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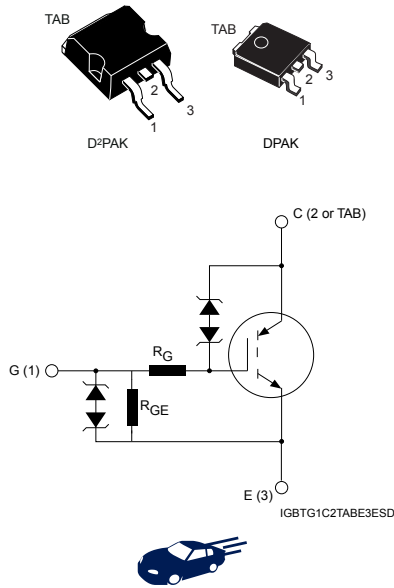
Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



Automotive-grade 450 V internally clamped IGBT E_{SCIS} 300 mJ



Features

- AEC-Q101 qualified
- SCIS energy of 300 mJ @ $T_J = 25\text{ }^\circ\text{C}$
- Parts are 100% tested in SCIS
- ESD gate-emitter protection
- Gate-collector high voltage clamping
- Logic level gate drive
- Very low saturation voltage
- High pulsed current capability
- Gate and gate-emitter resistor

Applications

- Automotive ignition coil driver circuit

Description

This application-specific IGBT utilizes the most advanced PowerMESH™ technology optimized for coil driving in the harsh environment of automotive ignition systems. These devices show very low on-state voltage and very high SCIS energy capability over a wide operating temperature range. Moreover, ESD-protected logic level gate input and an integrated gate resistor means no external protection circuitry is required.

Product status	
	STGB20N45LZAG
	STGD20N45LZAG
Product summary	
Order code	STGB20N45LZAG
Marking	GB20N45LZ
Package	D²PAK
Packing	Tape and reel
Order code	STGD20N45LZAG
Marking	GD20N45LZ
Package	DPAK
Packing	Tape and reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0\text{ V}$)	$V_{CES(\text{clamped})}$	V
V_{ECS}	Emitter-collector voltage ($V_{GE} = 0\text{ V}$)	20	V
I_C	Continuous collector current at $T_C = 25\text{ °C}$, $V_{GE} = 4\text{ V}$	25	A
	Continuous collector current at $T_C = 100\text{ °C}$, $V_{GE} = 4\text{ V}$	25	A
$I_{CP}^{(1)}$	Pulsed collector current	50	A
V_{GE}	Gate-emitter voltage	$V_{GE(\text{clamped})}$	V
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	150	W
$E_{SCIS_25}^{(2)}$	Self-clamping inductive switching energy	300	mJ
$E_{SCIS_150}^{(3)}$	Self-clamping inductive switching energy @ $T_J = 150\text{ °C}$	170	mJ
ESD	Human body model, $R = 1.5\text{ k}\Omega$, $C = 100\text{ pF}$	4	kV
	Charged device model	2	kV
T_{STG}	Storage temperature range	-55 to 175	°C
T_J	Operating junction temperature range		

1. Pulse width limited by maximum junction temperature.
2. Starting $T_J = 25\text{ °C}$, $L = 3\text{ mH}$, $R_g = 1\text{ k}\Omega$, $V_{cc} = 50\text{ V}$ during inductor charging and $V_{cc} = 0\text{ V}$ during the time in clamp. Parts are 100% electrically tested in production.
3. Starting $T_J = 150\text{ °C}$, $L = 3\text{ mH}$, $R_g = 1\text{ k}\Omega$, $V_{cc} = 50\text{ V}$ during inductor charging and $V_{cc} = 0\text{ V}$ during the time in clamp.

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		D ² PAK	DPAK	
$R_{thj\text{-case}}$	Thermal resistance junction-case	1		°C/W
$R_{thj\text{-amb}}$	Thermal resistance junction-ambient	62.5	100	°C/W

2 Electrical characteristics

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

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CES(\text{clamped})}$	Collector-emitter clamped voltage	$I_C = 2\text{ mA}, V_{GE} = 0\text{ V}$		450		V
		$I_C = 2\text{ mA}, V_{GE} = 0\text{ V}, T_J = -40\text{ °C to }175\text{ °C}$	415		475	V
$V_{(BR)ECS}$	Emitter-collector break-down voltage	$I_C = 75\text{ mA}, V_{GE} = 0\text{ V}$	20			V
$V_{GE(\text{clamped})}$	Gate-emitter clamped voltage	$I_G = \pm 2\text{ mA}, T_J = -40\text{ °C to }175\text{ °C}$	12		16	V
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 4\text{ V}, I_C = 6\text{ A}$		1.1	1.25	V
		$V_{GE} = 4.5\text{ V}, I_C = 10\text{ A}, T_J = 175\text{ °C}$		1.25	1.55	V
$V_{GE(\text{th})}$	Gate-threshold voltage	$V_{GE} = V_{CE}, I_C = 1\text{ mA}$	1.3	1.7	2.1	V
		$V_{GE} = V_{CE}, I_C = 1\text{ mA}, T_J = 175\text{ °C}$		1.05		V
I_{CES}	Collector cut-off current	$V_{CE} = 15\text{ V}, V_{GE} = 0\text{ V}, T_J = 150\text{ °C}$			20	μA
		$V_{CE} = 200\text{ V}, V_{GE} = 0\text{ V}, T_J = 150\text{ °C}$			100	μA
I_{GES}	Gate-emitter leakage current	$V_{GE} = \pm 10\text{ V}, V_{CE} = 0\text{ V}$		625		μA
		$V_{GE} = \pm 10\text{ V}, V_{CE} = 0\text{ V}, T_J = -40\text{ °C to }175\text{ °C}$	450		900	μA
R_{GE}	Gate emitter resistance		11	16	22	k Ω
R_G	Gate resistance			120		Ω

