

20 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)
- Short circuit withstand time 10 μ s
- IGBT co-packaged with ultra fast free-wheeling diode

Applications

- High frequency inverters
- Motor drivers

Description

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

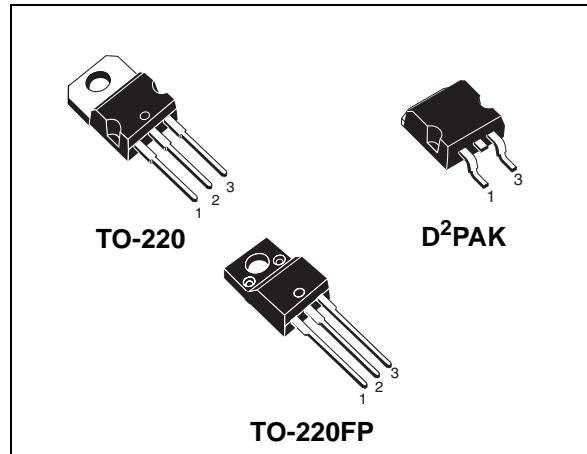


Figure 1. Internal schematic diagram

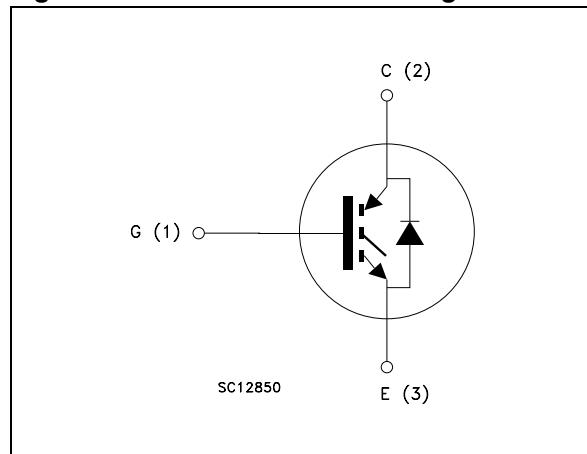


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGB19NC60KDT4	GB19NC60KD	D ² PAK	Tape and reel
STGF19NC60KD	GF19NC60KD	TO-220FP	Tube
STGP19NC60KD	GP19NC60KD	TO-220	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK TO-220	TO-220FP	
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	600		V
$I_C^{(1)}$	Collector current (continuous) at $T_C = 25^\circ\text{C}$	35	16	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100^\circ\text{C}$	20	10	A
$I_{CL}^{(2)}$	Turn-off latching current	75		A
$I_{CP}^{(3)}$	Pulsed collector current	75		A
V_{GE}	Gate-emitter voltage	± 20		V
I_F	Diode RMS forward current at $T_C = 25^\circ\text{C}$	20		A
I_{FSM}	Surge non repetitive forward current $t_p = 10 \text{ ms}$ sinusoidal	50		A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	125	32	W
t_{scw}	Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125^\circ\text{C}$, $R_G = 10 \Omega$, $V_{GE} = 12 \text{ V}$	10		μs
T_j	Operating junction temperature	– 55 to 150		$^\circ\text{C}$

1. Calculated according to the iterative formula:

$$I_c(T_c) = \frac{T_{J(MAX)} - T_c}{R_{thj-c} \times V_{CE(sat)(MAX)} \cdot (T_c, I_c)}$$

2. $V_{clamp} = 80\% \cdot (V_{CES})$, $T_j = 150^\circ\text{C}$, $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$

3. Pulse width limited by max. junction temperature allowed

Table 3. Thermal resistance

Symbol	Parameter	Value		Unit
		D ² PAK TO-220	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case IGBT max.	0.95	3.9	$^\circ\text{C/W}$
	Thermal resistance junction-case diode max.	3	5.6	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max.	62.5		$^\circ\text{C/W}$

