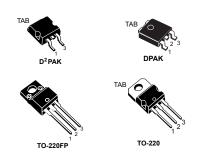
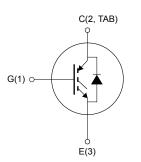


STGB5H60DF, STGD5H60DF STGF5H60DF, STGP5H60DF

Datasheet

Trench gate field-stop 600 V, 5 A high speed H series IGBT





Features

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

Applications

- Motor control
- UPS
- PFC

Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the H series of IGBTs, which represents an optimum compromise between conduction and switching losses to maximize the efficiency of high switching frequency converters. Furthermore, a slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.



Product status link
STGB5H60DF
STGD5H60DF
STGF5H60DF
STGP5H60DF



1 Electrical ratings

Table 1. Absolute maximum ratings

Complete	Parameter		Value		I I m i 4		
Symbol	Symbol Parameter		DPAK	TO-220FP	Unit		
V _{CES}	Collector-emitter voltage (V _{GE} = 0)		600		V		
1.	Continuous collector current at T _C = 25 °C	10		10 ⁽¹⁾	^		
I _C	Continuous collector current at T _C = 100 °C	5		5 ⁽¹⁾	Α		
I _{CP} ⁽²⁾	Pulsed collector current	20	20		Α		
$V_{\sf GE}$	Gate-emitter voltage	±20			V		
1	Continuous forward current T _C = 25 °C	10		10 ⁽¹⁾			
I _F	Continuous forward current at T _C = 100 °C 5			5 ⁽¹⁾	Α		
I _{FP} ⁽²⁾	Pulsed forward current	20		20(1)	Α		
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _c = 25 °C)					2500	V
P _{TOT}	Total power dissipation at T _C = 25 °C 88 83		24	W			
T _{STG}	Storage temperature range	-55 to 150			°C		
TJ	Operating junction temperature range	-55 to 175					

^{1.} Limited by maximum junction temperature.

Table 2. Thermal data

Cumbal	Baramatar	Value			
Symbol Parameter		D ² PAK, TO-220	DPAK	TO-220FP	Unit
R _{thJC}	Thermal resistance junction-case IGBT	1.7	1.8	6.2	°C/W
R _{thJC}	Thermal resistance junction-case diode	4	4.5	7	°C/W
R _{thJA}	Thermal resistance junction-ambient	62.5	100	62.5	°C/W

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^{2.} Pulse width limited by maximum junction temperature.



2 Electrical characteristics

 T_C = 25 °C unless otherwise specified.

Table 3. Static

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V _{(BR)CES}	Collector-emitter breakdown voltage	$V_{GE} = 0 \text{ V}, I_{C} = 2 \text{ mA}$	600			V
		V _{GE} = 15 V, I _C = 5 A		1.5	1.95	
V _{CE(sat)}	Collector-emitter saturation voltage	V _{GE} = 15 V, I _C = 5 A, T _J = 125 °C		1.6		V
		V _{GE} = 15 V, I _C = 5 A, T _J = 175 °C		1.7		
V _{GE(th)}	Gate threshold voltage	$V_{CE} = V_{GE}, I_{C} = 250 \mu A$	4.8	6.2	6.9	V
I _{CES}	Collector cut-off current	V _{CE} = 600 V , V _{GE} = 0 V			25	μΑ
I _{GES}	Gate-emitter leakage current	V _{GE} = ±20 V , V _{CE} = 0 V			±250	nA

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit		
C _{ies}	Input capacitance	V _{CE} = 25 V, f = 1 MHz, V _{GE} = 0 V				855		
C _{oes}	Output capacitance			34	-	pF		
C _{res}	Reverse transfer capacitance			19				
Qg	Total gate charge	V_{CC} = 480 V, I_{C} = 5 A, V_{GE} = 0 to 15 V (see Figure 35. Gate charge test circuit)		V 400 V 1 5 4 V 0 4 5 V	38			
Q _{ge}	Gate-emitter charge			6.5	-	nC		
Q _{gc}	Gate-collector charge			17.5				

