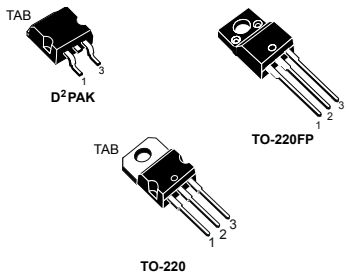
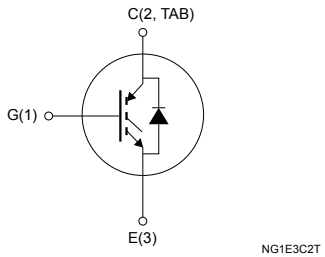
STGB15H60DF, STGF15H60DF, STGP15H60DF

Datasheet

Trench gate field-stop IGBT, H series 600 V, 14 A high speed





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

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
STGB15H60DF
STGF15H60DF
STGP15H60DF

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D^2PAK, TO-220	TO-220FP	
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	600		V
I_C	Continuous collector current at T_C = 25 °C	30	30 (1)	A
	Continuous collector current at T_C = 100 °C	15	15 (1)	
I_{CP} (2)	Pulsed collector current	60	60	A
V_{GE}	Gate-emitter voltage	±20		V
I_F	Continuous forward current T_C = 25 °C	30	30 (1)	A
	Continuous forward current at T_C = 100 °C	15	15 (1)	
I_{FP} (2)	Pulsed forward current	60	60	A
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	115	30	W
T_{STG}	Storage temperature range	-55 to 150		°C
T_J	Operating junction temperature range	-55 to 175		

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by maximum junction temperature.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		D^2PAK, TO-220	TO-220FP	
R_{thJC}	Thermal resistance junction-case IGBT	1.3	5	°C/W
R_{thJC}	Thermal resistance junction-case diode	2.78	6.25	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5	62.5	°C/W

2 Electrical characteristics

T_C = 25 °C unless otherwise specified.

Table 3. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_C = 2 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 15 A		1.6	2.0	V
		V_{GE} = 15 V, I_C = 15 A T_J = 125 °C		1.7		
		V_{GE} = 15 V, I_C = 15 A T_J = 175 °C		1.8		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5.0	6.0	7.0	V
I_{CES}	Collector cut-off current	V_{CE} = 600 V V_{GE} = 0 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{GE} = ±20 V V_{CE} = 0 V			±250	nA

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	1952	-	pF
C_{oes}	Output capacitance			78		
C_{res}	Reverse transfer capacitance			45		
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 15 A, V_{GE} = 0 to 15 V (see Figure 33. Gate charge test circuit)	-	81	-	nC
Q_{ge}	Gate-emitter charge			8		
Q_{gc}	Gate-collector charge			42		

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 15 A, R_G = 10 Ω, V_{GE} = 15 V (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		24.5	-	ns
t_r	Current rise time			8.2		
(di/dt)on	Turn-on current slope			1470		A/µs
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 15 A, R_G = 10 Ω, V_{GE} = 15 V T_J = 175 °C (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		25		ns
t_r	Current rise time			9		
(di/dt)on	Turn-on current slope			1370		A/µs

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{r(Voff)}$	Off voltage rise time	V_{CE} = 400 V, I_C = 15 A,		18		
$t_{d(off)}$	Turn-off delay time	R_G = 10 Ω, V_{GE} = 15 V (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		118		
t_f	Current fall time			69		
$t_{r(Voff)}$	Off voltage rise time	V_{CE} = 400 V, I_C = 15 A,		27	-	ns
$t_{d(off)}$	Turn-off delay time	R_G = 10 Ω, V_{GE} = 15 V		124		
t_f	Current fall time	T_J = 175 °C (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		101		
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 360 V, V_{GE} = 15 V, R_G = 10 Ω	3	5	-	µs

Table 6. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{on} (1)	Turn-on switching energy	V_{CE} = 400 V, I_C = 15 A,		136		
E_{off} (2)	Turn-off switching energy	R_G = 10 Ω, V_{GE} = 15 V (see Figure 32. Test circuit for inductive load switching)		207		
E_{ts}	Total switching energy			343		
E_{on} (1)	Turn-on switching energy	V_{CE} = 400 V, I_C = 15 A,	-	224	-	µJ
E_{off} (2)	Turn-off switching energy	R_G = 10 Ω, V_{GE} = 15 V		329		
E_{ts}	Total switching energy	T_J = 175 °C (see Figure 32. Test circuit for inductive load switching)		553		

1. *Including the reverse recovery of the diode.*
2. *Including the tail of the collector current.*

Table 7. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	I_F = 15 A	-	1.8	2.2	V
		I_F = 15 A, T_J = 175 °C		1.3		
t_{rr}	Reverse recovery time	Vr = 60 V; I_F = 15 A;		103		ns
Q_{rr}	Reverse recovery charge	di_F/dt = 100 A / µs (see Figure 35. Diode reverse recovery waveform)		128		nC
I_{rrm}	Reverse recovery current			2.5		A
t_{rr}	Reverse recovery time	V_r = 60 V; I_F = 15 A;	-	182		ns
Q_{rr}	Reverse recovery charge	di_F/dt = 100 A / µs		437		nC
I_{rrm}	Reverse recovery current	T_J = 175 °C (see Figure 35. Diode reverse recovery waveform)		4.8		A

