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Trench gate field-stop IGBT, M series 650 V, 10 A low-loss in D²PAK package

Datasheet - production data

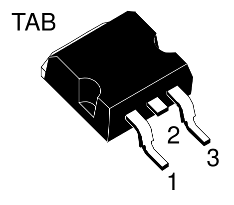
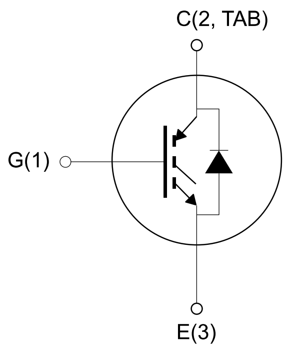


Figure 1: Internal schematic diagram



Features

- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ I_C = 10 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
STGB10M65DF2	G10M65DF2	D²PAK	Tape and reel

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	20	A
	Continuous collector current at T_C = 100 °C	10	
I_{CP}[(1)]	Pulsed collector current	40	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	20	A
	Continuous forward current at T_C = 100 °C	10	
I_{FP}[(1)]	Pulsed forward current	40	A
P_{TOT}	Total dissipation at T_C = 25 °C	115	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature range	- 55 to 175	

Notes:

[(1)]Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	1.3	°C/W
R_{thJC}	Thermal resistance junction-case diode	2.08	
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 = 250 μA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 10 A		1.55	2.0	V
		V_{GE} = 15 V, I_C = 10 A, T_J = 125 °C		1.9		
		V_{GE} = 15 V, I_C = 10 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 10 A		1.5	2.25	V
		I_F = 10 A, T_J = 125 °C		1.3		
		I_F = 10 A, T_J = 175 °C		1.2		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 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	-	840	-	pF
C_{oes}	Output capacitance		-	63	-	
C_{res}	Reverse transfer capacitance		-	16	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 10 A, V_{GE} = 0 to 15 V (see *Figure 30: " Gate charge test circuit"*)	-	28	-	nC
Q_{ge}	Gate-emitter charge		-	6	-	
Q_{gc}	Gate-collector charge		-	12	-	

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 = 10 A, V_{GE} = 15 V, R_G = 22 Ω (see *Figure 29: " Test circuit for inductive load switching"*)		19	-	ns
t_r	Current rise time			7.4	-	ns
$(di/dt)_{on}$	Turn-on current slope			1086	-	A/µs
$t_{d(off)}$	Turn-off-delay time			91	-	ns
t_f	Current fall time			92	-	ns
E_{on} (1)	Turn-on switching energy			0.12	-	mJ
E_{off} (2)	Turn-off switching energy			0.27	-	mJ
E_{ts}	Total switching energy			0.39	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 10 A, V_{GE} = 15 V, R_G = 22 Ω, T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*)		18	-	ns
t_r	Current rise time			9	-	ns
$(di/dt)_{on}$	Turn-on current slope			890	-	A/µs
$t_{d(off)}$	Turn-off-delay time			90	-	ns
t_f	Current fall time			170	-	ns
E_{on} (1)	Turn-on switching energy			0.26	-	mJ
E_{off} (2)	Turn-off switching energy			0.4	-	mJ
E_{ts}	Total switching energy			0.66	-	mJ
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 400 V, V_{GE} = 13 V, T_{Jstart} = 150 °C	10		-	µs
		V_{CC} ≤ 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	6		-	µs

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 = 10 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see *Figure 29: " Test circuit for inductive load switching"*)	-	96	-	ns
Q_{rr}	Reverse recovery charge		-	373	-	nC
I_{rrm}	Reverse recovery current		-	13	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	661	-	A/µs
E_{rr}	Reverse recovery energy		-	52	-	µJ
t_{rr}	Reverse recovery time	I_F = 10 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"*)	-	201	-	ns
Q_{rr}	Reverse recovery charge		-	1352	-	nC
I_{rrm}	Reverse recovery current		-	19	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	405	-	A/µs
E_{rr}	Reverse recovery energy		-	150	-	µJ

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

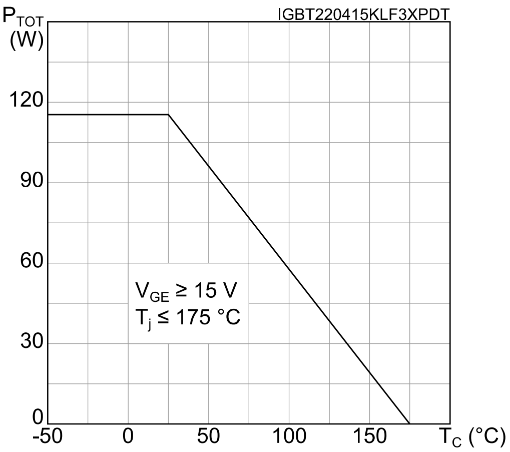


Figure 3: Collector current vs. case temperature

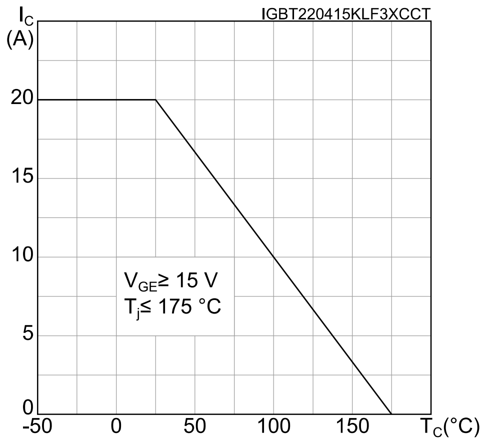


Figure 4: Output characteristics (T_J = 25 °C)

