

## Automotive-grade 400 V internally clamped IGBT E<sub>SCIS</sub> 320 mJ

Datasheet - production data

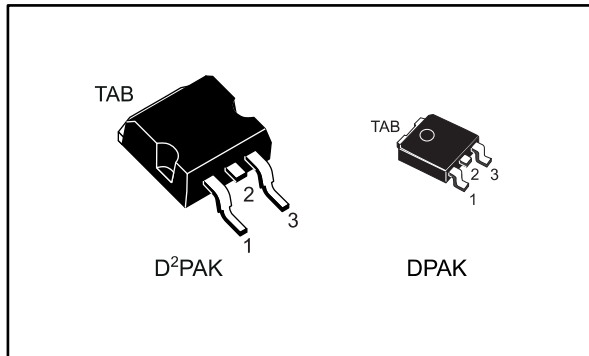
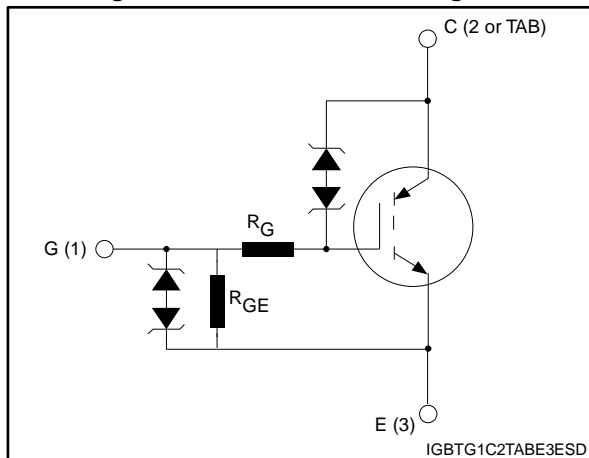



Figure 1: Internal schematic diagram



### Features

- AEC-Q101 qualified 
- SCIS energy of 320 mJ @ T<sub>J</sub> = 25 °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.

Table 1: Device summary

Order code	Marking	Package	Packing
STGB25N40LZAG	GB25N40LZ	D <sup>2</sup> PAK	Tape and reel
STGD25N40LZAG	GD25N40LZ	DPAK	

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	DPAK	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0 V)	V <sub>CES(clamped)</sub>		V
V <sub>ECS</sub>	Emitter-collector voltage (V <sub>GE</sub> = 0 V)	20		V
I <sub>C</sub>	Continuous collector current at T <sub>C</sub> = 25 °C, V <sub>GE</sub> = 4 V	25		A
	Continuous collector current at T <sub>C</sub> = 100 °C, V <sub>GE</sub> = 4 V	25		A
I <sub>CP</sub> <sup>(1)</sup>	Pulsed collector current	50		A
V <sub>GE</sub>	Gate-emitter voltage	V <sub>GE(clamped)</sub>		V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	150	125	W
E <sub>SCIS_25</sub> <sup>(2)</sup>	Self clamping inductive switching energy	320		mJ
E <sub>SCIS_150</sub> <sup>(3)</sup>	Self clamping inductive switching energy @ T <sub>J</sub> = 150 °C	180		mJ
ESD	Human body model, R = 1.5 kΩ, C = 100 pF	4		kV
	Charged device model	2		kV
T <sub>STG</sub>	Storage temperature range	- 55 to 175		°C
T <sub>J</sub>	Operating junction temperature range			

**Notes:**

<sup>(1)</sup>Pulse width limited by maximum junction temperature.

<sup>(2)</sup>Starting T<sub>J</sub> = 25 °C, L = 3 mH, R<sub>g</sub> = 1 kΩ, V<sub>CC</sub> = 50 V during inductor charging and V<sub>CC</sub> = 0 V during the time in clamp. Parts are 100% electrically tested in production.

<sup>(3)</sup>Starting T<sub>J</sub> = 150 °C, L = 3 mH, R<sub>g</sub> = 1 kΩ, V<sub>CC</sub> = 50 V during inductor charging and V<sub>CC</sub> = 0 V during the time in clamp.

Table 3: Thermal data

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	DPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case	1	1.2	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	62.5	100	°C/W

## 2 Electrical characteristics

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

**Table 4: Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CES(\text{clamped})}$	Collector-emitter clamped voltage	$I_C = 2\text{ mA}, V_{GE} = 0\text{ V}$		400		V
		$I_C = 2\text{ mA}, V_{GE} = 0\text{ V}, T_J = -40\text{ °C to }175\text{ °C}$	375		435	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	$V_{CE} = 15\text{ V}, V_{GE} = 0\text{ V}, T_J = 175\text{ °C}$			20	$\mu\text{A}$
		$V_{CE} = 200\text{ V}, V_{GE} = 0\text{ V}, T_J = 175\text{ °C}$			100	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{GE} = \pm 10\text{ V}, V_{CE} = 0\text{ V}$		625		$\mu\text{A}$
		$V_{GE} = \pm 10\text{ V}, V_{CE} = 0\text{ V}, T_J = -40\text{ °C to }175\text{ °C}$	450		900	$\mu\text{A}$
$R_{GE}$	Gate emitter resistance		11	16	22	$\text{k}\Omega$
$R_G$	Gate resistance			120		$\Omega$

**Table 5: 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	-	$\text{pF}$
$C_{oes}$	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	-	$\text{nC}$

