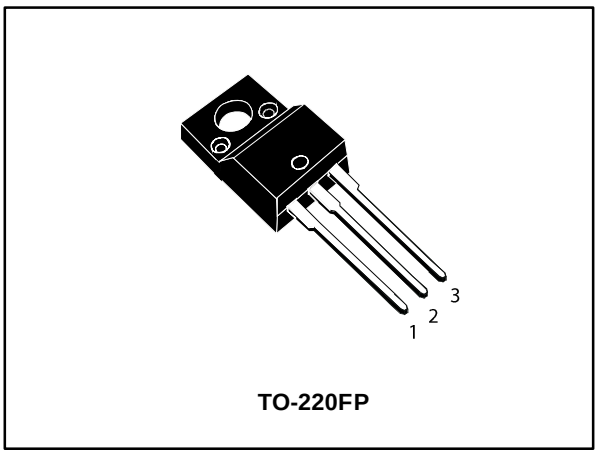
STGF15M65DF2

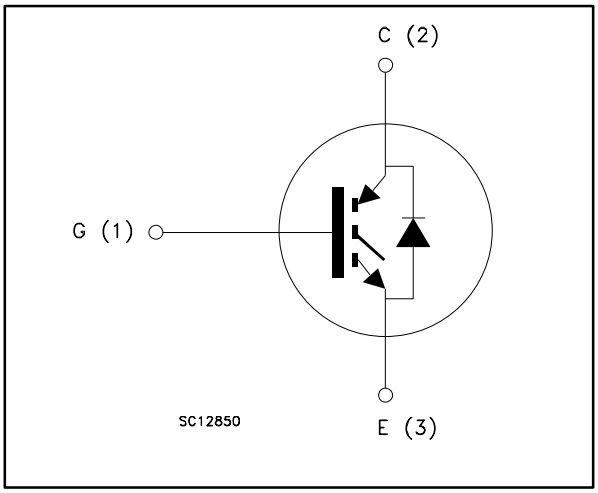
Trench gate field-stop IGBT M series, 650 V 15 A low loss

Datasheet - preliminary data



TO-220FP

Figure 1: Internal schematic diagram



Features

- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ I_C = 15 A
- Tight parameter 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 of IGBTs, which represents an optimum compromise in performance to maximize the efficiency of inverter systems where low loss and short-circuit capability are essential. Furthermore, a positive $V_{CE(sat)}$ temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGF15M65DF2	G15M65DF2	TO-220FP	Tube

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	650	V
I_C(1)	Continuous collector current at T_C = 25 °C	30	A
	Continuous collector current at T_C = 100 °C	15	
I_{CP}(2)	Pulsed collector current	60	A
V_{GE}	Gate-emitter voltage	±20	V
I_F(1)	Continuous forward current at T_C = 25 °C	30	A
	Continuous forward current at T_C = 100 °C	15	
I_{FP}(2)	Pulsed forward current	60	A
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)	2.5	kV
P_{TOT}	Total dissipation at T_C = 25 °C	31	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature	- 55 to 175	°C

Notes:

(1)Limited by maximum junction temperature.

(2)Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	4.8	°C/W
R_{thJC}	Thermal resistance junction-case diode	6.25	
R_{thJA}	Thermal resistance junction-ambient	62.5	

2 Electrical characteristics

T_C = 25 °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 V, I_C = 2 mA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 15 A		1.55	2.0	V
		V_{GE} = 15 V, I_C = 15 A, T_J = 125 °C		1.9		
		V_{GE} = 15 V, I_C = 15 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 15 A		1.7		V
		I_F = 15 A, T_J = 125 °C		1.5		
		I_F = 15 A, T_J = 175 °C		1.4		
$V_{GE(th)}$	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	µA

Table 5: 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	-	1250	-	pF
C_{oes}	Output capacitance		-	80	-	
C_{res}	Reverse transfer capacitance		-	25	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 15 A, V_{GE} = 15 V (see *Figure 30: " Gate charge test circuit"*)	-	45	-	nC
Q_{ge}	Gate-emitter charge		-	11	-	
Q_{gc}	Gate-collector charge		-	15	-	

