

## 30 A, 1200 V short circuit rugged IGBT with Ultrafast diode

### Features

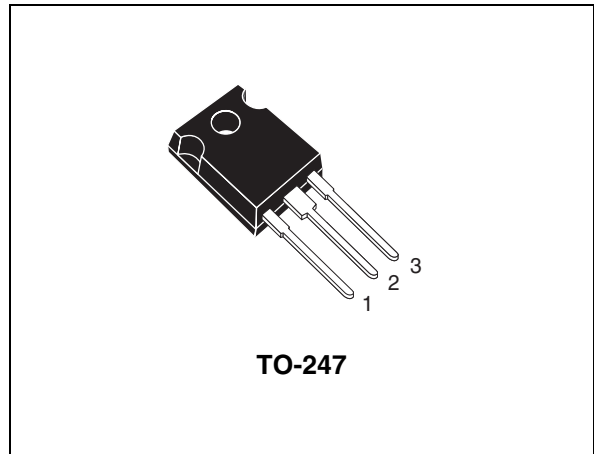
- Low on-losses
- High current capability
- Low gate charge
- Short circuit withstand time 10  $\mu$ s
- IGBT co-packaged with Ultrafast free-wheeling diode

### Applications

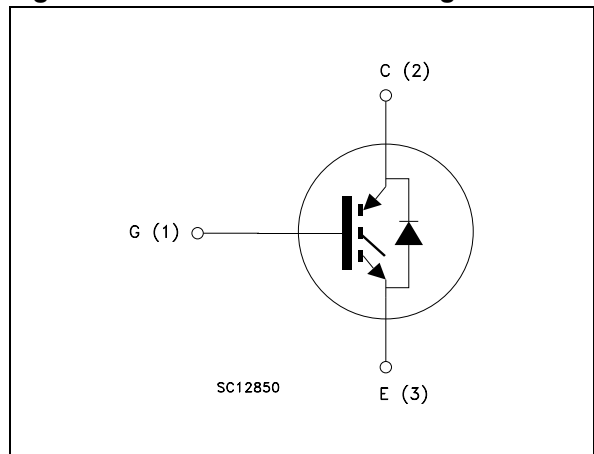
- Motor control

### Description

This high voltage and short-circuit rugged 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	Markings	Package	Packaging
STGW30N120KD	GW30N120KD	TO-247	Tube
STGWA30N120KD	GWA30N120KD	TO-247 long leads	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	V
$I_C^{(1)}$	Collector current (continuous) at 25 °C	60	A
$I_C^{(1)}$	Collector current (continuous) at 100 °C	30	A
$I_{CL}^{(2)}$	Turn-off latching current	100	A
$I_{CP}^{(3)}$	Pulsed collector current	100	A
$V_{GE}$	Gate-emitter voltage	±25	V
$t_{SCW}$	Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125\text{ °C}$ , $R_G = 10\ \Omega$ , $V_{GE} = 12\text{ V}$	10	µs
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	220	W
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	30	A
$I_{FSM}$	Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	100	A
$T_j$	Operating junction temperature	- 55 to 125	°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.  $V_{clamp} = 80\%$  of  $V_{CES}$ ,  $T_j = 125\text{ °C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$
3. Pulse width limited by max. junction temperature allowed

**Table 3. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT max.	0.45	°C/W
$R_{thj-case}$	Thermal resistance junction-case diode max.	1.6	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient IGBT max.	50	°C/W

## 2 Electrical characteristics

$T_{CASE}=25\text{ °C}$  unless otherwise specified.

