

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

Datasheet - preliminary data

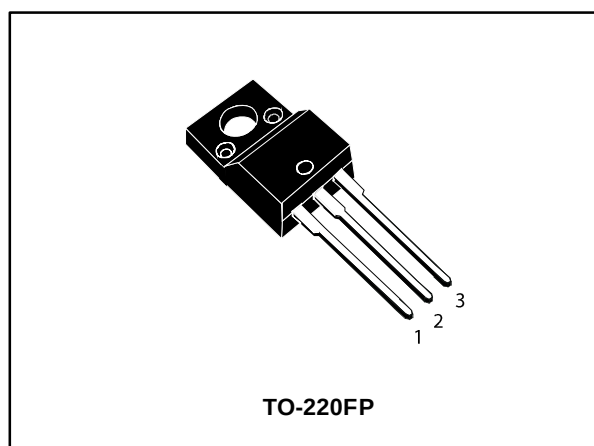
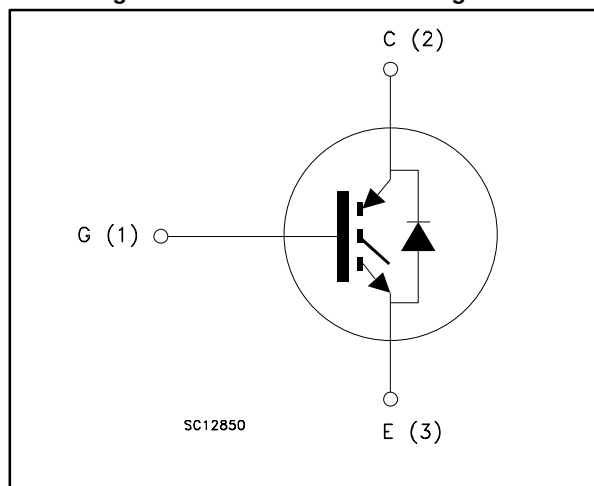


Figure 1: Internal schematic diagram



Features

- 6 μ s 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

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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

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

Table 4: Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 15\text{ A}$		1.55	2.0	V
		$V_{GE} = 15\text{ V}$, $I_C = 15\text{ A}$, $T_J = 125\text{ °C}$		1.9		
		$V_{GE} = 15\text{ V}$, $I_C = 15\text{ A}$, $T_J = 175\text{ °C}$		2.1		
V_F	Forward on-voltage	$I_F = 15\text{ A}$		1.7		V
		$I_F = 15\text{ A}$, $T_J = 125\text{ °C}$		1.5		
		$I_F = 15\text{ A}$, $T_J = 175\text{ °C}$		1.4		
$V_{GE(th)}$	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	μA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	1250	-	pF
C_{oes}	Output capacitance		-	80	-	
C_{res}	Reverse transfer capacitance		-	25	-	
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = 15\text{ V}$ (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	$V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 12\ \Omega$ (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/ μ s
$t_{d(off)}$	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	$V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 12\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (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/ μ s
$t_{d(off)}$	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	$V_{CC} \leq 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	6		-	μ s

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	$I_F = 15\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$ (see Figure 29: "Test circuit for inductive load switching") $di/dt = 1000\text{ A}/\mu\text{s}$	-	142	-	ns
Q_{rr}	Reverse recovery charge		-	525	-	nC
I_{rrm}	Reverse recovery current		-	13.4	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	790	-	A/ μ s
E_{rr}	Reverse recovery energy		-	64	-	μ J
t_{rr}	Reverse recovery time	$I_F = 15\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29: "Test circuit for inductive load switching") $di/dt = 1000\text{ A}/\mu\text{s}$	-	241	-	ns
Q_{rr}	Reverse recovery charge		-	1690	-	nC
I_{rrm}	Reverse recovery current		-	20	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	420	-	A/ μ s
E_{rr}	Reverse recovery energy		-	176	-	μ J

