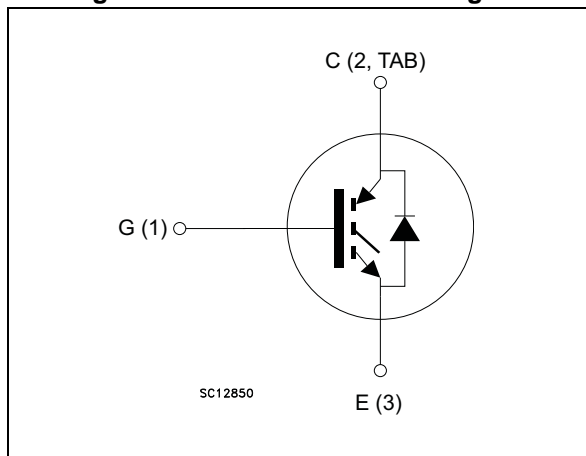


Figure 1. Internal schematic diagram



### Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Short-circuit rated
- Ultrafast soft recovery antiparallel diode

### Applications

- Motor control
- UPS, PFC

### Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses, maximizing the efficiency of very high frequency converters. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB20H60DF	GB20H60DF	D <sup>2</sup> PAK	Tape and reel
STGF20H60DF	GF20H60DF	TO-220FP	Tube
STGP20H60DF	GP20H60DF	TO-220	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	TO-220 D <sup>2</sup> PAK	TO-220FP	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600		V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	40	40 <sup>(1)</sup>	A
	Continuous collector current at $T_C = 100\text{ °C}$	20	20 <sup>(1)</sup>	A
$I_{CP}$ <sup>(2)</sup>	Pulsed collector current	80	80 <sup>(1)</sup>	A
$V_{GE}$	Gate-emitter voltage	±20		V
$I_F$	Continuous forward current $T_C = 25\text{ °C}$	40	40 <sup>(1)</sup>	A
	Continuous forward current at $T_C = 100\text{ °C}$	20	20 <sup>(1)</sup>	
$I_{FP}$ <sup>(2)</sup>	Pulsed forward current	80	80 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	167	37	W
$T_{STG}$	Storage temperature range	- 55 to 150		°C
$T_J$	Operating junction temperature	- 55 to 175		

1. Limited by maximum junction temperature.

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

**Table 3. Thermal data**

Symbol	Parameter	TO-220 D <sup>2</sup> PAK	TO-220FP	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.9	4	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	2.5	5.6	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	62.5		°C/W

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$		1.6	2.0	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 125\text{ °C}$		1.75		
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 175\text{ °C}$		1.8		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5.0	6.0	7.0	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	2750	-	pF
$C_{oes}$	Output capacitance		-	110	-	pF
$C_{res}$	Reverse transfer capacitance		-	65	-	pF
$Q_g$	Total gate charge	$V_{CC} = 400\text{ V}, I_C = 20\text{ A},$ $V_{GE} = 15\text{ V}$	-	115	-	nC
$Q_{ge}$	Gate-emitter charge		-	22	-	nC
$Q_{gc}$	Gate-collector charge		-	45	-	nC

Table 6. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$		42.5	-	ns
$t_r$	Current rise time			11.9	-	ns
$(di/dt)_{on}$	Turn-on current slope			1345	-	A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$		42.5	-	ns
$t_r$	Current rise time			13.4		ns
$(di/dt)_{on}$	Turn-on current slope			1180		A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$		20	-	ns
$t_{d(off)}$	Turn-off delay time			177	-	ns
$t_f$	Current fall time			55	-	ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$		26	-	ns
$t_{d(off)}$	Turn-off delay time			173	-	ns
$t_f$	Current fall time			86	-	ns
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$	3	5	-	$\mu$ s

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$	-	209	-	$\mu$ J	
$E_{off}^{(2)}$	Turn-off switching losses			-	261	-	$\mu$ J
$E_{ts}$	Total switching losses			-	470	-	$\mu$ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	-	480	-	$\mu$ J	
$E_{off}^{(2)}$	Turn-off switching losses			-	416	-	$\mu$ J
$E_{ts}$	Total switching losses			-	896	-	$\mu$ J

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_J = 175\text{ °C}$	-	1.8	2.2	V
				1.3		V
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$	-	90	-	ns
$Q_{rr}$	Reverse recovery charge			110		nC
$I_{rrm}$	Reverse recovery current			2.4		A
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$ $T_J = 175\text{ °C}$	-	180	-	ns
				466		nC
$I_{rrm}$	Reverse recovery current		-	5.2	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ( $T_J = 25^\circ\text{C}$ )

