

### Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- 6  $\mu$ s short-circuit withstand time
- Ultrafast soft recovery antiparallel diode
- 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.

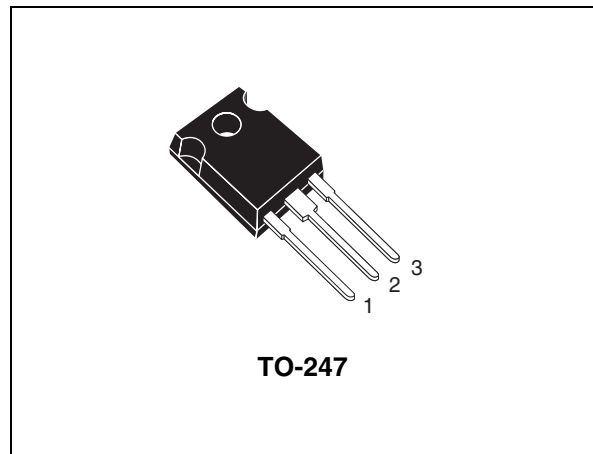


Figure 1. Internal schematic diagram

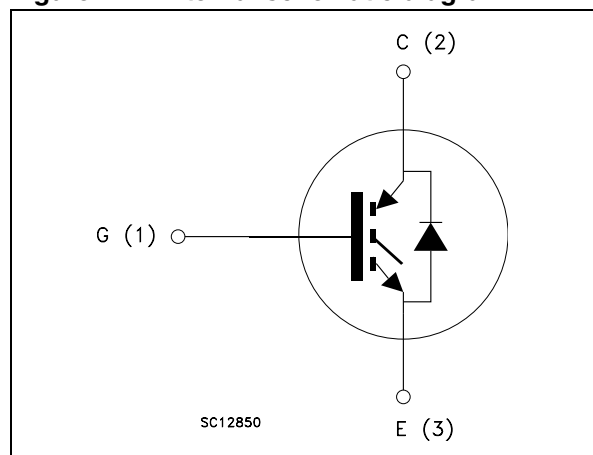


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW50H60DF	GW50H60DF	TO-247	Tube

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	100	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	50	A
$I_{CP}^{(1)}$	Pulsed collector current	200	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	30	A
$I_{FSM}$	Surge not repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	120	A
$P_{TOT}$	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 IGBT	0.35	$^{\circ}\text{C/W}$
$R_{thJC}$	Thermal resistance junction-case diode	1.5	$^{\circ}\text{C/W}$
$R_{thJA}$	Thermal resistance junction-ambient	50	$^{\circ}\text{C/W}$

## 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 ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$		1.8		V
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$ $T_J = 125\text{ °C}$		2.0		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$		6.0		V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			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		
$C_{res}$	Reverse transfer capacitance			140		
$Q_g$	Total gate charge	$V_{CC} = 400\text{ V}, I_C = 50\text{ A},$ $V_{GE} = 15\text{ V}$	-	217	-	nC
$Q_{ge}$	Gate-emitter charge			61		
$Q_{gc}$	Gate-collector charge			90		

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$	-	62	-	ns
$t_r$	Current rise time			28		
$(di/dt)_{on}$	Turn-on current slope			1800		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ °C}$	-	62	-	ns
$t_r$	Current rise time			29		
$(di/dt)_{on}$	Turn-on current slope			1680		
$t_r(V_{off})$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$	-	34	-	ns
$t_{d(off)}$	Turn-off delay time			178		
$t_f$	Current fall time			40		
$t_r(V_{off})$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ °C}$	-	45	-	ns
$t_{d(off)}$	Turn-off delay time			205		
$t_f$	Current fall time			80		

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$	-	0.89	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses			0.86		mJ
$E_{ts}$	Total switching losses			1.75		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	1.24	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses			1.15		mJ
$E_{ts}$	Total switching losses			2.39		mJ

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in [Figure 20](#). 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	$I_F = 30\text{ A}$ $I_F = 30\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2 1.65	2.5	V V
$t_{rr}$	Reverse recovery time	$I_F = 30\text{ A}, V_R = 50\text{ V},$ $di/dt = 100\text{ A}/\mu\text{s}$	-	55	-	ns
$Q_{rr}$	Reverse recovery charge			110		nC
$I_{rrm}$	Reverse recovery current			3		A
$t_{rr}$	Reverse recovery time	$I_F = 30\text{ A}, V_R = 50\text{ V},$ $di/dt = 100\text{ A}/\mu\text{s}, T_J = 125\text{ }^\circ\text{C}$	-	140	-	ns
$Q_{rr}$	Reverse recovery charge			400		nC
$I_{rrm}$	Reverse recovery current			5.5		A

