



# STGW50NC60W

N-channel 600V - 55A - TO-247  
Ultra fast switching PowerMESH™ IGBT

## Features

Type	V <sub>CES</sub>	V <sub>CE(sat)</sub> (max)@25°C	I <sub>C</sub> @100°C
STGW50NC60W	600V	< 2.6V	55A

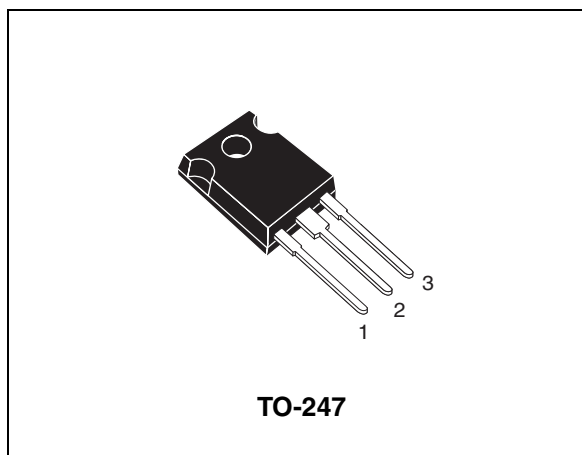
- Very high frequency operation
- Low C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross-conduction susceptibility)

## Applications

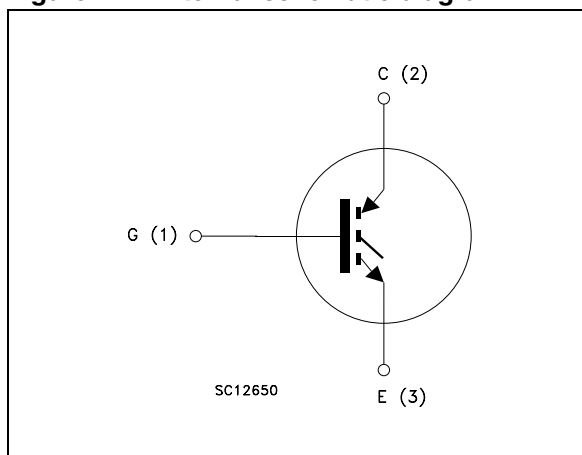
- Very high frequency inverters, UPS
- HF, SMPS and PFC in both hard switch and resonant topologies
- Motor drivers
- Welding

## Description

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “W” identifies a family optimized for very high frequency applications.



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW50NC60W	GW50NC60W	TO-247	Tube

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GS} = 0$ )	600	V
$I_C^{(1)}$	Collector current (continuous) at $T_C = 25^\circ\text{C}$	100	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100^\circ\text{C}$	55	A
$I_{CL}^{(2)}$	Turn-off SOA minimum current	250	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	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.  $V_{clamp} = 480\text{V}$ ,  $T_J = 150^\circ\text{C}$ ,  $R_G = 10\Omega$ ,  $V_{GE} = 15\text{V}$

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max IGBT	0.45	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	$^\circ\text{C/W}$

## 2 Electrical characteristics

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

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-emitter breakdown voltage	$I_C = 1\text{mA}$ , $V_{GE} = 0$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}$ , $I_C = 40\text{A}$ $V_{GE} = 15\text{V}$ , $I_C = 40\text{A}$ , $T_C = 125^{\circ}\text{C}$		2.1 1.9	2.6	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 ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}$ , $T_C = 25^{\circ}\text{C}$ $V_{CE} = \text{Max rating}$ , $T_C = 125^{\circ}\text{C}$			500 5	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{V}$ , $I_C = 40\text{A}$		25		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$ , $V_{GE} = 0$		4700		pF
$C_{oes}$	Output capacitance			410		pF
$C_{res}$	Reverse transfer capacitance			90		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{V}$ , $I_C = 40\text{A}$ ,		195		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{V}$ ,		32		nC
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 16</a>		82		nC