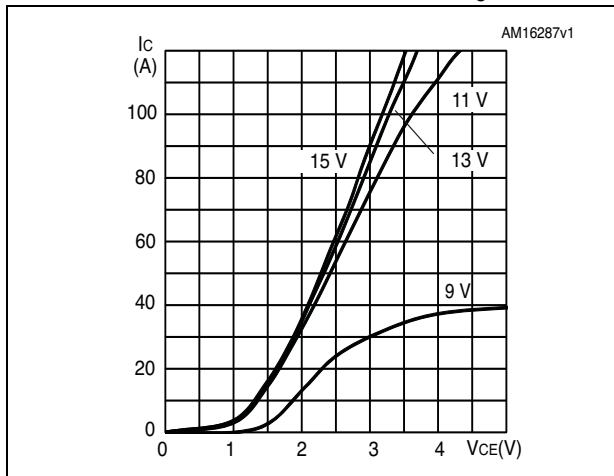


Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

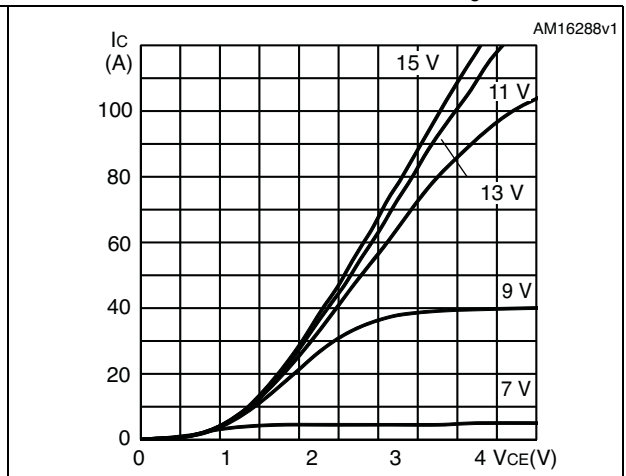


Figure 4. Transfer characteristics

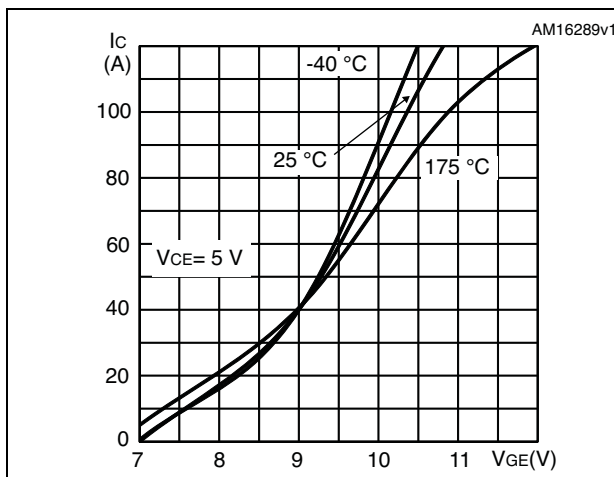


Figure 5. Normalized  $V_{GE(th)}$  vs junction temperature

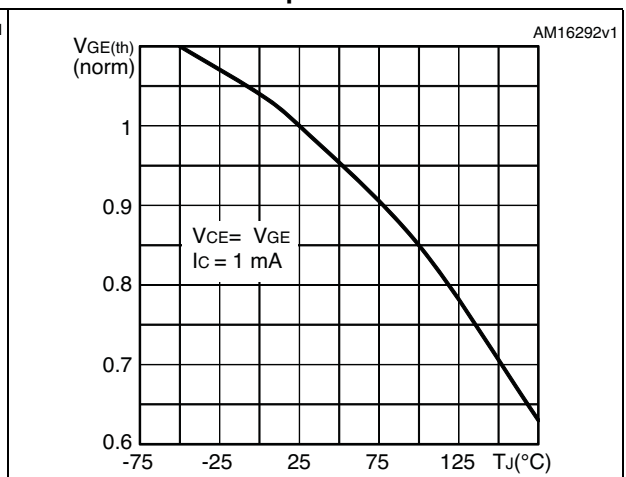


Figure 6. Collector current vs. case temperature for D<sup>2</sup>PAK and TO-220 Figure 7. Collector current vs. case temperature for TO-220FP

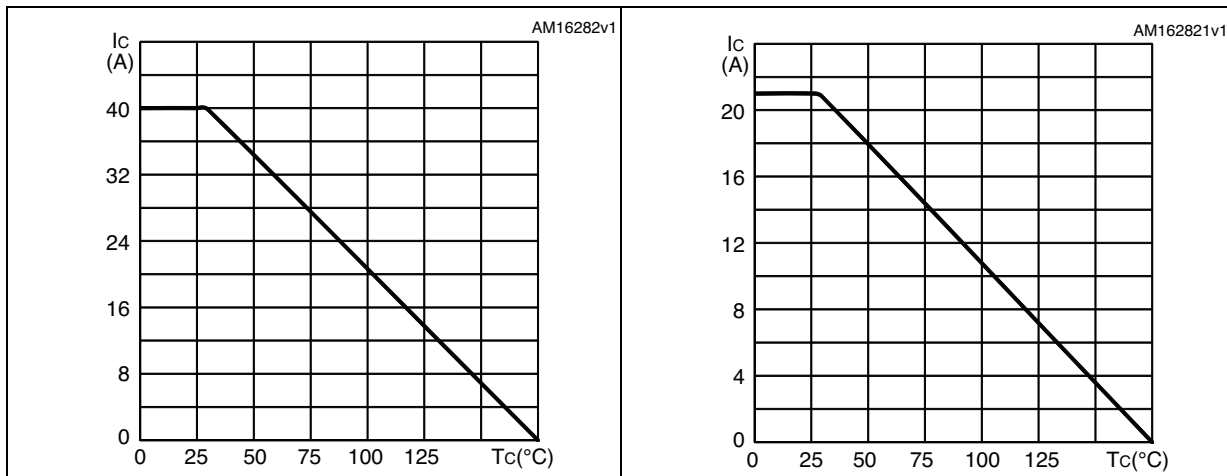


Figure 8. Collector current vs. frequency for D<sup>2</sup>PAK and TO-220

Figure 9. Collector current vs. frequency for TO-220FP

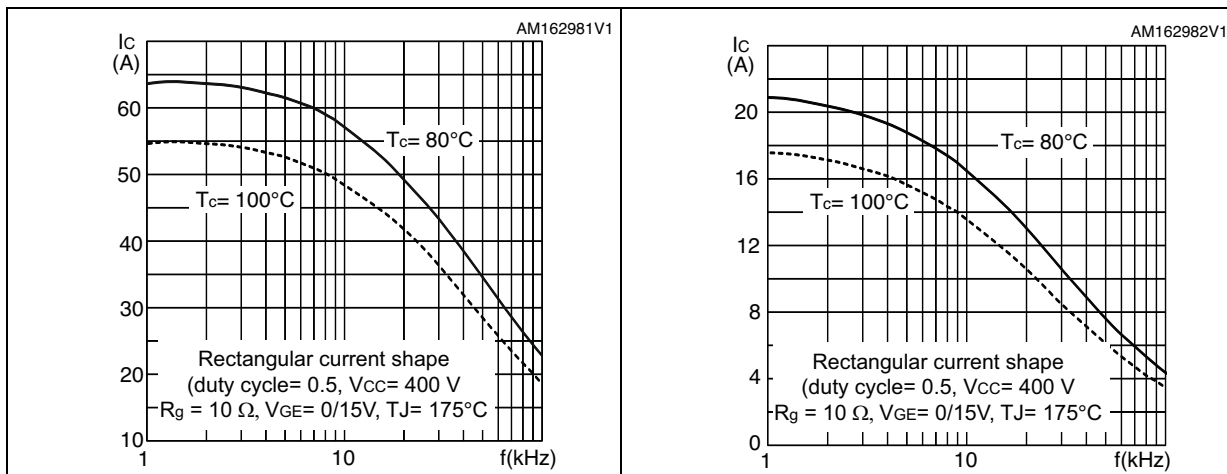


Figure 10. Power dissipation vs. case temperature for D<sup>2</sup>PAK and TO-220

