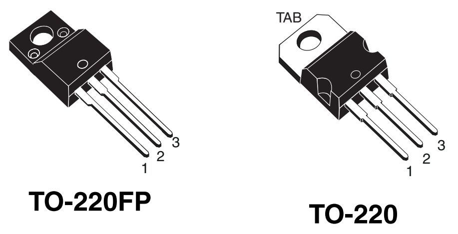
STGF19NC60SD
STGP19NC60SD

20 A, 600 V fast IGBT with Ultrafast diode

Features

- Very low on-voltage drop ($V_{CE(sat)}$)
- Minimum power losses at 5 kHz in hard switching
- Optimized performance for medium operating frequencies.
- IGBT co-packaged with Ultrafast freewheeling diode



Application

Medium frequency motor drives

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

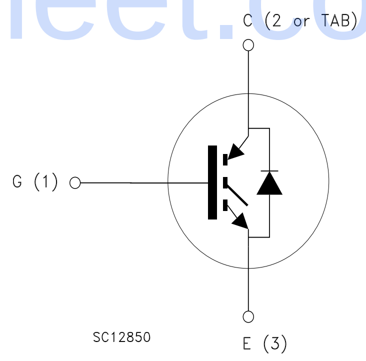


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGF19NC60SD	GF19NC60SD	TO-220FP	Tube
STGP19NC60SD	GP19NC60SD	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600		V
I_C (1)	Continuous collector current at T_C = 25°C	40	17	A
I_C (1)	Continuous collector current at T_C = 100°C	20	11	A
I_{CP} (2)	Pulsed collector current	80		A
I_{CL} (3)	Turn-off latching current	80		A
I_F	Diode RMS forward current at T_C = 25°C	20		A
I_{FSM}	Surge non repetitive forward current t_p = 10ms sinusoidal	50		A
V_{GE}	Gate-emitter voltage	±20		V
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T_C = 25 °C)		2500	V
P_{TOT}	Total dissipation at T_C = 25°C	130	32	W
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. Pulse width limited by maximum junction temperature and turn-off within RBSOA
3. Vclamp = 80% of V_{CES}, T_j =150 °C, R_G=10 Ω, V_{GE}=15 V

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
R_{thj-c}	Thermal resistance junction-case IGBT	0.96	3.9	°C/W
	Thermal resistance junction-case diode	3	5.5	°C/W
R_{thj-a}	Thermal resistance junction-ambient	62.5		°C/W

2 Electrical characteristics

(T_j = 25°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= 1mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE}= 15V, I_C= 12A V_{GE}= 15V, I_C=12A,T_j =125°C		1.55 1.35	1.9	V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C= 250 µA	4.2		6.2	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE}= 600 V V_{CE}= 600 V, T_j =125°C			150 1	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE}= ±20V, V_{CE}= 0			±100	nA
g_{fs}	Forward transconductance	V_{CE} = 15V, I_C= 12A		10		S

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25V, f = 1MHz, V_{GE} = 0	-	1190 135 28.5	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 480V, I_C = 12A, V_{GE} = 15V, *Figure 20*	-	54.5 8.7 25.8	-	nC nC 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} = 480V, I_C = 12A R_G= 10Ω, V_{GE}= 15V, *Figure 21*	-	17.5 6.2 1870	-	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} = 480V, I_C = 12A R_G= 10Ω, V_{GE}= 15V, T_j = 125°C *Figure 21*	-	17 6.5 1700	-	ns ns A/µs
$t_{r(Voff)}$ $t_{d(Voff)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 480V, I_C = 12A R_G= 10Ω, V_{GE}= 15V, *Figure 21*	-	90 175 215	-	ns ns ns
$t_{r(Voff)}$ $t_{d(Voff)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 480V, I_C = 12A R_G= 10Ω, V_{GE}= 15V, T_j = 125°C *Figure 21*	-	155 245 290	-	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 V, I_C = 12 A R_G= 10 Ω, V_{GE}= 15 V, *Figure 19*	-	135 815 995	-	µJ µJ µJ
E_{on} E_{off}(1) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 480 V, I_C = 12 A R_G= 10 Ω, V_{GE}= 15 V, T_j = 125 °C *Figure 19*	-	200 1175 1375	-	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 A I_F = 12 A, T_j = 125 °C		2.3 2.0		V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 12 A, V_R =40 V, di/dt=100 A/µs *Figure 22*		31 29.5 1.9		ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 12 A, V_R =40 V, di/dt=100 A/µs, T_j = 125 °C *Figure 22*		48.5 70.5 3		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