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

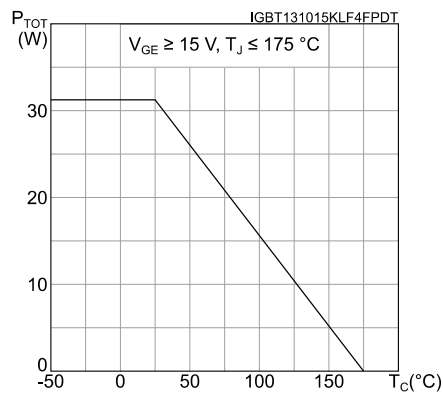


Figure 3: Collector current vs. case temperature

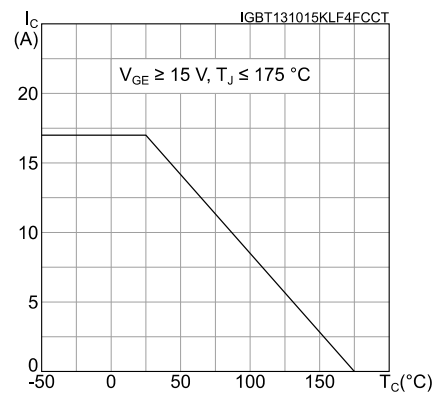


Figure 4: Output characteristics (T_J = 25 °C)

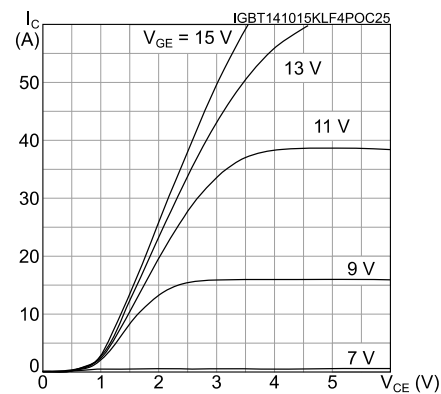


Figure 5: Output characteristics (T_J = 175 °C)

