



# THE DATASHEET OF STGF3NC120HD





# STGB3NC120HD STGF3NC120HD, STGP3NC120HD

7 A, 1200 V very fast IGBT with ultrafast diode

## Features

- High voltage capability
- High speed
- Very soft ultrafast recovery anti-parallel diode

## Applications

- Home appliance
- Lighting

## Description

This high voltage and very fast IGBT shows an excellent trade-off between low conduction losses and fast switching performance. It is designed in PowerMESH™ technology combined with high voltage ultrafast diode.

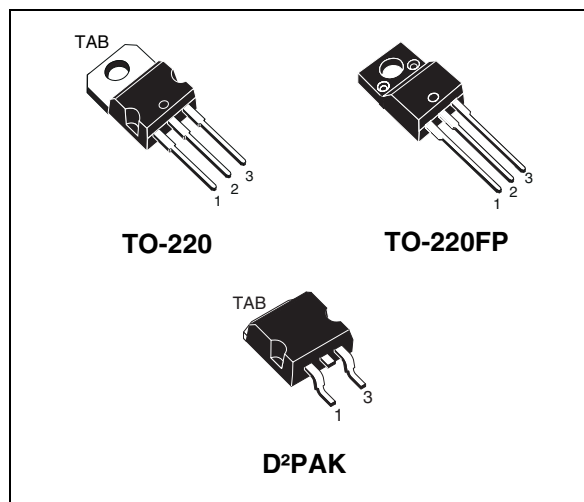


Figure 1. Internal schematic diagram

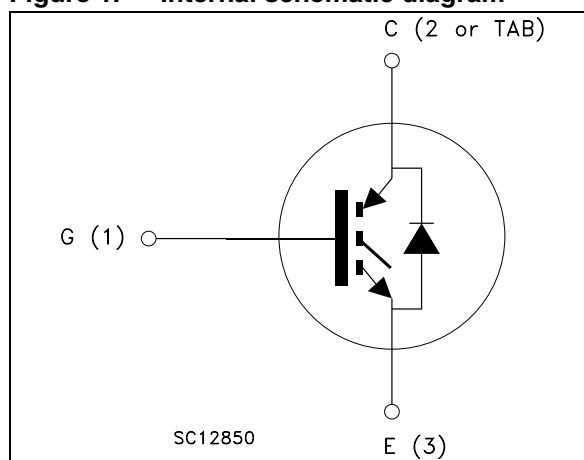


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB3NC120HDT4	GB3NC120HD	D <sup>2</sup> PAK	Tape and reel
STGF3NC120HD	GF3NC120HD	TO-220FP	Tube
STGP3NC120HD	GP3NC120HD	TO-220	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220/D <sup>2</sup> PAK	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	1200		V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25 °C	6	14	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	3	7	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	14		A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	20		A
V <sub>GE</sub>	Gate-emitter voltage	± 20		V
I <sub>F</sub>	Diode RMS forward current at T <sub>C</sub> = 25 °C	3		A
I <sub>FSM</sub>	Surge non repetitive forward current t <sub>p</sub> =10 ms sinusoidal	12		A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	25	75	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink	2500		V
T <sub>J</sub>	Operating junction temperature	-55 to 150		°C

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. V<sub>clamp</sub> = 80 % V<sub>CES</sub>, T<sub>J</sub> = 150 °C, R<sub>G</sub> = 10 Ω, V<sub>GE</sub> = 15 V

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

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220/D <sup>2</sup> PAK	
R <sub>thJC</sub>	Thermal resistance junction-case IGBT	5	1.65	°C/W
	Thermal resistance junction-case (diode)	3.5		°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	62.5		°C/W

## 2 Electrical characteristics

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

**Table 4. Static electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 3\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 3\text{ A}, T_J = 125\text{ °C}$		2.3 2.2	2.8	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\mu\text{A}$	2		5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$ $V_{CE} = 1200\text{ V}, T_J = 125\text{ °C}$			50 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 25\text{ V}, I_C = 3\text{ A}$		4		S

1. Pulse duration: 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0$	-	470	-	pF
$C_{oes}$	Output capacitance			45		pF
$C_{res}$	Reverse transfer capacitance			6		pF
$Q_g$	Total gate charge	$V_{CE} = 960\text{ V},$ $I_C = 3\text{ A}, V_{GE} = 15\text{ V}$	-	24	-	nC
$Q_{ge}$	Gate-emitter charge			3		nC
$Q_{gc}$	Gate-collector charge			10		nC

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 20)	-	15 3.5 880	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 20)	-	14.5 4 770	-	ns ns A/ $\mu$ s
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 20)	-	72 118 250	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 20)	-	132 210 470	-	ns ns ns

