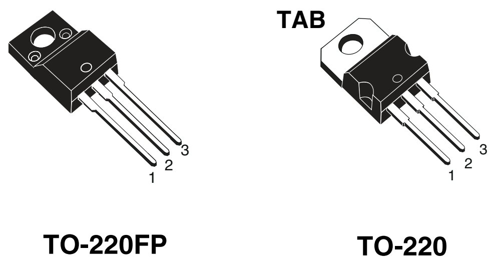
16 A, 600 V, low drop IGBT with soft and fast recovery diode

Features

- Low on-voltage drop ($V_{CE(sat)}$)
- High current capability
- Very soft ultra fast recovery antiparallel diode

Applications

- Light dimmer
- Static relays
- Motor drive



Description

This IGBT utilizes the advanced Power MESH™ process featuring extremely low on-state voltage drop in low-frequency working conditions (up to 1 kHz).

Figure 1. Internal schematic diagram

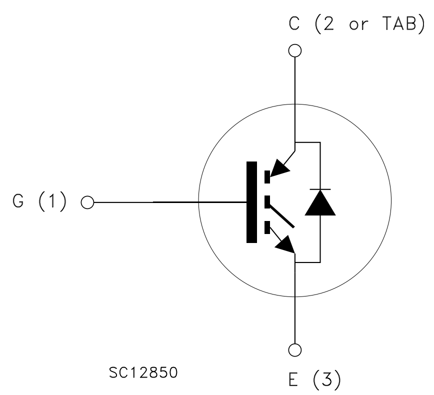


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGF10NB60SD	GF10NB60SD	TO-220FP	Tube
STGP10NB60SD	GP10NB60SD	TO-220	Tube

Contents

1 **Electrical ratings** 3

2 **Electrical characteristics** 4

2.1 Electrical characteristics (curves) 6

3 **Test circuits** 9

4 **Package mechanical data** 10

5 **Revision history** 14

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		STGF10NB60SD	STGP10NB60SD	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600		V
I_C (1)	Continuous collector current at T_C = 25 °C	23	29	A
I_C (1)	Continuous collector current at T_C = 100 °C	12	16	A
I_{CL} (2)	Turn-off latching current	20		A
I_{CP} (3)	Pulsed collector current	80		A
V_{GE}	Gate-emitter voltage	±20		V
I_F	Diode RMS forward current at T_C = 25 °C	20		A
I_{FSM}	Surge non repetitive forward current t_p = 10 ms sinusoidal	55		A
V_{ISO}	Isolation withstand voltage (RMS) from all three leads to external heatsink (t=1 s; T_C = 25 °C)	2500		V
P_{TOT}	Total dissipation at T_C = 25 °C	25	80	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. Vclamp = 80% of V_{CES}, T_j =150 °C, R_G=1kΩ, V_{GE}=15 V
3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		STGF10NB60SD	STGP10NB60SD	
$R_{thj-case}$	Thermal resistance junction-case IGBT	5	1.56	°C/W
$R_{thj-case}$	Thermal resistance junction-case diode	5.6	2.2	°C/W
$R_{thj-amb}$	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= 250 µA	600			V
$V_{(BR)ECS}$	Emitter-collector breakdown voltage (V_{GE}= 0)	I_C= 1 mA	20			V
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE}= ±20 V			±100	nA
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE}= 600 V V_{CE}= 600 V, T_j= 125 °C			10 100	µA µA
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C= 250 µA	2.5		5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE}= 15 V, I_C= 5 A V_{GE}= 15 V, I_C= 10 A V_{GE}= 15 V, I_C= 10 A, T_j= 125 °C		1.15 1.35 1.25	1.75	V
g_{fs} (1)	Forward transconductance	V_{CE} = 15 V , I_C = 10 A	5			S