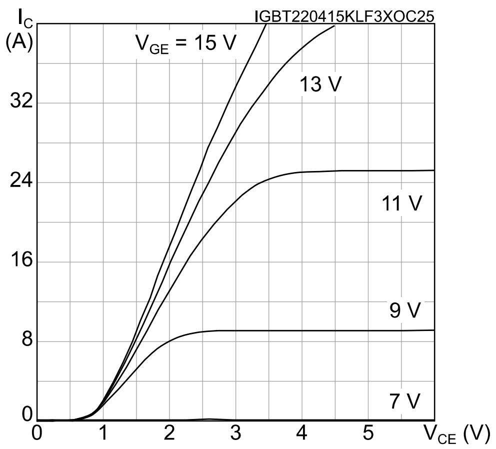


Figure 5: Output characteristics (T_J = 175 °C)

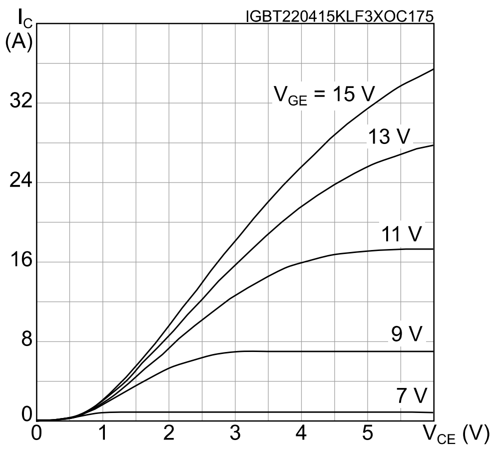


Figure 6: $V_{CE(sat)}$ vs. junction temperature

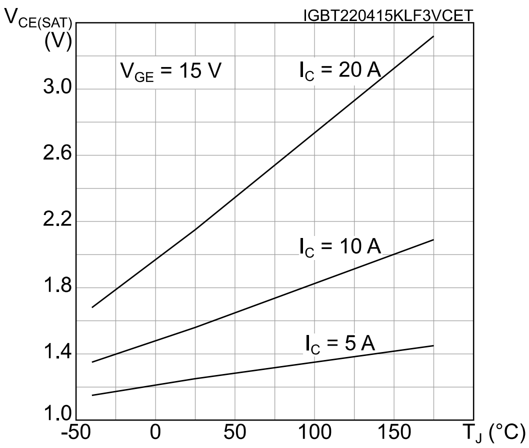


Figure 7: $V_{CE(sat)}$ vs. collector current

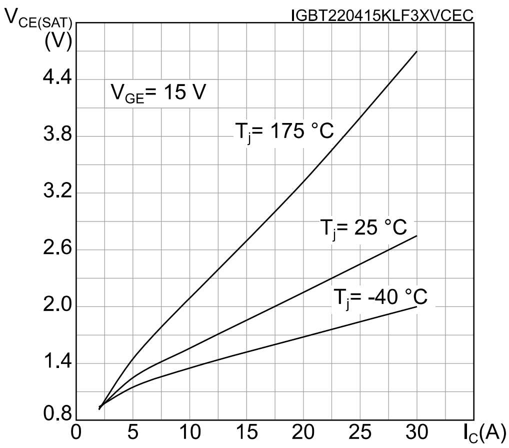


Figure 8: Collector current vs. switching frequency

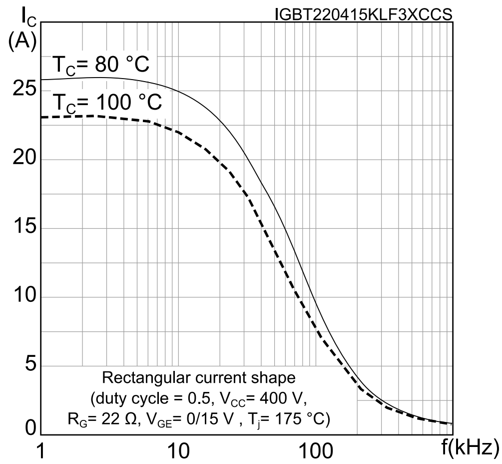


Figure 9: Forward bias safe operating area

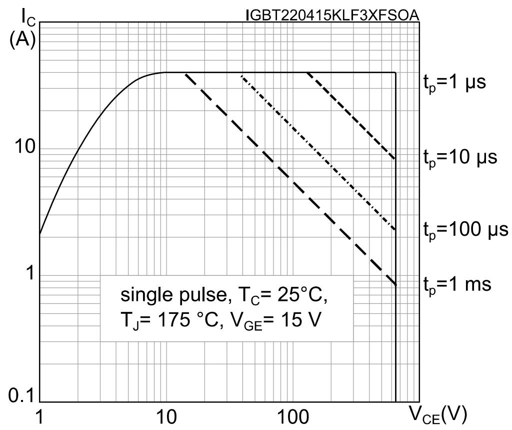


Figure 10: Transfer characteristics