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	1011	-	pF
C_{oes}	Output capacitance		-	87	-	
C_{res}	Reverse transfer capacitance		-	14	-	
Q_g	Total gate charge	$V_{CE} = 13\text{ V}, I_C = 10\text{ A}, V_{GE} = 0\text{ to }5\text{ V}$	-	26	-	nC

Table 5. Resistive load switching characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 14\text{ V}$, $V_{GE} = 5\text{ V}$,	-	1.1	-	μs
t_r	Current rise time	$R_L = 1\ \Omega$, $R_G = 1\ \text{k}\Omega$ (see Figure 17. Test circuit for resistive load switching)	-	3.6	-	μs
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 14\text{ V}$, $V_{GE} = 5\text{ V}$,	-	1.06	-	μs
t_r	Current rise time	$R_L = 1\ \Omega$, $R_G = 1\ \text{k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for resistive load switching)	-	3.5	-	μs

Table 6. Inductive load switching characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$, $L = 1\ \text{mH}$,	-	4.6	-	μs
t_f	Current fall time	$I_C = 10\ \text{A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\ \text{k}\Omega$	-	8.4	-	μs
dV/dt	Turn-off voltage slope	(see Figure 16. Test circuit for inductive load switching)	-	165	-	$\text{V}/\mu\text{s}$
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$, $L = 1\ \text{mH}$,	-	4.7	-	μs
t_f	Current fall time	$I_C = 10\ \text{A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\ \text{k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$	-	9.8	-	μs
dV/dt	Turn-off voltage slope	(see Figure 16. Test circuit for inductive load switching)	-	116	-	$\text{V}/\mu\text{s}$

2.1 Electrical characteristics (curves)

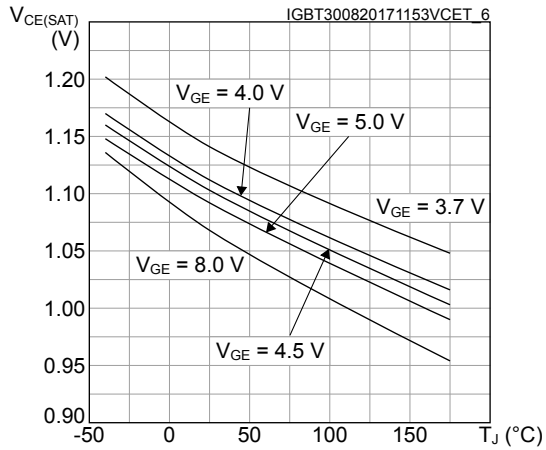
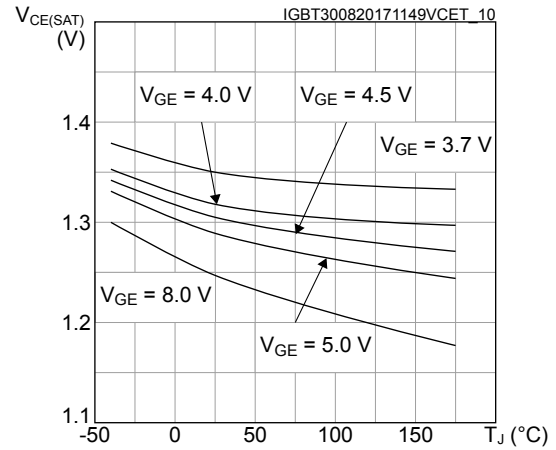
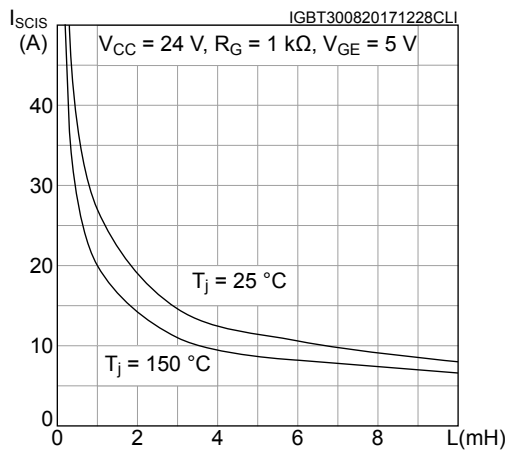
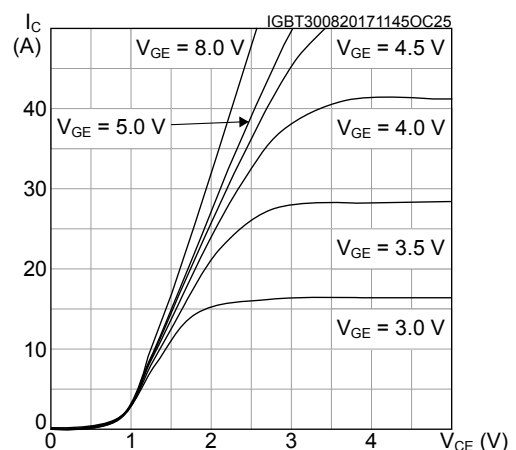
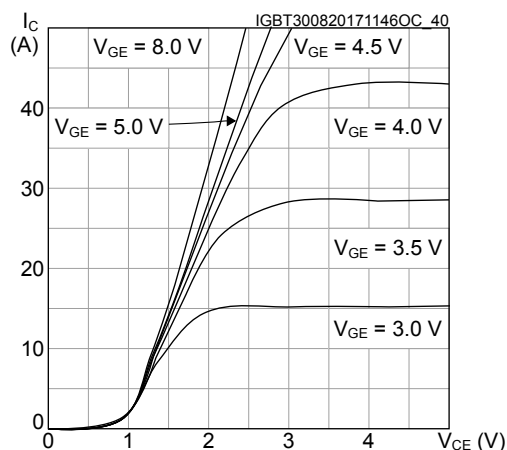
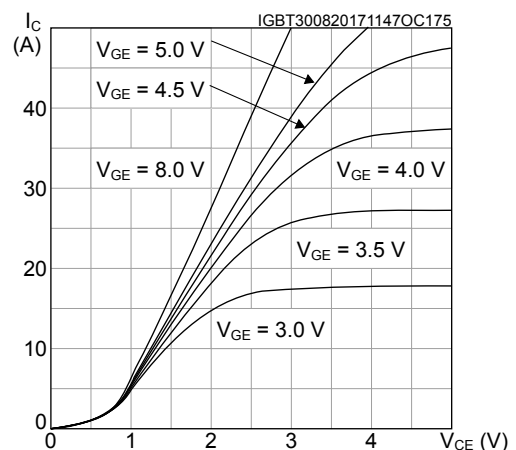
Figure 1. $V_{CE(sat)}$ vs junction temperature ($I_C = 6\text{ A}$)

