

### Features

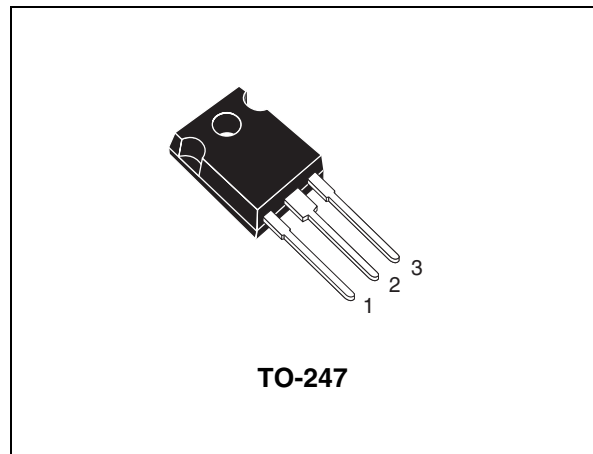
- High speed switching
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance
- 6  $\mu$ s short-circuit withstand time
- Lead free package

### Applications

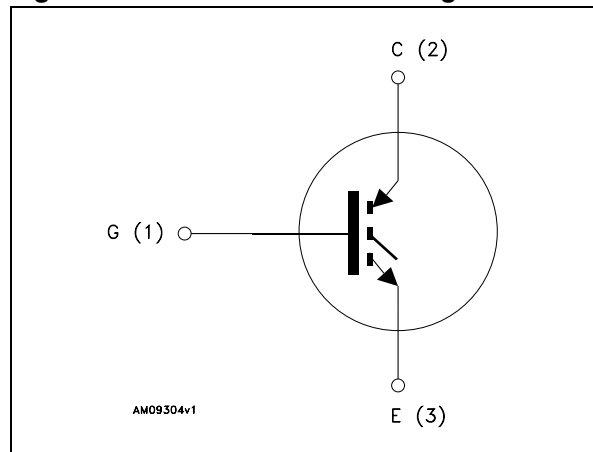
- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- High switching frequency converters

### Description

Using advanced proprietary trench gate and field stop structure, this IGBT leads to an optimized compromise between conduction and switching losses maximizing the efficiency for high switching frequency converters. Furthermore, a slightly positive  $V_{CE(sat)}$  temperature coefficient and a very tight parameter distribution result in an easier paralleling operation.



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW60H65F	GW60H65F	TO-247	Tube

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	650	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	120	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	60	A
$I_{CP}^{(1)}$	Pulsed collector current	240	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	360	W
$t_{SC}$	Short-circuit withstand time at $V_{CC} = 400\text{ V}$ , $V_{GE} = 15\text{ V}$	6	$\mu\text{s}$
$T_{STG}$	Storage temperature range	- 55 to 150	$^{\circ}\text{C}$
$T_J$	Operating junction temperature		

1. Pulse width limited by maximum junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case	0.35	$^{\circ}\text{C}/\text{W}$
$R_{thJA}$	Thermal resistance junction-ambient	50	$^{\circ}\text{C}/\text{W}$

## 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 ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		1.9		V
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$ $T_J = 125\text{ °C}$		2.1		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$		6.0		V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 650\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE}=0$		7150		pF
$C_{oes}$	Output capacitance		-	275	-	pF
$C_{res}$	Reverse transfer capacitance			140		pF
$Q_g$	Total gate charge	$V_{CC} = 400\text{ V}, I_C = 60\text{ A},$ $V_{GE} = 15\text{ V}$		217		nC
$Q_{ge}$	Gate-emitter charge			67		nC
$Q_{gc}$	Gate-collector charge			97		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}^{(1)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$		65		ns
$t_r^{(1)}$	Current rise time		-	30	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope			2000		A/ $\mu\text{s}$
$t_{d(on)}^{(1)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ °C}$		63		ns
$t_r^{(1)}$	Current rise time		-	33	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope			1800		A/ $\mu\text{s}$

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

$t_r(V_{off})$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$	-	35	-	ns
$t_{d(off)}$	Turn-off delay time		-	180	-	ns
$t_f$	Current fall time		-	43	-	ns
$t_r(V_{off})$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	46	-	ns
$t_{d(off)}$	Turn-off delay time		-	210	-	ns
$t_f$	Current fall time		-	85	-	ns

1.  $E_{on}$  is the turn-on losses when a SiC diode (STPSC1206D) 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).