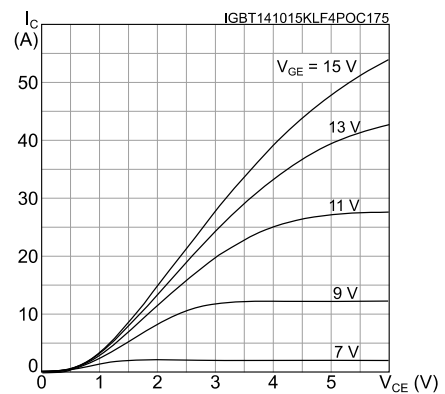


Figure 6: V_CE(sat) vs. junction temperature

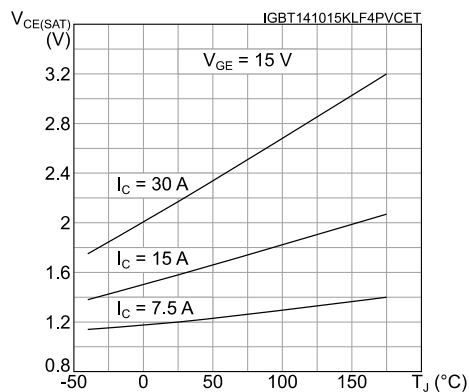


Figure 7: V_CE(sat) vs. collector current

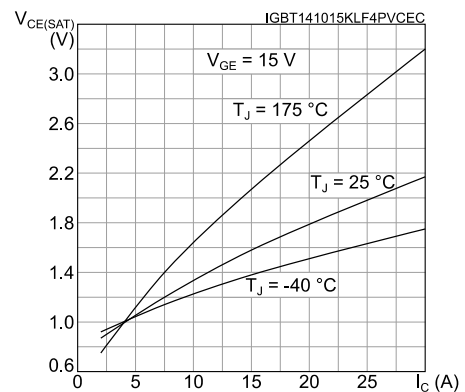


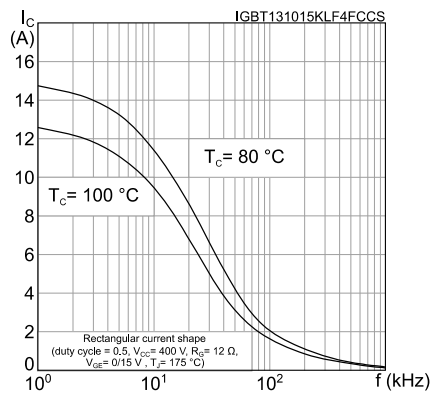
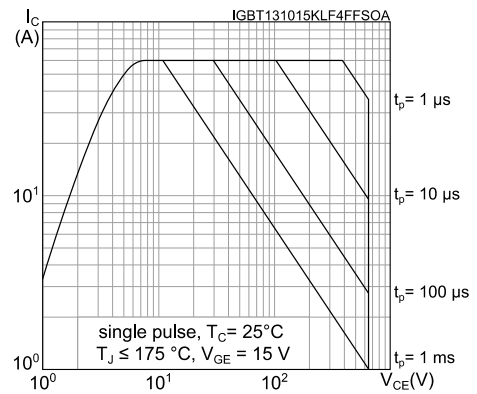
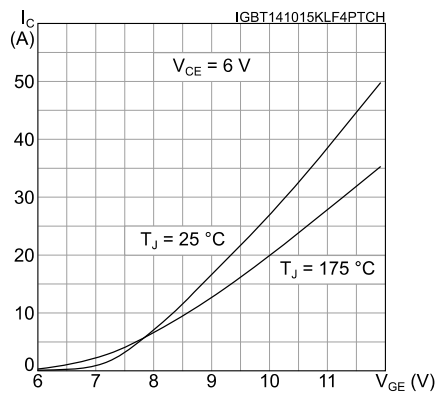
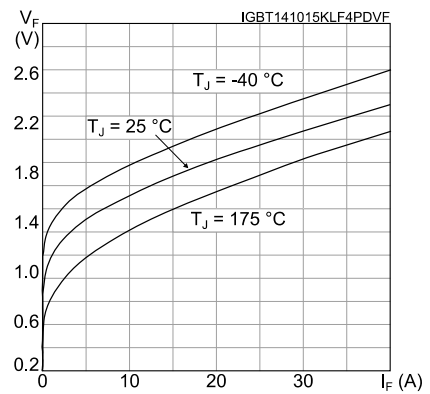
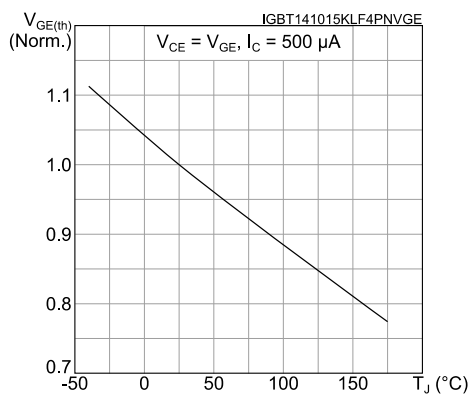
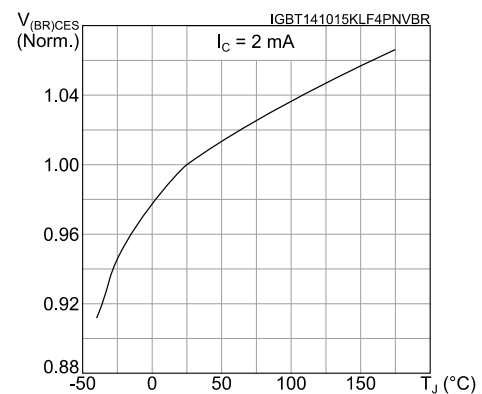
Figure 8: Collector current vs. switching frequency**Figure 9: Forward bias safe operating area****Figure 10: Transfer characteristics****Figure 11: Diode VF vs. forward current****Figure 12: Normalized V_{GE(th)} vs. junction temperature****Figure 13: Normalized V_{(BR)CES} vs. junction temperature**

