STGP7NC60HD
STGF7NC60HD - STGB7NC60HD

N-CHANNEL 14A - 600V - TO-220/TO-220FP/D²PAK
Very Fast PowerMESH™ IGBT

Table 1: General Features

TYPE	V_{CES}	$V_{CE(sat)}$ (Max) @25°C	I_C @100°C
STGP7NC60HD	600 V	< 2.5 V	14 A
STGF7NC60HD	600 V	< 2.5 V	6 A
STGB7NC60HD	600 V	< 2.5 V	14 A

- LOWER ON-VOLTAGE DROP (V_{cesat})
- OFF LOSSES INCLUDE TAIL CURRENT
- LOSSES INCLUDE DIODE RECOVERY ENERGY
- LOWER C_{RES}/C_{IES} RATIO
- HIGH FREQUENCY OPERATION UP TO 70 KHz
- VERY SOFT ULTRA FAST RECOVERY ANTI PARALLEL DIODE
- NEW GENERATION PRODUCTS WITH TIGHTER PARAMETER DISTRIBUTION

Figure 1: Package

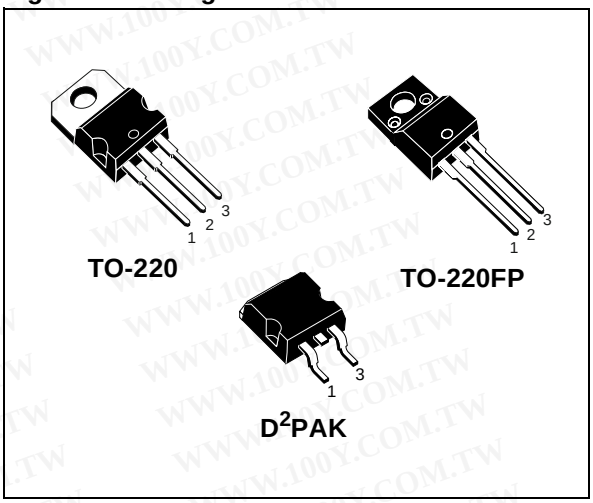
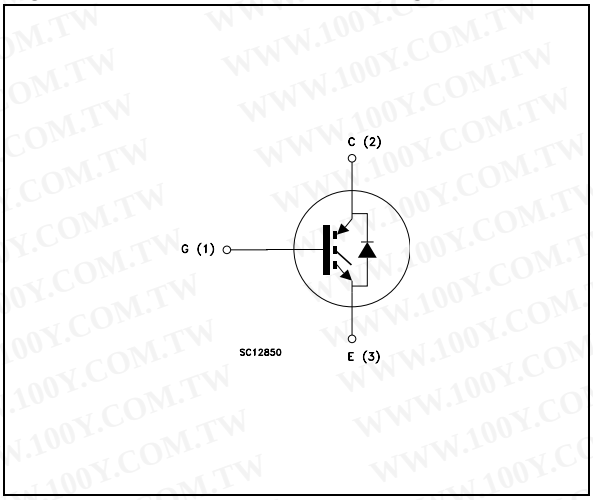


Figure 2: Internal Schematic Diagram



DESCRIPTION

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix "H" identifies a family optimized for high frequency applications in order to achieve very high switching performances (reduced tfall) maintaining a low voltage drop.

APPLICATIONS

- HIGH FREQUENCY INVERTERS
- SMPS AND PFC IN BOTH HARD SWITCH AND RESONANT TOPOLOGIES
- MOTOR DRIVERS

Table 2: Order Code

PART NUMBER	MARKING	PACKAGE	PACKAGING
STGP7NC60HD	GP7NC60HD	TO-220	TUBE
STGF7NC60HD	GF7NC60HD	TO-220FP	TUBE
STGB7NC60HDT4	GB7NC60HD	D²PAK	TAPE & REEL

Table 3: Absolute Maximum ratings

Symbol	Parameter	Value		Unit
		STGP7NC60HD STGB7NC60HD	STGF7NC60HD	
V_{CES}	Collector-Emitter Voltage (V_{GS} = 0)	600		V
V_{ECR}	Emitter-Collector Voltage	20		V
V_{GE}	Gate-Emitter Voltage	±20		V
I_C	Collector Current (continuous) at T_C = 25°C (#)	25	10	A
I_C	Collector Current (continuous) at T_C = 100°C (#)	14	6	A
I_{CM} (✉)	Collector Current (pulsed)	50		A
I_F	Diode RMS Forward Current at T_C = 25°C	20		A
P_{TOT}	Total Dissipation at T_C = 25°C	80	25	W
	Derating Factor	0.64	0.20	W/°C
V_{ISO}	Insulation Withstand Voltage A.C.(t = 1 sec; Tc = 25°C)	--	2500	V
T_{stg}	Storage Temperature	– 55 to 150		°C
T_j	Operating Junction Temperature			

(✉) Pulse width limited by max. junction temperature.

