



# STGB14NC60KD STGF14NC60KD - STGP14NC60KD

14 A - 600 V - short circuit rugged IGBT

## Features

- Low on-voltage drop ( $V_{CE(sat)}$ )
- Low  $C_{res} / C_{ies}$  ratio (no cross conduction susceptibility)
- Switching losses include diode recovery energy
- Very soft ultra fast recovery antiparallel diode
- Short circuit withstand time 10 $\mu$ s.

## Applications

- High frequency inverters
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

## Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

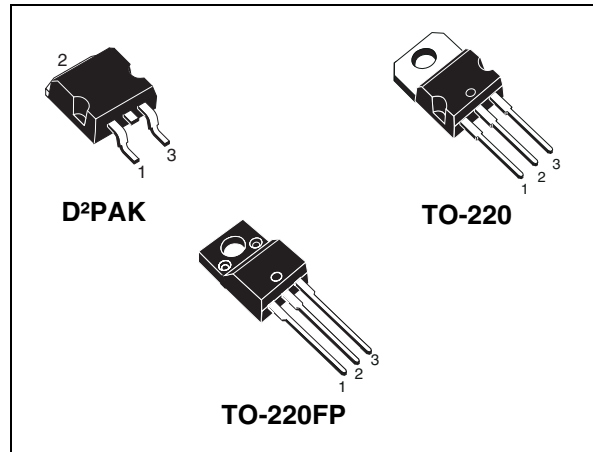


Figure 1. Internal schematic diagram

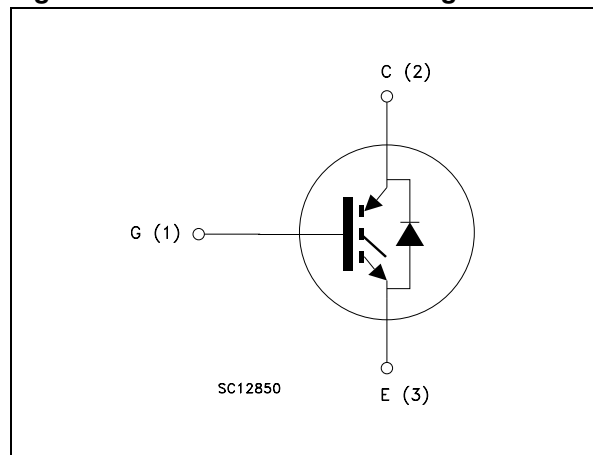


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGB14NC60KDT4	GB14NC60KD	D <sup>2</sup> PAK	Tape and reel
STGF14NC60KD	GF14NC60KD	TO-220FP	Tube
STGP14NC60KD	GP14NC60KD	TO-220	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220/D <sup>2</sup> PAK	TO-220FP	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600		V
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 25 °C	25	11	A
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100 °C	14	7	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	50		A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	50		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	20		A
I <sub>FSM</sub>	Surge non repetitive forward current t <sub>p</sub> = 10 ms sinusoidal	55		A
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)	--	2500	V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	80	28	W
t <sub>scw</sub>	Short circuit withstand time, V <sub>CE</sub> = 0.5V <sub>BR(CES)</sub> , T <sub>C</sub> = 125 °C, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 12 V	10		μs
T <sub>j</sub>	Operating junction temperature	– 55 to 150		°C

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

2. V<sub>clamp</sub> = 80% of 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 max. junction temperature allowed

**Table 3. Thermal resistance**

Symbol	Parameter	Value		Unit
		TO-220/D <sup>2</sup> PAK	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max	1.56	4.5	°C/W
R <sub>thj-case</sub>	Thermal resistance junction-case max diode	2.2	5.6	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5		°C/W

## 2 Electrical characteristics

( $T_{CASE}=25\text{ °C}$  unless otherwise specified)

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-emitter breakdown voltage ( $V_{GE}=0$ )	$I_C=1\text{ mA}$	600			V
$I_{GES}$	Gate-emitter leakage current ( $V_{CE}=0$ )	$V_{GE}=\pm 20\text{ V}$			$\pm 100$	nA
$I_{CES}$	Collector cut-off current ( $V_{GE}=0$ )	$V_{CE}=600\text{ V}$ $V_{CE}=600\text{ V}, T_C=125\text{ °C}$			150 1	$\mu\text{A}$ mA
$V_{GE(th)}$	Gate threshold voltage	$V_{CE}=V_{GE}, I_C=250\text{ }\mu\text{A}$	4.5		6.5	V
$V_{CE(SAT)}$	Collector-emitter saturation voltage	$V_{GE}=15\text{ V}, I_C=7\text{ A}$ $V_{GE}=15\text{ V}, I_C=7\text{ A}, T_C=125\text{ °C}$		2.1 1.8	2.5	V V
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE}=15\text{ V}, I_C=7\text{ A}$		3.2		S