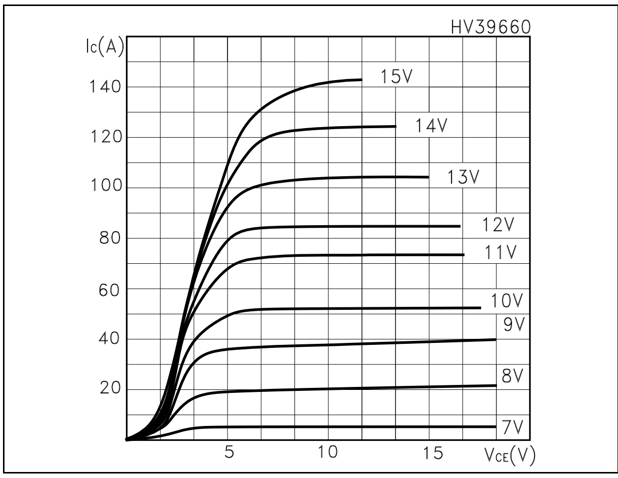


Figure 3. Transfer characteristics

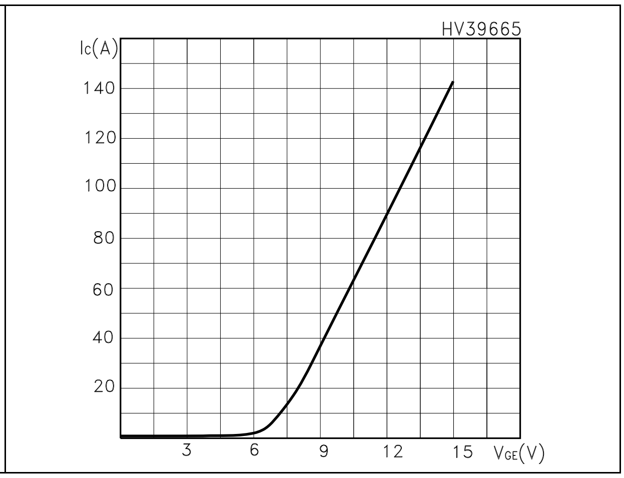


Figure 4. Transconductance

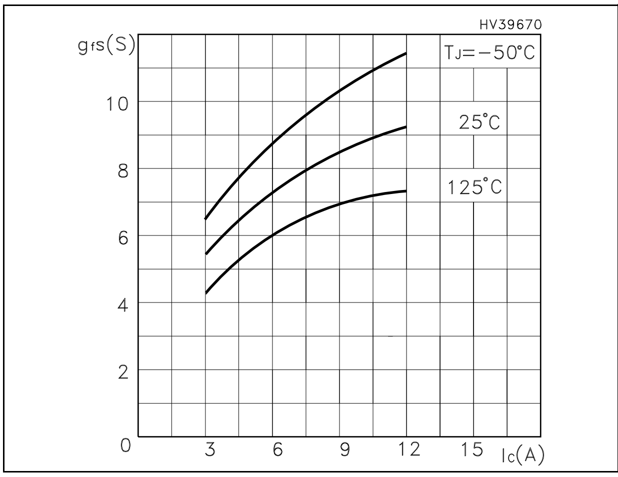


Figure 5. Collector-emitter on voltage vs temperature

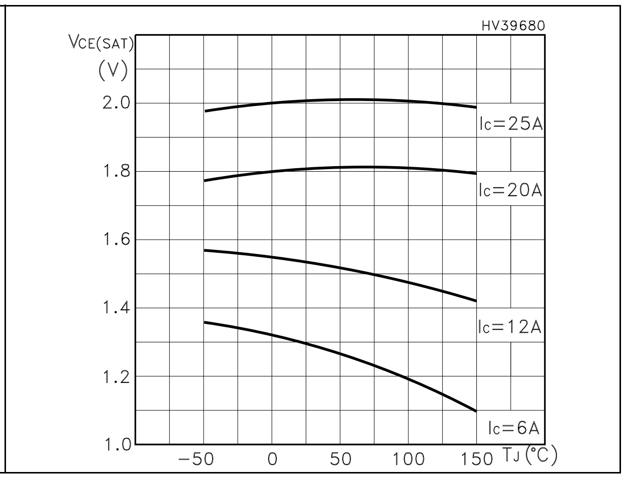


Figure 6. Gate charge vs gate-source voltage

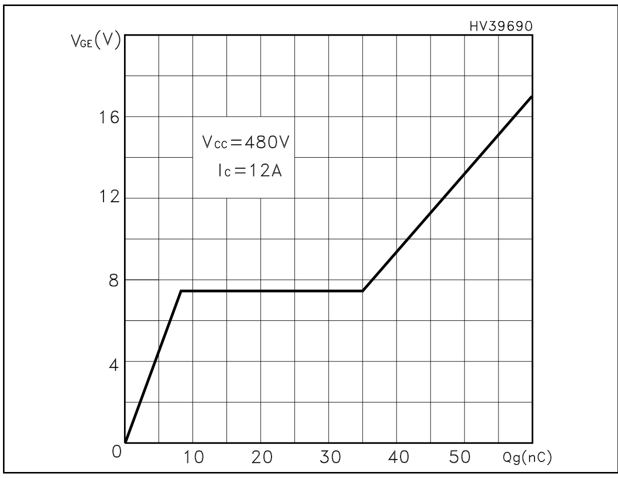


Figure 7. Capacitance variations

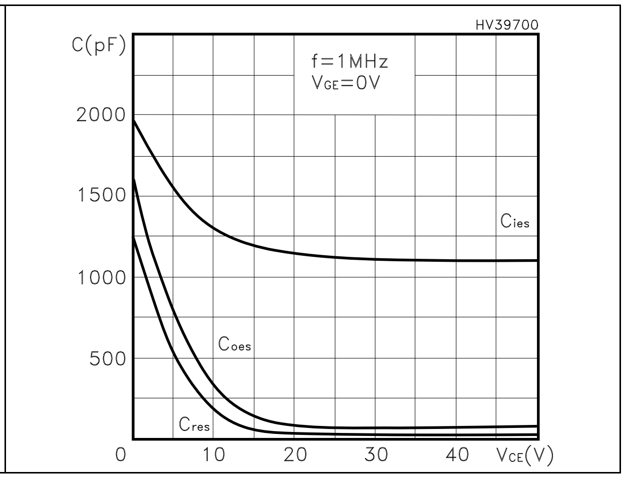