Table 4: Thermal Data

			Min.	Typ.	Max.	
Rthj-case	Thermal Resistance Junction-case	**TO-220** **D²PAK**			1.56	°C/W
		TO-220FP			5.0	°C/W
Rthj-amb	Thermal Resistance Junction-ambient				62.5	°C/W
T_L	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)			300		°C

ELECTRICAL CHARACTERISTICS (T_{CASE} =25°C UNLESS OTHERWISE SPECIFIED)

Table 5: Main Parameters

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-Emitter Breakdown Voltage	I_C = 1 mA, V_{GE} = 0	600			V
I_{CES}	Collector cut-off Current (V_{GE} = 0)	V_{CE} = Max Rating, T_C = 25 °C V_{CE} = Max Rating, T_C = 125 °C			10 1	µA mA
I_{GES}	Gate-Emitter Leakage Current (V_{CE} = 0)	V_{GE} = ± 20V , V_{CE} = 0			±100	nA
$V_{GE(th)}$	Gate Threshold Voltage	V_{CE} = V_{GE}, I_C = 250 µA	3.75		5.75	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE} = 15V, I_C = 7 A V_{GE} = 15V, I_C = 7 A, Tc= 125°C		1.85 1.7	2.5	V V

(#) Calculated according to the iterative formula:

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

ELECTRICAL CHARACTERISTICS (CONTINUED)

Table 6: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward Transconductance	V_{CE} = 15 V , I_C = 7 A		4.30		S
C_{ies}	Input Capacitance	V_{CE} = 25 V, f= 1 MHz, V_{GE} = 0		720		pF
C_{oes}	Output Capacitance			81		pF
C_{res}	Reverse Transfer Capacitance			17		pF
Q_g	Total Gate Charge	V_{CE} = 390 V, I_C = 7 A,		35	48	nC
Q_{ge}	Gate-Emitter Charge	V_{GE} = 15 V		7		nC
Q_{gc}	Gate-Collector Charge	(see Figure 22)		16		nC
I_{CL}	Turn-Off SOA Minimum Current	V_{clamp} = 480 V , Tj = 150°C R_G = 10 Ω, V_{GE} = 15 V	50			A

(1) Pulsed: Pulse duration= 300 µs, duty cycle 1.5%

Table 7: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time	V_{CC} = 390 V, I_C = 7 A		18.5		ns
t_r	Current Rise Time	R_G= 10 Ω, V_{GE}= 15V, Tj= 25°C		8.5		ns
$(di/dt)_{on}$	Turn-on Current Slope	(see Figure 19)		1060		A/µs
$t_{d(on)}$	Turn-on Delay Time	V_{CC} = 390 V, I_C = 7 A		18.5		ns
t_r	Current Rise Time	R_G= 10 Ω, V_{GE}= 15V, Tj= 125°C		7		ns
$(di/dt)_{on}$	Turn-on Current Slope	(see Figure 20)		1000		A/µs

Table 8: Switching Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$	Off Voltage Rise Time	V_{cc} = 390 V, I_C = 7 A,		27		ns
$t_{d(off)}$	Turn-off Delay Time	R_G = 10 Ω , V_{GE} = 15 V T_J = 25 °C		72		ns
t_f	Current Fall Time	(see Figure 20)		60		ns
$t_r(V_{off})$	Off Voltage Rise Time	V_{cc} = 390 V, I_C = 7 A,		56		ns
$t_{d(off)}$	Turn-off Delay Time	R_G = 10 Ω , V_{GE} = 15 V Tj = 125 °C		116		ns
t_f	Current Fall Time	(see Figure 20)		105		ns

Table 9: Switching Energy

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
Eon (2)	Turn-on Switching Losses	V_{CC} = 390 V, I_C = 7 A		95	125	µJ
E_{off} (3)	Turn-off Switching Loss	R_G= 10 Ω, V_{GE}= 15V, Tj= 25°C		115	150	µJ
E_{ts}	Total Switching Loss	(see Figure 19)		210	275	µJ
Eon (2)	Turn-on Switching Losses	V_{CC} = 390 V, I_C = 7 A		140		µJ
E_{off} (3)	Turn-off Switching Loss	R_G= 10 Ω, V_{GE}= 15V, Tj= 125°C		215		µJ
E_{ts}	Total Switching Loss	(see Figure 20)		355		µJ

(2) Eon 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)
(3) Turn-off losses include also the tail of the collector current.

Table 10: Collector-Emitter Diode

Symbol	Parameter	Test Condiction	Min.	Typ.	Max.	Unit
V_f	Forward On-Voltage	If = 3.5 A If = 3.5 A, Tj = 125 °C		1.3 1.1	1.9	V V
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current Softness factor of the diode	If = 7 A, V_R = 40 V, T_j = 25 °C, di/dt = 100 A/µs		37 22 40 2.1 0.68		ns ns nC A
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current Softness factor of the diode	If = 7 A, V_R = 40 V, T_j = 125 °C, di/dt = 100 A/µs		61 34 98 3.2 0.79		ns ns nC A