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Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t _{d(on)}	Turn-on delay time	V _{CE} = 400 V, I _C = 5 A,		30		
t _r	Current rise time	R _G = 47 Ω, V _{GE} = 15 V		10.8		ns
(di/dt)on	Turn-on current slope	(see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)		370		A/µs
t _{d(on)}	Turn-on delay time	V _{CE} = 400 V, I _C = 5 A,	-	28	-	
t _r	Current rise time	R_G = 47 Ω , V_{GE} = 15 V, T_J = 175 °C		11		ns
(di/dt)on	Turn-on current slope	(see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)		363	_	A/µs
$t_{r(Voff)}$	Off voltage rise time	V 400 V I 5 A		29		
t _{d(off)}	Turn-off delay time	$V_{CE} = 400 \text{ V}, I_{C} = 5 \text{ A},$ $R_{G} = 47 \Omega, V_{GE} = 15 \text{ V}$		140		
t _f	Current fall time	RG - 47 Ω, VGE - 15 V		95		
$t_{r(Voff)}$	Off voltage rise time		-	44	-	ns
t _{d(off)}	Turn-off delay time	$V_{CE} = 400 \text{ V}, I_{C} = 5 \text{ A},$ $R_{G} = 47 \Omega, V_{GE} = 15 \text{ V}, T_{J} = 175 ^{\circ}\text{C}$		146		
t _f	Current fall time	$RG - 47 \Omega$, $VGE = 15 V$, $IJ = 175 C$		134		
t _{sc}	Short-circuit withstand time	$V_{CC} \le 360 \text{ V}, V_{GE} = 15 \text{ V}, R_G = 47 \Omega$	-	5	-	μs

Table 6. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
E _{on} ⁽¹⁾	Turn-on switching energy	V = 400 V I = 5 A		56		
E _{off} (2)	Turn-off switching energy	$V_{CE} = 400 \text{ V}, I_{C} = 5 \text{ A},$ $R_{G} = 47 \Omega, V_{GF} = 15 \text{ V}$		78.5		
E _{ts}	Total switching energy	RG - 47 Ω, VGE - 15 V		134.5		1
E _{on} ⁽¹⁾	Turn-on switching energy	V - 400 V I - 5 A	-	87	-	μJ
E _{off} ⁽²⁾	Turn-off switching energy	$V_{CE} = 400 \text{ V}, I_{C} = 5 \text{ A},$ $R_{G} = 47 \Omega, V_{GE} = 15 \text{ V}, T_{J} = 175 ^{\circ}\text{C}$	134	134		
E _{ts}	Total switching energy	11. G -7. 12, VGE 10 V, 1J - 170 0		221		

^{1.} Including the reverse recovery of the diode.

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^{2.} Including the tail of the collector current.



Table 7. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V _F	Forward on-voltage	I _F = 5 A		2.1		V
V F	Forward on-voitage	I _F = 5 A, T _J = 175 °C	_	1.65	-	"
t _{rr}	Reverse recovery time	V = 400 V/L = 5 A		134.5		ns
Q _{rr}	Reverse recovery charge	V _{CC} = 400 V; I _F = 5 A; di _F /dt = 100 A / μs		48		nC
I _{rrm}	Reverse recovery current			1.38		Α
t _{rr}	Reverse recovery time	V_{CC} = 400 V; I _F = 5 A; di _F /dt = 100 A / μ s, T _J = 175 °C		157	-	ns
Q _{rr}	Reverse recovery charge			165		nC
I _{rrm}	Reverse recovery current			2.4		Α

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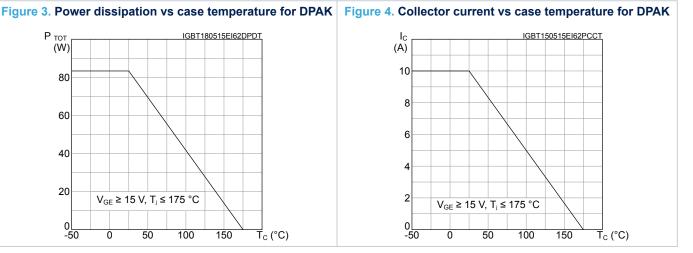


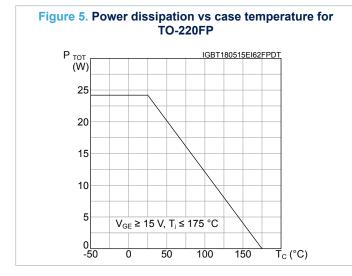
2.1 **Electrical characteristics (curves)**

