STGP15M65DF2

Trench gate field-stop IGBT M series, 650 V, 15 A low-loss in a TO-220 package

Datasheet - production data

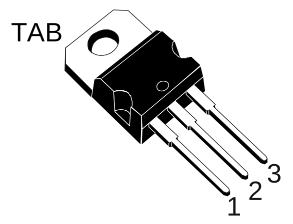
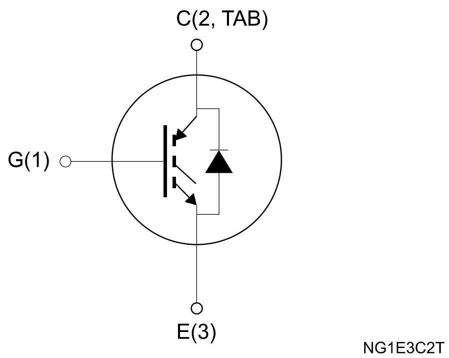


Figure 1: Internal schematic diagram



Features

- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ I_C = 15 A
- Tight parameter distribution
- Safer paralleling
- Positive $V_{CE(sat)}$ temperature coefficient
- Low thermal resistance
- Soft and very fast recovery antiparallel diode
- Maximum junction temperature: T_J = 175 °C

Applications

- Motor control
- UPS
- PFC
- General purpose inverter

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 low-loss and short-circuit functionality are essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGP15M65DF2	G15M65DF2	TO-220	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	Continuous collector current at T_C = 25 °C	30	A
	Continuous collector current at T_C = 100 °C	15	A
I_{CP} (1)	Pulsed collector current	60	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	30	A
I_F	Continuous forward current at T_C = 100 °C	15	A
I_{FP} (1)	Pulsed forward current	60	A
P_{TOT}	Total dissipation at T_C = 25 °C	136	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature range	- 55 to 175	°C

Notes:

(1)Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	1.1	°C/W
R_{thJC}	Thermal resistance junction-case diode	2.08	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5	°C/W

2 Electrical characteristics

T_J = 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 = 250 µA	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	2.6	V
		I_F = 15 A T_J = 125 °C		1.5		V
		I_F = 15 A T_J = 175 °C		1.4		V
$V_{GE(th)}$	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	-	pF
C_{res}	Reverse transfer capacitance		-	25	-	pF
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 15 A, V_{GE} = 0 to 15 V (see *Figure 30: " Gate charge test circuit"*)	-	45	-	nC
Q_{ge}	Gate-emitter charge		-	11	-	nC
Q_{gc}	Gate-collector charge		-	15	-	nC

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 energy			0.09	-	µJ
E_{off} (2)	Turn-off switching energy			0.45	-	µJ
E_{ts}	Total switching energy			0.54	-	µJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 15 A, R_G= 15 Ω, V_{GE} = 15 V, 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} (1)	Turn-on switching energy			0.22	-	µJ
E_{off} (2)	Turn-off switching energy			0.61	-	µJ
E_{ts}	Total switching energy			0.83	-	µJ
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 400 V, V_{GE}= 15 V, T_{Jstart}= 150 °C	6		-	µs
		V_{CC} ≤ 400 V, V_{GE}= 13 V, T_{Jstart}= 150 °C	10		-	

Notes:

(1)Including the reverse recovery of the diode.

(2)Including 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, di/dt = 1000 A/µs (see *Figure 29: " Test circuit for inductive load switching"*)	-	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, di/dt = 1000 A/µs, T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*)	-	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