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature for D²PAK and TO-220

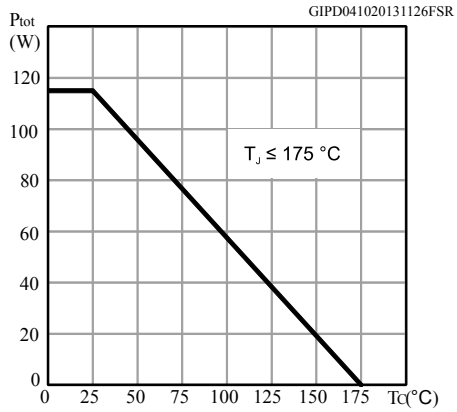


Figure 2. Collector current vs case temperature for D²PAK and TO-220

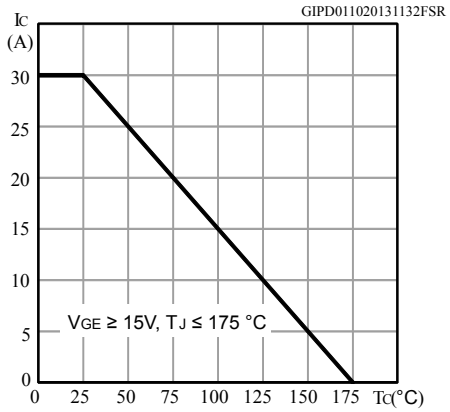


Figure 3. Power dissipation vs case temperature for TO-220FP

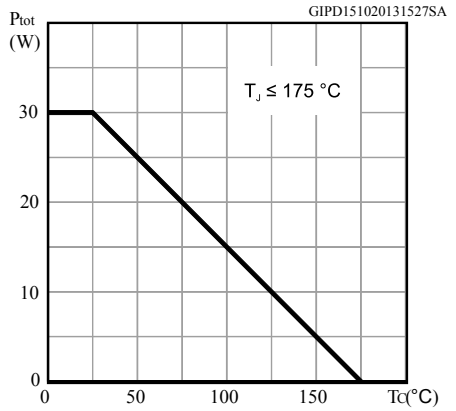


Figure 4. Collector current vs case temperature for TO-220FP

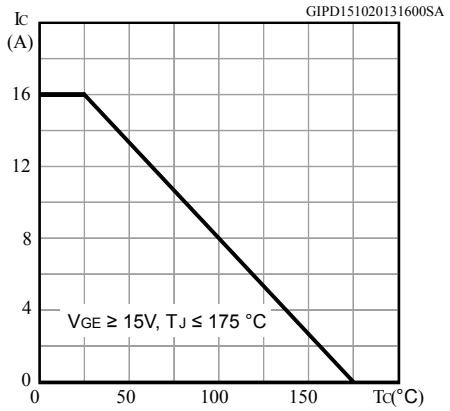


Figure 5. Output characteristics (T_J = 25°C)

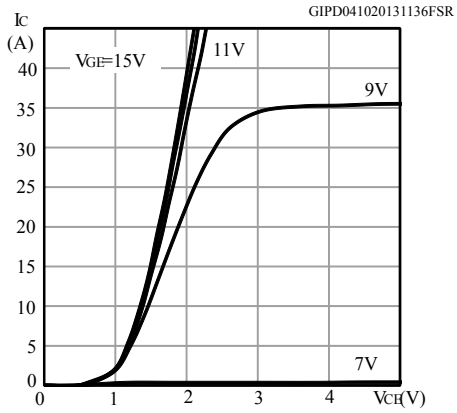


Figure 6. Output characteristics (T_J = 175°C)

