



STGB14NC60KD STGF14NC60KD, STGP14NC60KD

14 A, 600 V - short-circuit rugged IGBT

Features

- Short circuit withstand time 10μs.
- 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

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.

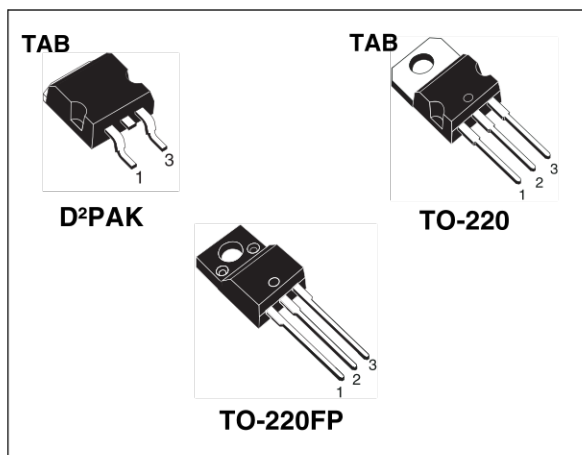


Figure 1. Internal schematic diagram

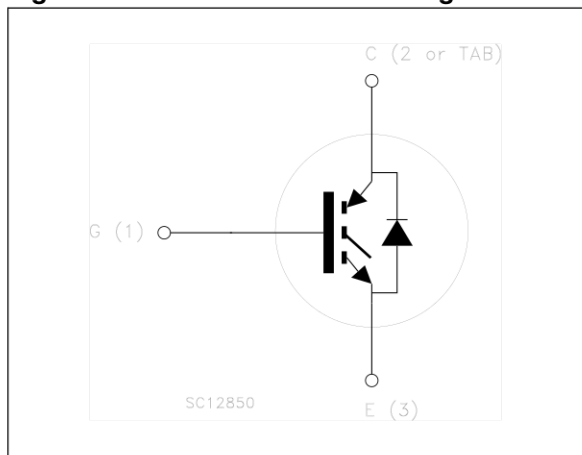


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGB14NC60KDT4	GB14NC60KD	D²PAK	Tape and reel
STGF14NC60KD	GF14NC60KD	TO-220FP	Tube
STGP14NC60KD	GP14NC60KD	TO-220	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/D ² PAK	TO-220FP	
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	600		V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	25	11	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	14	7	A
$I_{CL}^{(2)}$	Turn-off latching current	50		A
$I_{CP}^{(3)}$	Pulsed collector current	50		A
V_{GE}	Gate-emitter voltage	± 20		V
I_F	Diode RMS forward current at $T_C = 25\text{ °C}$	20		A
I_{FSM}	Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	55		A
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$; $T_C = 25\text{ °C}$)	--	2500	V
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	80	28	W
t_{scw}	Short circuit withstand time, $V_{CE} = 0.5V_{BR(CES)}$, $T_C = 125\text{ °C}$, $R_G = 10\text{ }\Omega$, $V_{GE} = 12\text{ V}$	10		μs
T_j	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. $V_{clamp} = 80\%$ of V_{CES} , $T_j = 150\text{ °C}$, $R_G = 10\text{ }\Omega$, $V_{GE} = 15\text{ V}$

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

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-220/D ² PAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case IGBT	1.56	4.5	°C/W
$R_{thj-case}$	Thermal resistance junction-case diode	2.2	5.6	°C/W
$R_{thj-amb}$	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 ($V_{GE} = 0$)	$I_C = 1\text{ mA}$	600			V
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_j = 125\text{ °C}$			150 1	μA 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	$V_{GE} = 15\text{ V}, I_C = 7\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 7\text{ A}, T_j = 125\text{ °C}$		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 μs , 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	$V_{CE} = 390\text{ V}, I_C = 7\text{ A},$ $V_{GE} = 15\text{ V}$ (see Figure 19)	-	34.4	-	nC
Q_{ge}	Gate-emitter charge			8.1		nC
Q_{gc}	Gate-collector charge			16.4		nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$		22.5		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 18)	-	8.5	-	ns
$(di/dt)_{on}$	Turn-on current slope			700		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$		22		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)	-	9.5	-	ns
$(di/dt)_{on}$	Turn-on current slope			680		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$,		60		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18)	-	116	-	ns
t_f	Current fall time			75		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$,		24		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)	-	196	-	ns
t_f	Current fall time			144		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$		82		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 18)	-	155	-	μ J
E_{ts}	Total switching losses			237		μ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$		131		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)	-	370	-	μ J
E_{ts}	Total switching losses			501		μ J

