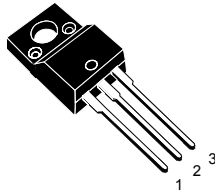
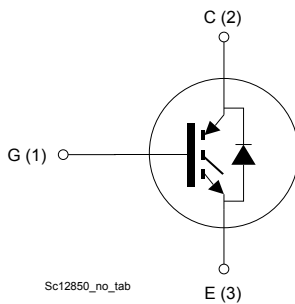


Trench gate field-stop, M series, 650 V, 20 A, low-loss IGBT



TO-220FP



Features

- High short-circuit withstand time
- $V_{CE(sat)} = 1.55 \text{ V (typ.) @ } I_C = 20 \text{ A}$
- Tight parameter distribution
- Safer paralleling
- 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. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and the tight parameter distribution result in safer paralleling operation.



Product status link

[STGF20M65DF2](#)

Product summary

Order code	STGF20M65DF2
Marking	G20M65DF2
Package	TO-220FP
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	650	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	40	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	20	A
$I_{CP}^{(2)}$	Pulsed collector current	80	A
V_{GE}	Gate-emitter voltage	± 20	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25\text{ °C}$	40	A
$I_F^{(1)}$	Continuous forward current at $T_C = 100\text{ °C}$	20	A
$I_{FP}^{(2)}$	Pulsed forward current	80	A
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$, $T_C = 25\text{ °C}$)	2.5	kV
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	32.6	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. Limited by maximum junction temperature.
2. Pulse width limited by maximum junction temperature.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	4.6	°C/W
R_{thJC}	Thermal resistance junction-case diode	6.25	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5	°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		$V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 12\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (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	$V_{CC} = 400\text{ V}$, $V_{GE} = 13\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	10		-	μs	
		$V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	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	$I_F = 20\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (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

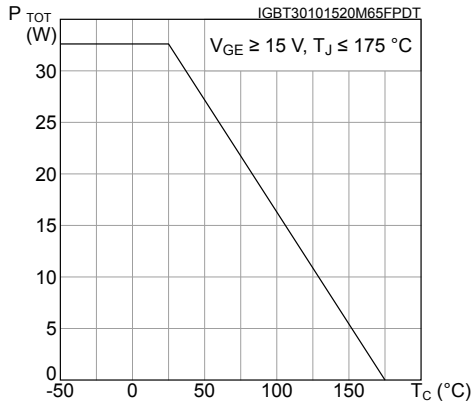


Figure 2. Collector current vs case temperature

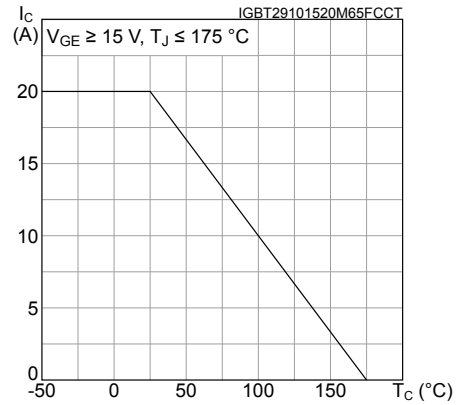


Figure 3. Output characteristics (T_J = 25 °C)

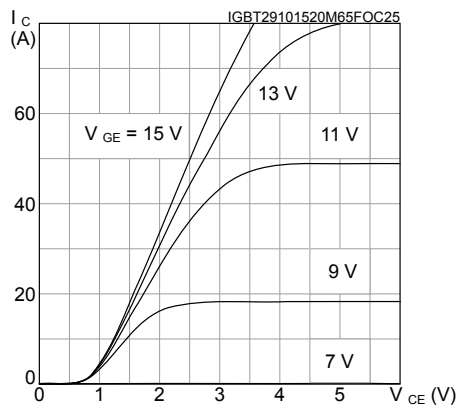


Figure 4. Output characteristics (T_J = 175 °C)