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 20\text{ A},$ $T_C = 125\text{ °C}$		2.8	3.85	V
				2.7		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	4.5		6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$ $V_{CE} = 1200\text{ V}, T_C = 125\text{ °C}$			500 10	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 25\text{ V}, I_C = 20\text{ A}$		20		S

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$ $C_{oes}$ $C_{res}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0$		2520		pF
	Output capacitance			170		pF
	Reverse transfer capacitance			33		pF
$Q_g$	Total gate charge	$V_{CE} = 960\text{ V},$ $I_C = 20\text{ A}, V_{GE} = 15\text{ V}$		105		nC
$Q_{ge}$	Gate-emitter charge			21		nC
$Q_{gc}$	Gate-collector charge			56		nC

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		36		ns
$t_r$	Current rise time	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$ (see Figure 17)		22		ns
$(di/dt)_{on}$	Turn-on current slope			840		A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		35		ns
$t_r$	Current rise time	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		22		ns
$(di/dt)_{on}$	Turn-on current slope	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 17)		760		A/ $\mu$ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		70		ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		251		ns
$t_f$	Current fall time	(see Figure 17)		260		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		140		ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		324		ns
$t_f$	Current fall time	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 17)		432		ns

**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		2.4		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		4.3		mJ
$E_{ts}$	Total switching losses	(see Figure 17)		6.7		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}, I_C = 20\text{ A}$		3.9		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		5.8		mJ
$E_{ts}$	Total switching losses	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 17)		9.7		mJ

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in Figure 17. 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	$I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_C = 125\text{ }^\circ\text{C}$		1.9 1.7		V V
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}, V_R = 45\text{ V},$		84		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$		235		nC
$I_{rrm}$	Reverse recovery current	(see Figure 20)		5.6		A
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}, V_R = 45\text{ V},$ $T_C = 125\text{ }^\circ\text{C},$		152		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$		722		nC
$I_{rrm}$	Reverse recovery current	(see Figure 20)		9		A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