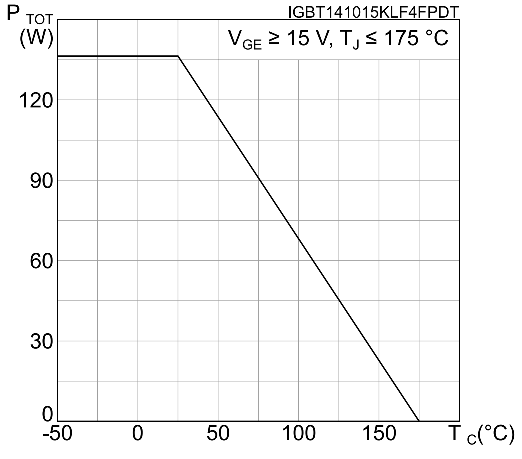


Figure 3: Collector current vs. case temperature

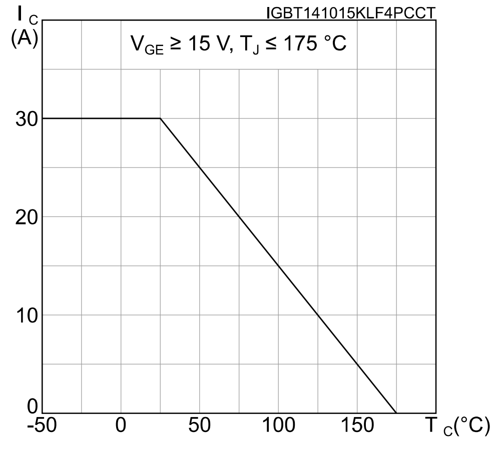


Figure 4: Output characteristics (T_J = 25 °C)

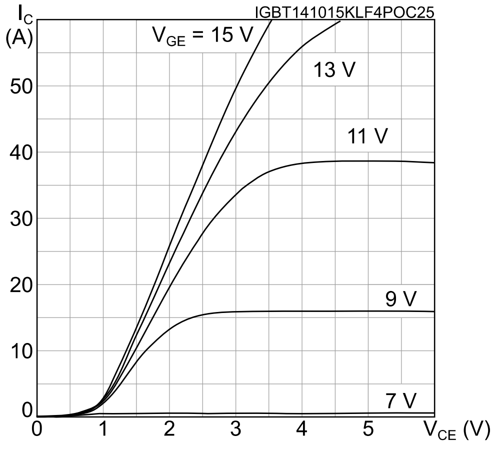


Figure 5: Output characteristics (T_J = 175 °C)