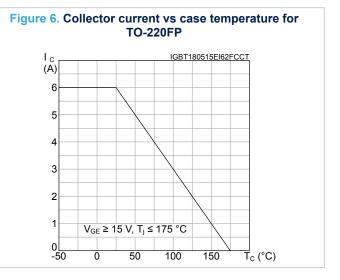
Figure 1. Power dissipation vs case temperature for D²PAK and TO-220 P_{TOT} (W) IGBT150515EI62PPDT 80 60 40 20 V_{GE} ≥ 15 V, T_i ≤ 175 °C 0 -50 T_C (°C) 50 100 150

Figure 2. Collector current vs case temperature for D²PAK, DPAK and TO-220 I_C (A) IGBT150515EI62PCCT 10 8 6 V_{GE} ≥ 15 V, T_j ≤ 175 °C 0 -50 T_C (°C) 50 100 150

P_{TOT} (W) IGBT180515EI62DPDT 80 60 40 20 $V_{GE} \ge 15 \text{ V}, T_{j} \le 175 \text{ }^{\circ}\text{C}$ 0 -50 100 150 T_C (°C)







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Figure 7. Output characteristics $(T_J = 25^{\circ}C)$

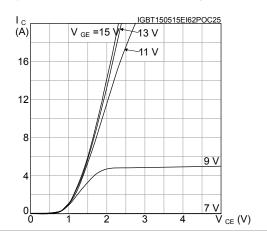


Figure 8. Output characteristics (T_J = 175°C)

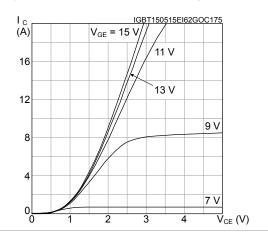


Figure 9. V_{CE(sat)} vs junction temperature

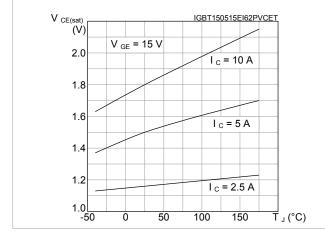


Figure 10. V_{CE(sat)} vs collector current

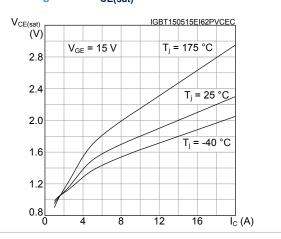


Figure 11. Collector current vs switching frequency for D²PAK, DPAK and TO-220

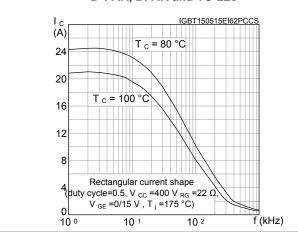
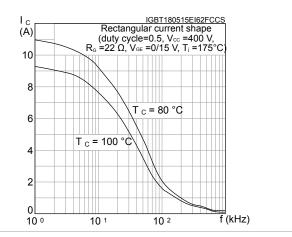


Figure 12. Collector current vs switching frequency for TO-220FP



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Figure 13. Forward bias safe operating area for D²PAK, DPAK and TO-220

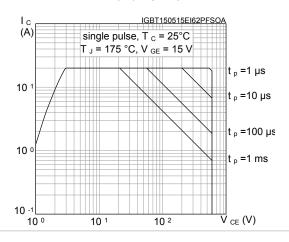


Figure 14. Forward bias safe operating area for TO-220FP

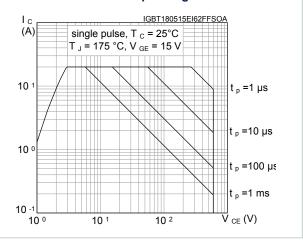


Figure 15. Transfer characteristics

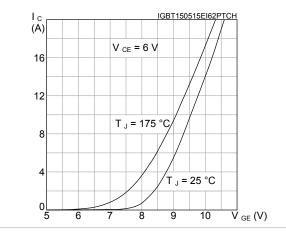


Figure 16. Diode V_F vs forward current

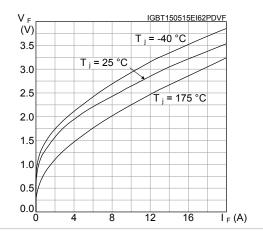


Figure 17. Normalized V_{GE(th)} vs junction temperature

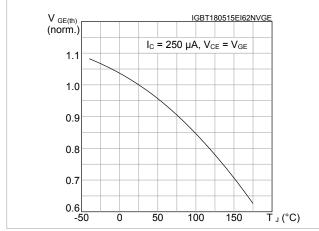
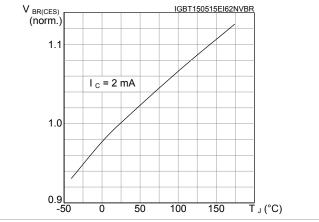