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$	-	0.75	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	1.05	-	mJ
$E_{ts}$	Total switching losses		-	1.80	-	mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	0.8	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	1.4	-	mJ
$E_{ts}$	Total switching losses		-	2.2	-	mJ

1.  $E_{on}$  is the turn-on losses when a SiC diode (STPSC1206D) 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.

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ( $T_J = -40\text{ }^\circ\text{C}$ ) Figure 3. Output characteristics ( $T_J = 25\text{ }^\circ\text{C}$ )

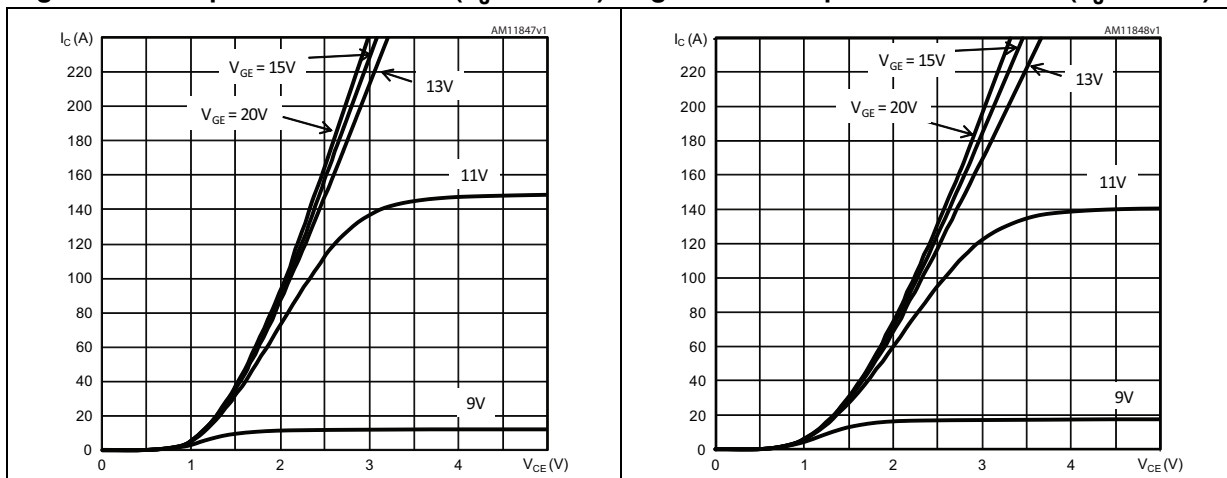


Figure 4. Output characteristics ( $T_J = 150\text{ }^\circ\text{C}$ ) Figure 5. Transfer characteristics

