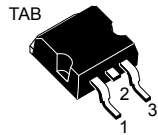
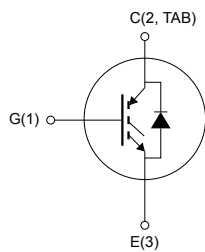


Trench gate field-stop 650 V, 6 A low-loss M series IGBT in a D²PAK package


D²PAK


NG1E3C2T



Features

- 6 μ s of minimum short-circuit withstand time
- Low $V_{CE(sat)} = 1.55$ V (typ.) at $I_C = 6$ 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 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

[STGB6M65DF2](#)

Product summary

Order code	STGB6M65DF2
Marking	G6M65DF2
Package	D ² PAK
Packing	Tape and reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage	650	V
I_C	Continuous collector current at $T_C = 25\text{ °C}$	12	A
	Continuous collector current at $T_C = 100\text{ °C}$	6	
$I_{CP}^{(1)}$	Pulsed collector current	24	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	12	A
	Continuous forward current at $T_C = 100\text{ °C}$	6	
$I_{FP}^{(1)}$	Pulsed collector current	24	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ °C}$	88	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. Pulse width limited by maximum junction temperature.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case, IGBT	1.7	°C/W
	Thermal resistance, junction-to-case, diode	5	
R_{thJA}	Thermal resistance, junction-to-ambient	62.5	°C/W

2 Electrical characteristics

$T_J = 25\text{ °C}$ 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	$V_{GE} = 15\text{ V}$, $I_C = 6\text{ A}$	-	1.55	2.0	V
		$V_{GE} = 15\text{ V}$, $I_C = 6\text{ A}$, $T_J = 125\text{ °C}$	-	1.9	-	
		$V_{GE} = 15\text{ V}$, $I_C = 6\text{ A}$, $T_J = 175\text{ °C}$	-	2.1	-	
V_F	Forward on-voltage	$I_F = 6\text{ A}$	-	2.2	-	V
		$I_F = 6\text{ A}$, $T_J = 125\text{ °C}$	-	2.0	-	
		$I_F = 6\text{ A}$, $T_J = 175\text{ °C}$	-	1.9	-	
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	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	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	530	-	pF
C_{oes}	Output capacitance		-	31	-	pF
C_{res}	Reverse transfer capacitance		-	11	-	pF
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 6\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see the Figure 29. Gate charge test circuit)	-	21.2	-	nC
Q_{ge}	Gate-emitter charge		-	5.2	-	nC
Q_{gc}	Gate-collector charge		-	8.8	-	nC

Table 5. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 6\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 22\ \Omega$ (see the Figure 28. Test circuit for inductive load switching)	-	15	-	ns
t_r	Current rise time		-	5.8	-	ns
$di/dt_{(on)}$	Turn-on current slope		-	828	-	A/ μ s
$t_{d(off)}$	Turn-off delay time		-	90	-	ns
t_f	Current fall time		-	130	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	0.036	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.200	-	mJ
E_{ts}	Total switching energy		-	0.236	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 6\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 22\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (see the Figure 28. Test circuit for inductive load switching)	-	17	-	ns
t_r	Current rise time		-	7	-	ns
$di/dt_{(on)}$	Turn-on current slope		-	685	-	A/ μ s
$t_{d(off)}$	Turn-off delay time		-	86	-	ns
t_f	Current fall time		-	205	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	0.064	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.290	-	mJ
E_{ts}	Total switching energy		-	0.354	-	mJ
t_{sc}	Short-circuit withstand time	$V_{CC} = 400\text{ V}$, $V_{GE} = 13\text{ V}$, starting $T_J \leq 150\text{ }^\circ\text{C}$	10	-	-	μ s
		$V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, starting $T_J \leq 150\text{ }^\circ\text{C}$	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	$I_F = 6\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see the Figure 28. Test circuit for inductive load switching)	-	140	-	ns
Q_{rr}	Reverse recovery charge		-	210	-	nC
I_{rrm}	Reverse recovery current		-	6.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	430	-	A/ μ s
E_{rr}	Reverse recovery energy		-	16	-	μ J
t_{rr}	Reverse recovery time	$I_F = 6\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see the Figure 28. Test circuit for inductive load switching)	-	200	-	ns
Q_{rr}	Reverse recovery charge		-	473	-	nC
I_{rrm}	Reverse recovery current		-	9.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	428	-	A/ μ s
E_{rr}	Reverse recovery energy		-	32	-	μ J