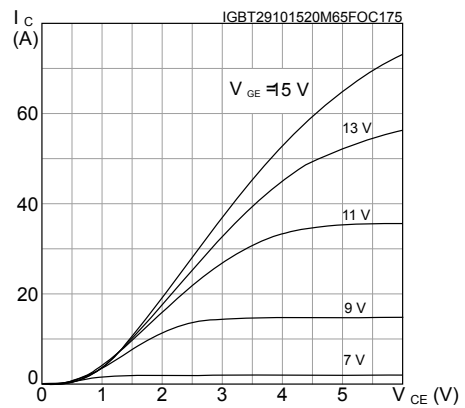


Figure 5. V_{CE(sat)} vs junction temperature

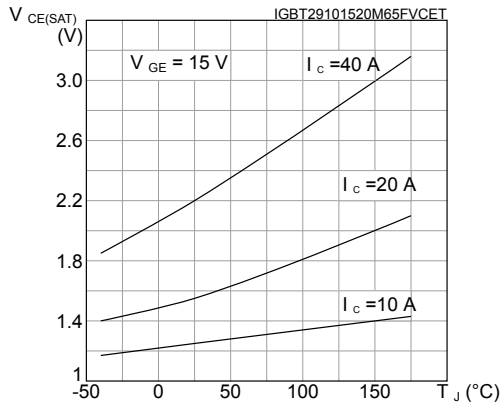


Figure 6. V_{CE(sat)} vs collector current

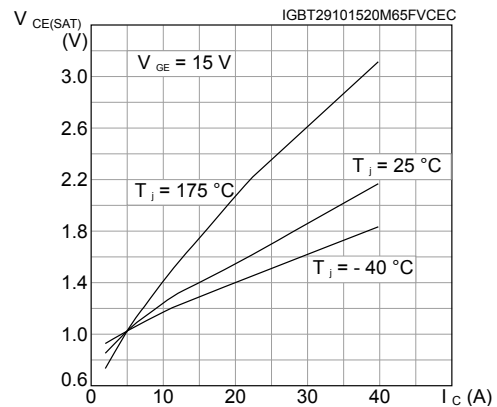


Figure 7. Collector current vs switching frequency

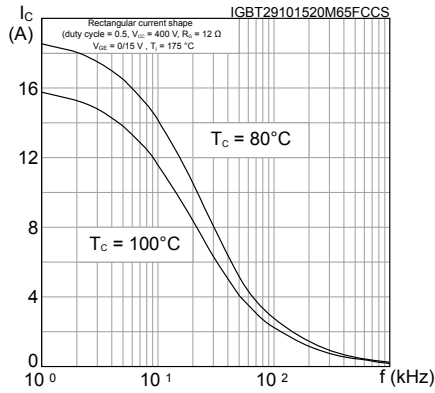


Figure 8. Forward bias safe operating area

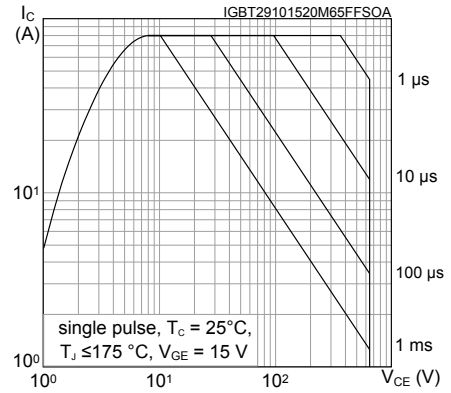


Figure 9. Transfer characteristics