Figure 3: Output Characteristics

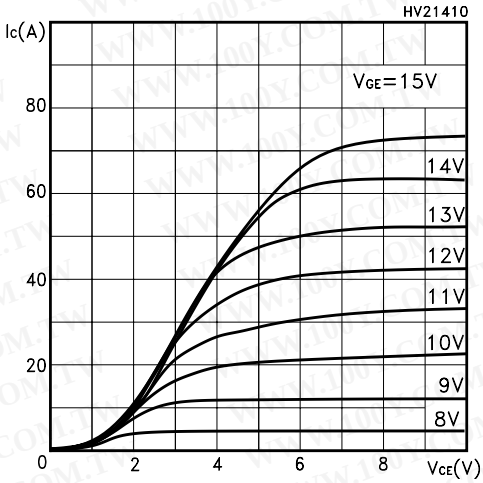


Figure 4: Transconductance

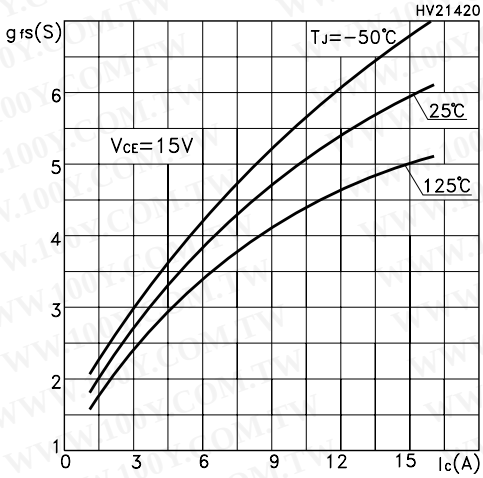


Figure 5: Collector-Emitter On Voltage vs Collector Current

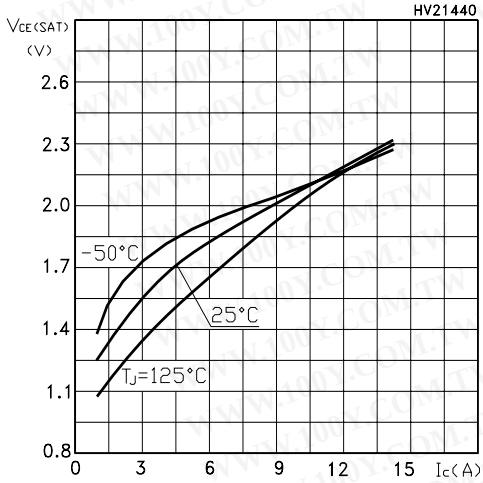


Figure 6: Transfer Characteristics

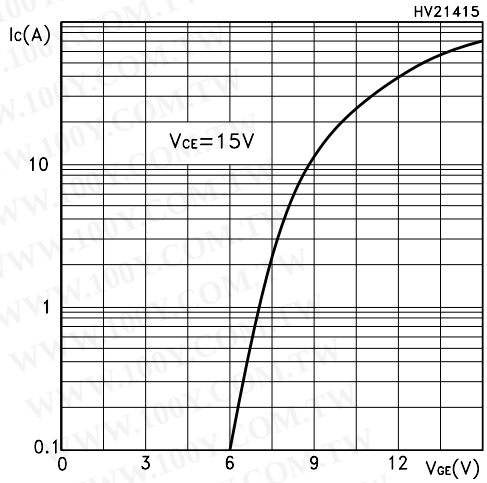


Figure 7: Collector-Emitter On Voltage vs Temperature

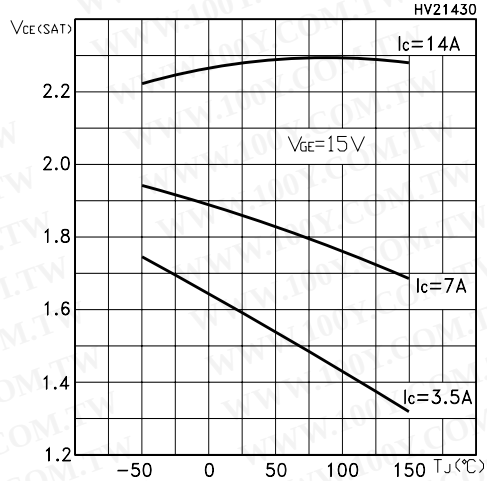


Figure 8: Normalized Gate Threshold vs Temperature

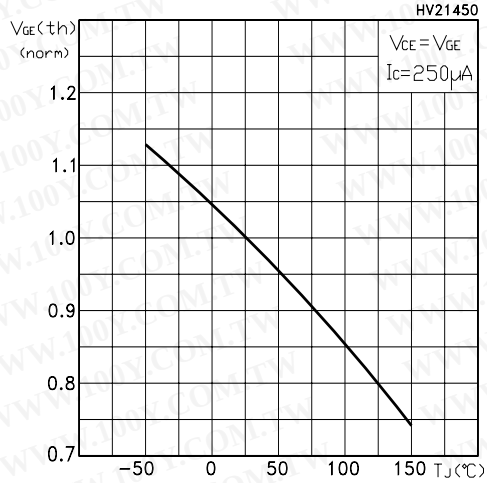


Figure 9: Normalized Breakdown Voltage vs Temperature

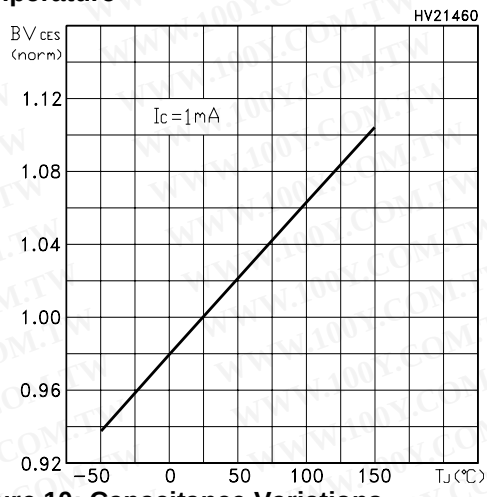