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

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} = 25 V, f = 1 MHz, V_{GE}= 0	-	610 65 12	-	pF pF pF
Q_g	Total gate charge	V_{CE} = 400 V, I_C = 10 A, V_{GE} = 15 V *(see Figure 19)*	-	33	-	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 V, I_C = 10 A R_G= 1 kΩ, V_{GE}= 15 V *(see Figure 18)*	-	0.7 0.46 8	-	µs µs 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 V, I_C = 10 A R_G= 1 kΩ, V_{GE}= 15 V *(see Figure 18)*	-	2.2 1.2 1.2	-	µs
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 480 V, I_C = 10 A R_G= 1 kΩ, V_{GE}= 15 V, T_j= 125 °C *(see Figure 18)*	-	3.8 1.2 1.9	-	µs

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Eon (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 480 V, I_C = 10 A R_G= 1 kΩ, V_{GE}= 15 V *(see Figure 18)*	-	0.6 5 5.6	-	mJ mJ mJ
E_{off} (2)	Turn-off switching losses	V_{CC} = 480 V, I_C = 10 A R_G= 1 kΩ, V_{GE}= 15 V, T_j= 125 °C *(see Figure 18)*	-	8	-	mJ

1. Eon 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 = 10 A I_F = 10 A, T_C= 125 °C		 1.4	2.2	V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 7 A, V_R = 40 V, di/dt = 100 A/µs *(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 A, V_R = 40 V, T_j = 125 °C, di/dt = 100 A/µs *(see Figure 21)*		61 98 3.2		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