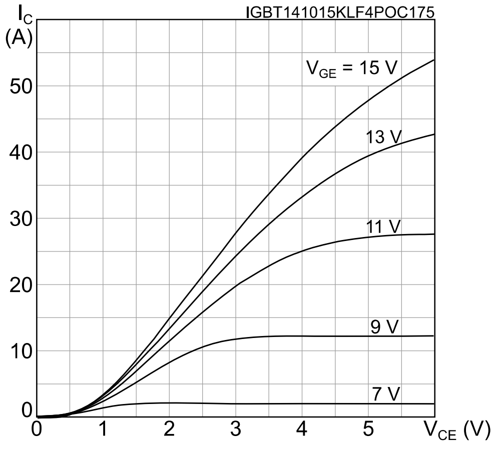


Figure 6: $V_{CE(sat)}$ vs. junction temperature

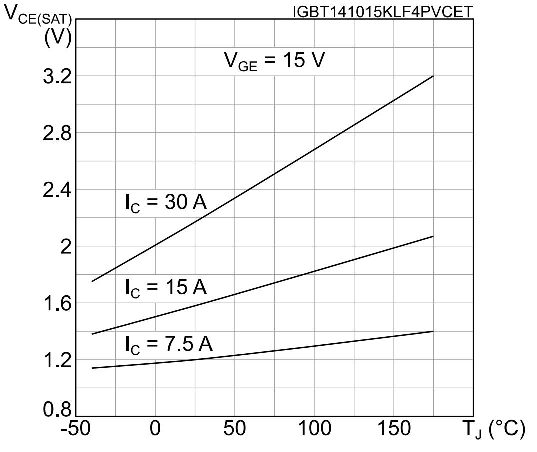


Figure 7: $V_{CE(sat)}$ vs. collector current

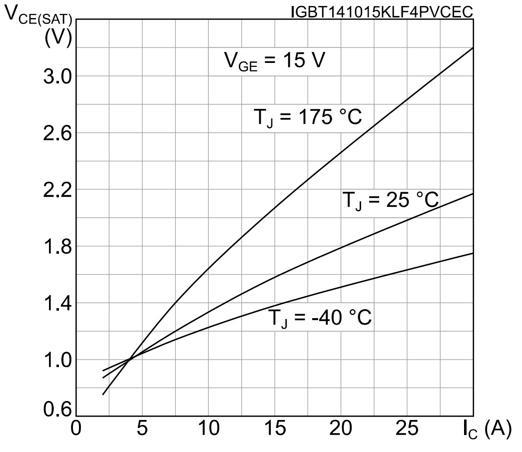


Figure 8: Collector current vs. switching frequency

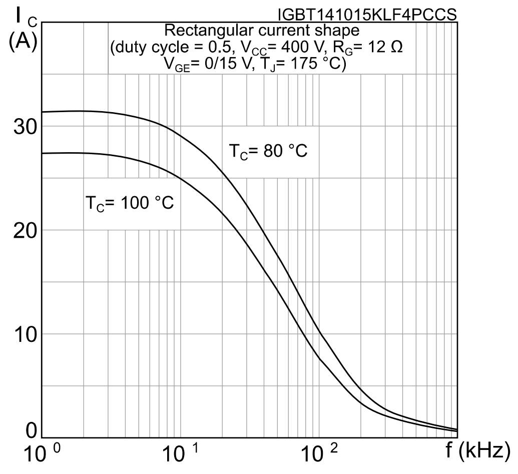


Figure 9: Forward bias safe operating area

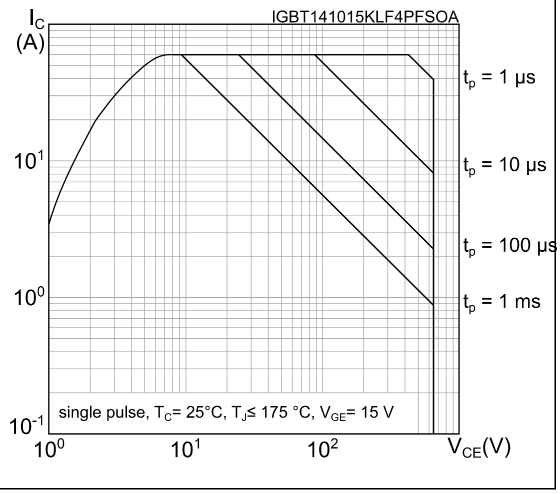


Figure 10: Transfer characteristics

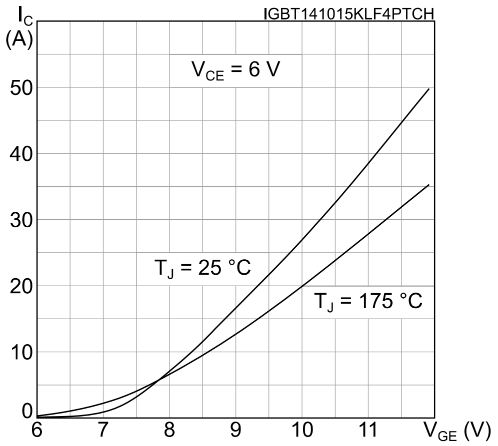


Figure 11: Diode V_F vs. forward current