Figure 10: Capacitance Variations

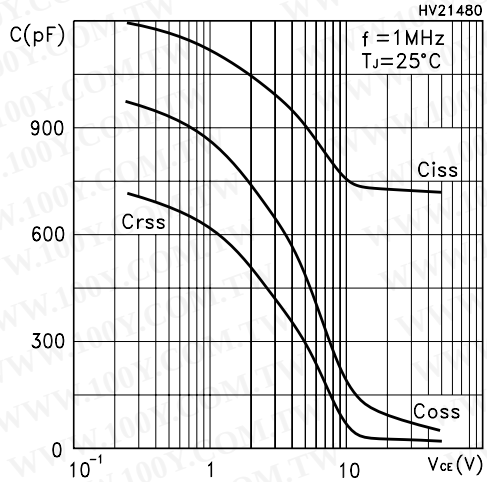


Figure 11: Total Switching Losses vs Gate Resistance

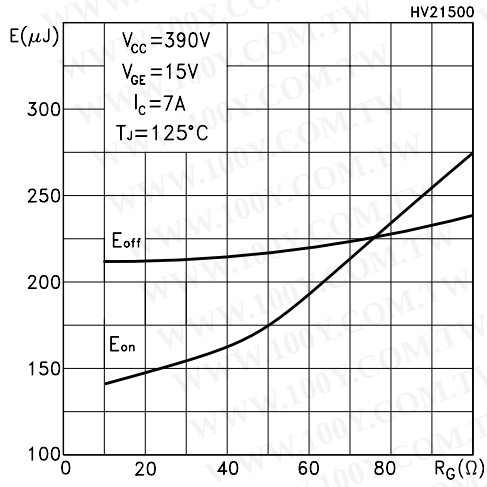


Figure 12: Gate Charge vs Gate-Emitter Voltage

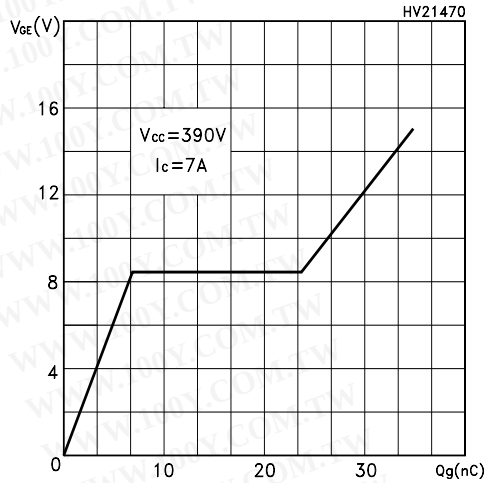


Figure 13: Total Switching Losses vs Temperature

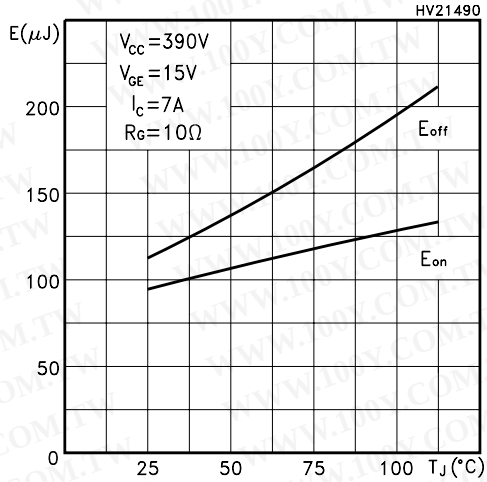


Figure 14: Total Switching Losses vs Collector Current

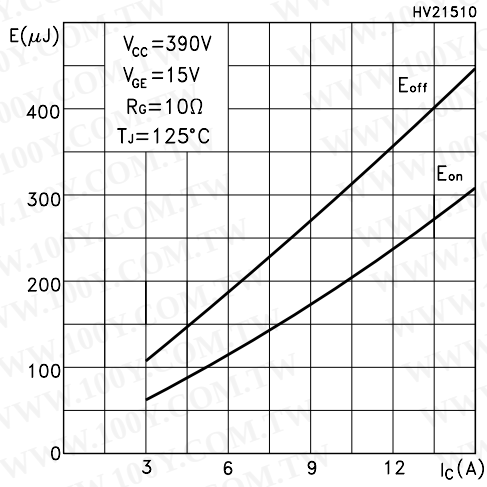


Figure 15: Thermal Impedance For TO-220/ D²PAK

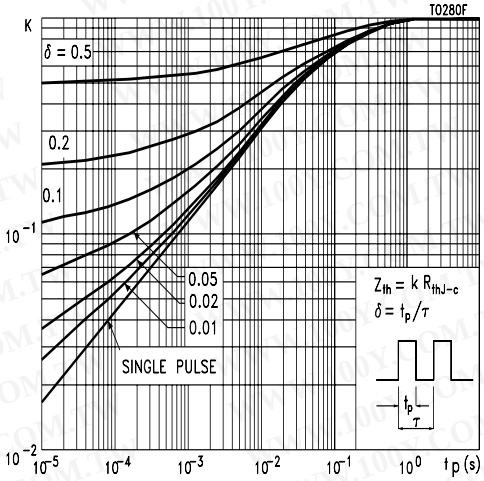


Figure 16: Thermal Impedance For TO-220FP

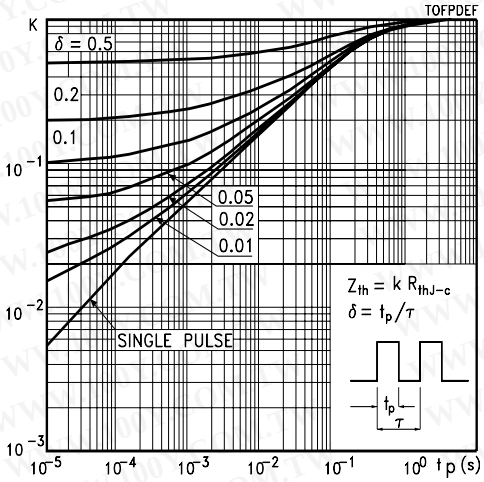