**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 20)	-	236 290 526	-	$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 800\text{ V}$ , $I_C = 3\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 20)	-	360 620 980	-	$\mu$ J $\mu$ J $\mu$ J

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & Diode are at the same temperature (25 °C and 125 °C)
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	$I_F = 1.5\text{ A}$ $I_F = 1.5\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.6 1.3	2.0	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 3\text{ A}$ , $V_R = 40\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 23)	-	51 85 3.3		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 3\text{ A}$ , $V_R = 40\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 23)	-	64 133 4.2		ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

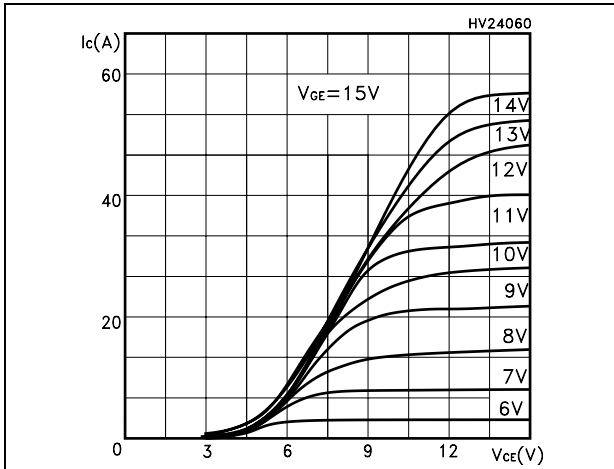


Figure 3. Transfer characteristics

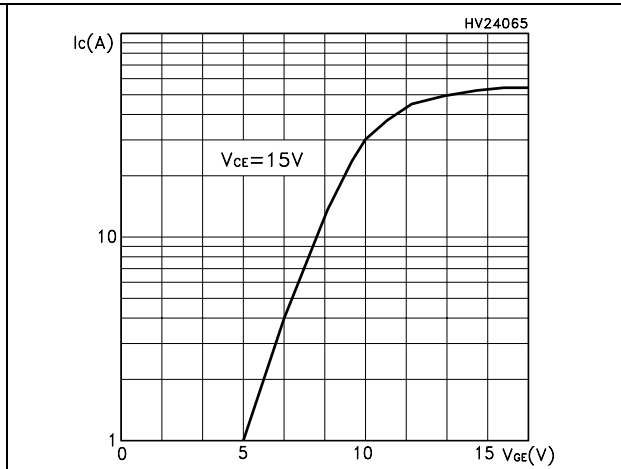


Figure 4. Transconductance

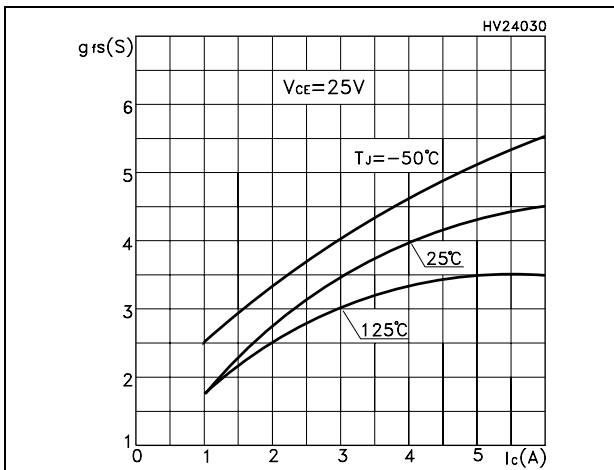


Figure 5. Collector-emitter on voltage vs. temperature

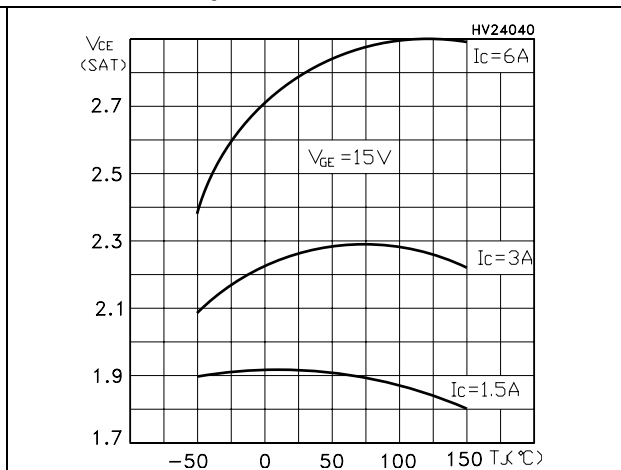


Figure 6. Collector-emitter on voltage vs. collector current

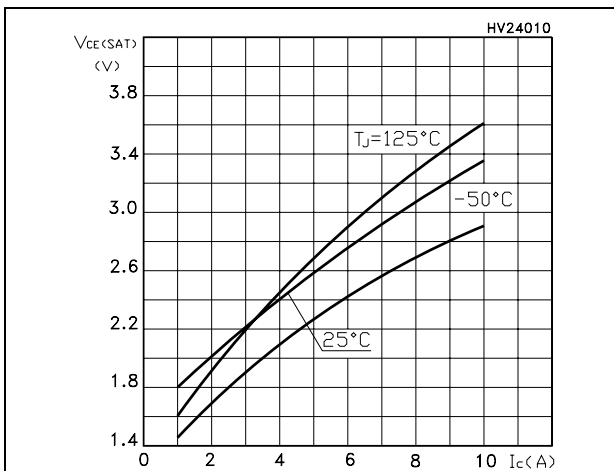
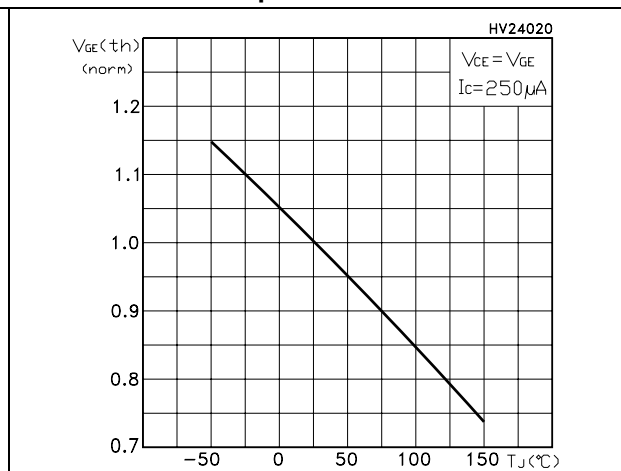
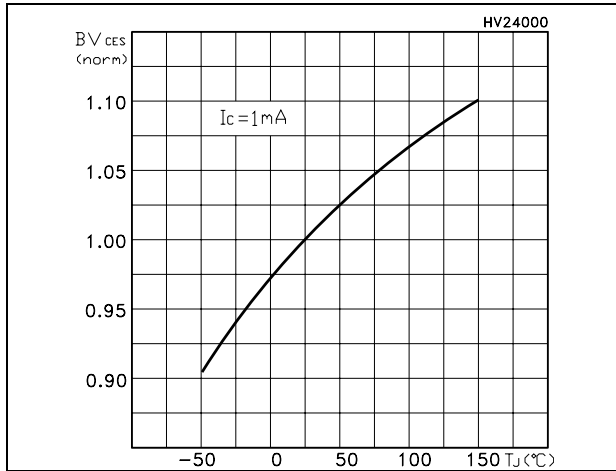


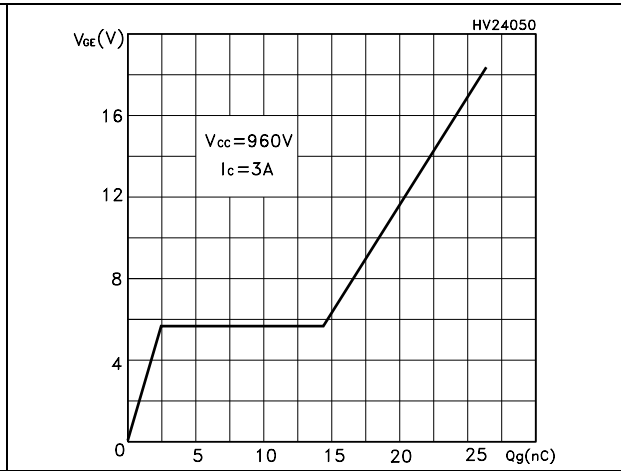
Figure 7. Normalized gate threshold voltage vs. temperature



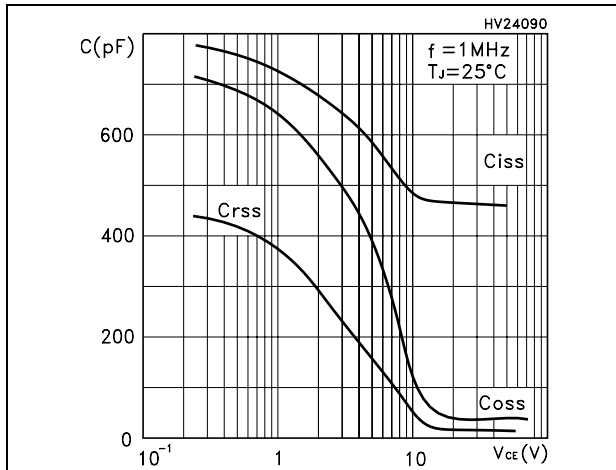
**Figure 8. Normalized breakdown voltage vs. temperature**