1. Pulsed: 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	$V_{CE}=25\text{ V}, f=1\text{ MHz}, V_{GE}=0$		760		pF
$C_{oes}$	Output capacitance			86		pF
$C_{res}$	Reverse transfer capacitance			15.5		pF
$Q_g$	Total gate charge	$V_{CE}=390\text{ V}, I_C=7\text{ A},$		34.4		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE}=15\text{ V}$		8.1		nC
$Q_{gc}$	Gate-collector charge	(see Figure 19)		16.4		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	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 18)		22.5 8.5 700		ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ (see Figure 18)		22 9.5 680		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	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 18)		60 116 75		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_C = 125\text{ }^\circ\text{C}$ (see Figure 18)		24 196 144		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	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 18)		82 155 237		$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 7\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ (see Figure 18)		131 370 501		$\mu$ J $\mu$ J $\mu$ J

- $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and DIODE are at the same temperature (25°C and 125°C)
- 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	$I_F = 7\text{ A}$ $I_F = 7\text{ A}$ , $T_C = 125\text{ }^\circ\text{C}$		1.8 1.3	2.1	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 7\text{ A}$ , $V_R = 40\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 21)		37 40 2.1		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 7\text{ A}$ , $V_R = 40\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 21)		61 98 3.2		ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

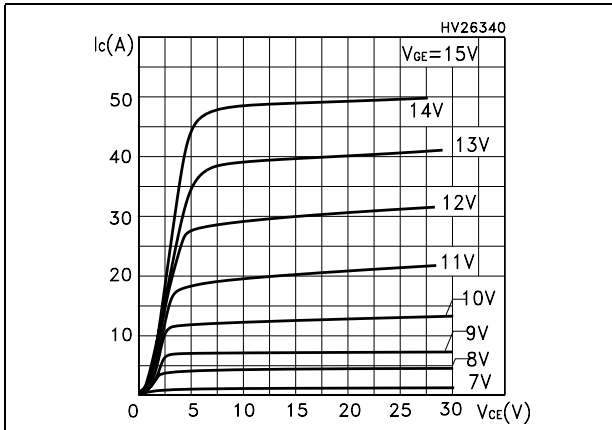


Figure 3. Transfer characteristics