1. 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)

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	$I_F = 7\text{ A}$ $I_F = 7\text{ A}$, $T_C = 125\text{ }^\circ\text{C}$		1.8 1.3	2.1	V V
t_{rr}	Reverse recovery time	$I_F = 7\text{ A}$, $V_R = 40\text{ V}$,		37		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 21)		40		nC
I_{rrm}	Reverse recovery current			2.1		A
t_{rr}	Reverse recovery time	$I_F = 7\text{ A}$, $V_R = 40\text{ V}$,		61		ns
Q_{rr}	Reverse recovery charge	$T_j = 125\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 21)		98		nC
I_{rrm}	Reverse recovery current			3.2		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

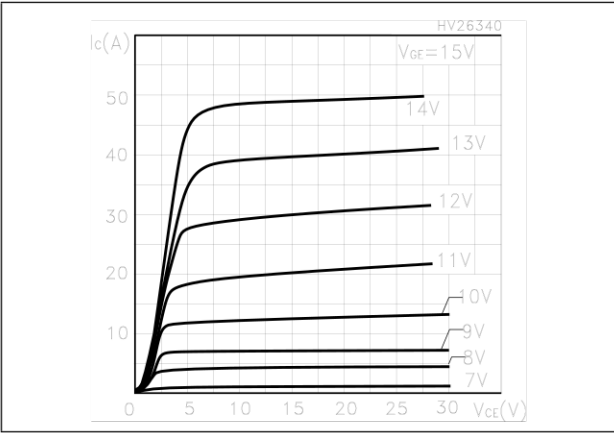


Figure 3. Transfer characteristics

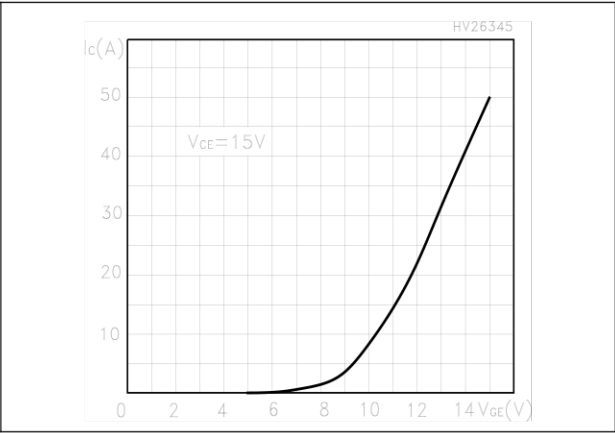


Figure 4. Transconductance