Figure 18. Normalized V_{(BR)CES} vs junction temperature



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10 0

0.00

10 -1

Figure 19. Capacitance variation

C (pF)

10 3

C (es)

10 1

f = 1 MHz

C res

10 ¹

10 0

10 ²

∇ _{CE} (V)

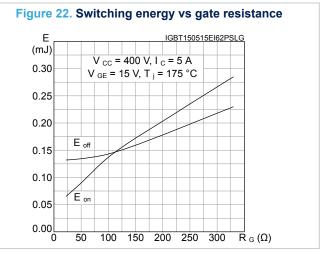
Figure 20. Gate charge vs. gate-emitter voltage V_{GE} (V) GADG280220201428GCGE V_{CC} = 480 V, I_C = 5 A, I_G = 1 mA 15 12 9 6 3 0 Q_g (nC) 8 16 24 32 40

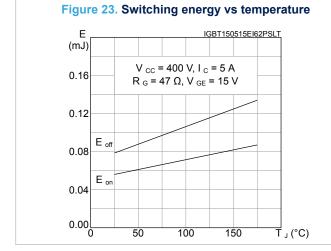
6

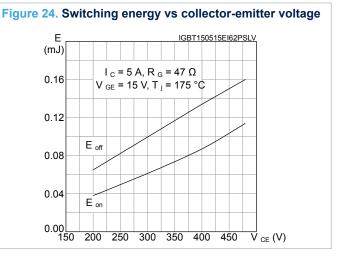
8

10

I_C (A)







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Figure 25. Short circuit time and current vs V_{GE}

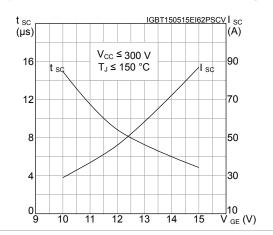


Figure 26. Switching times vs collector current

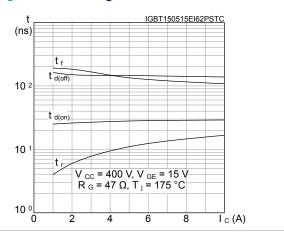


Figure 27. Switching times vs gate resistance

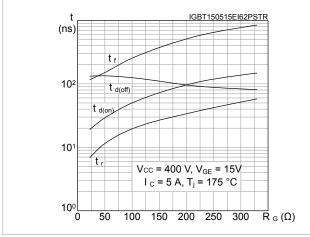


Figure 28. Reverse recovery current vs diode current slope

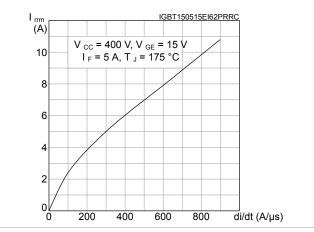


Figure 29. Reverse recovery time vs diode current slope

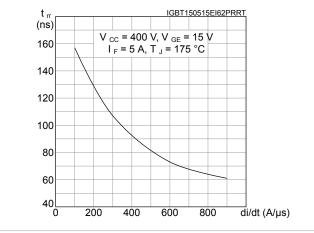
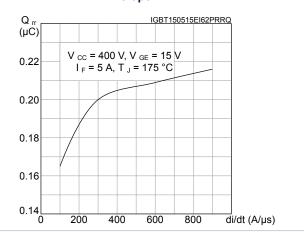
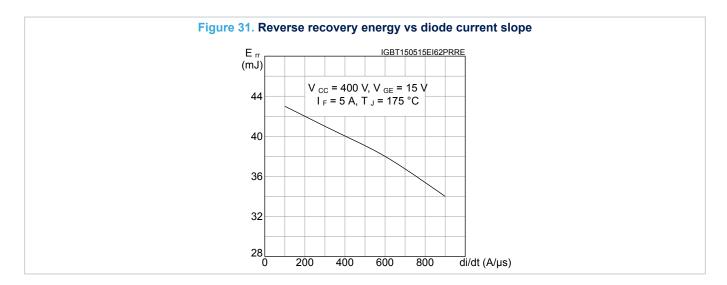