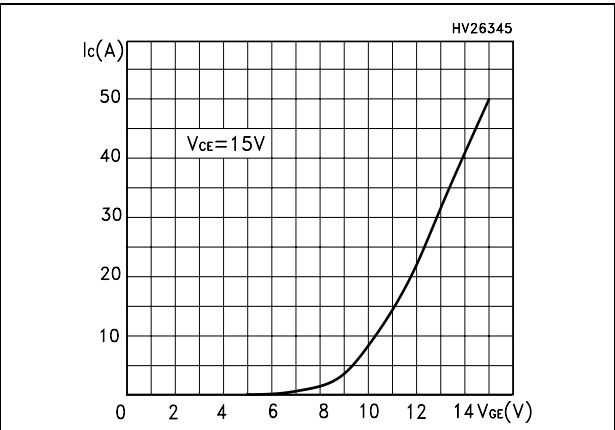


Figure 4. Transconductance

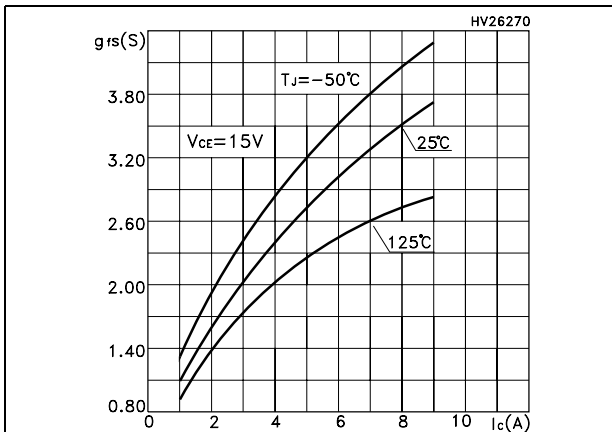


Figure 5. Collector-emitter on voltage vs temperature

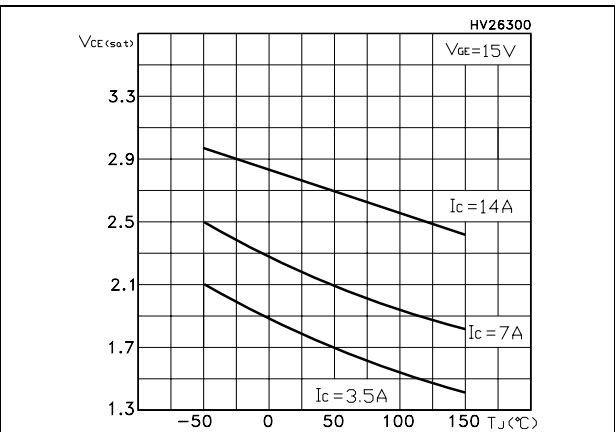


Figure 6. Collector-emitter on voltage vs collector current

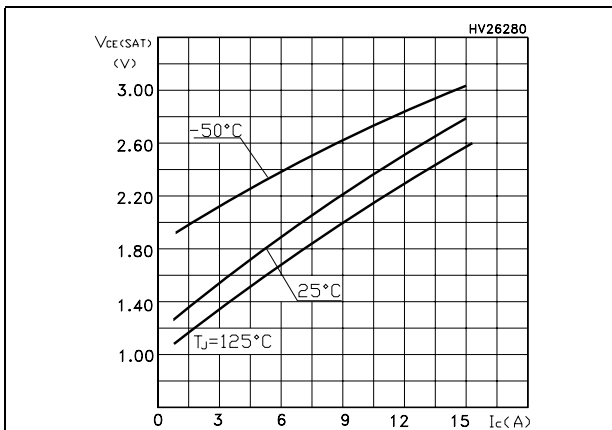


Figure 7. Normalized gate threshold vs temperature

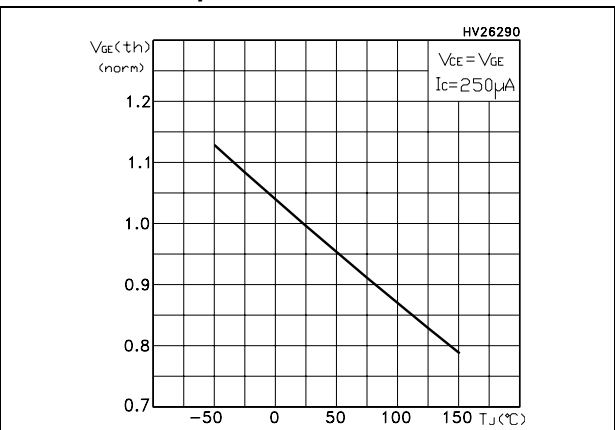


Figure 8. Normalized breakdown voltage vs temperature

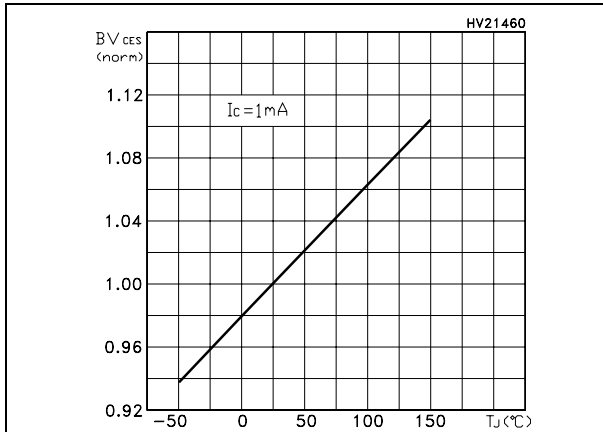


Figure 9. Gate charge vs gate-emitter voltage

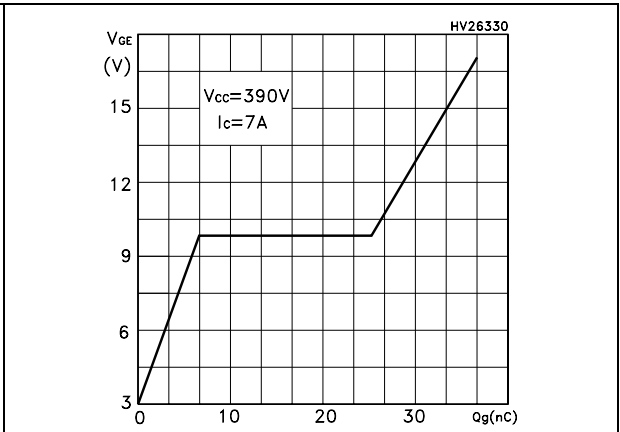


Figure 10. Capacitance variations

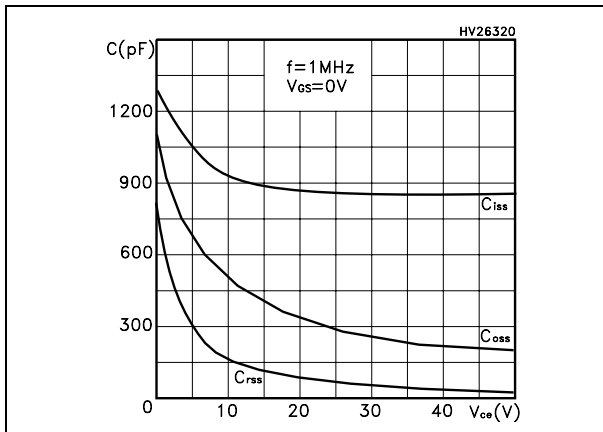


Figure 11. Switching losses vs temperature

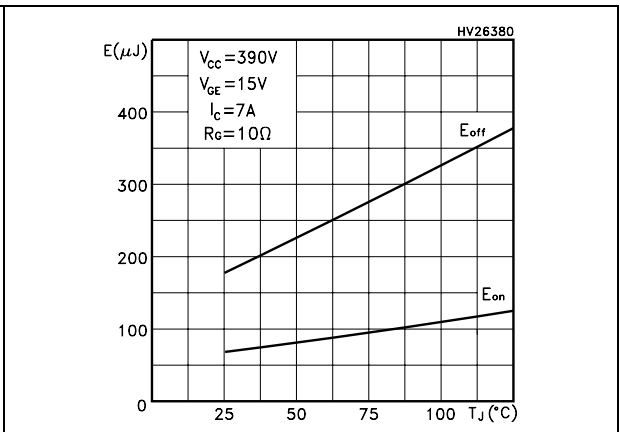


Figure 12. Switching losses vs gate resistance Figure 13. Switching losses vs collector current

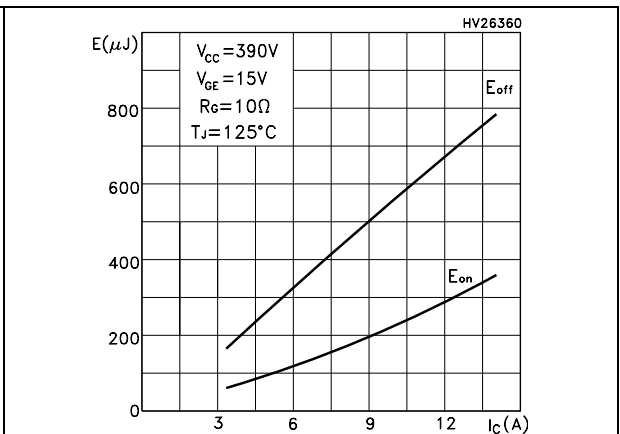
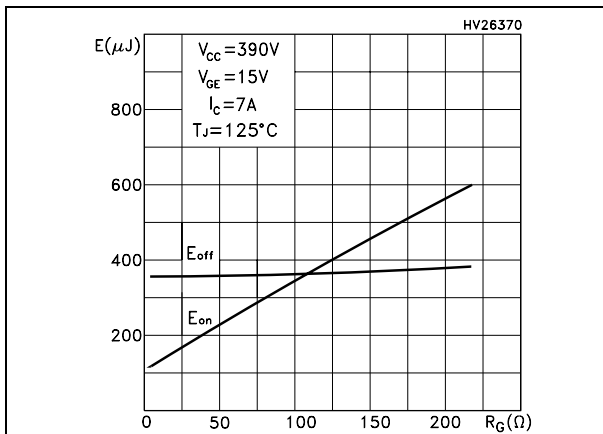