2.1 Electrical characteristics (curves)

Figure 1. Total power dissipation vs temperature

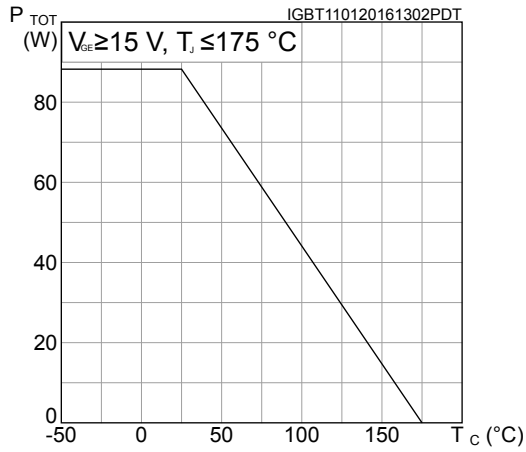


Figure 2. Maximum collector current vs temperature

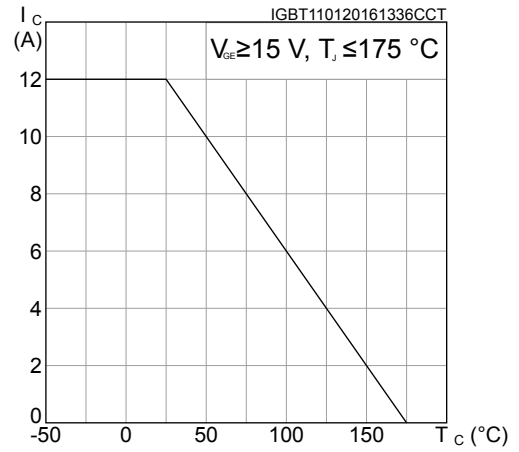


Figure 3. Typical output characteristics (T_J = 25 °C)

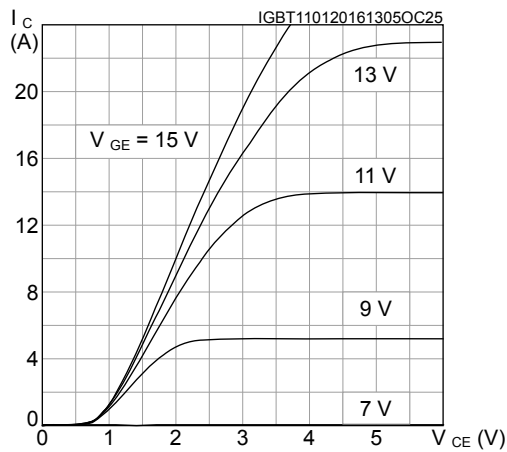


Figure 4. Typical output characteristics (T_J = 175 °C)