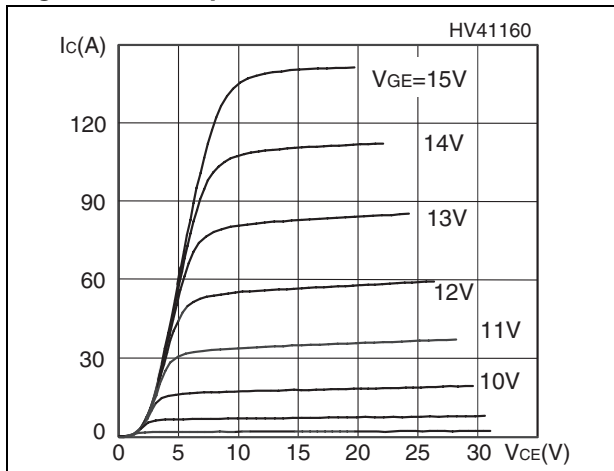


Figure 3. Transfer characteristics

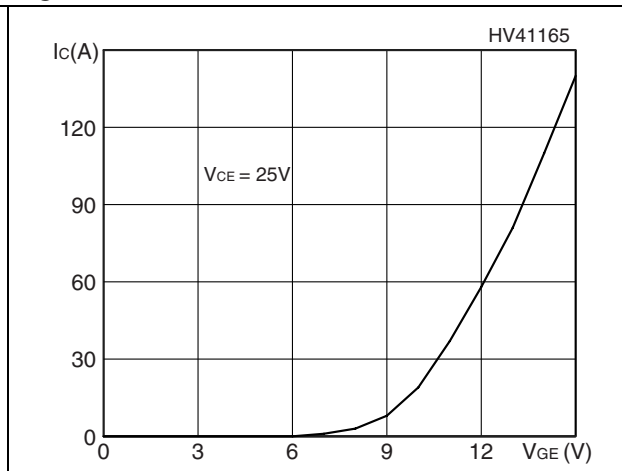


Figure 4. Transconductance

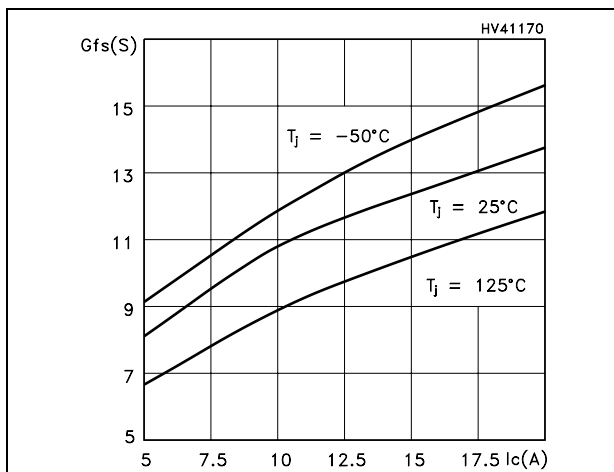


Figure 5. Collector-emitter on voltage vs. temperature

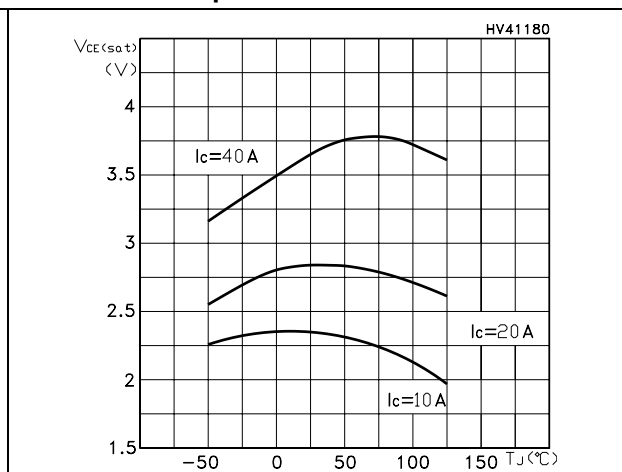


Figure 6. Gate charge vs. gate-source voltage

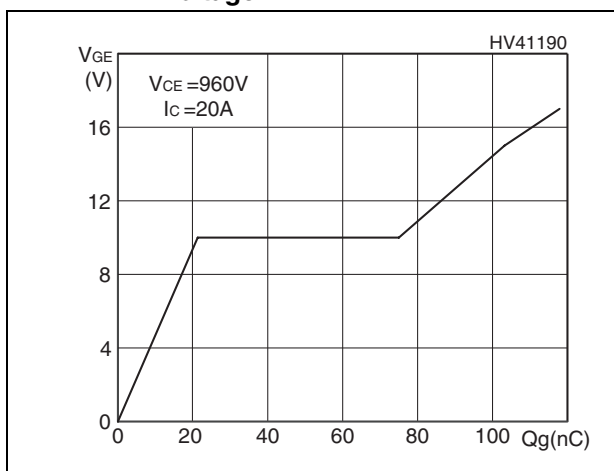
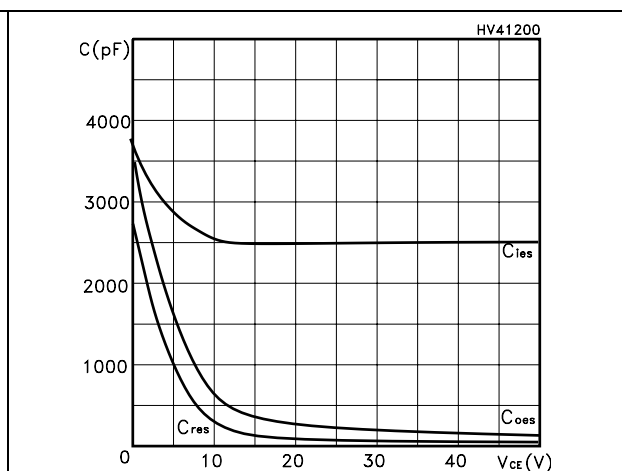
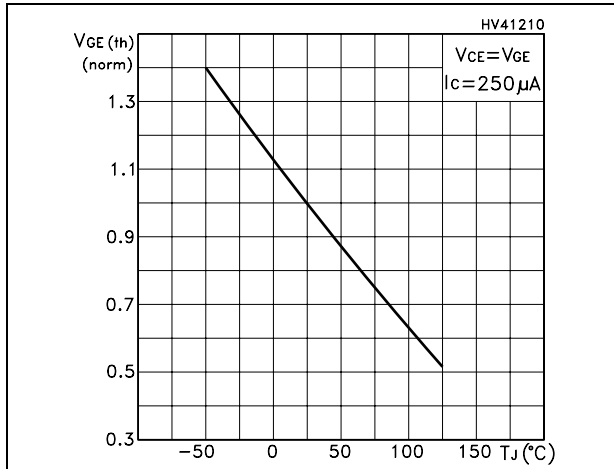