Figure 14. Thermal impedance

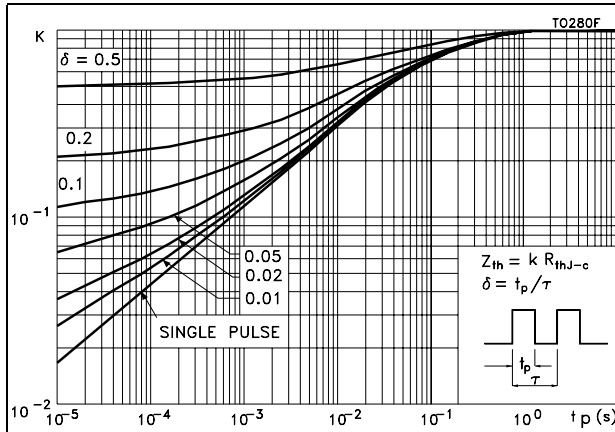


Figure 15. Turn-off SOA

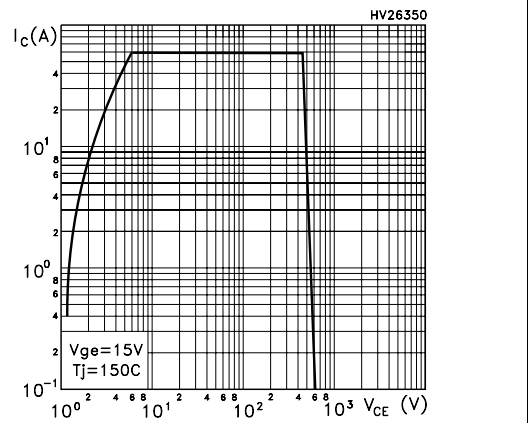


Figure 16. Thermal impedance for TO-220FP

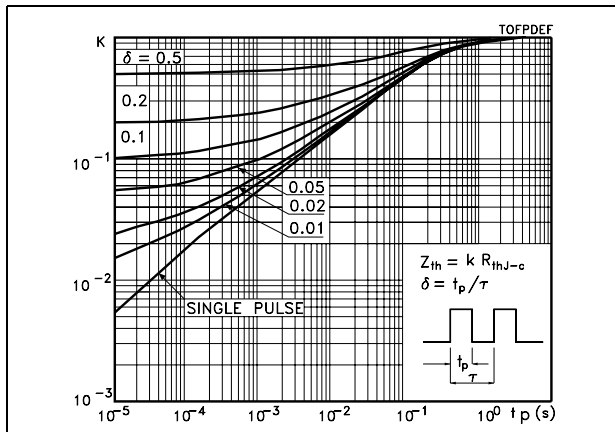
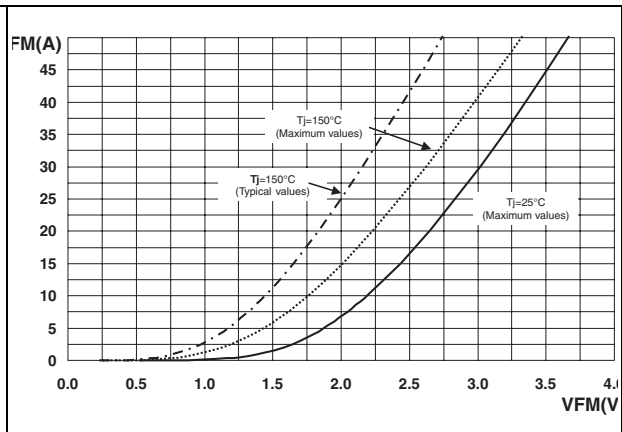