**Table 5. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V$		52		ns
$t_r$	Current rise time			17		ns
$(di/dt)_{on}$	Turn-on current slope			2400		A/ $\mu s$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$		50		ns
$t_r$	Current rise time			19		ns
$(di/dt)_{on}$	Turn-on current slope			2020		A/ $\mu s$
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V,$		31		ns
$t_{d(Voff)}$	Turn-off delay time			240		ns
$t_f$	Current fall time			35		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$		59		ns
$t_{d(Voff)}$	Turn-off delay time			280		ns
$t_f$	Current fall time			63		ns

**Table 6. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V,$ <i>Figure 15</i>		365	470	$\mu J$
$E_{off}^{(1)}$	Turn-off switching losses			560	790	$\mu J$
$E_{ts}$	Total switching losses			925	1260	$\mu J$
$E_{on}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 40A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>Figure 15</i>		635		$\mu J$
$E_{off}^{(2)}$	Turn-off switching losses			910		$\mu J$
$E_{ts}$	Total switching losses			1545		$\mu J$

1. Turn-off losses include also the tail of the collector current

2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

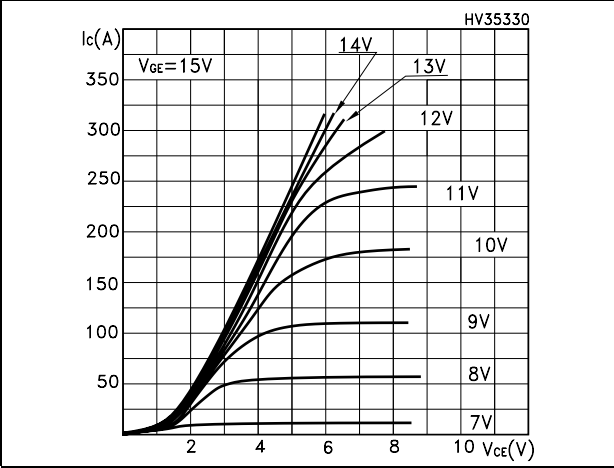


Figure 2. Transfer characteristics

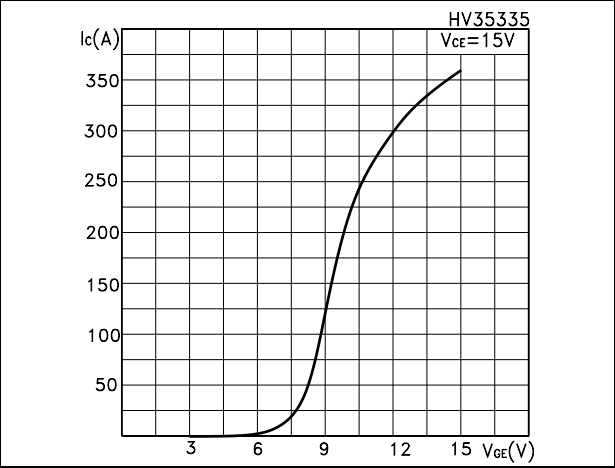


Figure 3. Transconductance

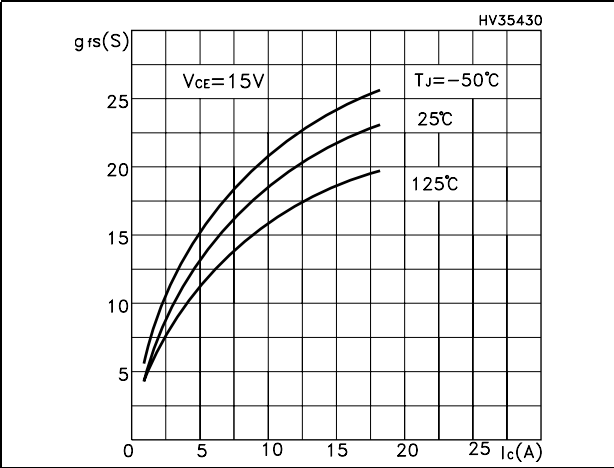


Figure 4. Collector-emitter on voltage vs temperature

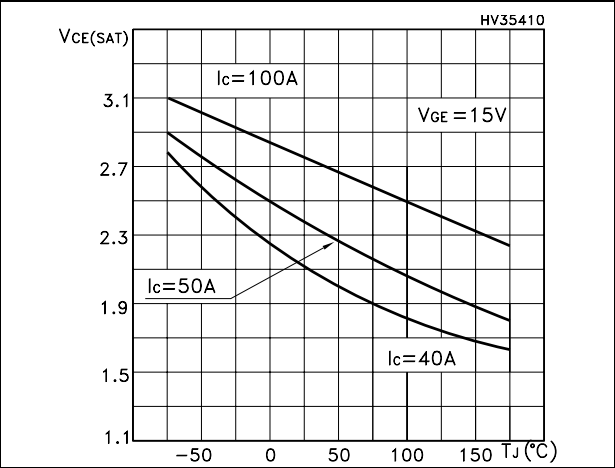


Figure 5. Gate charge vs gate-source voltage Figure 6. Capacitance variations

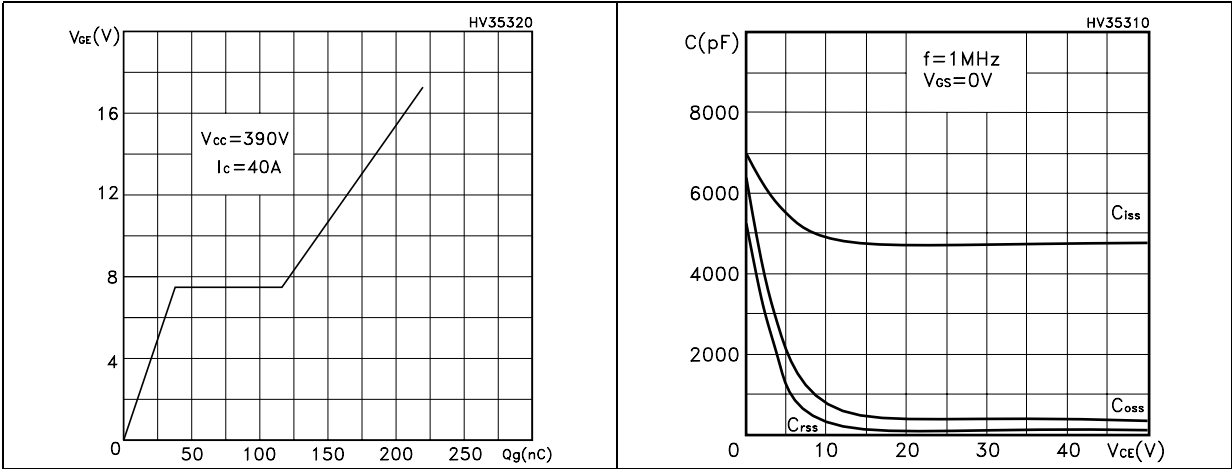


Figure 7. Normalized gate threshold voltage vs temperature Figure 8. Collector-emitter on voltage vs collector current