Table 6: Resistive load switching characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 14\text{ V}$ , $V_{GE} = 5\text{ V}$ , $R_L = 1\ \Omega$ , $R_G = 1\text{ k}\Omega$ (see <a href="#">Figure 18: "Test circuit for resistive load switching"</a> )	-	1.1	-	$\mu\text{s}$
$t_r$	Rise time		-	3.6	-	$\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 14\text{ V}$ , $V_{GE} = 5\text{ V}$ , $R_L = 1\ \Omega$ , $R_G = 1\text{ k}\Omega$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 18: "Test circuit for resistive load switching"</a> )	-	1.06	-	$\mu\text{s}$
$t_r$	Rise time		-	3.5	-	$\mu\text{s}$

Table 7: Inductive load switching characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$ , $L = 1\text{ mH}$ , $I_C = 10\text{ A}$ , $V_{GE} = 5\text{ V}$ , $R_G = 1\text{ k}\Omega$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> )	-	4.6	-	$\mu\text{s}$
$t_f$	Fall time		-	8.4	-	$\mu\text{s}$
dV/dt	Turn-off voltage slope		-	165	-	V/ $\mu\text{s}$
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$ , $L = 1\text{ mH}$ , $I_C = 10\text{ A}$ , $V_{GE} = 5\text{ V}$ , $R_G = 1\text{ k}\Omega$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> )	-	4.7	-	$\mu\text{s}$
$t_f$	Fall time		-	9.8	-	$\mu\text{s}$
dV/dt	Turn-off voltage slope		-	122	-	V/ $\mu\text{s}$

## 2.1 Electrical characteristics (curves)

Figure 2:  $V_{CE(sat)}$  vs. junction temperature ( $I_c = 6.0\text{ A}$ )

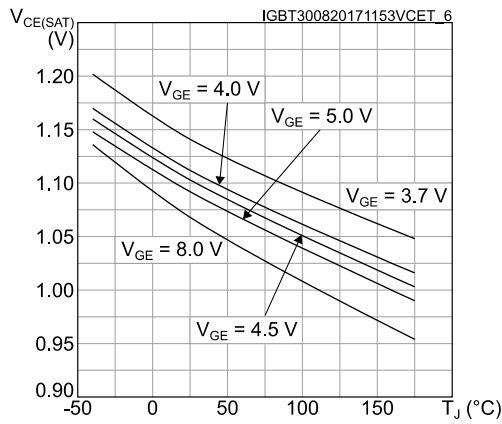


Figure 3:  $V_{CE(sat)}$  vs. junction temperature ( $I_c = 10.0\text{ A}$ )

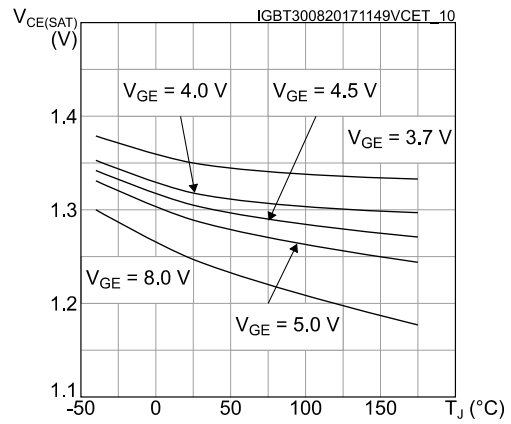


Figure 4: Self clamped inductive switching current vs. inductance

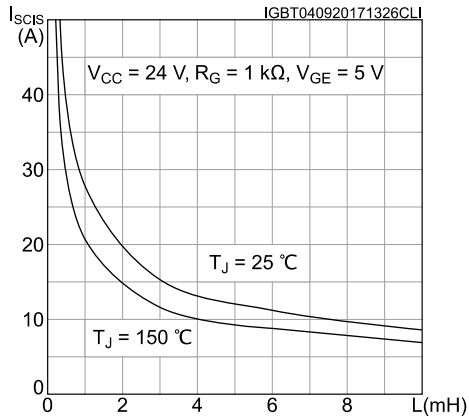


Figure 5: Output characteristics ( $T_J = 25\text{ }^{\circ}\text{C}$ )

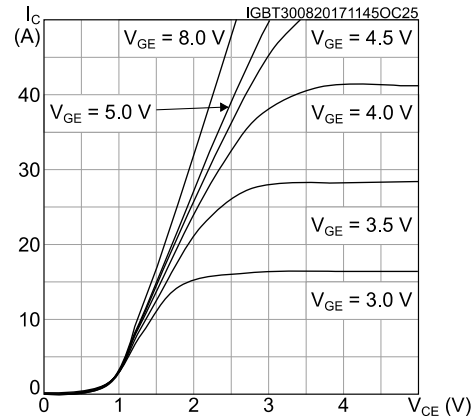


Figure 6: Output characteristics ( $T_J = -40\text{ }^{\circ}\text{C}$ )