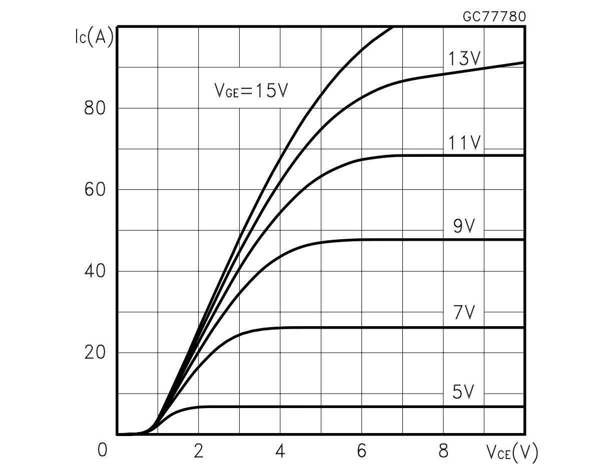


Figure 3. Transfer characteristics

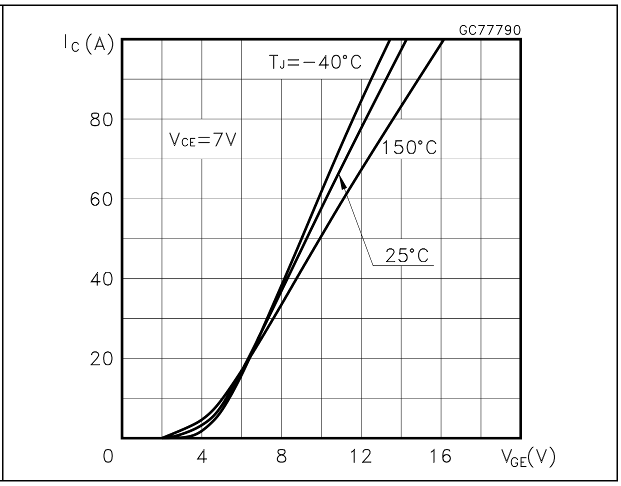


Figure 4. Transconductance

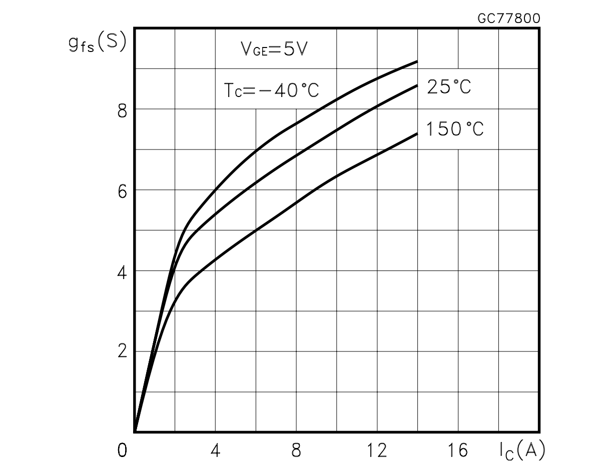


Figure 5. Collector-emitter on voltage vs. temperature

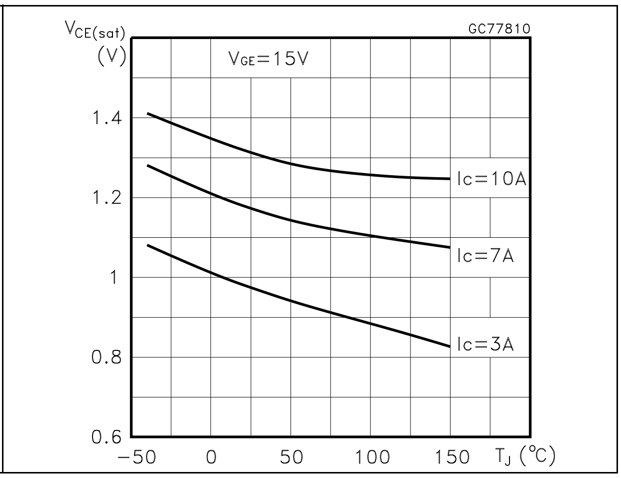


Figure 6. Collector-emitter on voltage vs. collector current