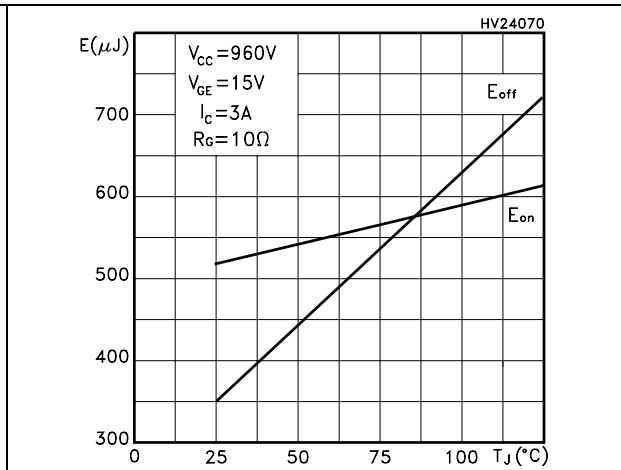
**Figure 9. Gate charge vs. gate-source voltage**



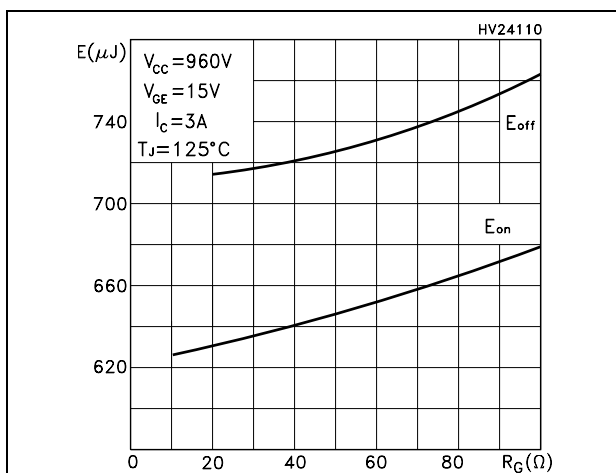
**Figure 10. Capacitance variations**



**Figure 11. Switching losses vs. temperature**



**Figure 12. Switching losses vs. gate resistance**



**Figure 13. Switching losses vs. collector current**

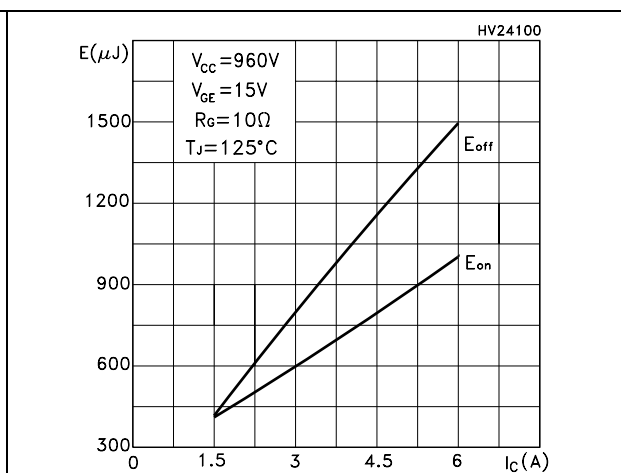


Figure 14. Collector-emitter diode characteristics