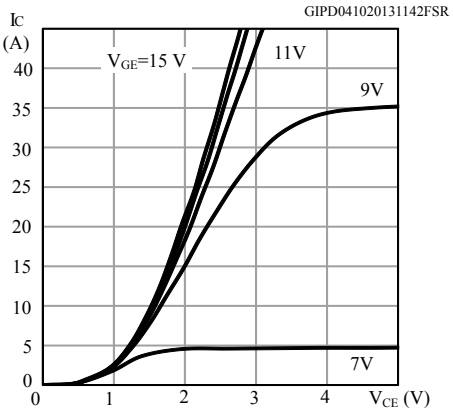


Figure 7. $V_{CE(sat)}$ vs junction temperature

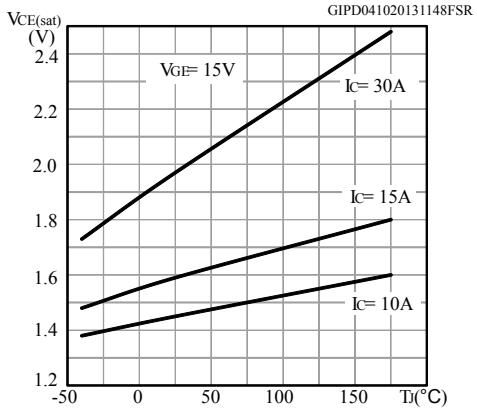


Figure 8. $V_{CE(sat)}$ vs collector current

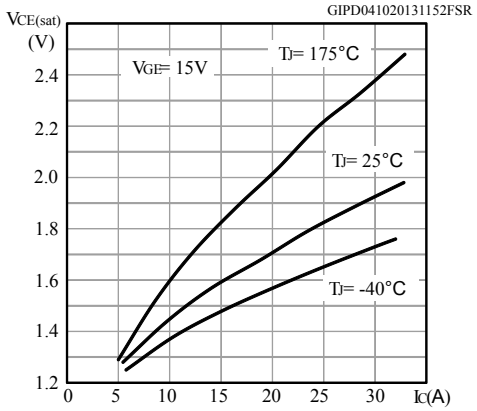


Figure 9. Collector current vs switching frequency for D²PAK and TO-220

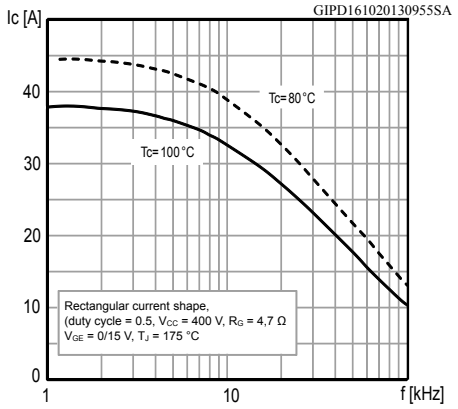


Figure 10. Collector current vs switching frequency for TO-220FP

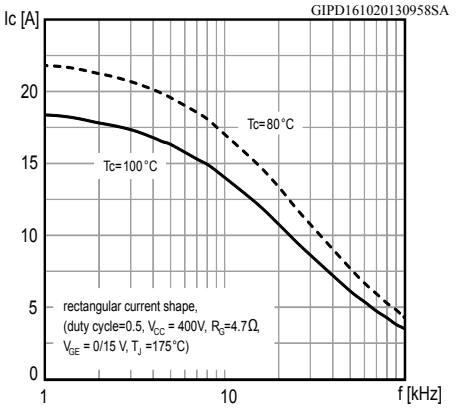


Figure 11. Forward bias safe operating area for D²PAK and TO-220

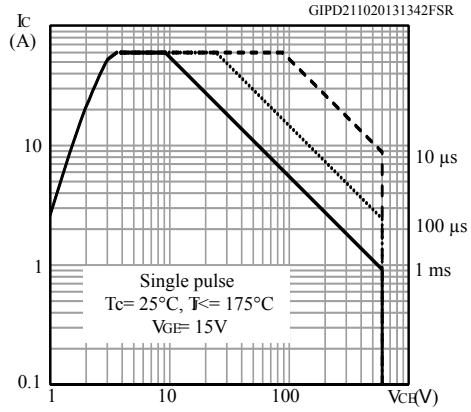


Figure 12. Forward bias safe operating area for TO-220FP

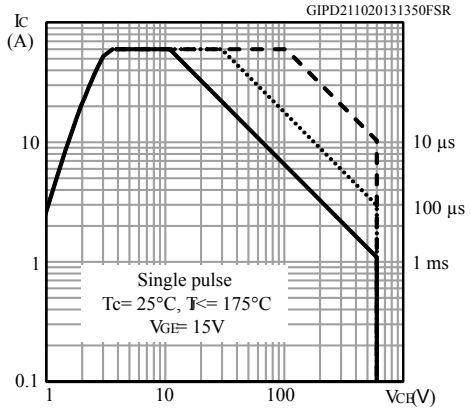


Figure 13. Transfer characteristics

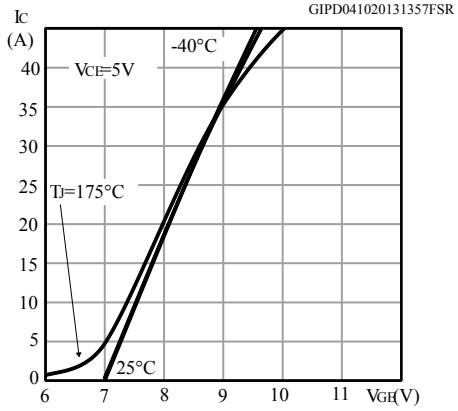


Figure 14. Diode V_F vs forward current

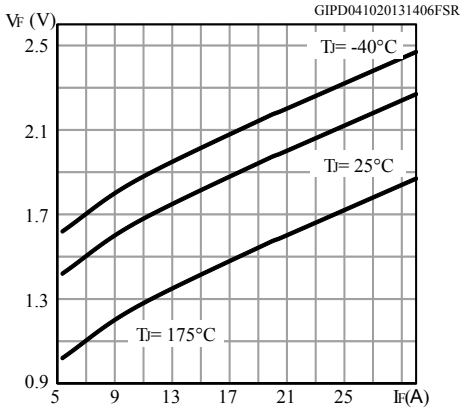


Figure 15. Normalized $V_{GE(th)}$ vs junction temperature

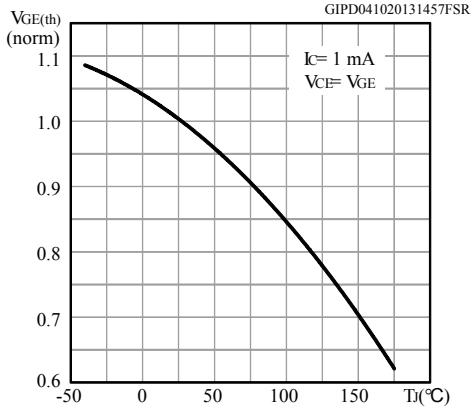