Figure 2. $V_{CE(sat)}$ vs junction temperature ($I_C = 10\text{ A}$)

Figure 3. Self-clamped inductive switching current

Figure 4. Output characteristics ($T_J = 25\text{ °C}$)

Figure 5. Output characteristics ($T_J = -40\text{ °C}$)

Figure 6. Output characteristics ($T_J = 175\text{ °C}$)


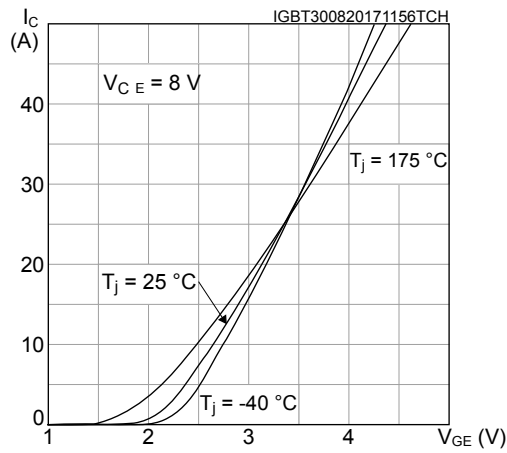
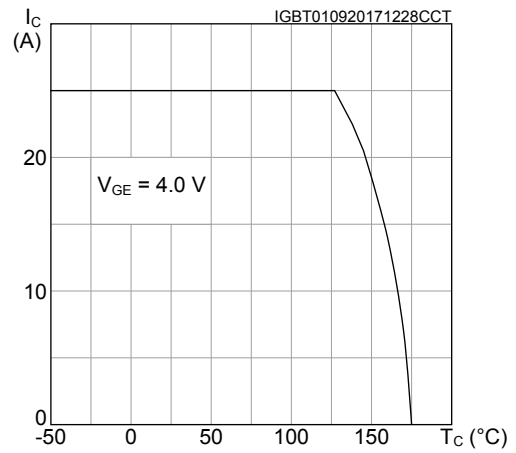