Figure 8. Normalized gate threshold voltage vs temperature

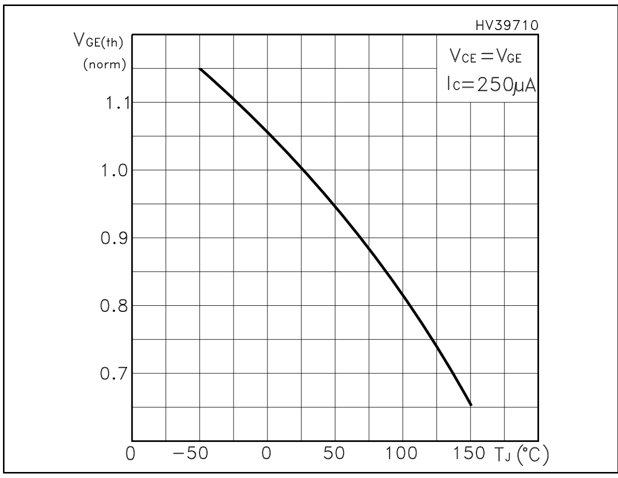


Figure 9. Collector-emitter on voltage vs collector current

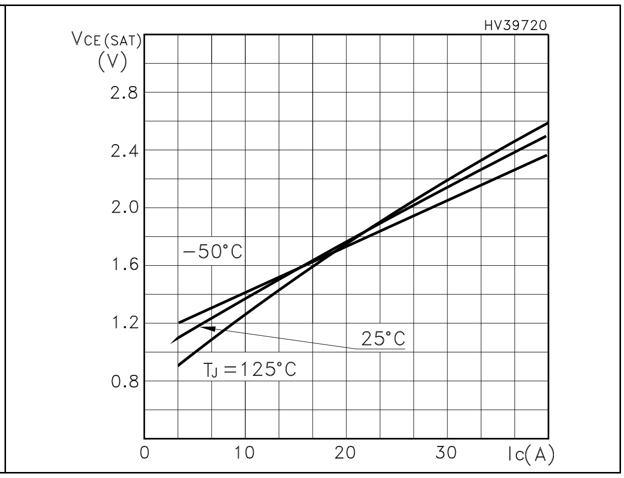


Figure 10. Normalized breakdown voltage vs temperature

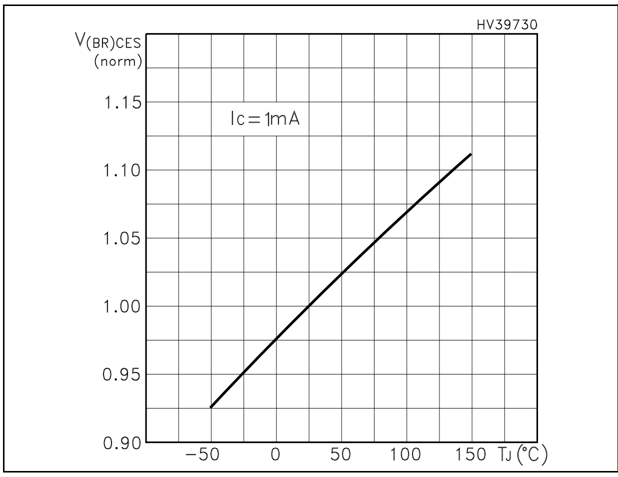


Figure 11. Switching losses vs temperature

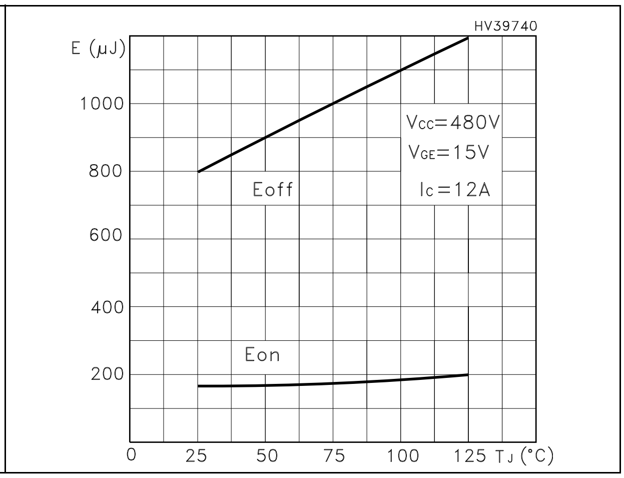


Figure 12. Switching losses vs gate resistance

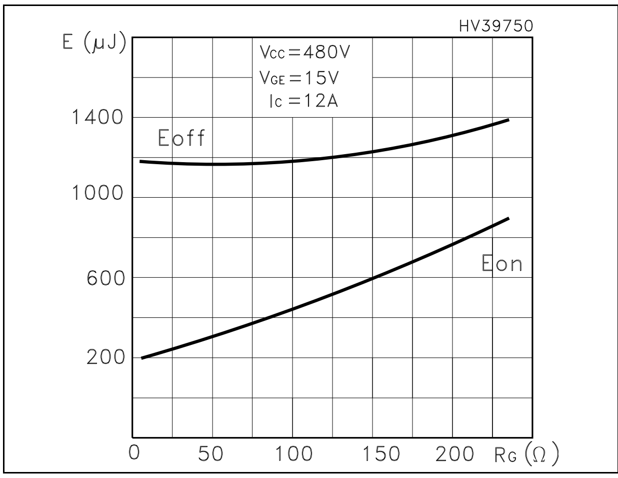