Figure 17: Turn-Off SOA

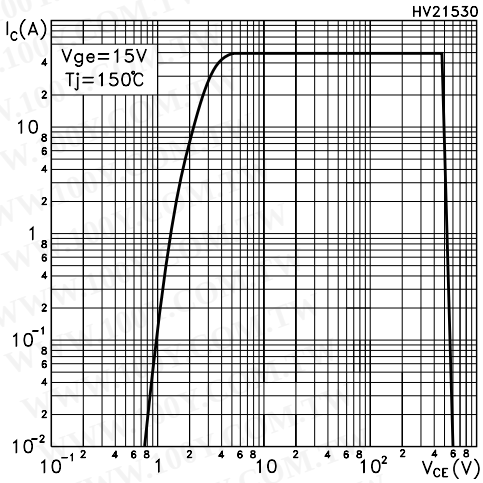


Figure 18: Emitter-Collector Diode Characteristics

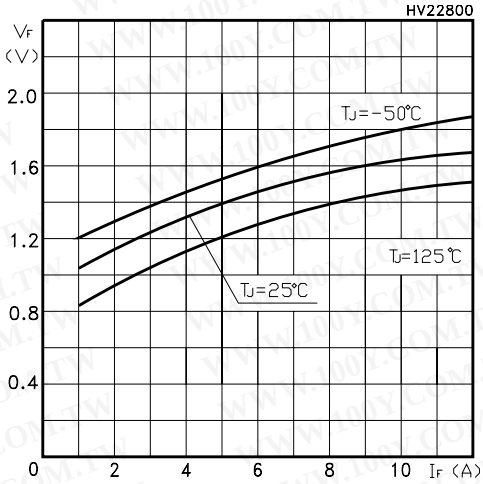
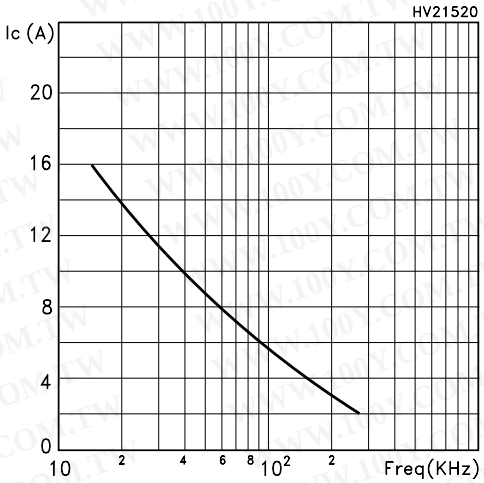


Figure 19: Ic vs Frequency



For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

1) The maximum power dissipation is limited by maximum junction to case thermal resistance:

$$P_D = \Delta T / R_{THJ-C}$$

considering $\Delta T = T_J - T_C = 125\ °C - 75\ °C = 50°C$

2) The conduction losses are:

$$P_C = I_C * V_{CE(SAT)} * \delta$$

with 50% of duty cycle, V_{CESAT} typical value @125°C.