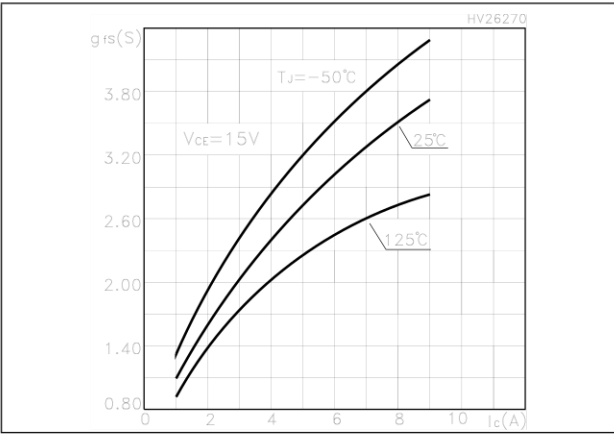


Figure 5. Collector-emitter on voltage vs temperature

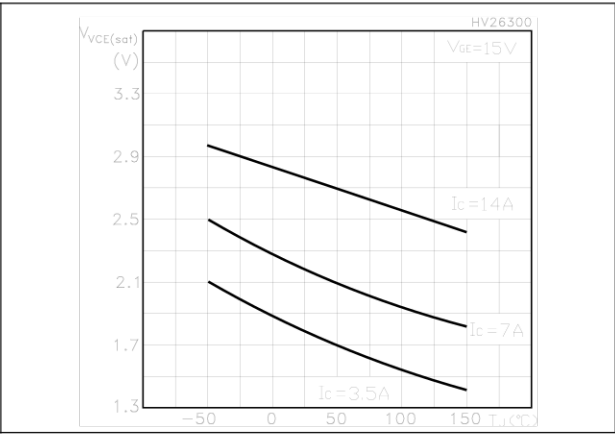


Figure 6. Collector-emitter on voltage vs collector current



Figure 7. Normalized gate threshold vs temperature

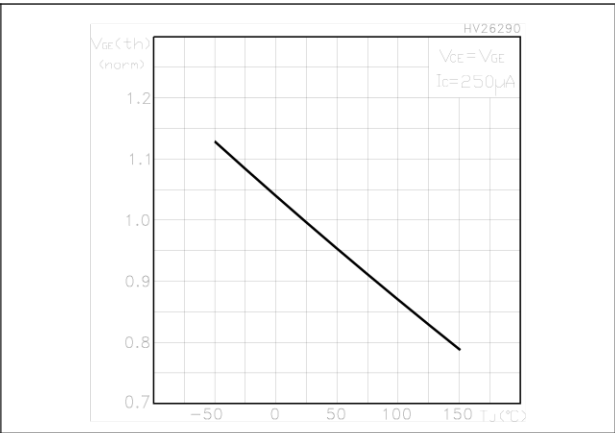


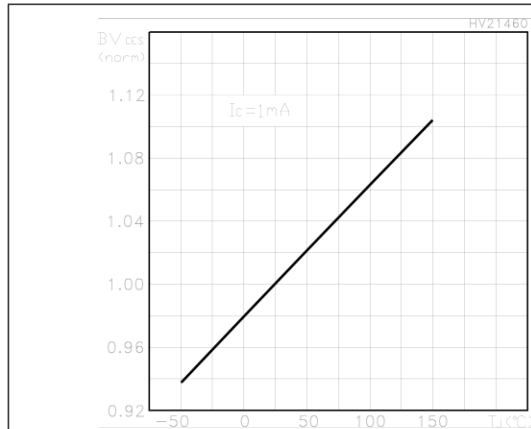
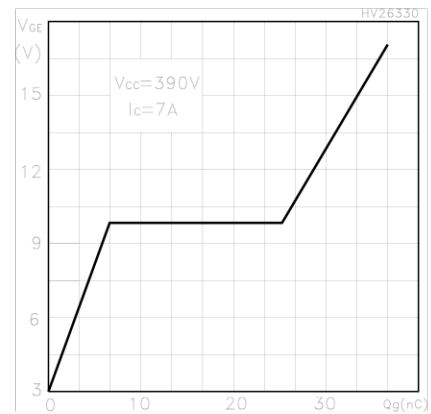
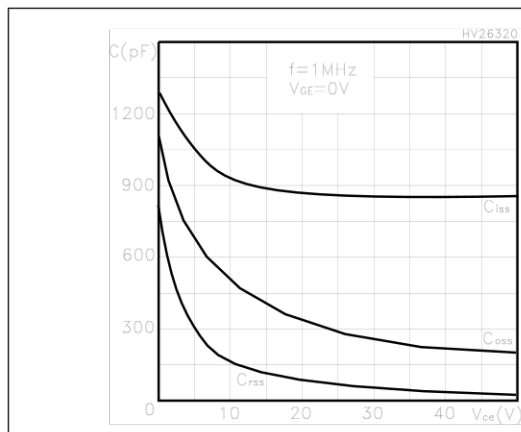
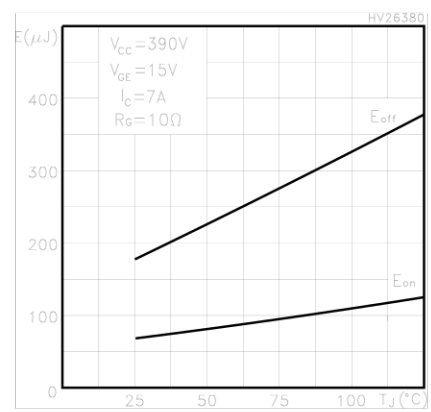
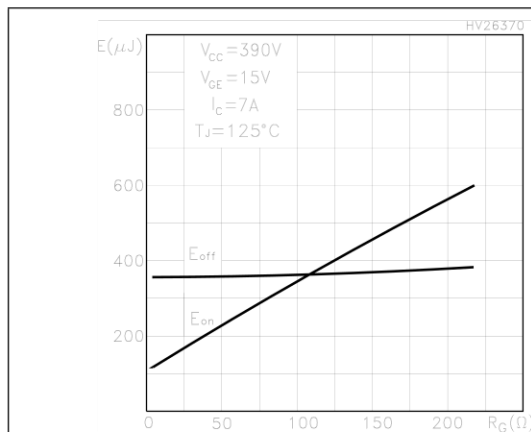
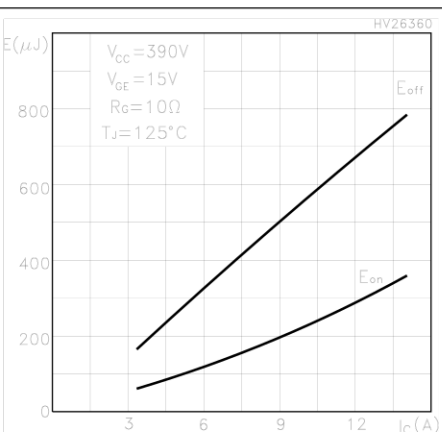
Figure 8. Normalized breakdown voltage vs temperature**Figure 9. Gate charge vs gate-emitter voltage****Figure 10. Capacitance variations****Figure 11. Switching losses vs temperature****Figure 12. Switching losses vs gate resistance****Figure 13. Switching losses vs collector current**