Figure 13. Switching losses vs collector current

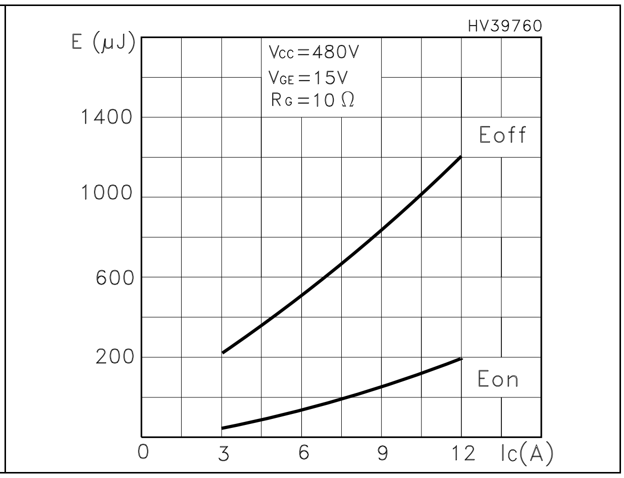


Figure 14. Turn-off SOA

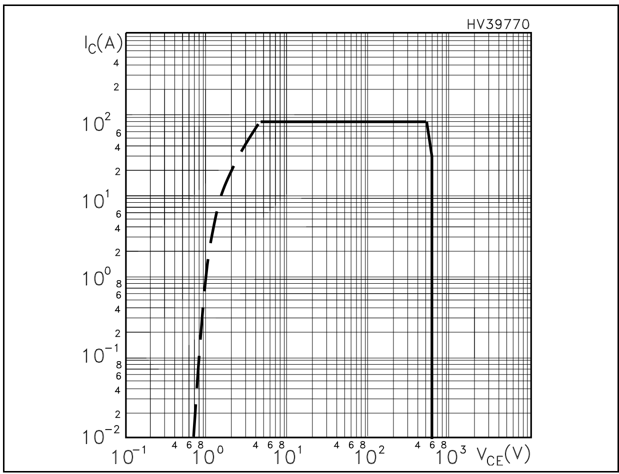


Figure 15. Thermal impedance for TO-220

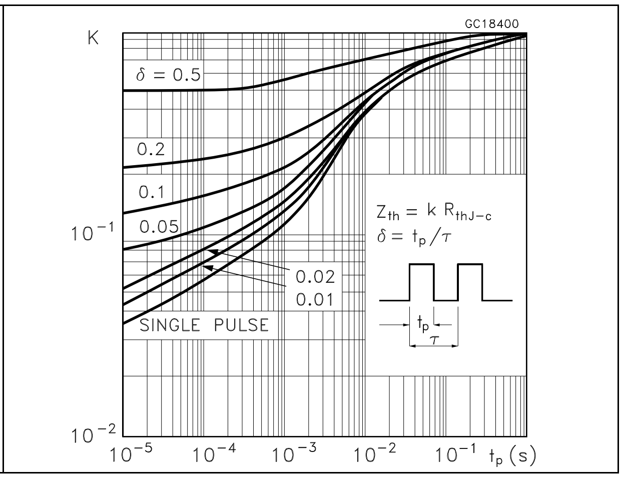


Figure 16. Thermal impedance for TO-220FP

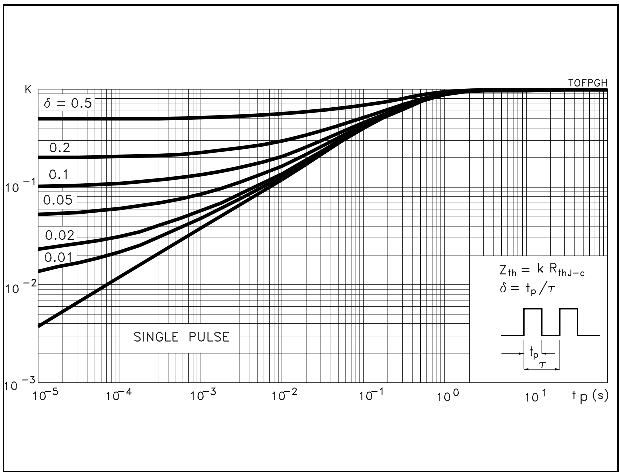


Figure 17. Forward voltage drop versus forward current

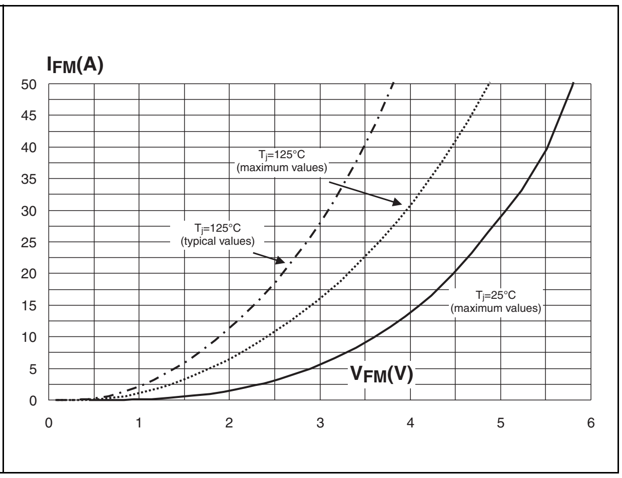