3) Power dissipation during ON & OFF commutations is due to the switching frequency:

$$P_{SW} = (E_{ON} + E_{OFF}) * freq.$$

4) Typical values @ 125°C for switching losses are used (test conditions: V_{CE} = 390V, V_{GE} = 15V, R_G = 3.3 Ohm). Furthermore, diode recovery energy is included in the E_{ON} (see note 2), while the tail of the collector current is included in the E_{OFF} measurements (see note 3).

Figure 20: Test Circuit for Inductive Load Switching

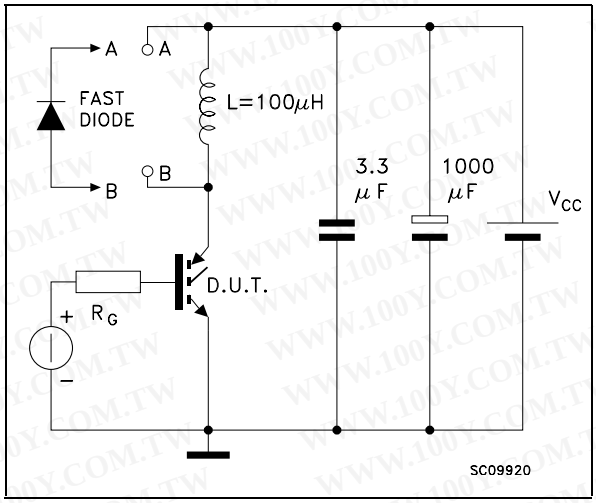


Figure 21: Switching Waveforms

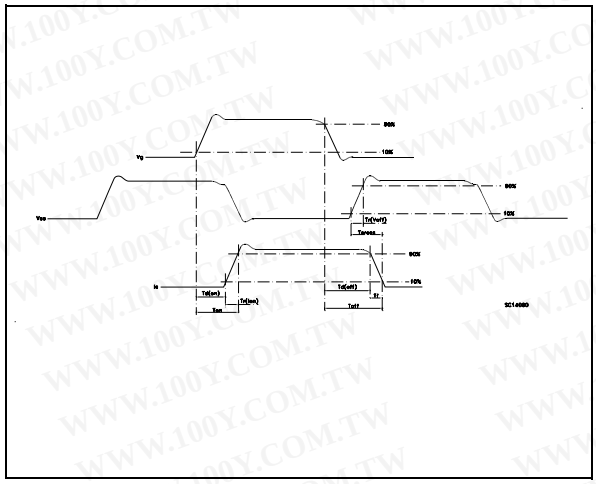


Figure 22: Gate Charge Test Circuit

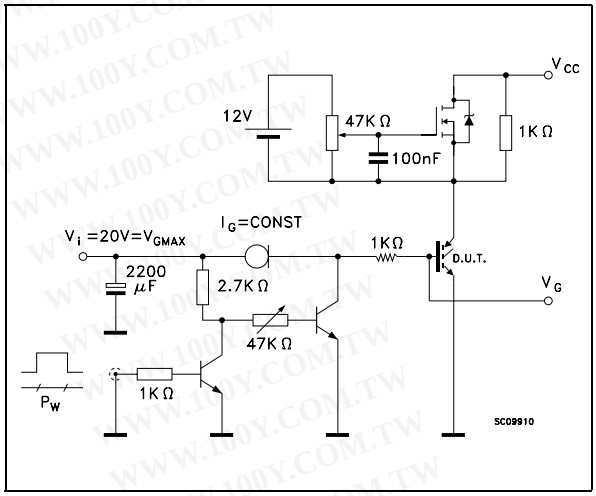
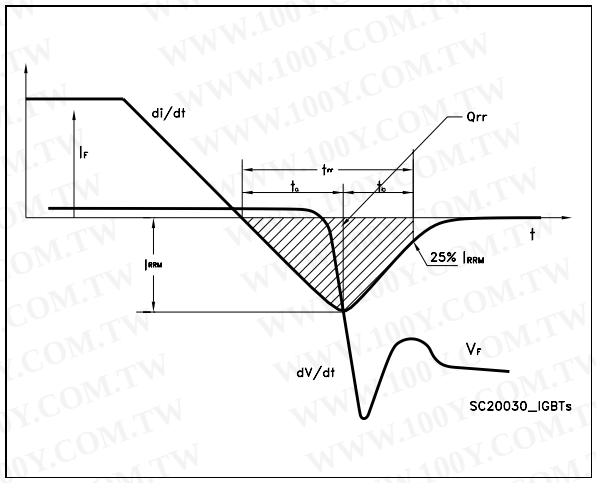
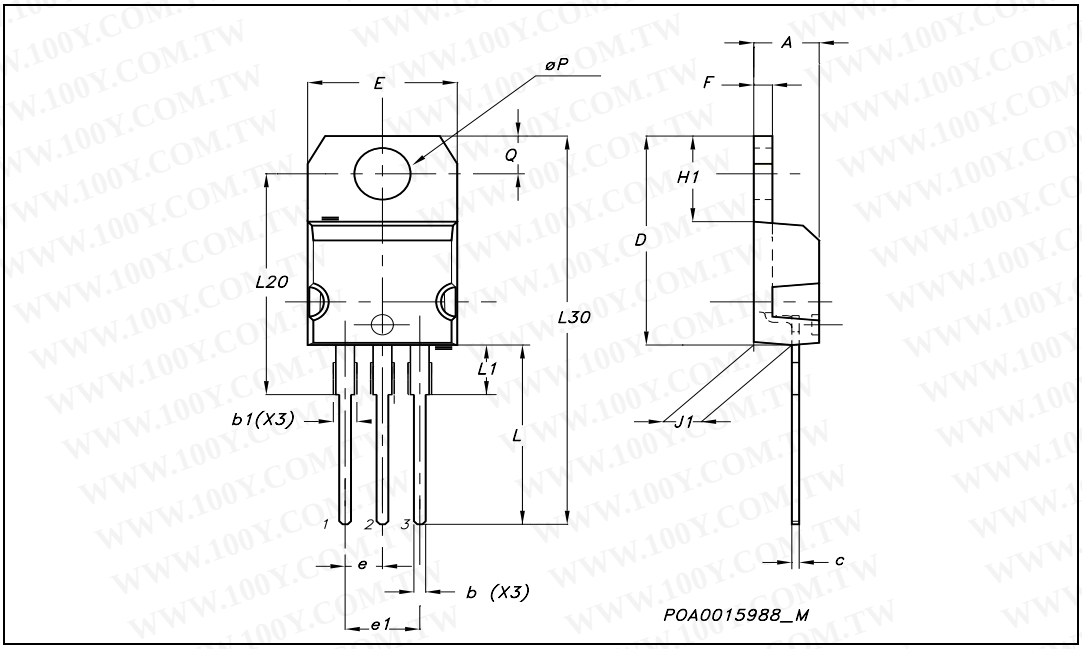