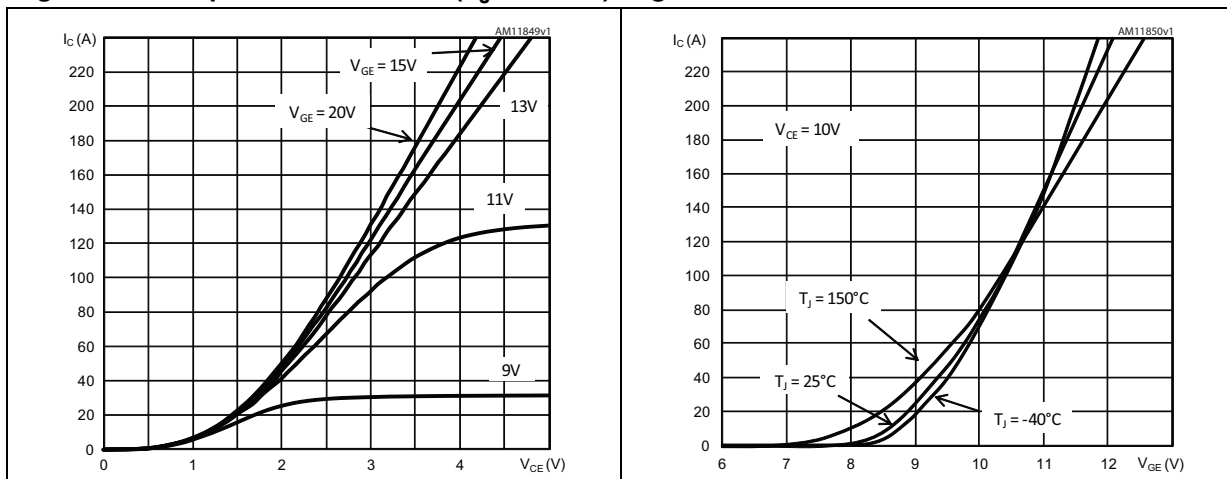


Figure 6.  $V_{CE(SAT)}$  vs. junction temperature Figure 7.  $V_{CE(SAT)}$  vs. collector current