Figure 14: Capacitance variations

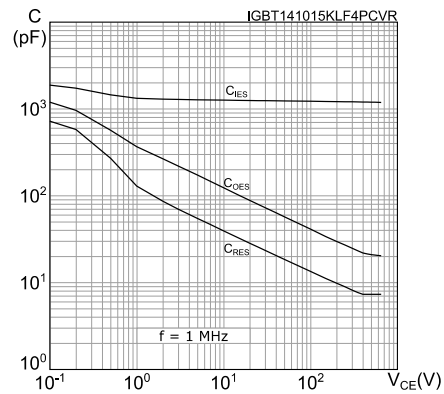


Figure 15: Gate charge vs. gate-emitter voltage

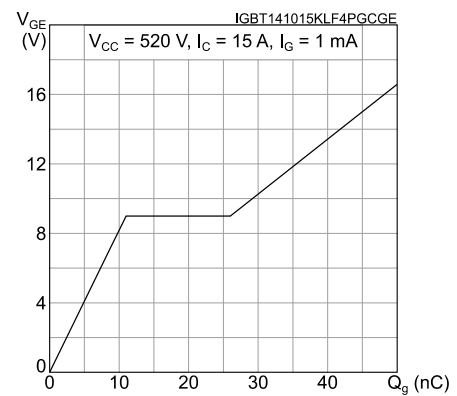


Figure 16: Switching loss vs. collector current

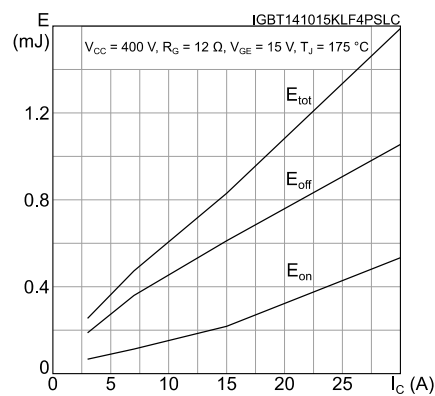


Figure 17: Switching loss vs. gate resistance

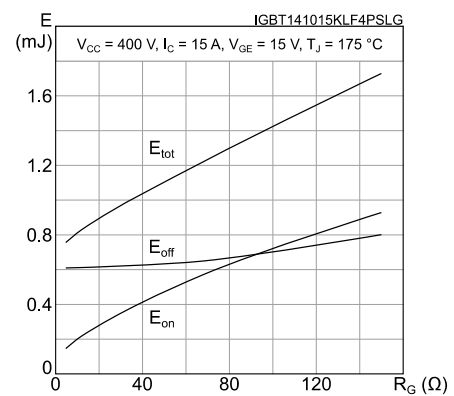


Figure 18: Switching loss vs. temperature

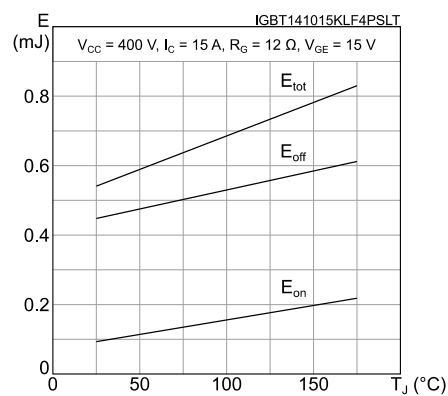


Figure 19: Switching loss vs. collector emitter voltage

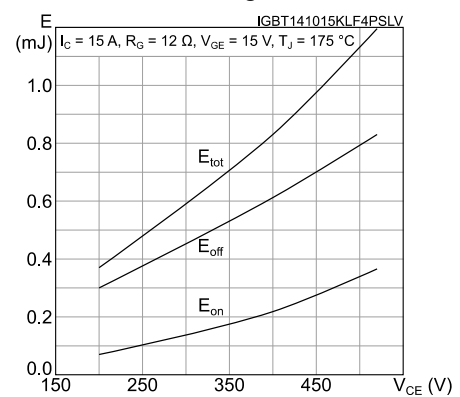


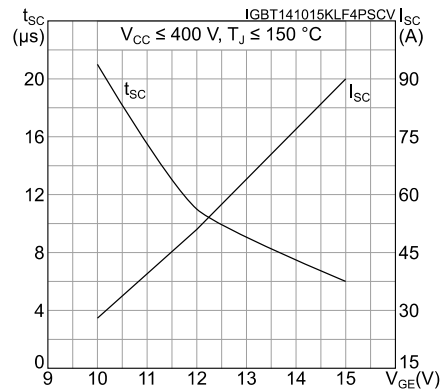