Figure 23: Diode Recovery Time Waveforms



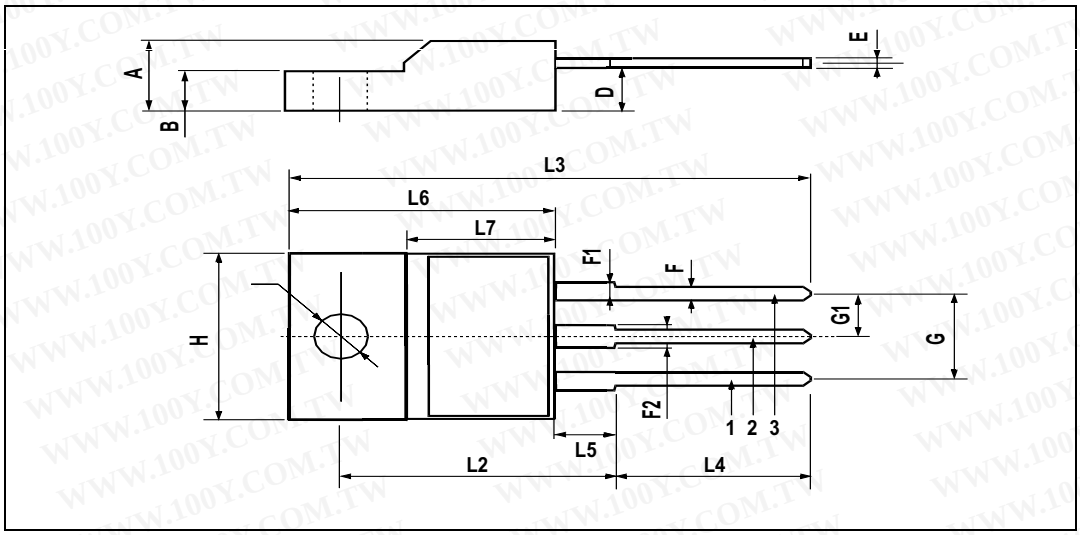
TO-220 MECHANICAL DATA

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



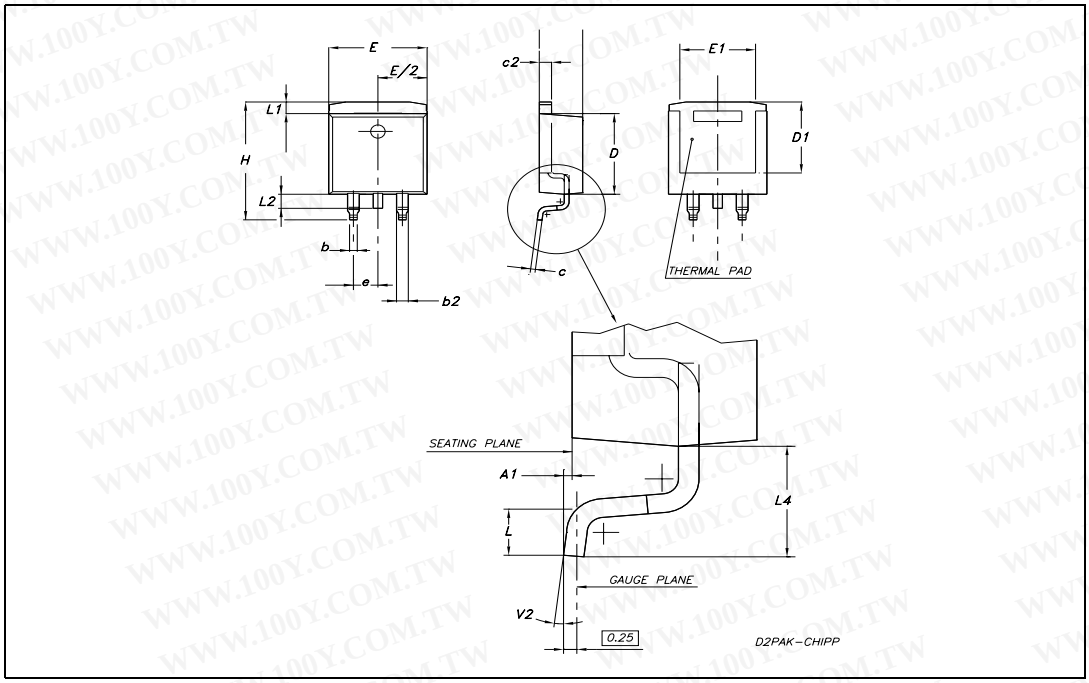
TO-220FP MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	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		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126

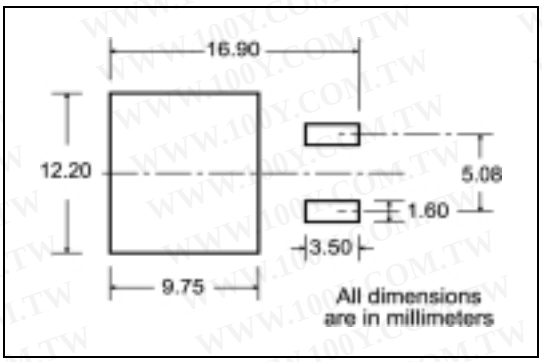


TO-263 (D^2PAK) MECHANICAL DATA

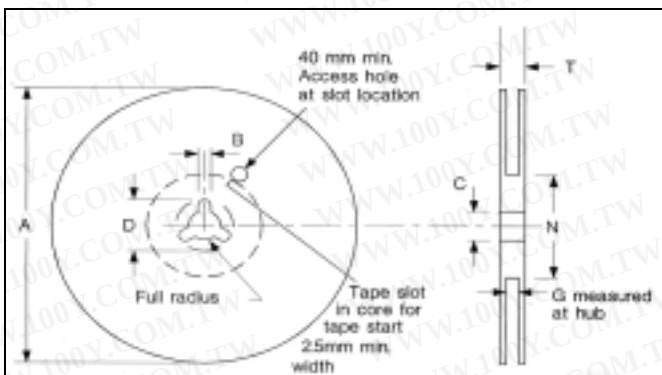
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.32		4.57	0.178		0.180
A1	0.00		0.25	0.00		0.009
b	0.71		0.91	0.028		0.350
b2	1.15		1.40	0.045		0.055
c	0.46		0.61	0.018		0.024
c2	1.22		1.40	0.048		0.055
D	8.89	9.02	9.40	0.350	0.355	0.370