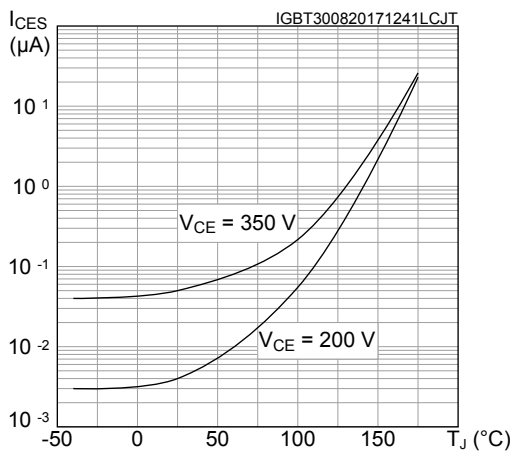
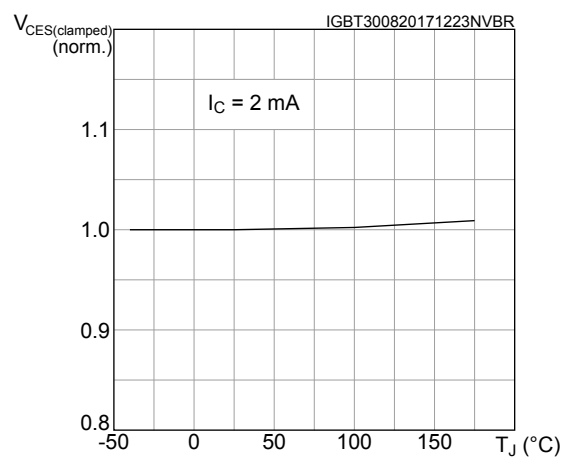
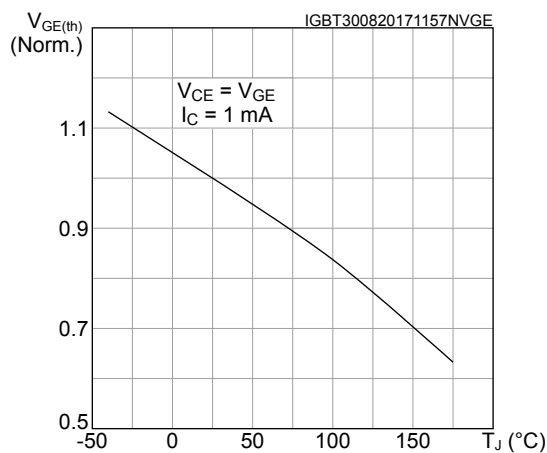
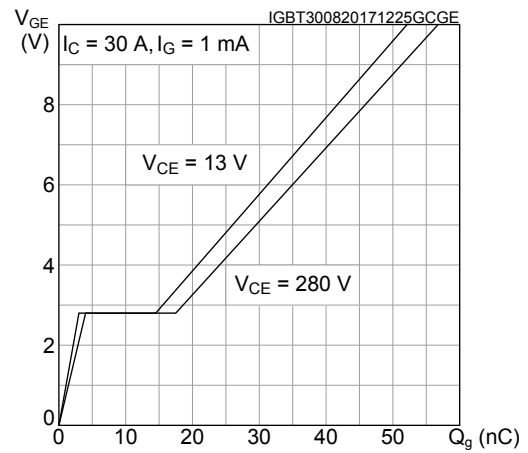
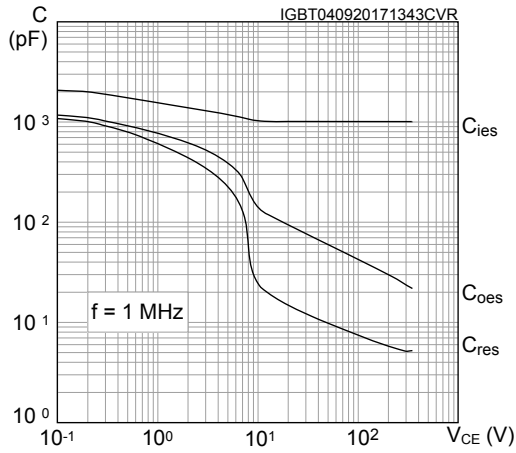
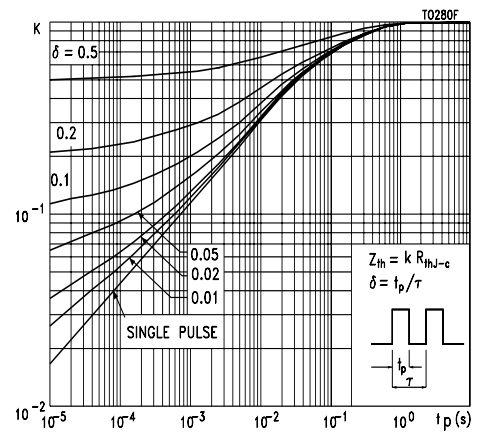
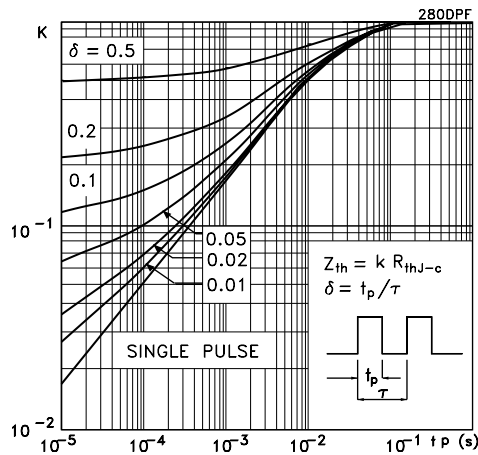
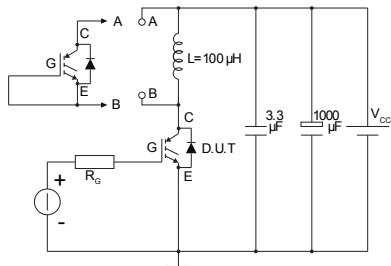
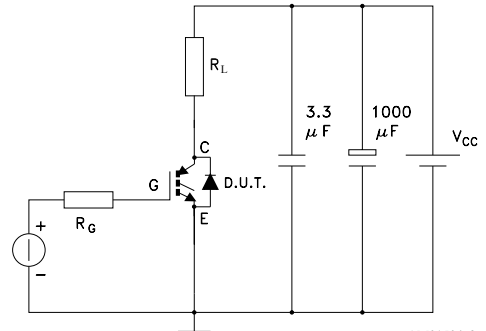
Figure 7. Transfer characteristics

