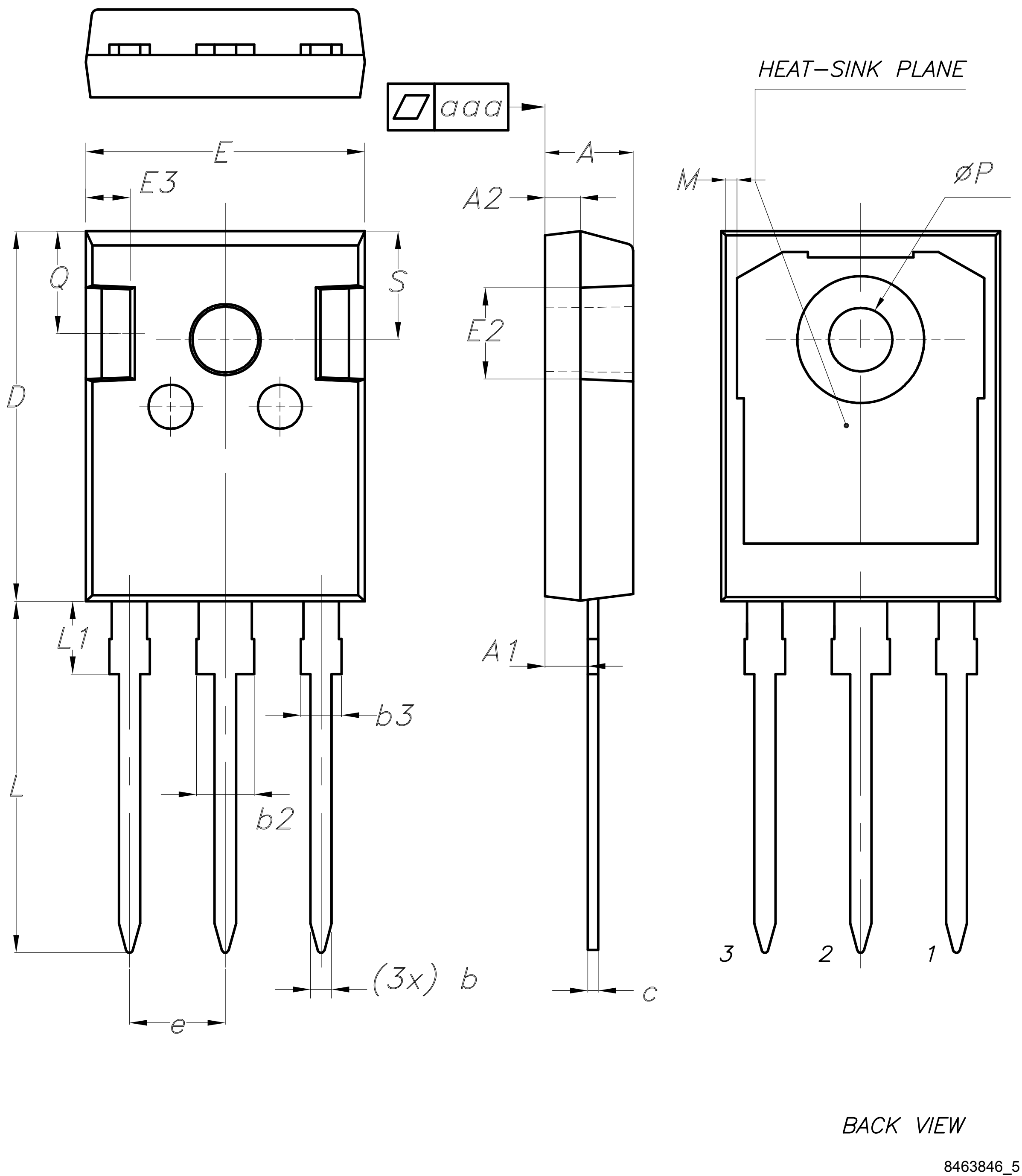


Table 7. TO-247 long leads package mechanical data

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
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

Revision history

Table 8. Document revision history

Date	Revision	Changes
10-Nov-2015	1	First release.
14-Apr-2016	2	Updated *Figure 13: "Normalized $V_{(BR)CES}$ vs. junction temperature"*. Minor text changes.
08-Oct-2018	3	Updated *Table 3. Static characteristics*. Minor text changes
15-Oct-2024	4	Updated SC12850 internal schematic no tab on cover page. Updated Description on cover page. Updated Section 4.1: TO-247 long leads package information. Minor text changes.

Contents