Figure 17. Forward voltage drop versus forward current





### 3 Test circuit

Figure 18. Test circuit for inductive load switching

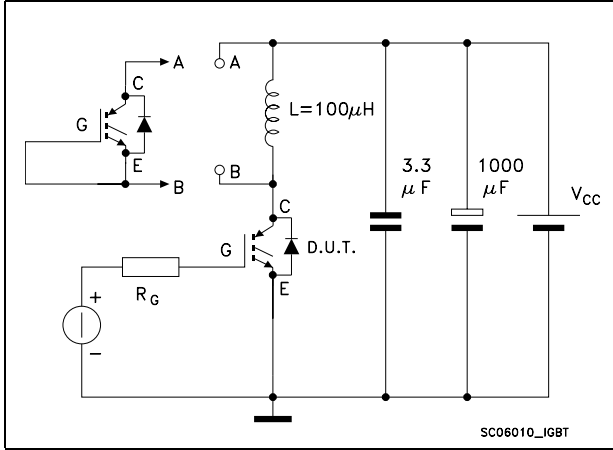


Figure 19. Gate charge test circuit

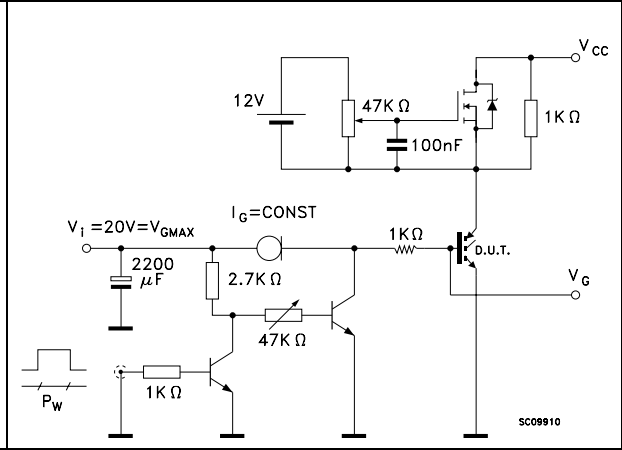


Figure 20. Switching waveforms

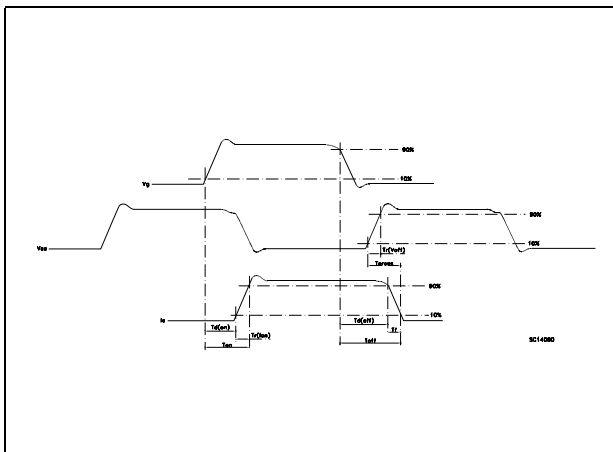
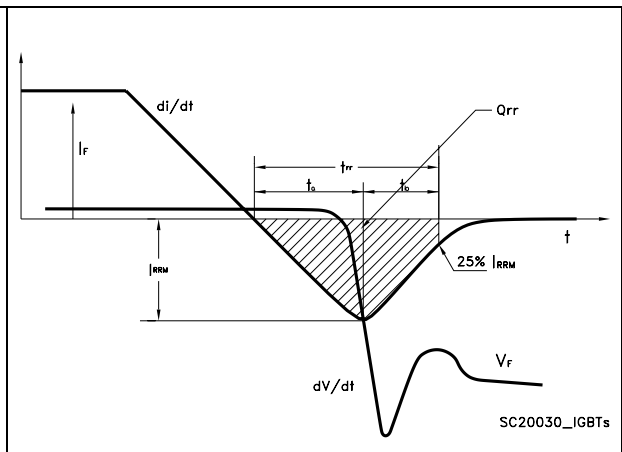