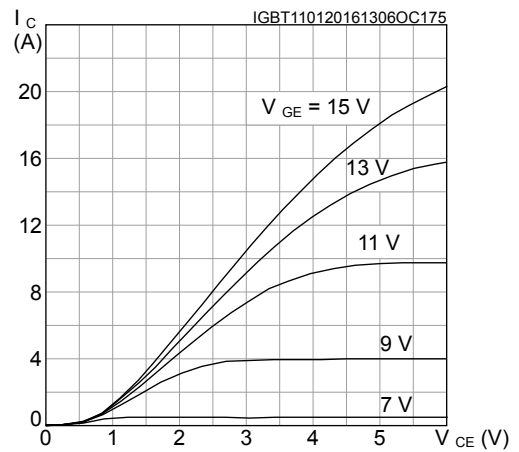


Figure 5. Typical transfer characteristics

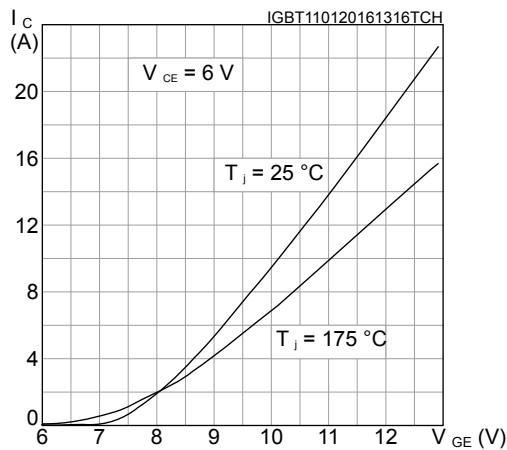


Figure 6. Typical V_CE(sat) vs temperature

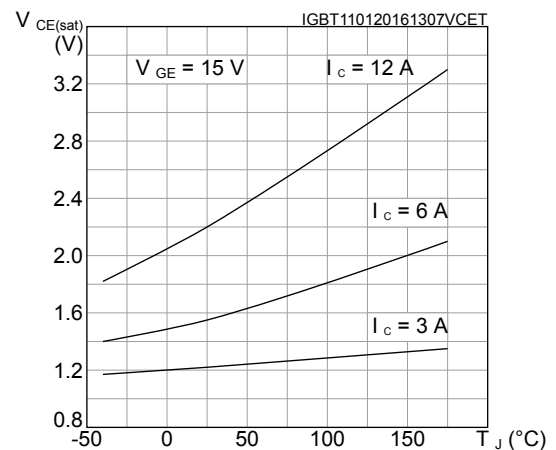


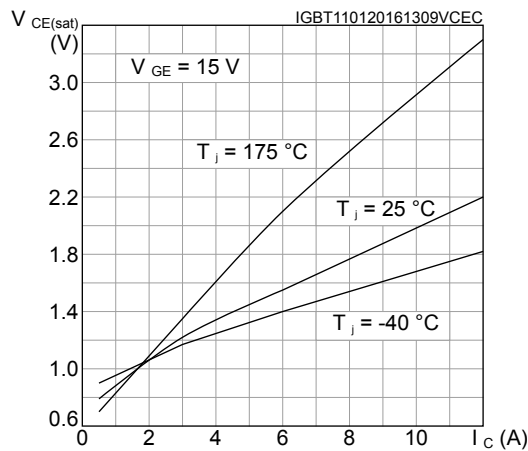
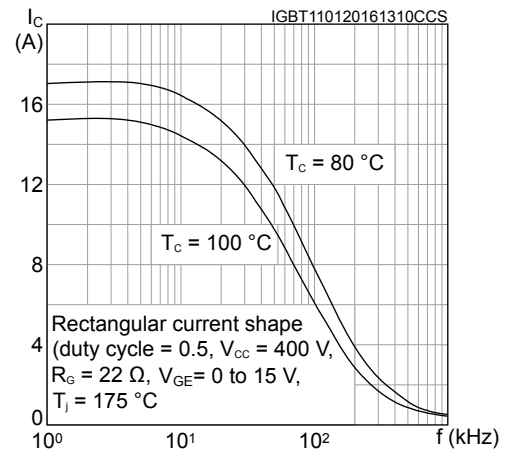
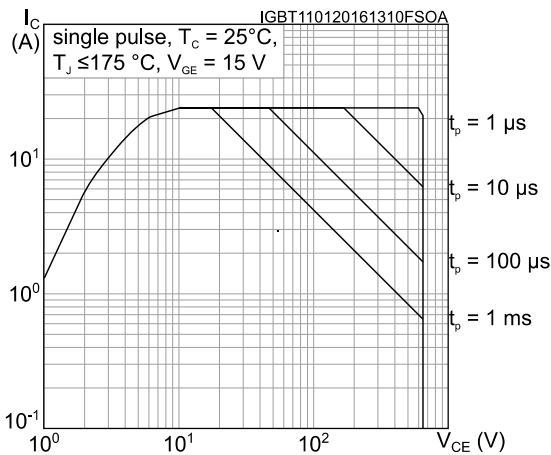
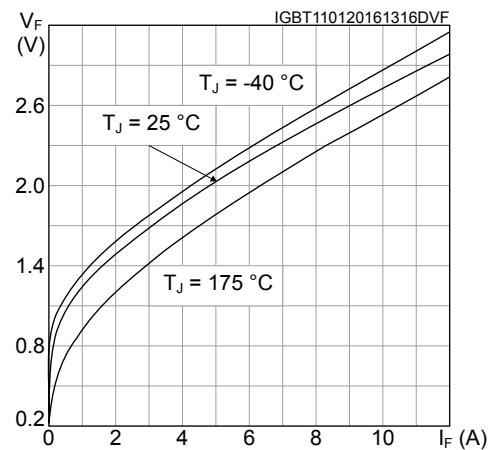
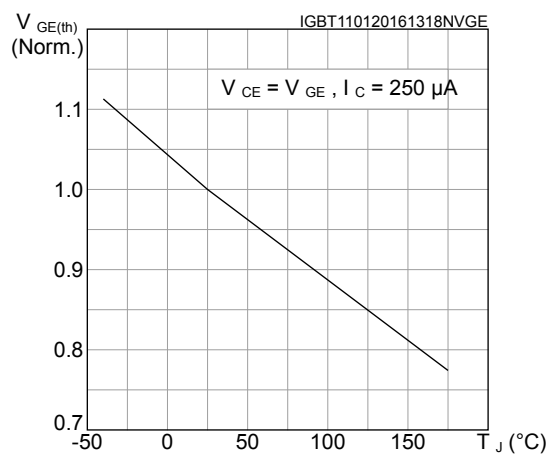
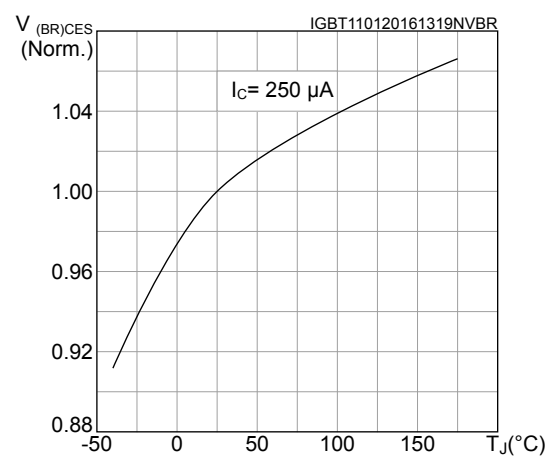
Figure 7. Typical $V_{CE(sat)}$ vs collector current