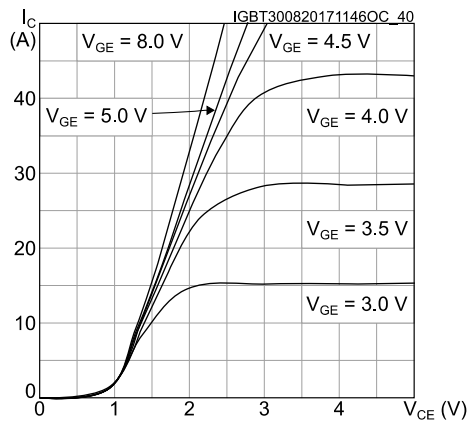
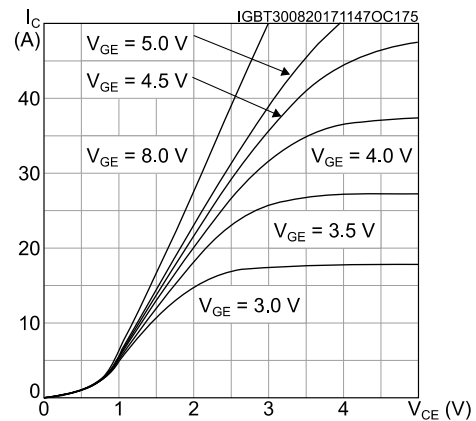
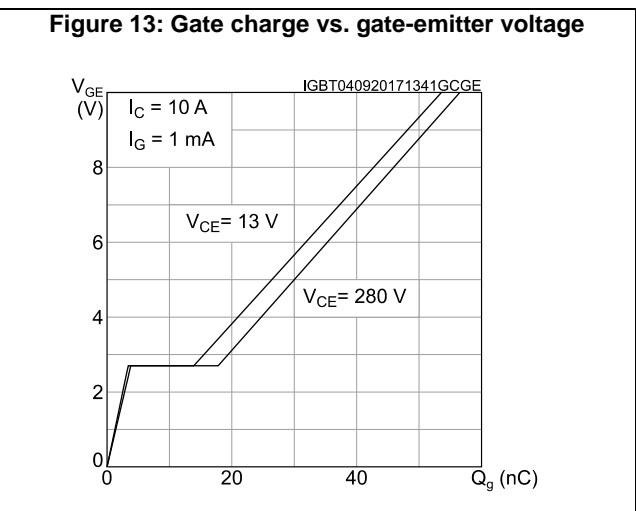
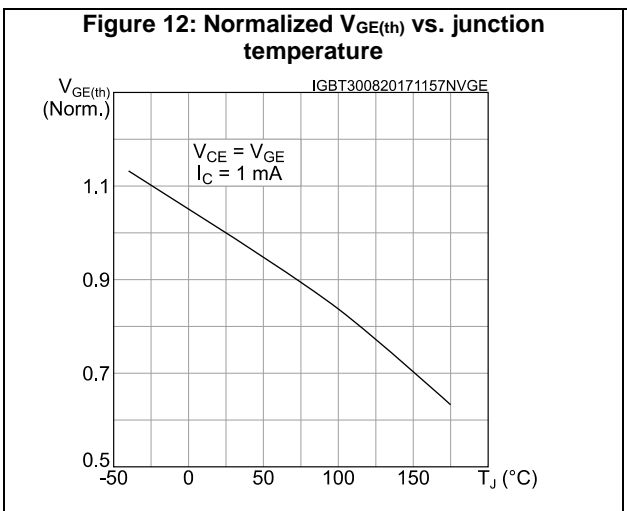
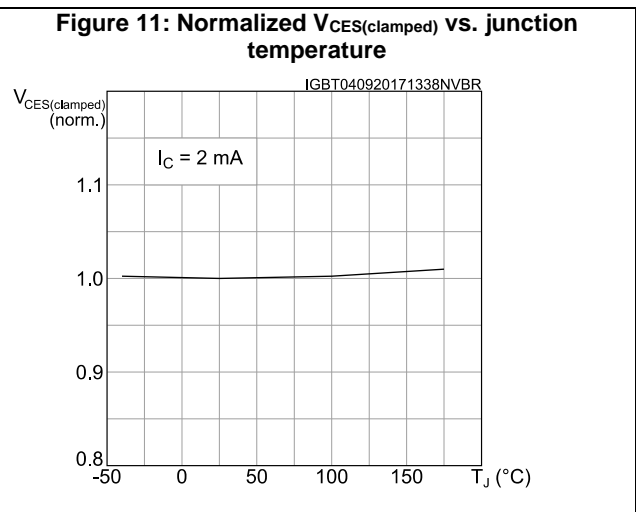
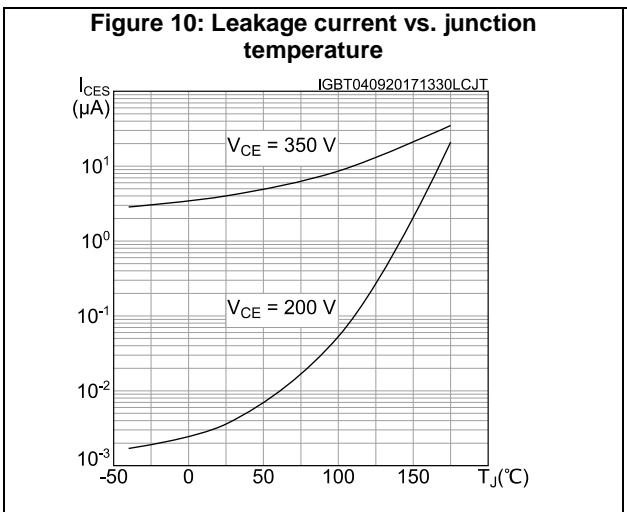