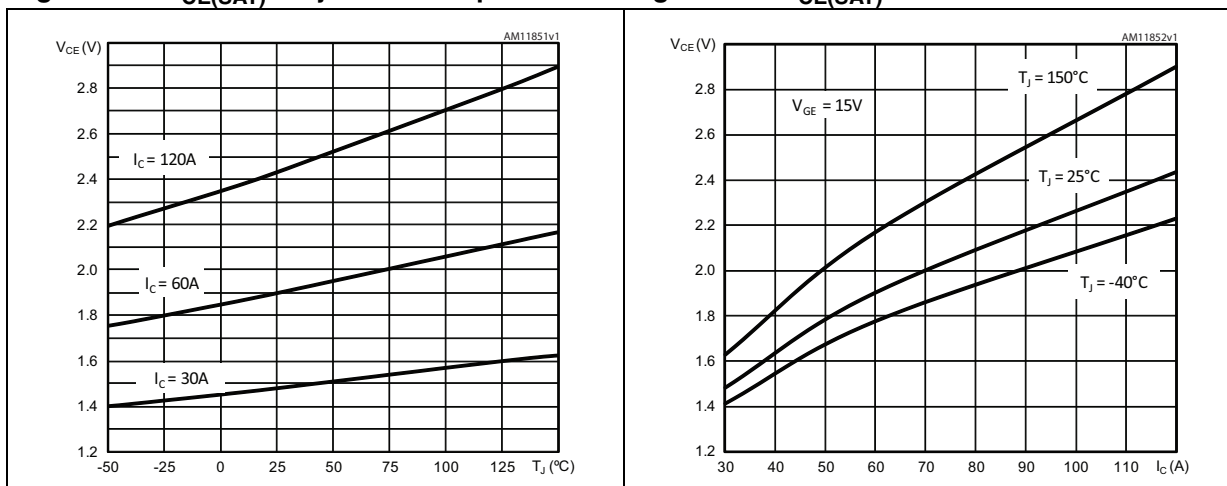


Figure 8. Normalized  $V_{GE(th)}$  vs. junction temperature

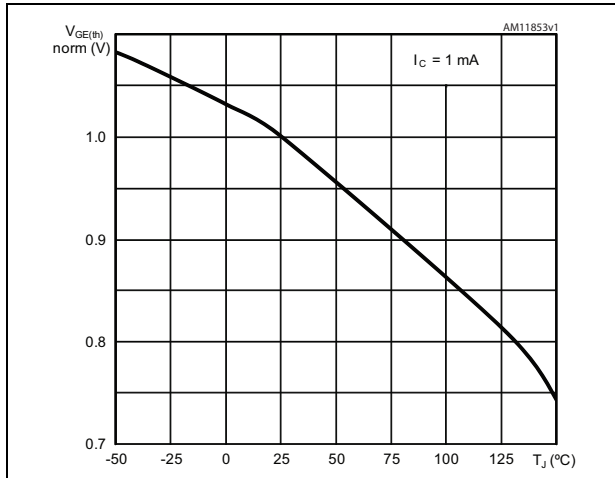


Figure 9. Gate charge vs. gate-emitter voltage

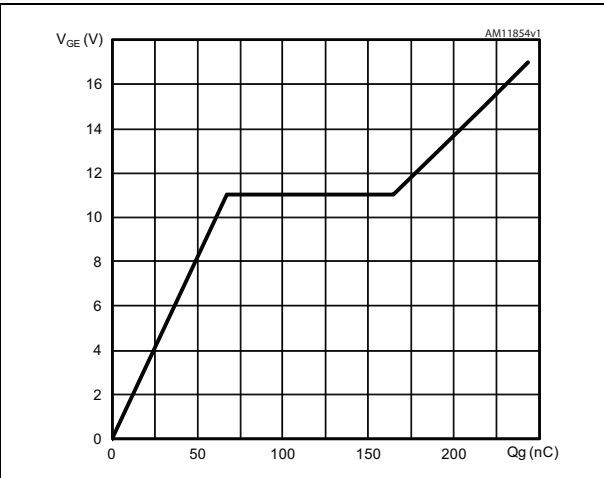


Figure 10. Capacitance variations ( $f = 1$  MHz,  $V_{GE} = 0$ )

