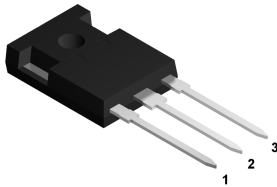
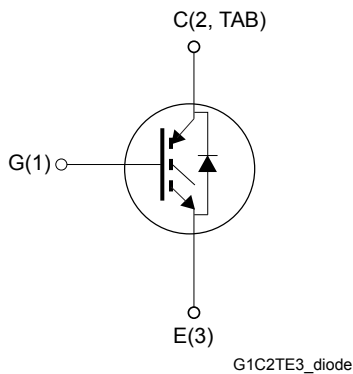


Trench gate field-stop, 650 V, 20 A low-loss M series IGBT in a TO-247 long leads package



TO-247 long leads



Features

- Maximum junction temperature: $T_J = 175\text{ °C}$
- High short-circuit withstand time
- $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 20\text{ A}$
- 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 $T_C = 25\text{ °C}$	40	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	20	A
$I_{CP}^{(1)}$	Pulsed collector current	80	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	40	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	20	A
$I_{FP}^{(1)}$	Pulsed forward current	80	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ °C}$	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

$T_C = 25\text{ °C}$ unless otherwise specified

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$		1.55	2.0	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ °C}$		1.95		
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 175\text{ °C}$		2.1		
V_F	Forward on-voltage	$I_F = 20\text{ A}$		1.85		V
		$I_F = 20\text{ A}, T_J = 125\text{ °C}$		1.65		
		$I_F = 20\text{ A}, T_J = 175\text{ °C}$		1.55		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 500\text{ }\mu\text{A}$	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 4. Dynamic characteristics

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

Table 5. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 12\ \Omega$ (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		$V_{CC} = 400\text{ V}$, $V_{GE} = 13\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$ $V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$		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			10		-	μs
				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	$I_F = 20\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (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	$I_F = 20\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (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)