Figure 14. Thermal impedance for TO-220 and D²PAK

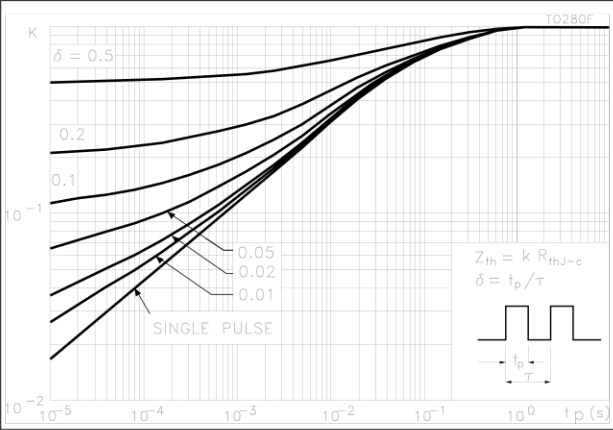


Figure 15. Turn-off SOA

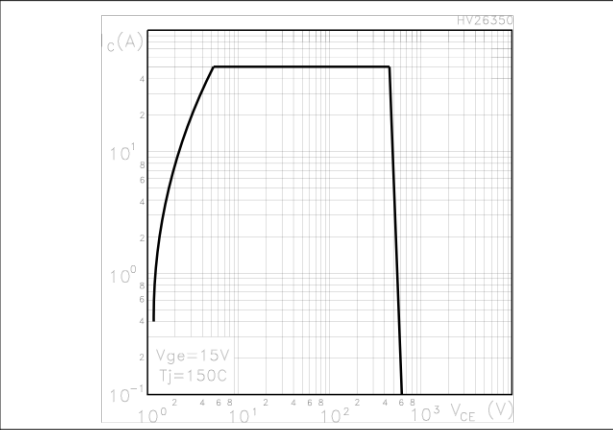


Figure 16. Thermal impedance for TO-220FP

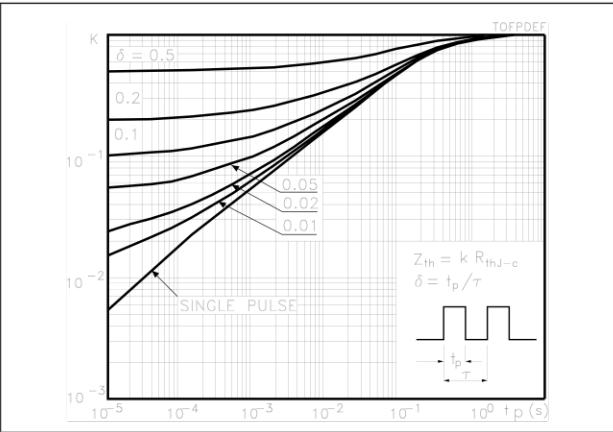
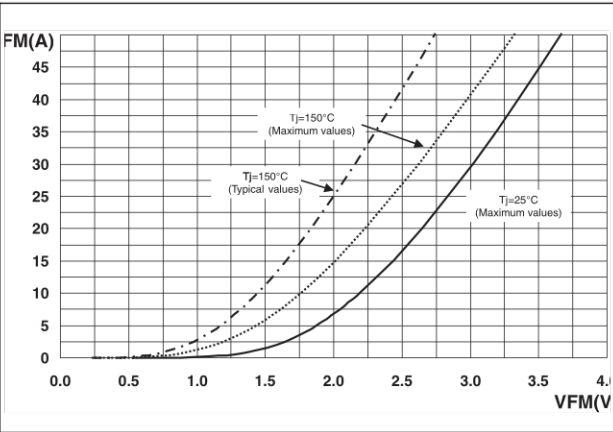