Figure 8. Collector current vs switching frequency

Figure 9. Forward bias safe operating area

Figure 10. Diode typical forward characteristics

Figure 11. Normalized gate threshold vs temperature

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


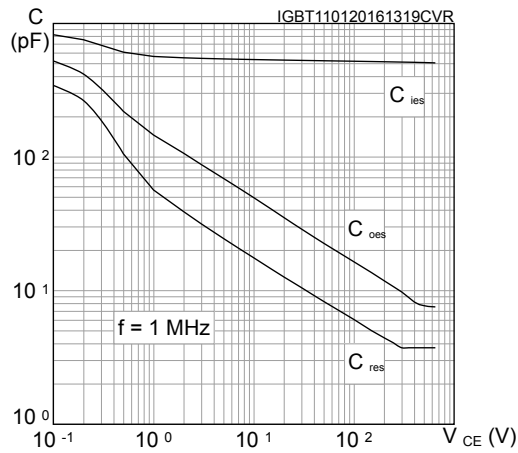
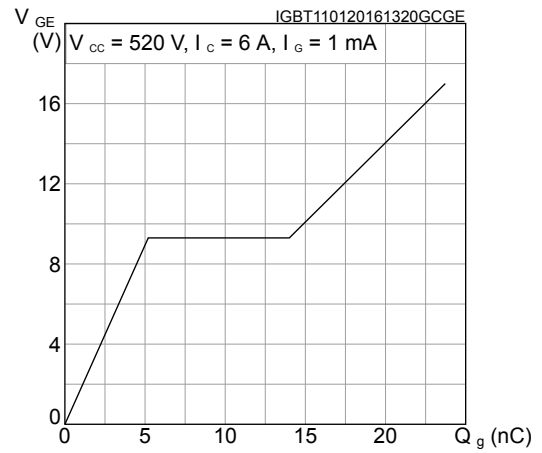
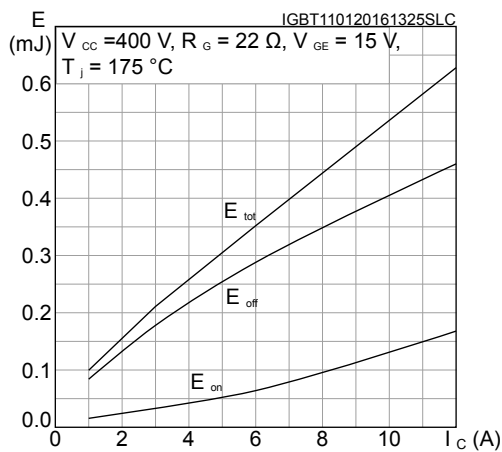
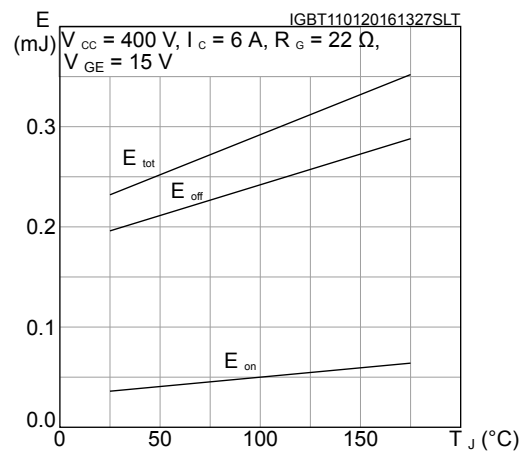
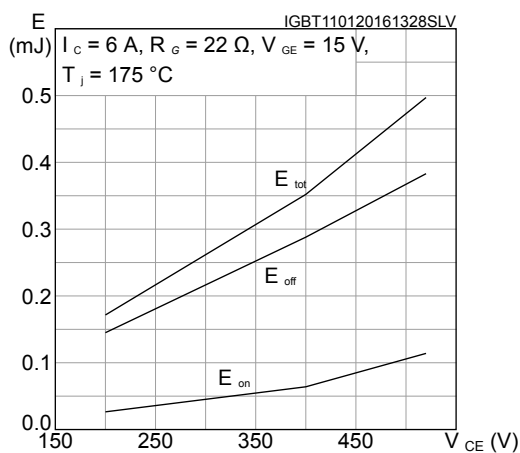
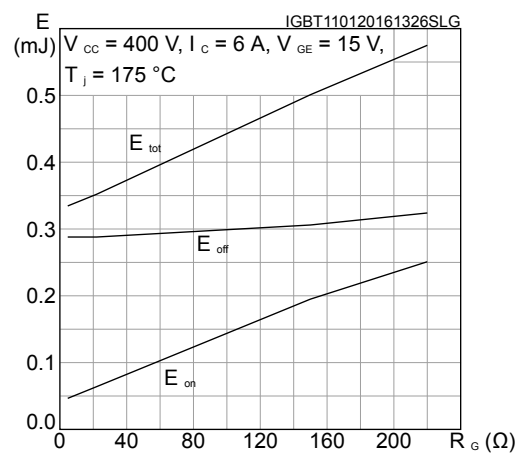
Figure 13. Typical capacitance characteristics