Figure 16. Normalized $V_{(BR)CES}$ vs junction temperature

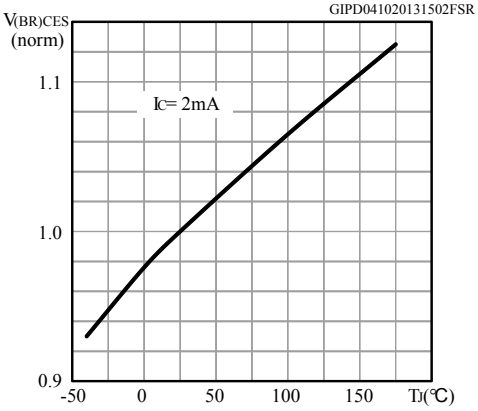


Figure 17. Capacitance variation

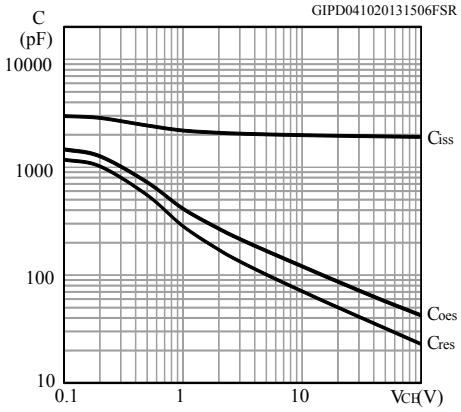


Figure 18. Gate charge vs gate-emitter voltage

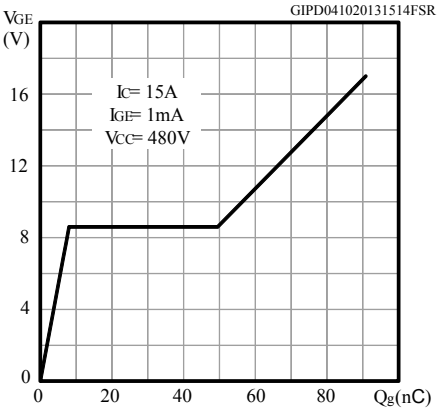


Figure 19. Switching evergy vs collector current

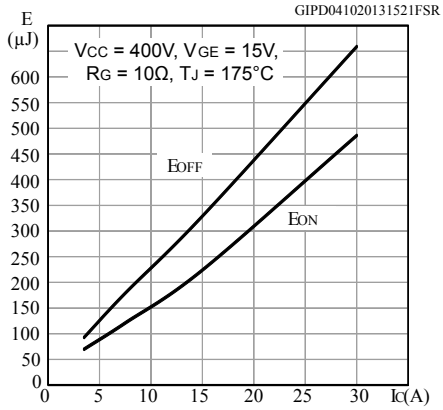


Figure 20. Switching energy vs gate resistance

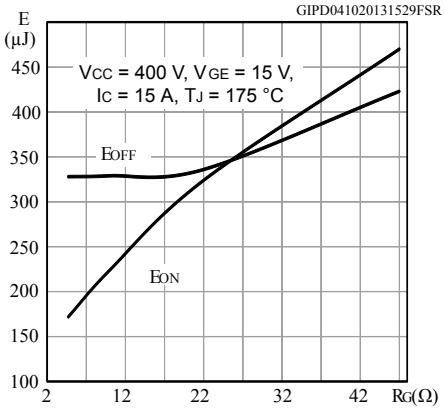


Figure 21. Switching energy vs temperature

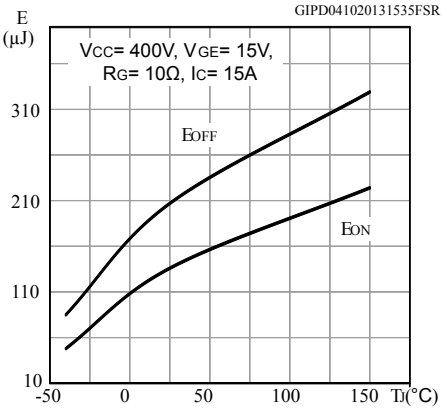


Figure 22. Switching energy vs collector-emitter voltage

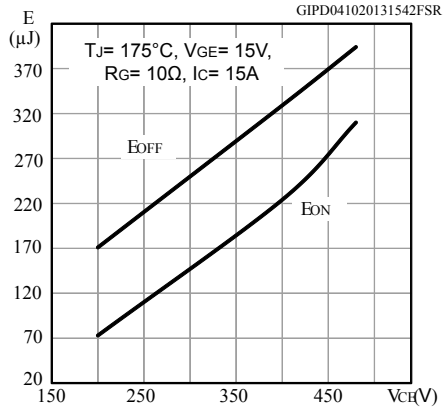


Figure 23. Short-circuit time and current vs V_{GE}

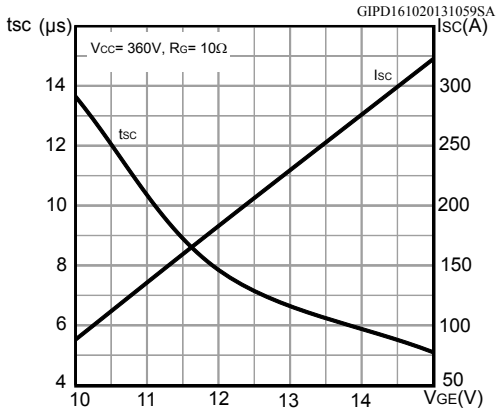


Figure 24. Switching times vs collector current

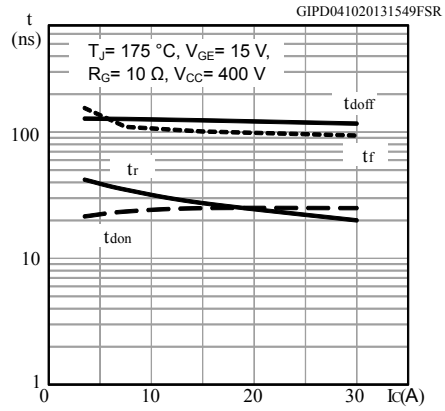


Figure 25. Switching times vs gate resistance