Figure 17. Forward voltage drop versus forward current



3 Test circuits

Figure 18. Test circuit for inductive load switching

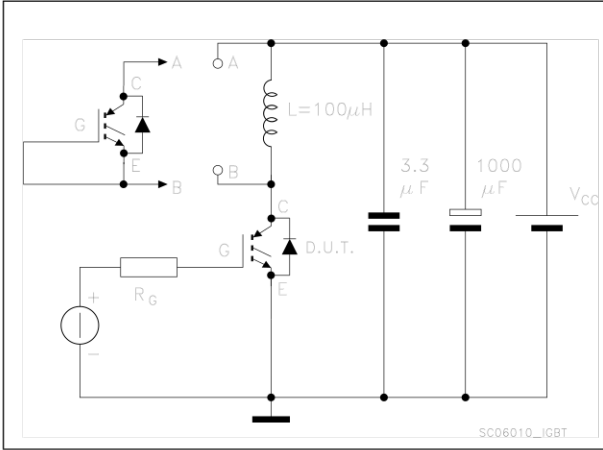


Figure 19. Gate charge test circuit

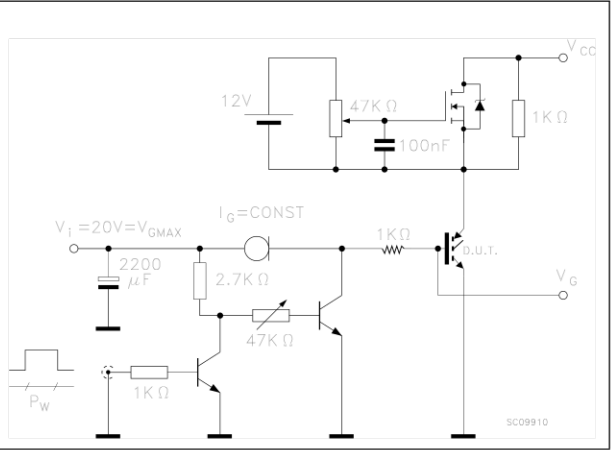


Figure 20. Switching waveforms

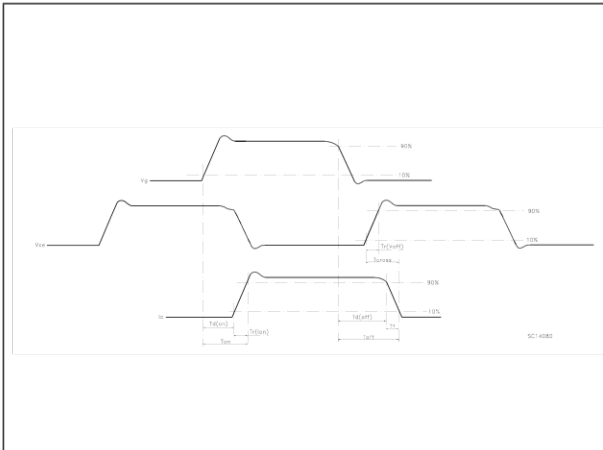
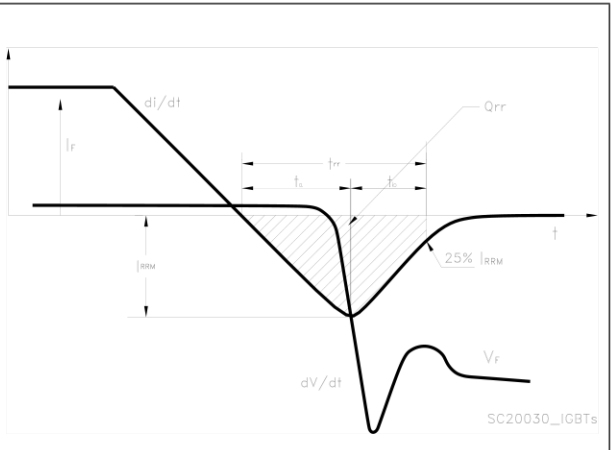


Figure 21. Diode recovery times waveform

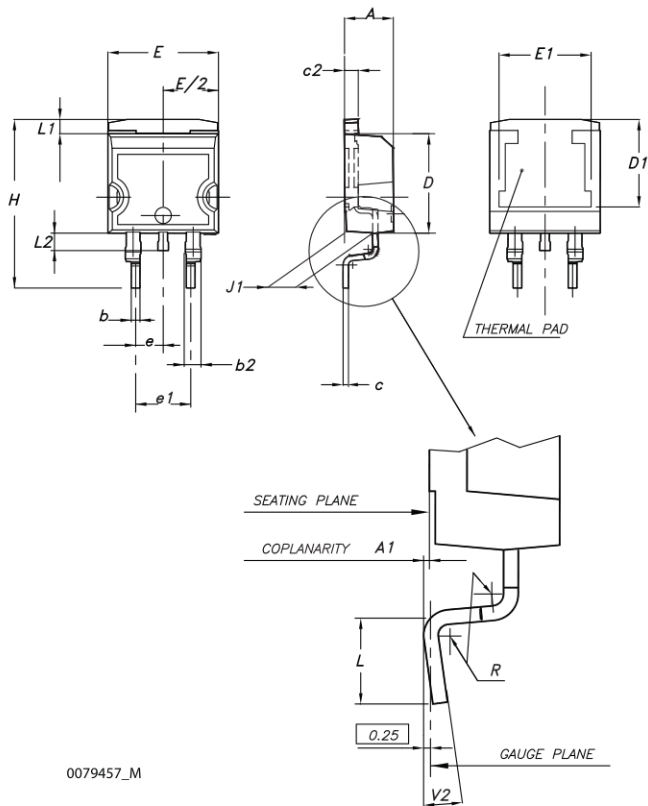


4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in 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.