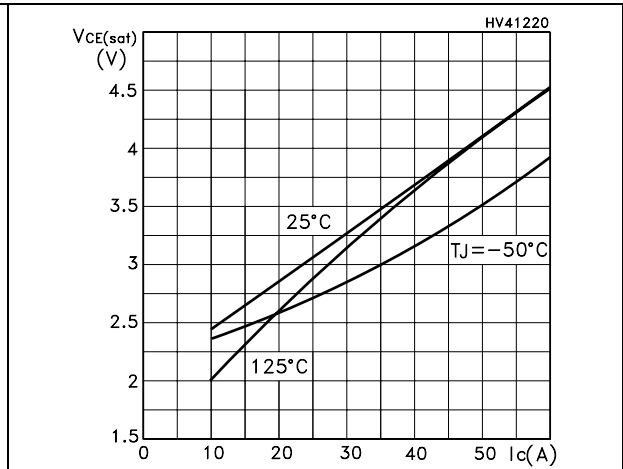
Figure 7. Capacitance variations



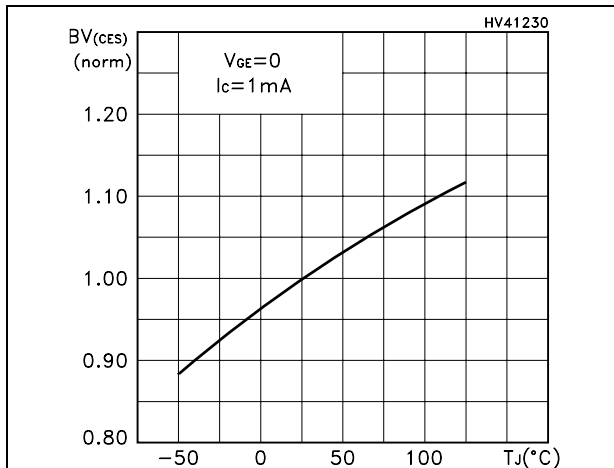
**Figure 8. Normalized gate threshold voltage vs. temperature**



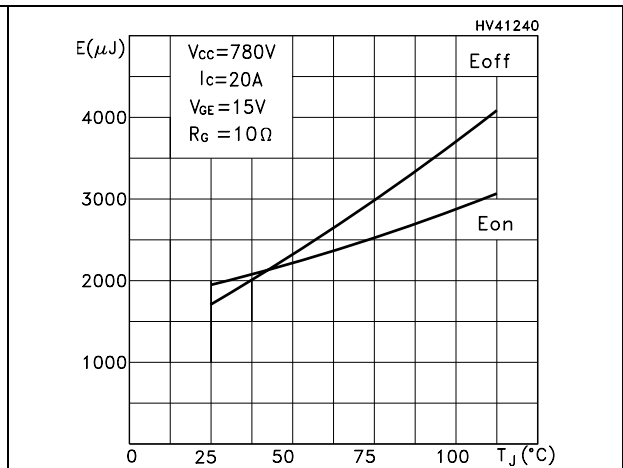
**Figure 9. Collector-emitter on voltage vs. collector current**



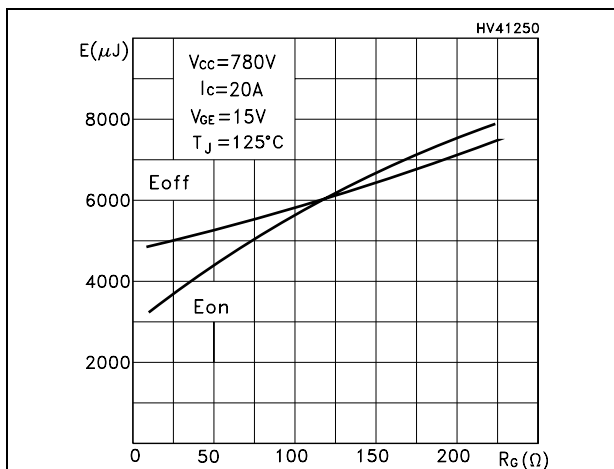
**Figure 10. Normalized breakdown voltage vs. temperature**