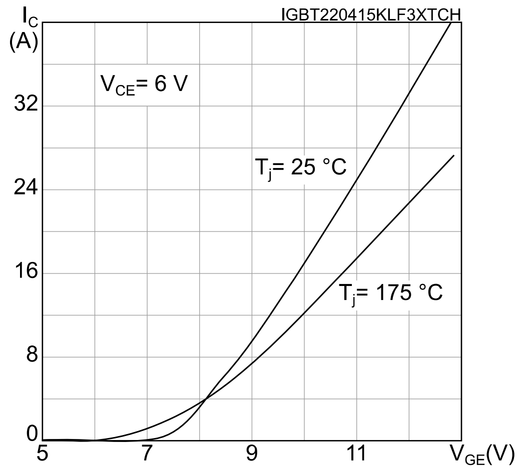


Figure 11: Diode V_F vs. forward current

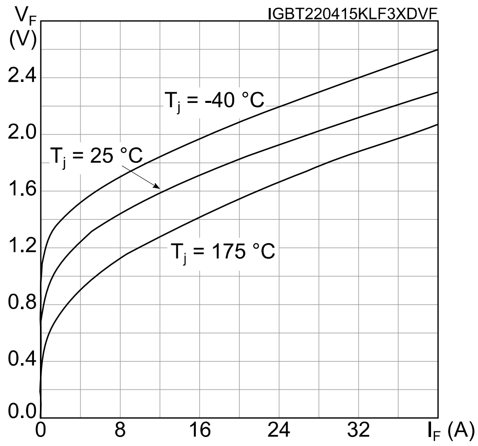


Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature

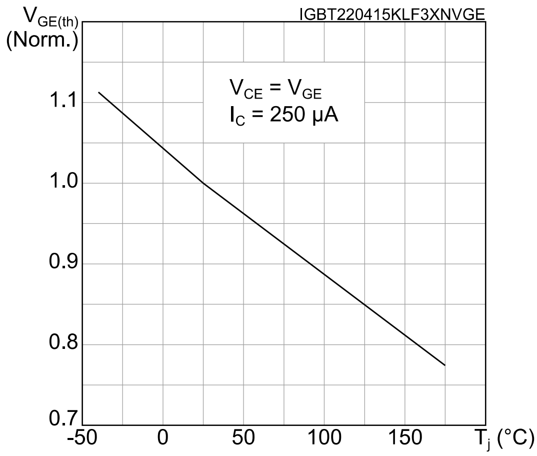


Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

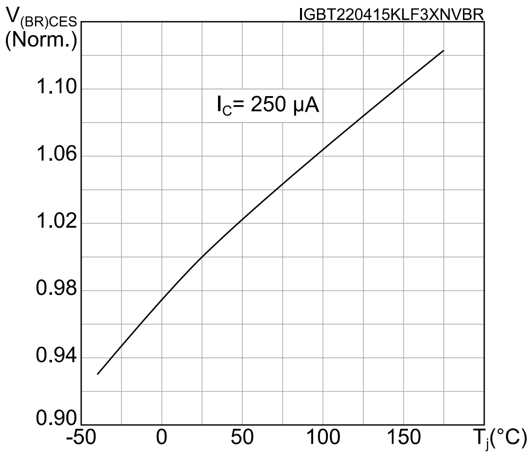


Figure 14: Capacitance variations

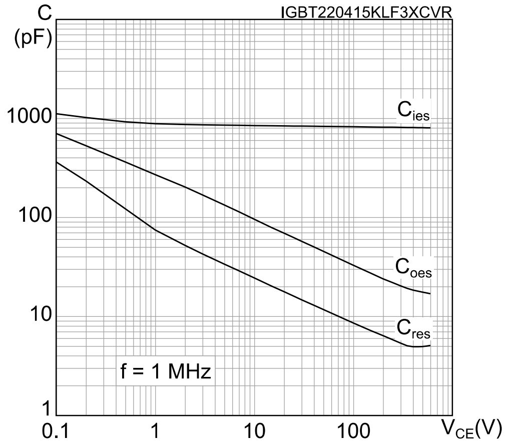


Figure 15: Gate charge vs. gate-emitter voltage

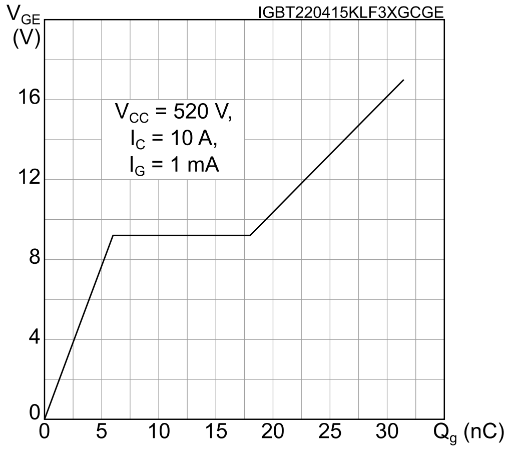


Figure 16: Switching energy vs. collector current

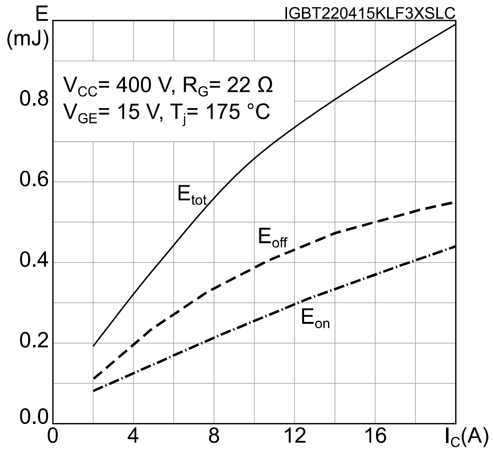