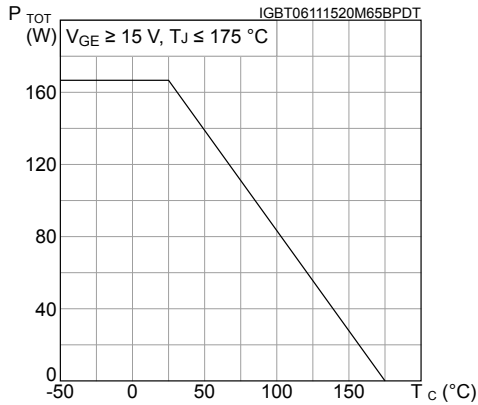
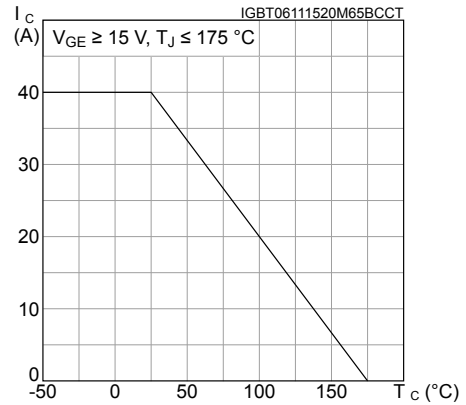
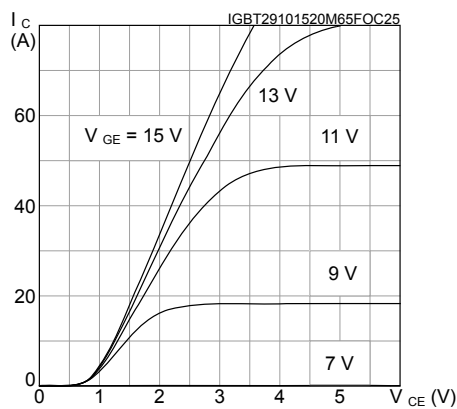
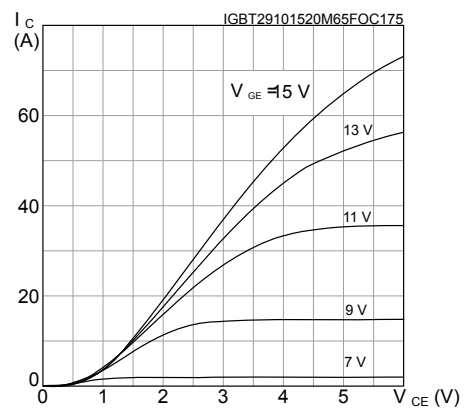
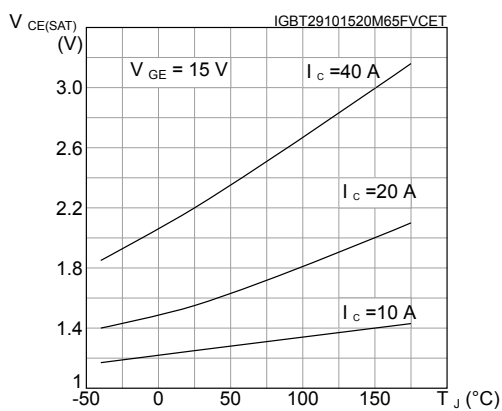
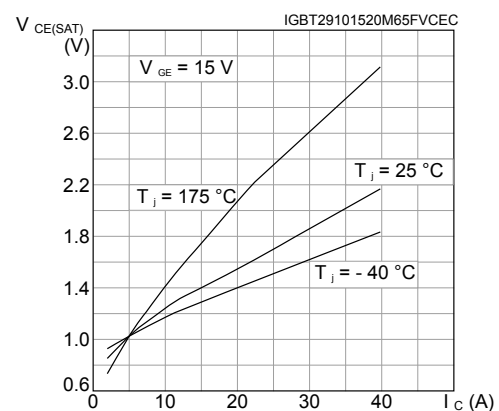
Figure 1. Power dissipation vs case temperature

Figure 2. Collector current vs case temperature

Figure 3. Output characteristics ($T_J = 25 \text{ }^\circ\text{C}$)

Figure 4. Output characteristics ($T_J = 175 \text{ }^\circ\text{C}$)