2 Electrical characteristics

($T_{CASE} = 25^\circ\text{C}$ 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
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 15 \text{ V}, I_C = 12 \text{ A}$ $V_{GE} = 15 \text{ V}, I_C = 12 \text{ A}, T_C = 125^\circ\text{C}$		2.0 1.8	2.75	V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 600 \text{ V}$ $V_{CE} = 600 \text{ V}, T_C = 125^\circ\text{C}$			150 1	μA mA
$V_{GE(\text{th})}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250 \mu\text{A}$	4.5		6.5	V
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20 \text{ V}$			± 100	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15 \text{ V}, I_C = 12 \text{ A}$		15		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			1170		pF
C_{oes}	Output capacitance			127		pF
C_{res}	Reverse transfer capacitance	$V_{CE} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GE} = 0$		28		pF
Q_g	Total gate charge			55		nC
Q_{ge}	Gate-emitter charge	$V_{CE} = 480 \text{ V}, I_C = 12 \text{ A}, V_{GE} = 15 \text{ V}$		11		nC
Q_{gc}	Gate-collector charge	(see Figure 19)		26		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	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 18)		30 8 1450		ns ns A/ μs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, $T_c = 125^\circ\text{C}$ (see Figure 18)		30 8 1380		ns ns A/ μs
$t_r(V_{off})$ $t_d(off)$ t_f	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 18)		35 105 85		ns ns ns
$t_r(V_{off})$ $t_d(off)$ t_f	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$, $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$ $T_c = 125^\circ\text{C}$ (see Figure 18)		65 145 125		ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
E_{on} $E_{off}^{(1)}$ E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 18)		165 255 420		μJ μJ μJ
E_{on} $E_{off}^{(1)}$ E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 480 \text{ V}$, $I_C = 12 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, $T_c = 125^\circ\text{C}$ (see Figure 18)		250 445 695		μJ μJ μJ

1. 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	$I_F = 12 \text{ A}$ $I_F = 12 \text{ A}, T_c = 125 \text{ }^\circ\text{C}$		1.9 1.6		V V
t_{rr}	Reverse recovery time	$I_F = 12 \text{ A}, V_R = 40 \text{ V},$ $di/dt = 100 \text{ A}/\mu\text{s}$		31		ns
Q_{rr}	Reverse recovery charge			30		nC
I_{rrm}	Reverse recovery current	(see Figure 21)		2		A
t_{rr}	Reverse recovery time	$I_F = 12 \text{ A}, V_R = 40 \text{ V},$ $T_c = 125 \text{ }^\circ\text{C}, di/dt = 100 \text{ A}/\mu\text{s}$		50		ns
Q_{rr}	Reverse recovery charge			70		nC
I_{rrm}	Reverse recovery current	(see Figure 21)		4		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

