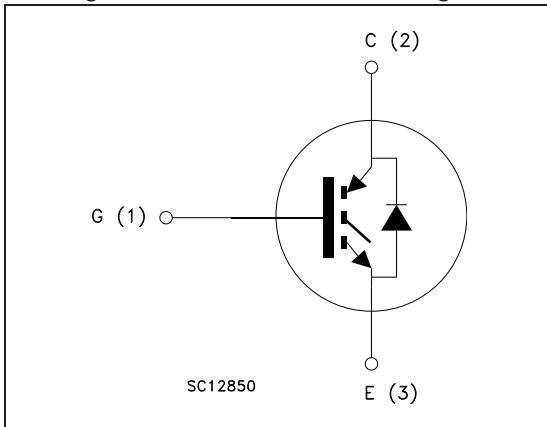


**Figure 1. Internal schematic diagram**



### Features

- Low on-losses
- Low on-voltage drop ( $V_{CE(sat)}$ )
- High current capability
- IGBT co-packaged with ultrafast free-wheeling diode
- Low gate charge
- Ideal for soft switching application

### Application

- Induction heating
- High frequency inverters
- UPS

### Description

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

**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW35NC120HD	GW35NC120HD	TO-247 long leads	Tube

# Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>4</b>
	2.1 Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuits</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Revision history</b> .....	<b>12</b>

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	60	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	32	A
$I_{CL}^{(2)}$	Turn-off latching current	135	A
$I_{CP}^{(3)}$	Pulsed collector current	135	A
$V_{GE}$	Gate-emitter voltage	$\pm 25$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	235	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 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.  $V_{clamp} = 80\%$  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 data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.53	°C/W
	Thermal resistance junction-case diode	1.5	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient	50	°C/W

## 2 Electrical characteristics

( $T_j = 25\text{ °C}$  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	$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_j = 125\text{ °C}$		2.2 2.0	2.75	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 250\mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$ $V_{CE} = 1200\text{ V}$ , $T_j = 125\text{ °C}$			500 10	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 25\text{ V}$ , $I_C = 20\text{ A}$		14		S

1. Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$	-	2510	-	pF
$C_{oes}$	Output capacitance		-	175	-	pF
$C_{res}$	Reverse transfer capacitance		-	30	-	pF
$Q_g$	Total gate charge	$V_{CE} = 960\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$	-	110	-	nC
$Q_{ge}$	Gate-emitter charge		-	16	-	nC
$Q_{gc}$	Gate-collector charge		-	49	-	nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	29	-	ns
$t_r$	Current rise time	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>	-	11	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1820	-	A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	27	-	ns
$t_r$	Current rise time	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125 \text{ } ^\circ\text{C}$ <i>Figure 17</i>	-	14	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1580	-	A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	90	-	ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>	-	275	-	ns
$t_f$	Current fall time		-	312	-	ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	150	-	ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125 \text{ } ^\circ\text{C}$ <i>Figure 17</i>	-	336	-	ns
$t_f$	Current fall time		-	592	-	ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	1660	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>		4438		$\mu$ J
$E_{ts}$	Total switching losses			6098		$\mu$ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960 \text{ V}$ , $I_C = 20 \text{ A}$	-	3015	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10 \text{ } \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125 \text{ } ^\circ\text{C}$ <i>Figure 17</i>	-	6900	-	$\mu$ J
$E_{ts}$	Total switching losses		-	9915	-	$\mu$ J

1.  $E_{on}$  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)

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	2.5	V
$t_{rr}$	Reverse recovery time	$I_F = 20 \text{ A}$ , $V_R = 27 \text{ V}$ , $T_j = 125 \text{ } ^\circ\text{C}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	152	-	ns
$Q_{rr}$	Reverse recovery charge	<i>Figure 20</i>	-	722	-	nC
$I_{rrm}$	Reverse recovery current		-	9	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

