

45 A - 600 V ultra fast IGBT

Features

- Low C_{RES} / C_{IES} ratio (no cross conduction susceptibility)
- Very soft ultra fast recovery anti parallel diode

Applications

- High frequency inverters, UPS
- Motor drivers
- HF, SMPS and PFC in both hard switch and resonant topologies
- Welding
- Induction heating

Description

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

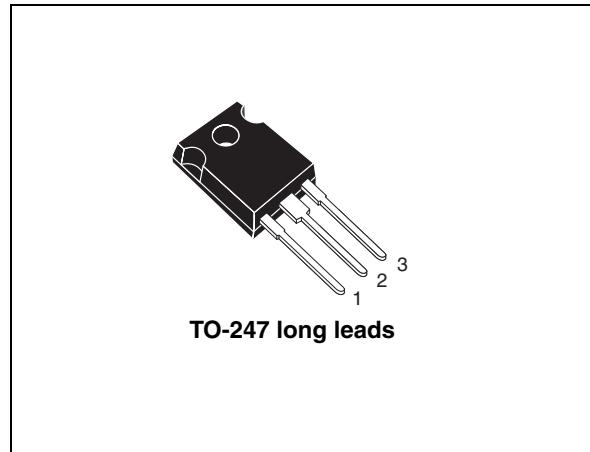


Figure 1. Internal schematic diagram

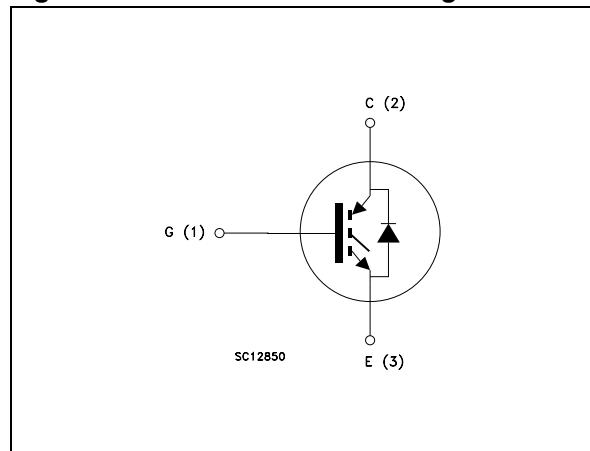


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW45NC60WD	GW45NC60WD	TO-247 long leads	Tube

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
2.1	Electrical characteristics (curves)	7
3	Test circuit	10
4	Package mechanical data	11
5	Revision history	13

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GS} = 0$)	600	V
$I_C^{(1)}$	Collector current (continuous) at $T_C=25\text{ }^\circ\text{C}$	90	A
$I_C^{(1)}$	Collector current (continuous) at $T_C=100\text{ }^\circ\text{C}$	45	A
$I_{CL}^{(2)}$	Turn-off latching current	230	A
$I_{CP}^{(3)}$	Pulsed collector current	230	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Diode RMS forward current at $T_C=25\text{ }^\circ\text{C}$	30	A
I_{FSM}	Surge non repetitive forward current $t_p=10\text{ ms}$ sinusoidal	120	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	285	W
T_j	Operating junction temperature	- 55 to 150	$^\circ\text{C}$

1. Calculated according to the iterative formula:

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

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

3. Pulse width limited by max junction temperature allowed

Table 3. Thermal resistance

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.437	$^\circ\text{C/W}$
$R_{thj-case}$	Thermal resistance junction-case diode	1.5	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	$^\circ\text{C/W}$

2 Electrical characteristics

($T_{CASE} = 25^\circ\text{C}$ unless otherwise specified)

Table 4. Static (electrical characteristics)