Figure 3. Transfer characteristics

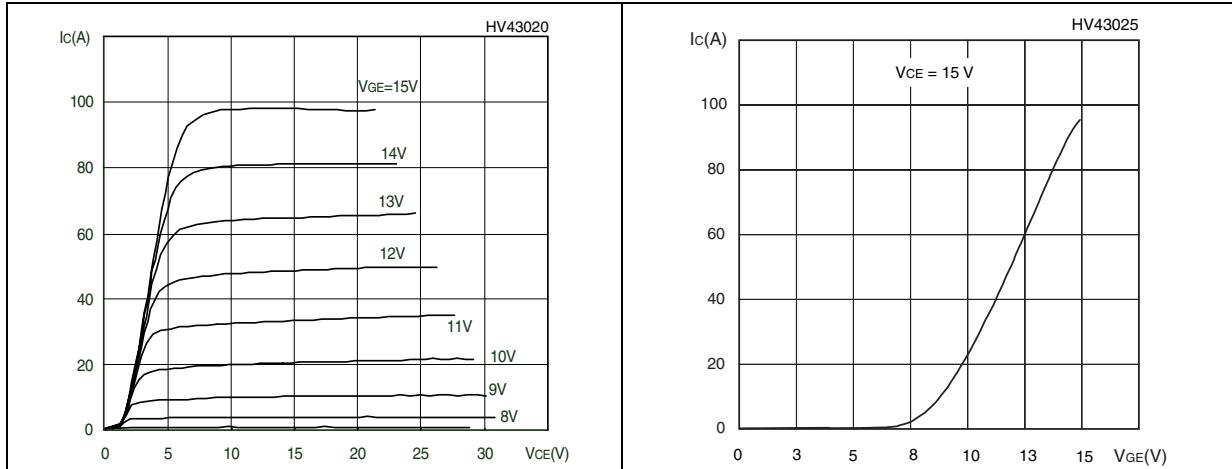


Figure 4. Transconductance

Figure 5. Collector-emitter on voltage vs temperature

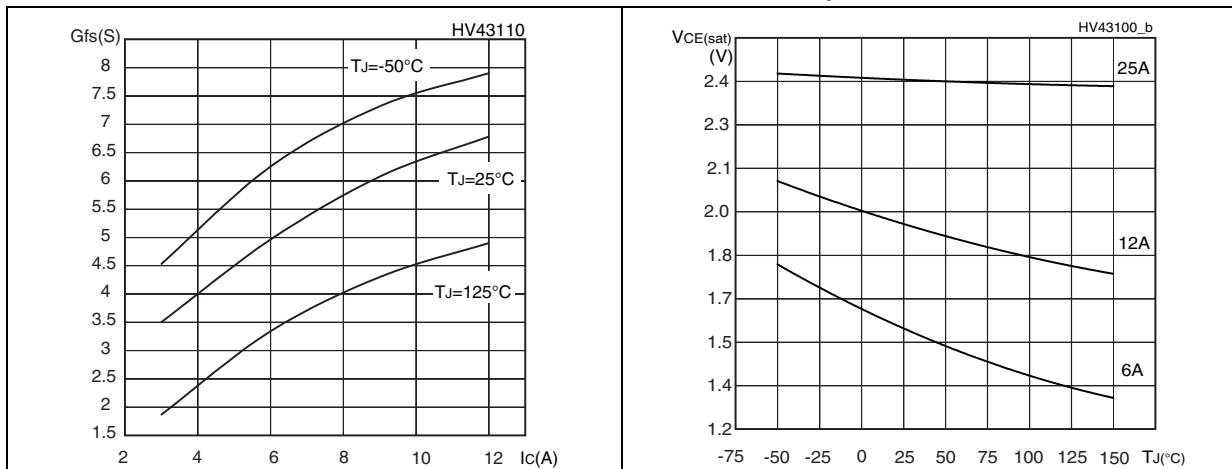


Figure 6. Gate charge vs gate-source voltage

Figure 7. Capacitance variations

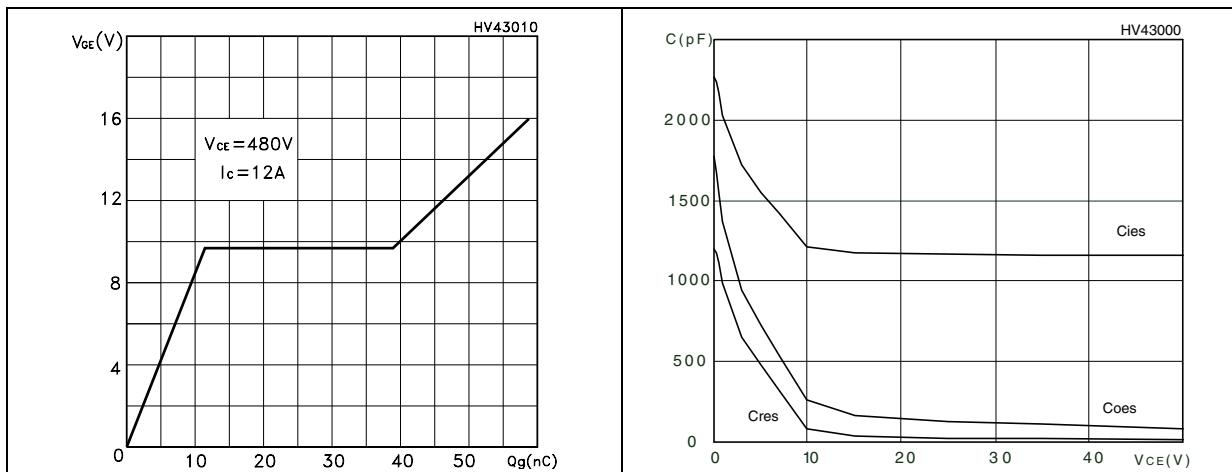


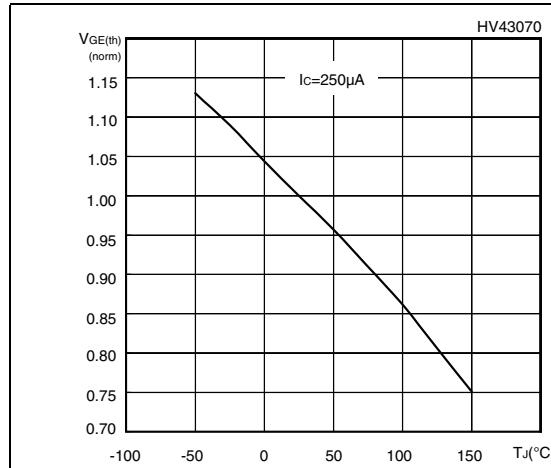
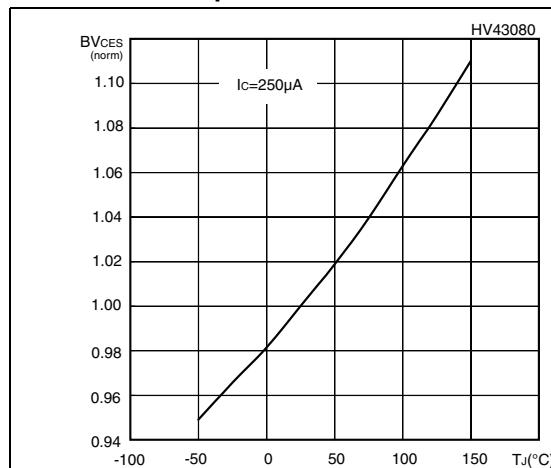
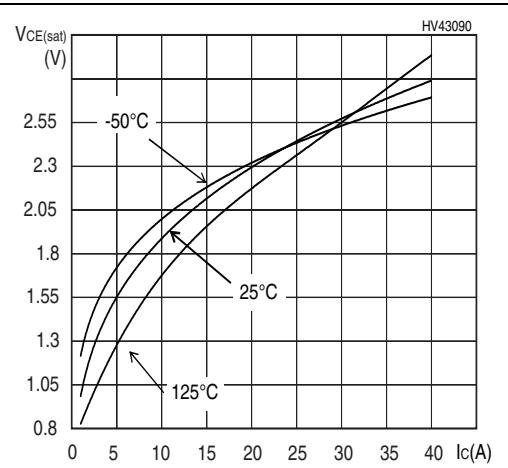