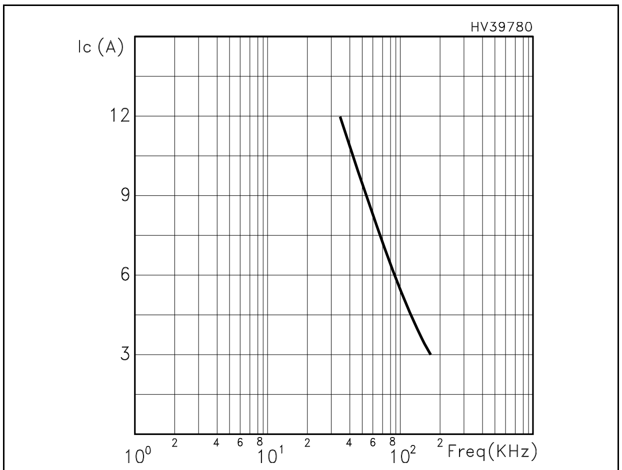


Figure 18. I_C vs. frequency



2.2 Frequency applications

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:

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

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

Equation 1

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

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

- The conduction losses are:

Equation 2

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

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

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

Equation 3

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

Typical values @ 125°C for switching losses are used (test conditions: V_{CE} = 480V, V_{GE}=15V, R_G = 10 Ohm). Furthermore, diode recovery energy is included in the E_{ON} (see *Note 1*), while the tail of the collector current is included in the E_{OFF} measurements.