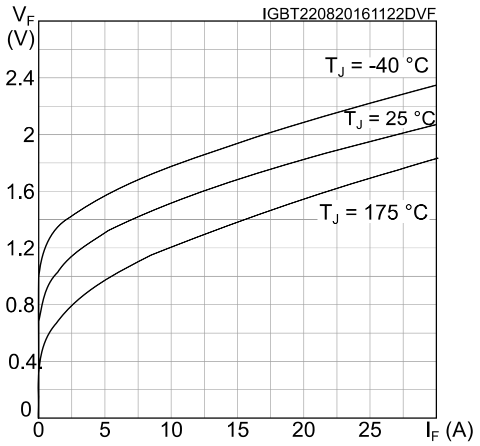


Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature

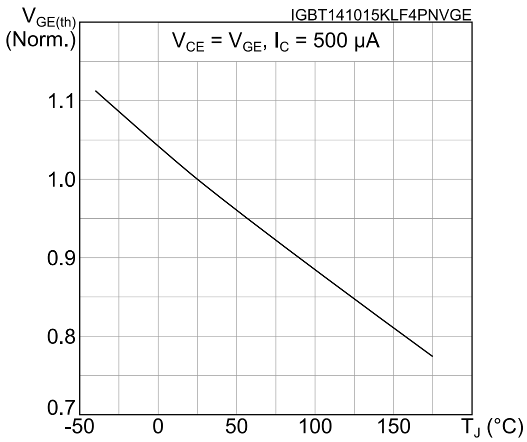


Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

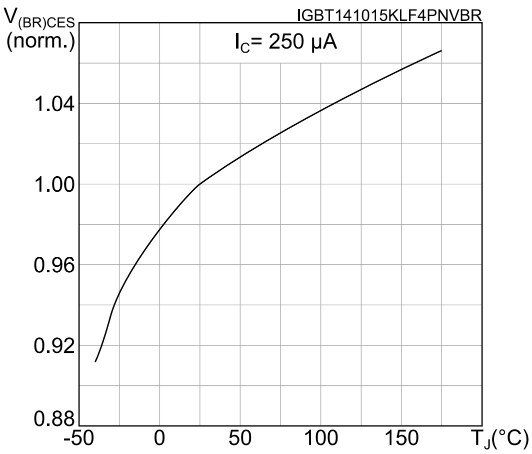


Figure 14: Capacitance variations

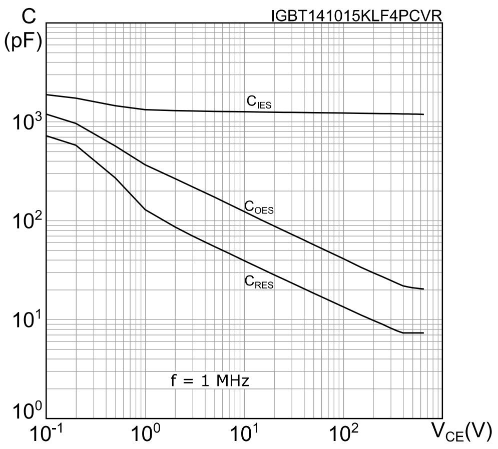


Figure 15: Gate charge vs. gate-emitter voltage

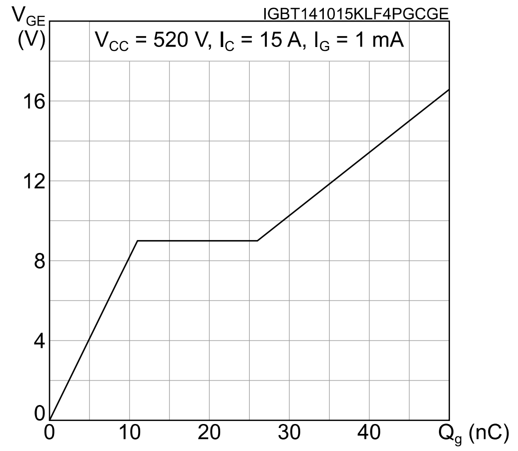


Figure 16: Switching energy vs. collector current

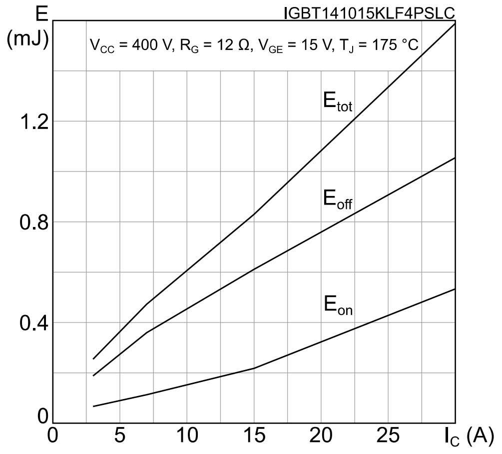


Figure 17: Switching energy vs. gate resistance