Figure 21. Diode recovery times waveform

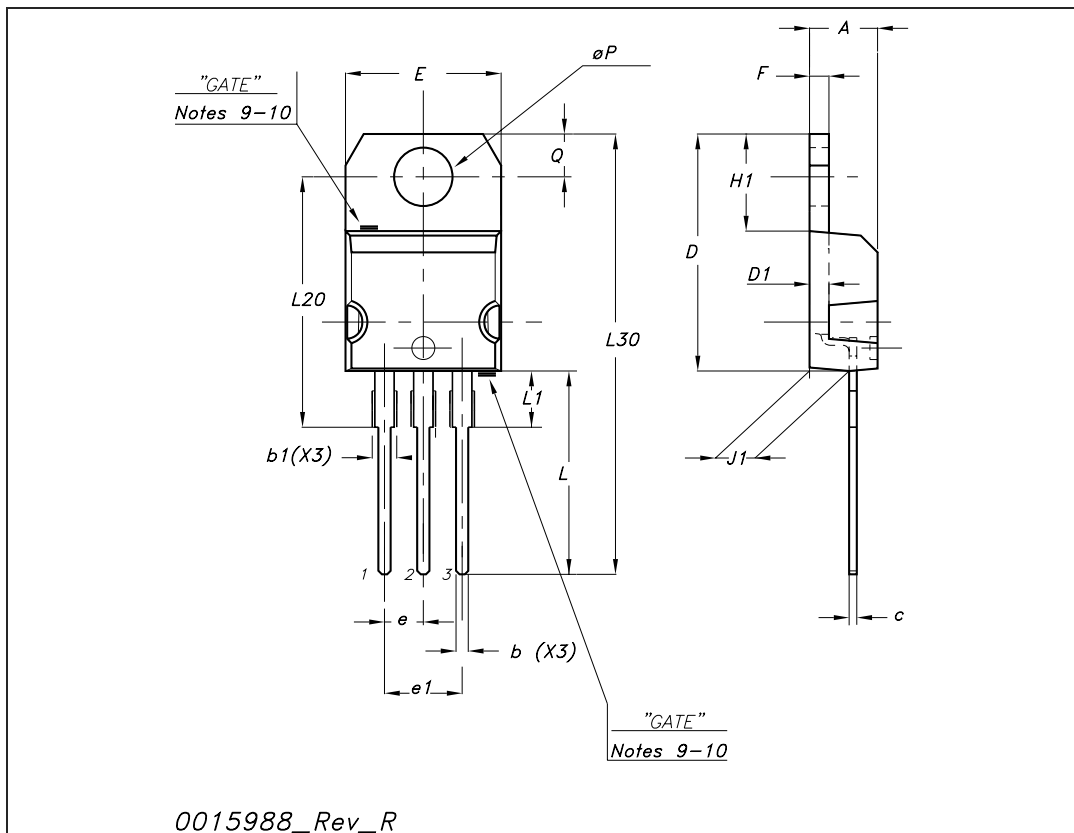


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

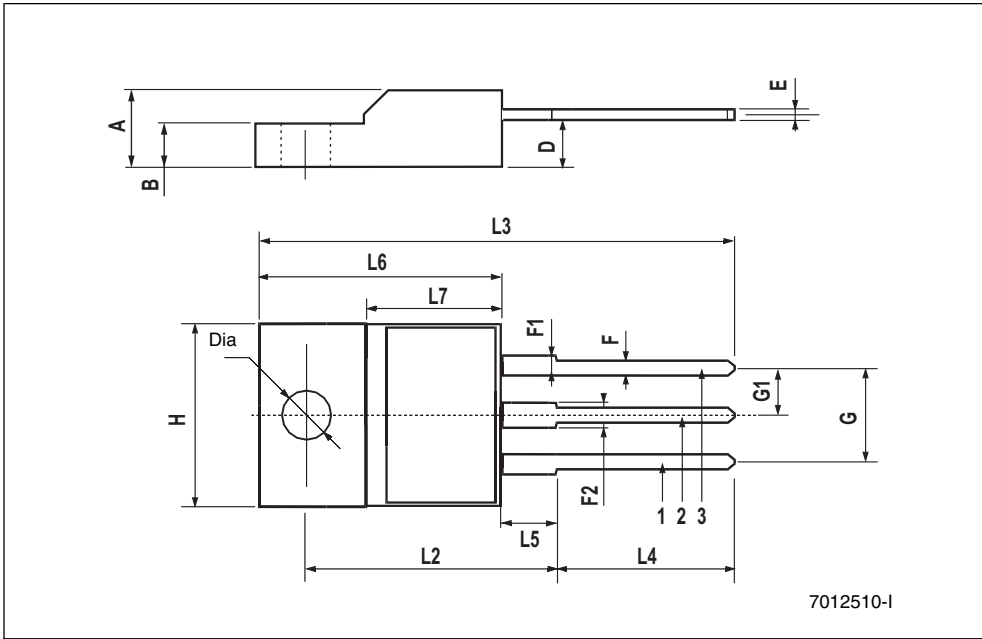
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