Figure 17: Switching energy vs. gate resistance

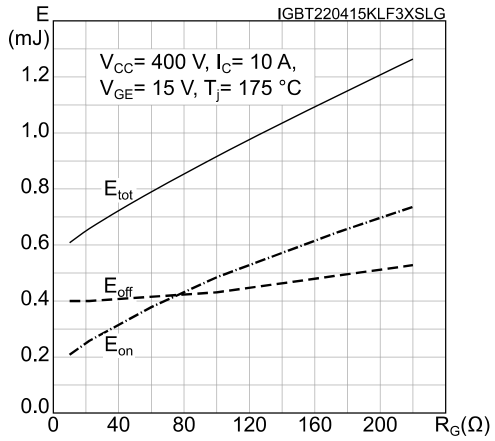


Figure 18: Switching energy vs. temperature

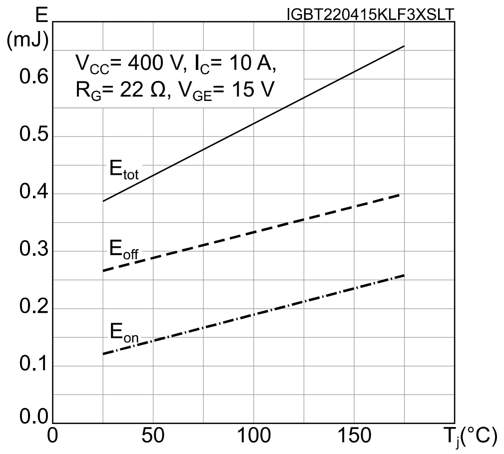


Figure 19: Switching energy vs. collector emitter voltage

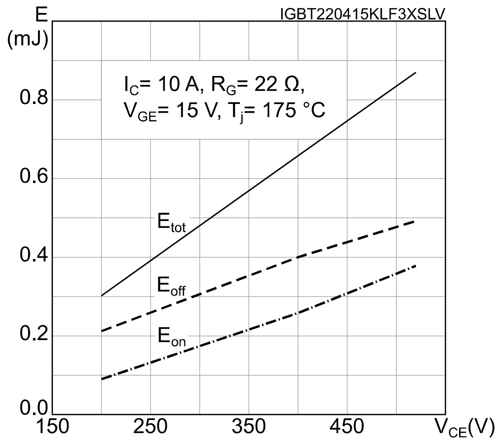


Figure 20: Short-circuit time and current vs. V_{GE}

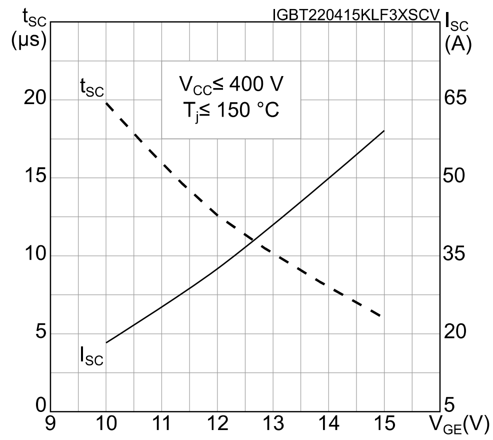


Figure 21: Switching times vs. collector current

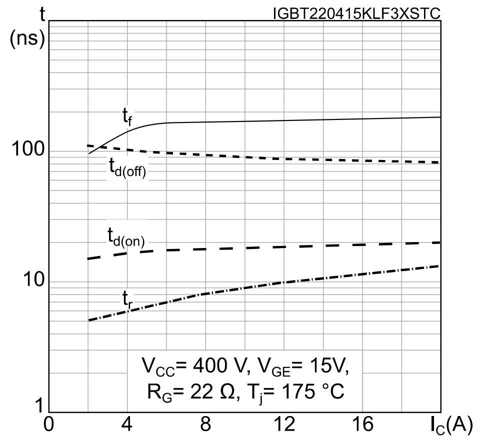


Figure 22: Switching times vs. gate resistance