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	$V_{GE} = 15 \text{ V}, I_C = 30 \text{ A}$ $V_{GE} = 15 \text{ V}, I_C = 30 \text{ A}, T_c = 125^\circ\text{C}$		2.1 1.9	2.6	V V
$V_{GE(\text{th})}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250 \mu\text{A}$	3.75		5.75	V
I_{CES}	Collector-emitter leakage current ($V_{GE} = 0$)	$V_{CE} = 600 \text{ V}$ $V_{CE} = 600 \text{ V}, T_c = 125^\circ\text{C}$			500 5	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20 \text{ V}$			± 100	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15 \text{ V}, I_C = 30 \text{ A}$		20		S

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

Table 5. Dynamic (electrical characteristics)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance			2900		pF
C_{oes}	Output capacitance			298		pF
C_{res}	Reverse transfer capacitance	$V_{CE} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GE} = 0$		59		pF
Q_g	Total gate charge			126		nC
Q_{ge}	Gate-emitter charge	$V_{CE} = 390 \text{ V}, I_C = 30 \text{ A},$ $V_{GE} = 15 \text{ V},$ <i>(see Figure 18)</i>		16		nC
Q_{gc}	Gate-collector charge			46		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	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 17)		33 12 2600		ns ns A/ μs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, $T_C = 125 \text{ }^\circ\text{C}$ (see Figure 17)		32 14 2300		ns ns A/ μs
$t_r(V_{off})$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$, $R_{GE} = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 17)		26 168 36		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$, $R_{GE} = 10 \Omega$, $V_{GE} = 15 \text{ V}$, $T_C = 125 \text{ }^\circ\text{C}$ (see Figure 17)		54 213 67		ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$ $E_{off}^{(2)}$ E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, (see Figure 17)		302 349 651		μJ μJ μJ
$E_{on}^{(1)}$ $E_{off}^{(2)}$ E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390 \text{ V}$, $I_C = 30 \text{ A}$ $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, $T_C = 125 \text{ }^\circ\text{C}$ (see Figure 17)		553 750 1303		μJ μJ μJ

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in Figure 20. E_{on} include diode recovery energy. If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & 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	$I_F = 30 \text{ A}$ $I_F = 30 \text{ A}, T_C = 125 \text{ }^\circ\text{C}$		2.4 1.8		V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30 \text{ A}, V_R = 50 \text{ V}$, $di/dt = 100 \text{ A}/\mu\text{s}$ (see Figure 20)		45 56 2.55		ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30 \text{ A}, V_R = 50 \text{ V}$, $T_C = 125 \text{ }^\circ\text{C}$, $di/dt = 100 \text{ A}/\mu\text{s}$ (see Figure 20)		100 290 5.8		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