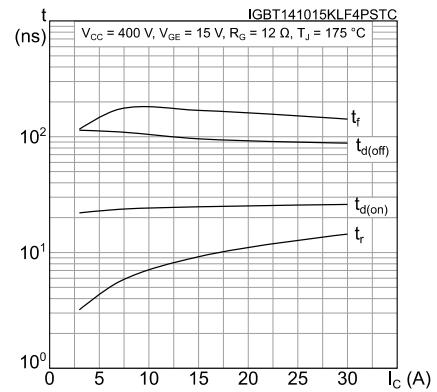
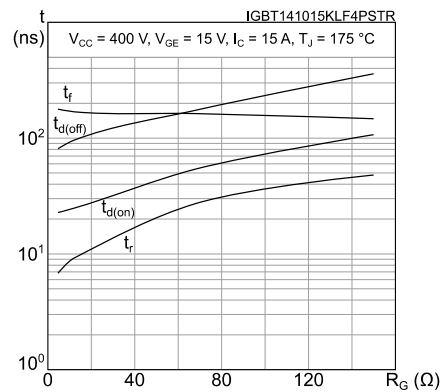
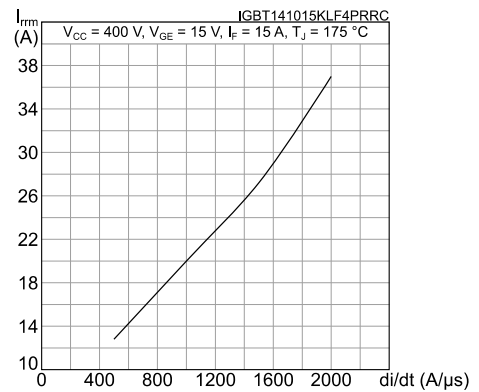
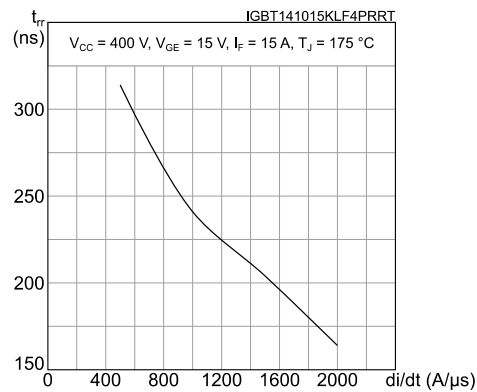
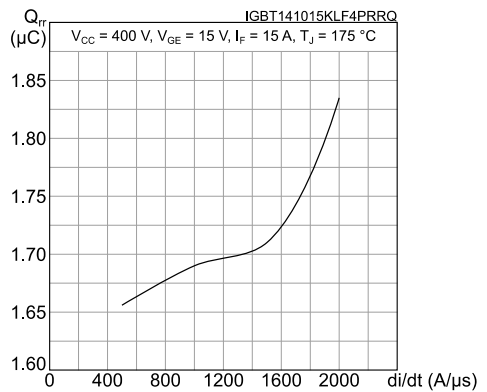
Figure 20: Short-circuit time and current vs. V_{GE}**Figure 21: Switching times vs. collector current****Figure 22: Switching times vs. gate resistance****Figure 23: Reverse recovery current vs. diode current slope****Figure 24: Reverse recovery time vs. diode current slope****Figure 25: Reverse recovery charge vs. diode current slope**