Figure 8. Collector current vs case temperature

Figure 9. Leakage current vs temperature

Figure 10. Normalized $V_{CES(\text{clamped})}$ vs temperature

Figure 11. Normalized $V_{GE(\text{th})}$ vs temperature

Figure 12. Gate charge vs gate-emitter voltage


Figure 13. Capacitance variations

Figure 14. Thermal impedance for D²PAK

Figure 15. Thermal impedance for DPAK


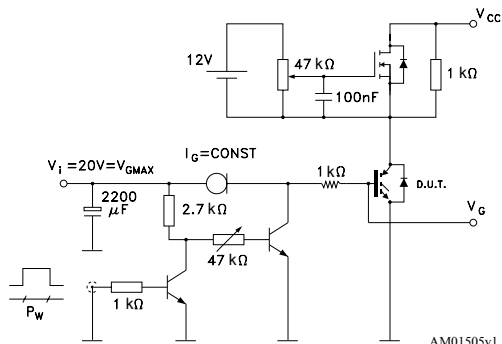
3 Test circuits

Figure 16. Test circuit for inductive load switching


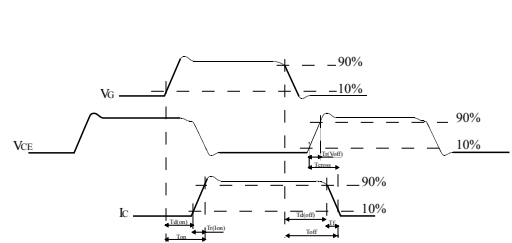
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Figure 17. Test circuit for resistive load switching


AM01504v2

Figure 18. Gate charge test circuit


AM01505v1

Figure 19. Switching waveform


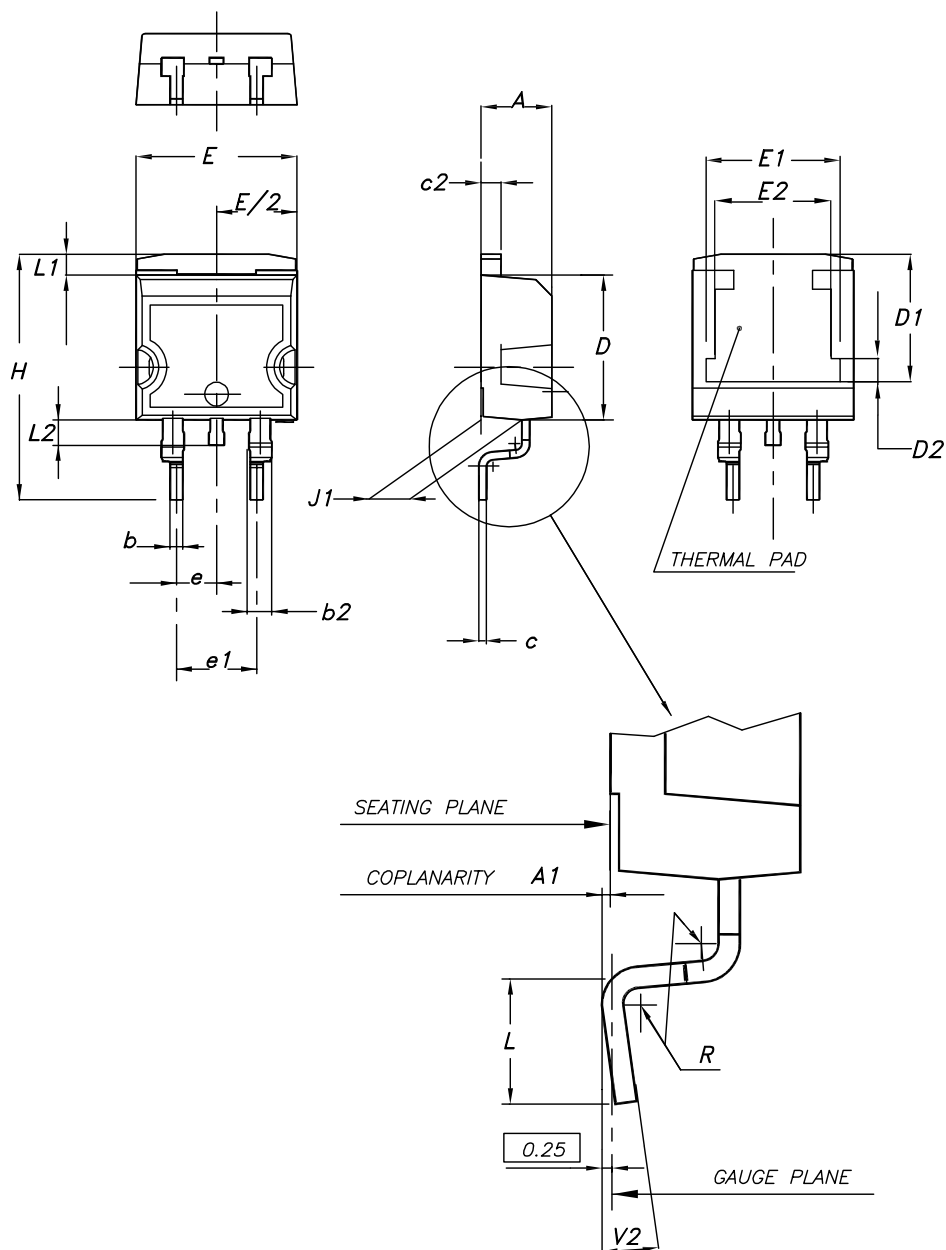
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4 Package information