D1	8.01			0.315		
E	10.04		10.28	0.395		0.404
e		2.54			0.010	
H	13.10		13.70	0.515		0.540
L	1.30		1.70	0.051		0.067
L1	1.15		1.39	0.045		0.054
L2	1.27		1.77	0.050		0.069
L4	2.70		3.10	0.106		0.122
V2	0°		8°	0°		8°



D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



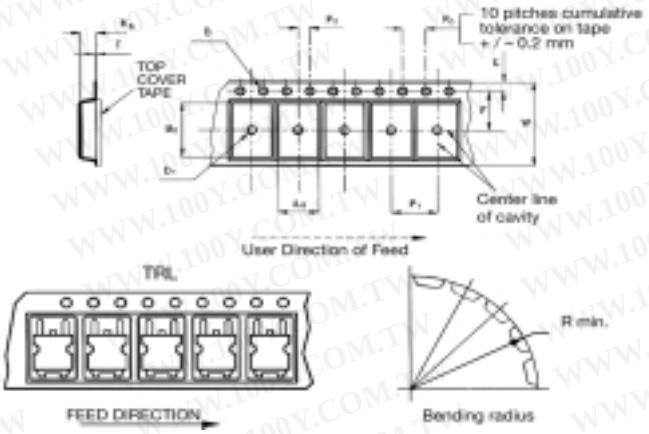
REEL MECHANICAL DATA

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		0795	
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



* on sales type

Table 11: Revision History 9

Date	Revision	Description of Changes
07-Jun-2004	4	Stylesheet update. No content change
19-Aug-2004	5	Complete Version
17-Sep-2004	6	Figure 18 has been added
09-Nov-2004	7	Final datasheet
19-Jan-2005	8	Datasheet updated
09-Jun-2005	9	Modified title