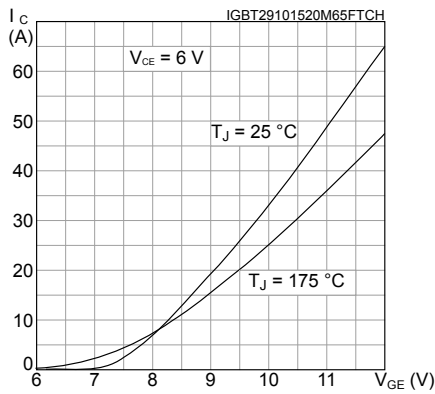


Figure 10. Diode V_F vs forward current

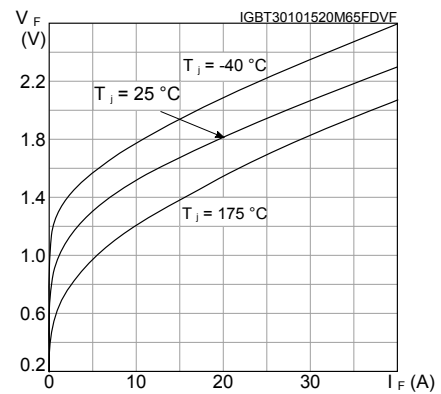


Figure 11. Normalized V_{GE(th)} vs junction temperature

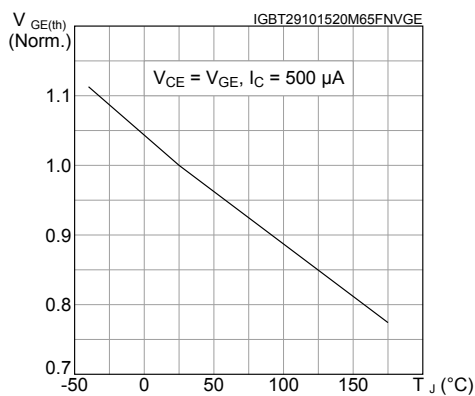


Figure 12. Normalized V_{(BR)CES} vs junction temperature

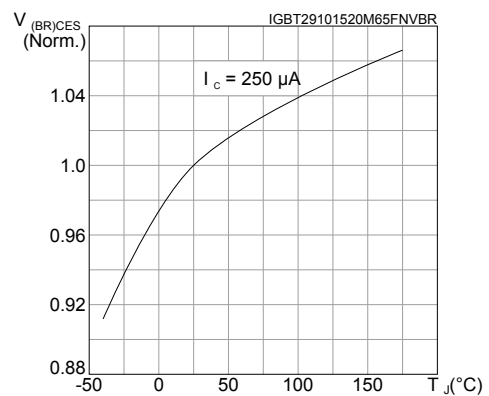


Figure 13. Capacitance variations

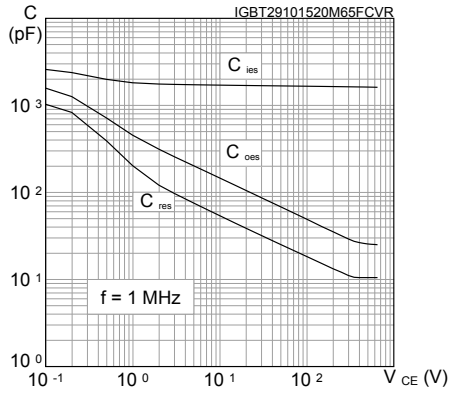


Figure 14. Gate charge vs gate-emitter voltage