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 (TO-263) type A package information

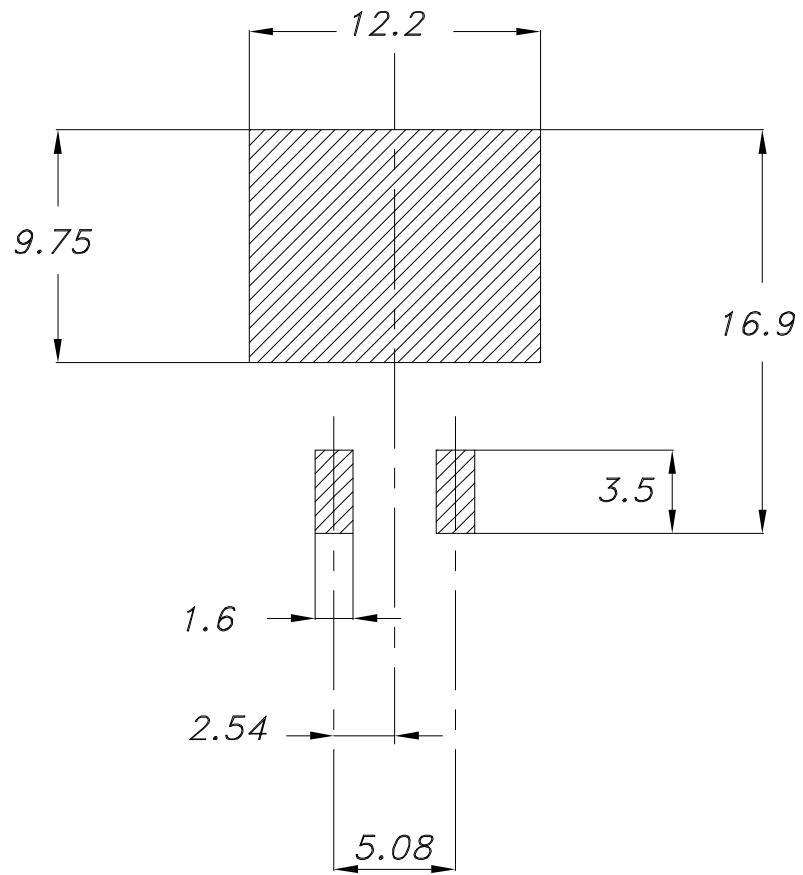
Figure 20. D²PAK (TO-263) type A package outline



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

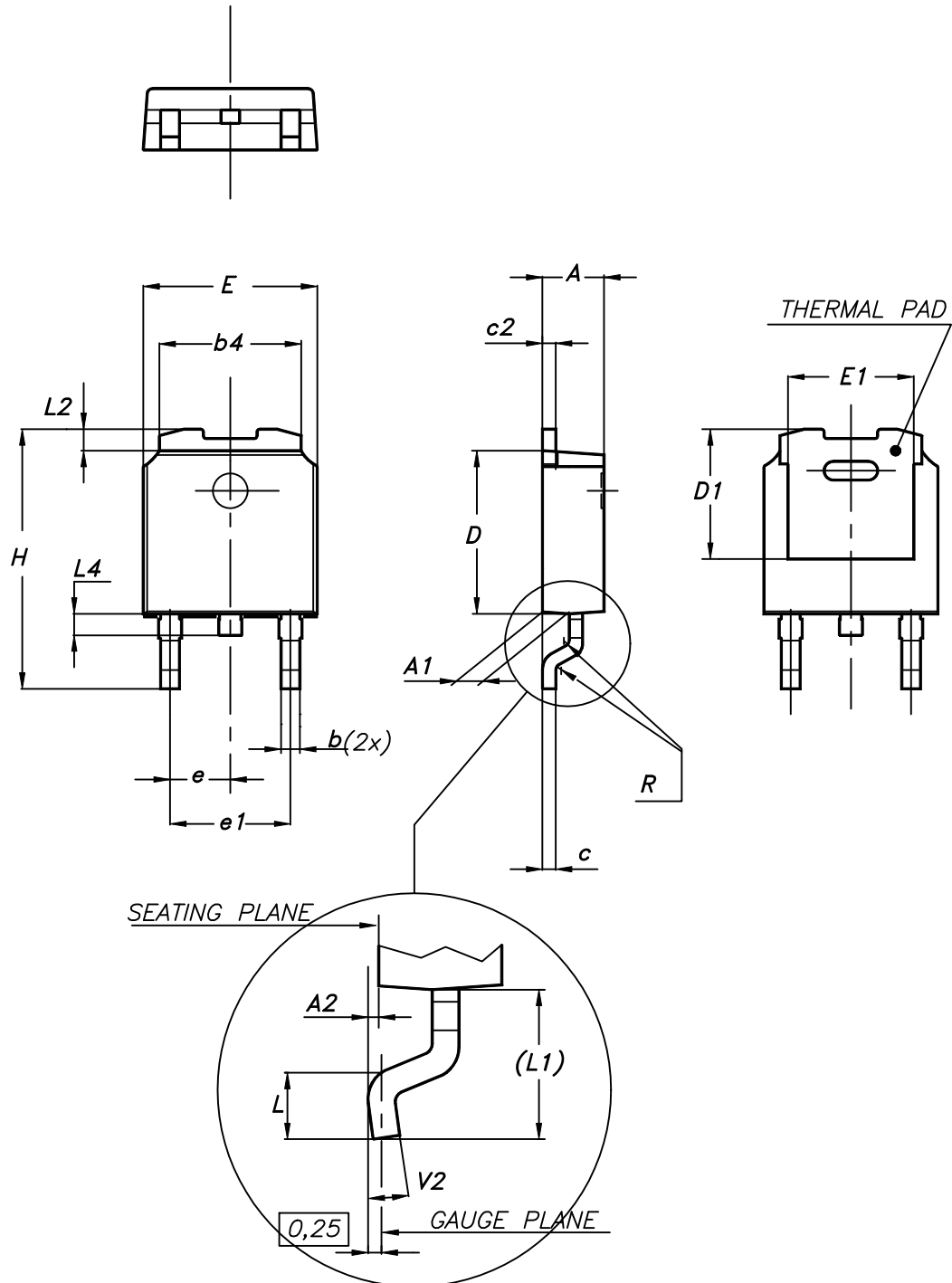
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R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