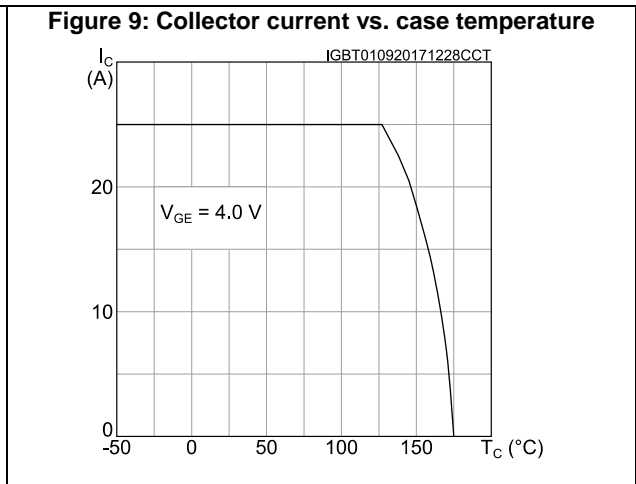
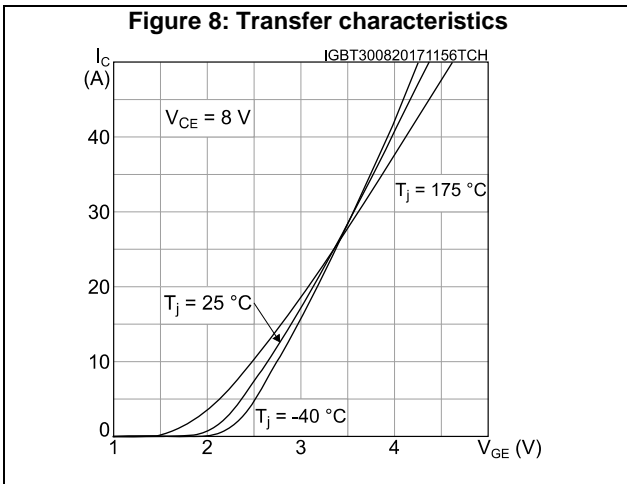
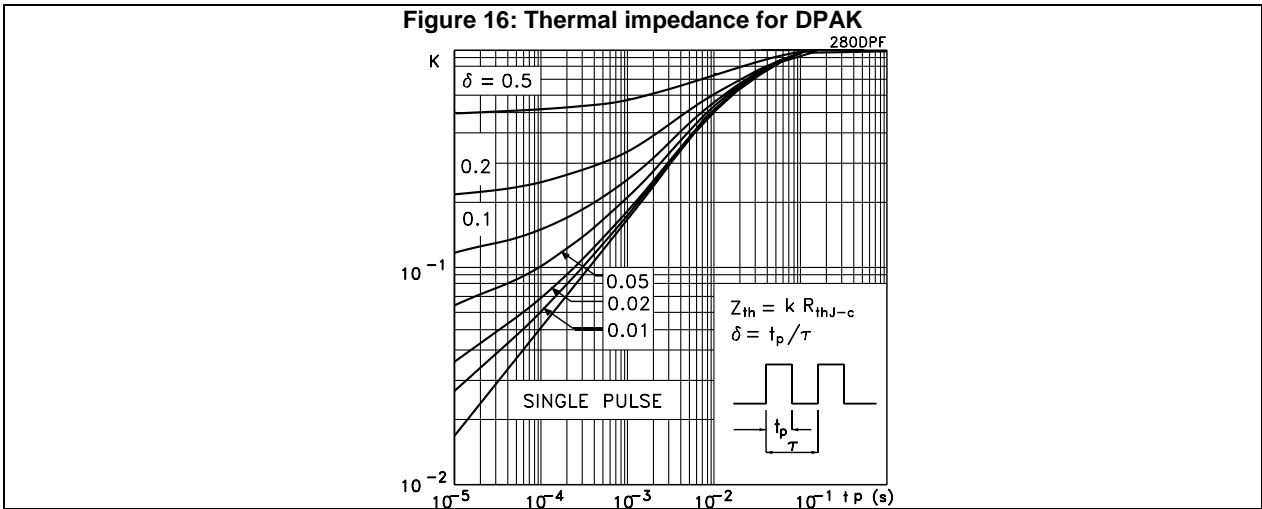
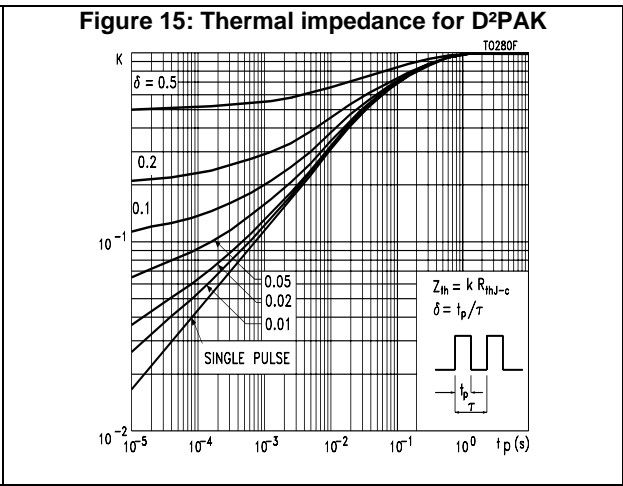
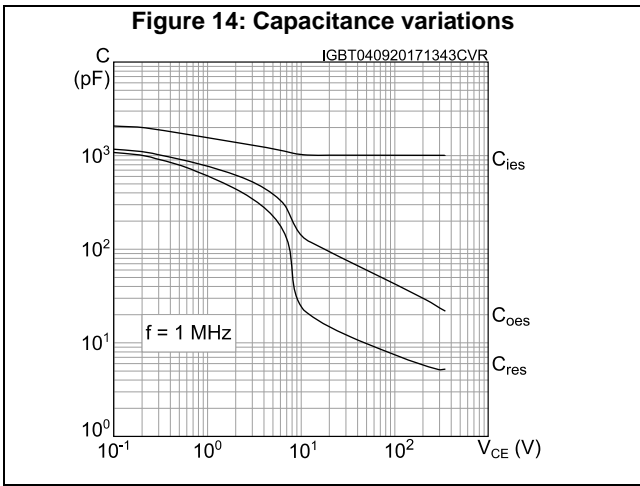