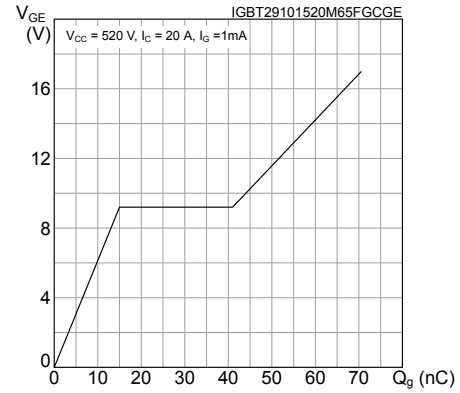


Figure 15. Switching loss vs collector current

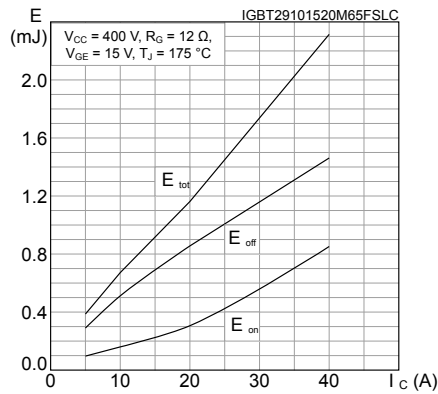


Figure 16. Switching loss vs gate resistance

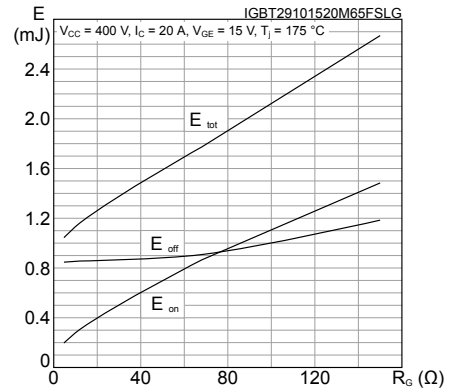


Figure 17. Switching loss vs temperature

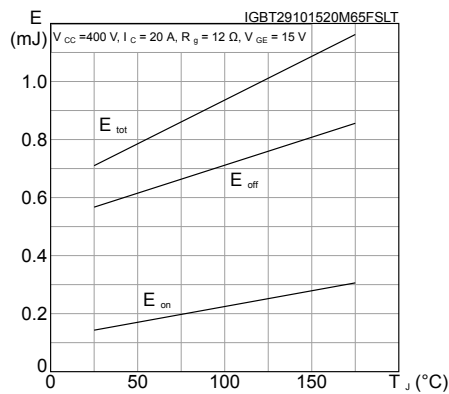


Figure 18. Switching loss vs collector emitter voltage

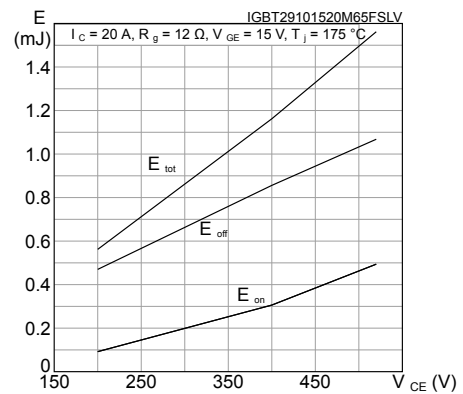


Figure 19. Short-circuit time and current vs V_{GE}

