

**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

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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
$I_C^{(1)}$	Continuous collector current at $T_C = 25^\circ\text{C}$	60	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100^\circ\text{C}$	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 $T_C = 25^\circ\text{C}$	235	W
$I_F$	Diode RMS forward current at $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

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  $V_{CES}$ ,  $T_j = 125^\circ\text{C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$

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	$^\circ\text{C/W}$
	Thermal resistance junction-case diode	1.5	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	50	$^\circ\text{C/W}$

## 2 Electrical characteristics

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

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{CES}}$	Collector-emitter breakdown voltage ( $V_{\text{GE}} = 0$ )	$I_C = 1 \text{ mA}$	1200			V
$V_{\text{CE}(\text{sat})}$	Collector-emitter saturation voltage	$V_{\text{GE}} = 15 \text{ V}, I_C = 20 \text{ A}$ , $V_{\text{GE}} = 15 \text{ V}, I_C = 20 \text{ A}, T_j = 125^\circ\text{C}$		2.2 2.0	2.75	V
$V_{\text{GE}(\text{th})}$	Gate threshold voltage	$V_{\text{CE}} = V_{\text{GE}}, I_C = 250 \mu\text{A}$	3.75		5.75	V
$I_{\text{CES}}$	Collector cut-off current ( $V_{\text{GE}} = 0$ )	$V_{\text{CE}} = 1200 \text{ V}$ $V_{\text{CE}} = 1200 \text{ V}, T_j = 125^\circ\text{C}$			500 10	$\mu\text{A}$ mA
$I_{\text{GES}}$	Gate-emitter leakage current ( $V_{\text{CE}} = 0$ )	$V_{\text{GE}} = \pm 20 \text{ V}$			$\pm 100$	nA
$g_{\text{fs}}^{(1)}$	Forward transconductance	$V_{\text{CE}} = 25 \text{ V}, I_C = 20 \text{ A}$		14		S

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{\text{ies}}$	Input capacitance	$V_{\text{CE}} = 25 \text{ V}, f = 1 \text{ MHz}, V_{\text{GE}} = 0$	-	2510	-	pF
$C_{\text{oes}}$	Output capacitance		-	175	-	pF
$C_{\text{res}}$	Reverse transfer capacitance		-	30	-	pF
$Q_g$	Total gate charge	$V_{\text{CE}} = 960 \text{ V}$ , $I_C = 20 \text{ A}, V_{\text{GE}} = 15 \text{ V}$	-	110	-	nC
$Q_{\text{ge}}$	Gate-emitter charge		-	16	-	nC
$Q_{\text{gc}}$	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	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>	-	29	-	ns
$t_r$	Current rise time		-	11	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1820	-	$\text{A}/\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ <i>Figure 17</i>	-	27	-	ns
$t_r$	Current rise time		-	14	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1580	-	$\text{A}/\mu\text{s}$
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>	-	90	-	ns
$t_{d(off)}$	Turn-off delay time		-	275	-	ns
$t_f$	Current fall time		-	312	-	ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ <i>Figure 17</i>	-	150	-	ns
$t_{d(off)}$	Turn-off delay time		-	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	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , <i>Figure 17</i>	-	1660	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses			4438	-	$\mu\text{J}$
$E_{ts}$	Total switching losses			6098	-	$\mu\text{J}$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960 \text{ V}, I_C = 20 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ <i>Figure 17</i>	-	3015	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses		-	6900	-	$\mu\text{J}$
$E_{ts}$	Total switching losses		-	9915	-	$\mu\text{J}$

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 ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ )
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	$I_F = 20 \text{ A}$ $I_F = 20 \text{ A}, T_C = 125^\circ\text{C}$	-	1.9 1.7	2.5	V V
$t_{rr}$	Reverse recovery time	$I_F = 20 \text{ A}, V_R = 27 \text{ V}$ , $T_j = 125^\circ\text{C}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ <i>Figure 20</i>	-	152	-	ns
$Q_{rr}$	Reverse recovery charge		-	722	-	nC
$I_{rrm}$	Reverse recovery current		-	9	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