Figure 7: Output characteristics ( $T_J = 175\text{ }^{\circ}\text{C}$ )



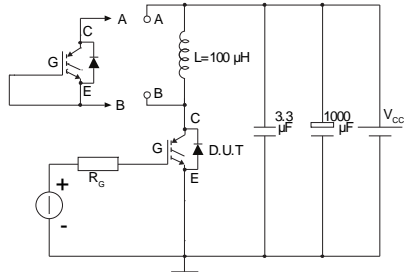






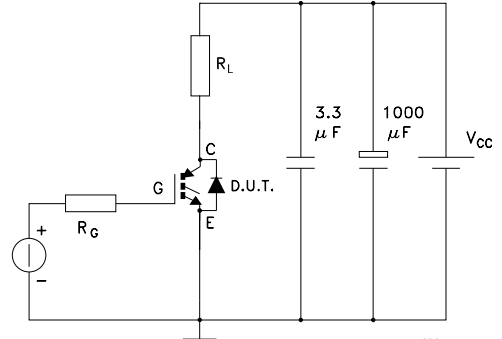
### 3 Test circuits

**Figure 17: Test circuit for inductive load switching**



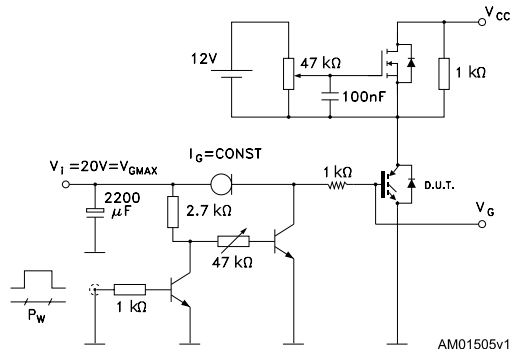
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**Figure 18: Test circuit for resistive load switching**



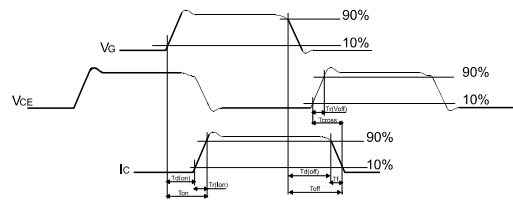
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**Figure 19: Gate charge test circuit**