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 V, I_C = 15 A, V_{GE} = 15 V, R_G = 12 Ω (see *Figure 29: " Test circuit for inductive load switching"*)		24	-	ns
t_r	Current rise time			7.8	-	ns
$(di/dt)_{on}$	Turn-on current slope			1570	-	A/µs
$t_{d(off)}$	Turn-off-delay time			93	-	ns
t_f	Current fall time			106	-	ns
E_{on}(1)	Turn-on switching losses			0.09	-	mJ
E_{off}(2)	Turn-off switching losses			0.45	-	mJ
E_{ts}	Total switching losses			0.54	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 15 A, V_{GE} = 15 V, R_G = 12 Ω T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*)		24.8	-	ns
t_r	Current rise time			9.2	-	ns
$(di/dt)_{on}$	Turn-on current slope			1300	-	A/µs
$t_{d(off)}$	Turn-off-delay time			96	-	ns
t_f	Current fall time			169	-	ns
E_{on}	Turn-on switching losses			0.22	-	mJ
E_{off}	Turn-off switching losses			0.61	-	mJ
E_{ts}	Total switching losses			0.83	-	mJ
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	6		-	µs

Notes:

(1)Energy losses include reverse recovery of the diode.

(2)Turn-off losses also include 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 = 15 A, V_R = 400 V, V_{GE} = 15 V (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	142	-	ns
Q_{rr}	Reverse recovery charge		-	525	-	nC
I_{rrm}	Reverse recovery current		-	13.4	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	790	-	A/µs
E_{rr}	Reverse recovery energy		-	64	-	µJ
t_{rr}	Reverse recovery time	I_F = 15 A, V_R = 400 V, V_{GE} = 15 V T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	241	-	ns
Q_{rr}	Reverse recovery charge		-	1690	-	nC
I_{rrm}	Reverse recovery current		-	20	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	420	-	A/µs
E_{rr}	Reverse recovery energy		-	176	-	µJ

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

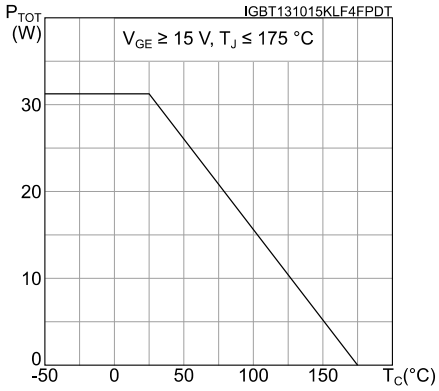


Figure 3: Collector current vs. case temperature

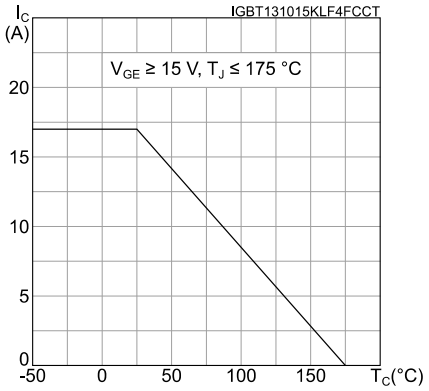


Figure 4: Output characteristics (TJ = 25 °C)

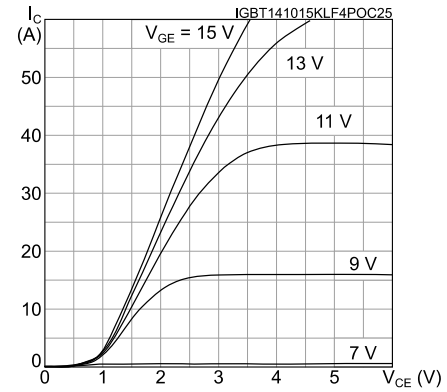


Figure 5: Output characteristics (TJ = 175 °C)