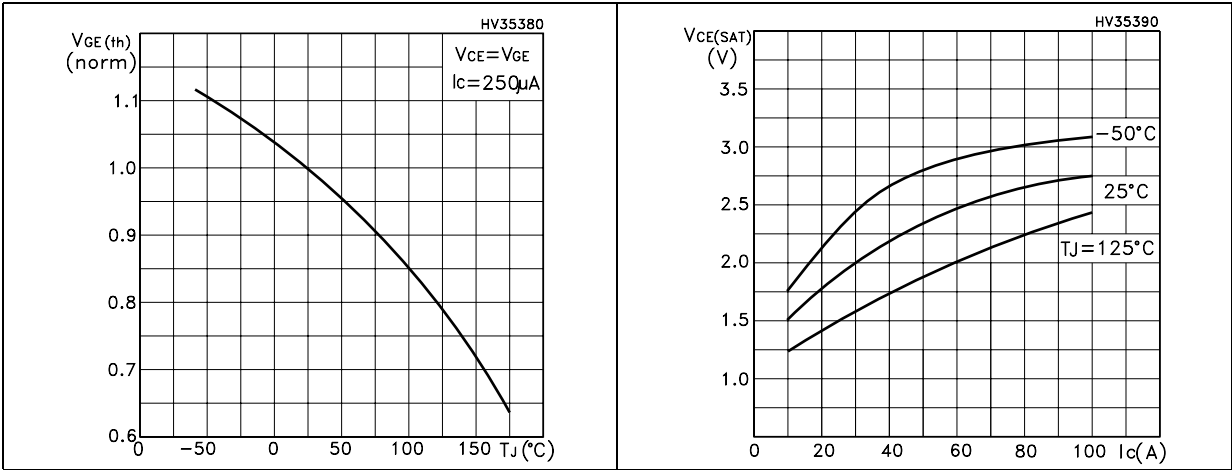


Figure 9. Normalized breakdown voltage vs temperature Figure 10. Switching losses vs temperature

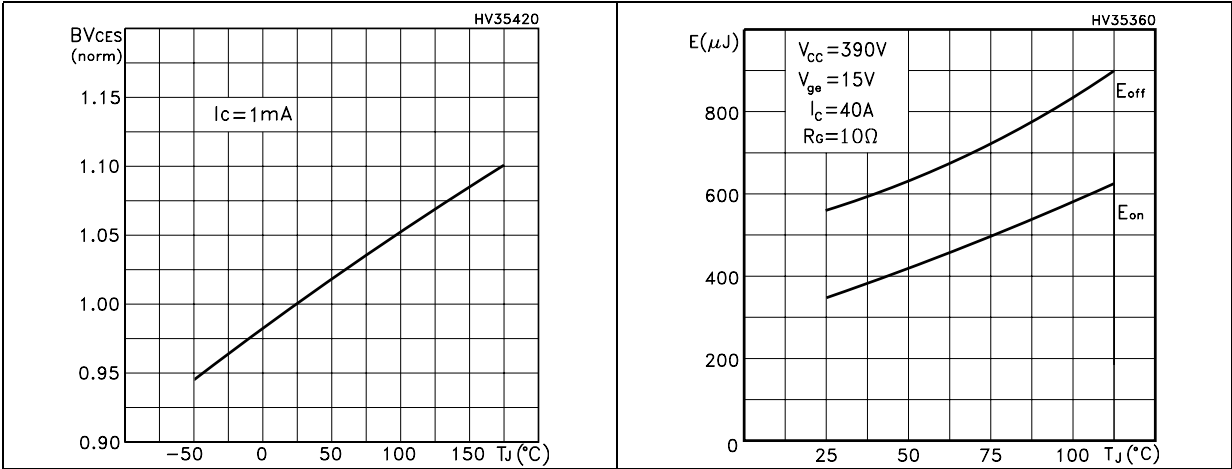


Figure 11. Switching losses vs gate resistance Figure 12. Switching losses vs collector current