**Figure 11. Switching losses vs. temperature**



**Figure 12. Switching losses vs. gate resistance**



**Figure 13. Switching losses vs. collector current**

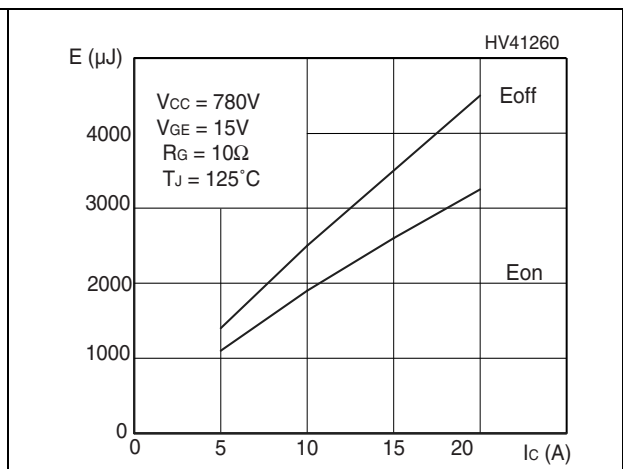


Figure 14. Thermal impedance

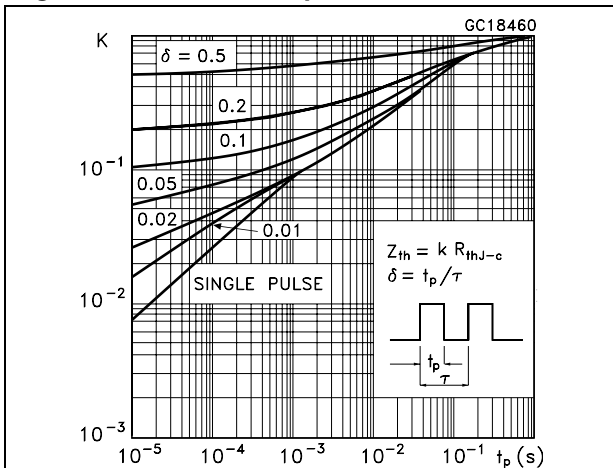


Figure 15. Turn-off SOA

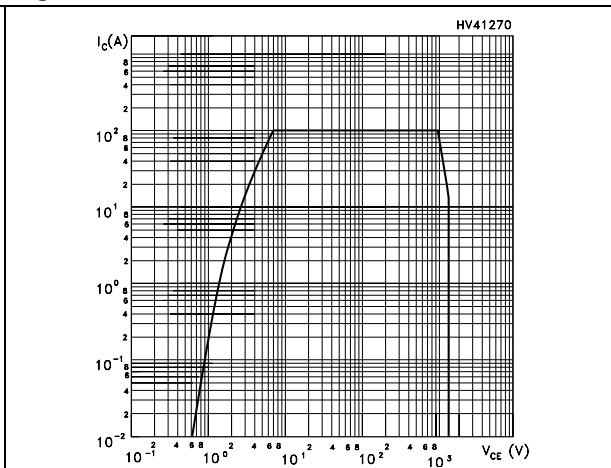
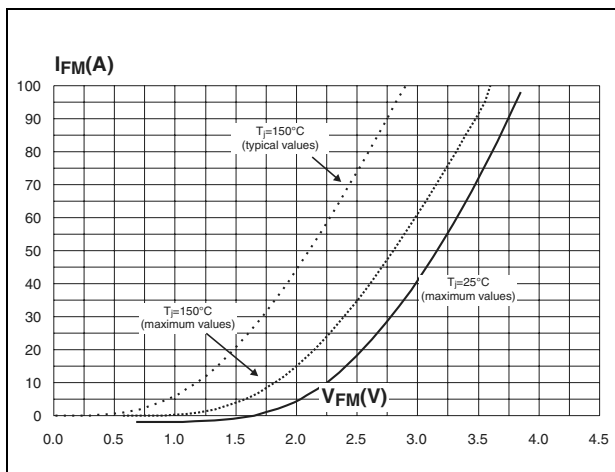