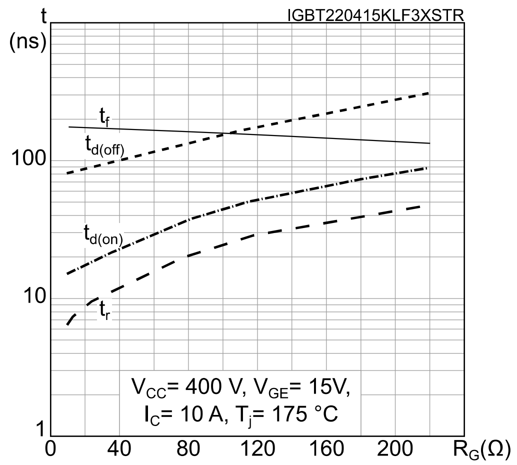


Figure 23: Reverse recovery current vs. diode current slope

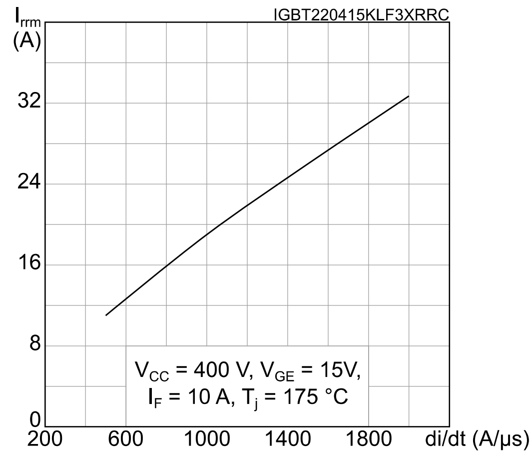


Figure 24: Reverse recovery time vs. diode current slope

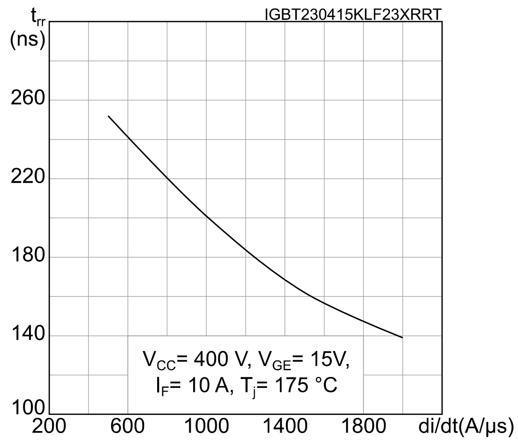


Figure 25: Reverse recovery charge vs. diode current slope

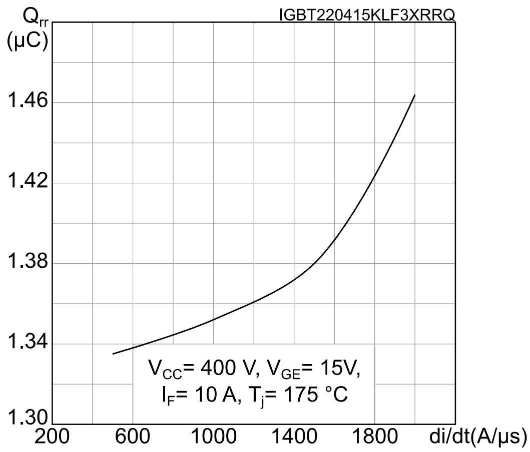


Figure 26: Reverse recovery energy vs. diode current slope

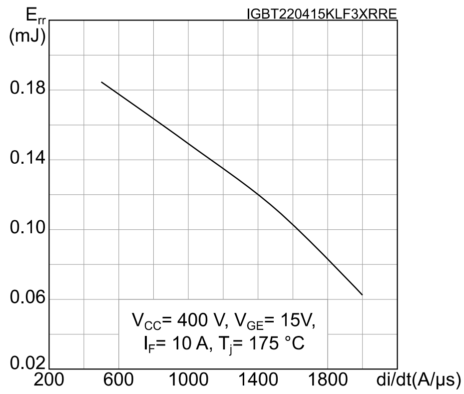


Figure 27: Thermal impedance for IGBT

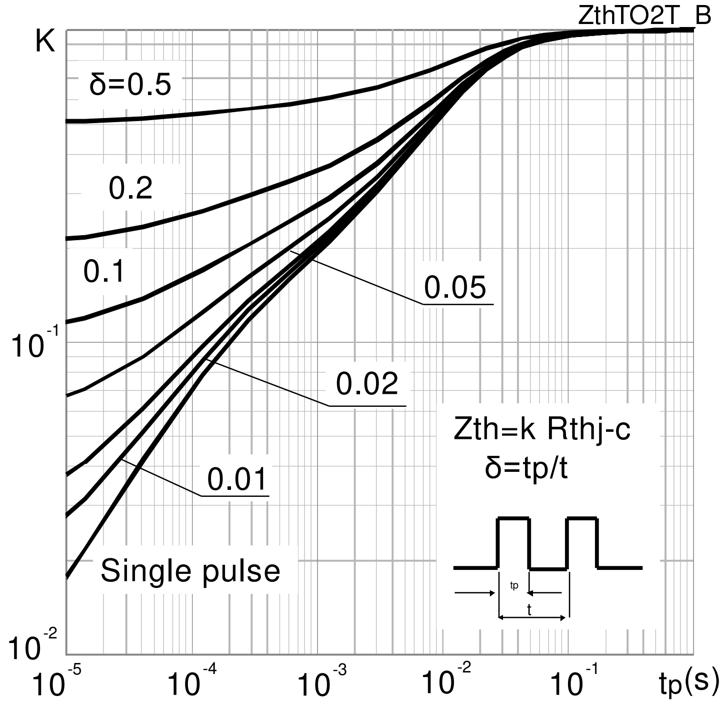
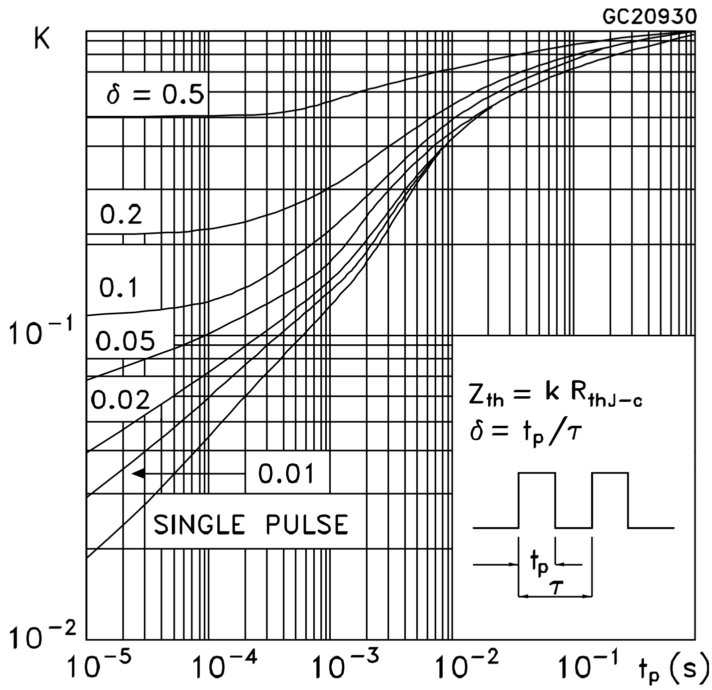