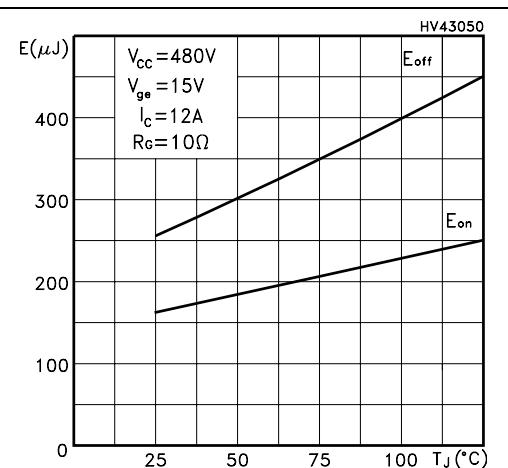
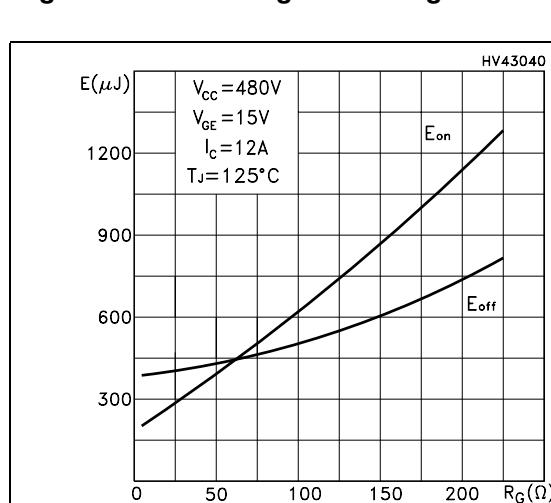
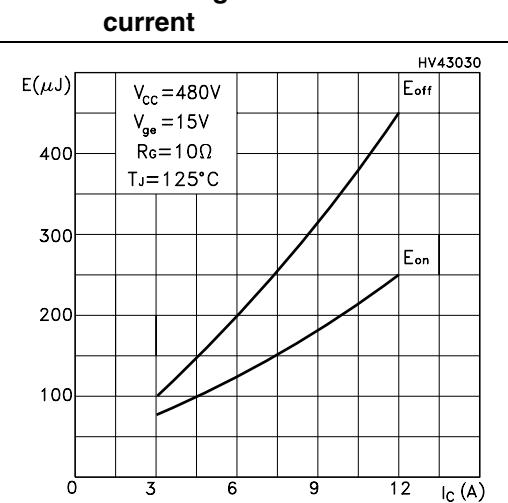
Figure 8. Normalized gate threshold voltage vs temperature**Figure 10. Normalized breakdown voltage vs temperature****Figure 9. Collector-emitter on voltage vs collector current****Figure 11. Switching losses vs temperature****Figure 12. Switching losses vs gate resistance****Figure 13. Switching losses vs collector current**