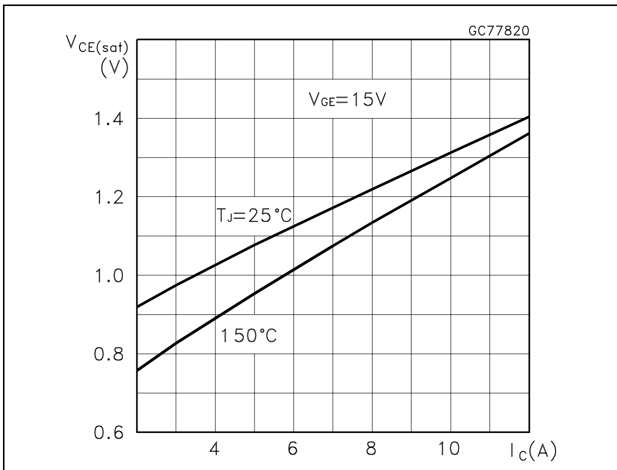


Figure 7. Normalized gate threshold vs. temperature

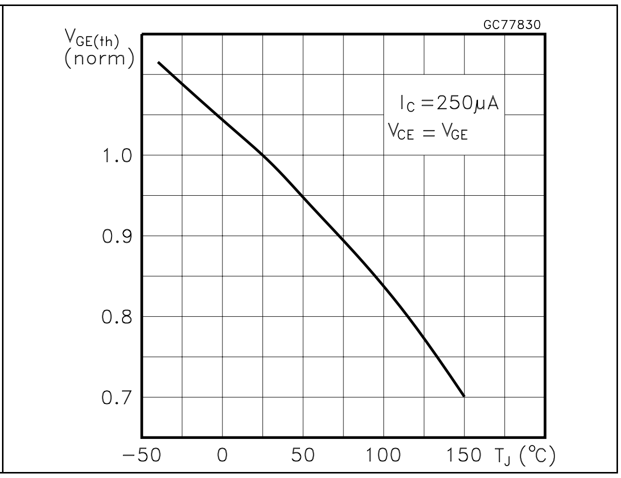


Figure 8. Normalized breakdown voltage vs. temperature

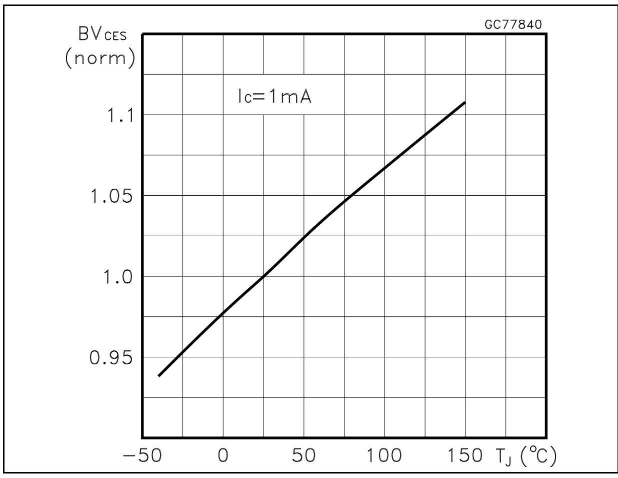


Figure 9. Gate charge vs. gate-emitter voltage