AM01505v1

**Figure 20: Switching waveform**



AM01506v1

## 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 D<sup>2</sup>PAK (TO-263) type A package information

Figure 21: D<sup>2</sup>PAK (TO-263) type A package outline

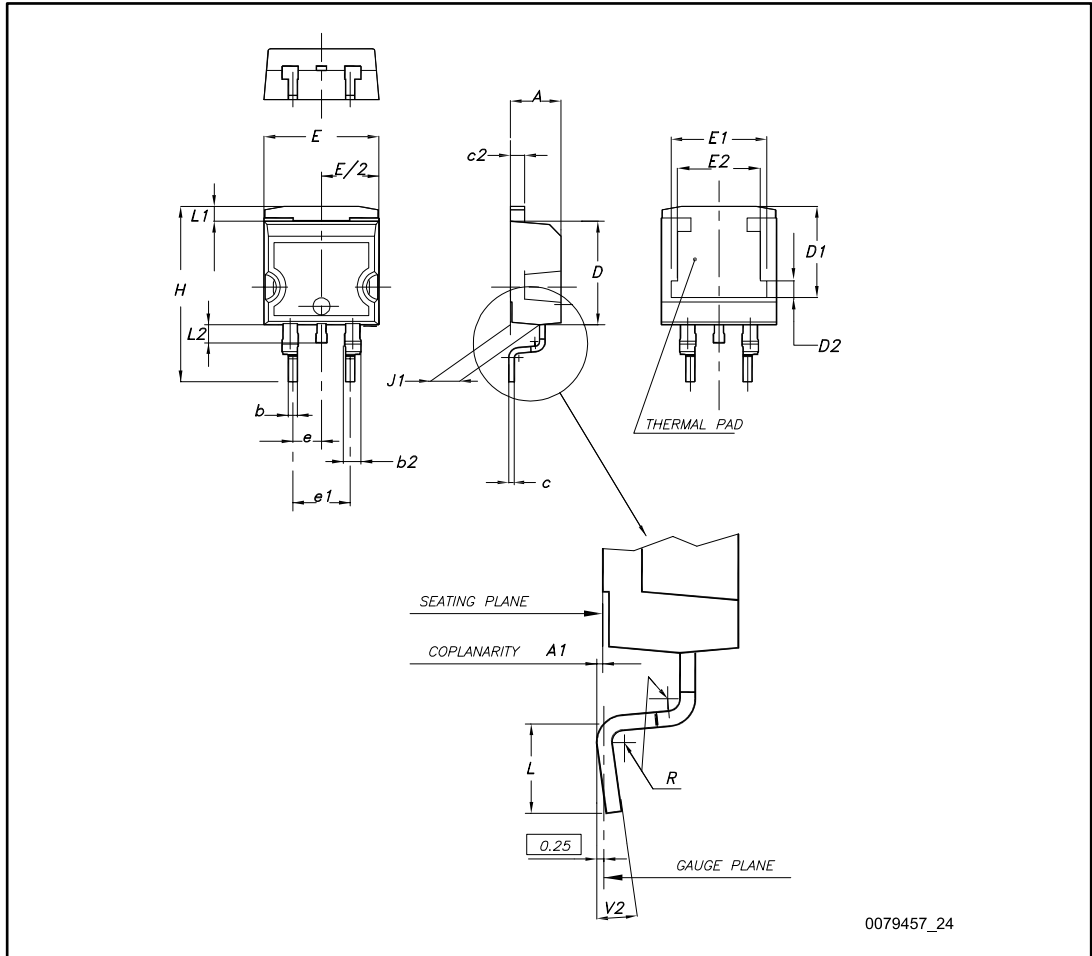
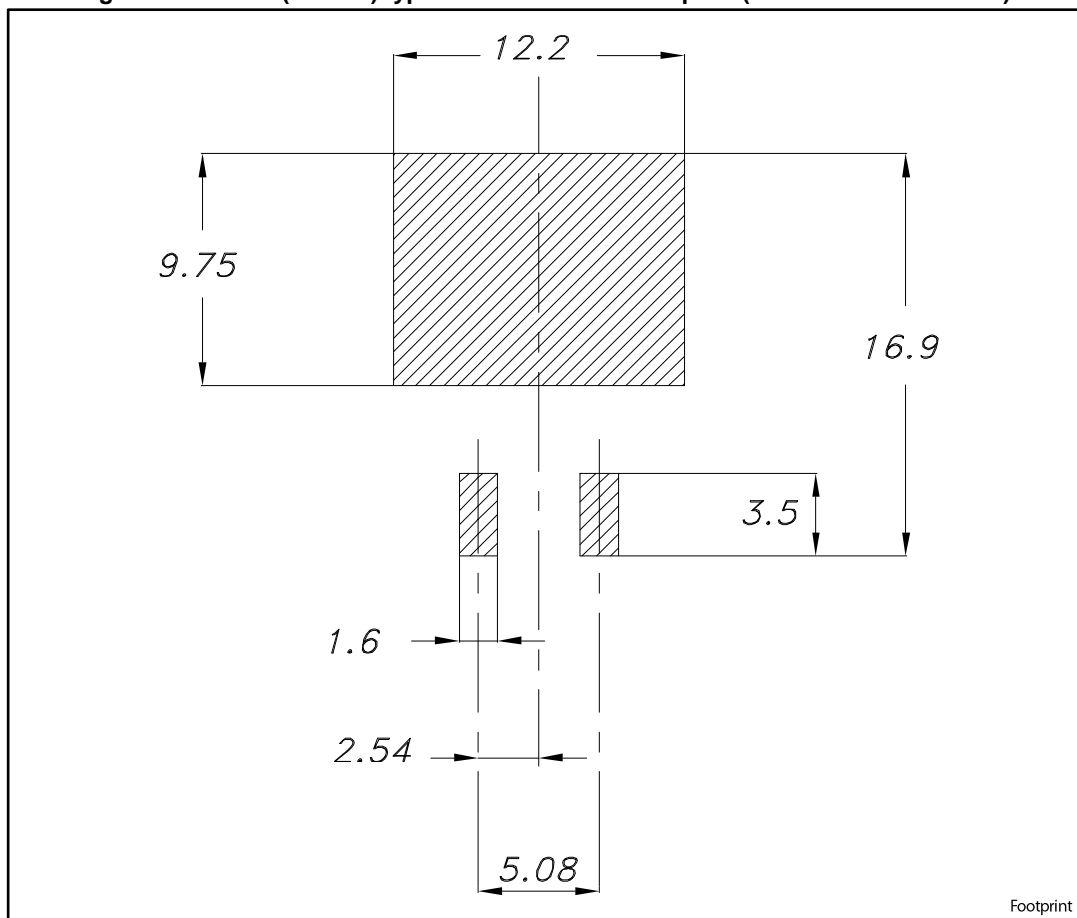


Table 8: D<sup>2</sup>PAK (TO-263) type A package mechanical data

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 22: D<sup>2</sup>PAK (TO-263) type A recommended footprint (dimensions are in mm)