Figure 11. Power dissipation vs. case temperature for TO-220FP

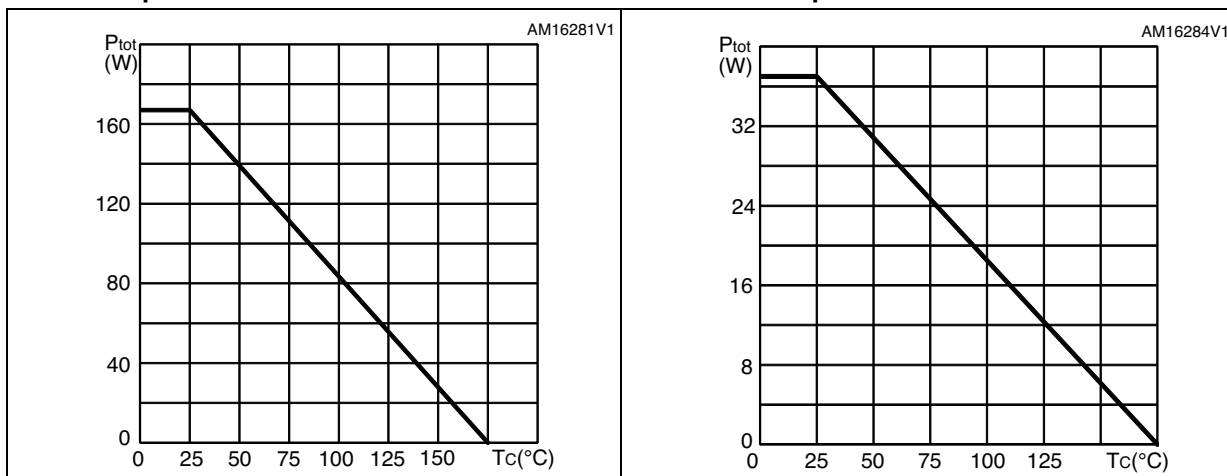




Figure 12.  $V_{CE(sat)}$  vs. junction temperature

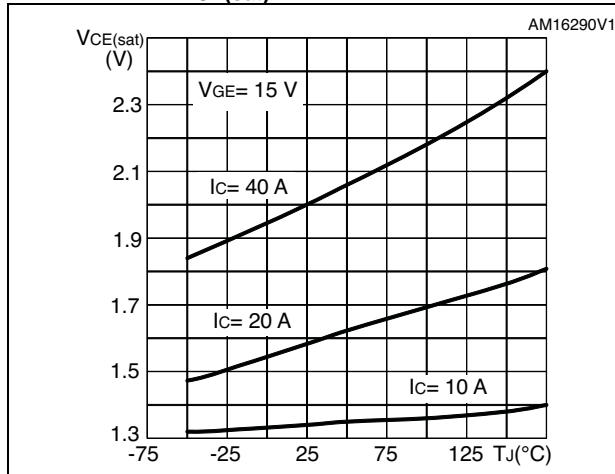


Figure 13.  $V_{CE(sat)}$  vs. collector current

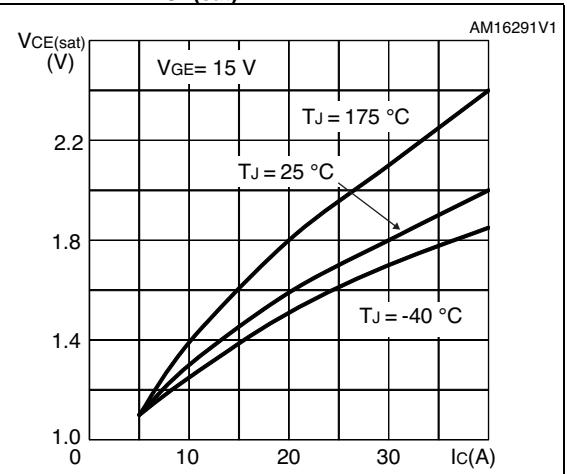


Figure 14. Forward bias safe operating area for D<sup>2</sup>PAK and TO-220

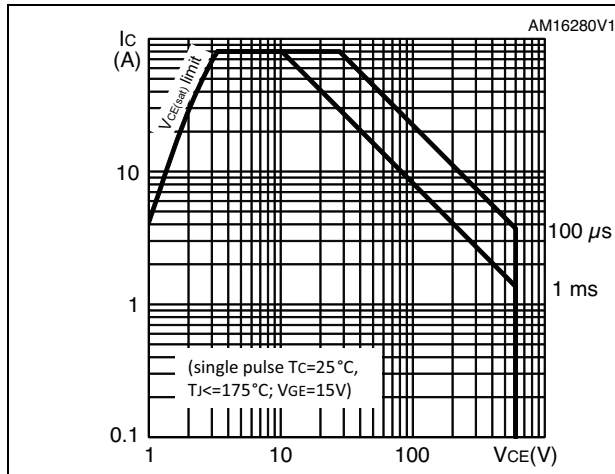


Figure 15. Thermal impedance for D<sup>2</sup>PAK and TO-220

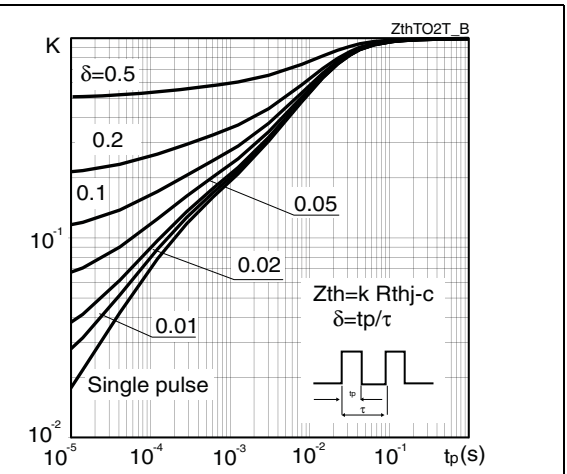


Figure 16. Forward bias safe operating area for TO-220FP

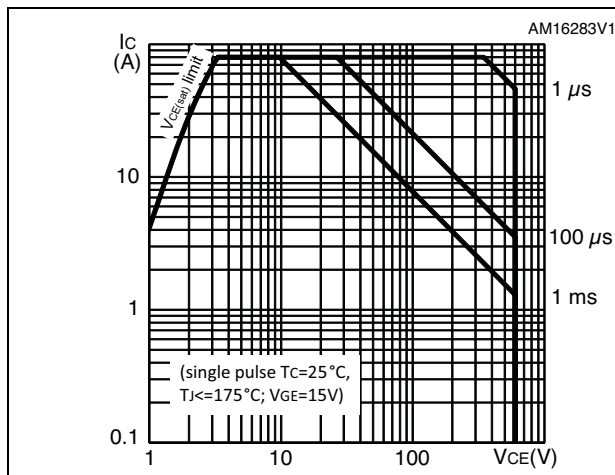


Figure 17. Thermal impedance for TO-220FP

