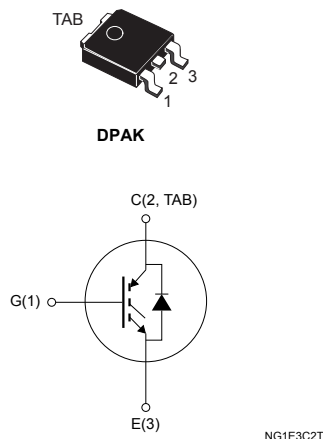


Trench gate field-stop, 650 V, 6 A, low-loss M series IGBT in a DPAK package



Product status link

[STGD6M65DF2](#)

Product summary

Order code	STGD6M65DF2
Marking	G6M65DF2
Package	DPAK
Packing	Tape and reel

Features

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

Applications

- Industrial motor control
- PFC converters, single phase input
- Uninterruptable power supplies (UPS)

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.

1 Electrical ratings

Table 1. 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	12	A
	Continuous collector current at $T_C = 100$ °C	6	
$I_{CP}^{(1)}$	Pulsed collector current	24	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at $T_C = 25$ °C	12	A
	Continuous forward current at $T_C = 100$ °C	6	
$I_{FP}^{(1)}$	Pulsed forward current	24	A
P_{TOT}	Total power dissipation at $T_C = 25$ °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 is 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	100	°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	$I_F = 6\text{ A}$		2.6	3.5	V
		$I_F = 6\text{ A}$, $T_J = 125\text{ °C}$		2.3		
		$I_F = 6\text{ A}$, $T_J = 175\text{ °C}$		2.2		
$V_{GE(th)}$	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 Figure 28. 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 Figure 27. 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 Figure 27. 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	$V_{CC} \leq 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	6		-	μ s
		$V_{CC} \leq 400\text{ V}$, $V_{GE} = 13\text{ V}$, $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	10		-	

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 Figure 27. 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 Figure 27. 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)

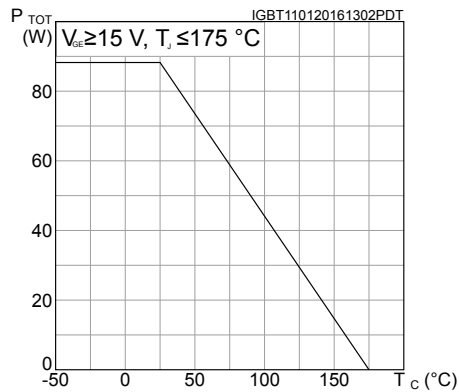
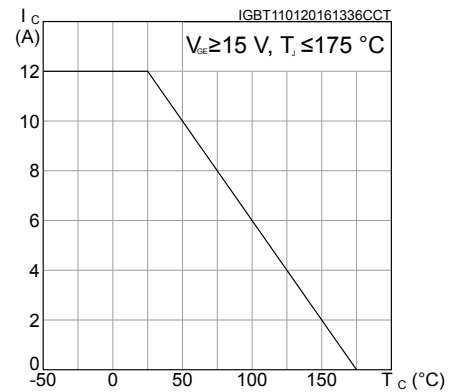
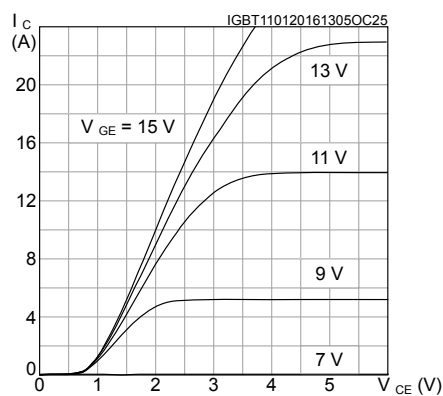
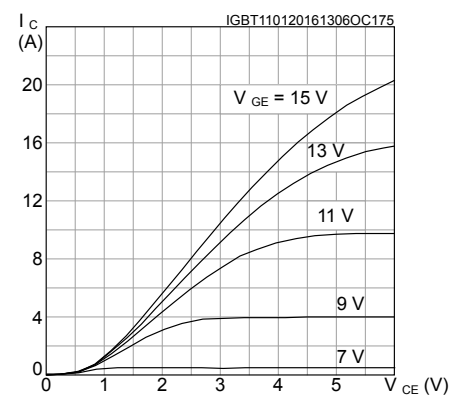
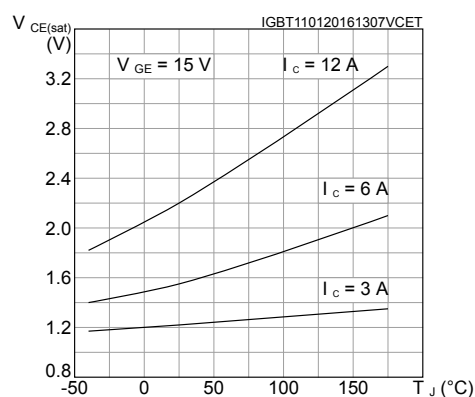
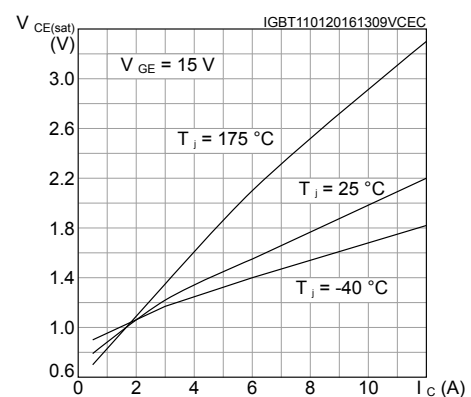
Figure 1. Power dissipation vs. case temperature