Figure 16. Forward voltage drop vs. forward current





### 3 Test circuit

Figure 17. Test circuit for inductive load switching

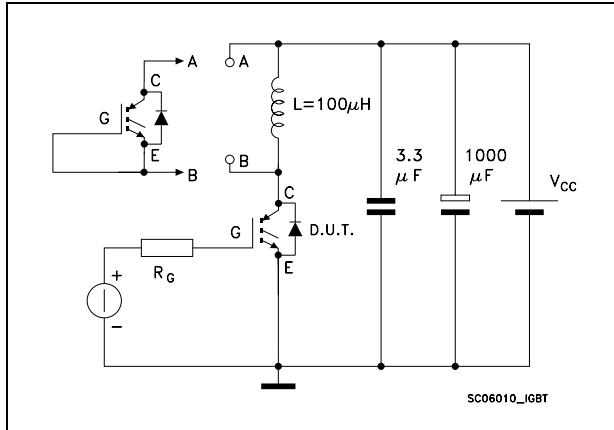


Figure 18. Gate charge test circuit

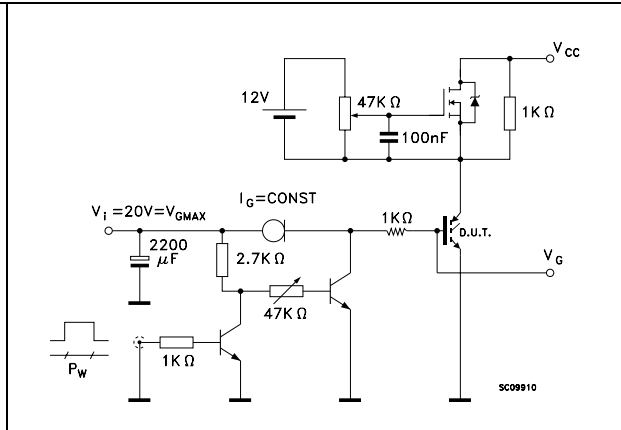


Figure 19. Switching waveform

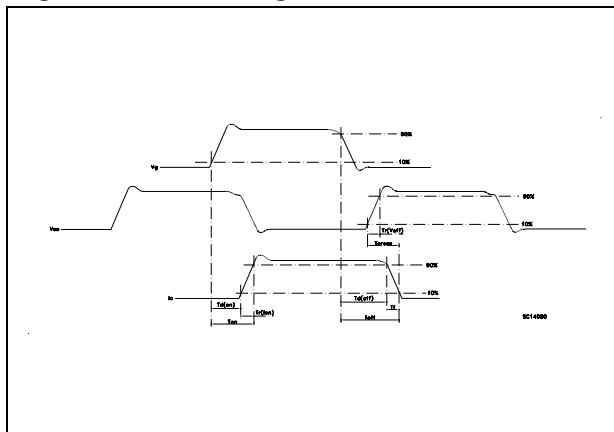
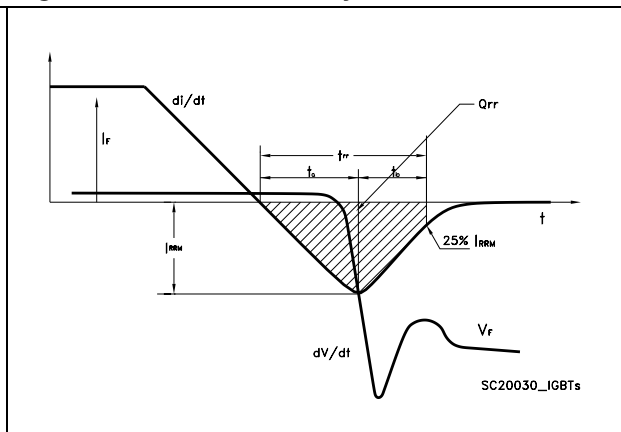


Figure 20. Diode recovery time waveform



## 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](http://www.st.com). ECOPACK® is an ST trademark.

**Table 9. TO-247 mechanical data**

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 21. TO-247 drawing dimensions