D²PAK (TO-263) mechanical data

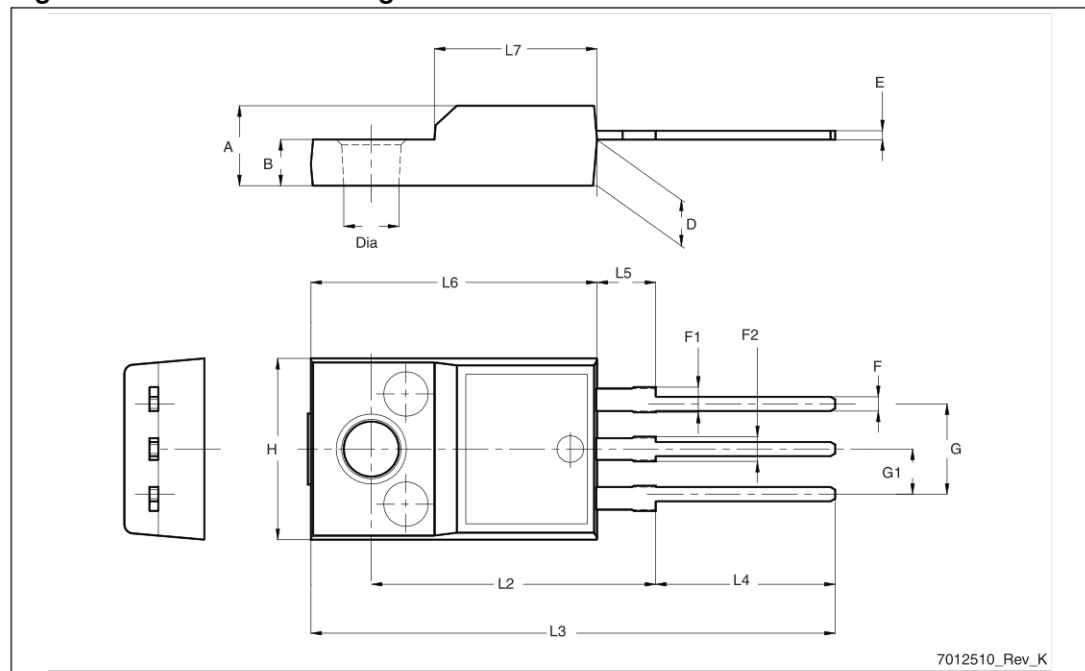
Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
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°