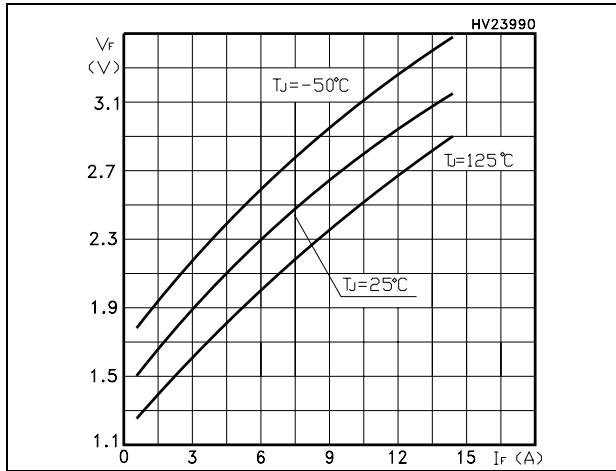


Figure 15. Power losses @  $I_C = 3\text{ A}$

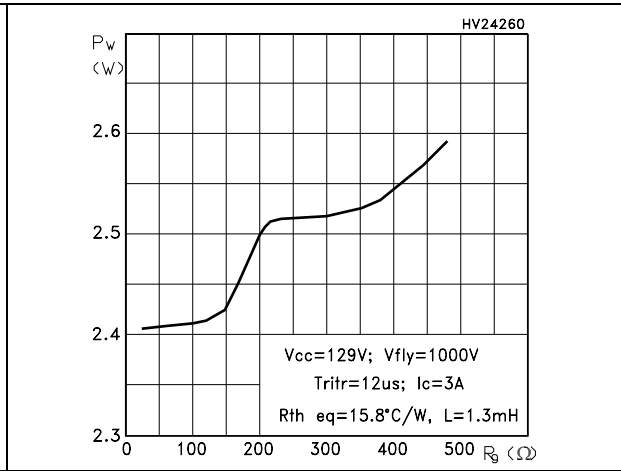


Figure 16. Power losses @  $I_C = 2\text{ A}$

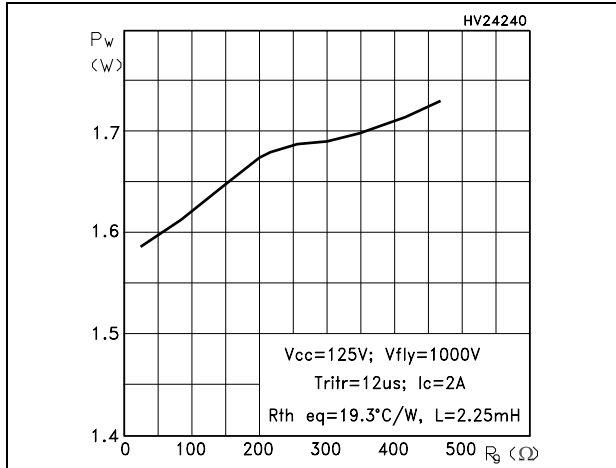


Figure 17. Thermal impedance for TO-220

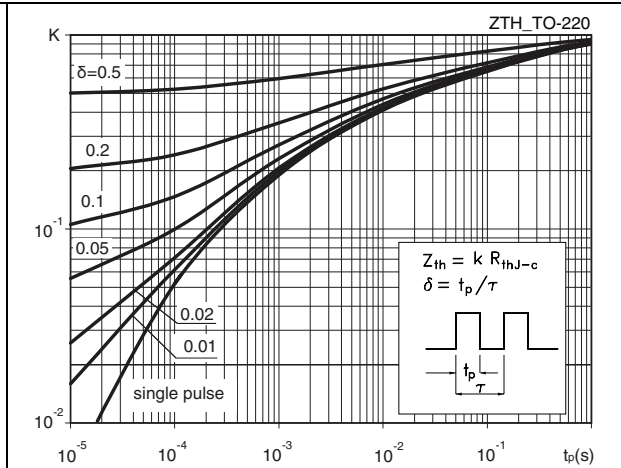


Figure 18. Turn-off SOA

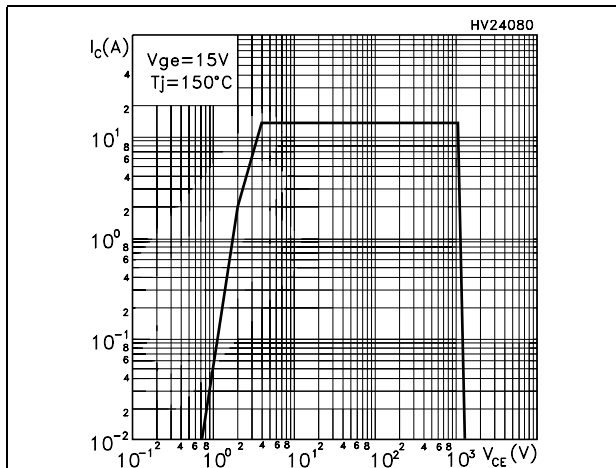
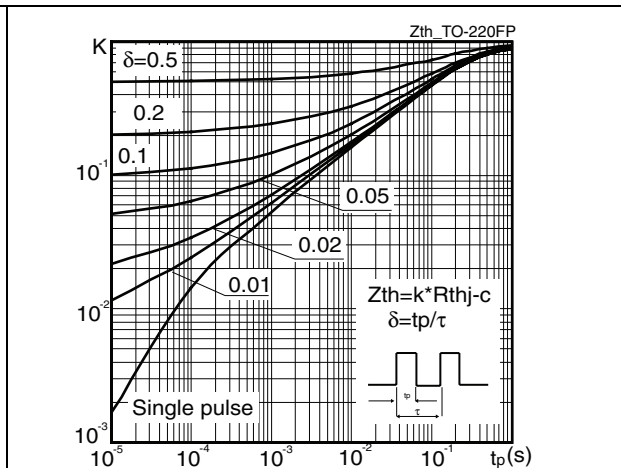