Figure 2. Collector current vs. case temperature

Figure 3. Output characteristics (T_J = 25 °C)

Figure 4. Output characteristics (T_J = 175 °C)

Figure 5. V_CE(sat) vs. junction temperature

Figure 6. V_CE(sat) vs. collector current


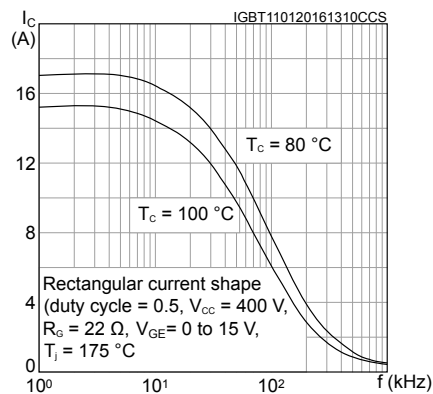
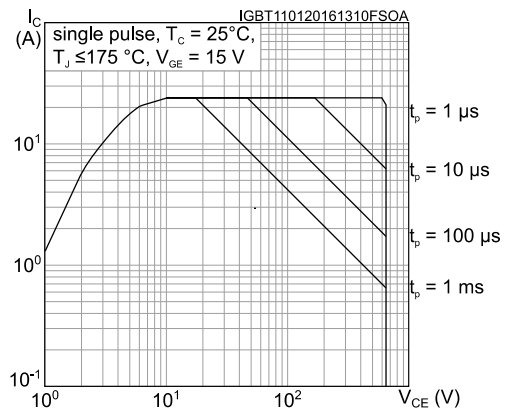
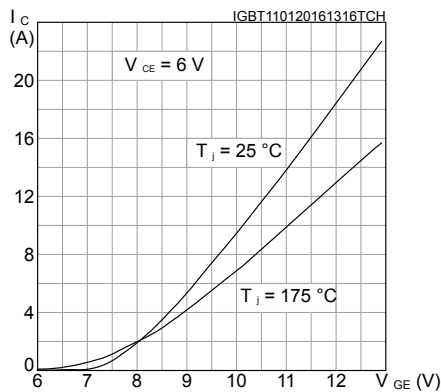
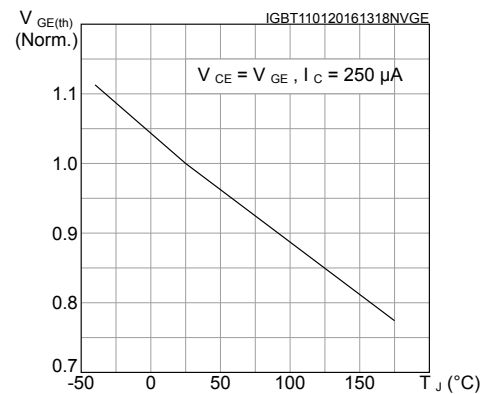
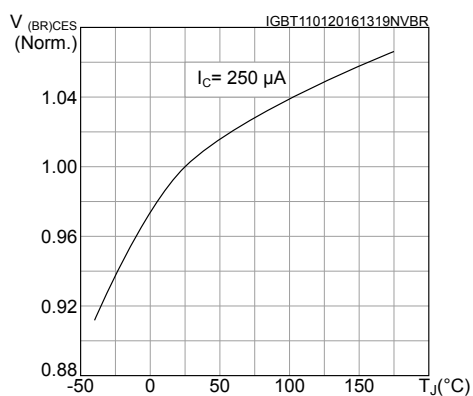
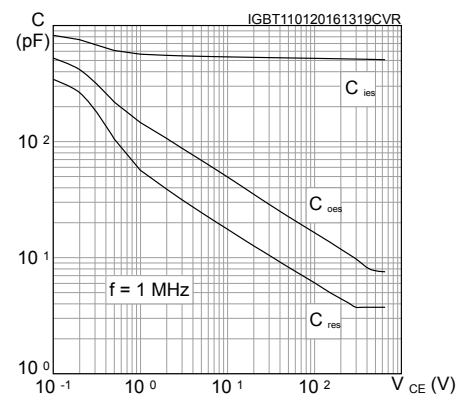
Figure 7. Collector current vs. switching frequency