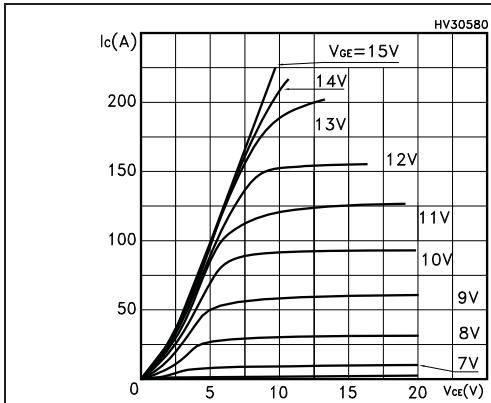


Figure 3. Transfer characteristics

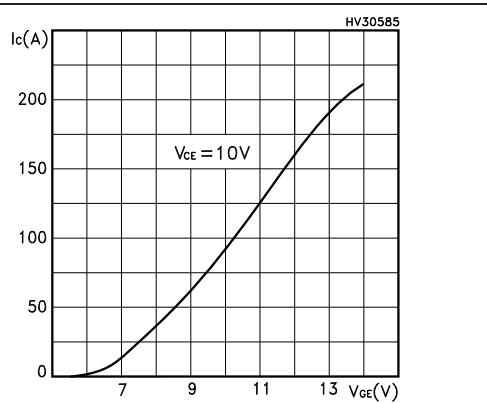


Figure 4. Transconductance

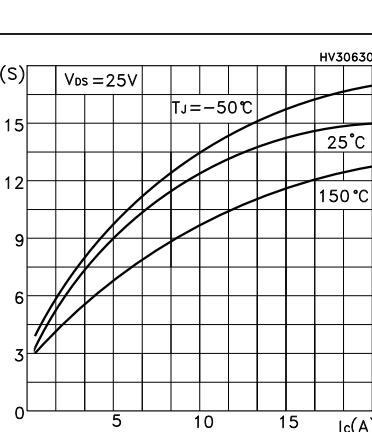


Figure 5. Collector-emitter on voltage vs. temperature

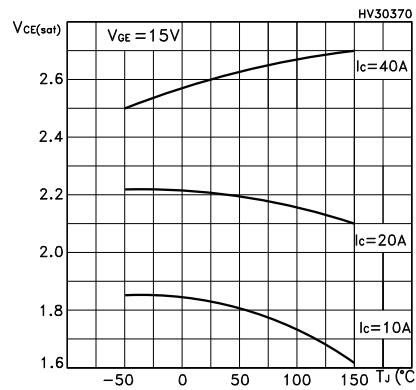


Figure 6. Gate charge vs. gate-source voltage

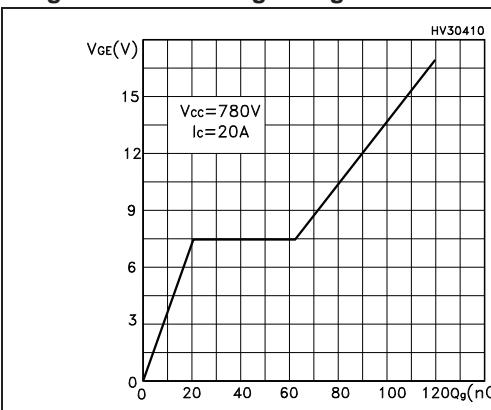
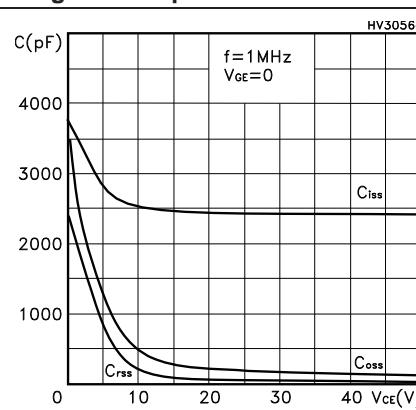