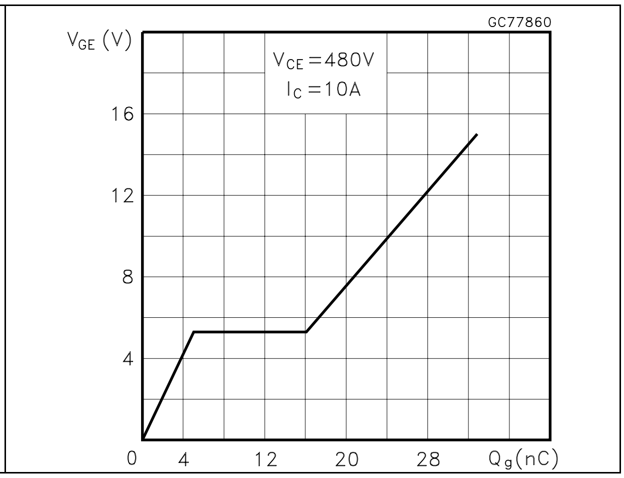


Figure 10. Capacitance variations

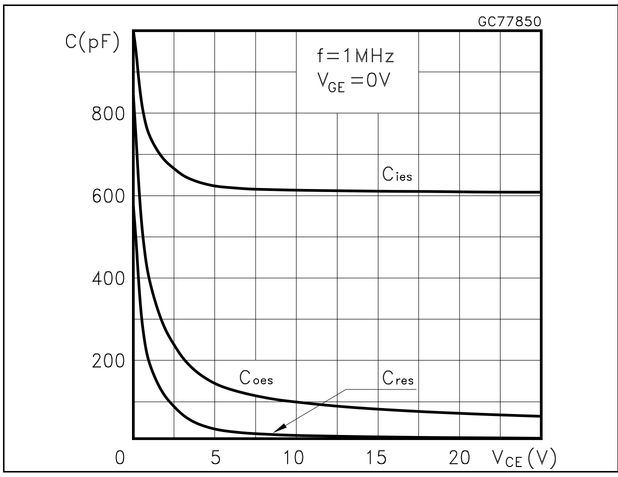


Figure 11. Switching losses vs. temperature

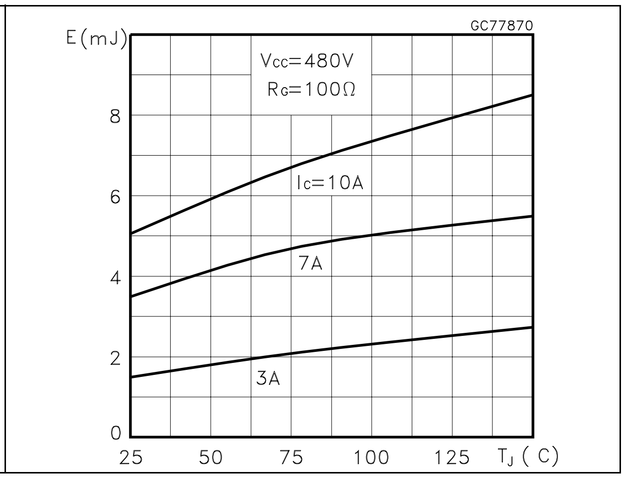


Figure 12. Switching losses vs. gate resistance

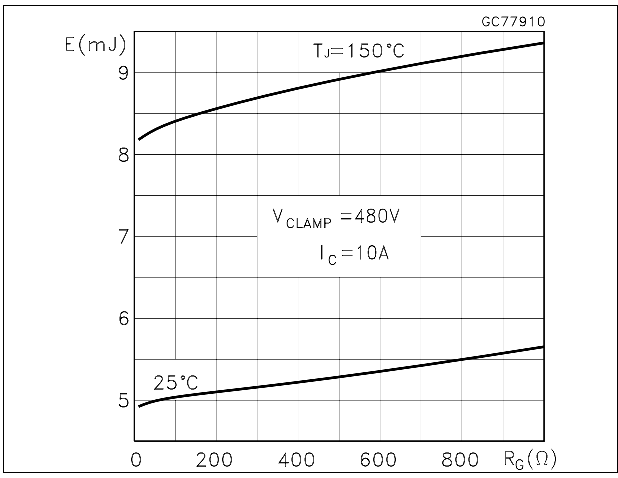


Figure 13. Switching losses vs. collector current