Figure 14. Typical gate charge characteristics

Figure 15. Typical switching energy vs collector current

Figure 16. Typical switching energy vs temperature

Figure 17. Typical switching energy vs collector emitter voltage

Figure 18. Typical switching energy vs gate resistance


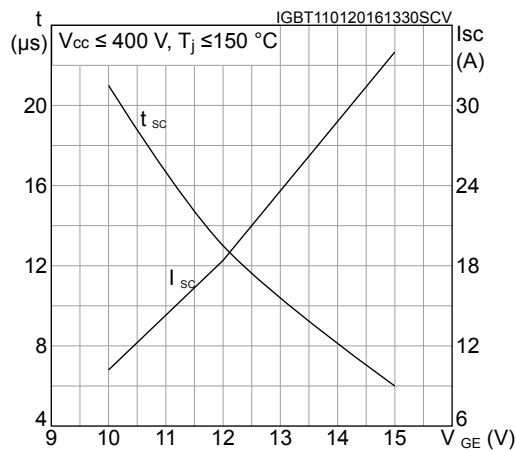
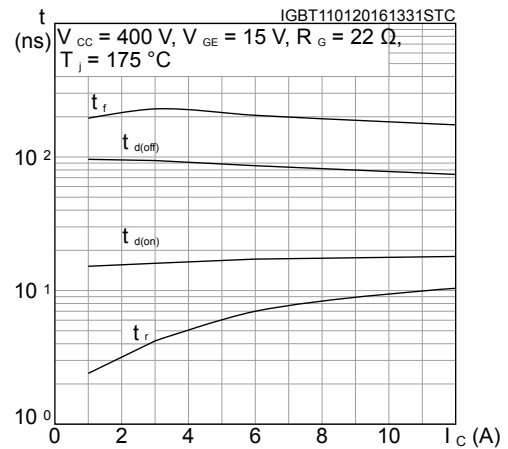
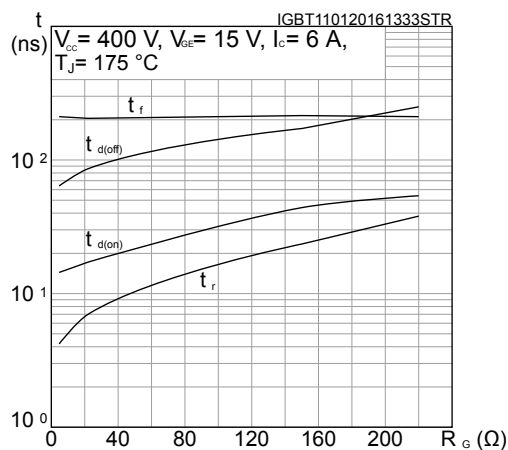
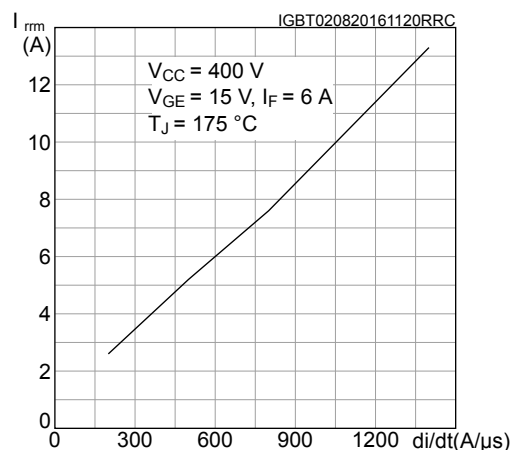
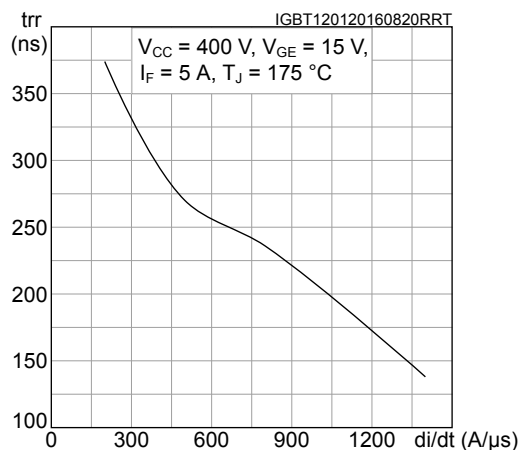
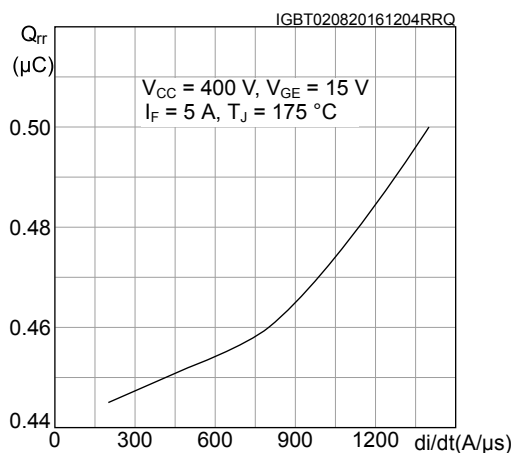
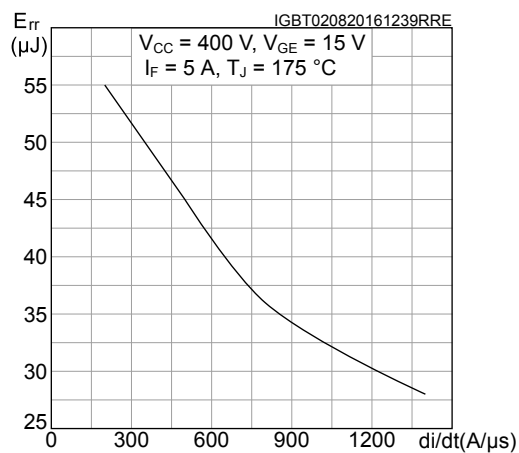
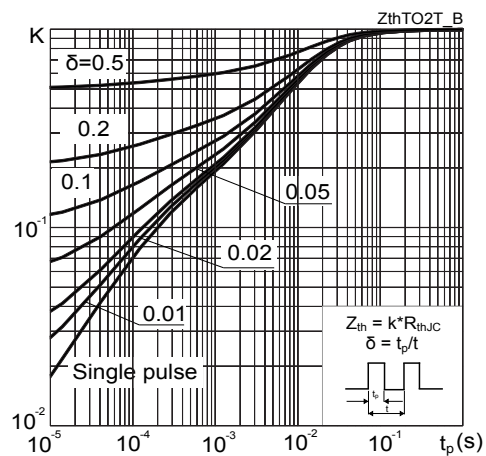
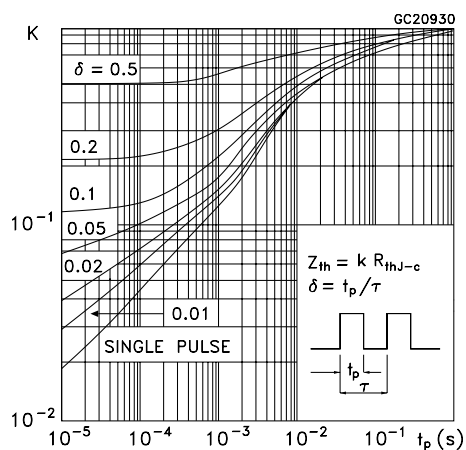
Figure 19. Short-circuit time and current vs V_{GE}