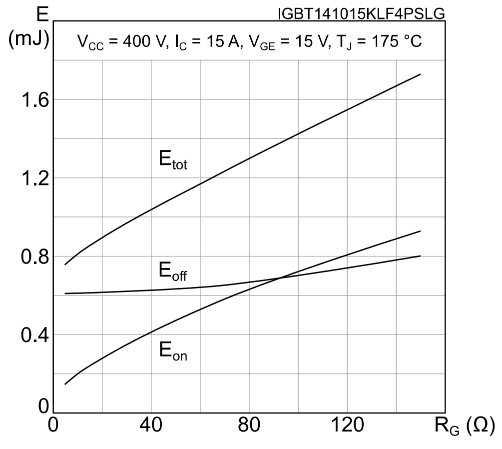


Figure 18: Switching energy vs. temperature

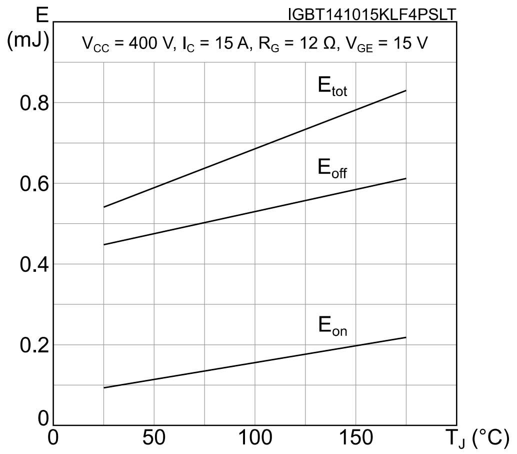


Figure 19: Switching energy vs. collector emitter voltage

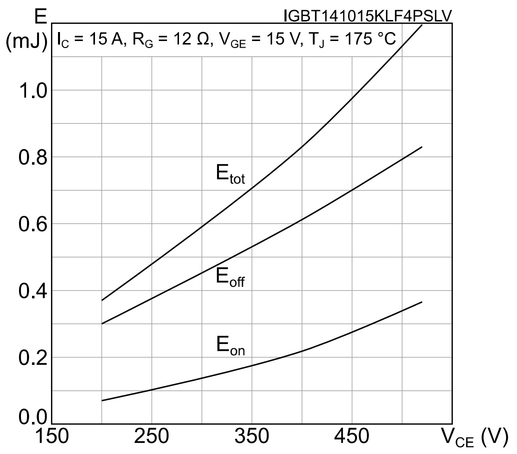


Figure 20: Short-circuit time and current vs. V_{GE}

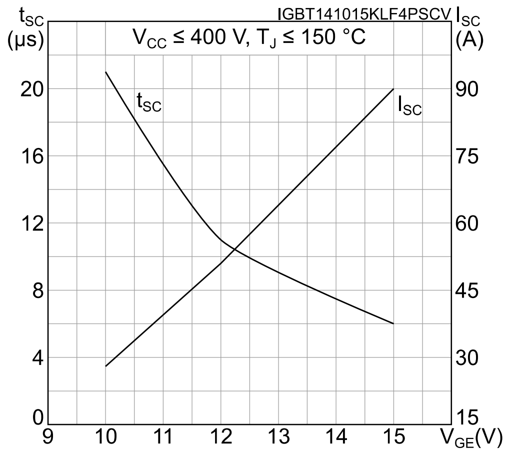


Figure 21: Switching times vs. collector current

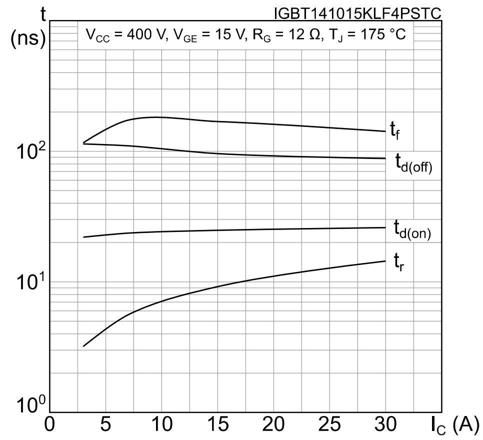


Figure 22: Switching times vs. gate resistance

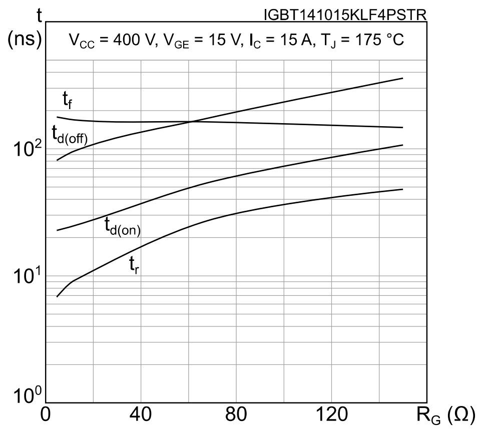