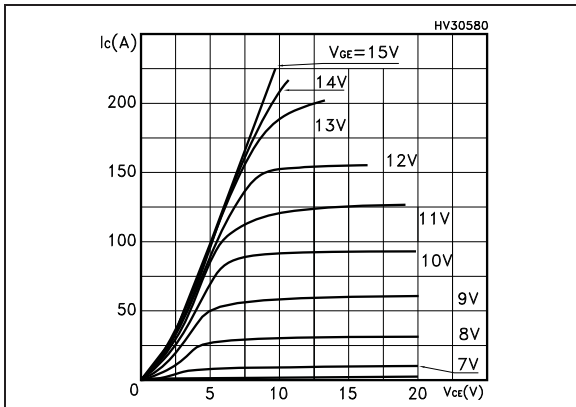


Figure 3. Transfer characteristics

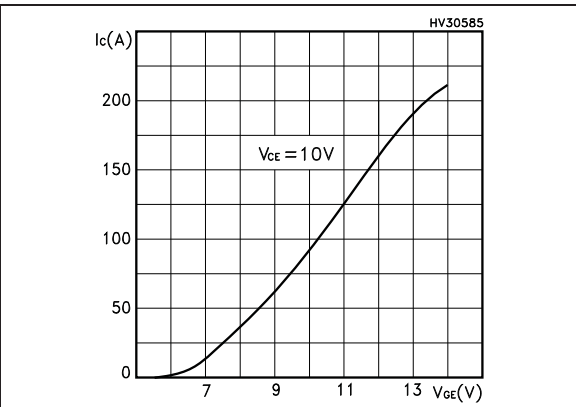


Figure 4. Transconductance

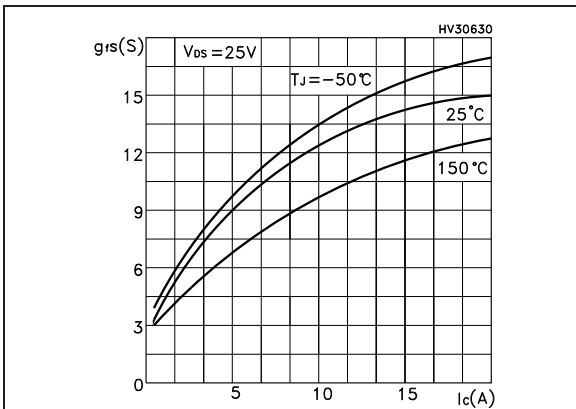


Figure 5. Collector-emitter on voltage vs. temperature

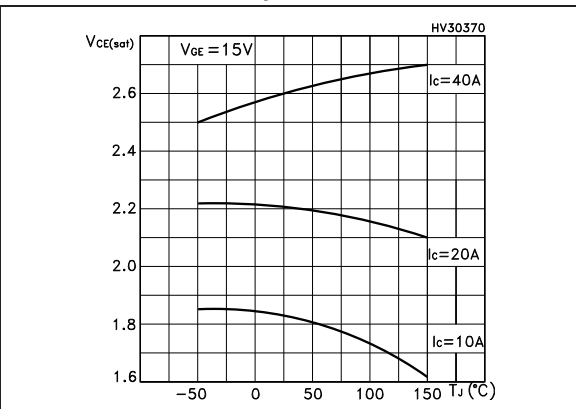


Figure 6. Gate charge vs. gate-source voltage

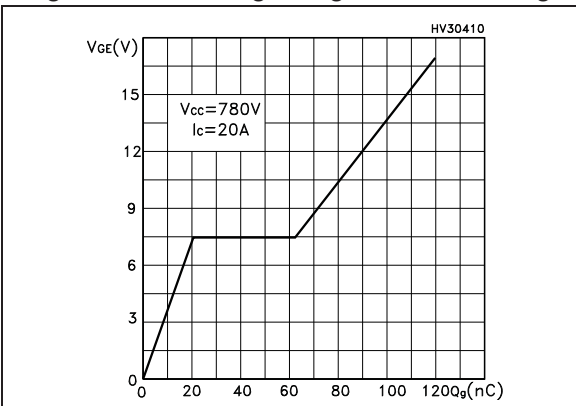


Figure 7. Capacitance variations

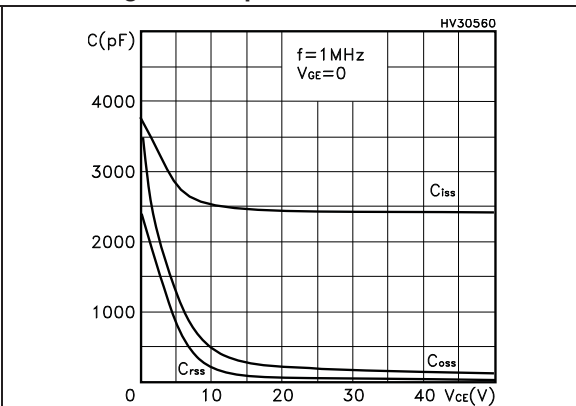