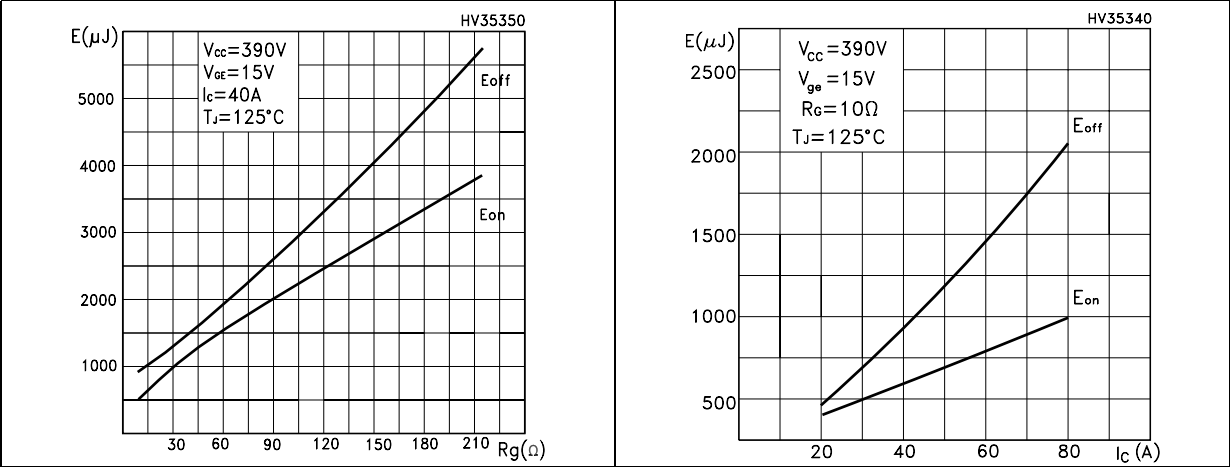
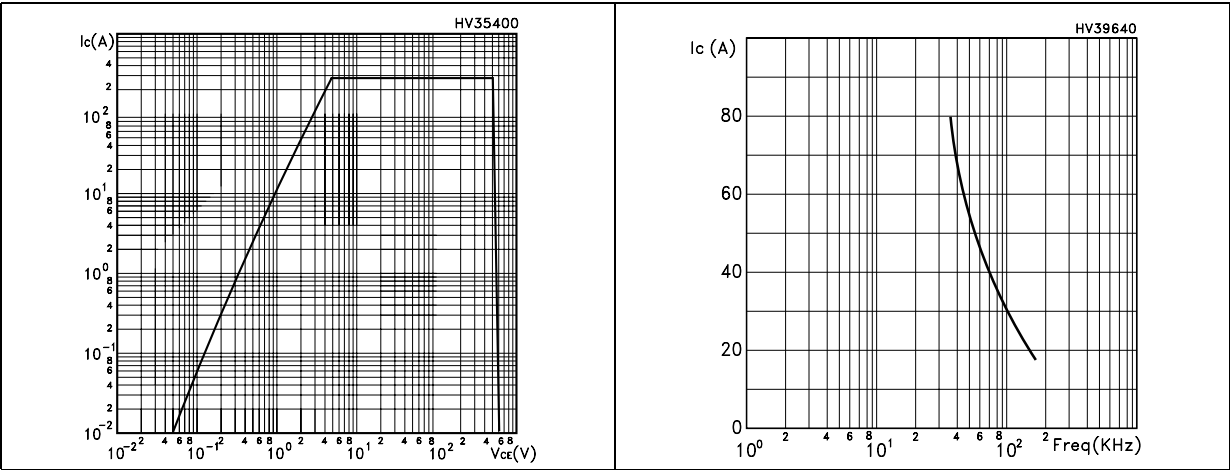


Figure 13. Turn-off SOA Figure 14.  $I_c$  vs. frequency





## 2.2 Frequency applications

For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

- The maximum power dissipation is limited by maximum junction to case thermal resistance:

### Equation 1

$$P_D = \Delta T / R_{THJ-C}$$

considering  $\Delta T = T_J - T_C = 125\text{ }^{\circ}\text{C} - 75\text{ }^{\circ}\text{C} = 50\text{ }^{\circ}\text{C}$

- The conduction losses are:

### Equation 2

$$P_C = I_C * V_{CE(SAT)} * \delta$$

with 50% of duty cycle,  $V_{CESAT}$  typical value @125°C.

- Power dissipation during ON & OFF commutations is due to the switching frequency:

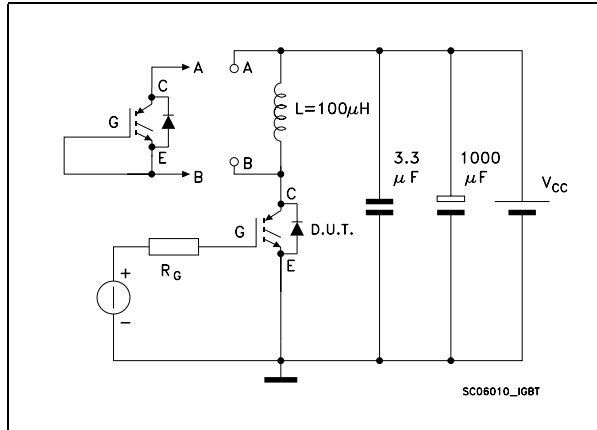
### Equation 3

$$P_{SW} = (E_{ON} + E_{OFF}) * \text{freq.}$$

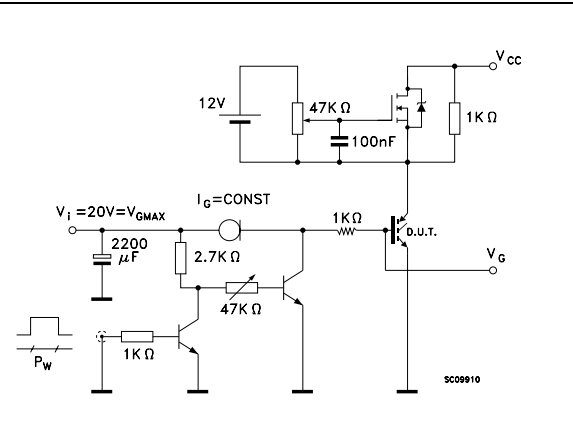
- Typical values @ 125°C for switching losses are used (test conditions:  $V_{CE} = 390\text{V}$ ,  $V_{GE} = 15\text{V}$ ,  $R_G = 10\text{ Ohm}$ ). Furthermore, diode recovery energy is included in the  $E_{ON}$  (see note 2), while the tail of the collector current is included in the  $E_{OFF}$  measurements (see note 3).

### 3 Test circuit

**Figure 15. Test circuit for inductive load switching**



**Figure 16. Gate charge test circuit**

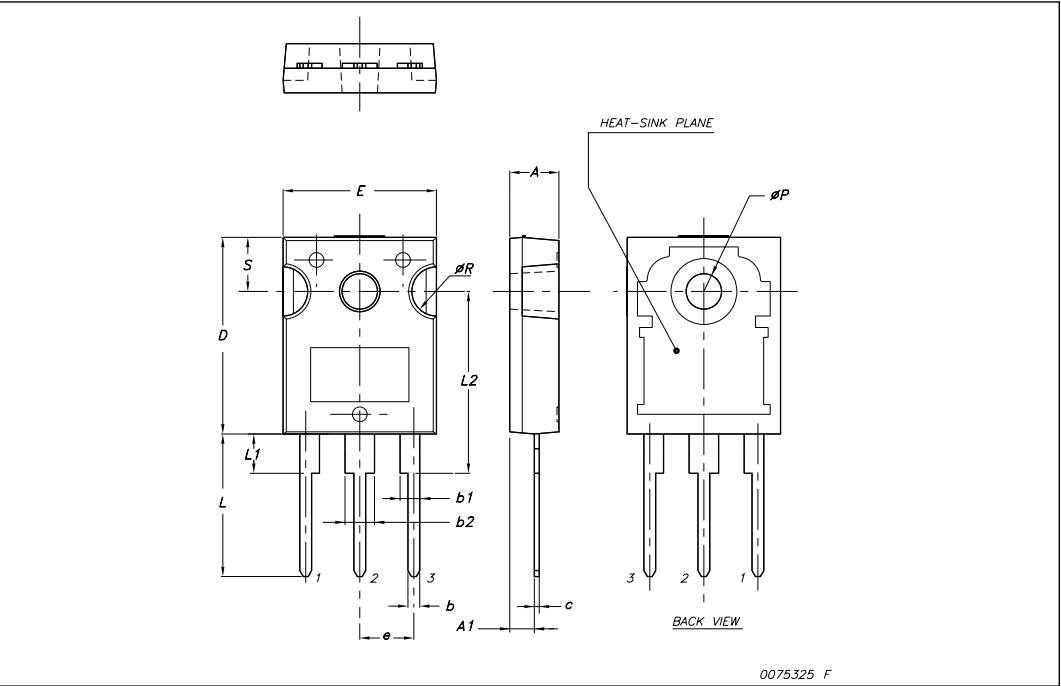


## 4 Package mechanical data

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](http://www.st.com)

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		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
øP	3.55		3.65
øR	4.50		5.50
S		5.50	



## 5 Revision history

**Table 7. Document revision history**

Date	Revision	Changes
24-Aug-2007	1	Initial release.

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