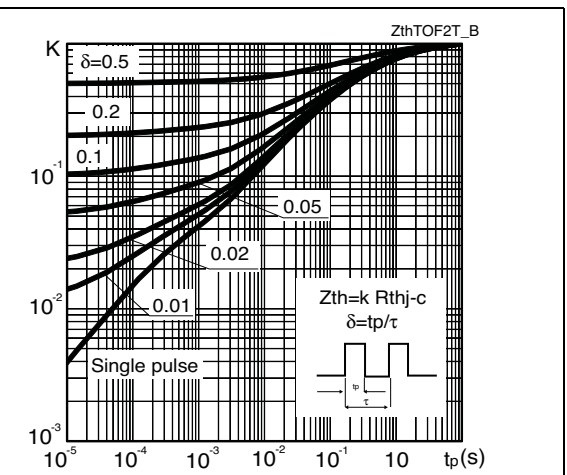


Figure 18. Diode  $V_F$  vs. forward current

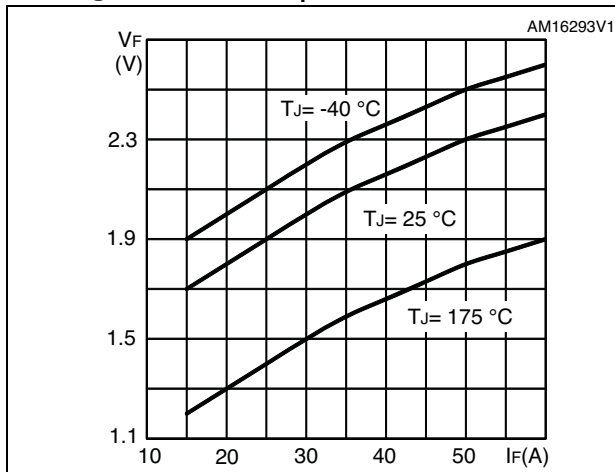


Figure 19. Gate charge vs. gate-emitter voltage

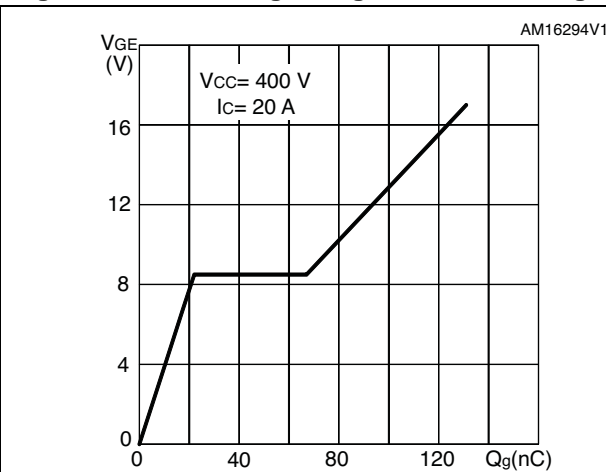


Figure 20. Capacitance variations vs.  $V_{CE}$

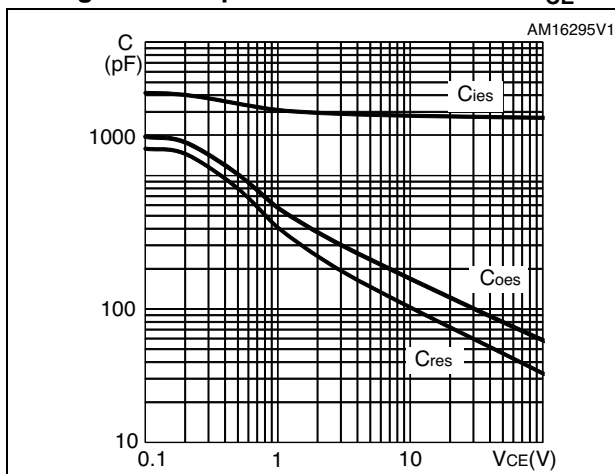


Figure 21. Switching losses vs. gate resistance

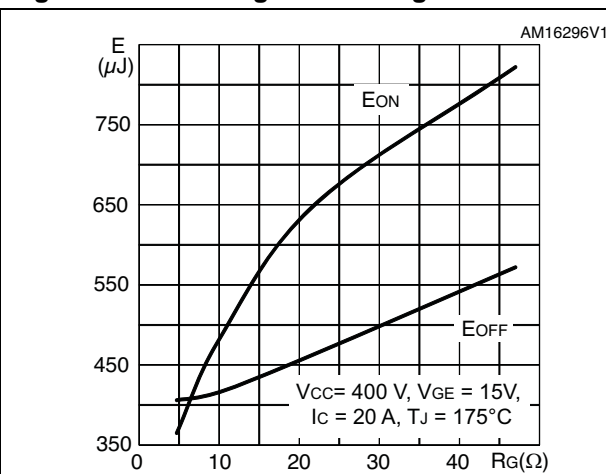


Figure 22. Switching losses vs. collector current

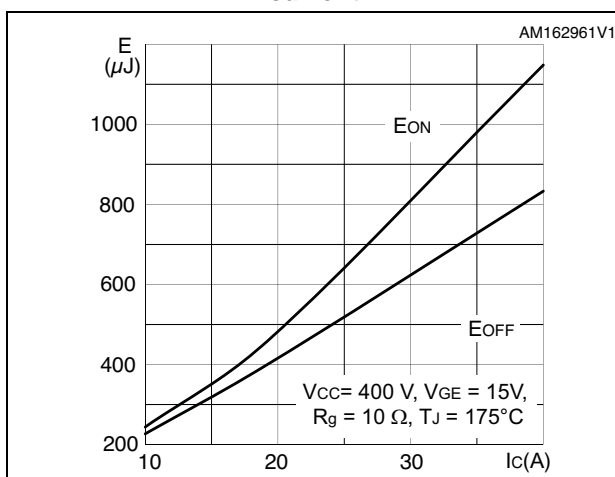


Figure 23. Switching losses vs. temperature

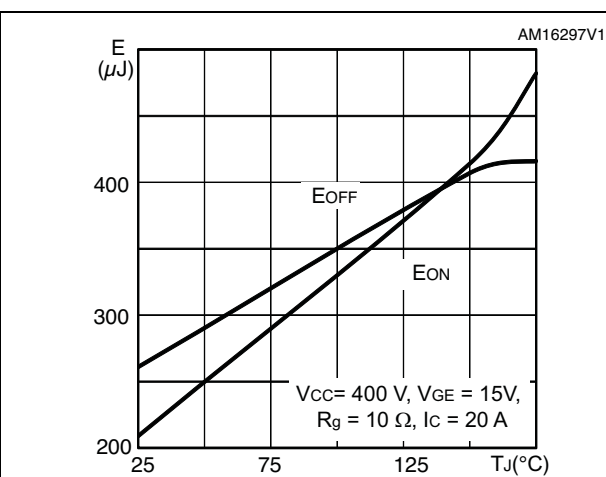
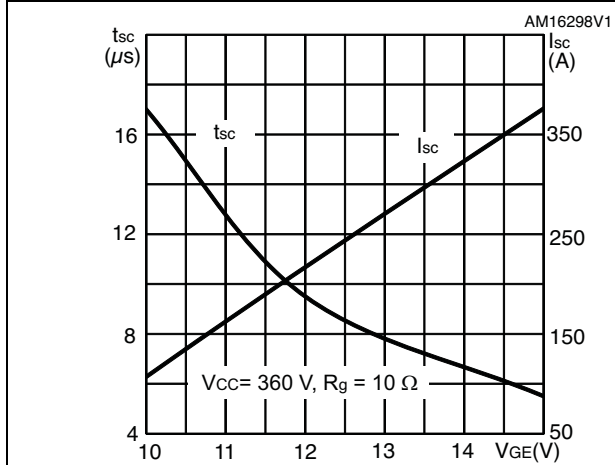
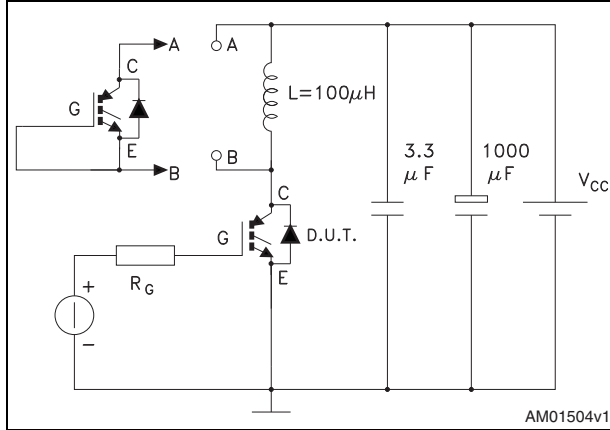