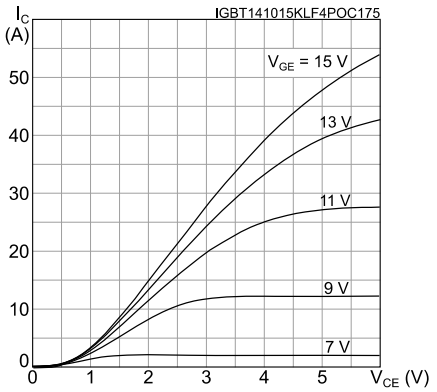


Figure 6: VCE(sat) vs. junction temperature

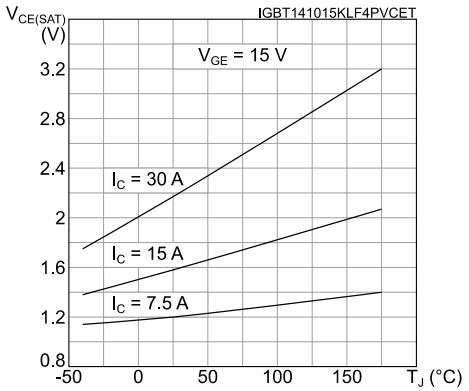


Figure 7: VCE(sat) vs. collector current

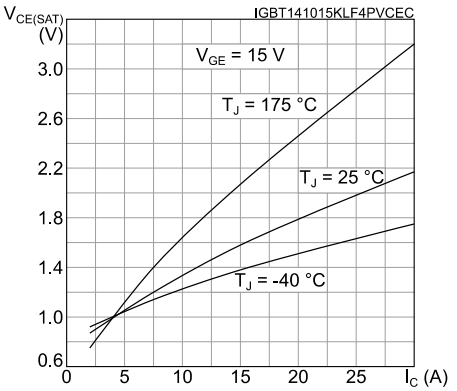


Figure 8: Collector current vs. switching frequency

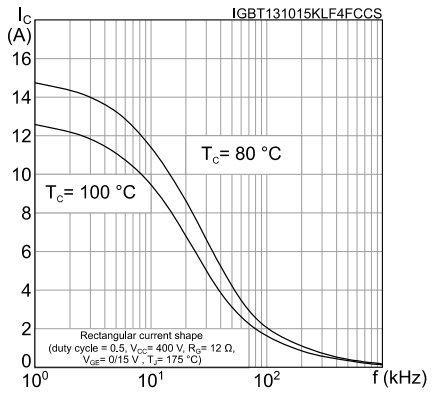


Figure 9: Forward bias safe operating area

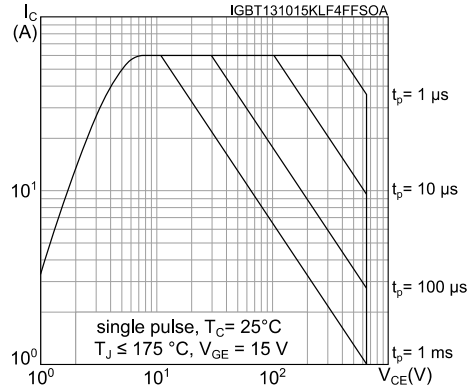


Figure 10: Transfer characteristics

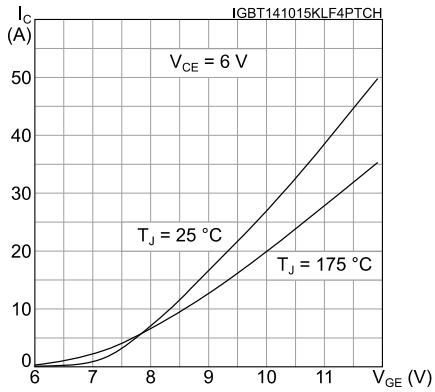


Figure 11: Diode VF vs. forward current

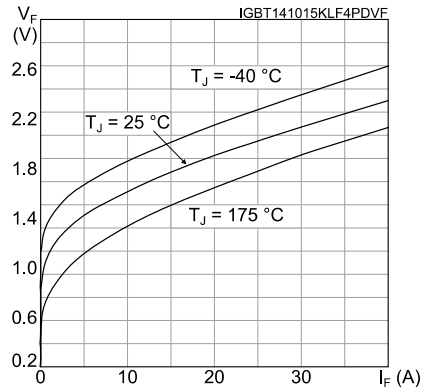


Figure 12: Normalized VGE(th) vs. junction temperature