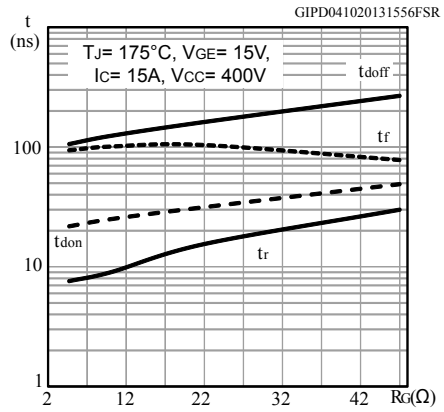


Figure 26. Reverse recovery current vs diode current slope

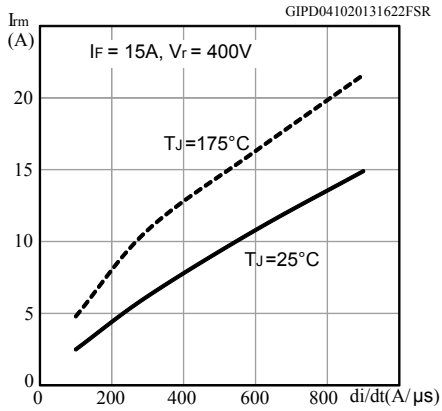


Figure 27. Reverse recovery time vs diode current slope

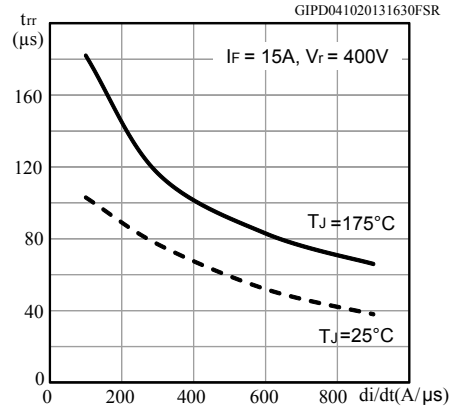


Figure 28. Reverse recovery charge vs diode current slope

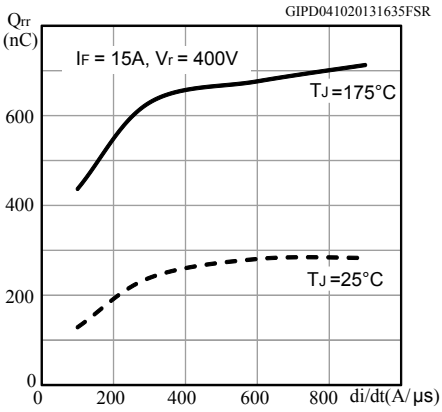


Figure 29. Reverse recovery energy vs diode current slope

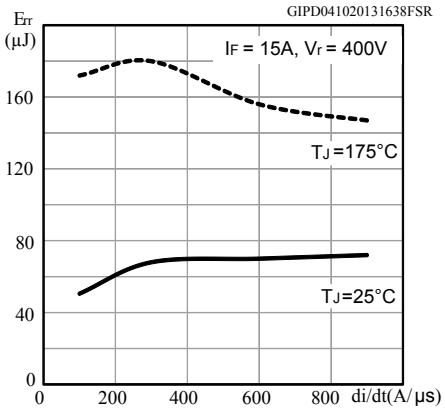


Figure 30. Thermal impedance for IGBT

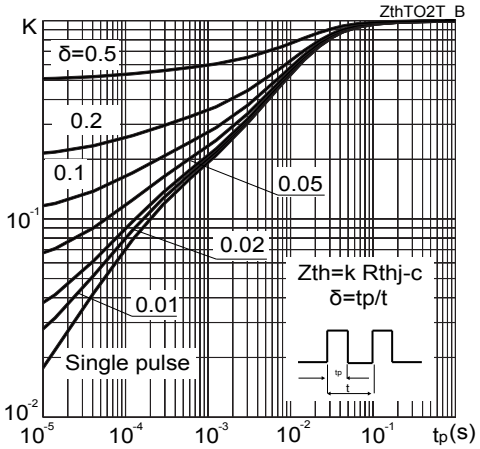
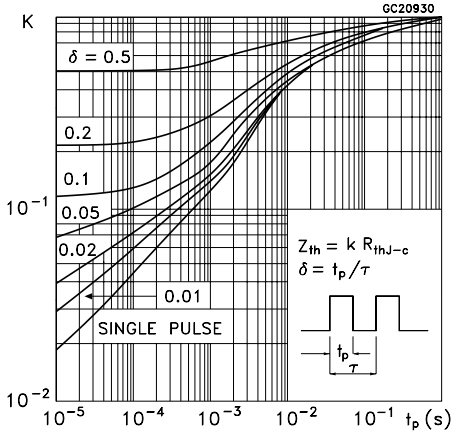


Figure 31. Thermal impedance for diode



3 Test circuits

Figure 32. Test circuit for inductive load switching

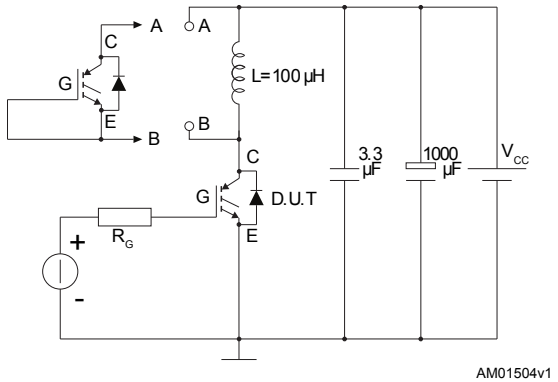


Figure 33. Gate charge test circuit

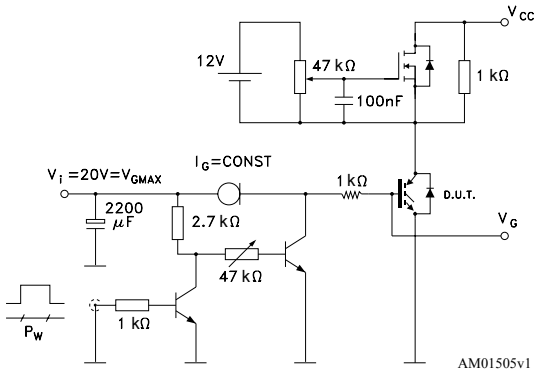


Figure 34. Switching waveform

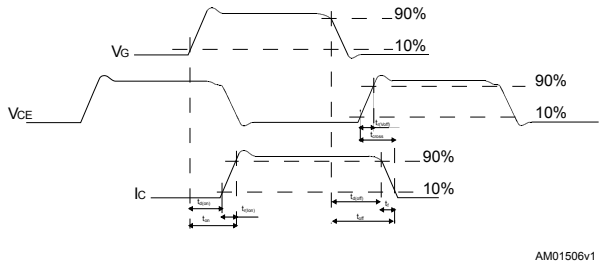
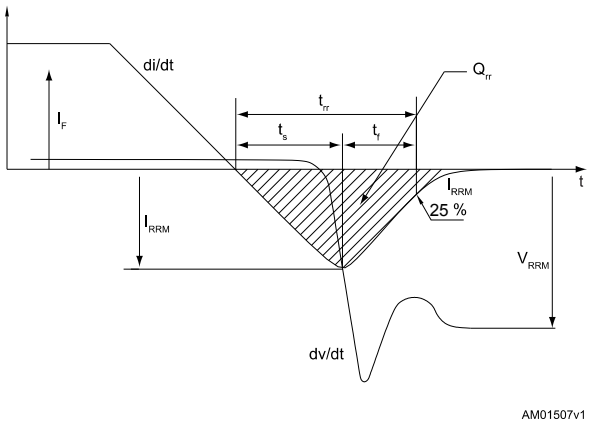