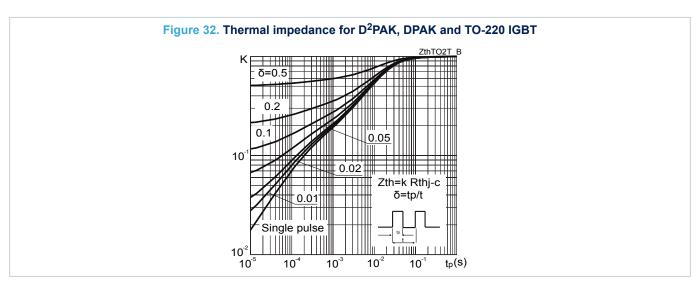
Figure 30. Reverse recovery charge vs diode current slope

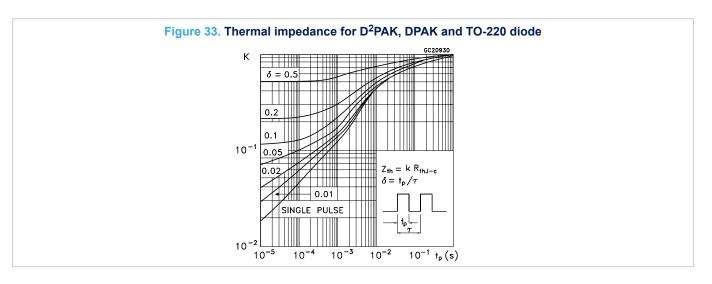


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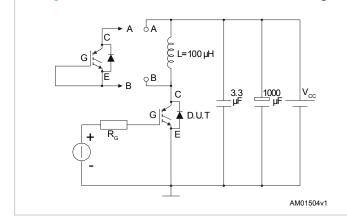


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3 Test circuits

Figure 34. Test circuit for inductive load switching



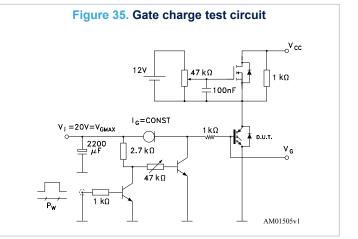


Figure 36. Switching waveform

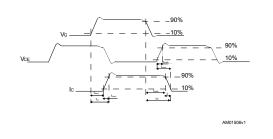


Figure 37. Diode reverse recovery waveform

di/dt

t_r

Q_r

RRM
25 %

AM01507v1

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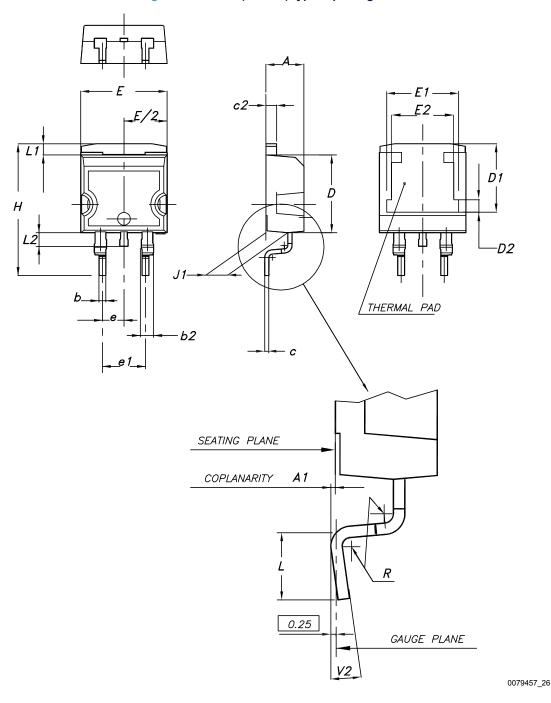


4 Package information

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 38. D²PAK (TO-263) type A package outline



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Table 8. D²PAK (TO-263) type A package mechanical data

Dim.	mm					
Dim.	Min.	Тур.	Max.			
Α	4.40		4.60			
A1	0.03		0.23			
b	0.70		0.93			
b2	1.14		1.70			
С	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			
е		2.54				
e1	4.88		5.28			
Н	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°			