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

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


Figure 7. Collector current vs switching frequency

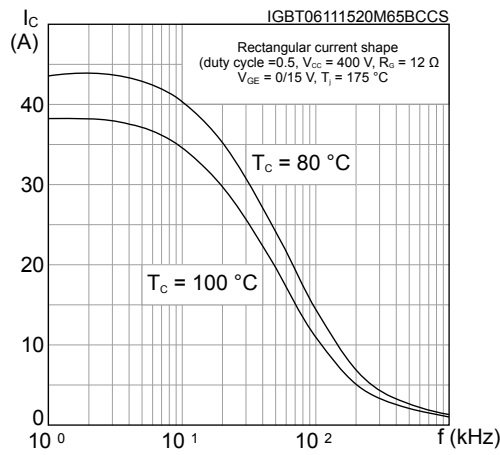


Figure 8. Forward bias safe operating area

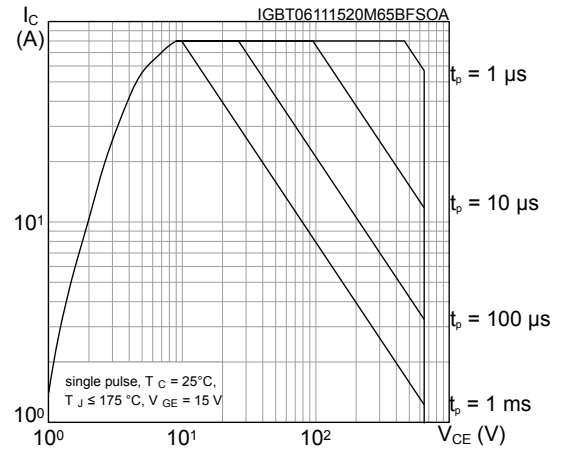


Figure 9. Transfer characteristics

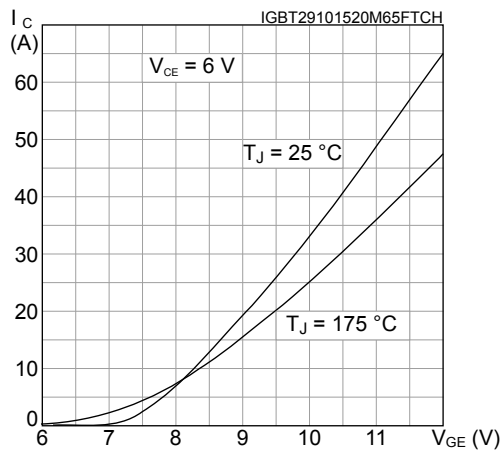


Figure 10. Diode V_F vs forward current

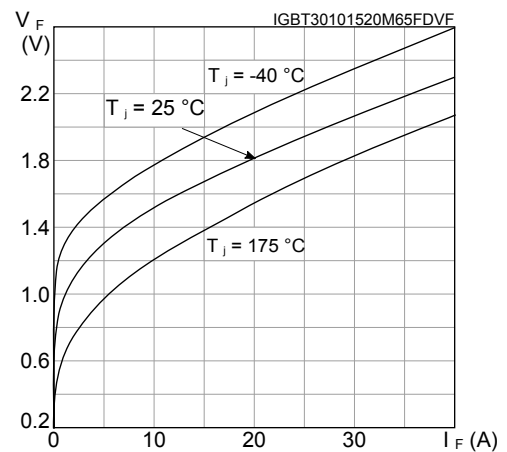