Figure 35. Diode reverse recovery waveform



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 A2 package information

Figure 36. D²PAK (TO-263) type A2 package outline

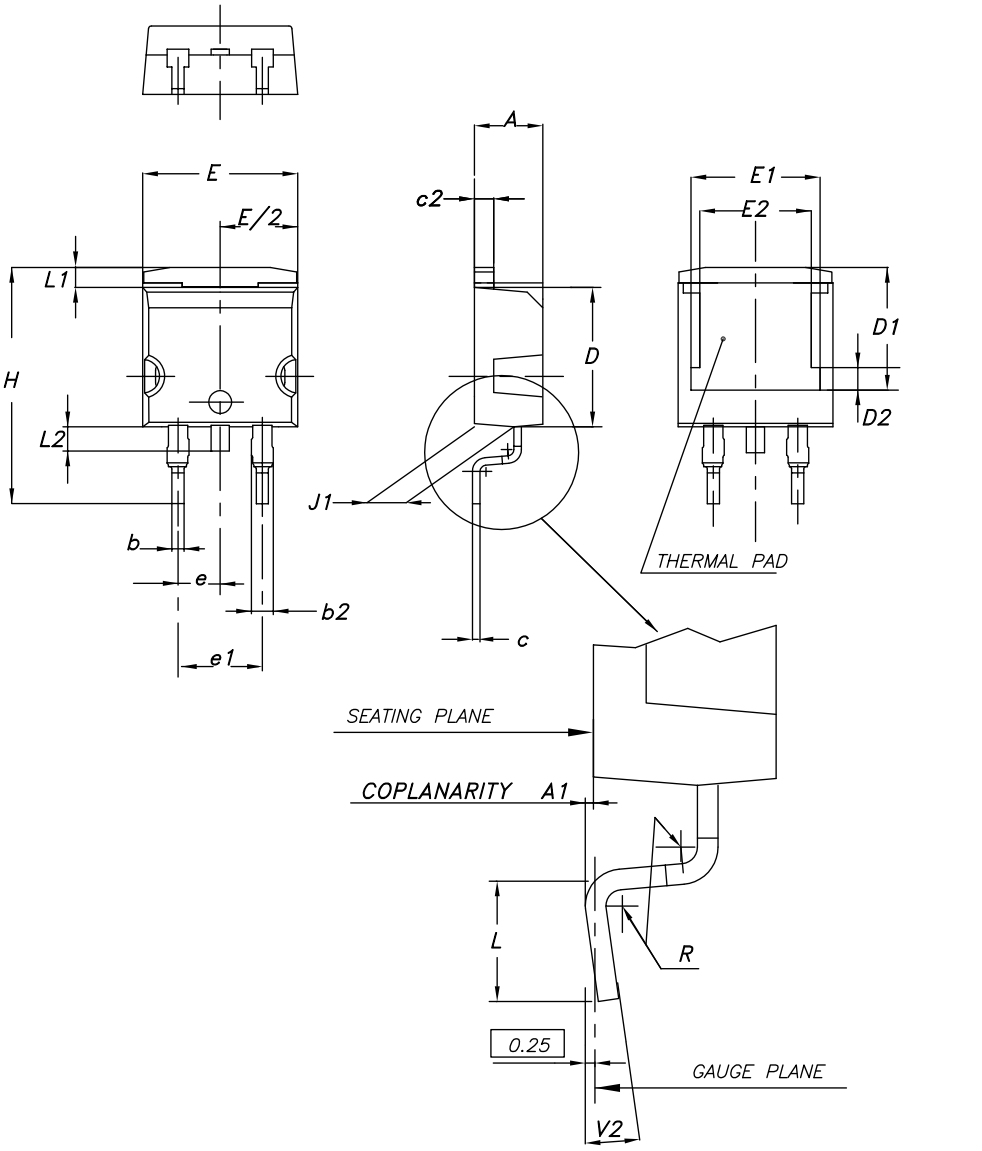
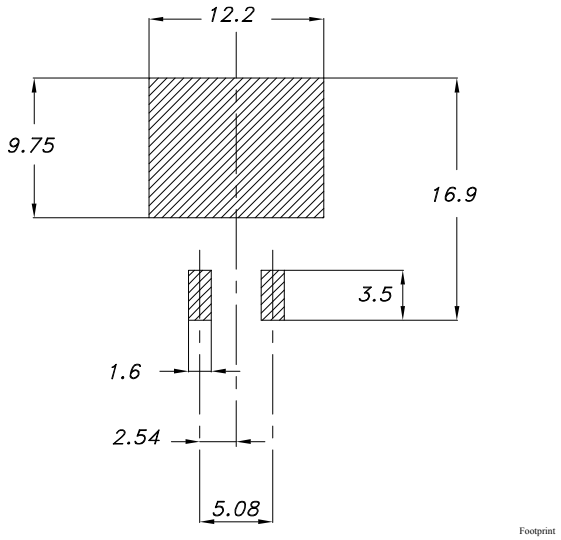


Table 8. **D²PAK (TO-263) type A2 package mechanical data**

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	8.70	8.90	9.10
E2	7.30	7.50	7.70
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 37. **D²PAK (TO-263) recommended footprint (dimensions are in mm)**