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Figure 39. D²PAK (TO-263) recommended footprint (dimensions are in mm)

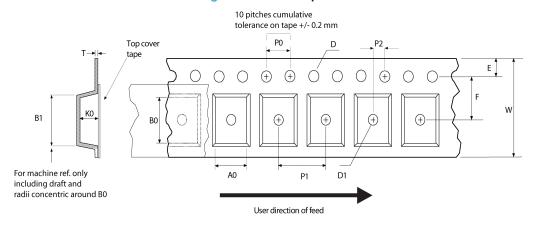
Footprint_26

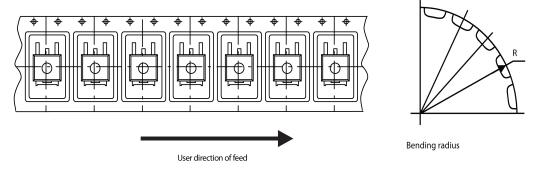
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4.2 D²PAK packing information

Figure 40. D²PAK tape outline



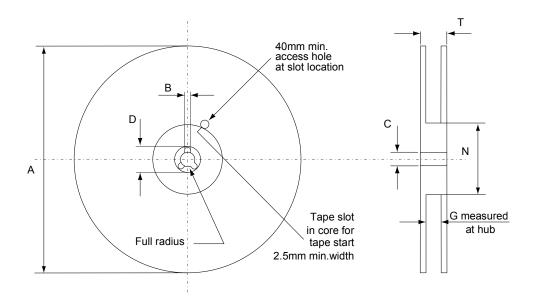


AM08852v1

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Figure 41. D²PAK reel outline



AM06038v1

Table 9. D²PAK tape and reel mechanical data

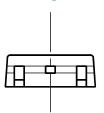
Таре			Reel			
Dim.	mm		Dim.	mr	n	
Dilli.	Min.	Max.	Dilli.	Min.	Max.	
A0	10.5	10.7	А		330	
В0	15.7	15.9	В	1.5		
D	1.5	1.6	С	12.8	13.2	
D1	1.59	1.61	D	20.2		
E	1.65	1.85	G	24.4	26.4	
F	11.4	11.6	N	100		
K0	4.8	5.0	Т		30.4	
P0	3.9	4.1				
P1	11.9	12.1	Base q	uantity	1000	
P2	1.9	2.1	Bulk quantity		1000	
R	50					
Т	0.25	0.35				
W	23.7	24.3				

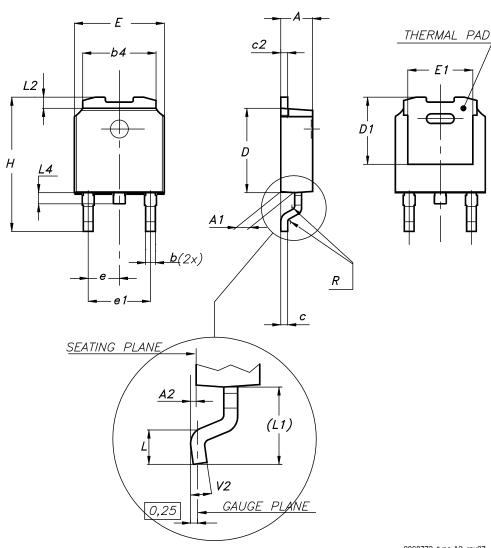
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4.3 DPAK (TO-252) type A2 package information

Figure 42. DPAK (TO-252) type A2 package outline





0068772_type-A2_rev27

Table 10. DPAK (TO-252) type A2 mechanical data

Dim.	mm			
Dilli.	Min.	Тур.	Max.	
А	2.20		2.40	
A1	0.90		1.10	

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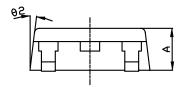
Dim	mm				
Dim.	Min.	Тур.	Max.		
A2	0.03		0.23		
b	0.64		0.90		
b4	5.20		5.40		
С	0.45		0.60		
c2	0.48		0.60		
D	6.00		6.20		
D1	4.95	5.10	5.25		
Е	6.40		6.60		
E1	5.10	5.20	5.30		
е	2.159	2.286	2.413		
e1	4.445	4.572	4.699		
Н	9.35		10.10		
L	1.00		1.50		
L1	2.60	2.80	3.00		
L2	0.65	0.80	0.95		
L4	0.60		1.00		
R		0.20			
V2	0°		8°		