3 Test circuits

Figure 19. Test circuit for inductive load switching

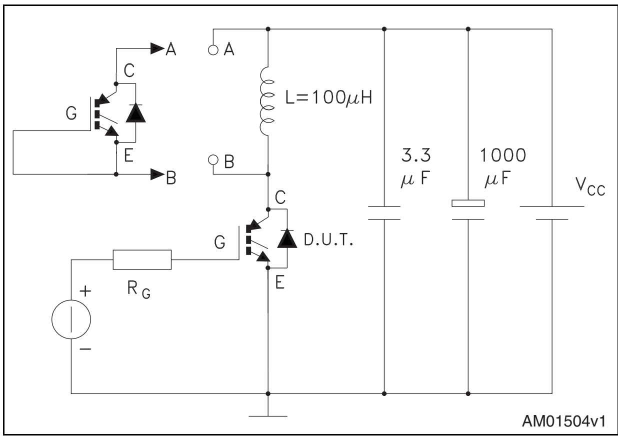


Figure 20. Gate charge test circuit

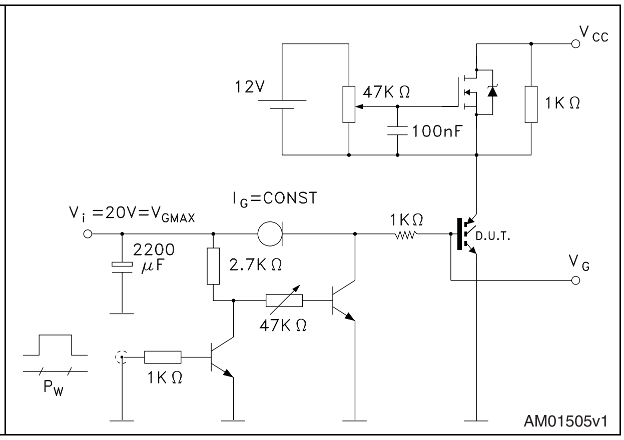


Figure 21. Switching waveform

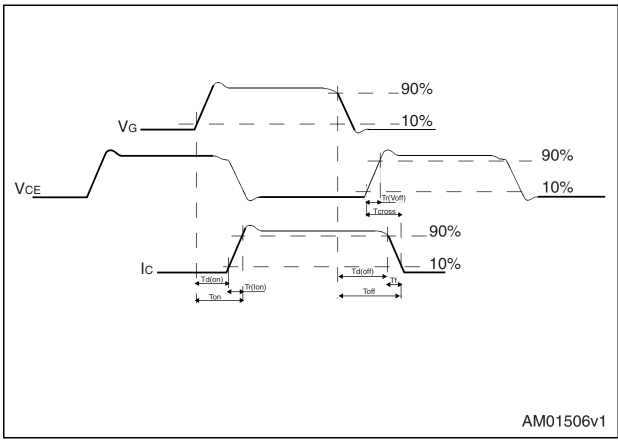
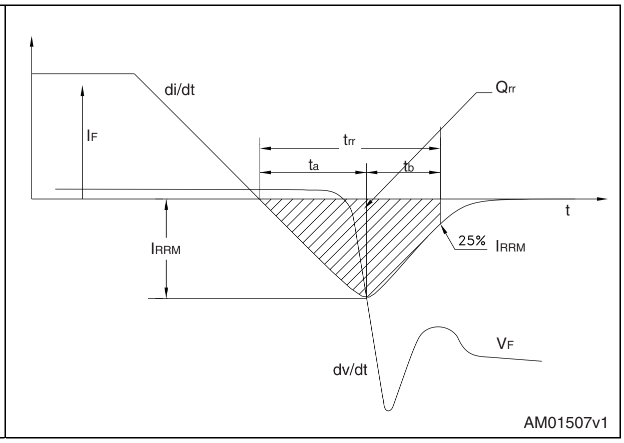