Figure 8. Normalized gate threshold voltage vs. temperature

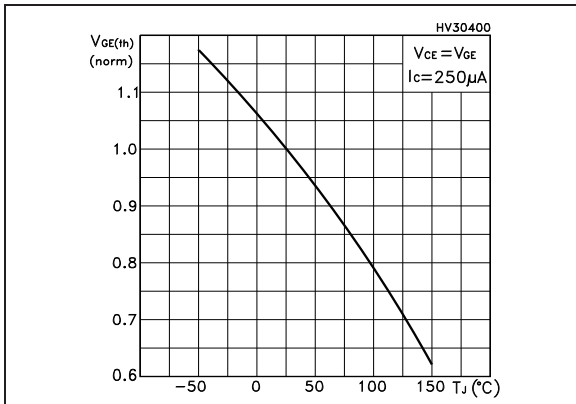


Figure 9. Collector-emitter on voltage vs. collector current

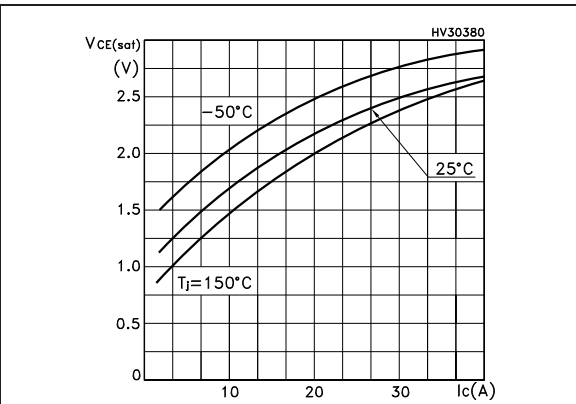


Figure 10. Normalized breakdown voltage vs. temperature

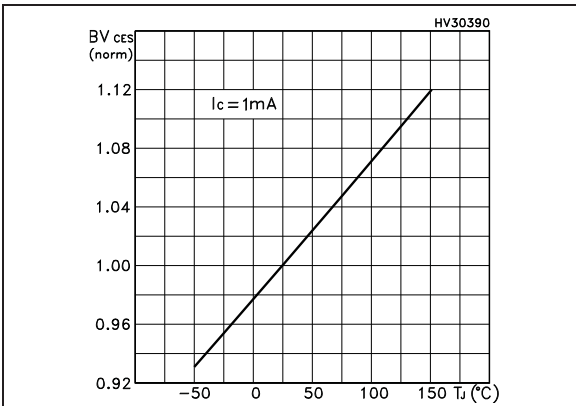


Figure 11. Switching losses vs. temperature

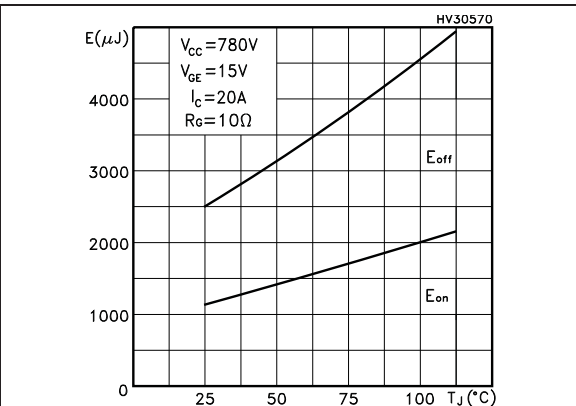


Figure 12. Switching losses vs. gate resistance Figure 13. Switching losses vs. collector current