Figure 11. Normalized V_GE(th) vs junction temperature

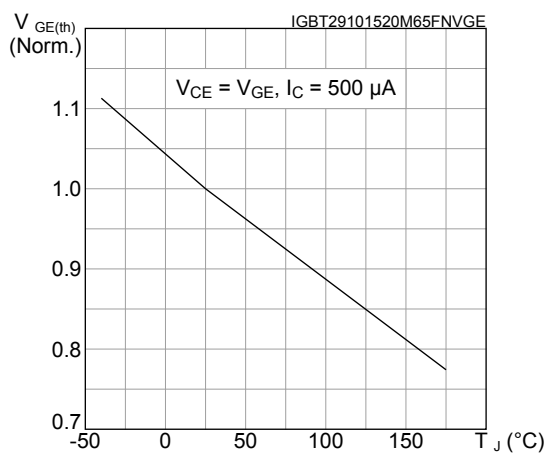


Figure 12. Normalized V_(BR)CES vs junction temperature

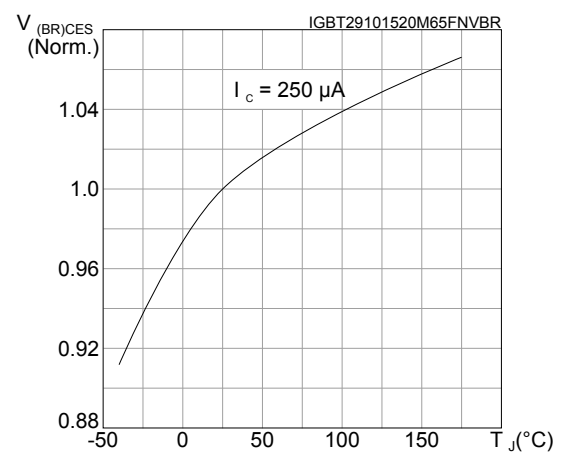


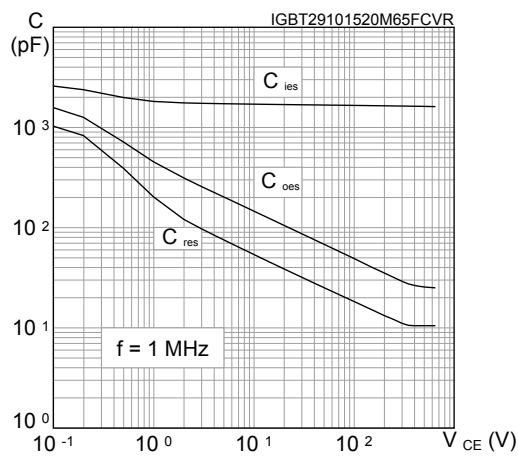
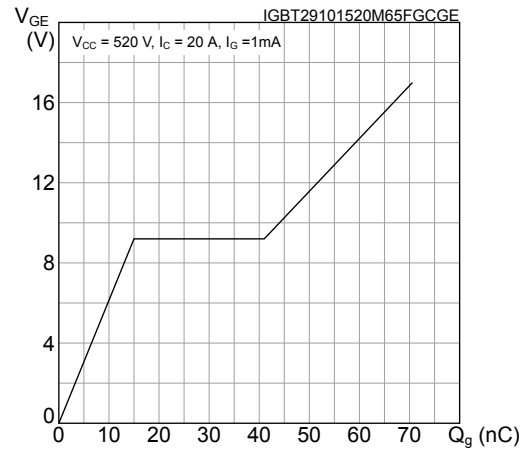
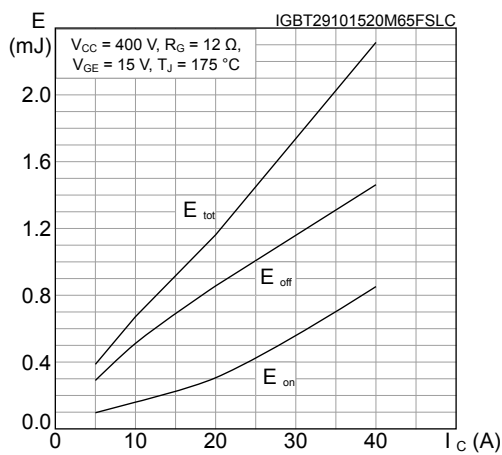
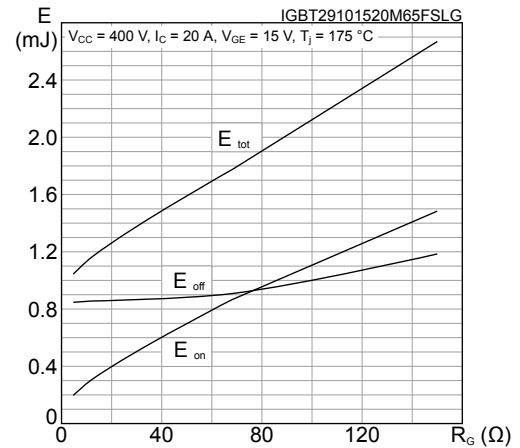
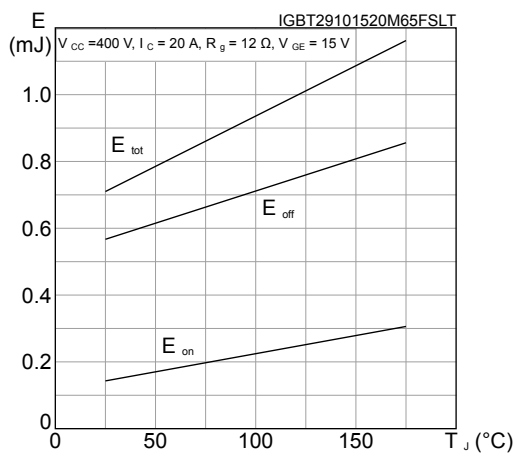
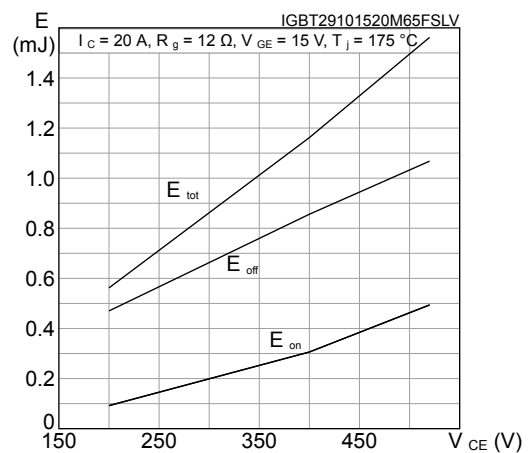
Figure 13. Capacitance variations