Figure 24. Short-circuit time and current vs.  $V_{GE}$



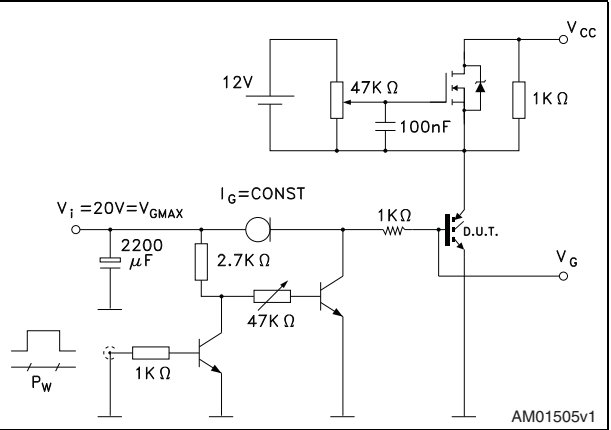
### 3 Test circuits

Figure 25. Test circuit for inductive load switching



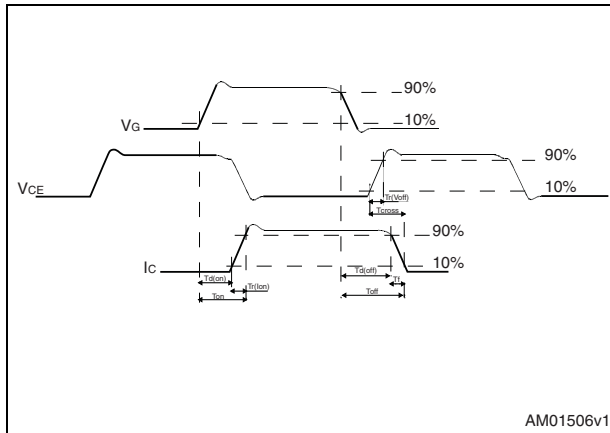
AM01504v1

Figure 26. Gate charge test circuit



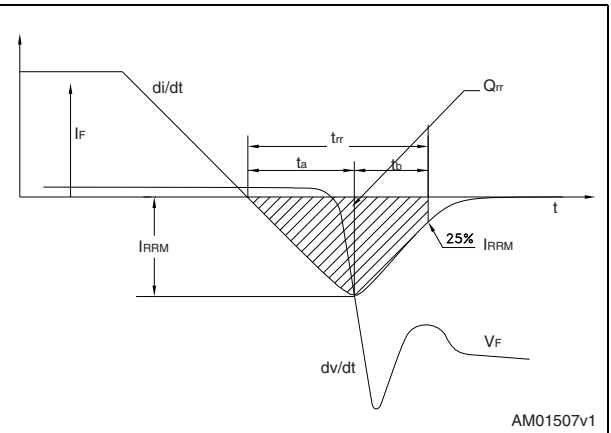
AM01505v1

Figure 27. Switching waveform



AM01506v1

Figure 28. Diode recovery time waveform



AM01507v1

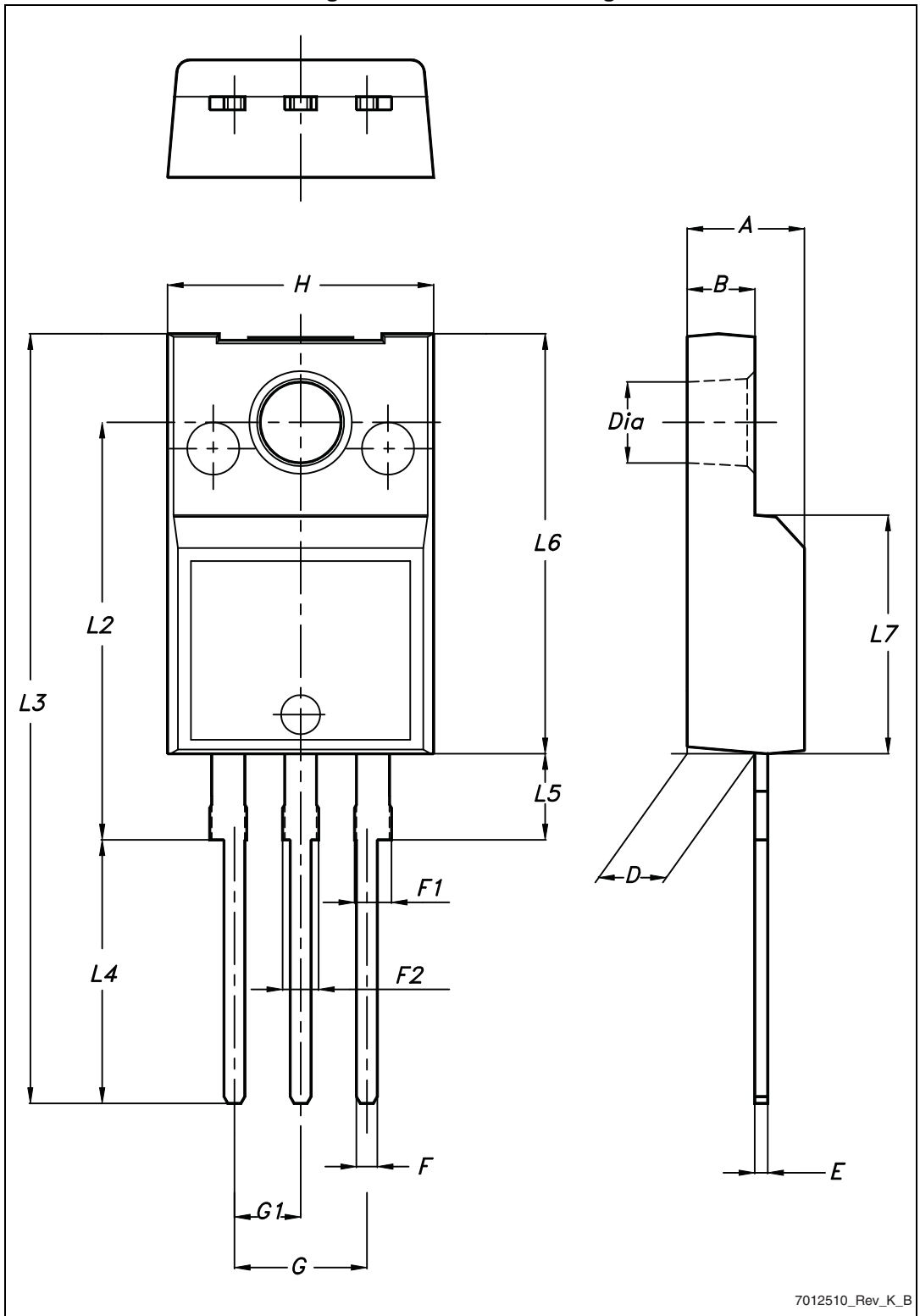