Figure 7. Capacitance variations



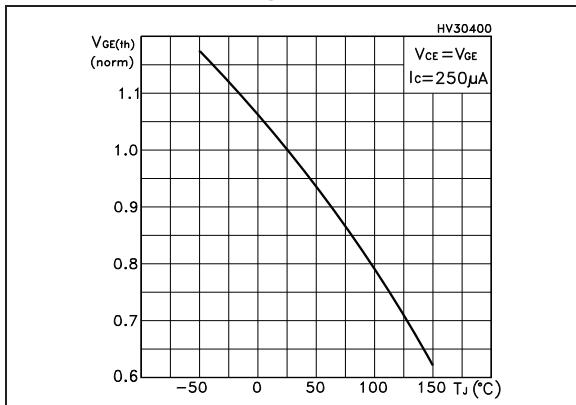
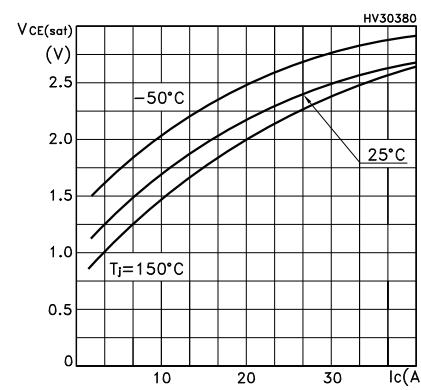
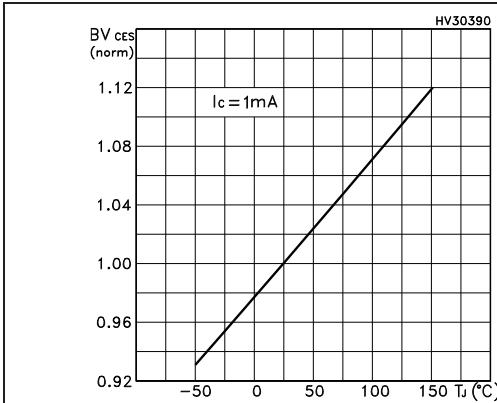
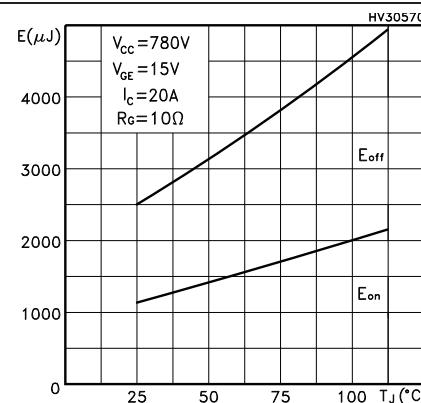
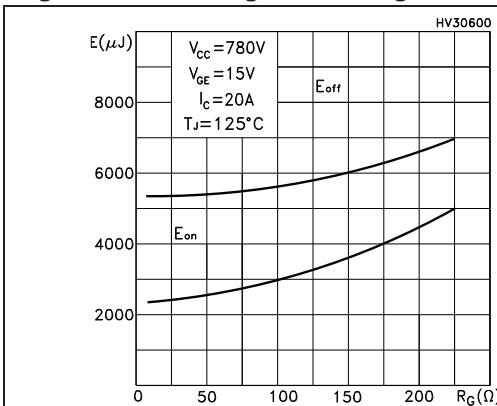
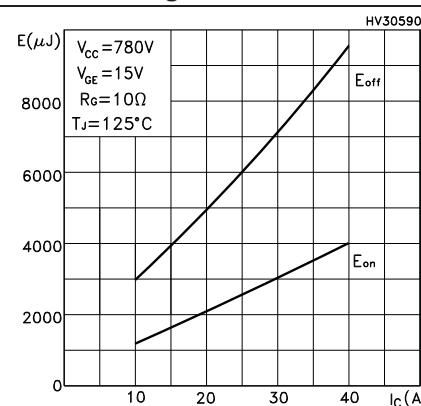
**Figure 8. Normalized gate threshold voltage vs. temperature****Figure 9. Collector-emitter on voltage vs. collector current****Figure 10. Normalized breakdown voltage vs. temperature****Figure 11. Switching losses vs. temperature****Figure 12. Switching losses vs. gate resistance****Figure 13. Switching losses vs. collector current**