### 4.2 DPAK (TO-252) type A2 package information

Figure 23: DPAK (TO-252) type A2 package outline

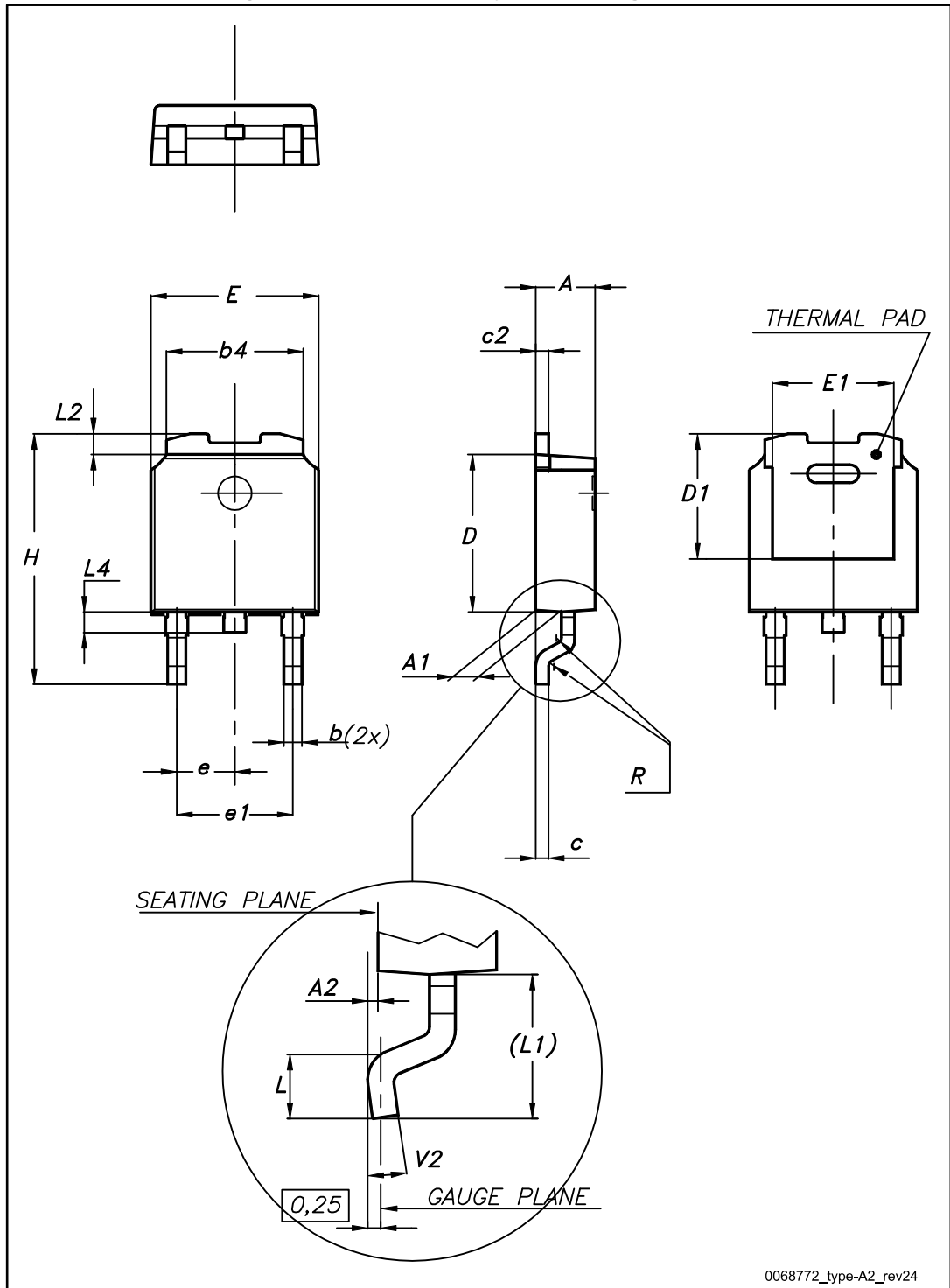
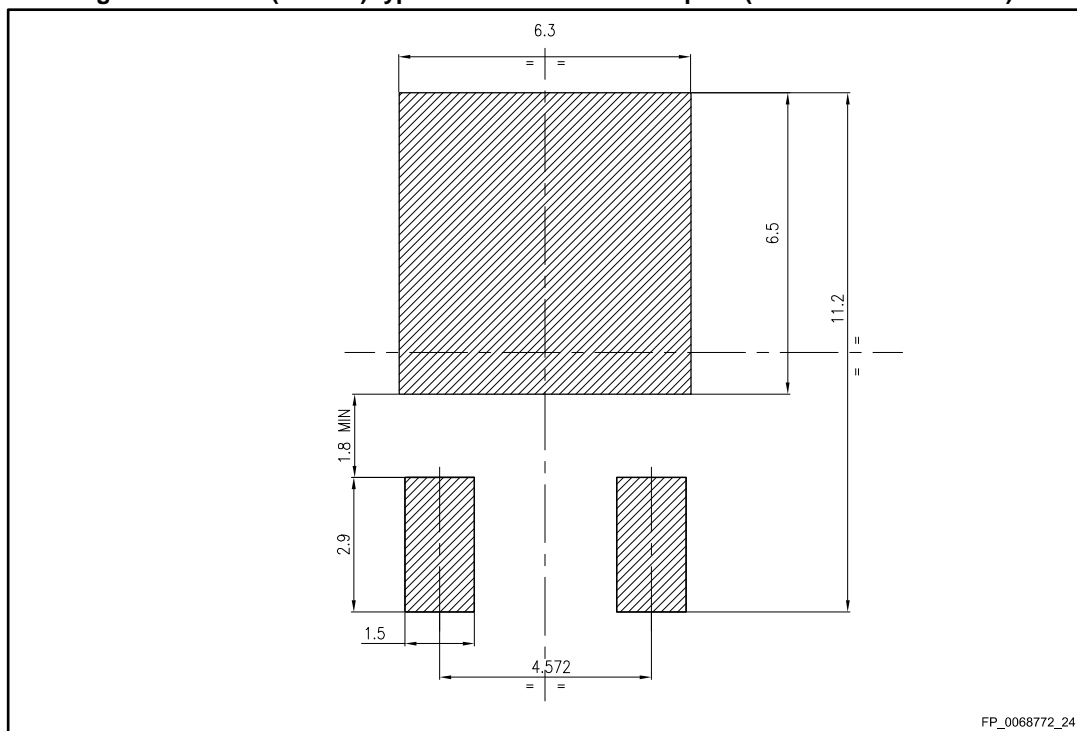


Table 9: DPAK (TO-252) type A2 mechanical data

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 24: DPAK (TO-252) type A2 recommended footprint (dimensions are in mm)