Figure 19. Thermal impedance for TO-220FP



### 3 Test circuit

Figure 20. Test circuit for inductive load switching

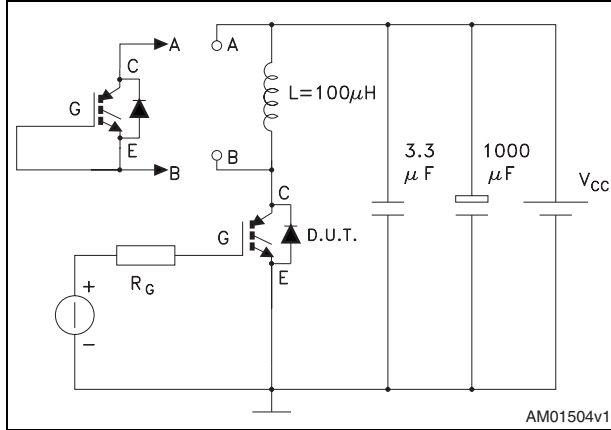


Figure 21. Gate charge test circuit

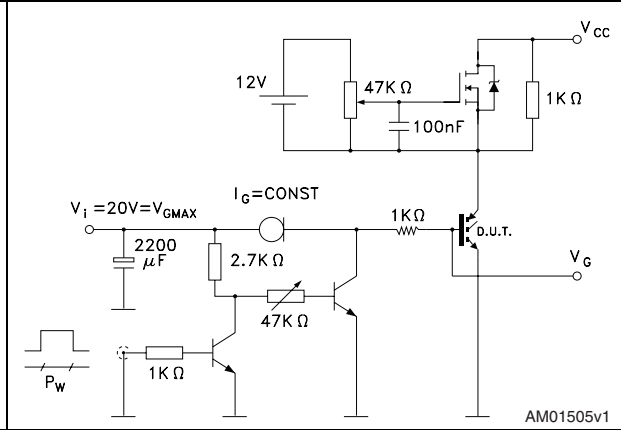


Figure 22. Switching waveform

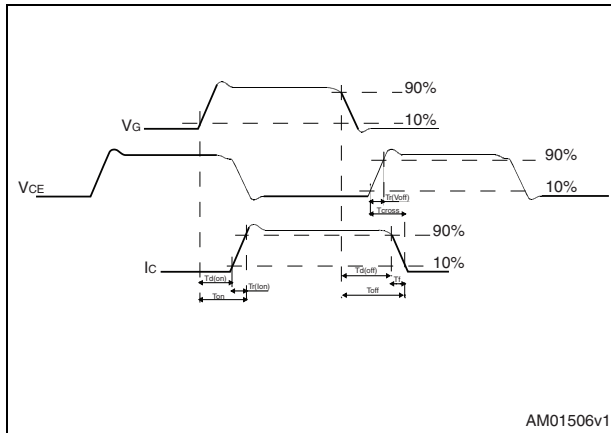
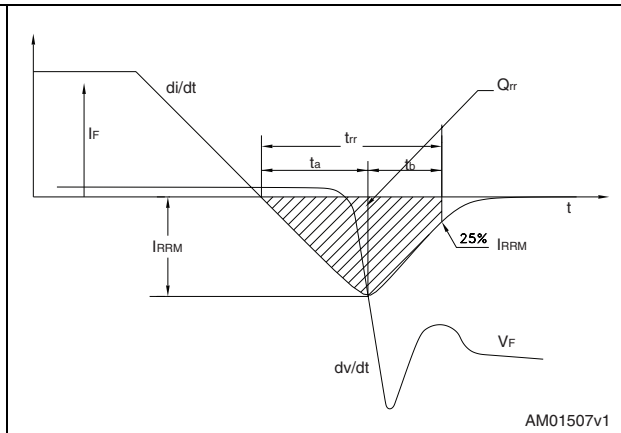