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

**Table 9. TO-220FP mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 29. TO-220FP drawing



7012510\_Rev\_K\_B

Table 10. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 30. TO-220 type A drawing

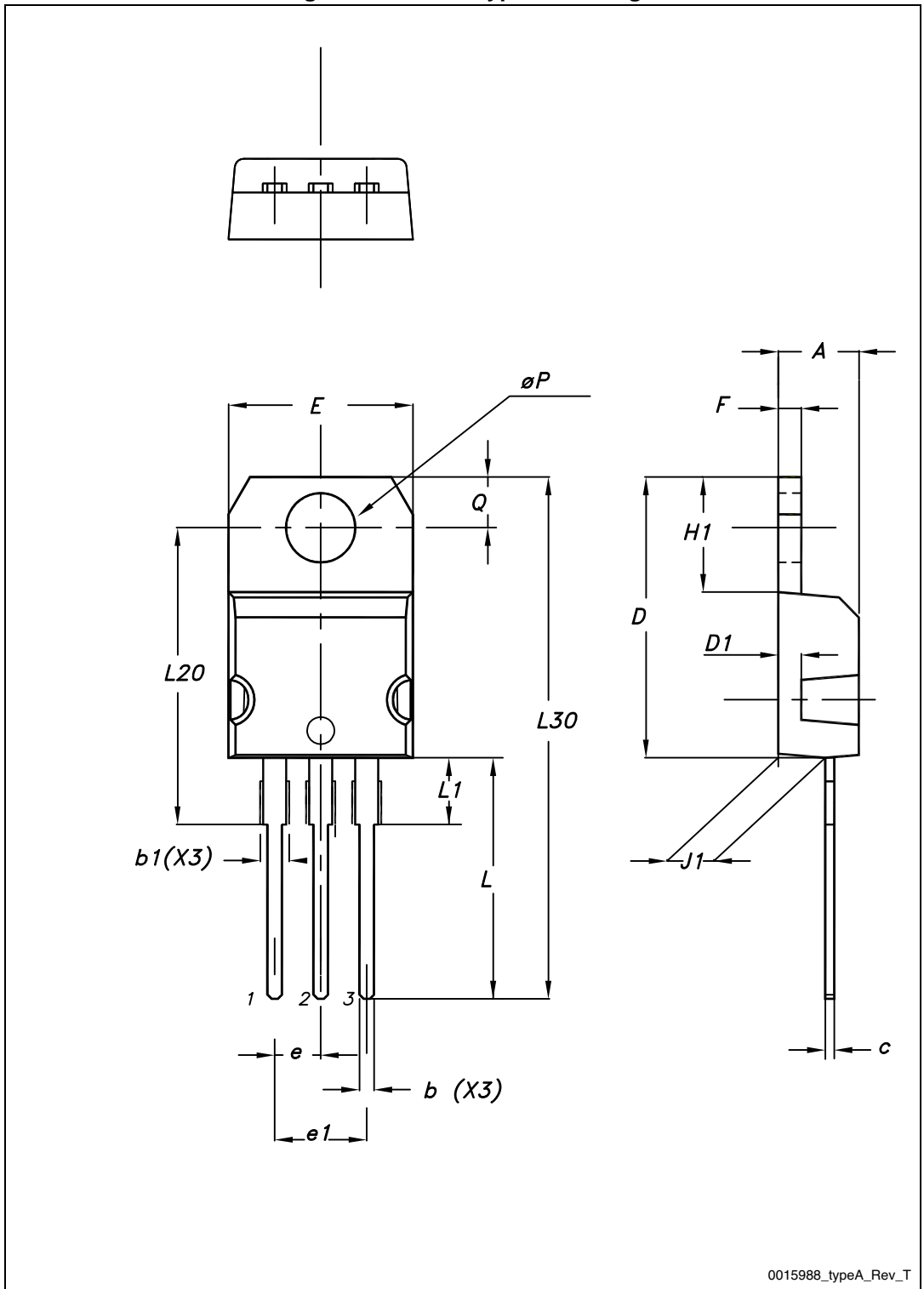




Table 11. D<sup>2</sup>PAK mechanical data

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		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 31. D<sup>2</sup>PAK drawing