Figure 8. Forward bias safe operating area

Figure 9. Transfer characteristics

Figure 10. Normalized $V_{GE(th)}$ vs. junction temperature

Figure 11. Normalized $V_{(BR)CES}$ vs. junction temperature

Figure 12. Capacitance variations


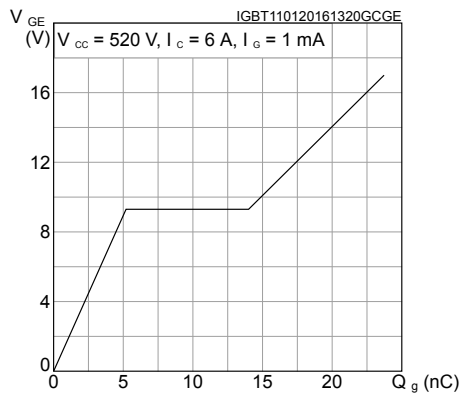
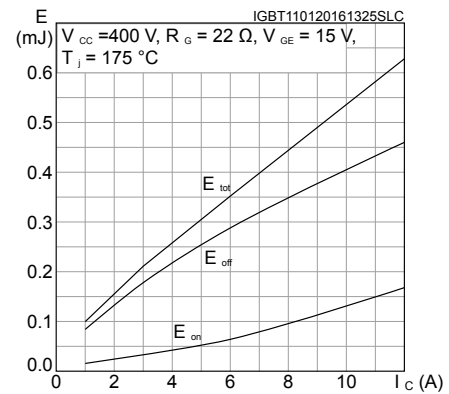
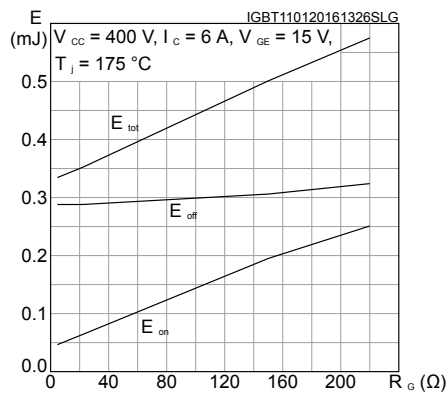
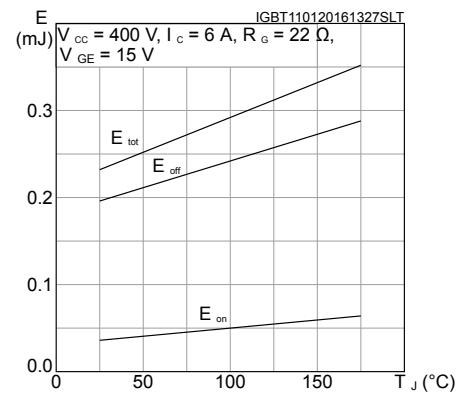
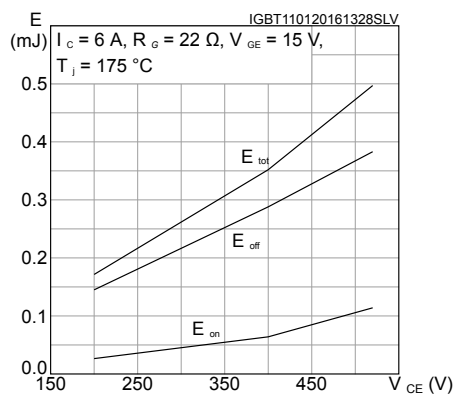
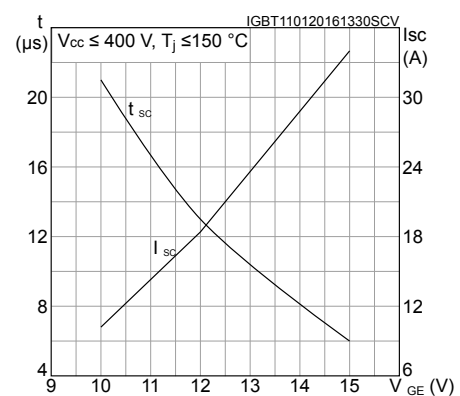
Figure 13. Gate charge vs. gate-emitter voltage