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}

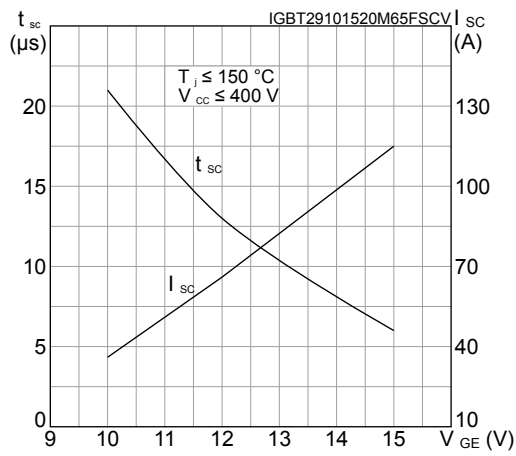


Figure 20. Switching times vs collector current

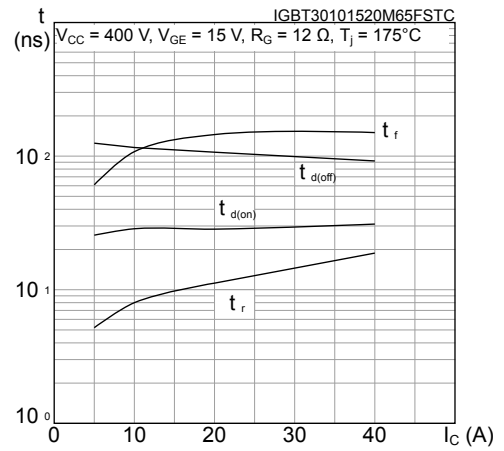


Figure 21. Switching times vs gate resistance

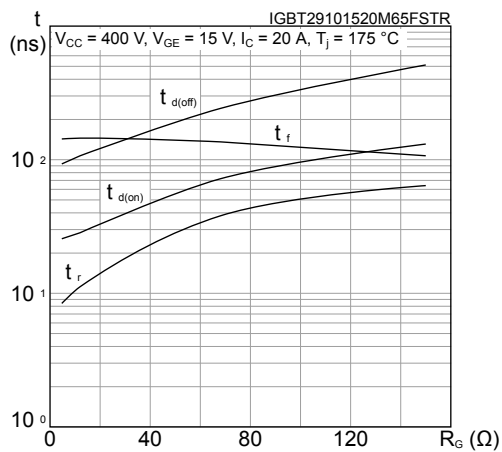


Figure 22. Reverse recovery current vs diode current slope