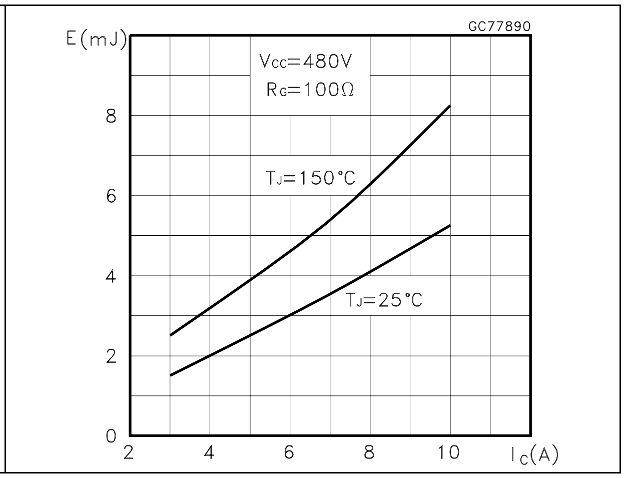


Figure 14. Thermal impedance for TO-220

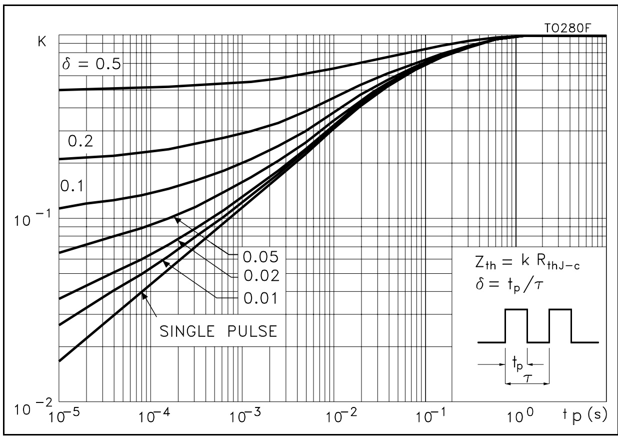


Figure 15. Thermal impedance for TO-220FP

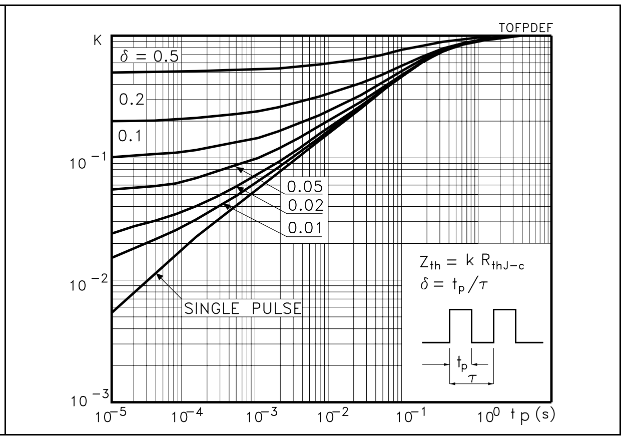


Figure 16. Turn-off SOA

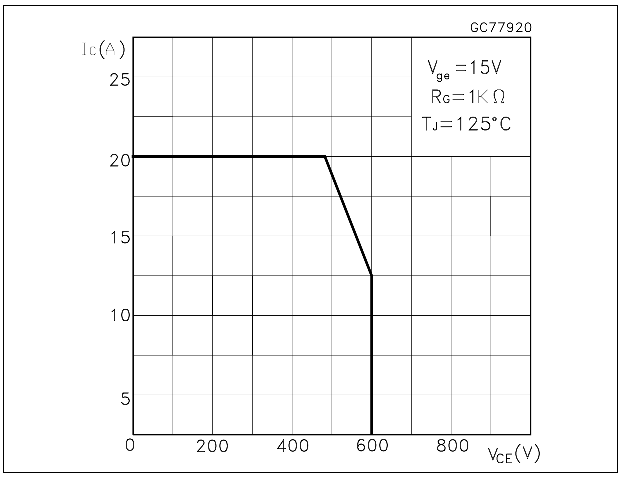
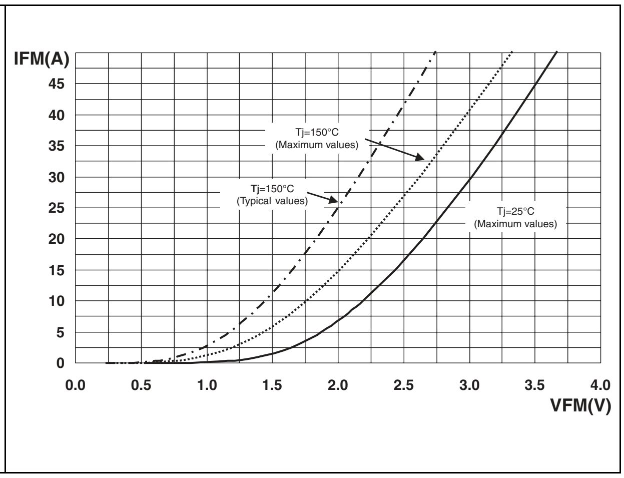