Figure 21. D²PAK (TO-263) recommended footprint (dimensions are in mm)


Footprint

4.2 DPAK (TO-252) type A2 package information

Figure 22. DPAK (TO-252) type A2 package outline

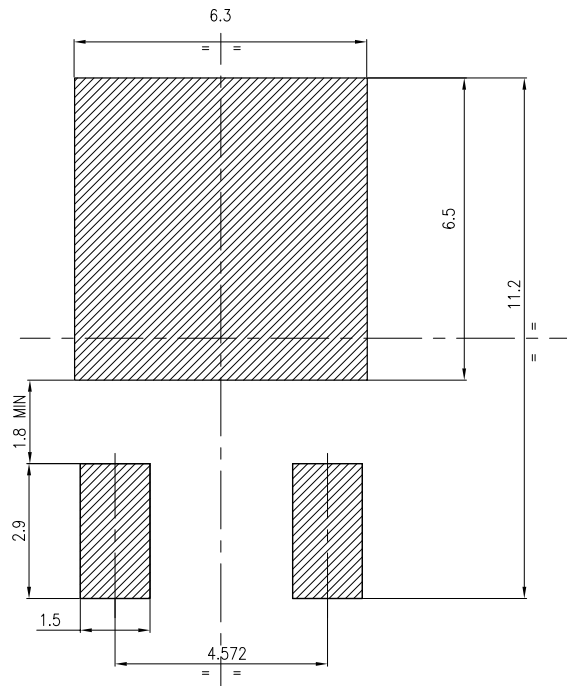


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Table 8. DPAK (TO-252) type A2 mechanical data

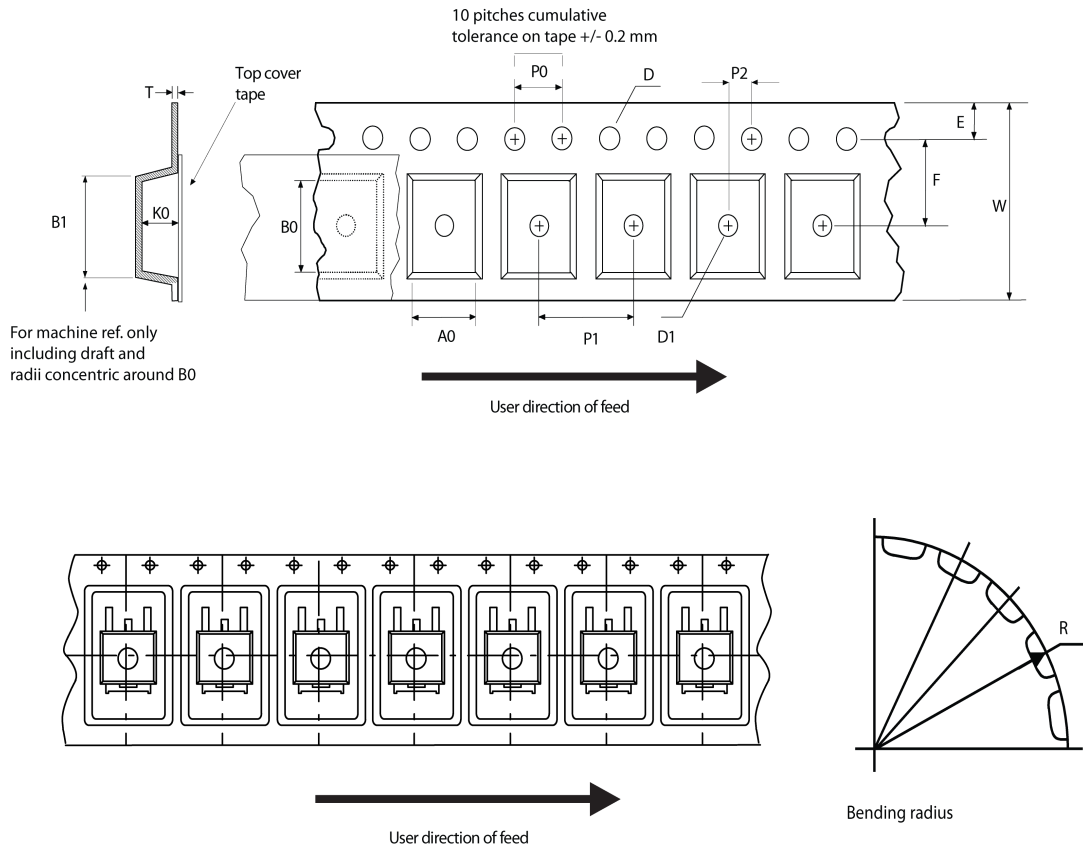
Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	5.10	5.20	5.30
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
L1	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 23. DPAK (TO-252) recommended footprint (dimensions are in mm)