Figure 14. Thermal Impedance

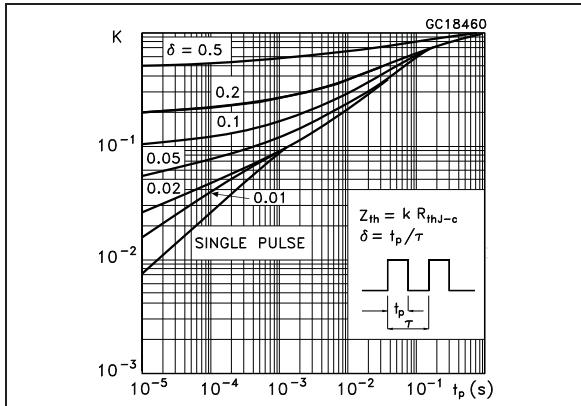


Figure 15. Reverse biased SOA

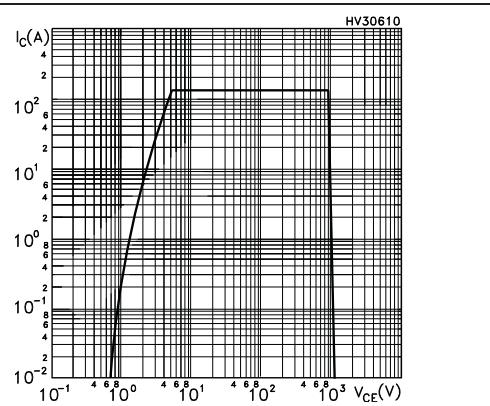
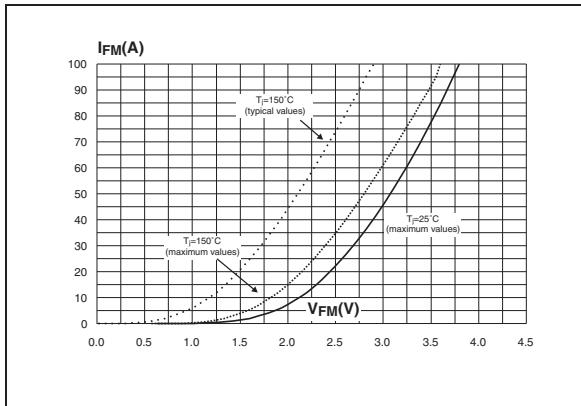
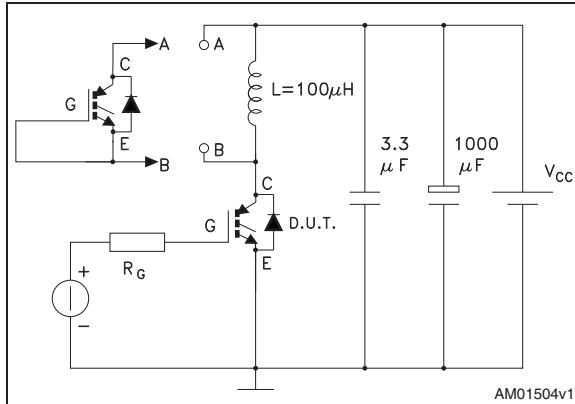


Figure 16. Forward voltage drop vs. forward current

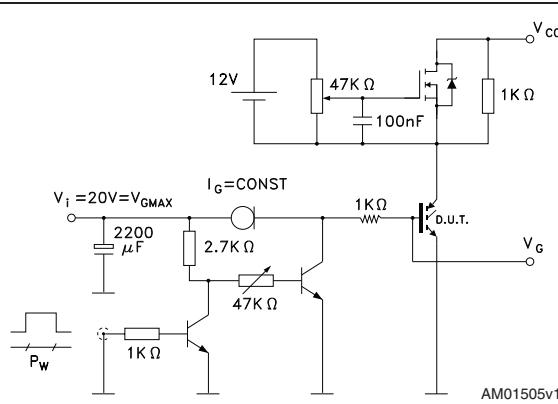


### 3 Test circuits

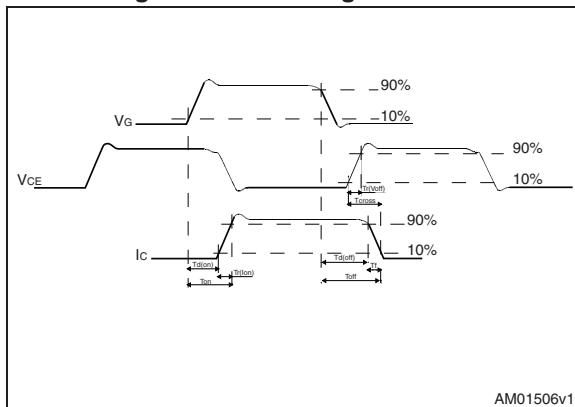
**Figure 17. Test circuit for inductive load switching**