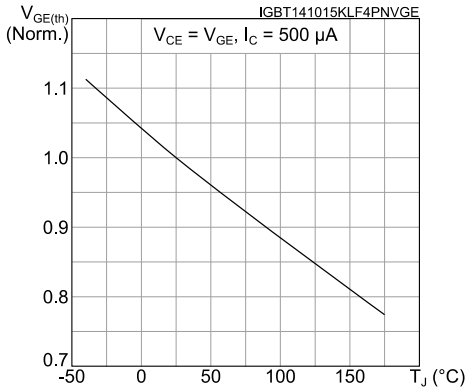


Figure 13: Normalized V(BR)CES vs. junction temperature

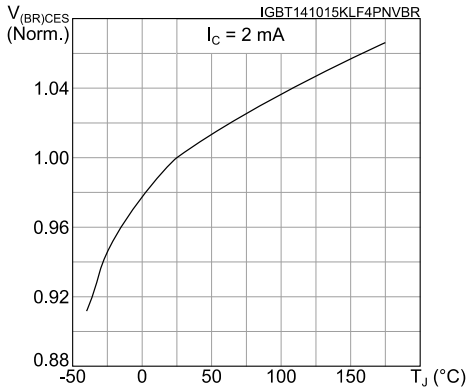


Figure 14: Capacitance variations

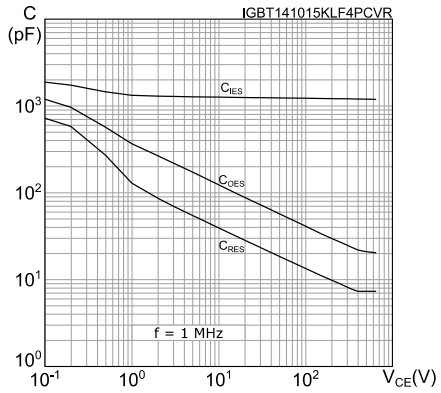


Figure 15: Gate charge vs. gate-emitter voltage

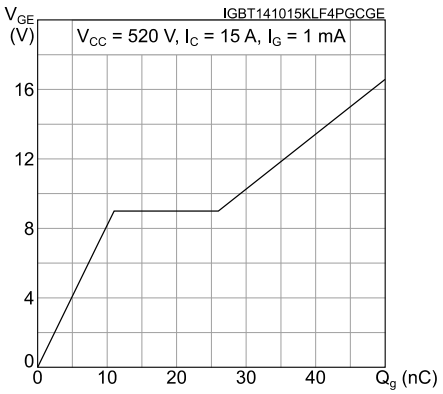


Figure 16: Switching loss vs. collector current

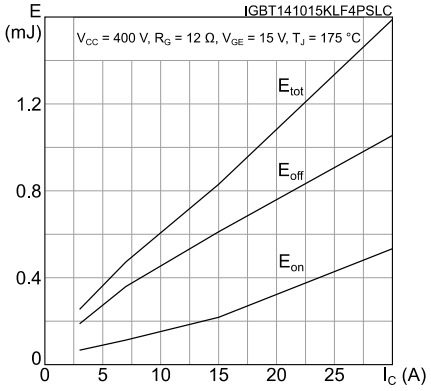


Figure 17: Switching loss vs. gate resistance

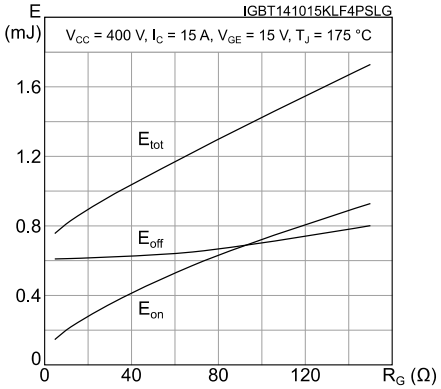


Figure 18: Switching loss vs. temperature

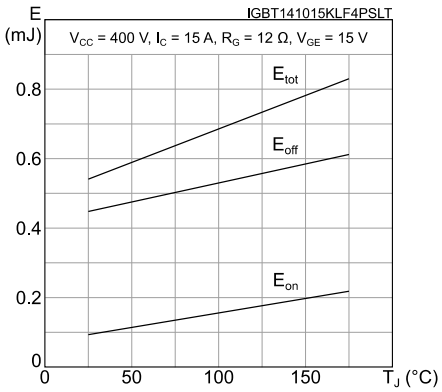