Figure 14. Switching energy vs. collector current

Figure 15. Switching energy vs. gate resistance

Figure 16. Switching energy vs. temperature

Figure 17. Switching energy vs. collector emitter voltage

Figure 18. Short-circuit time and current vs. V_GE


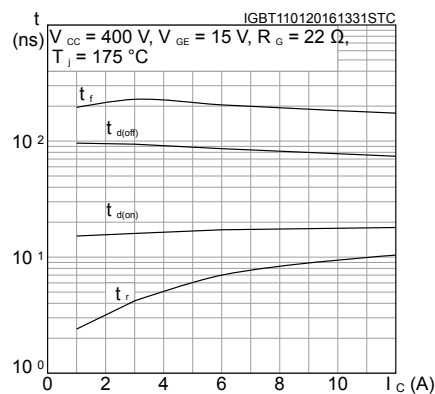
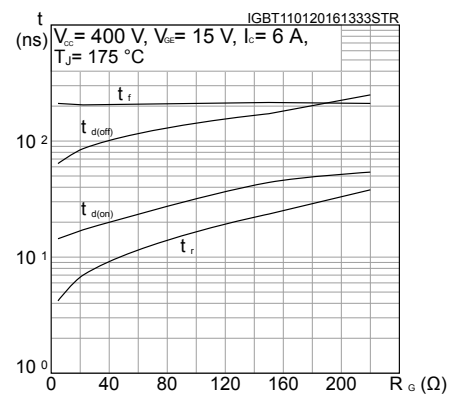
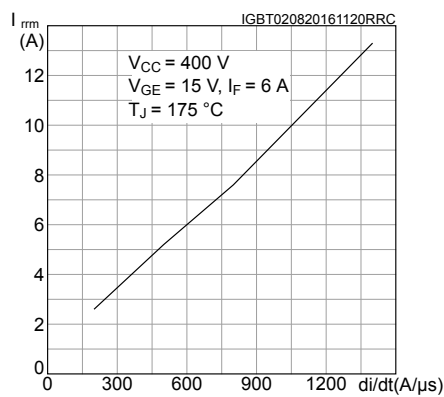
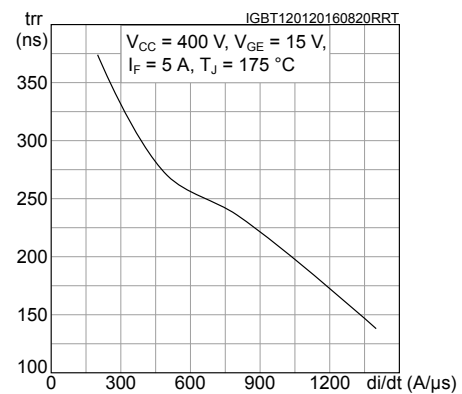
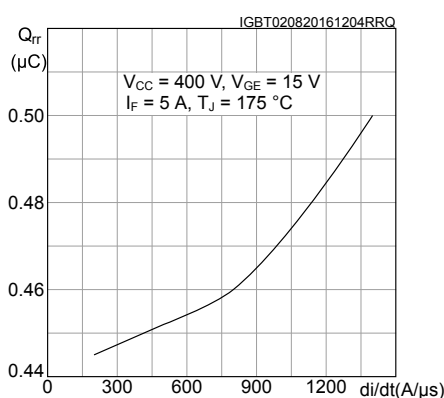
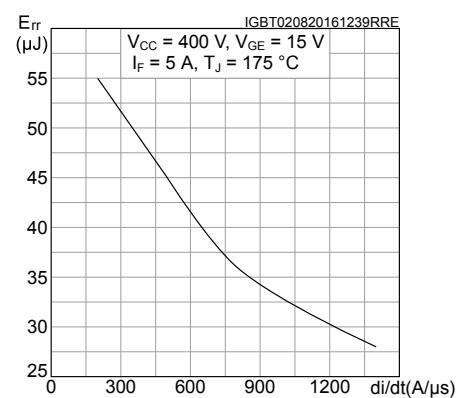
Figure 19. Switching times vs. collector current