Figure 17. Forward voltage drop versus forward current



3 Test circuits

Figure 18. Test circuit for inductive load switching

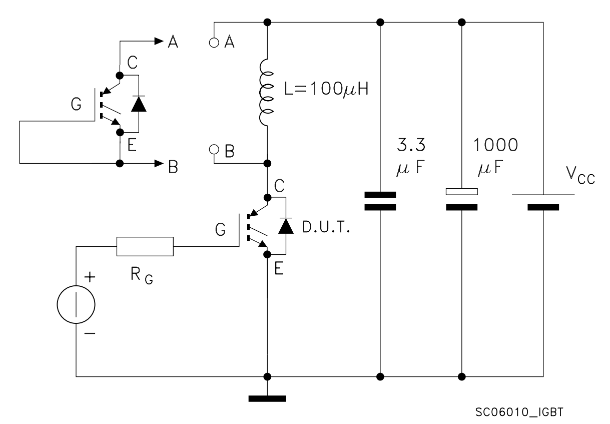


Figure 19. Gate charge test circuit

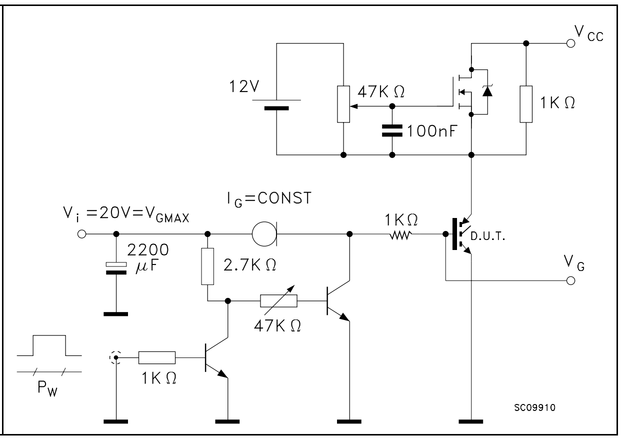


Figure 20. Switching waveforms

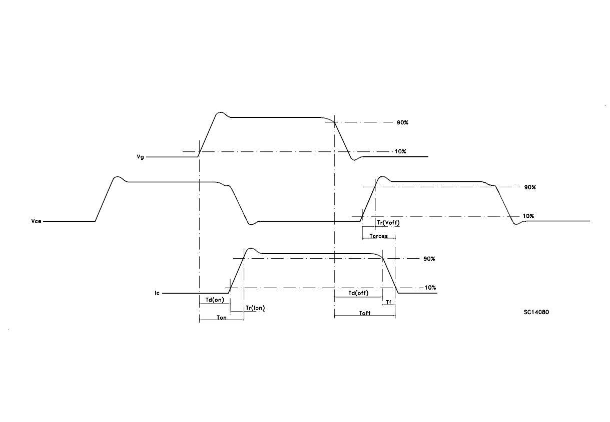
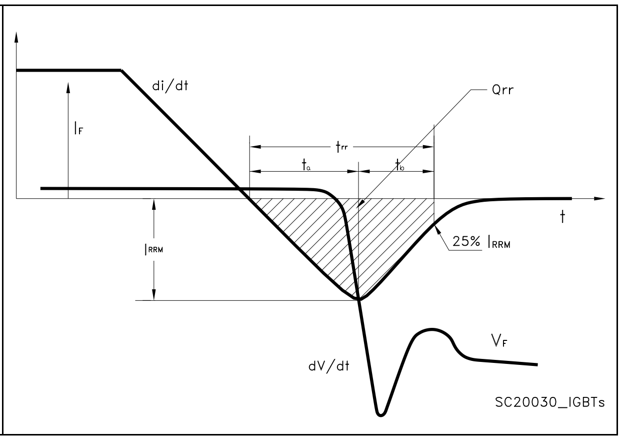


Figure 21. Diode recovery times waveform



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.