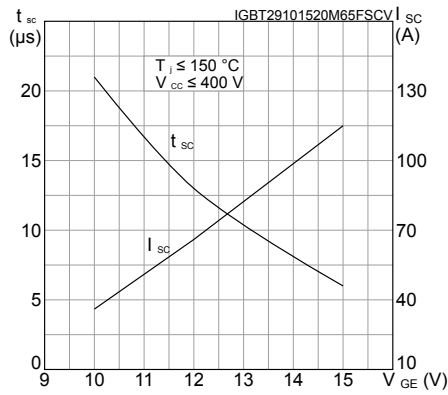


Figure 20. Switching times vs collector current

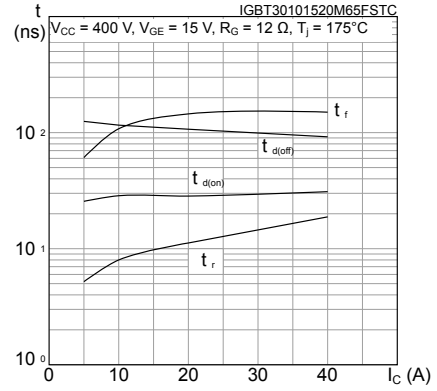


Figure 21. Switching times vs gate resistance

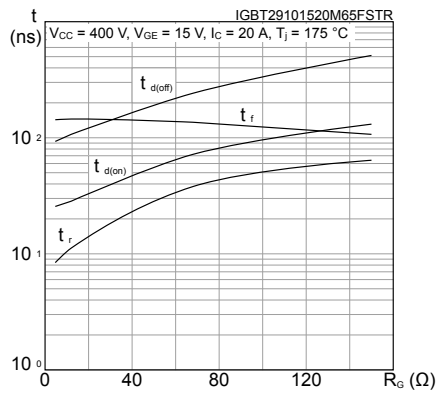


Figure 22. Reverse recovery current vs diode current slope

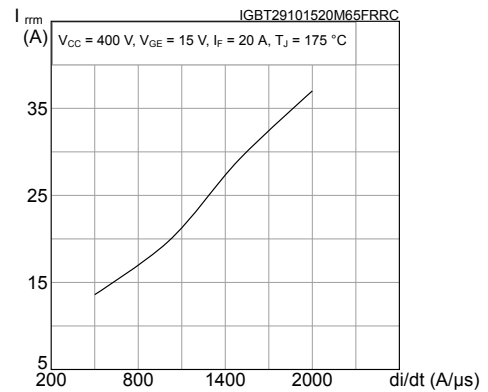


Figure 23. Reverse recovery time vs diode current slope

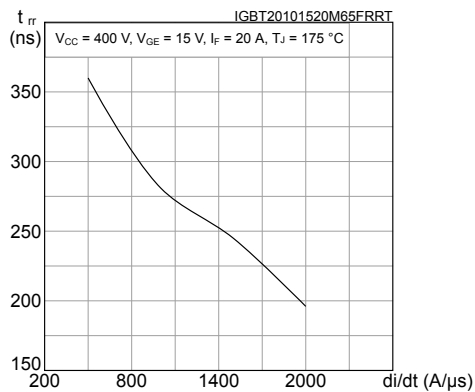