Figure 19: Switching loss vs. collector emitter voltage

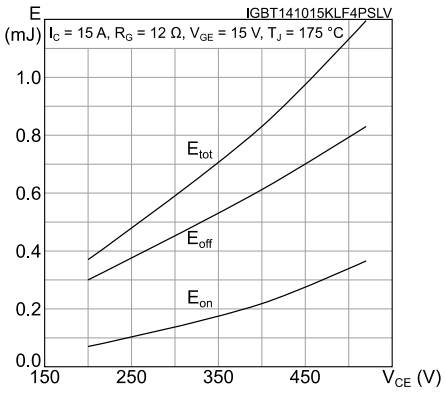


Figure 20: Short-circuit time and current vs. VGE

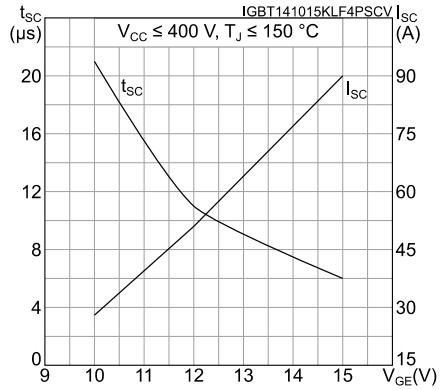


Figure 21: Switching times vs. collector current

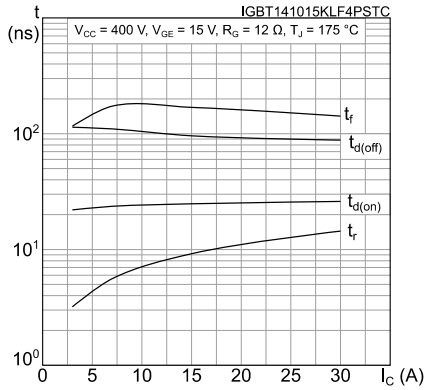


Figure 22: Switching times vs. gate resistance

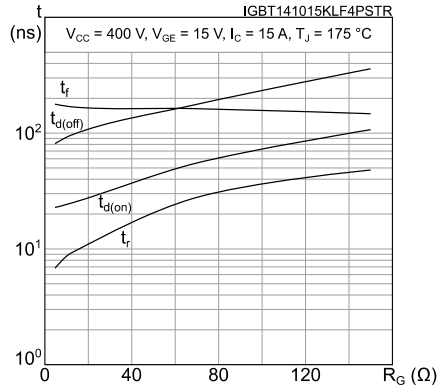


Figure 23: Reverse recovery current vs. diode current slope

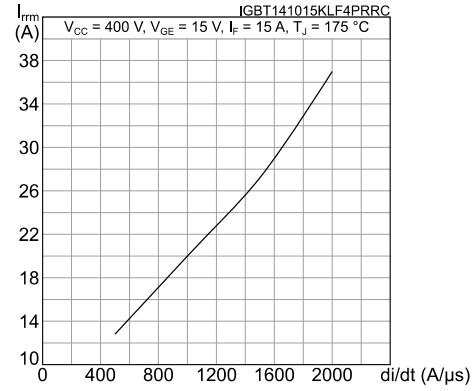


Figure 24: Reverse recovery time vs. diode current slope

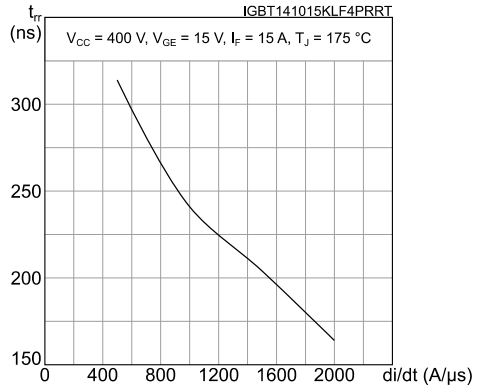