0079457_M

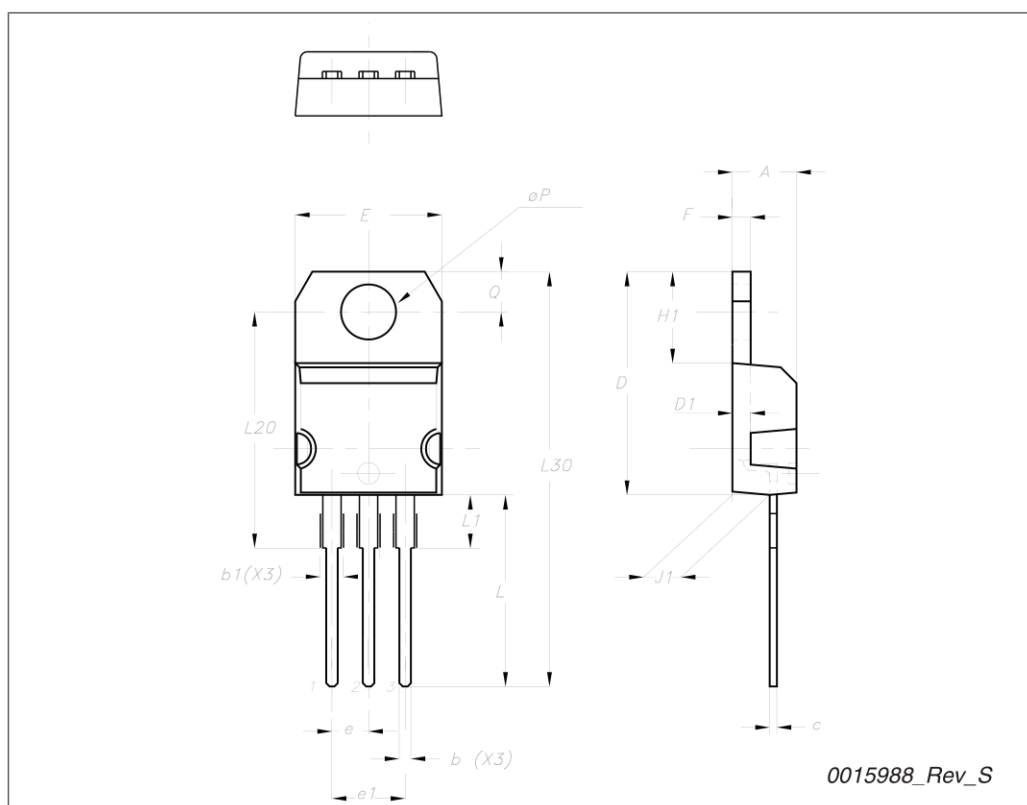
Table 9. TO-220FP mechanical data

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 22. TO-220FP drawing

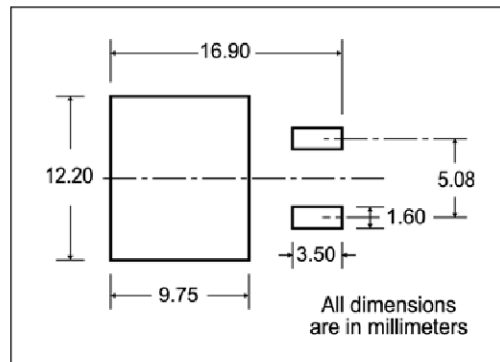
TO-220 type A mechanical data

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