Figure 20. Typical switching times vs collector current

Figure 21. Typical switching times vs gate resistance

Figure 22. Typical reverse recovery current vs. diode current slope

Figure 23. Typical reverse recovery time vs diode current slope

Figure 24. Typical reverse recovery charge vs. diode current slope


Figure 25. Typical reverse recovery energy vs diode current slope

Figure 26. IGBT normalized transient thermal impedance

Figure 27. Diode normalized transient thermal impedance


3 Test circuits

Figure 28. Test circuit for inductive load switching

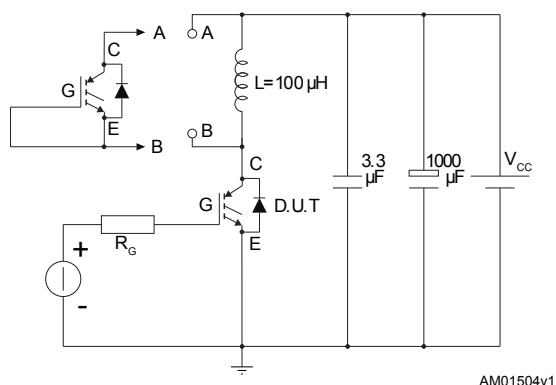


Figure 29. Gate charge test circuit

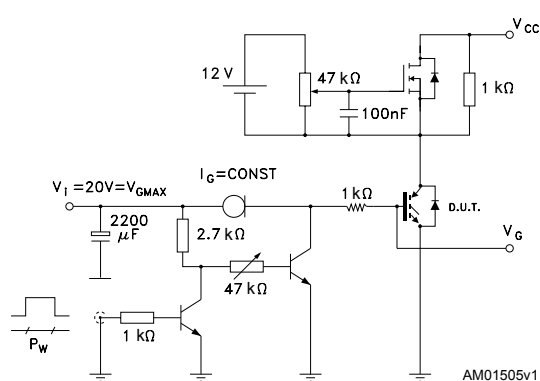


Figure 30. Switching waveform

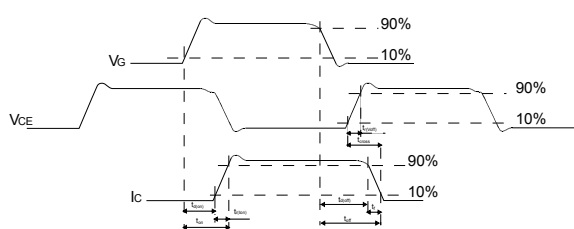
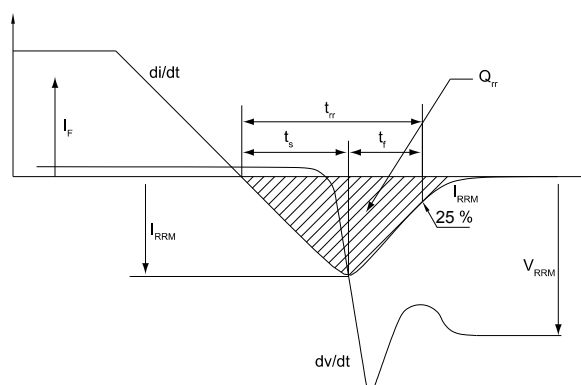