Figure 14. Turn-off SOA

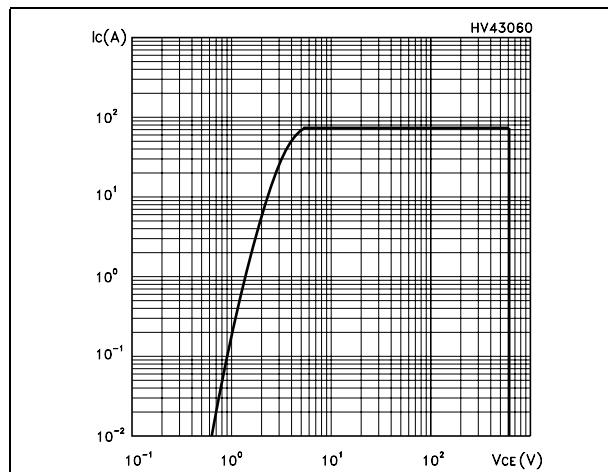


Figure 15. Emitter-collector diode characteristics

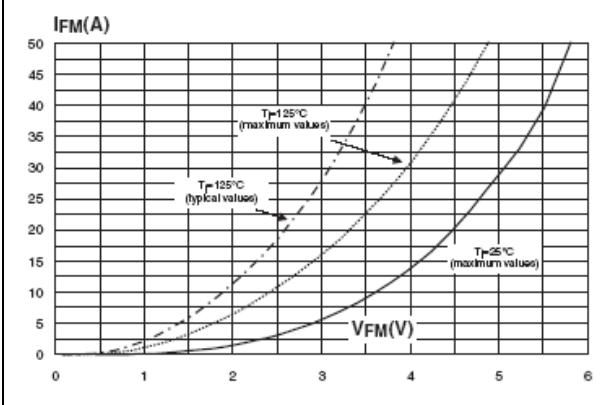
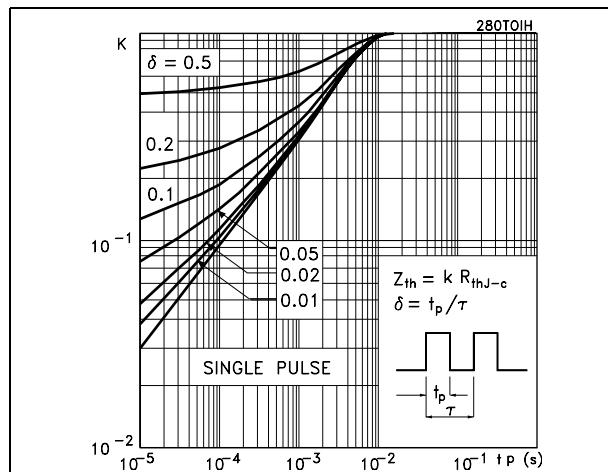
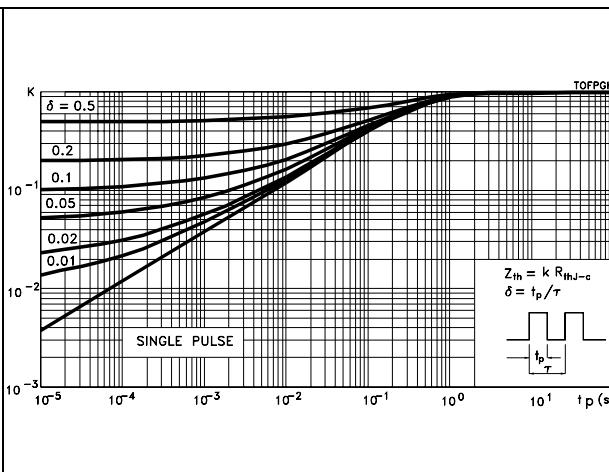
Figure 16. Thermal impedance for TO-220, D²PAK