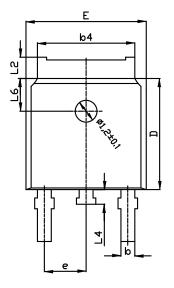
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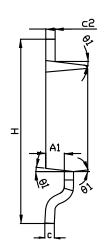


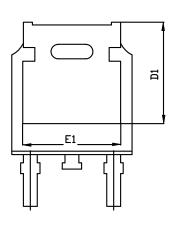
4.4 DPAK (TO-252) type C2 package information

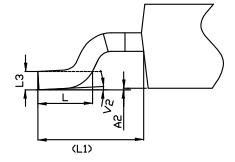
Figure 43. DPAK (TO-252) type C2 package outline











0068772_C2_25

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Table 11. DPAK (TO-252) type C2 mechanical data

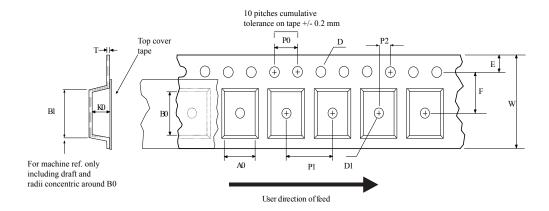
Dim.	mm			
	Min.	Тур.	Max.	
Α	2.20	2.30	2.38	
A1	0.90	1.01	1.10	
A2	0.00		0.10	
b	0.72		0.85	
b4	5.13	5.33	5.46	
С	0.47		0.60	
c2	0.47		0.60	
D	6.00	6.10	6.20	
D1	5.10		5.60	
E	6.50	6.60	6.70	
E1	5.20		5.50	
е	2.186	2.286	2.386	
Н	9.80	10.10	10.40	
L	1.40	1.50	1.70	
L1	2.90 REF			
L2	0.90		1.25	
L3	0.51 BSC			
L4	0.60	0.80	1.00	
L6	1.80 BSC			
θ1	5°	7°	9°	
θ2	5°	7°	9°	
V2	0°		8°	

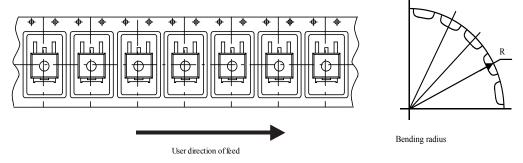
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4.5 DPAK (TO-252) packing information

Figure 44. DPAK (TO-252) tape outline



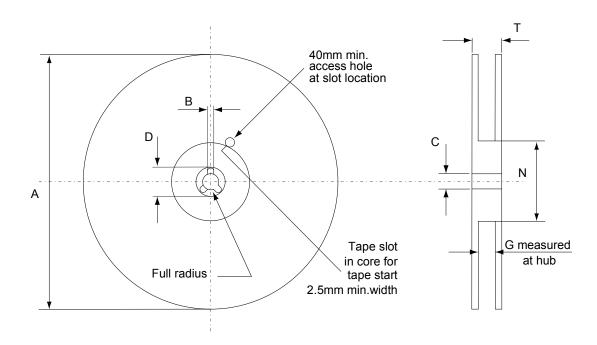


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Figure 45. DPAK (TO-252) reel outline



AM06038v1

Table 12. DPAK (TO-252) tape and reel mechanical data

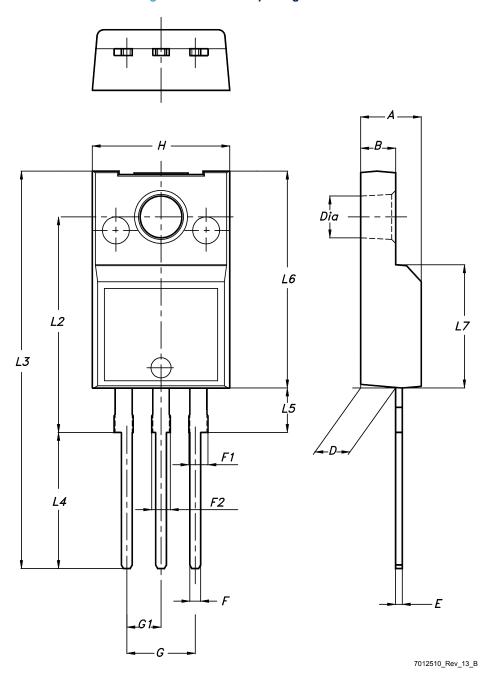
Таре		Reel				
Dim.	mm		D	1	mm	
	Min.	Max.	Dim.	Min.	Max.	
A0	6.8	7	А		330	
В0	10.4	10.6	В	1.5		
B1		12.1	С	12.8	13.2	
D	1.5	1.6	D	20.2		
D1	1.5		G	16.4	18.4	
Е	1.65	1.85	N	50		
F	7.4	7.6	Т		22.4	
K0	2.55	2.75				
P0	3.9	4.1	Base qty.		2500	
P1	7.9	8.1	Bulk qty.		2500	
P2	1.9	2.1				
R	40					
Т	0.25	0.35				
W	15.7	16.3				