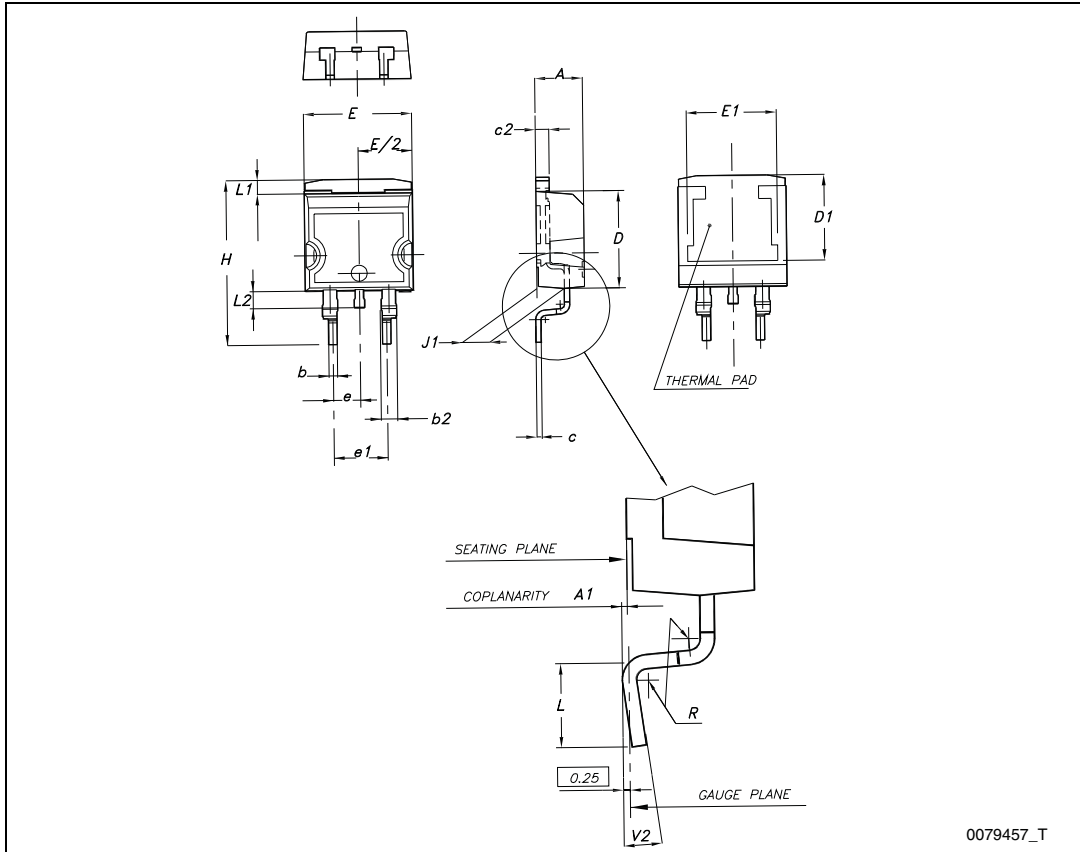
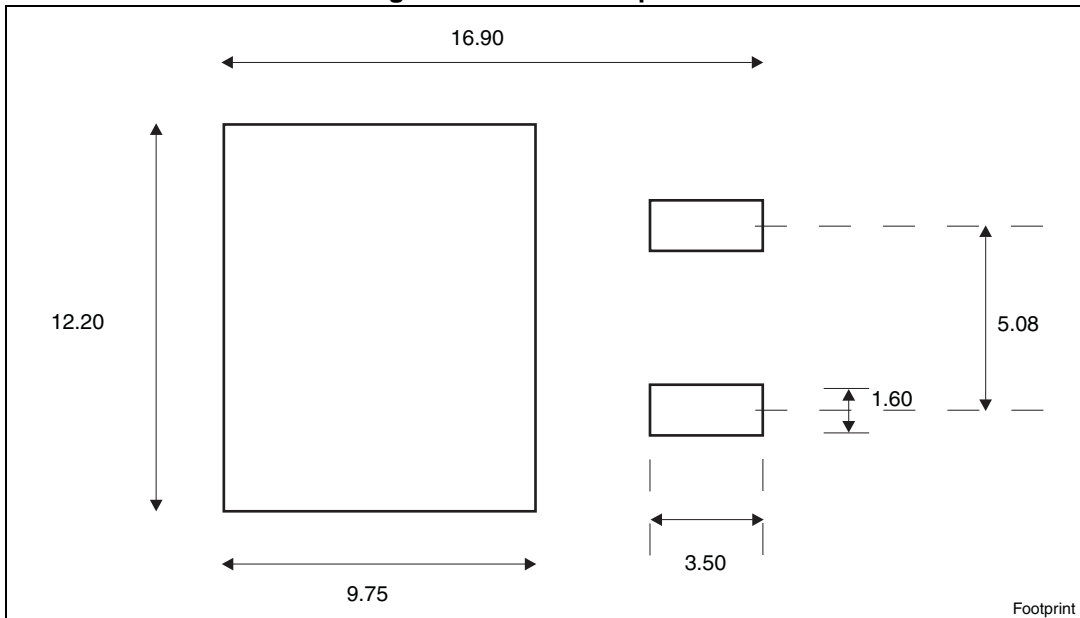


Figure 32. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

## 5 Packaging mechanical data

Table 12. 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 qty	1000
P2	1.9	2.1		Bulk qty	1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 33. Tape