Figure 17. Thermal impedance for TO-220FP



3 Test circuits

Figure 18. Test circuit for inductive load switching

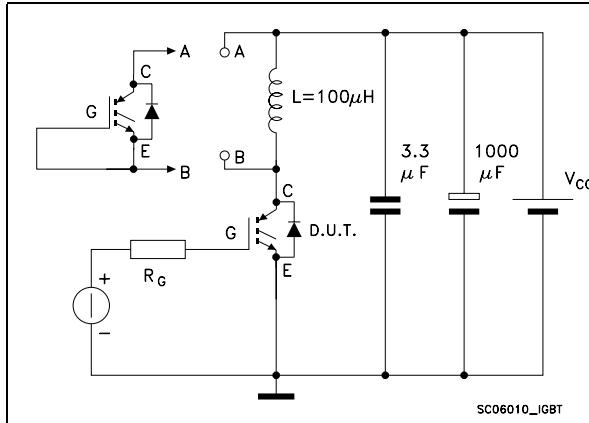


Figure 19. Gate charge test circuit

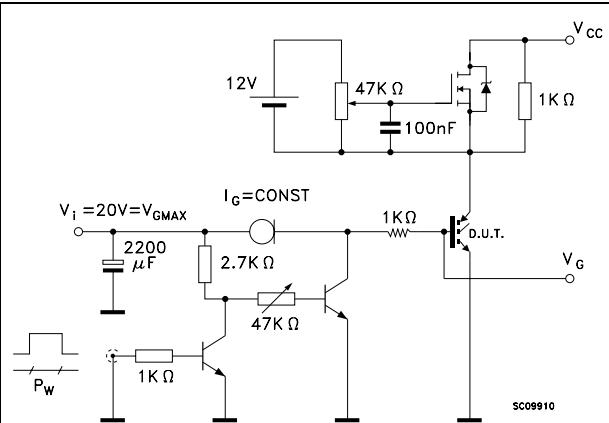


Figure 20. Switching waveforms

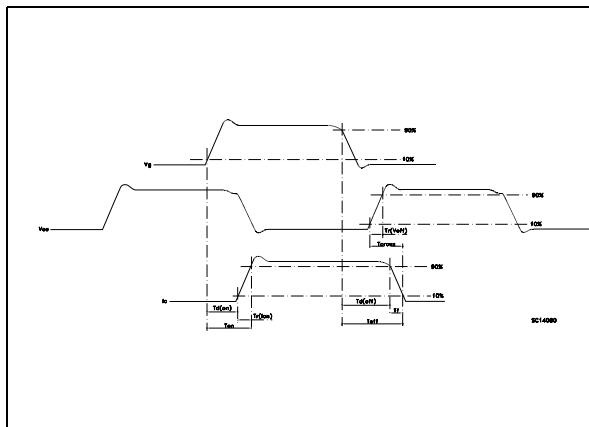
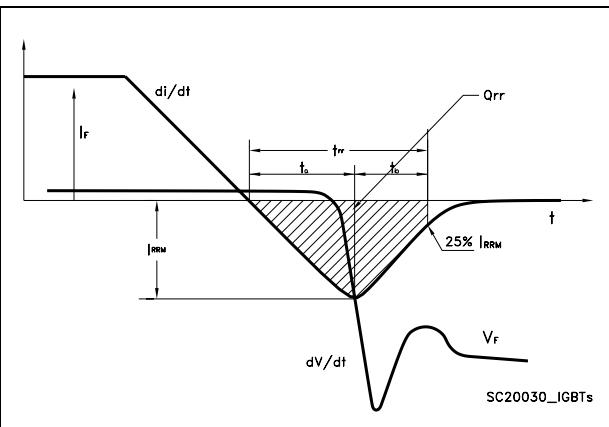