Figure 20. Switching times vs. gate resistance

Figure 21. Reverse recovery current vs. diode current slope

Figure 22. Reverse recovery time vs. diode current slope

Figure 23. Reverse recovery charge vs. diode current slope

Figure 24. Reverse recovery energy vs. diode current slope


Figure 25. Thermal impedance for IGBT

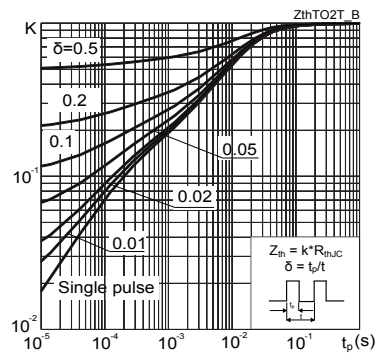
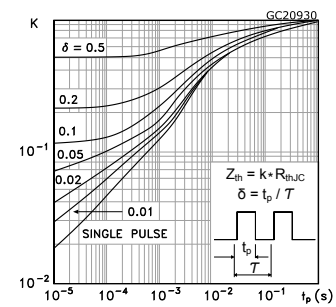


Figure 26. Thermal impedance for diode



3 Test circuits

Figure 27. Test circuit for inductive load switching

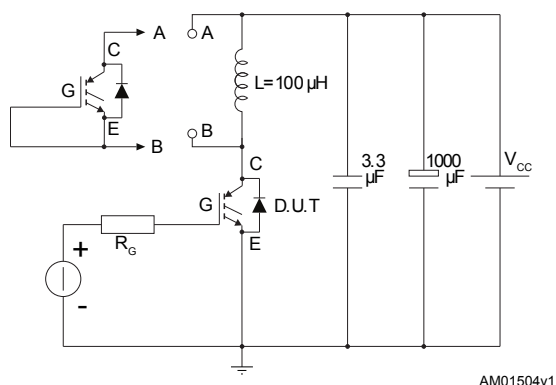


Figure 28. Gate charge test circuit

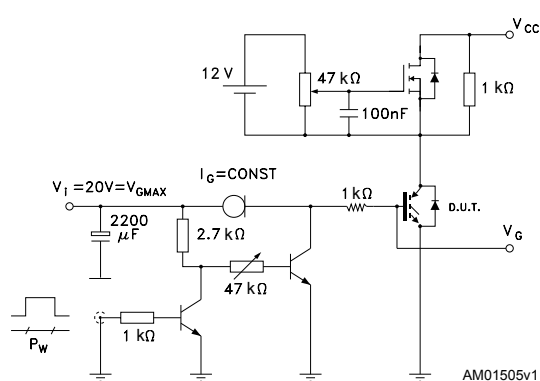


Figure 29. Switching waveform

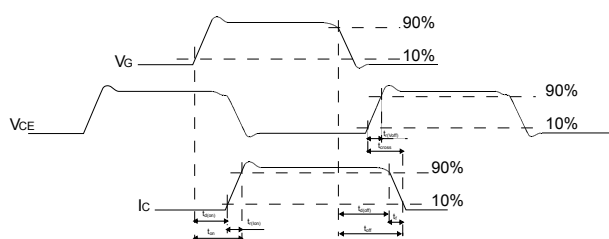
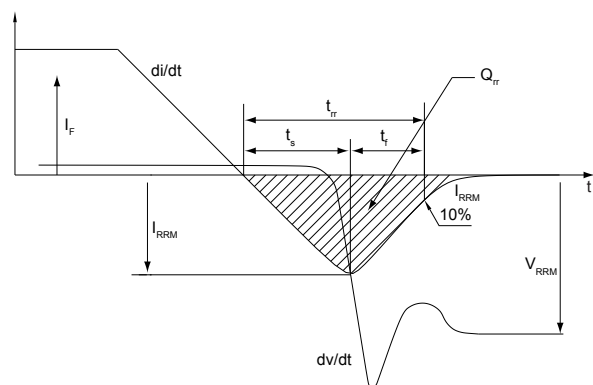