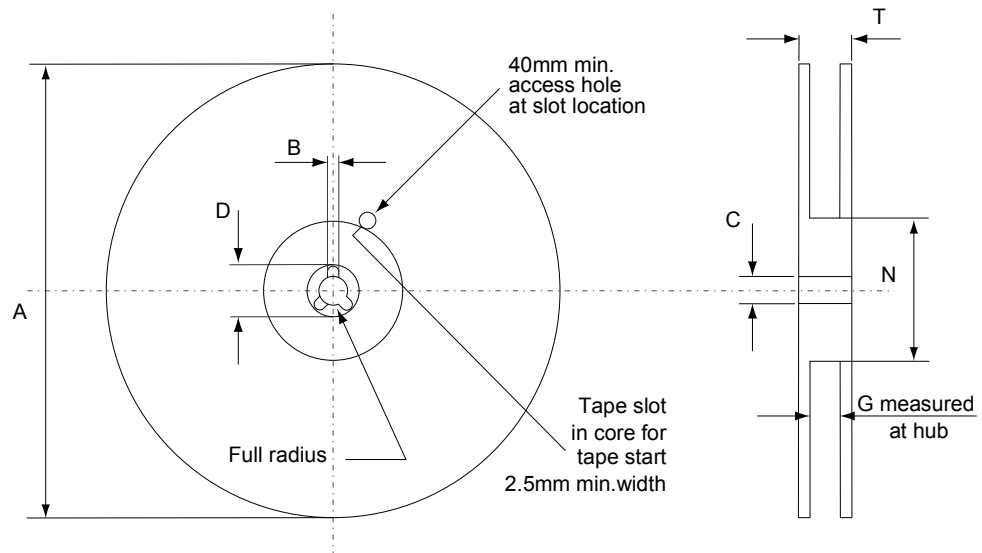


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4.3 D²PAK and DPAK packing information

Figure 24. Tape outline


AM08852v1

Figure 25. Reel outline


AM06038v1

Table 9. D²PAK 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	Base quantity Bulk quantity			
P1	11.9	12.1				1000
P2	1.9	2.1				1000
R	50					
T	0.25	0.35				
W	23.7	24.3				

Table 10. DPAK 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 11. Document revision history

Date	Revision	Changes
30-Oct-2015	1	First release.
01-Sep-2017	2	Modified <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 3: "Thermal data"</i> , <i>Table 4: "Static characteristics"</i> and <i>Table 5: "Dynamic characteristics"</i> . Added <i>Section 2.1: "Electrical characteristics (curves)"</i> . Modified <i>Section 4: "Package information"</i> . Minor text changes.
06-Sep-2017	3	Modified <i>Figure 2: "$V_{CE(sat)}$ vs. junction temperature ($I_C = 6.0\text{ A}$)"</i> , <i>Figure 4: "Self clamped inductive switching current vs. inductance"</i> and <i>Figure 11: "Normalized $V_{CES(clamped)}$ vs. junction temperature"</i> . Minor text changes.
11-Sep-2017	4	Modified <i>Section 4.1: "D²PAK (TO-263) type A package information"</i> . Minor text changes.
02-Nov-2017	5	Updated <i>Table 4: "Static characteristics"</i> . Minor text changes
21-Feb-2018	6	Removed maturity status indication from cover page. The document status is production data. Updated Section 1 Electrical ratings , Table 2. Thermal data and Table 3. Static characteristics . Minor text changes

Contents

1	Electrical ratings	2
2	Electrical characteristics	3
2.1	Electrical characteristics (curves)	5
3	Test circuits	8
4	Package information	9
4.1	D ² PAK (TO-263) type A package information	9
4.2	DPAK (TO-252) type A2 package information	11
4.3	D ² PAK and DPAK packing information	14
	Revision history	18
	Contents	19
	Disclaimer	20

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