4.2 D²PAK packing information

Figure 38. **D²PAK tape outline**

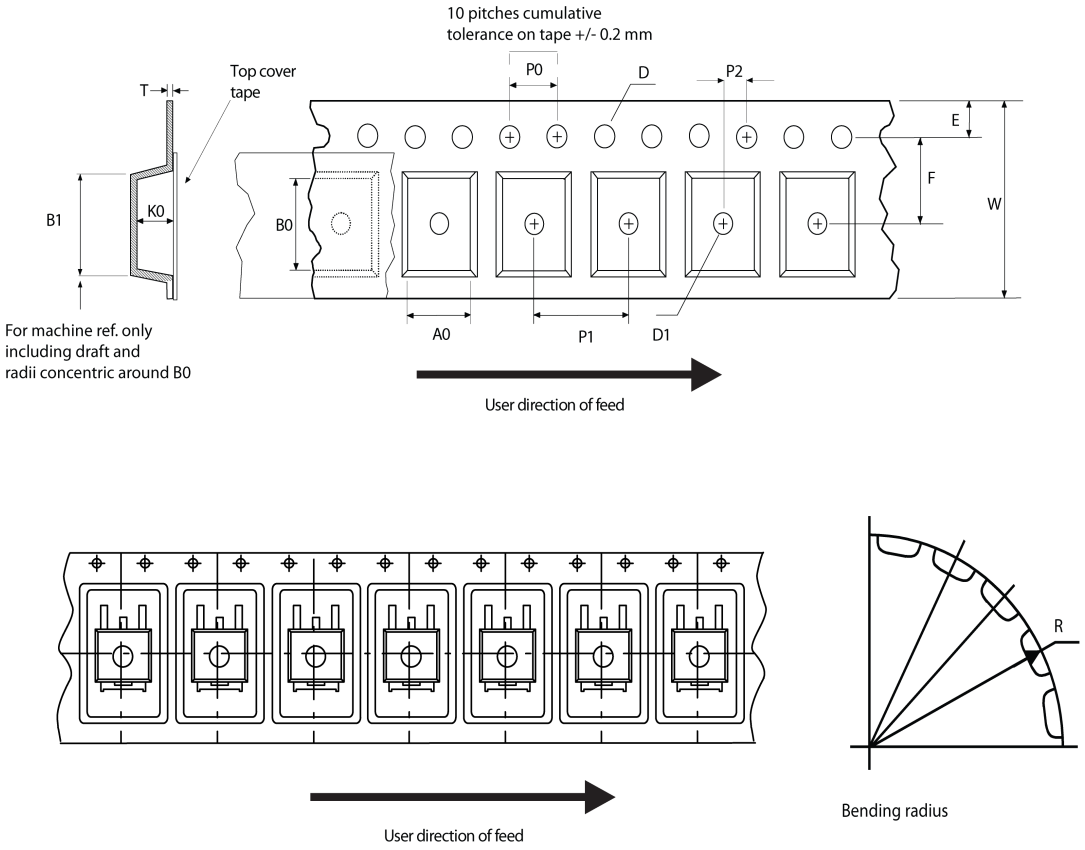


Figure 39. **D²PAK reel outline**

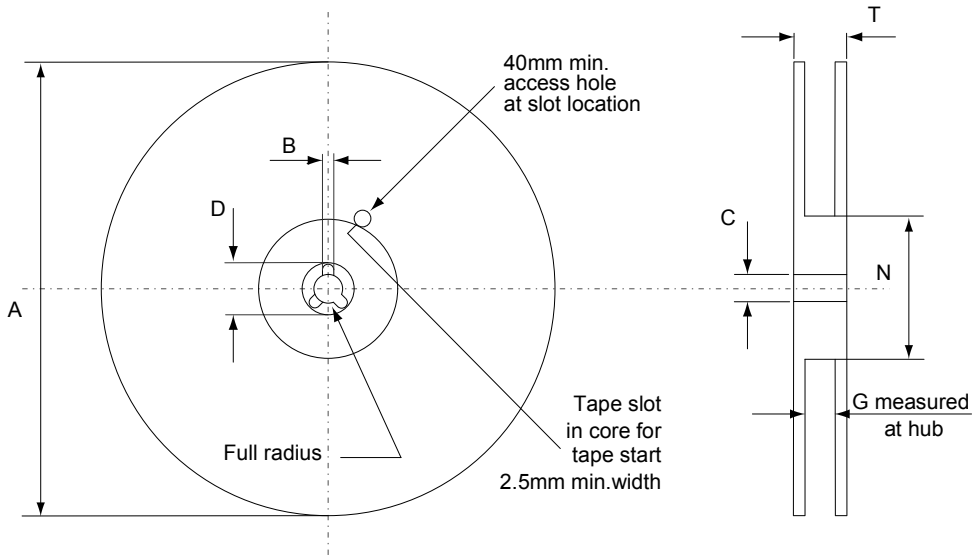


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Table 9. **D²PAK tape and reel mechanical data**

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			
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			