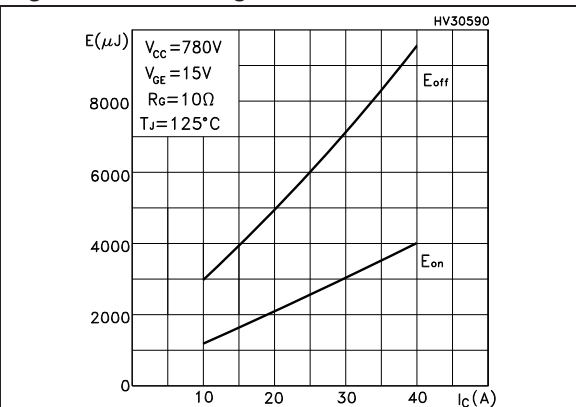
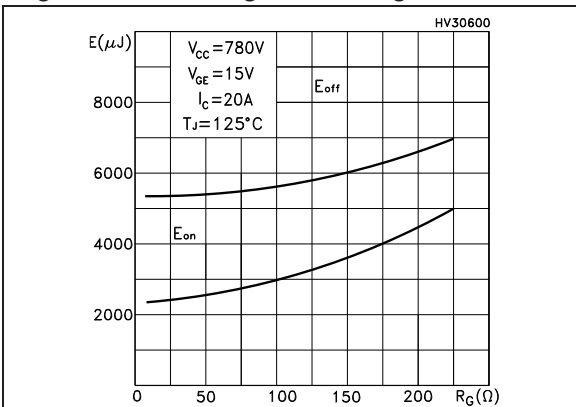


Figure 14. Thermal Impedance

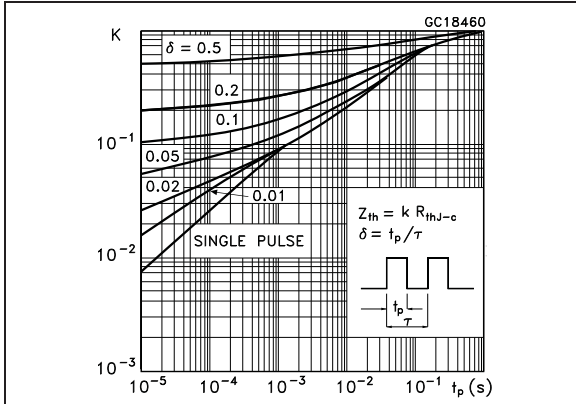


Figure 15. Reverse biased SOA

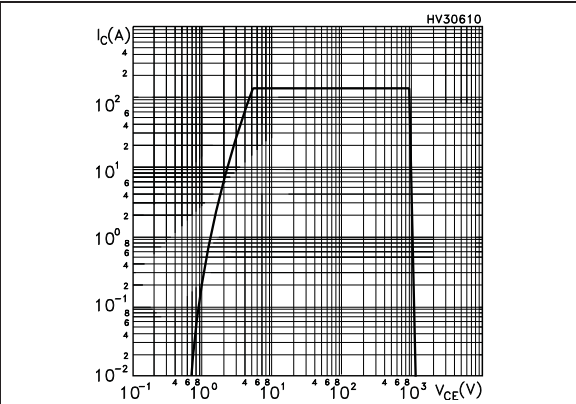
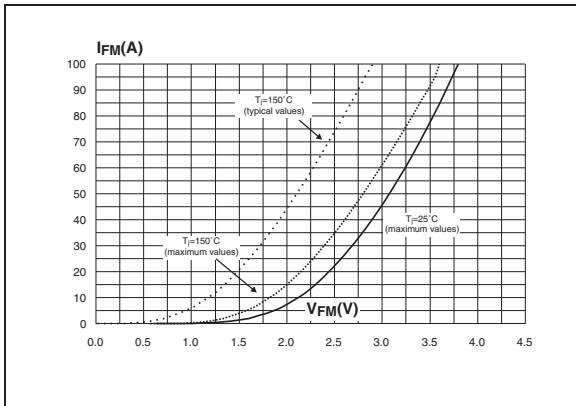