Figure 22. Diode recovery time waveform



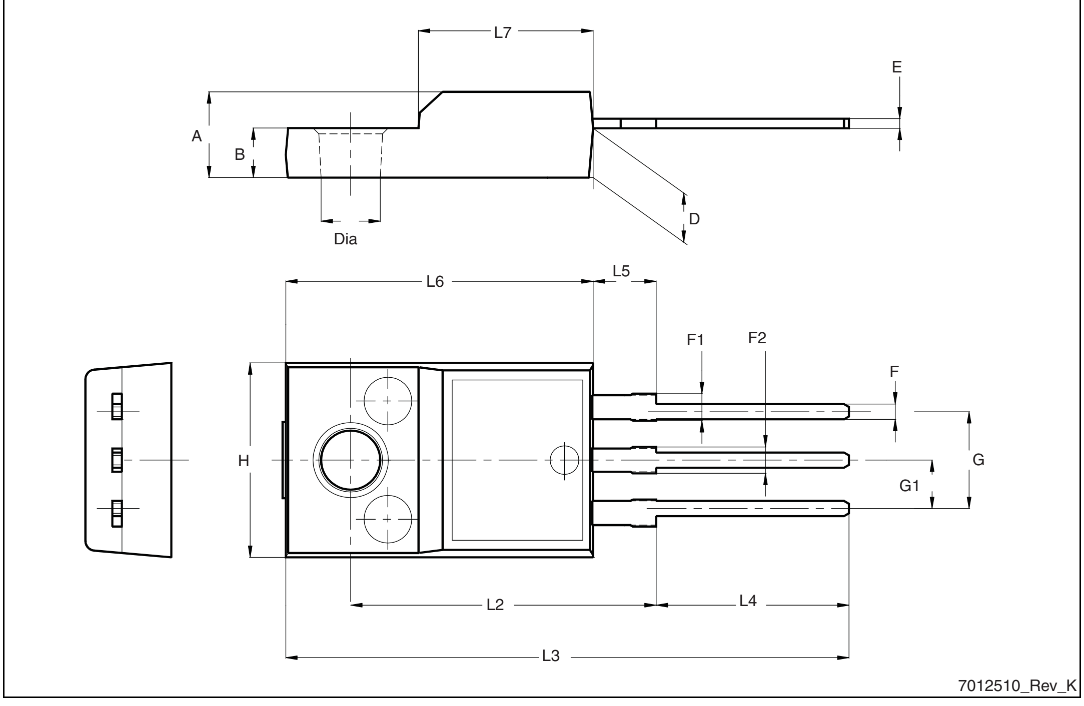
4 Package mechanical data

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. ECOPACK is an ST trademark.

Table 9. TO-220FP mechanical data

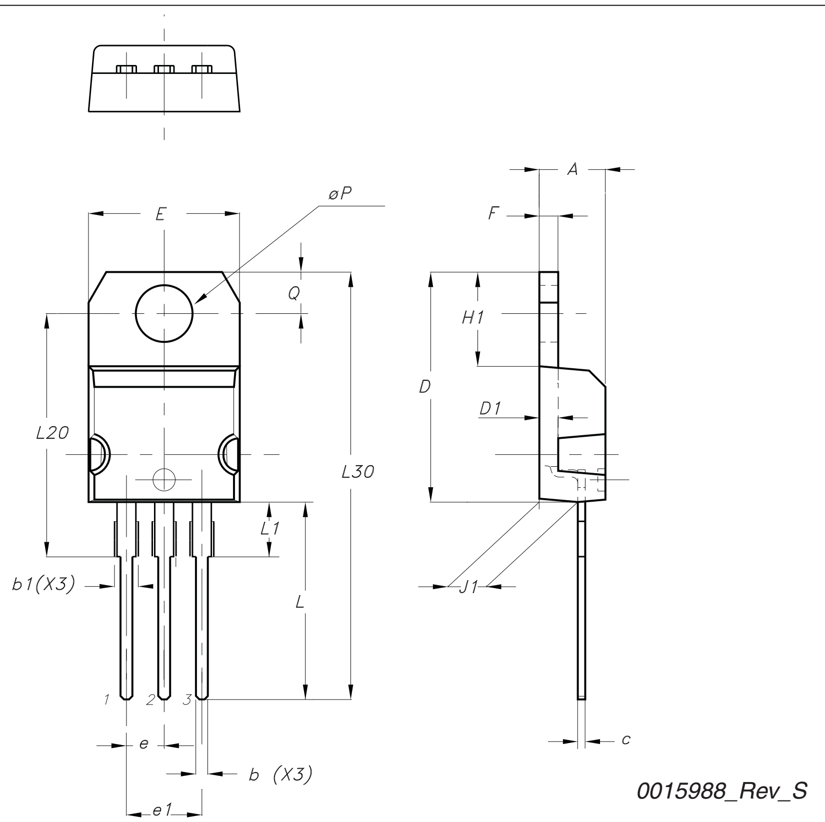
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 23. 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	
∅P	3.75		3.85
Q	2.65		2.95



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
02-Jul-2007	1	First release
13-Aug-2007	2	From target to preliminary version
18-Sep-2007	3	Added new section: *Electrical characteristics (curves)*
05-Nov-2010	4	– Cover page has been updated – Modified gate threshold voltage range on *Table 4: Static* – Updated TO-220 mechanical data – Added new package, mechanical data: TO-220FP