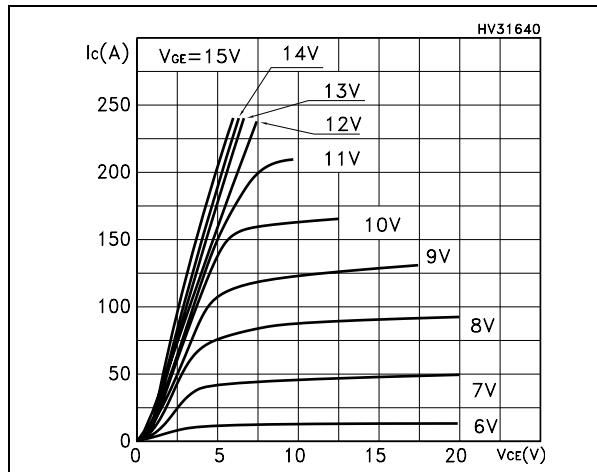


Figure 3. Transfer characteristics

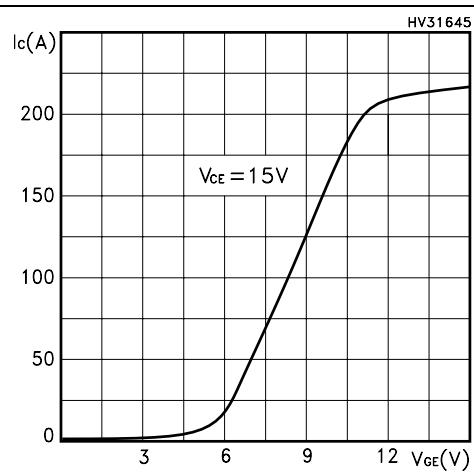


Figure 4. Transconductance

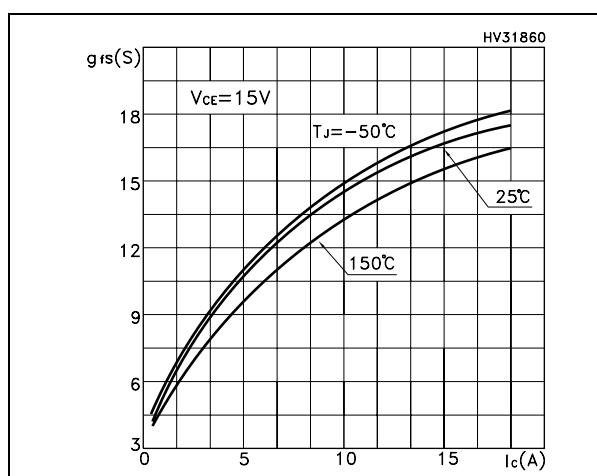


Figure 5. Collector-emitter on voltage vs temperature

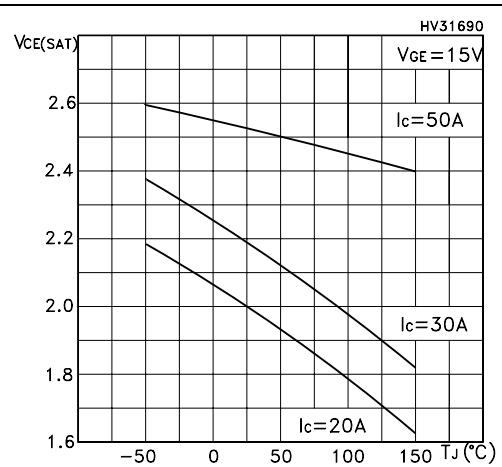


Figure 6. Collector-emitter on voltage vs collector current

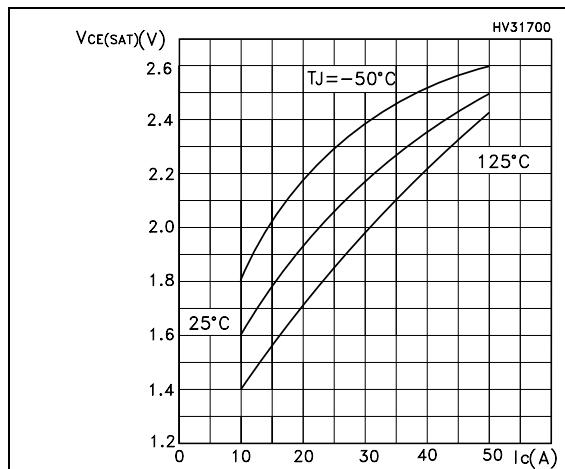


Figure 7. Normalized gate threshold vs temperature

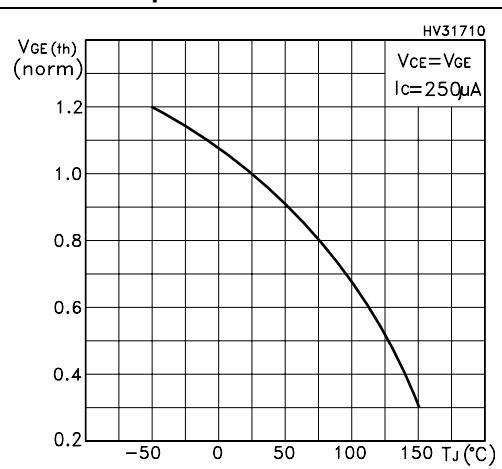


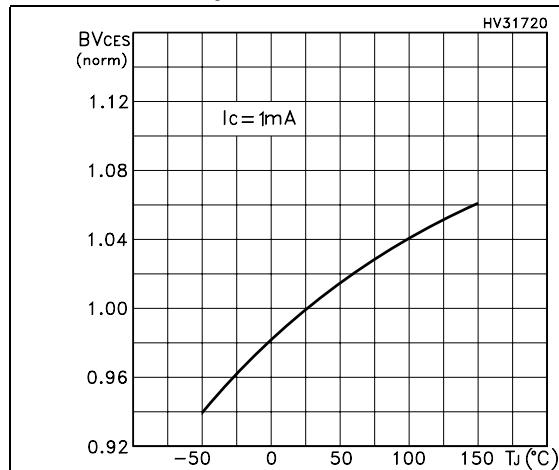