Figure 16. Forward voltage drop vs. forward current





### 3 Test circuits

Figure 17. Test circuit for inductive load switching

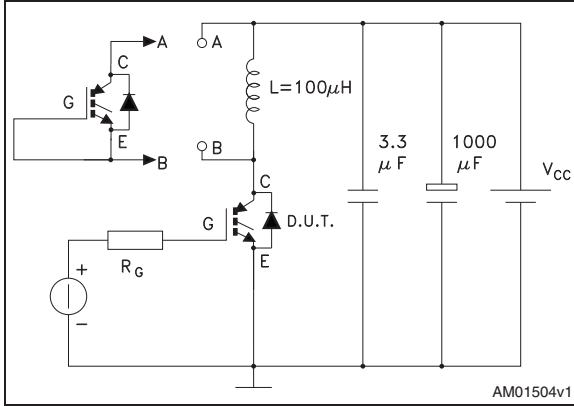


Figure 18. Gate charge test circuit

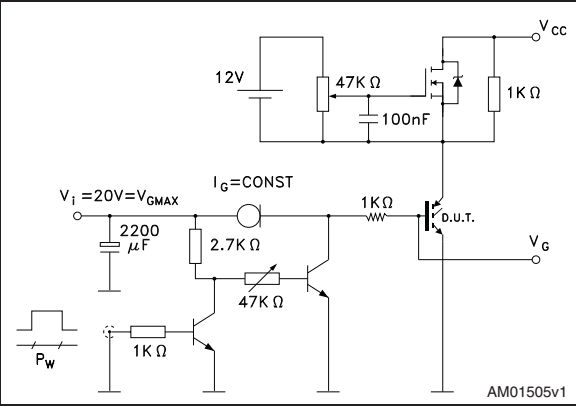


Figure 19. Switching waveform

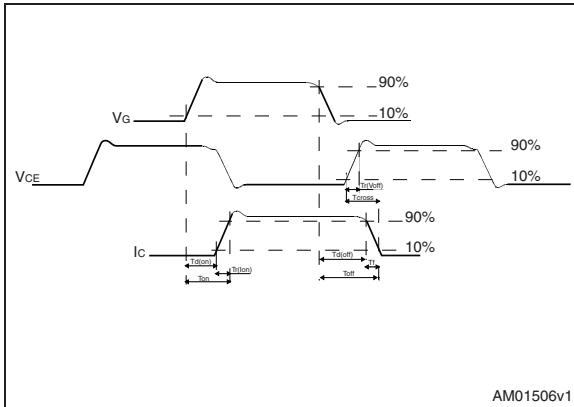
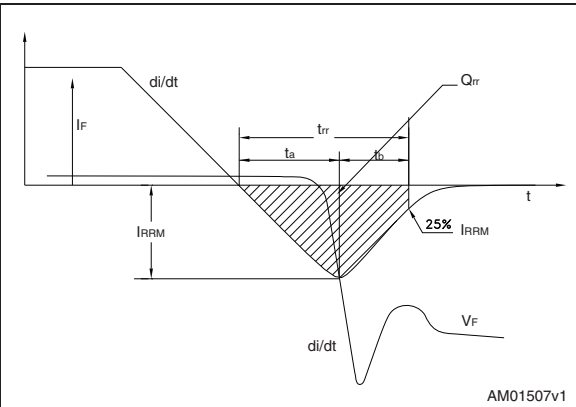