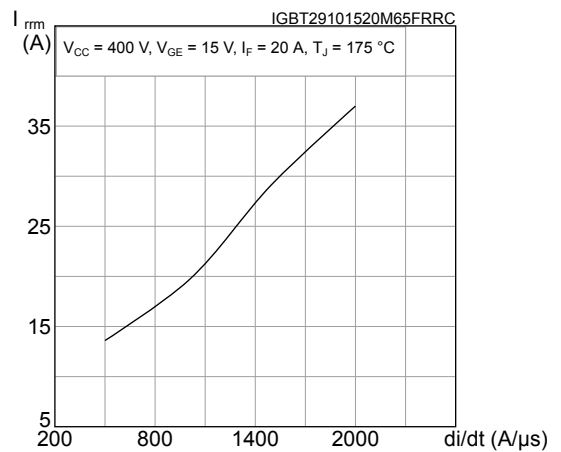


Figure 23. Reverse recovery time vs diode current slope

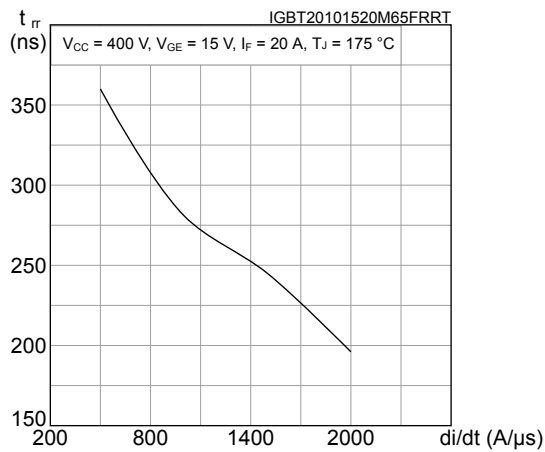


Figure 24. Reverse recovery charge vs diode current slope

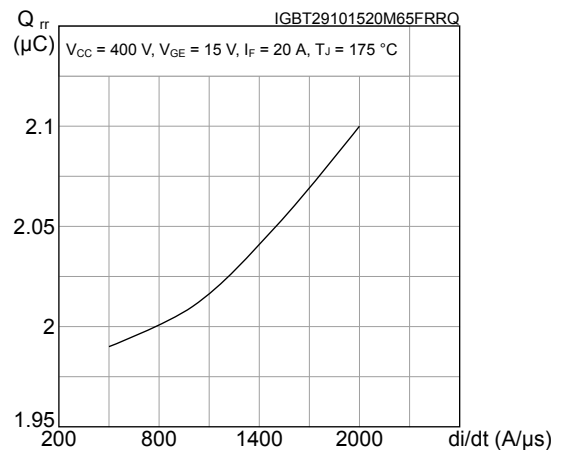


Figure 25. Reverse recovery energy vs diode current slope