Figure 30. Diode reverse recovery waveform

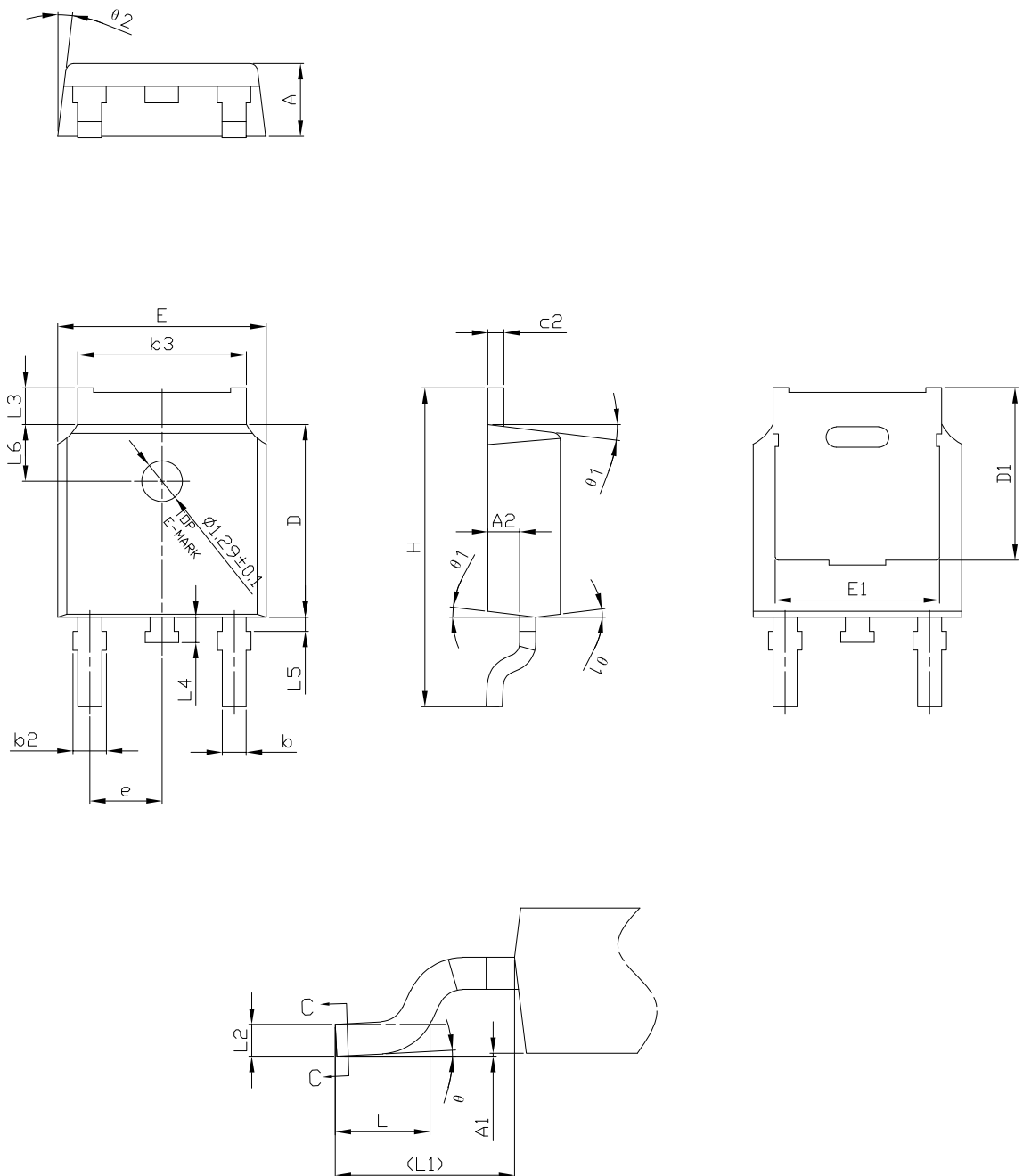


4 Package information

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 DPAK (TO-252) type C3 package information