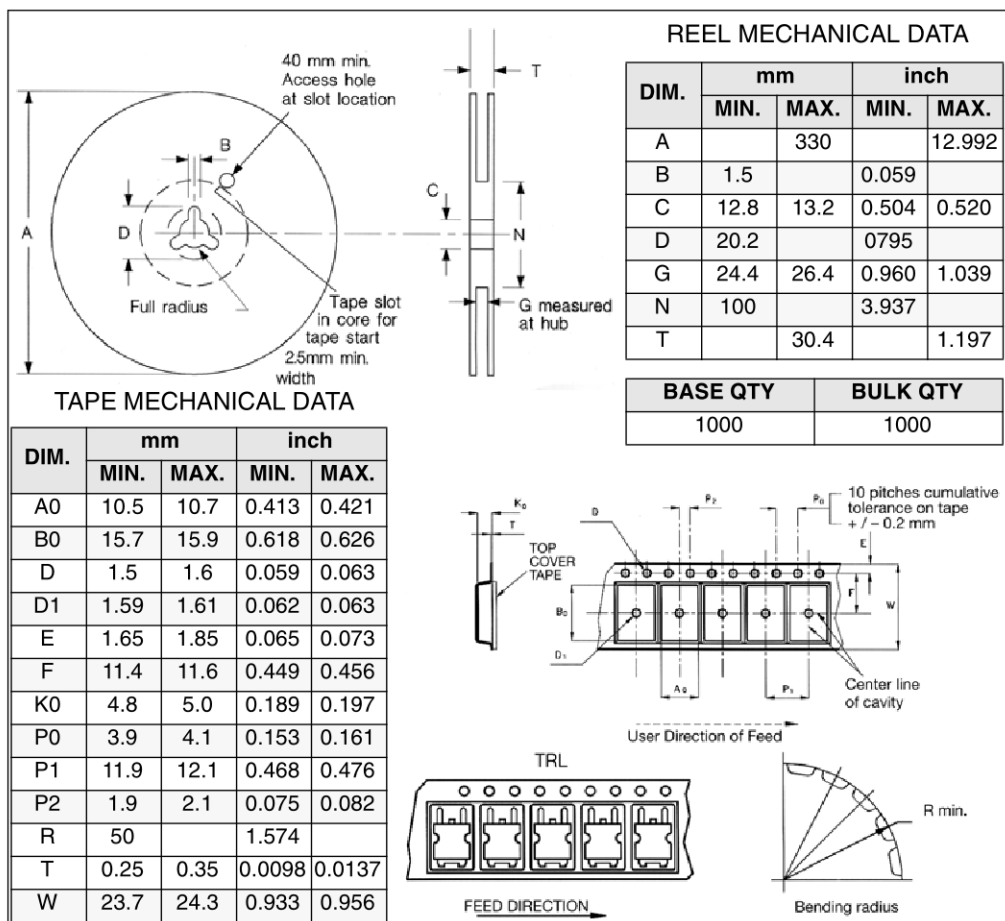


5 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



* on sales type

6 Revision history

Table 10. 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 Table 4
15-Mar-2010	7	Updated packages mechanical data.

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