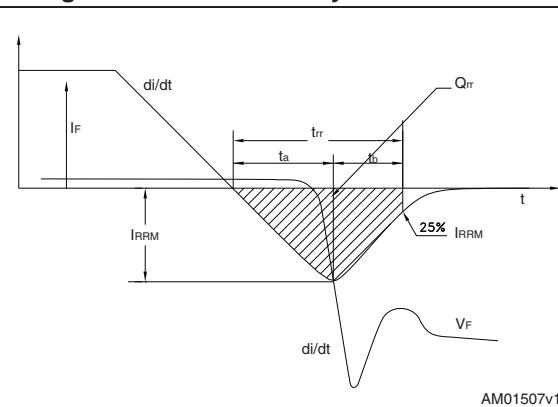
**Figure 18. Gate charge test circuit**



**Figure 19. Switching waveform**



**Figure 20. Diode recovery time waveform**



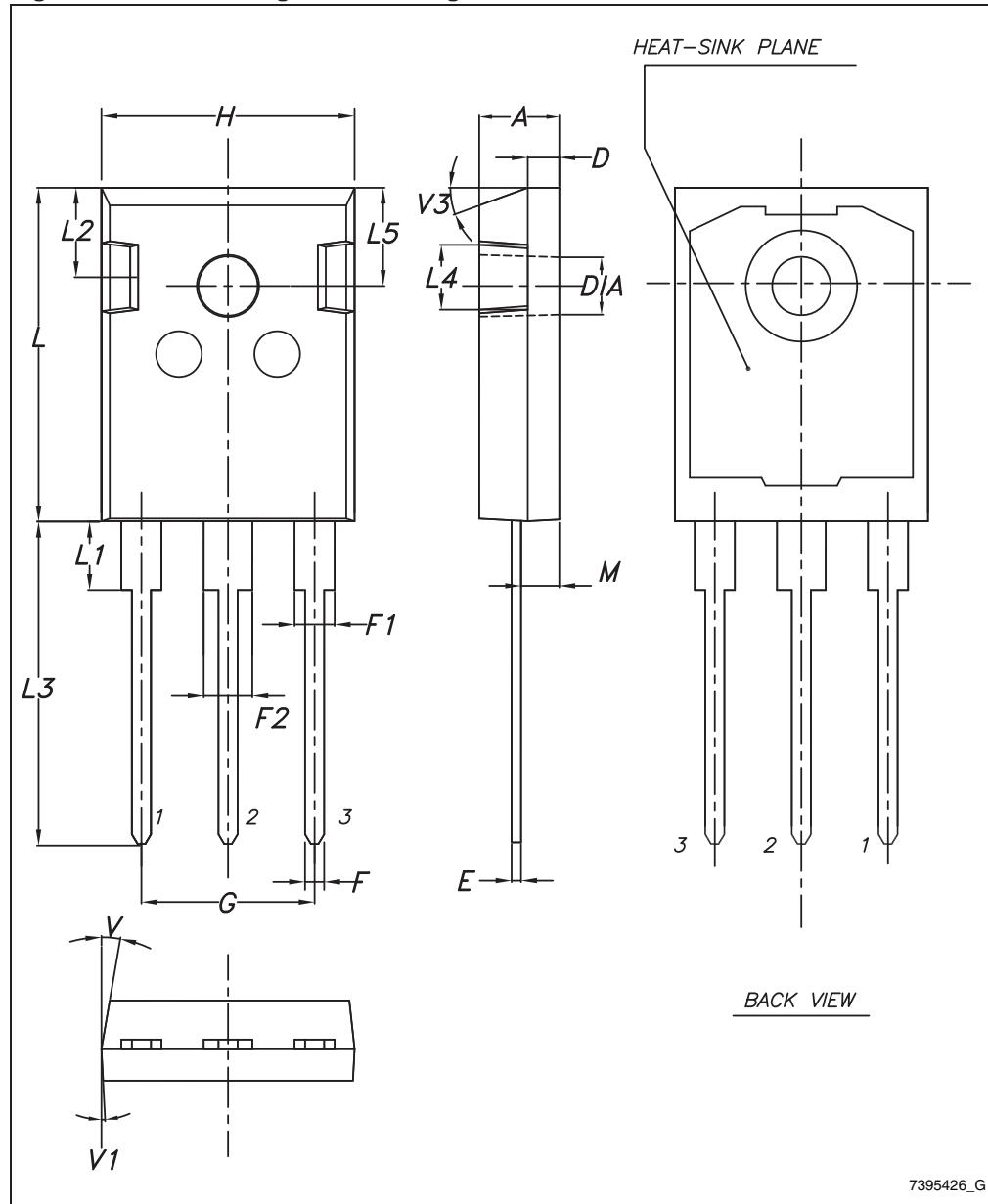
## 4 Package mechanical data

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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