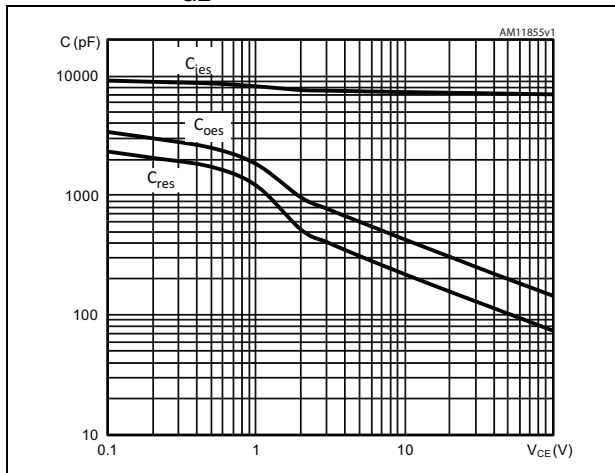


Figure 11. Switching losses vs. collector current

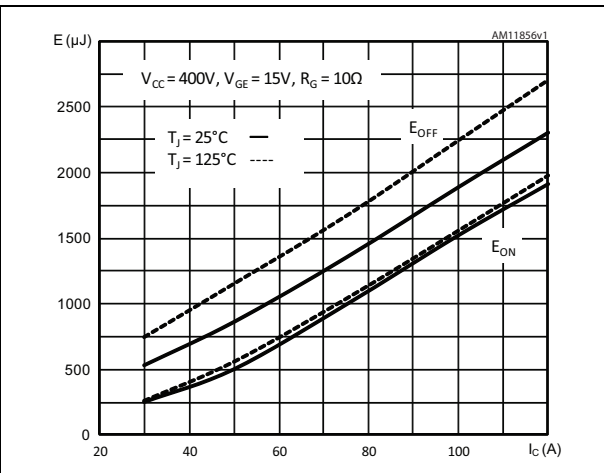


Figure 12. Switching losses vs. gate resistance

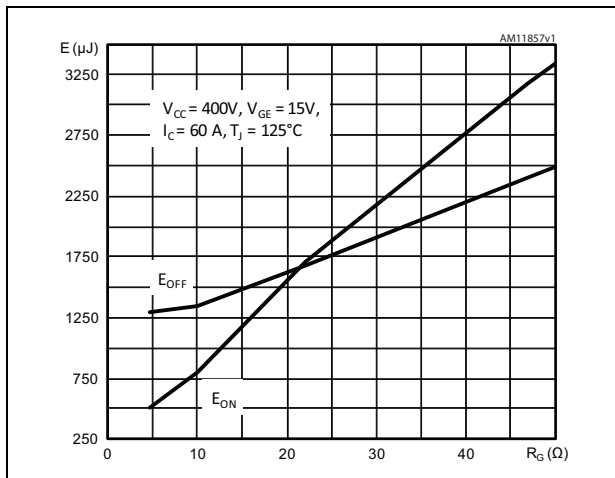


Figure 13. Switching losses vs. temperature

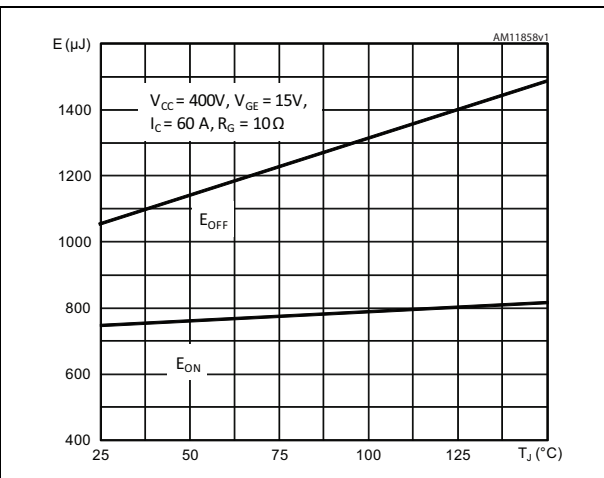


Figure 14. Turn-OFF SOA

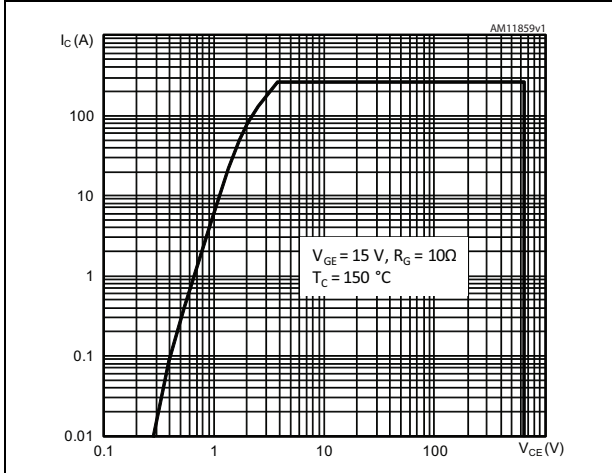