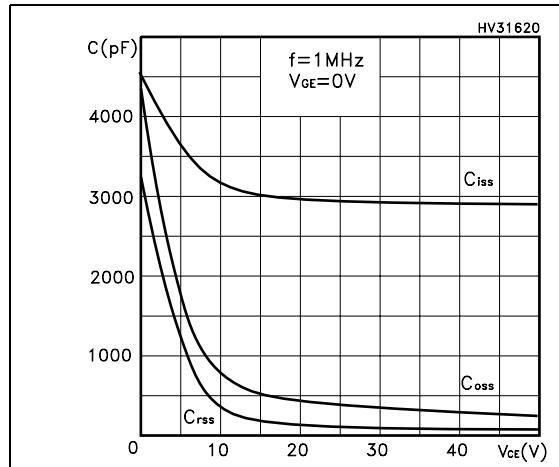
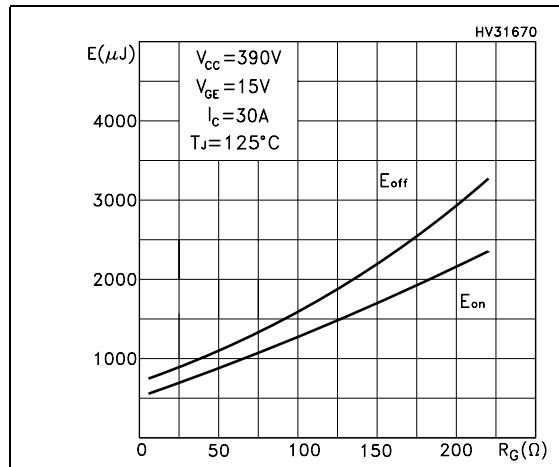
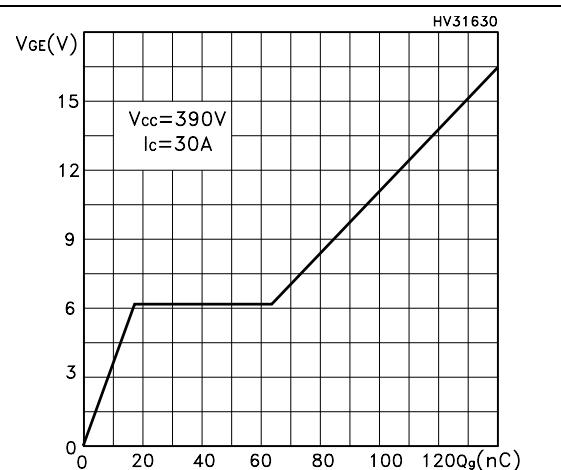
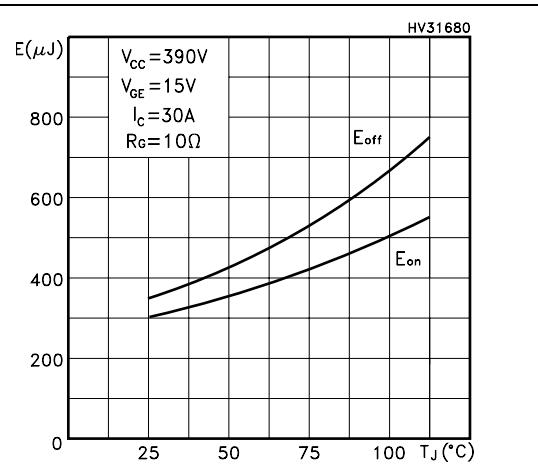
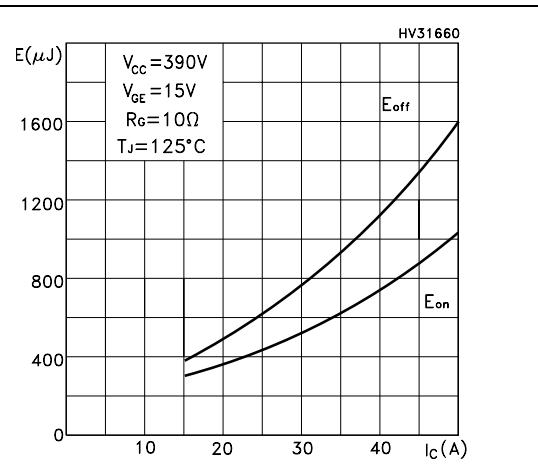
Figure 8. Normalized breakdown voltage vs temperature**Figure 10. Capacitance variations****Figure 12. Switching losses vs gate resistance****Figure 9. Gate charge vs gate-emitter voltage****Figure 11. Switching losses vs temperature****Figure 13. Switching losses vs collector current**