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

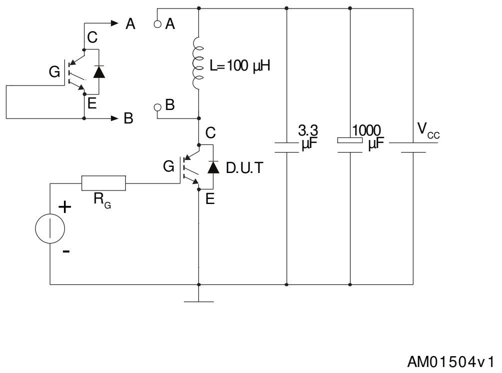


Figure 30: Gate charge test circuit

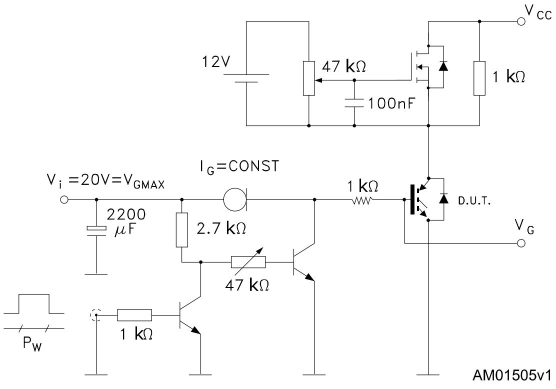


Figure 31: Switching waveform

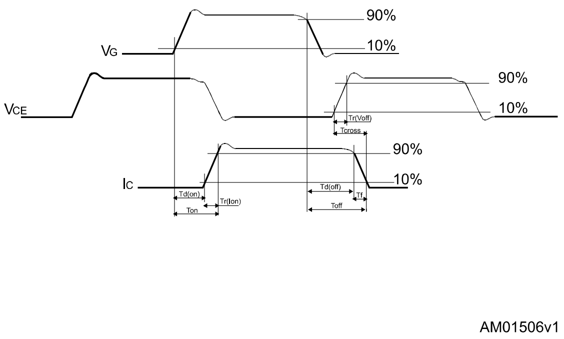
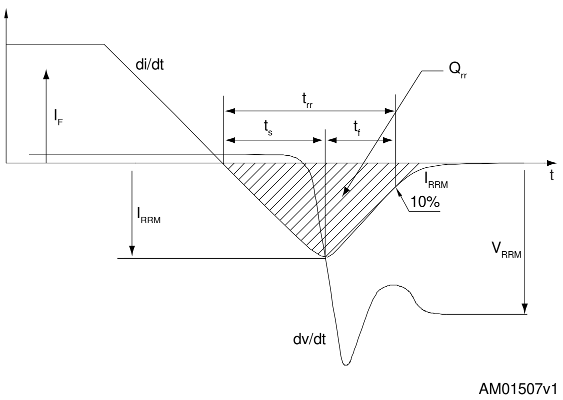