Figure 15. Short circuit time & current vs.  $V_{GE}$

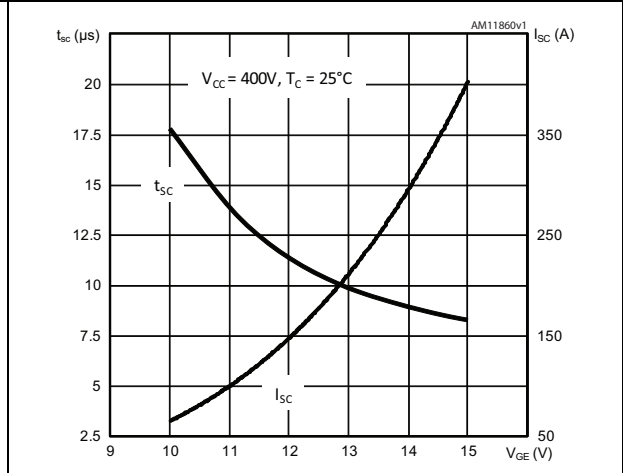
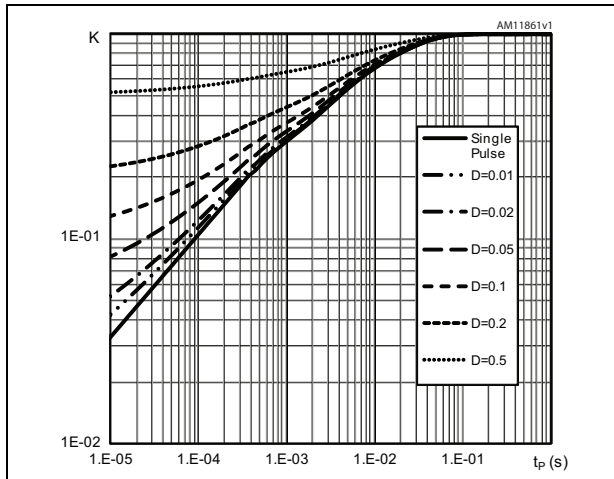
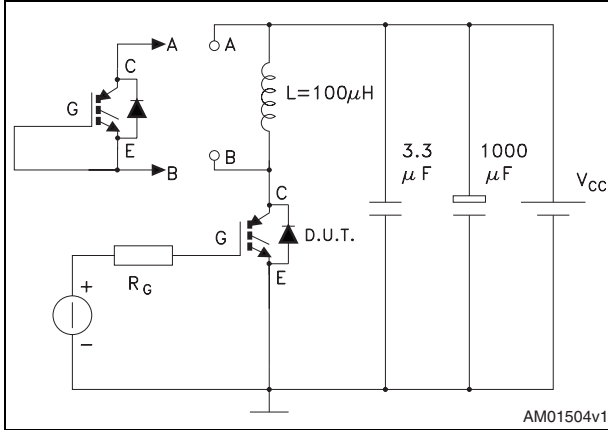


Figure 16. Maximum normalized  $Z_{th}$  junction to case (IGBT)

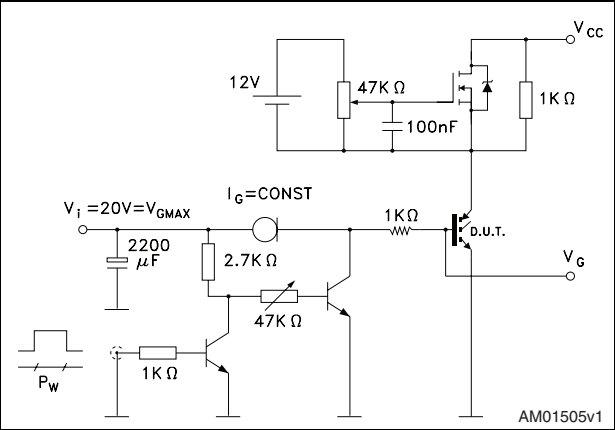


### 3 Test circuits

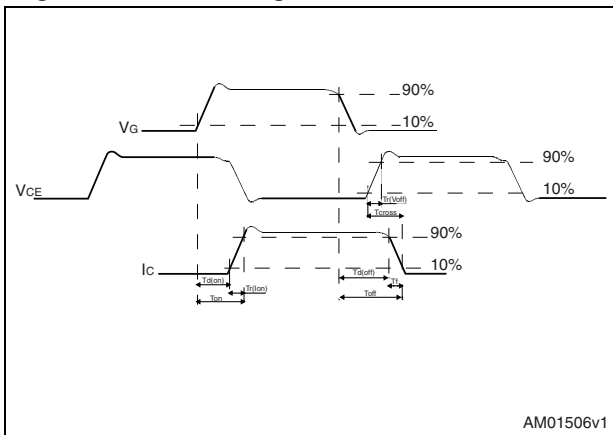
**Figure 17. Test circuit for inductive load switching**