Figure 25: Reverse recovery charge vs. diode current slope

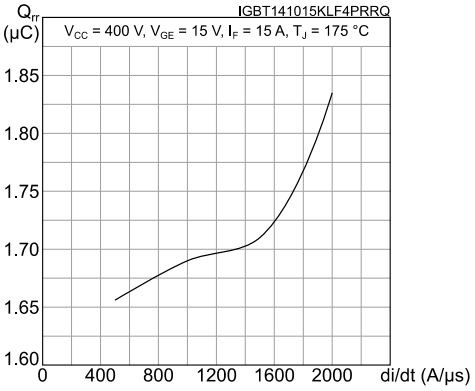


Figure 26: Reverse recovery energy vs. diode current slope

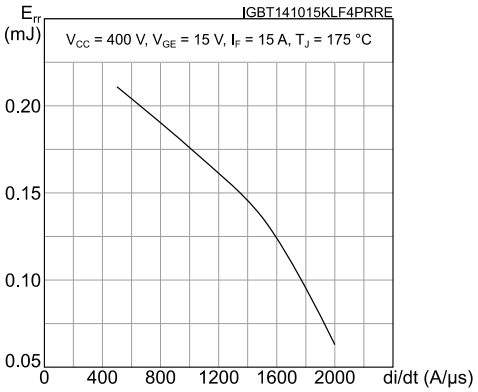


Figure 27: Thermal impedance for IGBT

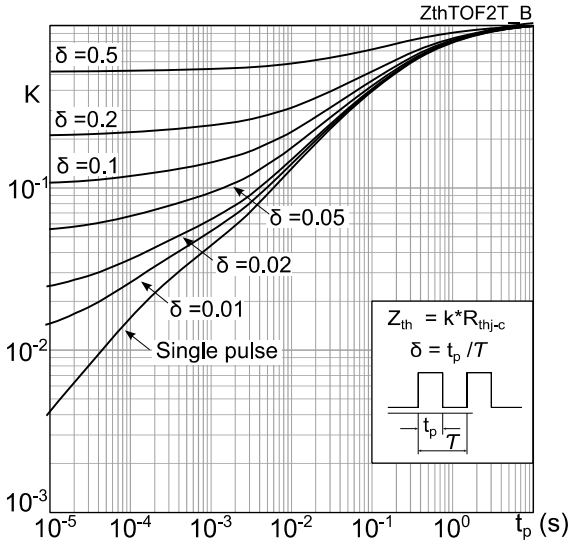
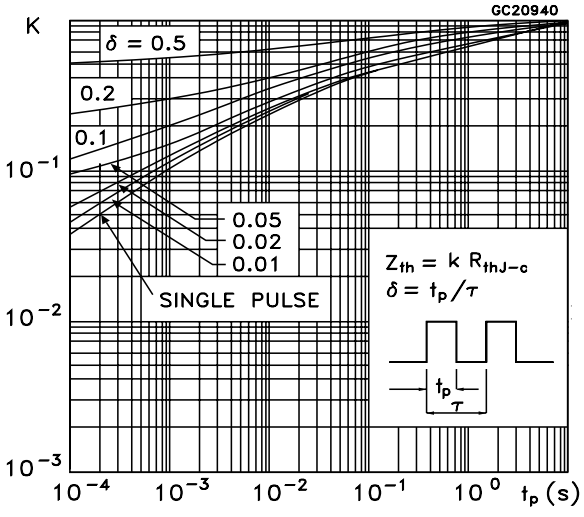


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

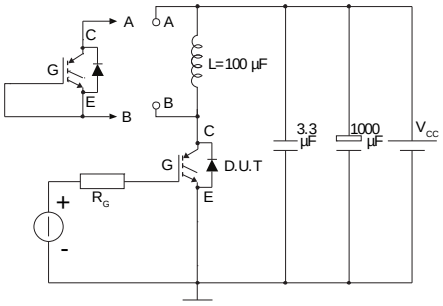


Figure 30: Gate charge test circuit

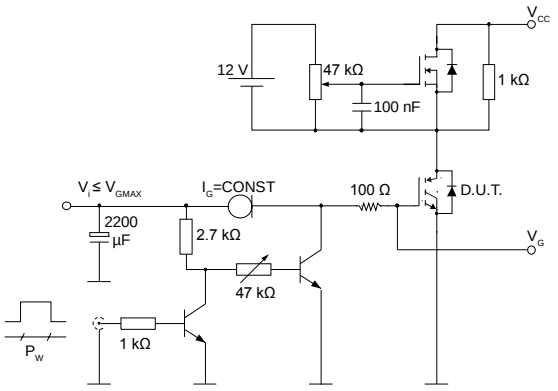


Figure 31: Switching waveform

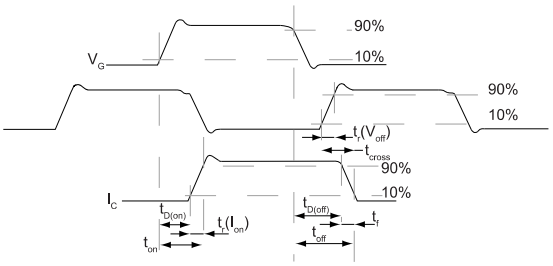
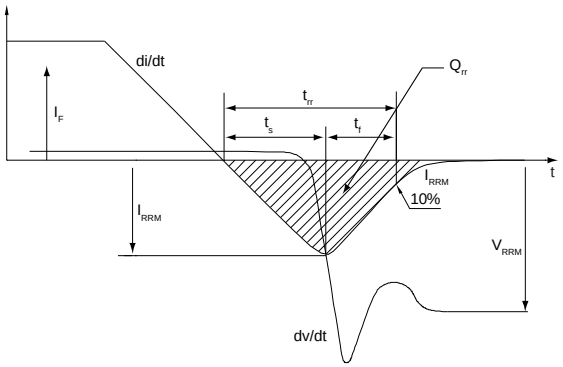