### 4.3 Packing information

Figure 25: Tape outline

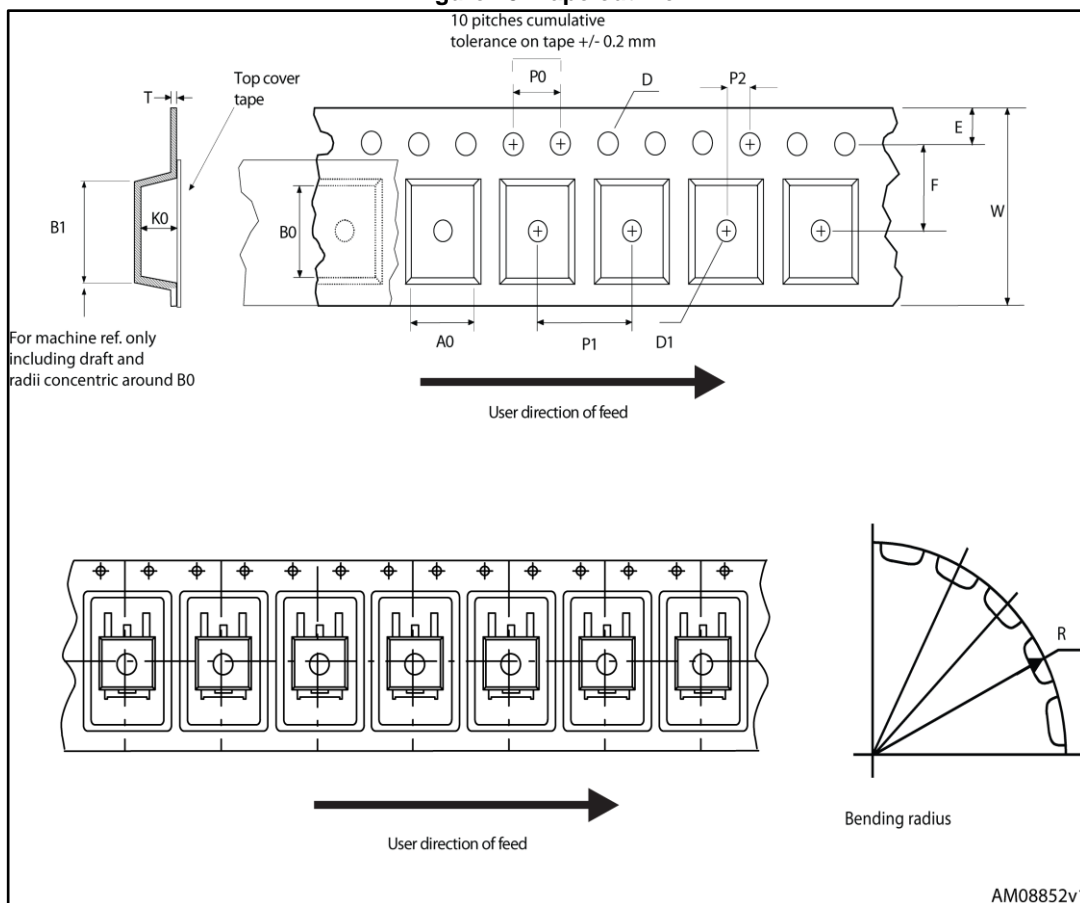
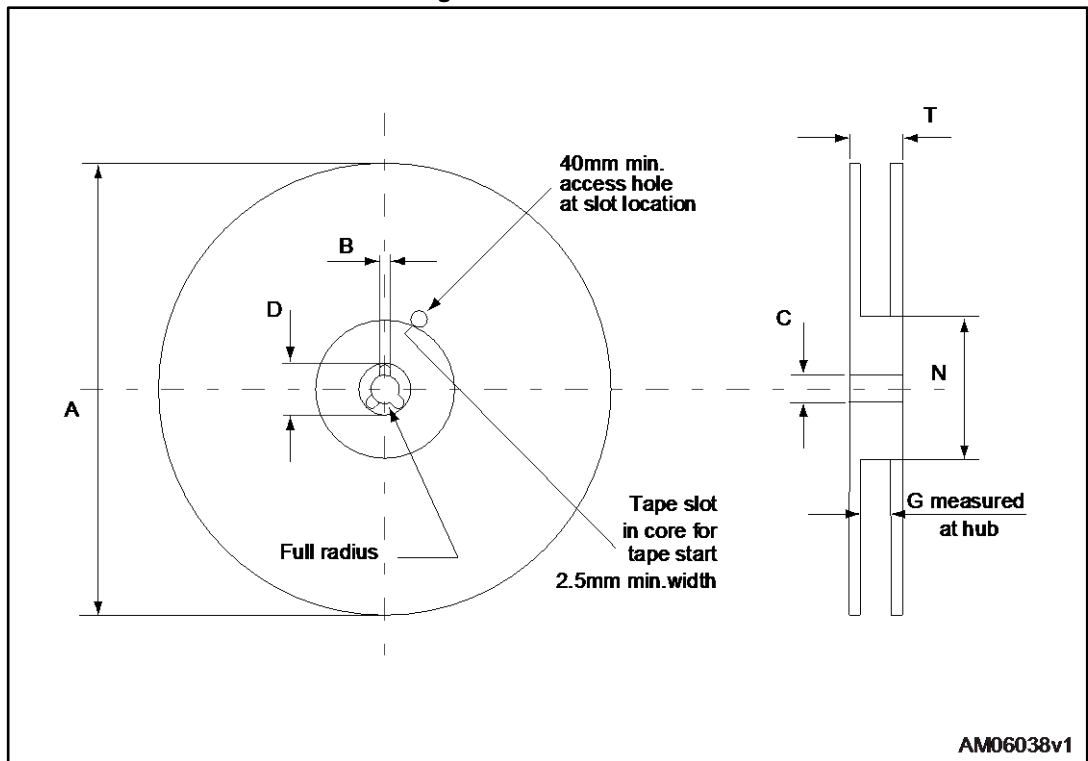




Figure 26: Reel outline



AM06038v1

Table 10: D<sup>2</sup>PAK 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			

Table 11: 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			

## 5 Revision history

Table 12: Document revision history

Date	Revision	Changes
05-Sep-2017	1	First release.
11-Sep-2017	2	Modified <a href="#">Section 4.1: "D<sup>2</sup>PAK (TO-263) type A package information"</a> Minor text changes.

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