Figure 32: Diode reverse recovery waveform



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 D²PAK package information

Figure 33: D²PAK (TO-263) type A package outline

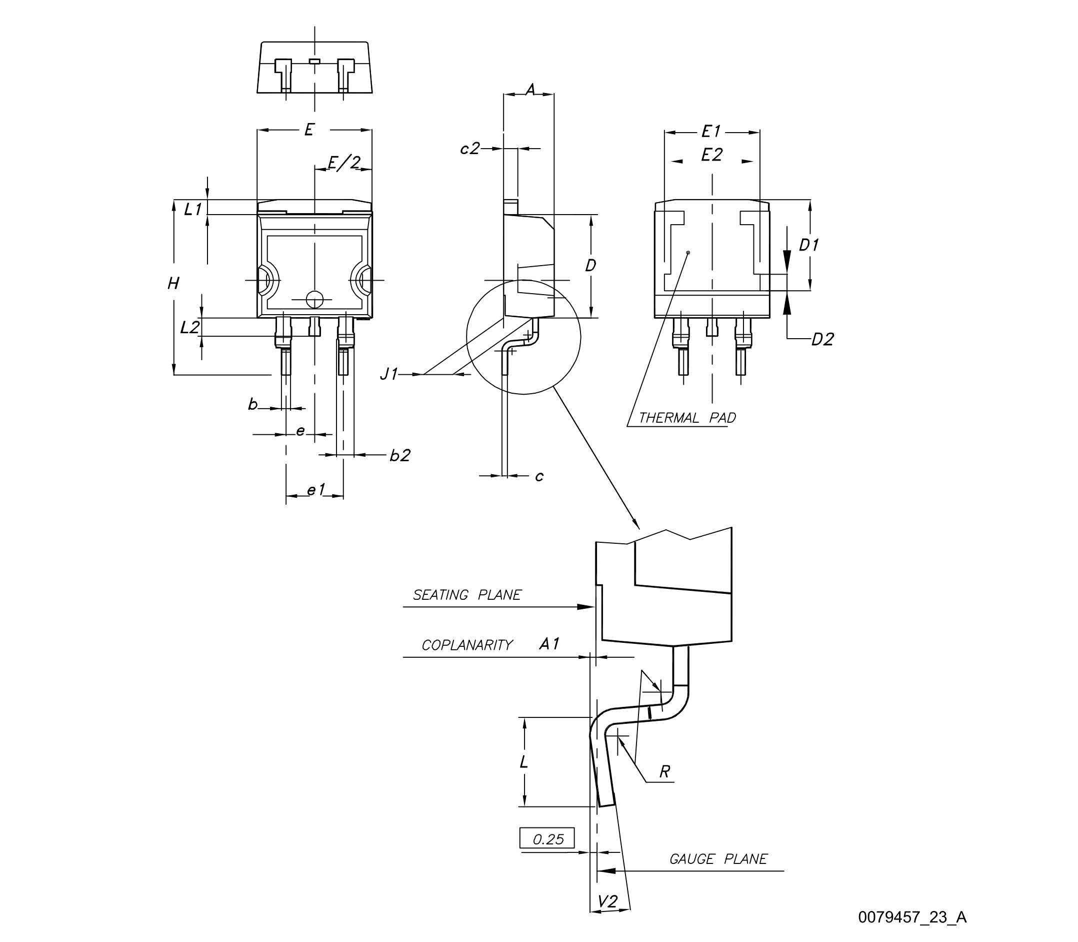
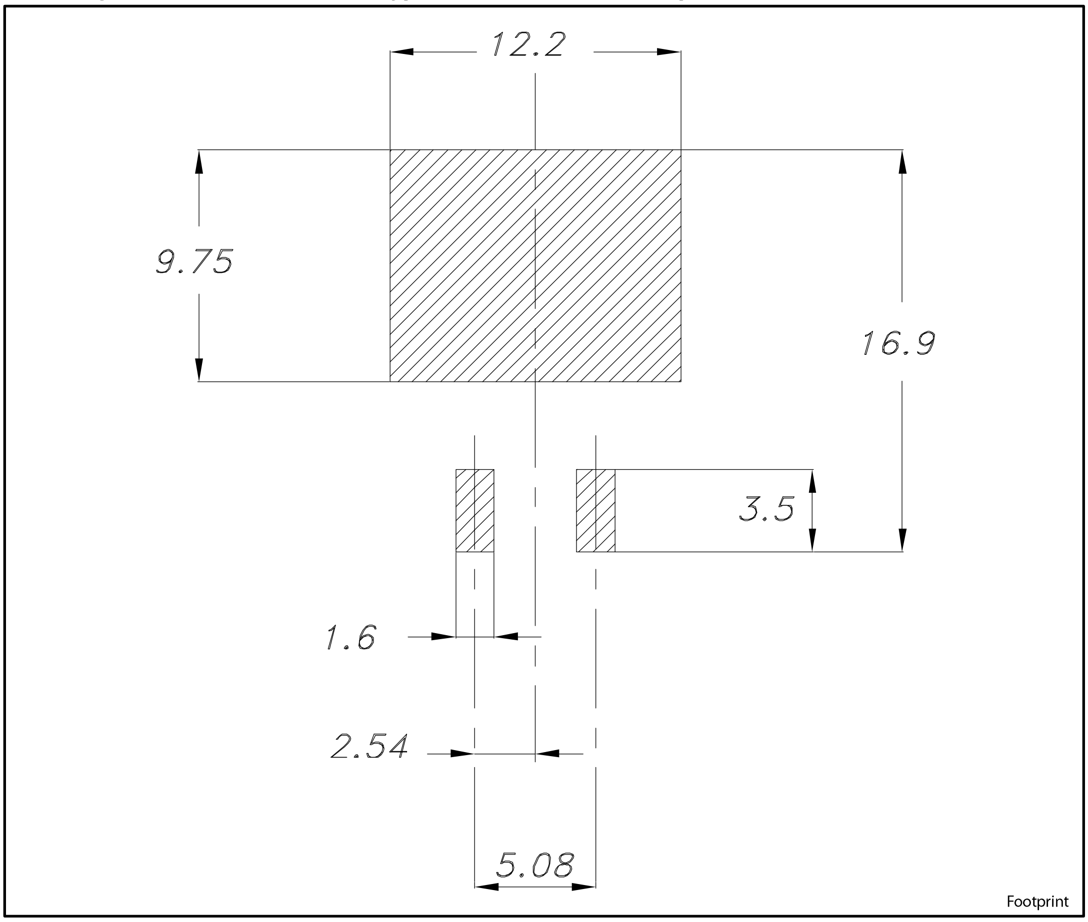


Table 8: D²PAK (TO-263) type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

Figure 34: D²PAK (TO-263) type A recommended footprint (dimensions are in mm)