Figure 32: Diode reverse recovery waveform



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 33: TO-220FP package outline

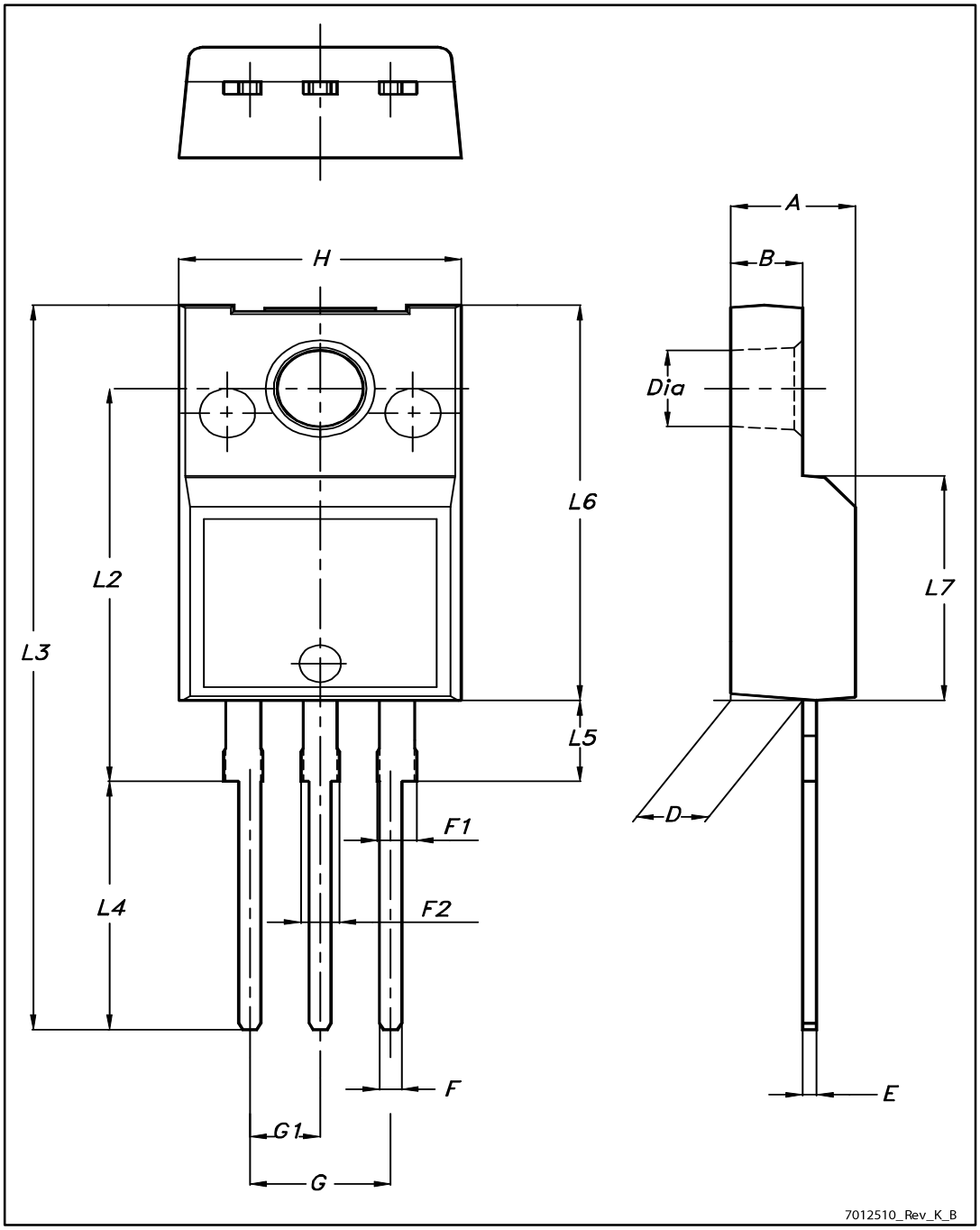


Table 8: TO-220FP package mechanical data

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

5 Revision history

Table 9: Document revision history

Date	Revision	Changes
14-Oct-2015	1	First release.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.