Figure 31. Diode reverse recovery waveform

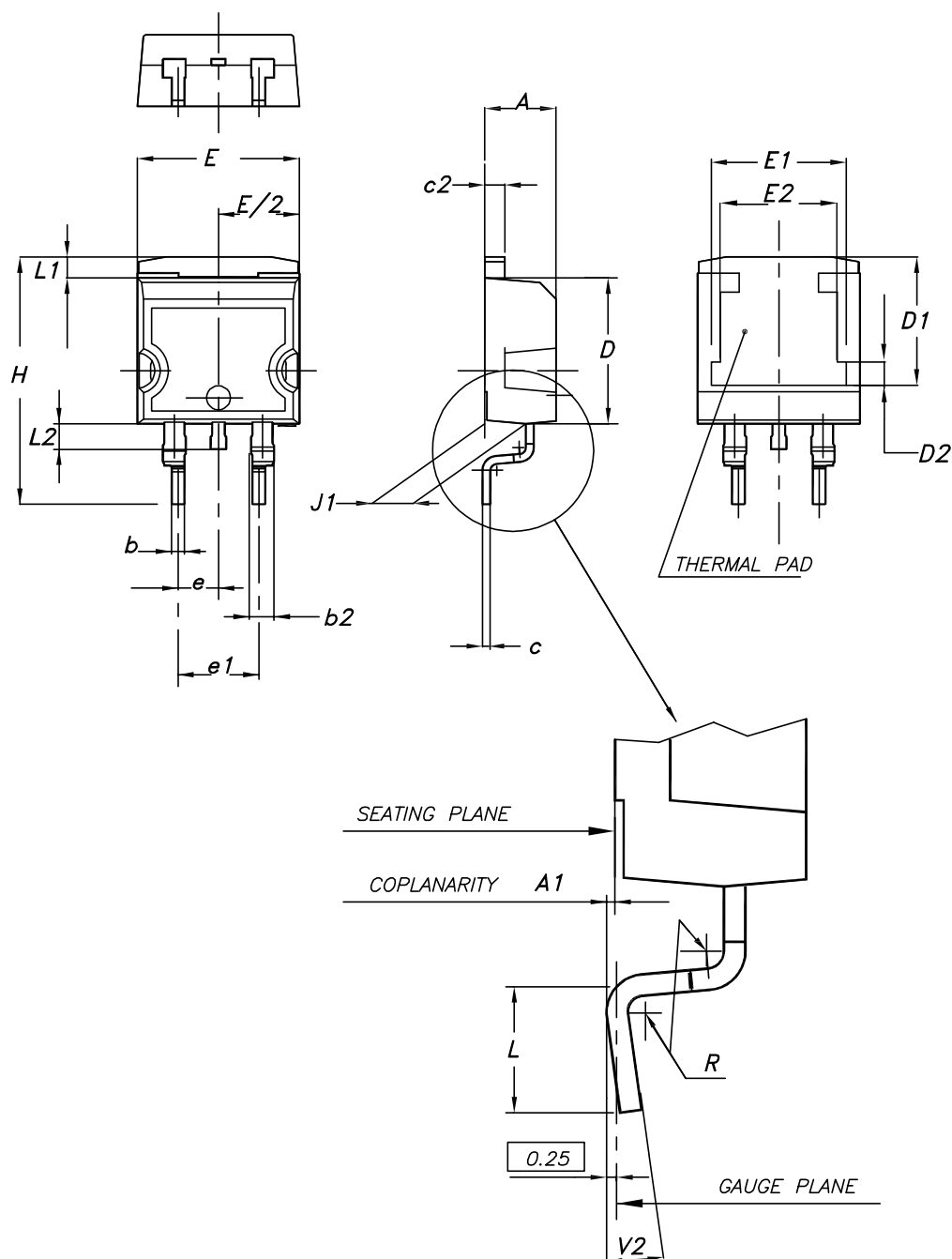


4 Package information

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 (TO-263) type A package information