4.3 TO-220FP package information

Figure 40. **TO-220FP package outline**

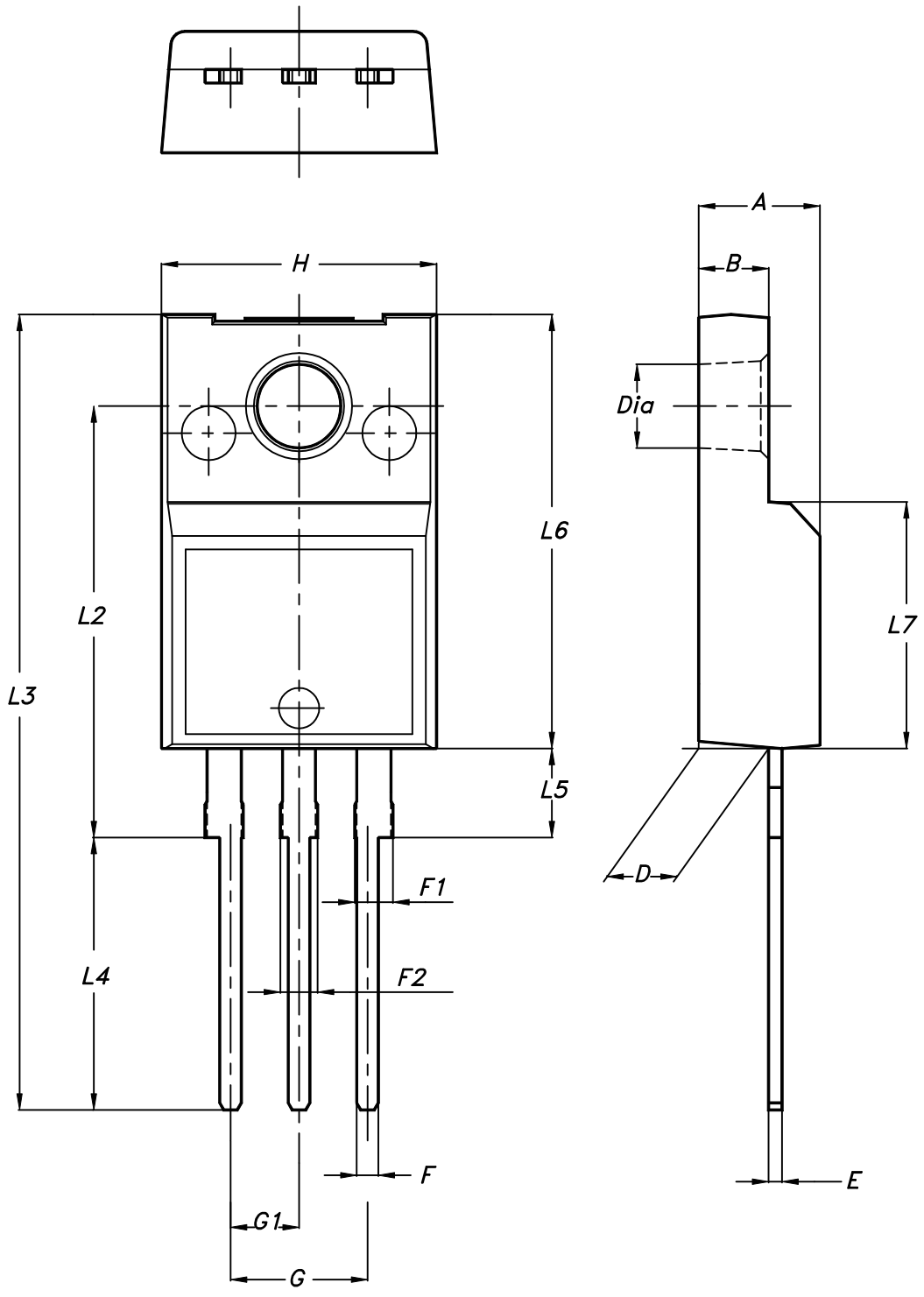

Table 10. **TO-220FP package mechanical data**

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

4.4 TO-220 type A package information

Figure 41. **TO-220 type A package outline**

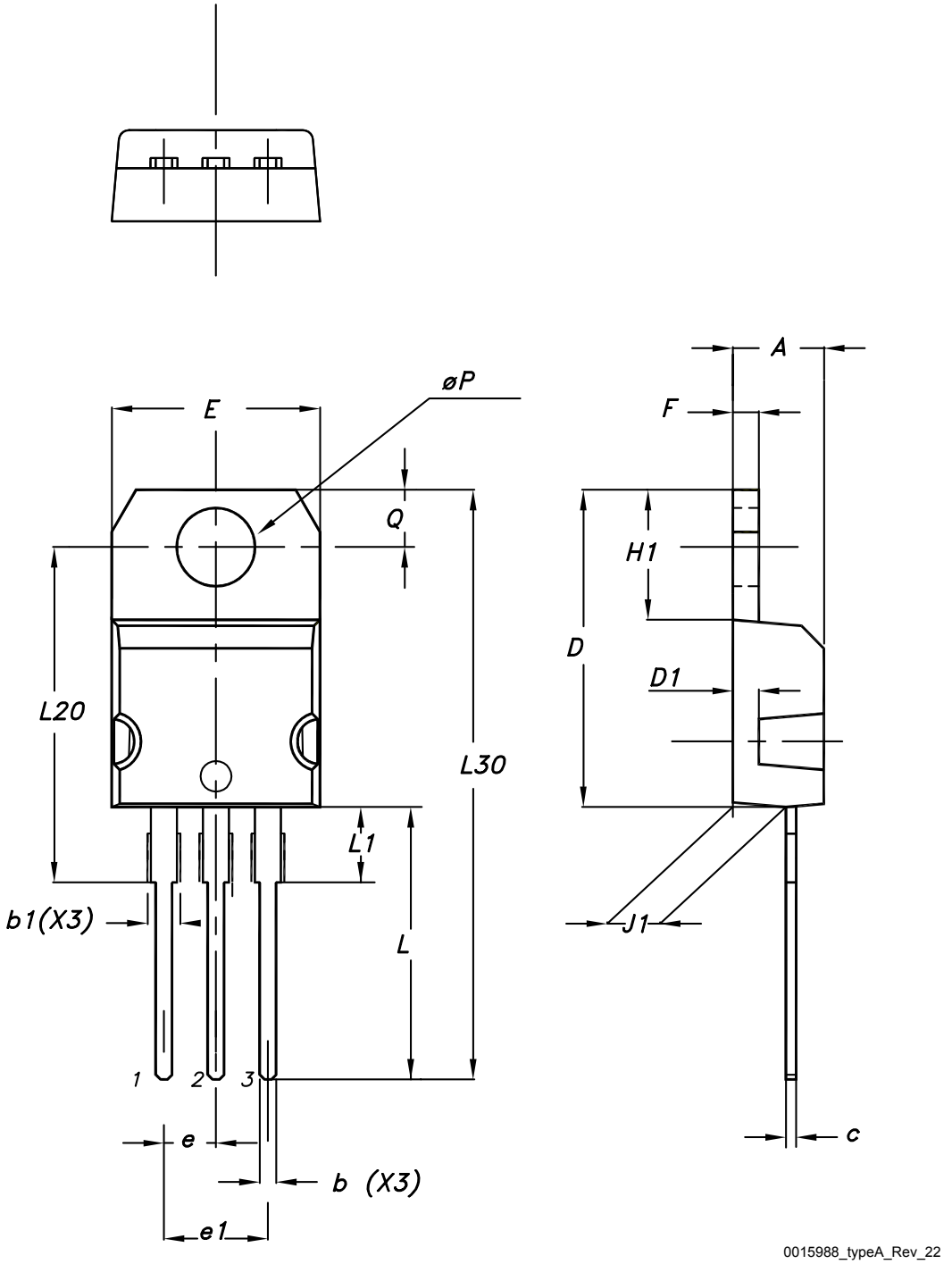

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Table 11. **TO-220 type A package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

5 Ordering information

Table 12. **Order codes**

Order code	Marking	Package	Packing
STGB15H60DF	GB15H60DF	D^2PAK	Tape and reel
STGF15H60DF	GF15H60DF	TO-220FP	Tube
STGP15H60DF	GP15H60DF	TO-220	

Revision history

Table 13. **Document revision history**

Date	Version	Changes
12-Aug-2013	1	Initial release.
17-Oct-2013	2	Document status promoted form preliminary to production data. Added *Section 2.1: Electrical characteristics (curves)*. Minor text changes.
09-Apr-2019	3	Updated applications and description on cover page. Updated Section 4 Package information. Minor text changes.

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