Figure 14. Thermal impedance

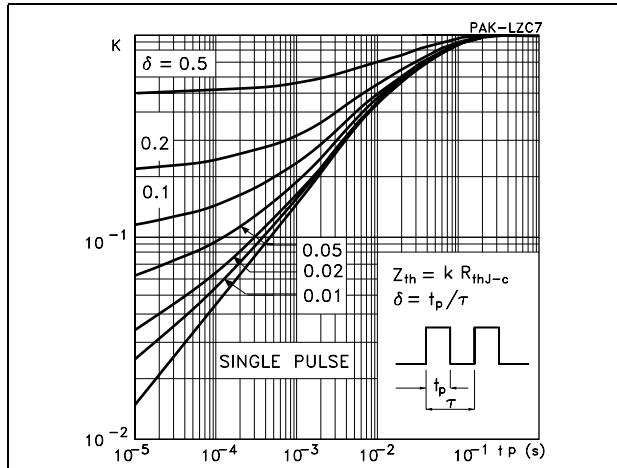


Figure 15. Turn-off SOA

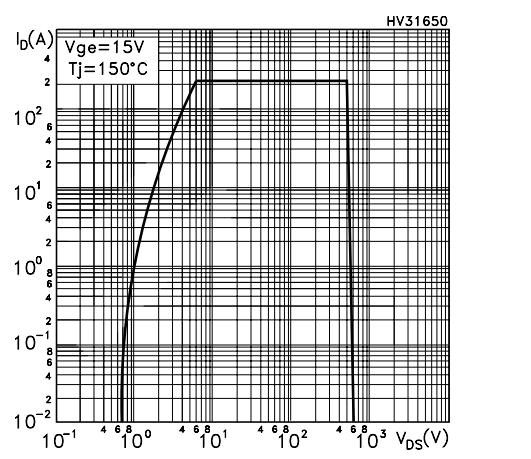
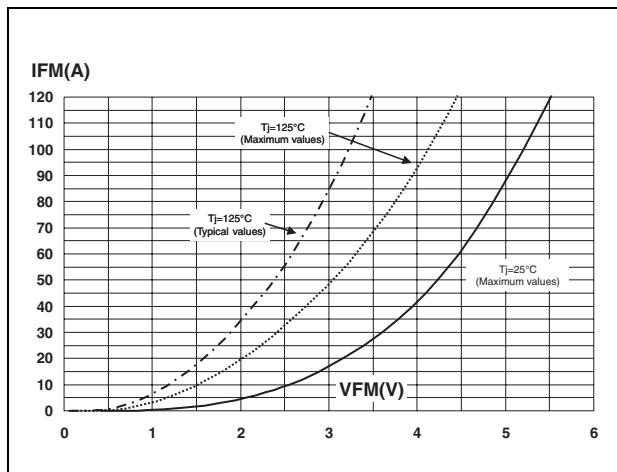