Figure 20. Diode recovery time waveform



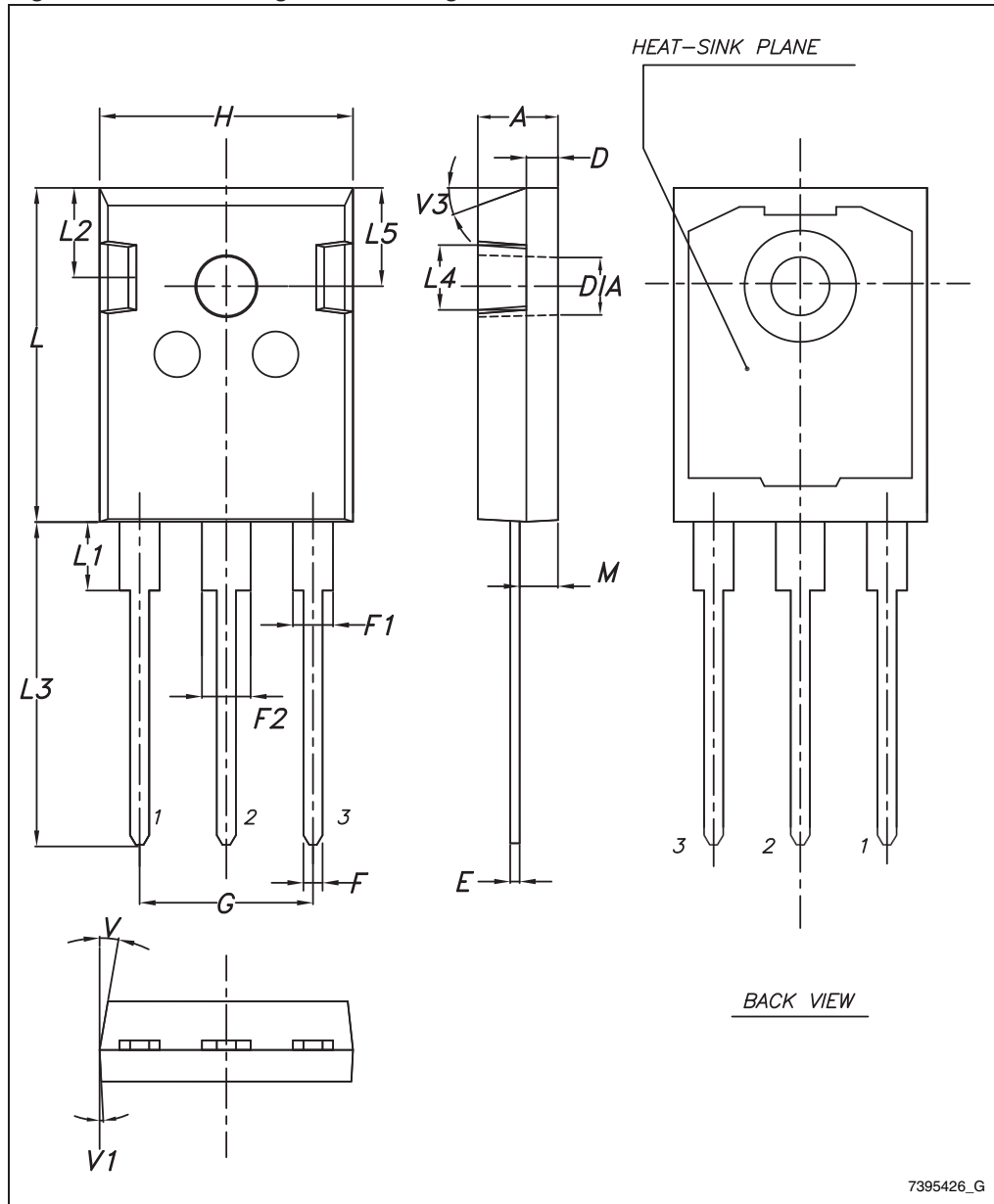
## 4 Package mechanical data

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 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	2.25		2.55
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

Figure 21. TO-247 long leads drawing



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
25-Jan-2008	1	First issue.
07-May-2009	2	<i>Section 4: Package mechanical data</i> has been updated.
12-Dec-2013	3	Updated <i>Section 4: Package mechanical data</i> . Minor text changes.

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