Figure 23. Diode recovery time waveform



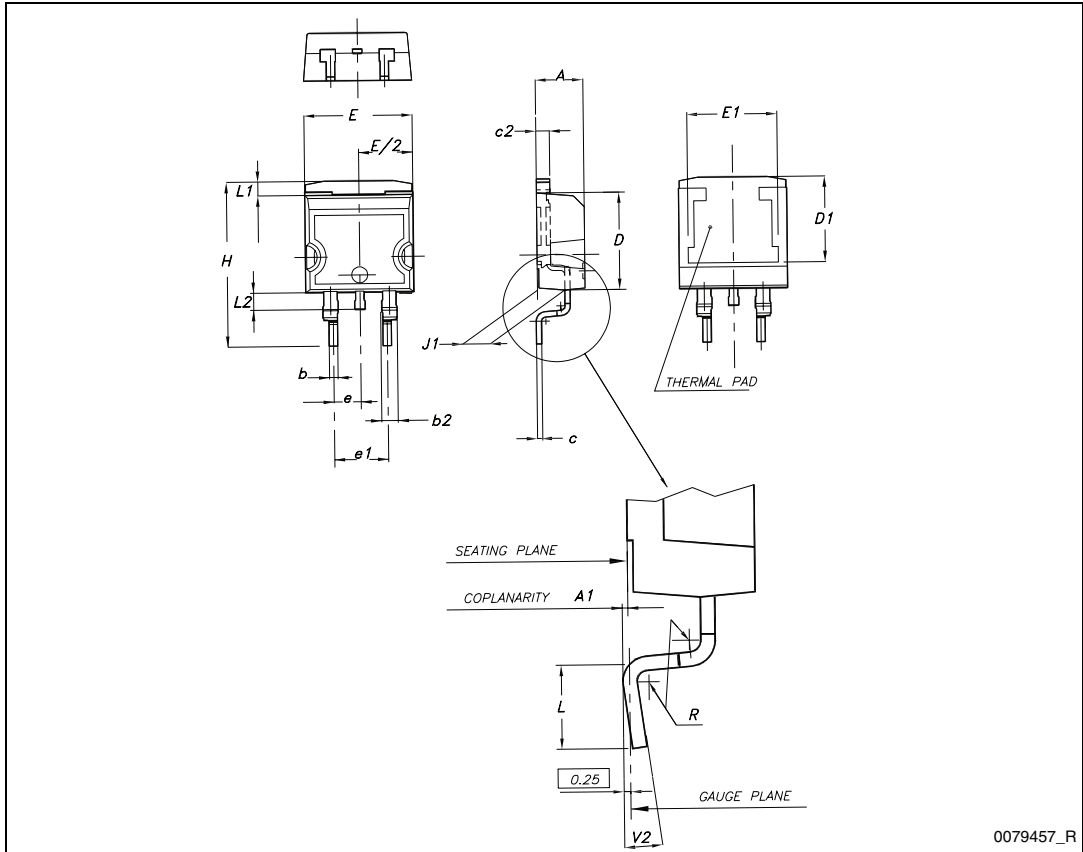
## 4 Package mechanical data

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.

**Table 9. D<sup>2</sup>PAK (TO-263) 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°

D<sup>2</sup>PAK (TO-263) drawing

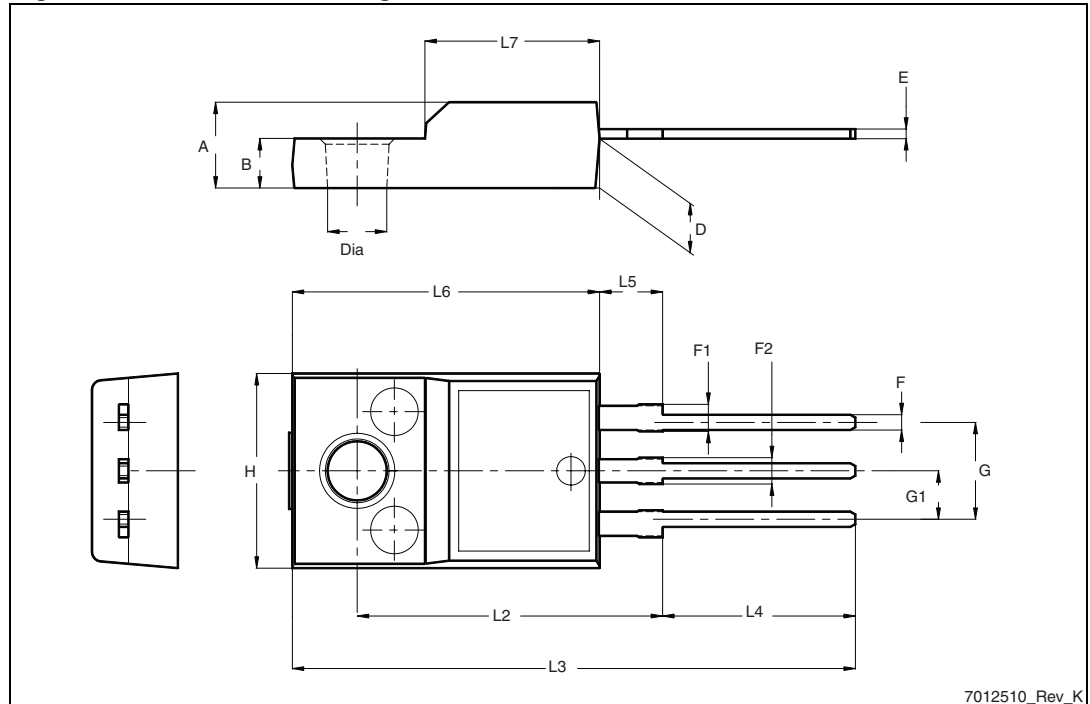


0079457\_R

Table 10. 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 24. TO-220FP drawing