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4.6 TO-220FP package information

Figure 46. TO-220FP package outline



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Table 13. TO-220FP package mechanical data

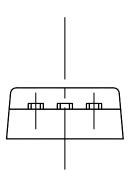
Dim.	mm			
Dim.	Min.	Тур.	Max.	
Α	4.40		4.60	
В	2.50		2.70	
D	2.50		2.75	
E	0.45		0.70	
F	0.75		1.00	
F1	1.15		1.70	
F2	1.15		1.70	
G	4.95		5.20	
G1	2.40		2.70	
Н	10.00		10.40	
L2		16.00		
L3	28.60		30.60	
L4	9.80		10.60	
L5	2.90		3.60	
L6	15.90		16.40	
L7	9.00		9.30	
Dia	3.00		3.20	

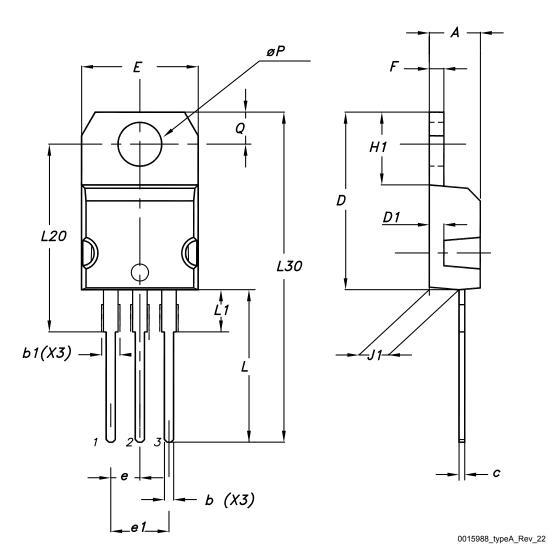
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4.7 TO-220 type A package information

Figure 47. TO-220 type A package outline





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Table 14. TO-220 type A package mechanical data

Dim.	mm		
	Min.	Тур.	Max.
Α	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
С	0.48		0.70
D	15.25		15.75
D1		1.27	
Е	10.00		10.40
е	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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øΡ	3.75		3.85
Q	2.65		2.95

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5 Ordering information

Table 15. Order codes

Order code	Marking	Package	Packing	
STGB5H60DF	GB5H60DF	D ² PAK	Tape and reel	
STGD5H60DF	GD5H60DF	DPAK		
STGF5H60DF	GF5H60DF	TO-220FP	Tube	
STGP5H60DF	GP5H60DF	TO-220	Tube	

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Revision history

Table 16. Document revision history

Date	Version	Changes
28-Nov-2014	1	Initial release.
23-Feb-2015	2	Updated Section 2: Electrical characteristics and Section 4: Package information.
		Minor text changes.
	3	Text and formatting changes throughout document
		In Section 1: Electrical ratings:
		- updated Table 2 and Table 3
18-May-2015		In Section 2: Electrical characteristics:
10-Iviay-2013		- updated Table 4, Table 5, Table 6, Table 7 and Table 8
		Added Section 2.1: Electrical characteristics (curves)
		Updated Section 4.2: DPAK package information
		Document status promoted from "preliminary data" to "production data"
	18 4	Removed maturity status indication from cover page.
18-Sep-2018		Updated Section 4 Package information.
		Minor text changes.
02-Mar-2020)20 5	Updated Table 4. Dynamic.
		Updated Figure 20. Gate charge vs. gate-emitter voltage.
		Minor text changes.

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