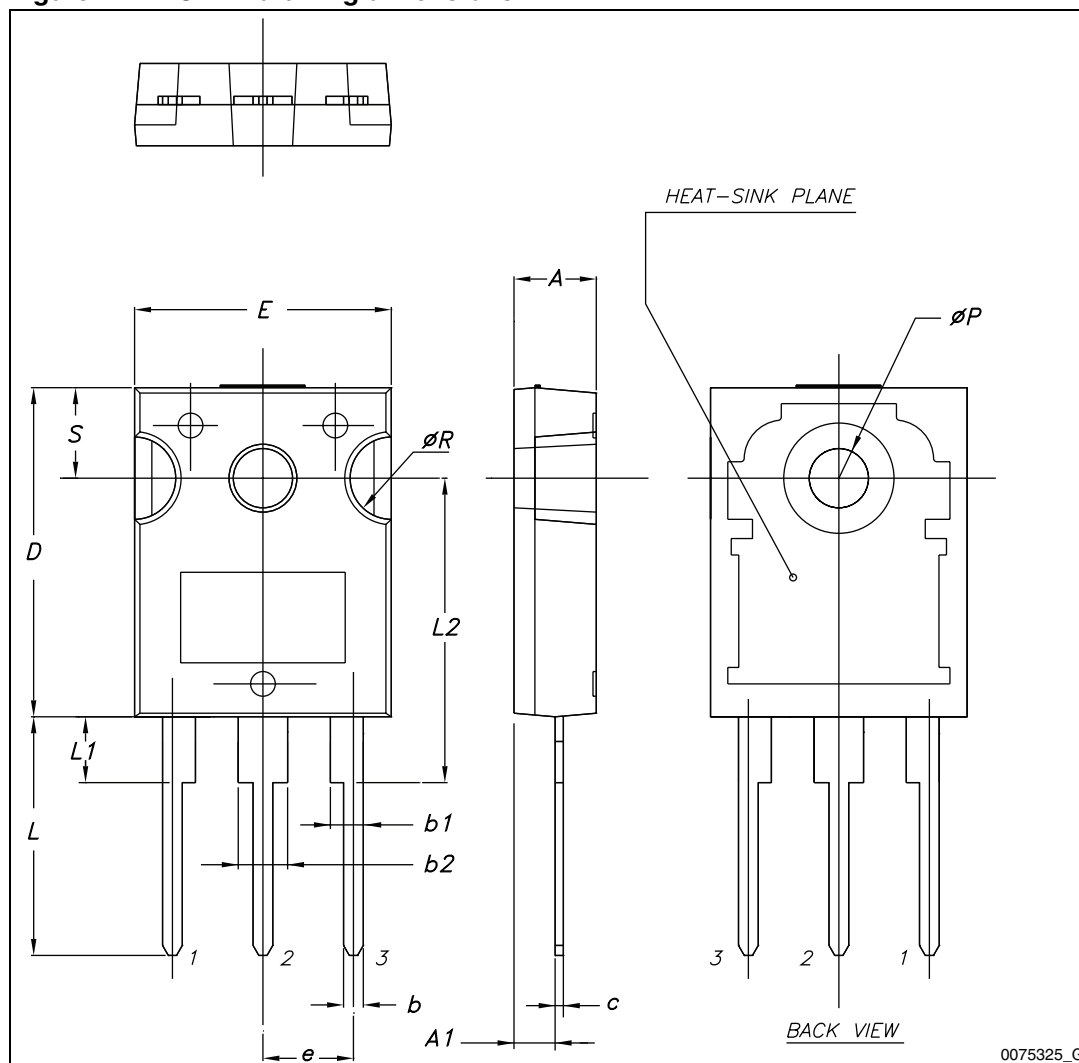
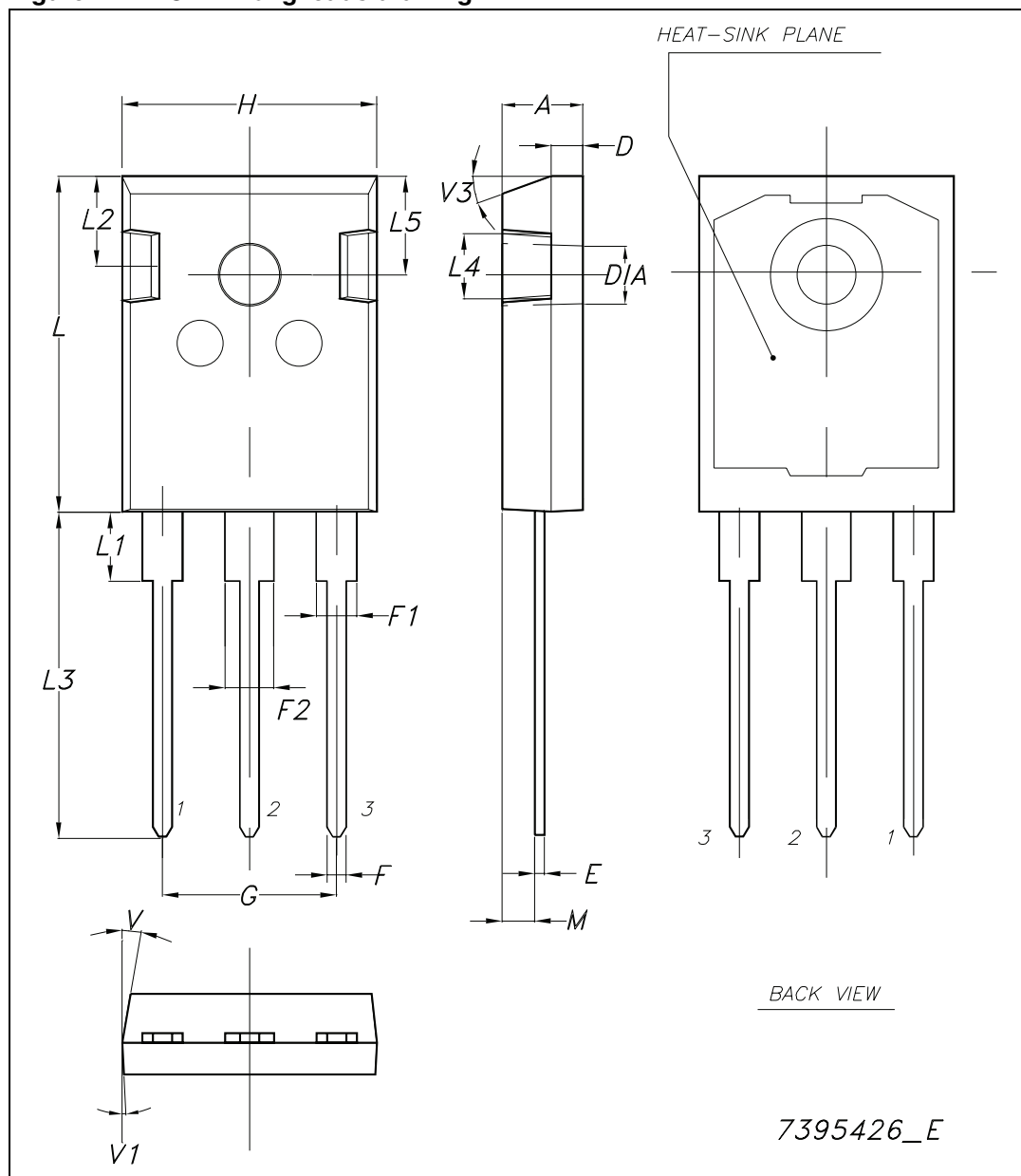


Table 10. TO-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G	10.90 BSC		
H	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
M	2.27		2.52
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

Figure 22. TO-247 long leads drawing



## 5 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
29-Jan-2008	1	Initial release
18-Jun-2008	2	Update values in <a href="#">Table 2</a>
02-Dec-2008	3	Update $P_{TOT}$ and $R_{thj-case}$ value (see <a href="#">Table 2</a> and <a href="#">Table 3</a> )
17-Jan-2012	4	Added order code STGWA30N120KD <a href="#">Table 1 on page 1</a> , mechanical data TO-247 long leads <a href="#">Table 10 on page 12</a> and <a href="#">Figure 22 on page 13</a> .
27-Feb-2012	5	Modified: <a href="#">Description on page 1</a> .

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