Figure 23: Reverse recovery current vs. diode current slope

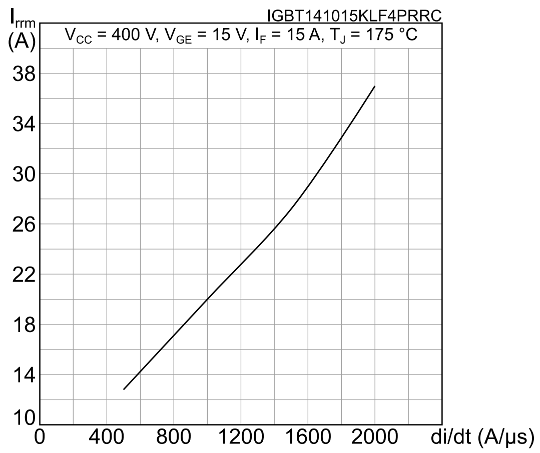


Figure 24: Reverse recovery time vs. diode current slope

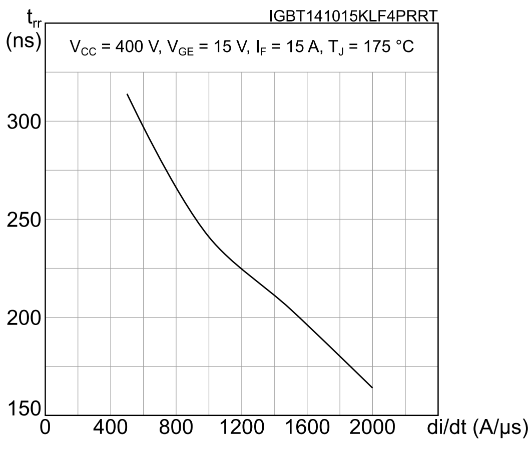


Figure 25: Reverse recovery charge vs. diode current slope

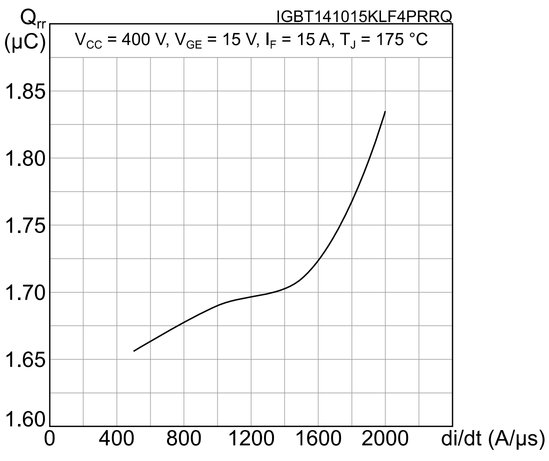


Figure 26: Reverse recovery energy vs. diode current slope

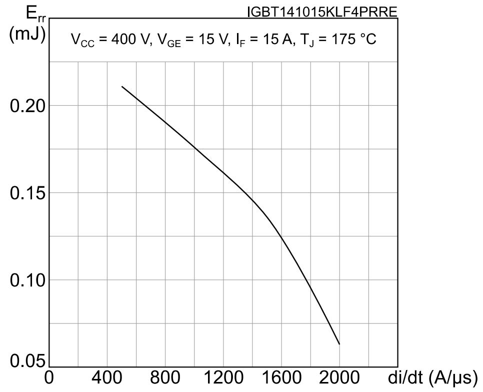


Figure 27: Thermal impedance for IGBT

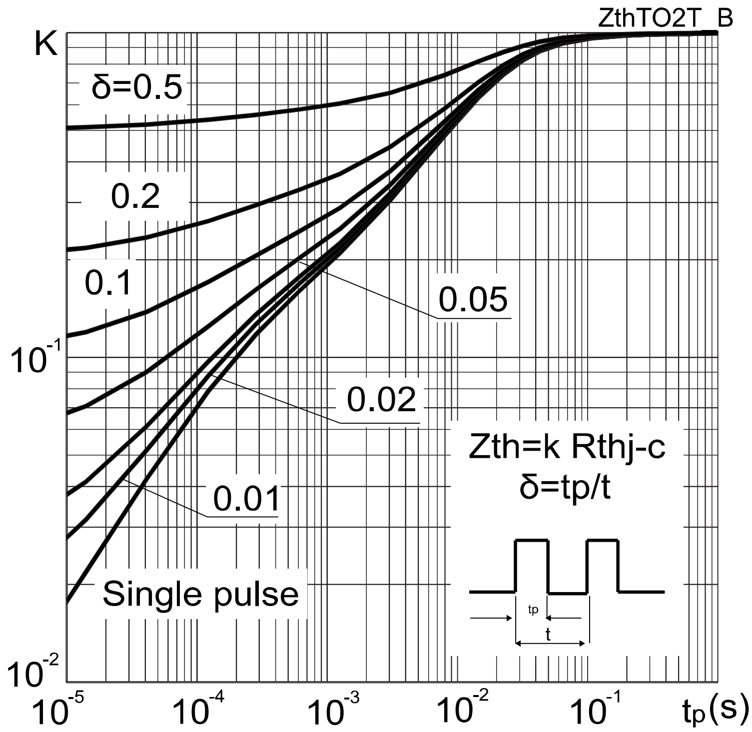
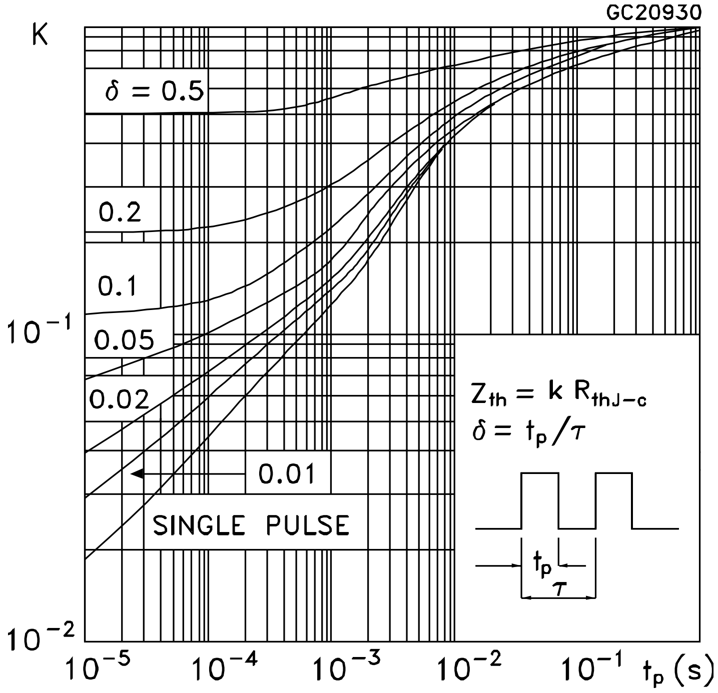