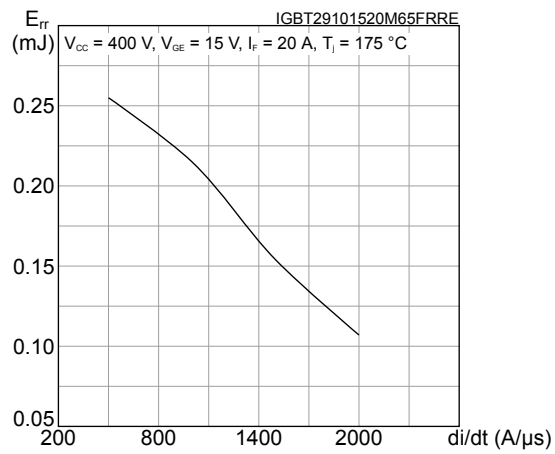


Figure 26. Thermal impedance for IGBT

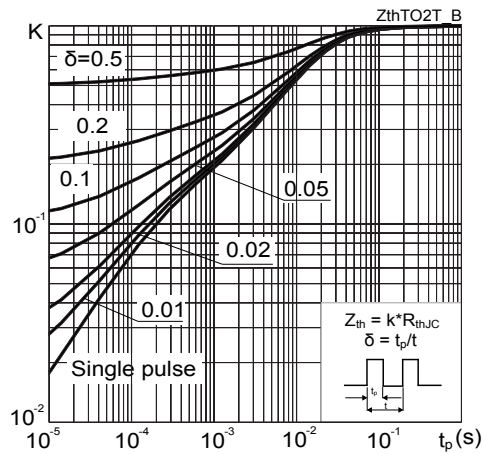
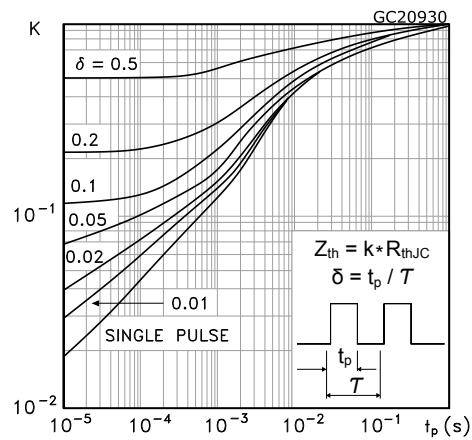
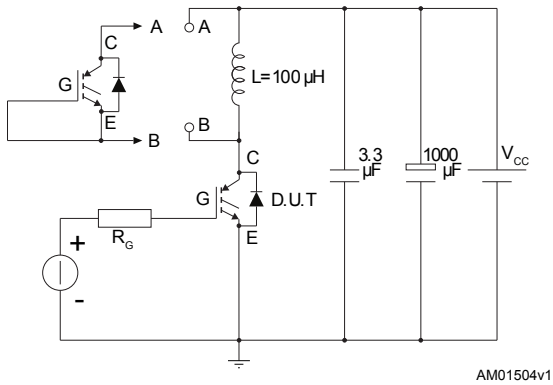
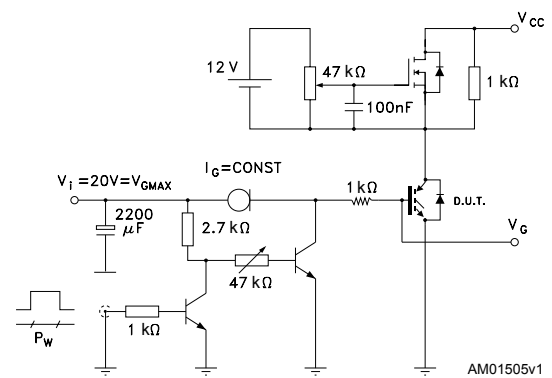
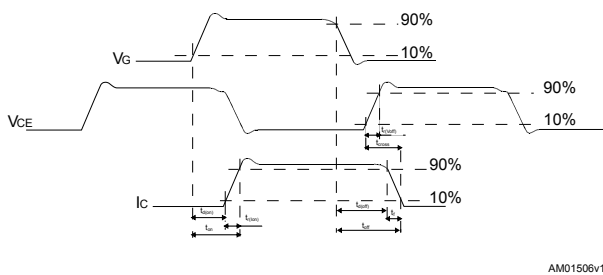
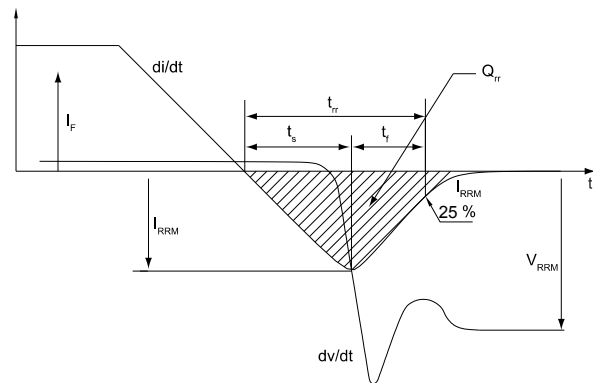