Figure 21. Diode recovery times waveform

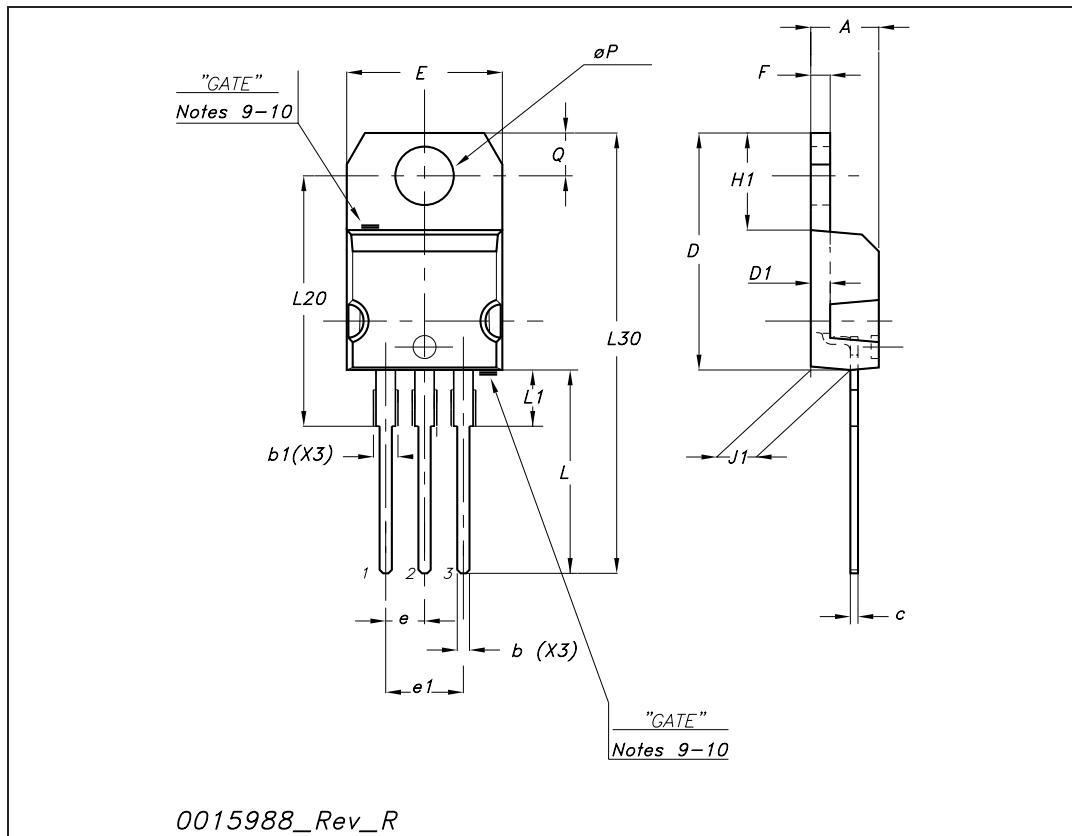


4 Package mechanical data

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

TO-220 mechanical data

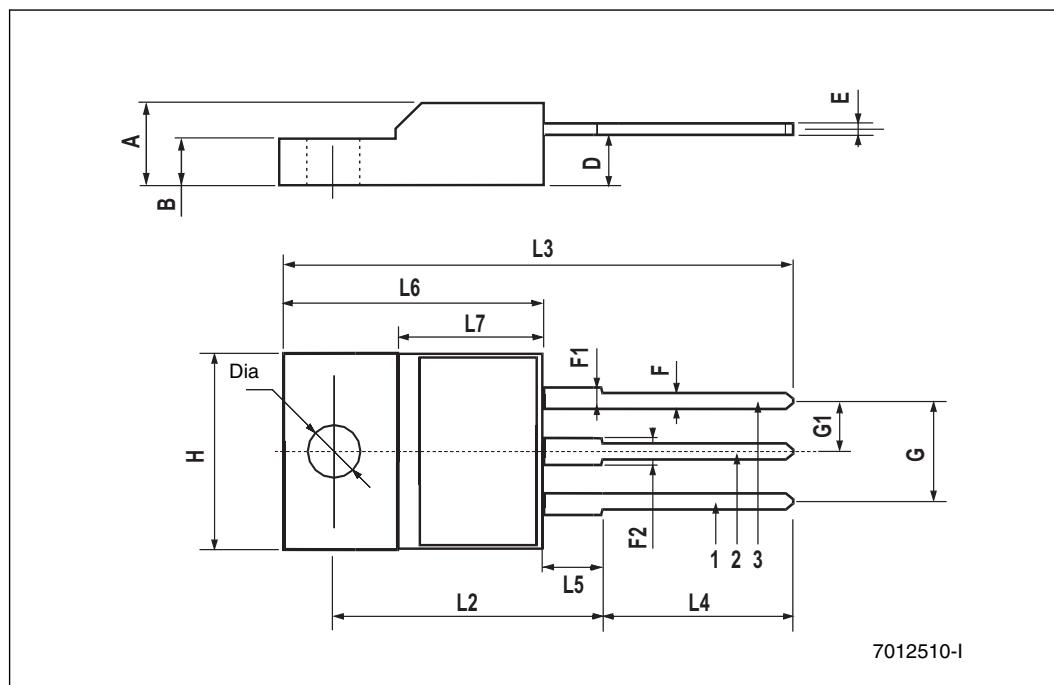
Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		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	
$\emptyset P$	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