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

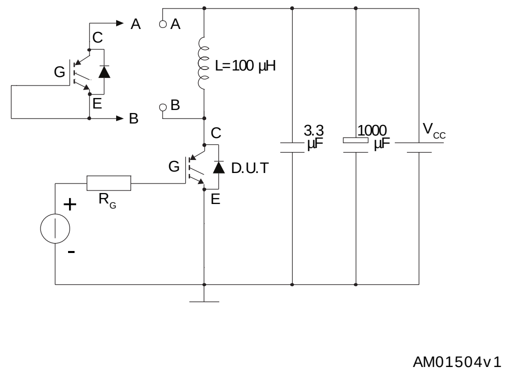


Figure 30: Gate charge test circuit

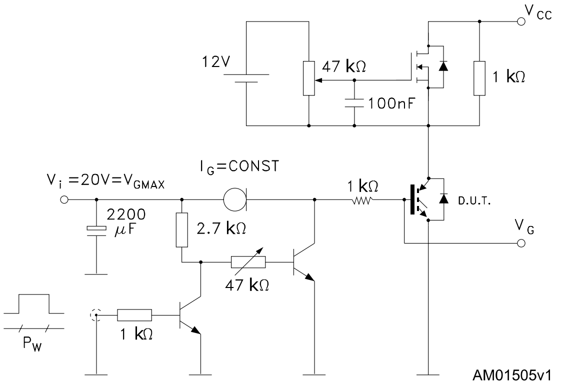


Figure 31: Switching waveform

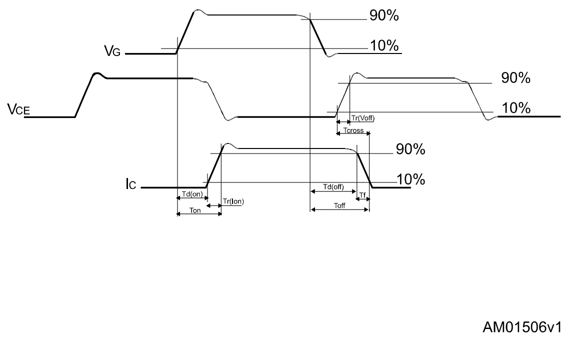
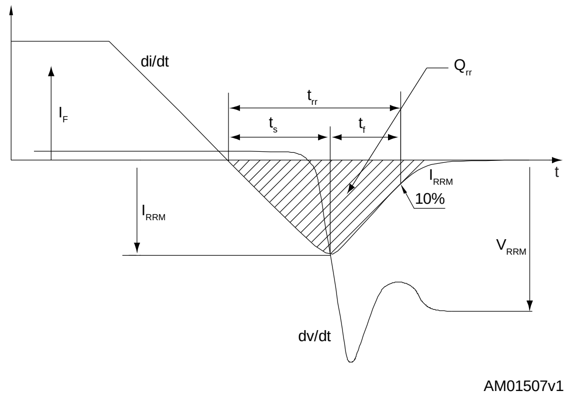


Figure 32: Diode reverse recovery waveform



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-220 type A package information