Figure 24. Reverse recovery charge vs diode current slope

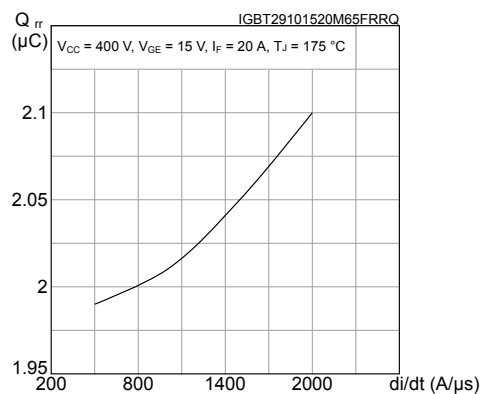


Figure 25. Reverse recovery energy vs diode current slope



Figure 26. Thermal impedance for IGBT

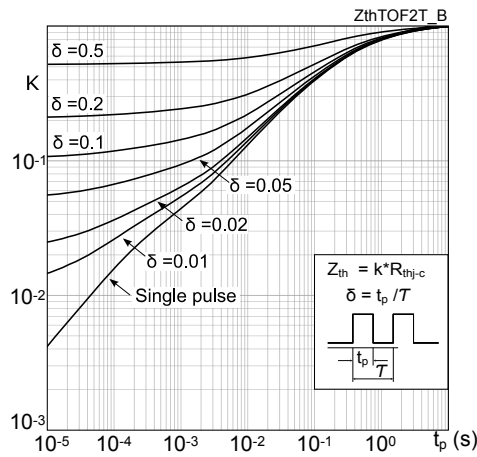
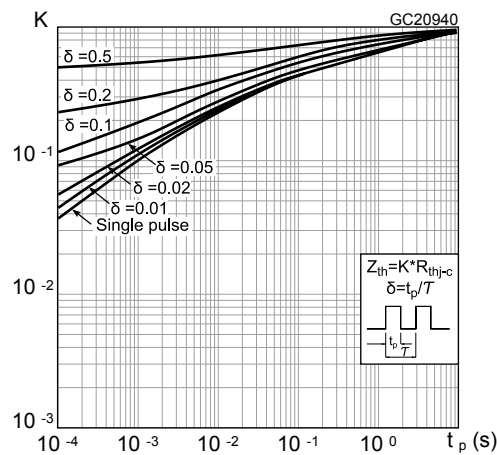
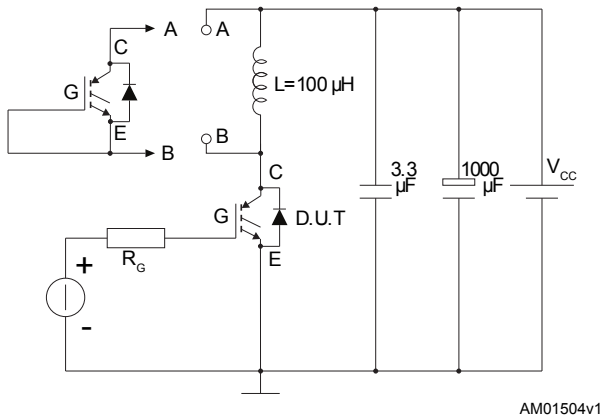
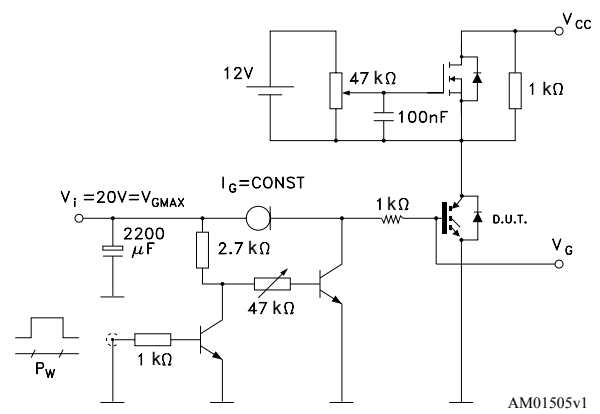
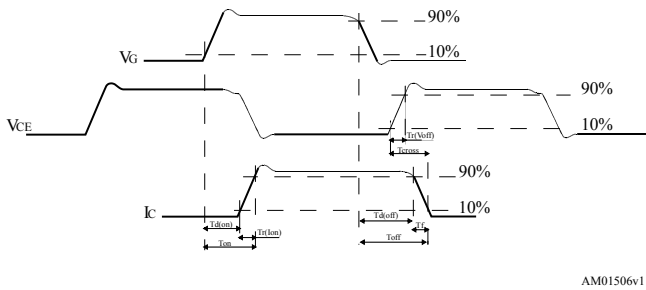
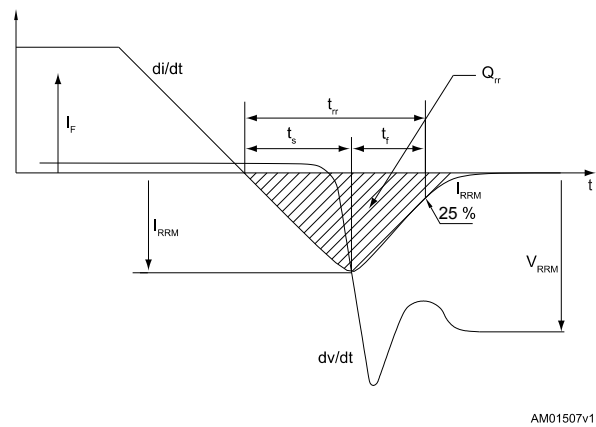