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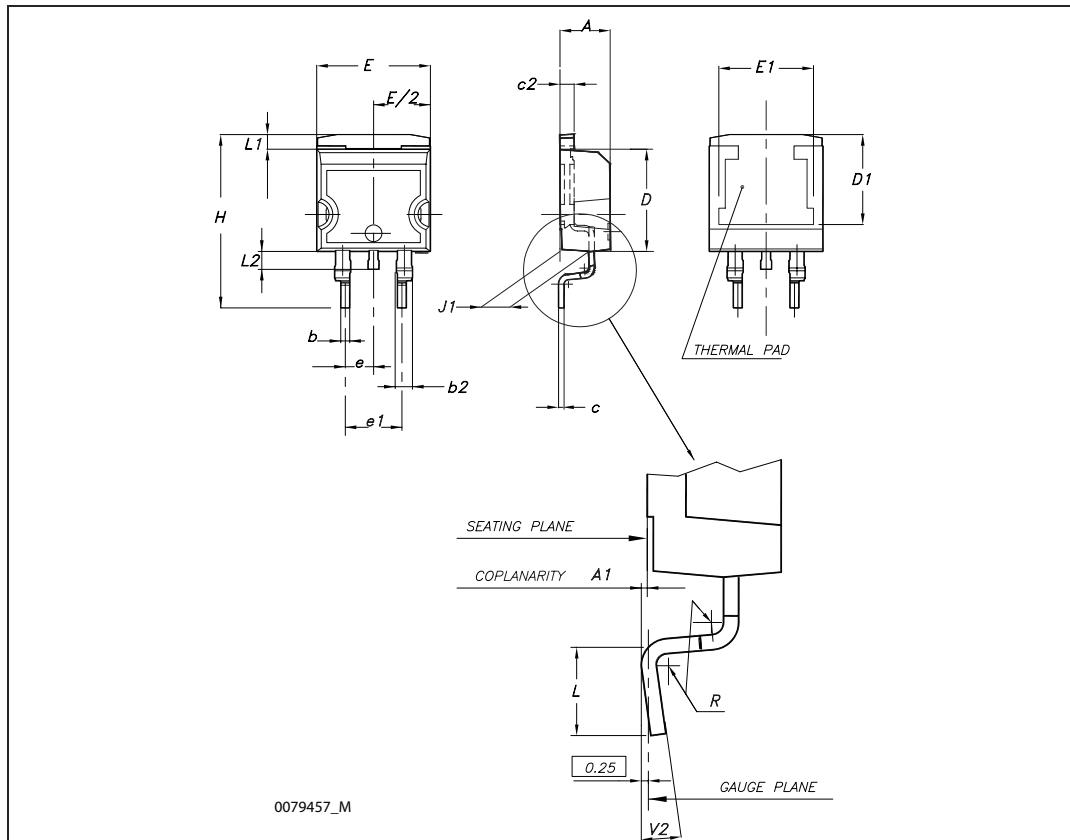
TO-220FP mechanical data

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



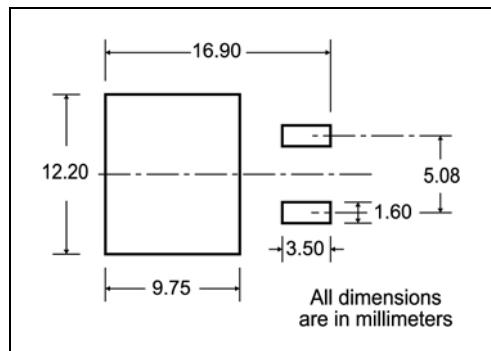
D²PAK (TO-263) mechanical data

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°



5 Packing mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

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	

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

User Direction of Feed

Center line of cavity

TRL

FEED DIRECTION

Bending radius R min.

* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
08-May-2008	1	Initial release
28-May-2008	2	<ul style="list-style-type: none">– Value on Table 3: Thermal resistance has been changed.– Inserted Figure 16: Thermal impedance for TO-220, D²PAK and Figure 17: Thermal impedance for TO-220FP

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