4.2 D²PAK packing information

Figure 35: D²PAK type A tape outline

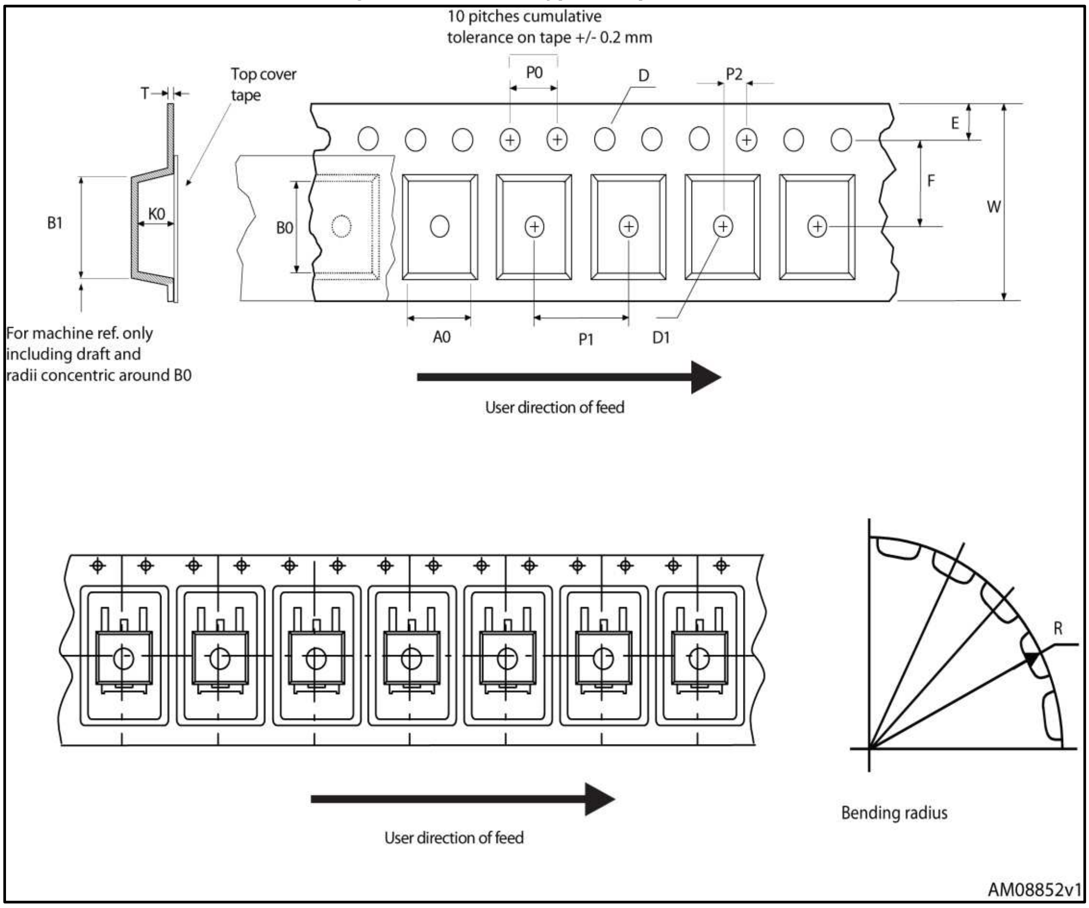


Figure 36: D²PAK type A reel outline

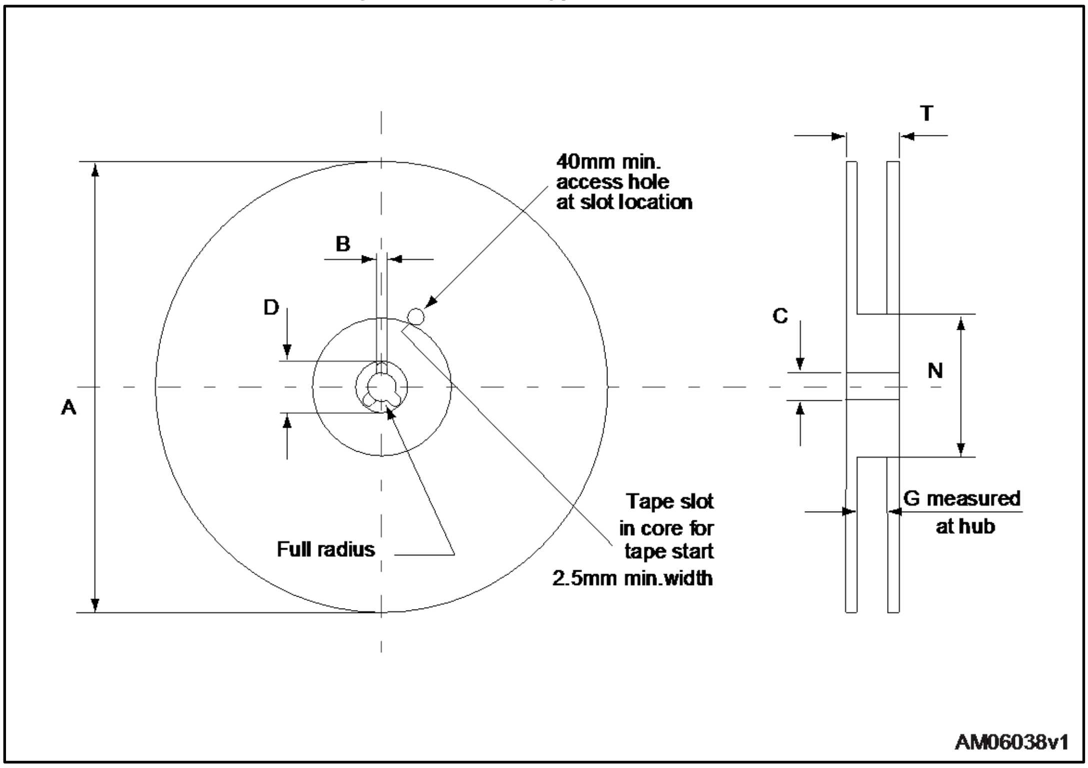


Table 9: D²PAK type A tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

5 Revision history

Table 10: Document revision history

Date	Revision	Changes
10-Feb-2015	1	First release.
23-Apr-2015	2	Minor text edits throughout document In Section 2 Electrical characteristics: - updated Table 4: Static characteristics - updated Table 5: Dynamic characteristics - updated Table 6: IGBT switching characteristics (inductive load) - updated Table 7: Diode switching characteristics (inductive load) Added Section 2.1 Electrical characteristics (curves)
11-Jun-2015	3	Document status promoted from preliminary to production data.
31-Jul-2015	4	Updated table titled: "Diode switching characteristics (inductive load)".
20-Oct-2015	5	Updated *Table 5: "Dynamic characteristics"* and *Table 6: "IGBT switching characteristics (inductive load)"*. Updated *Figure 8: "Collector current vs. switching frequency"*.
04-Apr-2017	6	Modified title, features and applications on cover page Modified *Table 2: "Absolute maximum ratings"*, *Table 4: "Static characteristics"*, *Table 6: "IGBT switching characteristics (inductive load)"* and *Table 7: "Diode switching characteristics (inductive load)"* Minor text changes.