Figure 16. Emitter-collector diode characteristics



3 Test circuit

Figure 17. Test circuit for inductive load switching

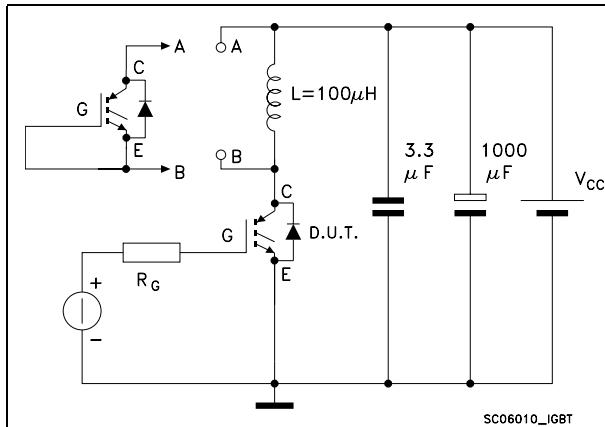


Figure 18. Gate charge test circuit

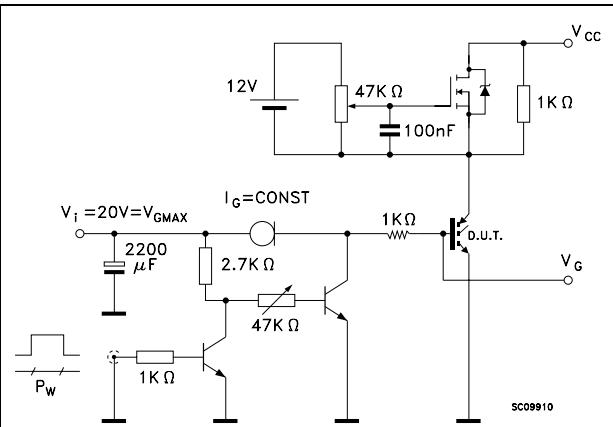


Figure 19. Switching waveforms

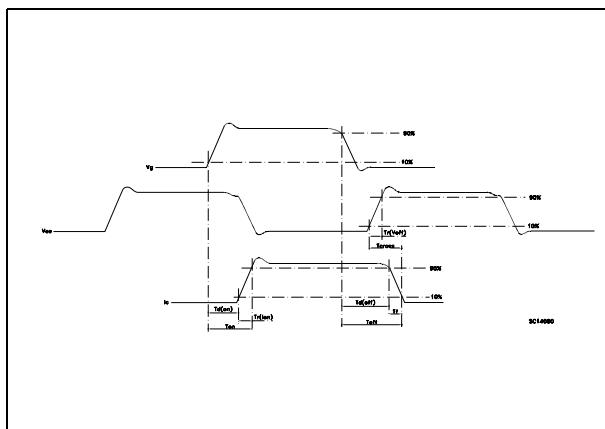
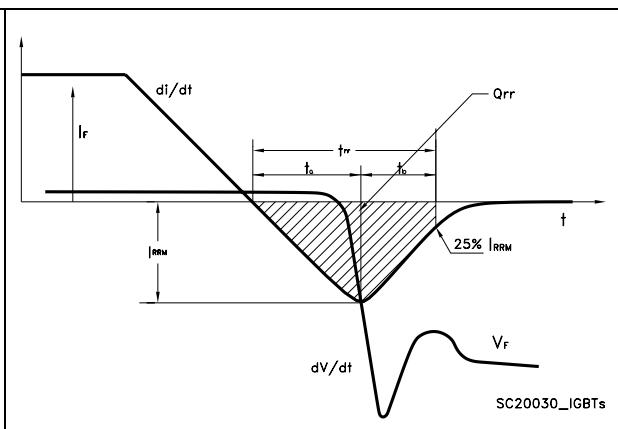