Figure 26: Reverse recovery energy vs. diode current slope

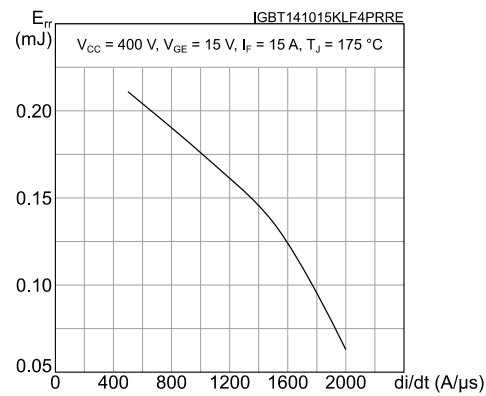


Figure 27: Thermal impedance for IGBT

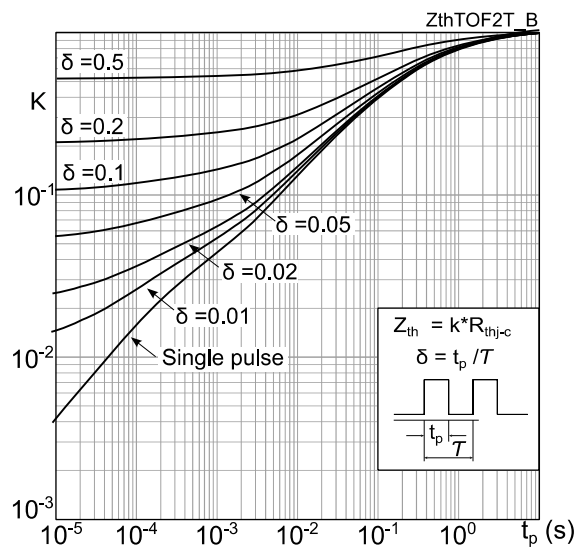
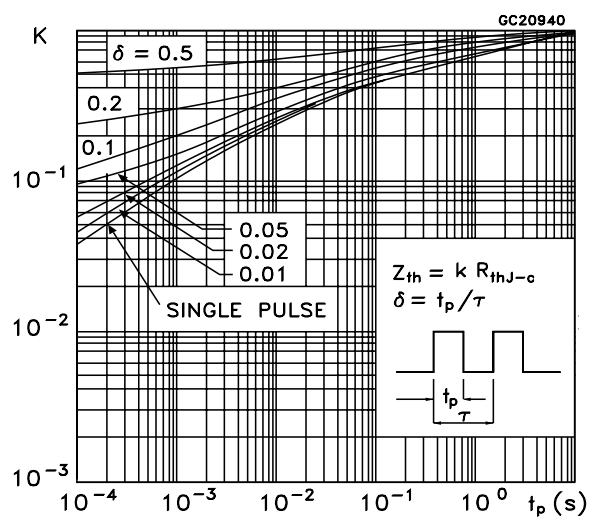
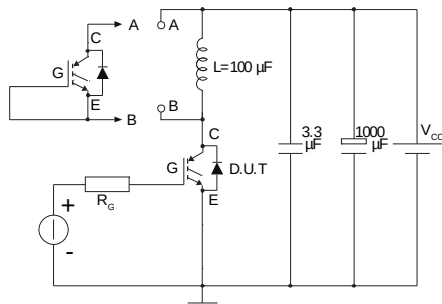


Figure 28: Thermal impedance for diode



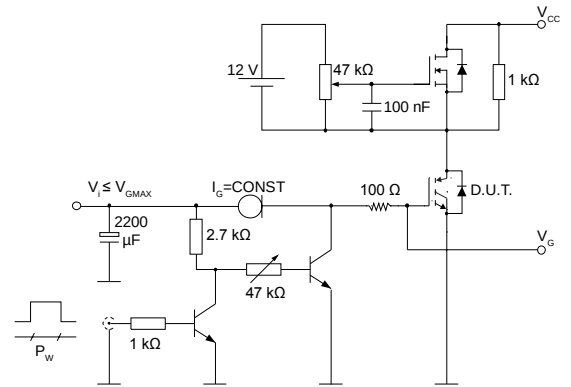
3 Test circuits

Figure 29: Test circuit for inductive load switching



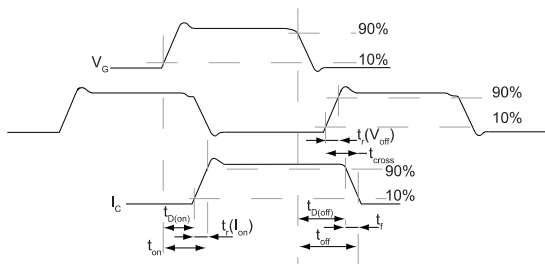
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Figure 30: Gate charge test circuit



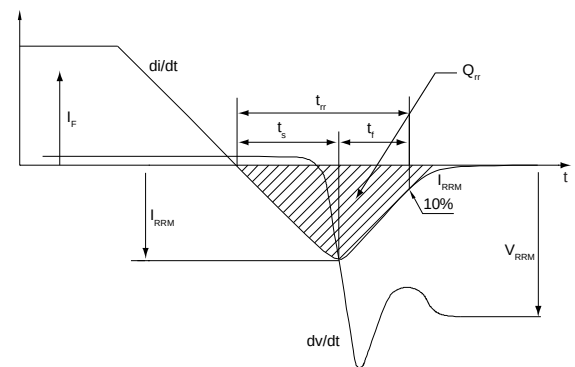
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Figure 31: Switching waveform



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Figure 32: Diode reverse recovery waveform



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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.

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