**Figure 18. Gate charge test circuit**



**Figure 19. Switching waveform**





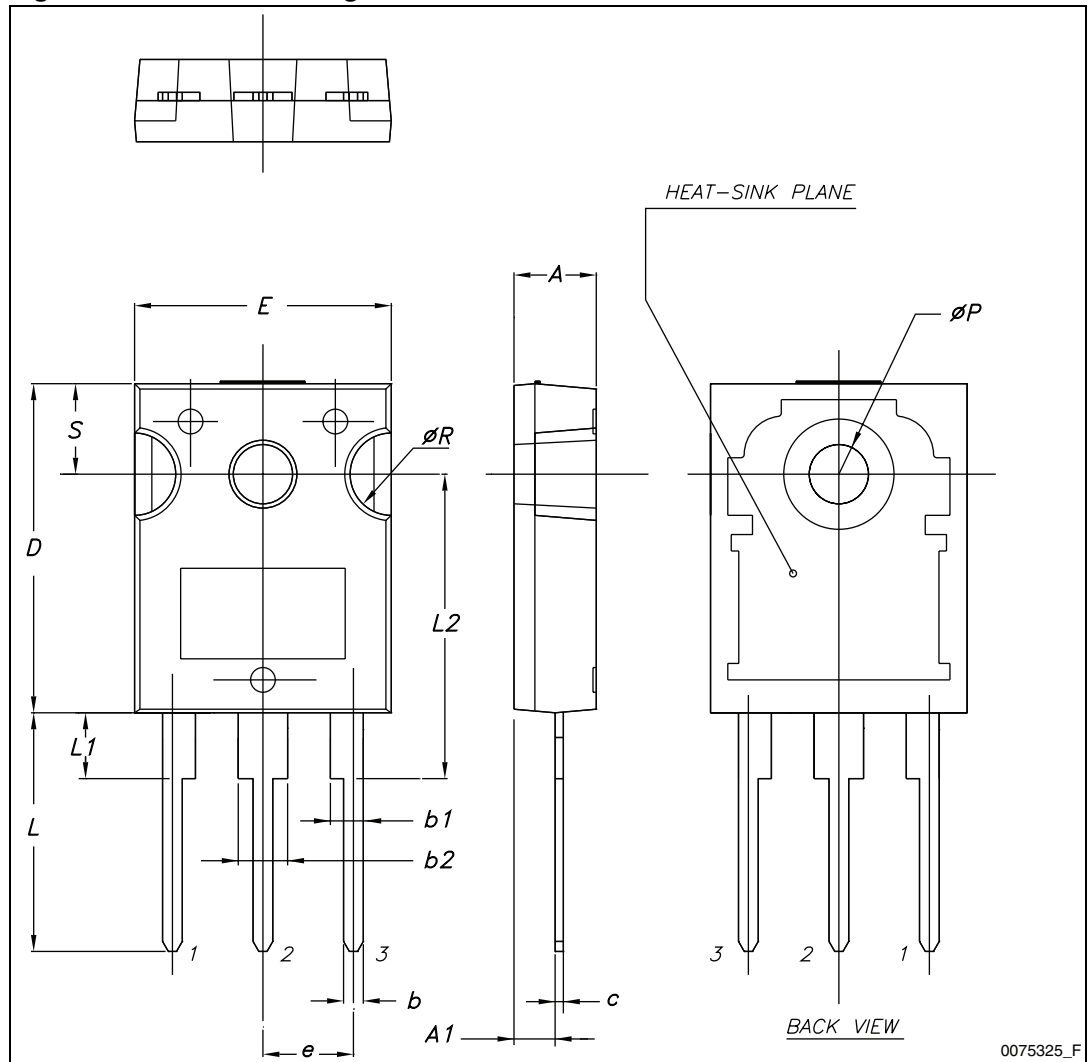
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

**Table 8. 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	

Figure 20. TO-247 drawing



0075325\_F

## 5 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
05-Jul-2011	1	Initial release.
12-Jan-2012	2	Document status promoted from preliminary data to datasheet.
10-Feb-2012	3	Added: <a href="#">Section 2.1: Electrical characteristics (curves)</a> .
31-Jul-2012	4	Updated: <a href="#">Figure 8 on page 6</a> .

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