Figure 27. Thermal impedance for diode



3 Test circuits

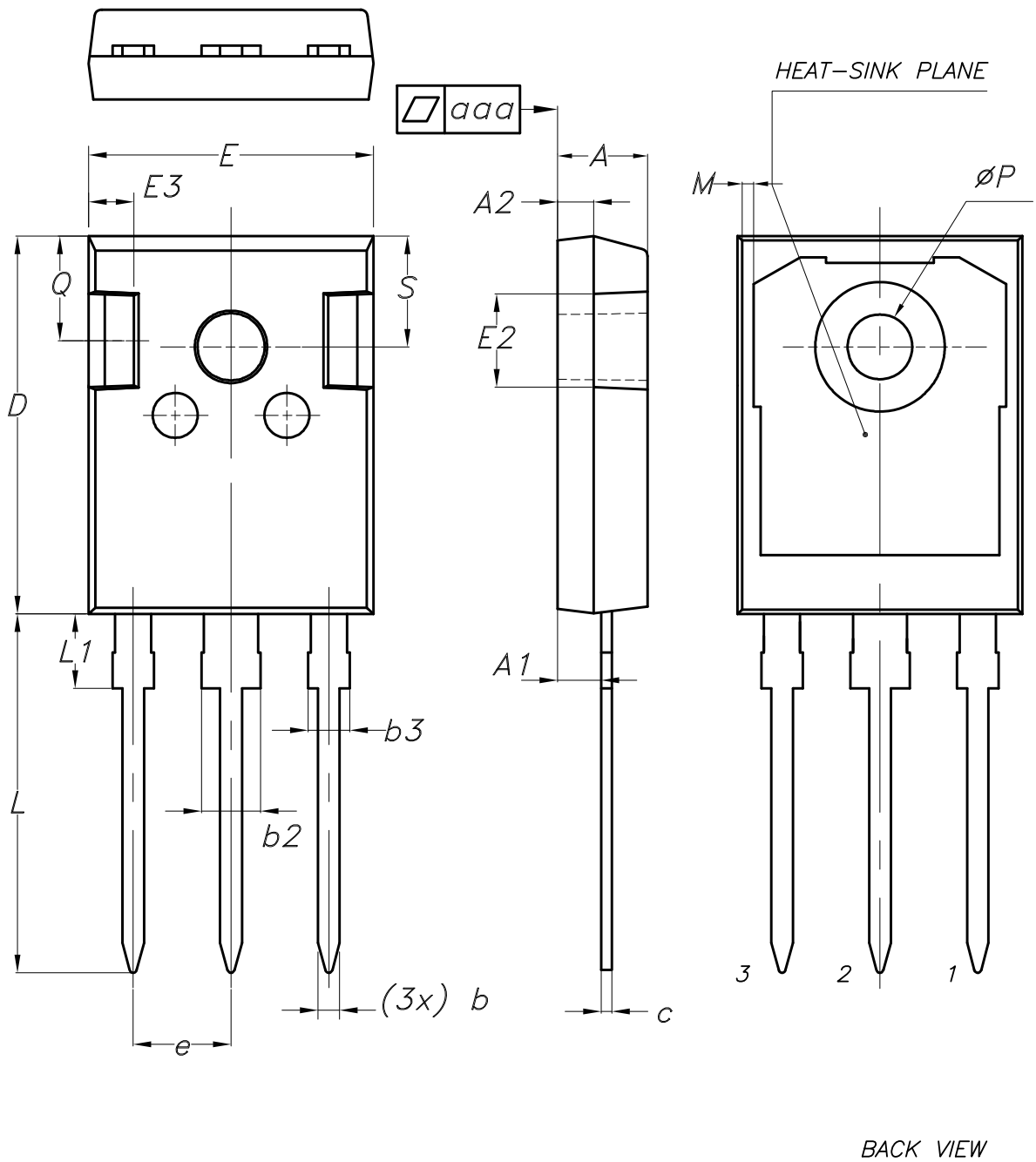
Figure 28. Test circuit for inductive load switching

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



BACK VIEW

8463846_5

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 <i>Figure 13: "Normalized $V_{(BR)CES}$ vs. junction temperature"</i> . Minor text changes.
08-Oct-2018	3	Updated <i>Table 3. Static characteristics</i> . 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.

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3	Test circuits	10
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4.1	TO-247 long leads package information	11
	Revision history	13

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