Figure 33: TO-220 type A package outline

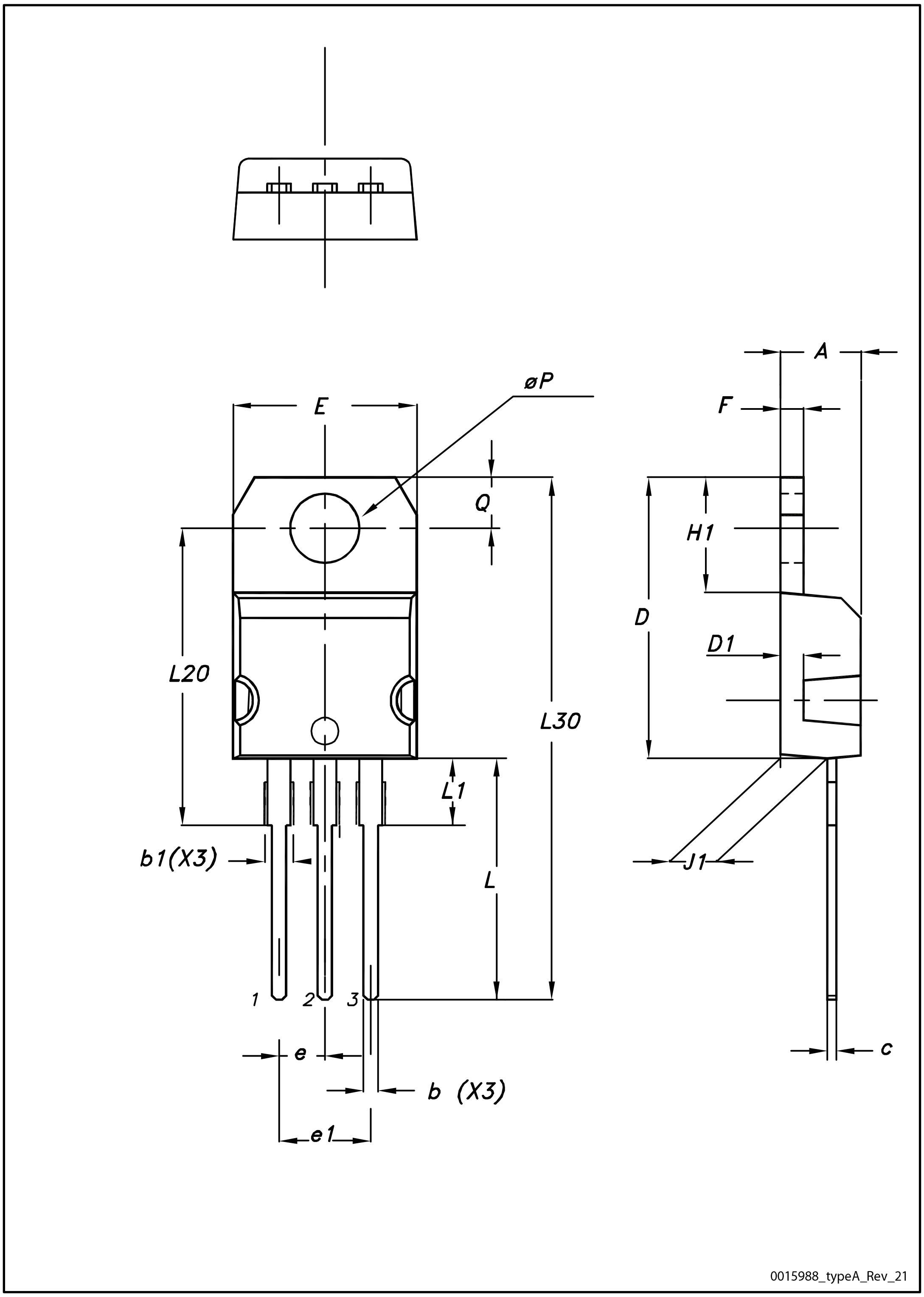


Table 8: TO-220 type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

5 Revision history

Table 9: Document revision history

Date	Revision	Changes
14-Oct-2015	1	First release.
13-Nov-2015	2	Document status promoted from preliminary to production data.
22-Aug-2016	3	Updated T*able 2: "Absolute maximum ratings"* and *Table 6: "IGBT switching characteristics (inductive load)".* Updated *Figure 16: "Switching energy vs. collector current", Figure 17: "Switching energy vs. gate resistance", Figure 18: "Switching energy vs. temperature"* and *Figure 19: "Switching energy vs. collector emitter voltage".* Changed *Figure 11: "Diode VF vs. forward current".*
28-Apr-2017	4	Modified: title, features and applications on cover page. Modified *Table 4: "Static characteristics"*, *Table 5: "Dynamic characteristics"*, *Table 7: "Diode switching characteristics (inductive load)"*. Minor text changes.