Figure 32. D²PAK (TO-263) type A package outline

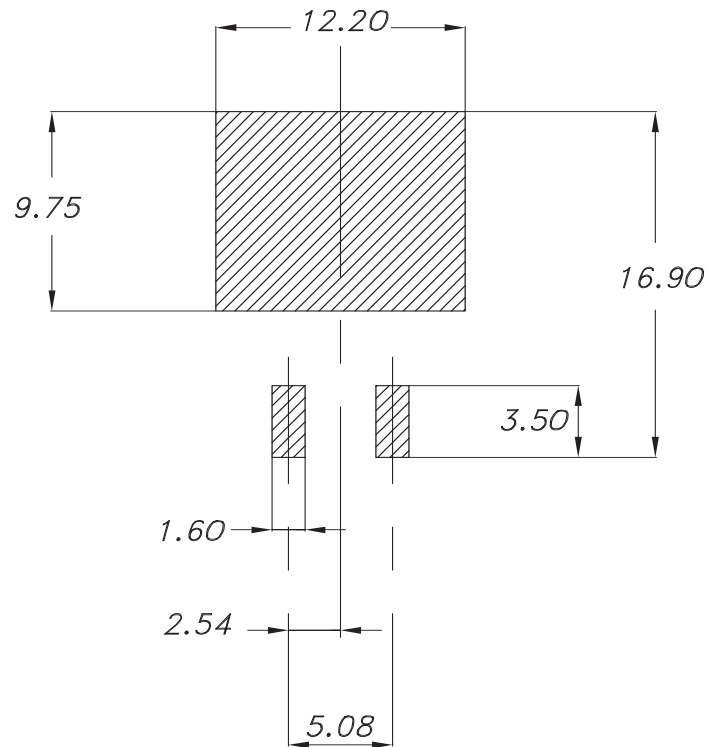


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Table 7. D²PAK (TO-263) type A package mechanical data

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	8.30	8.50	8.70
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°

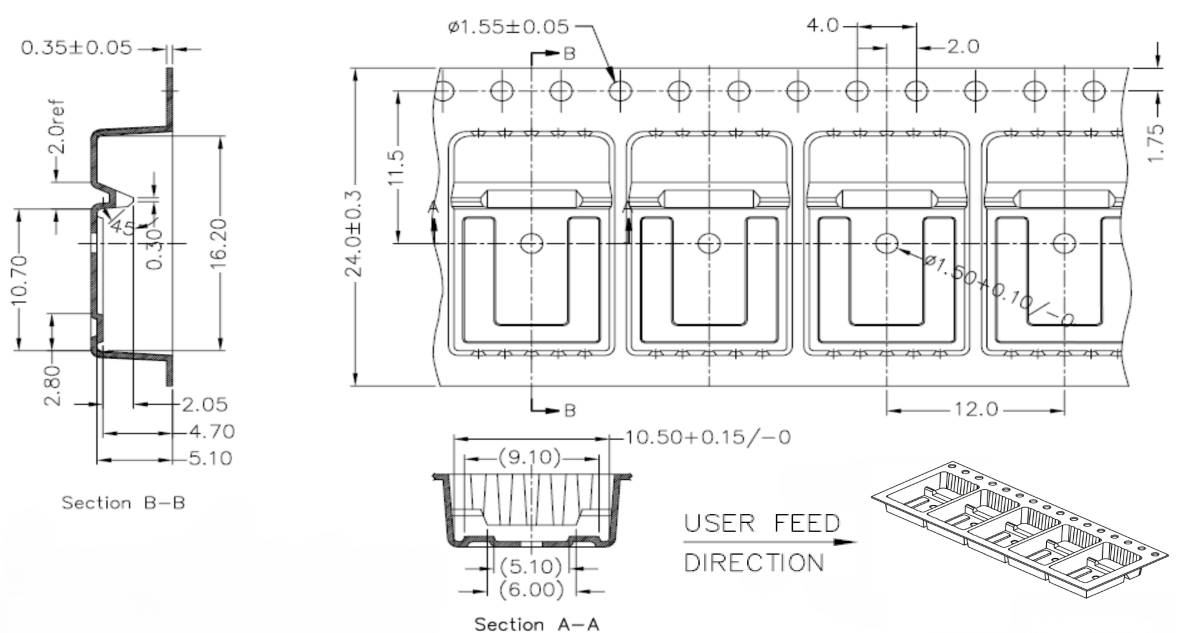
Figure 33. D²PAK (TO-263) recommended footprint (dimensions are in mm)



0079457_Rev27_footprint

4.2 D²PAK packing information

Figure 34. D²PAK tape drawing (dimensions are in mm)



DM01095771_1

Revision history

Table 8. Document revision history

Date	Version	Changes
30-Nov-2015	1	First release.
13-Jan-2016	2	Modified: <i>Table 4: Static characteristics</i> , <i>Table 5: Dynamic characteristics</i> , <i>Table 6: IGBT switching characteristics (inductive load)</i> , and <i>Table 7: Diode switching characteristics (inductive load)</i> . Added: <i>Section 2.1: Electrical characteristics (curves)</i> . Minor text changes.
02-Aug-2016	3	Updated <i>Table 2: Absolute maximum ratings</i> , <i>Table 4: Static characteristics</i> , <i>Table 6: IGBT switching characteristics (inductive load)</i> and <i>Table 7: Diode switching characteristics (inductive load)</i> . Updated <i>Figure 9: Forward bias safe operating area</i> , <i>Figure 12: Normalized $V_{GE(th)}$ vs junction temperature</i> , <i>Figure 20: Shortcircuit time and current vs V_{GE}</i> and <i>Figure 23: Reverse recovery current vs diode current slope</i> . Changed <i>Figure 25: Reverse recovery charge vs diode current slope</i> and <i>Figure 26: Reverse recovery energy vs diode current slope</i> .
12-May-2025	4	Updated Section 4: Package information .

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3	Test circuits	10
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