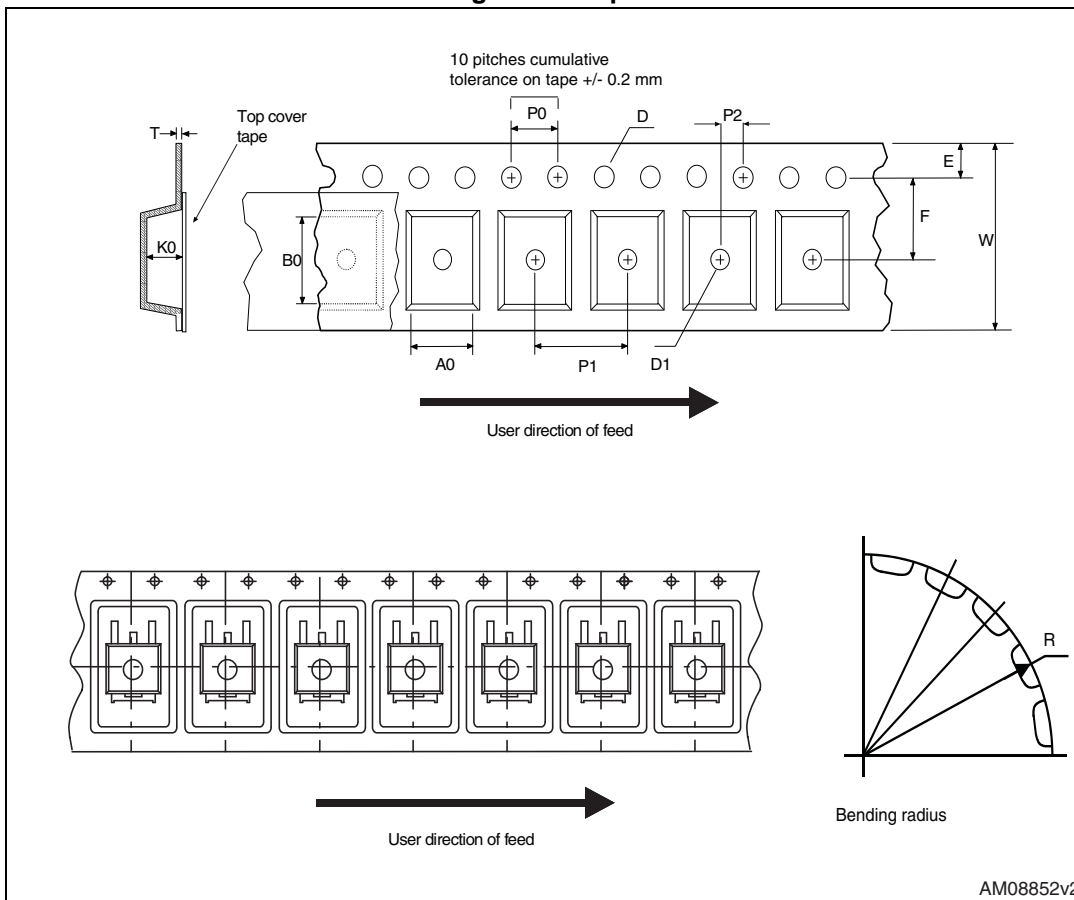
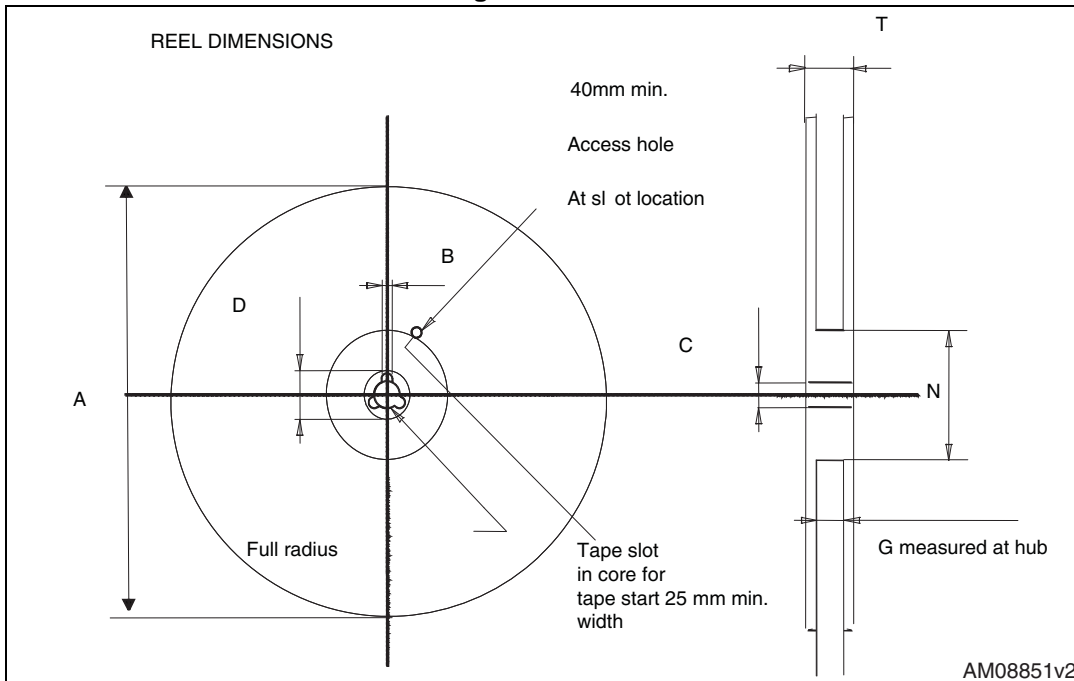


Figure 34. Reel



## 6 Revision history

Table 13. Document revision history

Date	Revision	Changes
03-Oct-2012	1	Initial release.
18-Mar-2013	2	Added new order code STGF20H60DF, mechanical data <a href="#">Table 9</a> and <a href="#">Figure 29 on page 14</a> . Added <a href="#">Chapter 2.1: Electrical characteristics (curves)</a> .
22-Mar-2013	3	Document status promoted from preliminary to production data.
03-Jun-2013	4	Updated $P_{TOT}$ in <a href="#">Table 2: Absolute maximum ratings</a> , $R_{thJC}$ in <a href="#">Table 3: Thermal data</a> and <a href="#">Figure 10: Power dissipation vs. case temperature for D<sup>2</sup>PAK and TO-220</a> . Updated <a href="#">Section 4: Package mechanical data</a> for TO-220.

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