Figure 20. Diode recovery times waveform

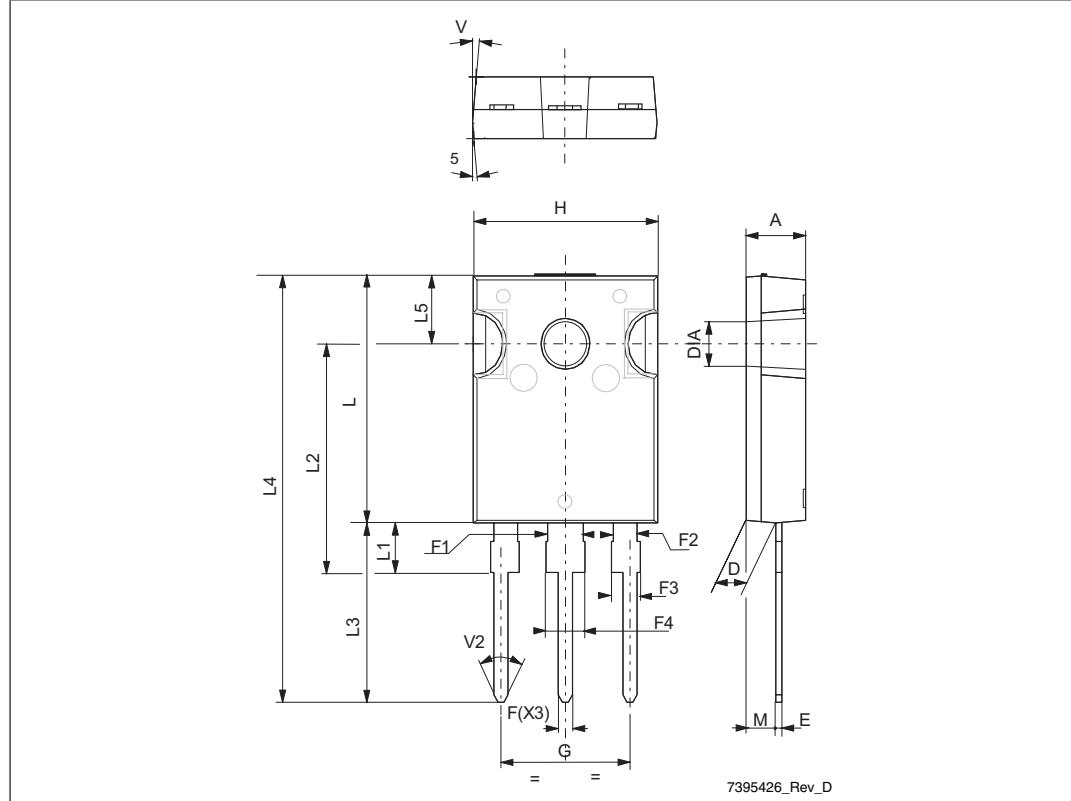


4 Package mechanical data

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-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.85		5.16
D	2.2		2.6
E	0.4		0.8
F	1		1.4
F1		3	
F2		2	
F3	1.9		2.4
F4	3		3.4
G		10.9	
H	15.45		16.03
L	19.85		21.09
L1	3.7		4.3
L2	18.3		19.13
L3	14.2		20.3
L4	34.05		41.38
L5	5.35		6.3
M	2		3
V		5°	
V2		60°	
DIAM	3.55		3.65



5 Revision history

Table 9. Document revision history

Date	Revision	Changes
05-Jun-2008	1	First release

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