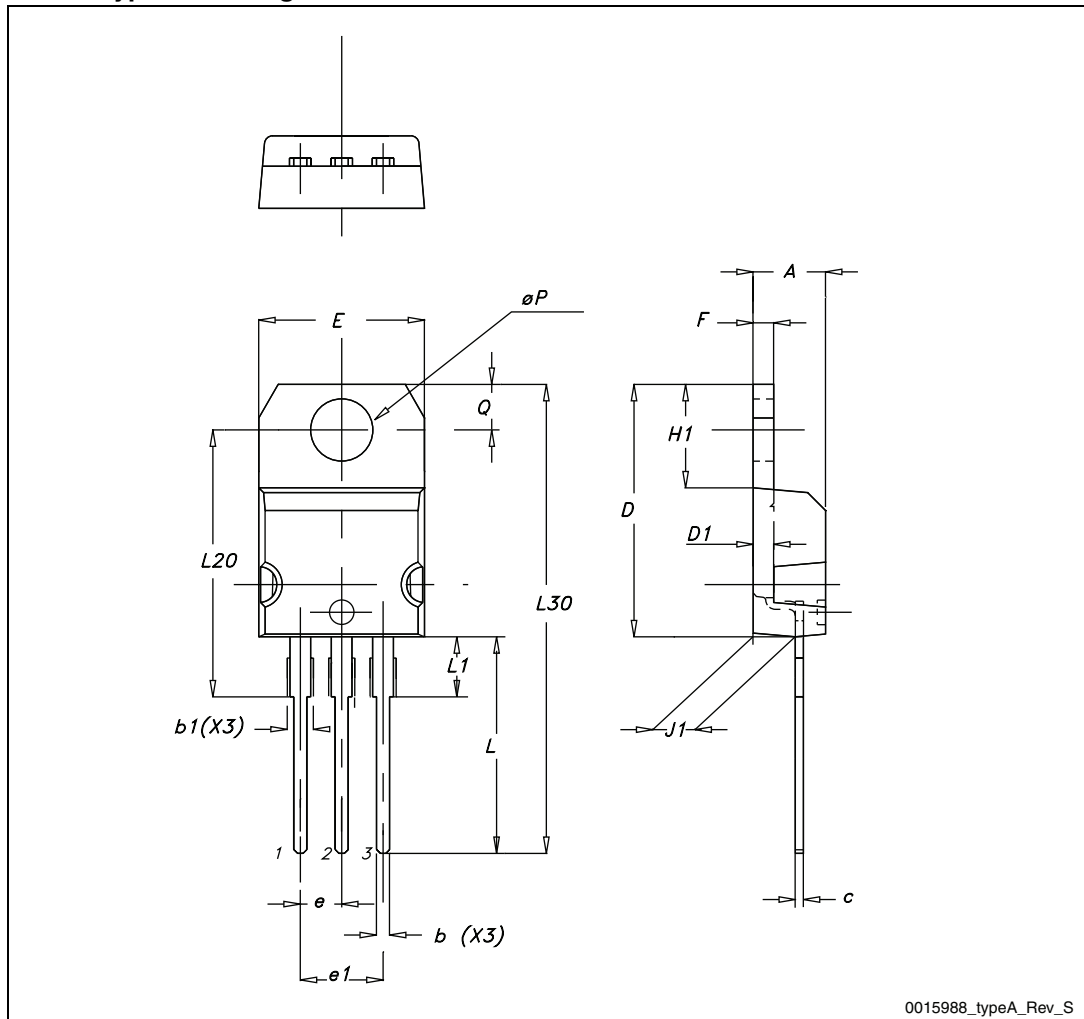


7012510\_Rev\_K

Table 11. 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	
∅P	3.75		3.85
Q	2.65		2.95

TO-220 type A drawing



0015988\_typeA\_Rev\_S

## 5 Revision history

Table 12. Document revision history

Date	Revision	Changes
13-Dec-2004	1	First release.
21-Jan-2005	2	Modified <a href="#">Figure 18: Turn-off SOA</a> .
03-May-2010	3	Added new package, mechanical data: TO-220.
25-Jan-2011	4	Added new package, mechanical data: D <sup>2</sup> PAK.

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