Figure 27. Thermal impedance for diode



3 Test circuits

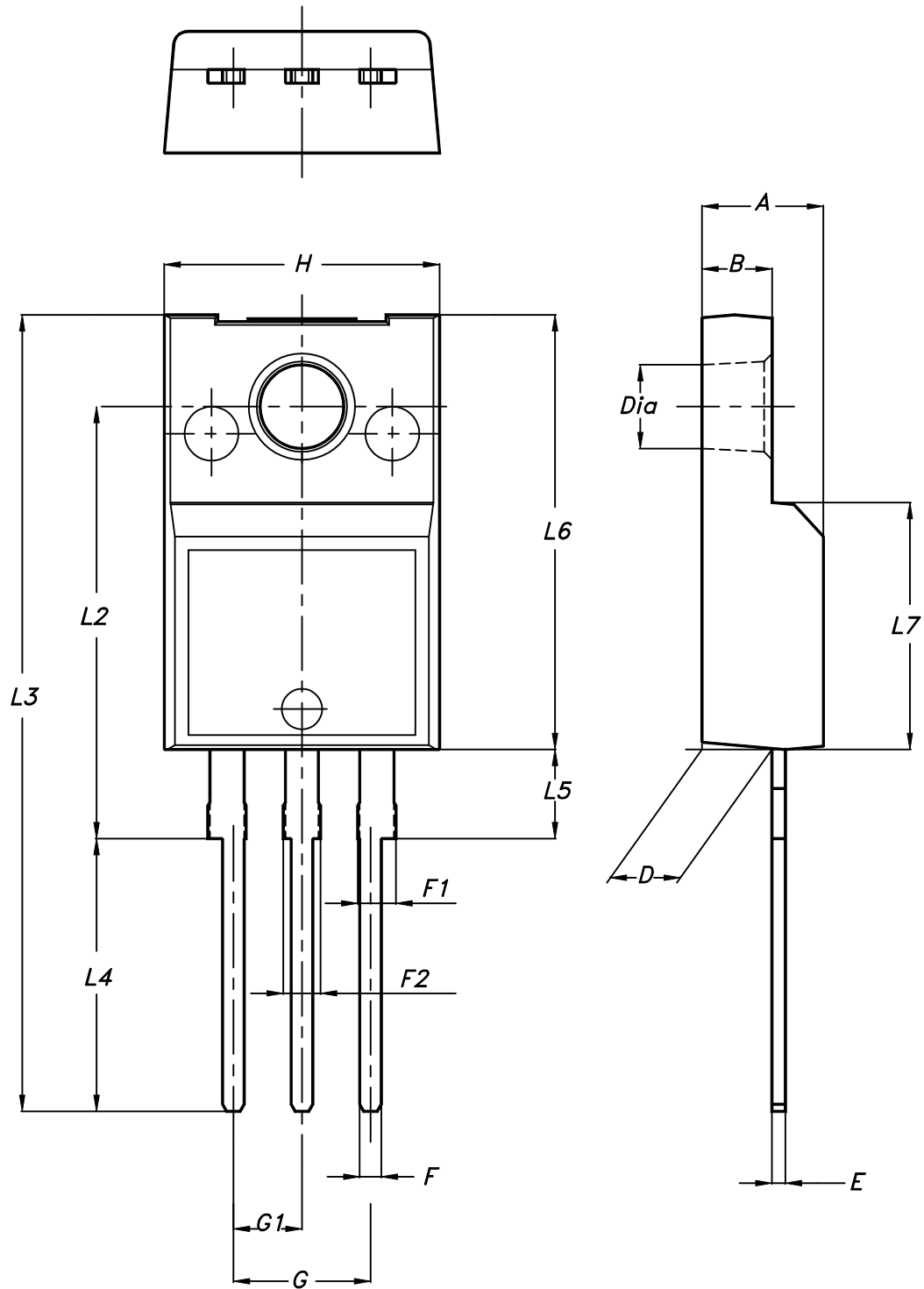
Figure 28. Test circuit for inductive load switching

Figure 29. Gate charge test circuit

Figure 30. Switching waveform

Figure 31. Diode reverse recovery waveform


4 Package information

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-220FP package information

Figure 32. TO-220FP package outline



7012510_Rev_12_B

Table 7. TO-220FP package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Revision history

Table 8. Document revision history

Date	Revision	Changes
02-Nov-2015	1	First release.
24-Feb-2016	2	Document status promoted from preliminary to production data
10-Mar-2016	3	Updated <i>Figure 13: "Normalized $V_{(BR)CES}$ vs. junction temperature</i> . Minor text changes.
08-Oct-2018	4	Updated Table 3. Static characteristics . Minor text changes

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	Revision history	14
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