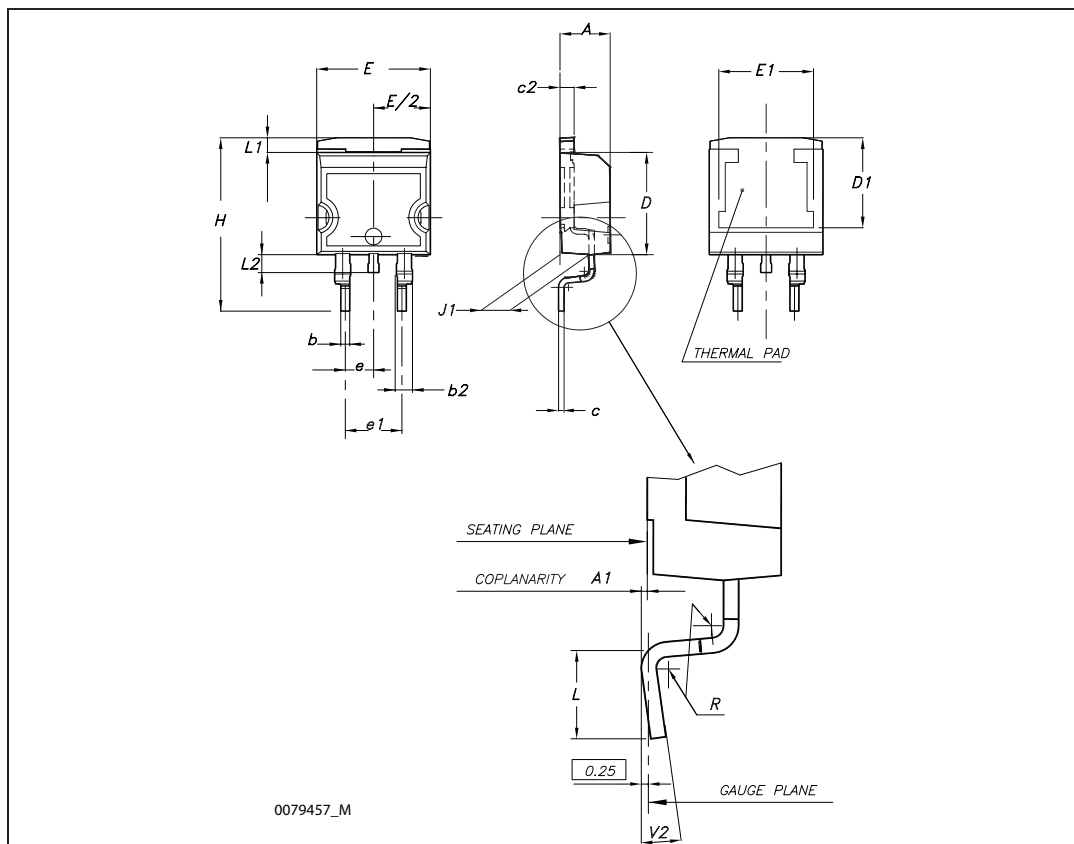
**TO-220FP mechanical data**

Dim.	mm.			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	3		3.2	0.118		0.126



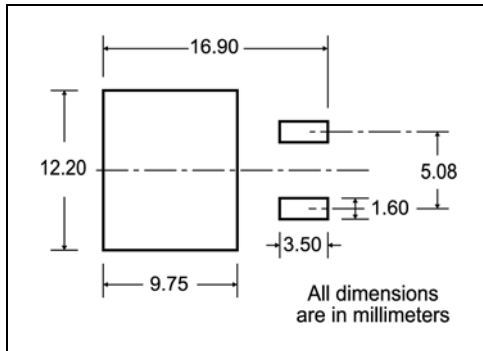
D<sup>2</sup>PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



# 5 Packaging mechanical data

## D<sup>2</sup>PAK FOOTPRINT



## TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

**REEL MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

TRL

Bending radius R min.

\* on sales type

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
14-Jun-2005	1	New release
05-Jul-2005	2	Complete version
22-Jul-2005	3	Value changed in table 6
27-Jan-2006	4	Inserted ecopack indication
28-Apr-2006	5	New template, modified curves 6 and 8
02-Apr-2008	6	Modified test conditions on <a href="#">Table 4</a>

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