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

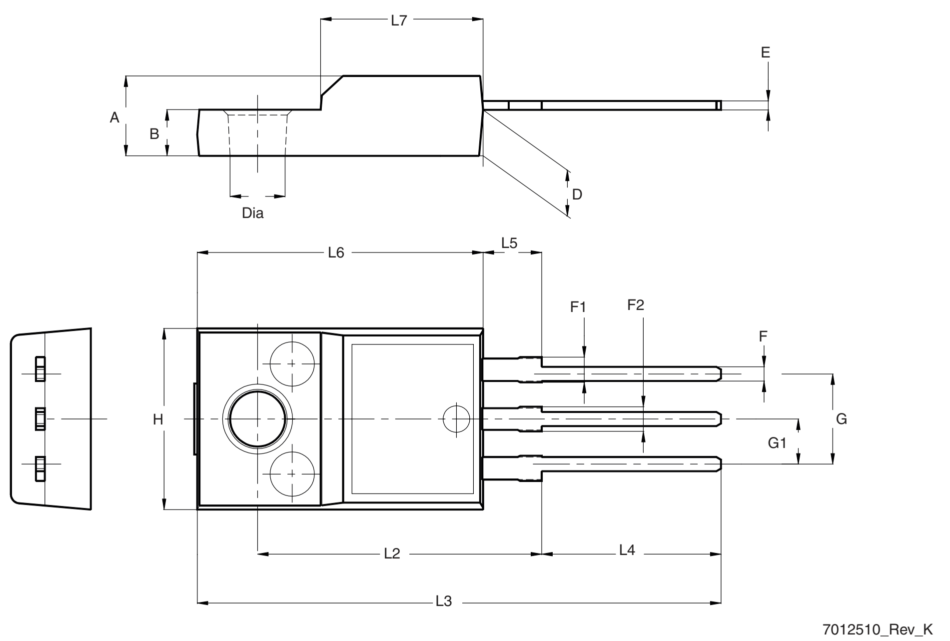
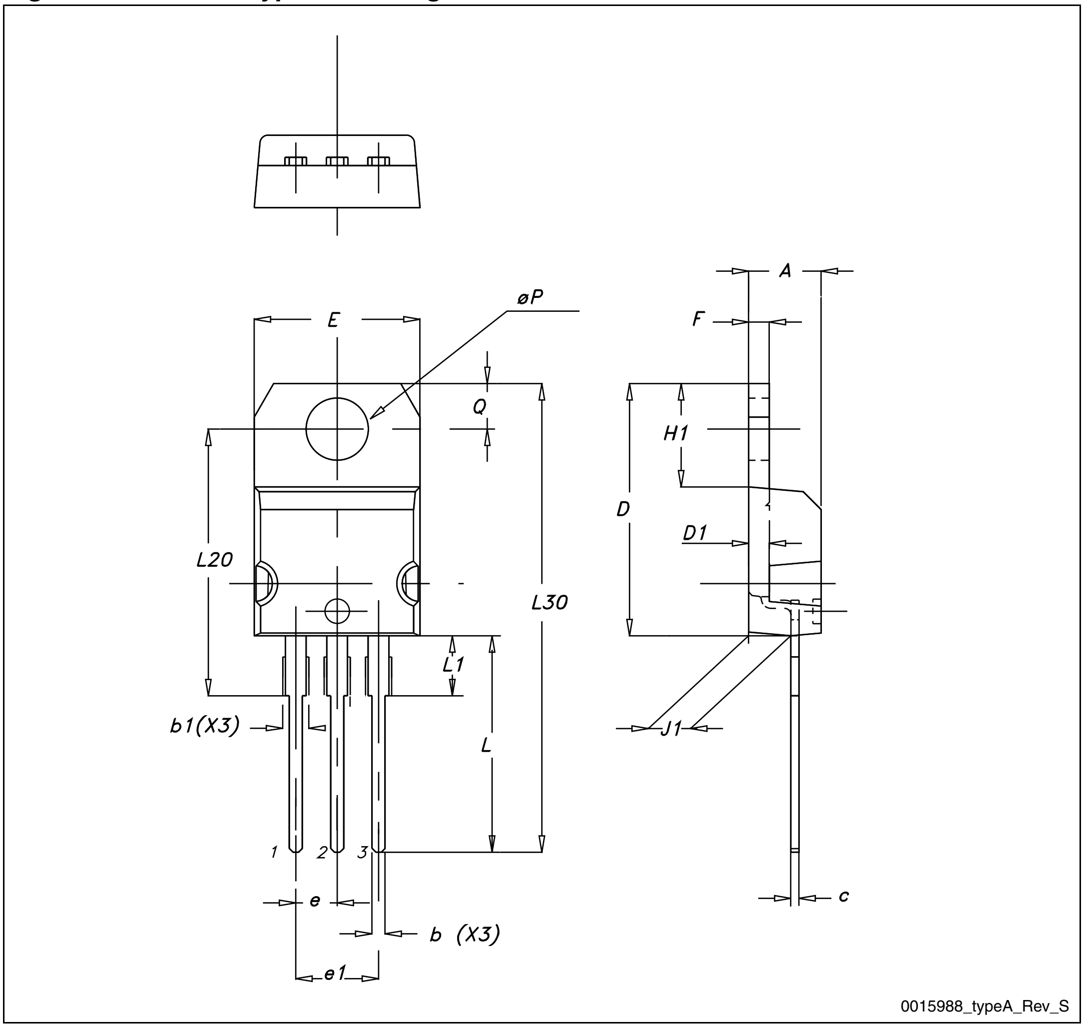


Table 10. TO-220 type A mechanical data

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

Figure 23. TO-220 type A drawing



5 Revision history

Table 11. Document revision history

Date	Revision	Changes
18-Nov-2005	1	New release.
16-Dec-2010	2	Inserted device in TO-220FP. Updated *Table 2: Absolute maximum ratings*, *Table 8: Collector-emitter diode* and packages mechanical data *Section 4: Package mechanical data*.
22-Sep-2011	3	Modified: unit value *Table 7 on page 5*, *Figure 2* and *Figure 3 on page 6*.