Figure 31. DPAK (TO-252) type C3 package outline

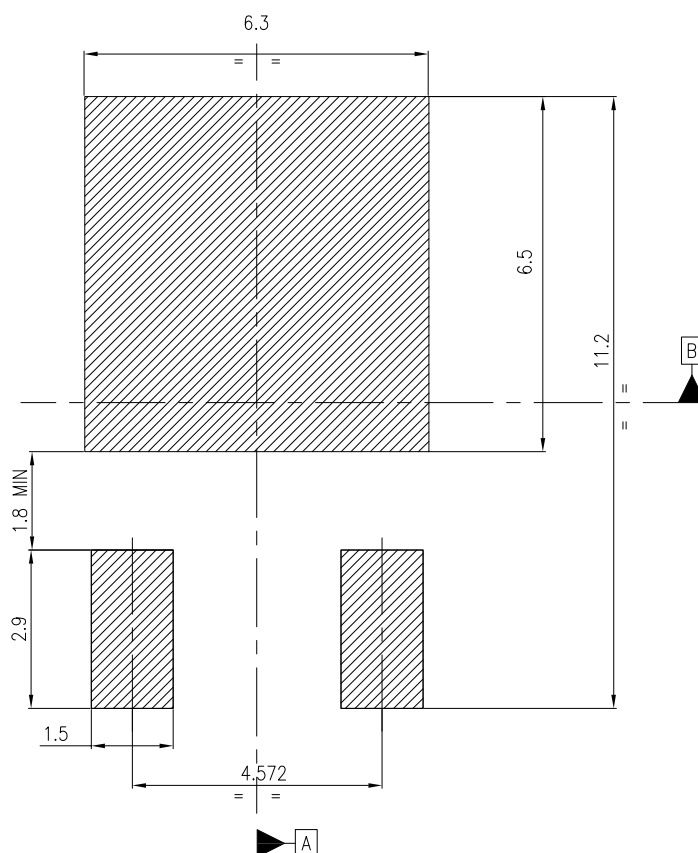


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Table 7. DPAK (TO-252) type C3 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.00		0.10
A2	0.90	1.01	1.10
b	0.72		0.85
b2	0.72		1.10
b3	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.20	5.45	5.70
E	6.50	6.60	6.70
E1	5.00	5.20	5.40
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.51 BSC		
L3	0.90		1.25
L4	0.60	0.80	1.00
L5	0.15		0.75
L6	1.80 REF		
θ	0°		8°
θ1	5°	7°	9°
θ2	5°	7°	9°

Figure 32. DPAK (TO-252) recommended footprint (dimensions are in mm)



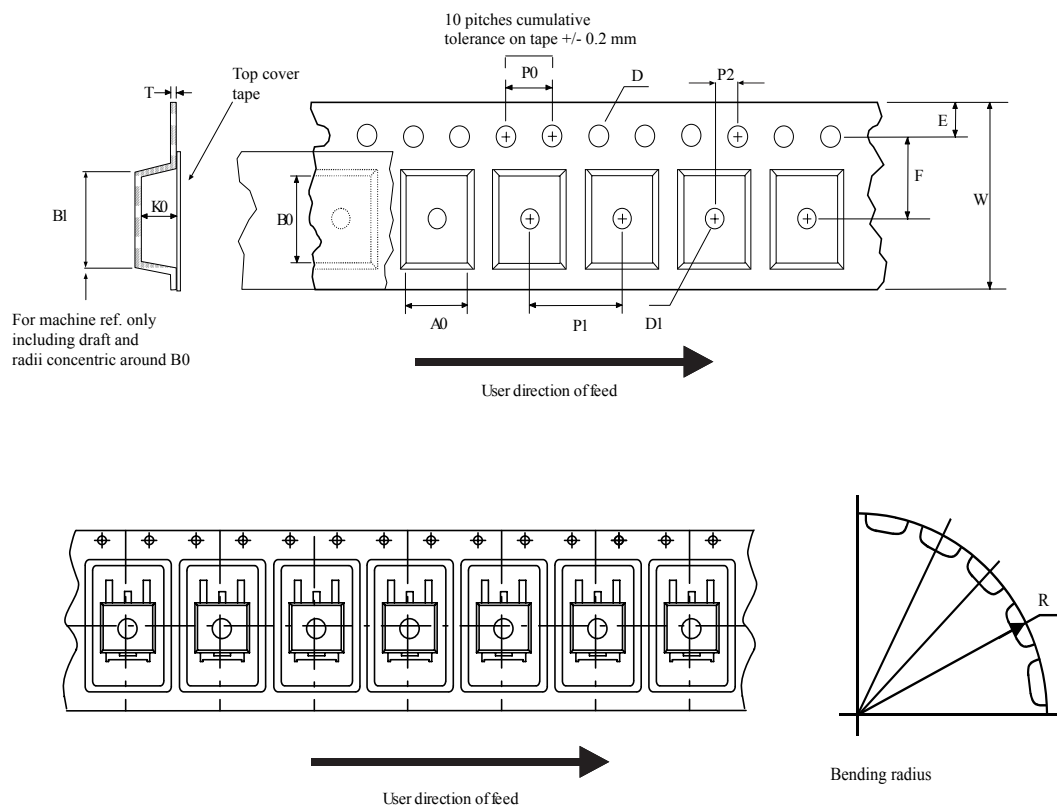
Notes:

- 1) This footprint is able to ensure insulation up to 630 Vrms (according to CEI IEC 664-1)
- 2) The device must be positioned within $\boxed{\Phi 0.05 \text{ A B}}$

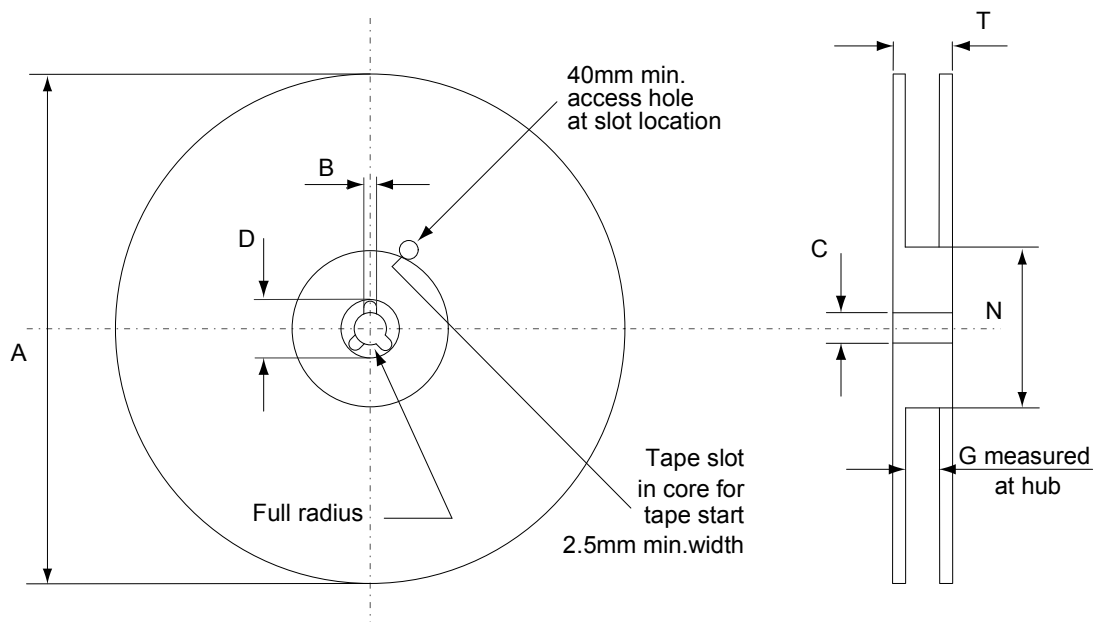
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4.2 DPAK (TO-252) packing information

Figure 33. DPAK (TO-252) tape outline



AM08852v1

Figure 34. DPAK (TO-252) reel outline


AM06038v1

Table 8. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Revision history

Table 9. Document revision history

Date	Revision	Changes
30-Nov-2015	1	First release.
13-Jan-2016	2	Modified: <i>Table 4: "Static characteristics", Table 5: "Dynamic characteristics", Table 6: "IGBT switching characteristics (inductive load)" and Table 7: "Diode switching characteristics (inductive load)"</i> Added: <i>Section 2.1: "Electrical characteristics (curves)"</i> Minor text changes
04-Aug-2016	3	Updated: <i>Table 2: "Absolute maximum ratings", Table 4: "Static characteristics", Table 6: "IGBT switching characteristics (inductive load)", Table 7: "Diode switching characteristics (inductive load)"</i> . Updated <i>Figure 9: "Forward bias safe operating area", Figure 12: "Normalized $V_{GE(th)}$ vs. junction temperature", Figure 20: "Short-circuit time and current vs. V_{GE}", Figure 23: "Reverse recovery current vs. diode current slope"</i> . Changed: <i>Figure 25: "Reverse recovery charge vs. diode current slope", and Figure 26: "Reverse recovery energy vs. diode current slope"</i> . Document status promoted from preliminary to production data.
09-Jun-2023	4	Updated the entire Section 4 Package information. Minor text changes.
13-Jul-2023	5	Minor text changes.
14-May-2025	6	Updated Table 3. Static characteristics . Removed <i>Figure 10. Diode V_F vs. forward current</i> . Removed <i>DPAK (TO-252) type A2 package information</i> .

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