## 2.1 Electrical characteristics (curves)

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

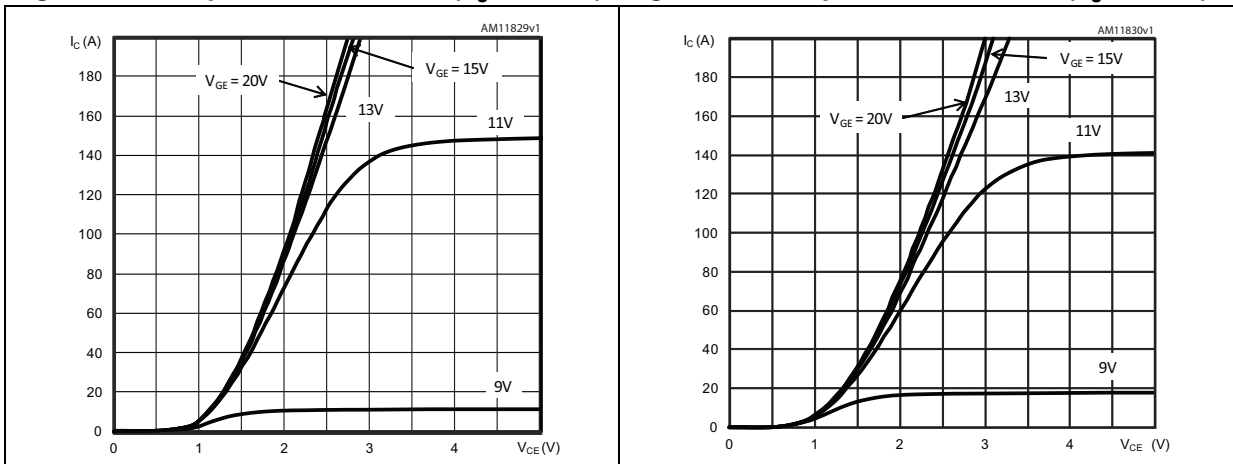


Figure 4. Output characteristics ( $T_J = 150\text{ }^\circ\text{C}$ ) Figure 5. Transfer characteristics

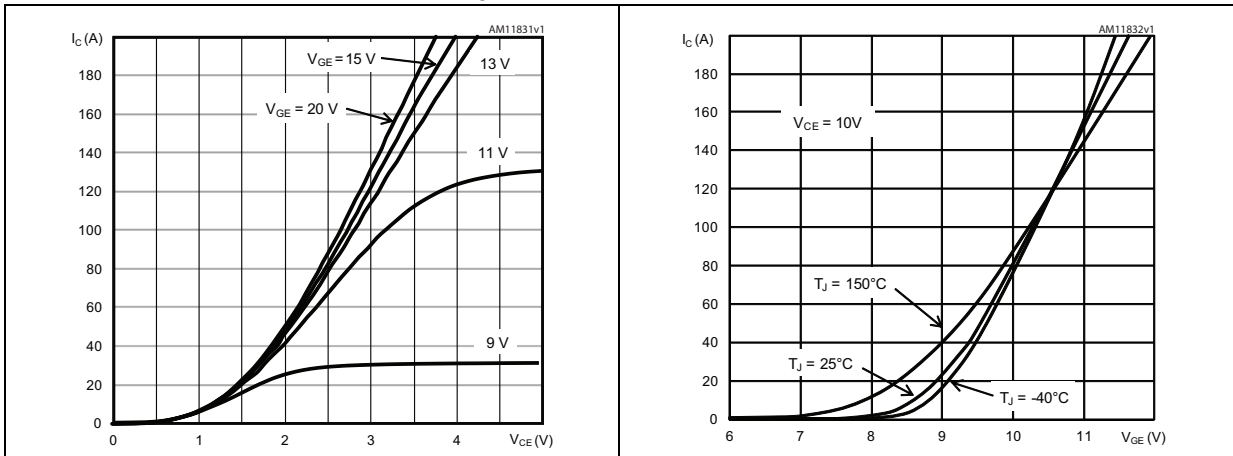


Figure 6.  $V_{CE(SAT)}$  vs. junction temperature Figure 7.  $V_{CE(SAT)}$  vs. collector current

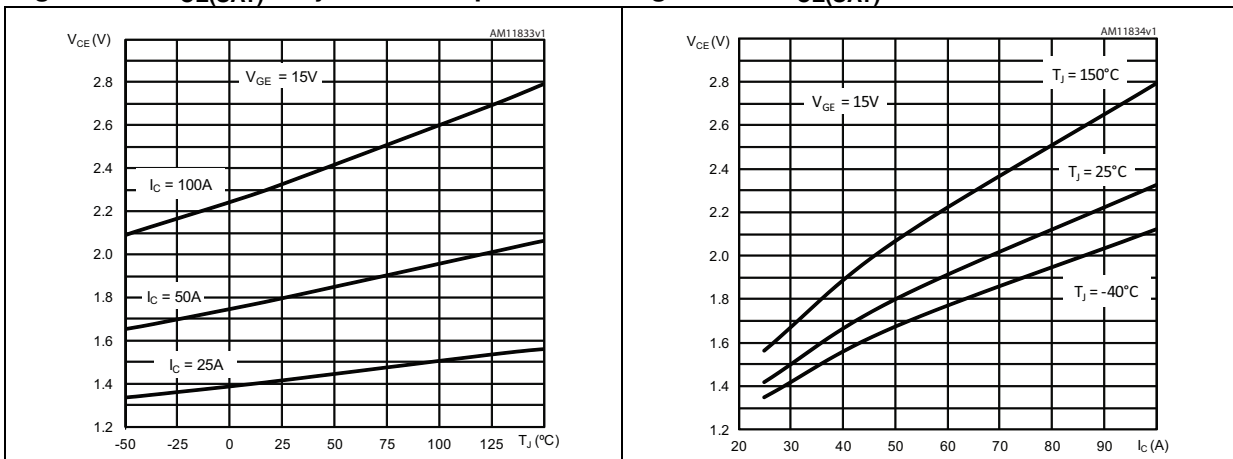


Figure 8. Normalized  $V_{GE(th)}$  vs. junction temperature

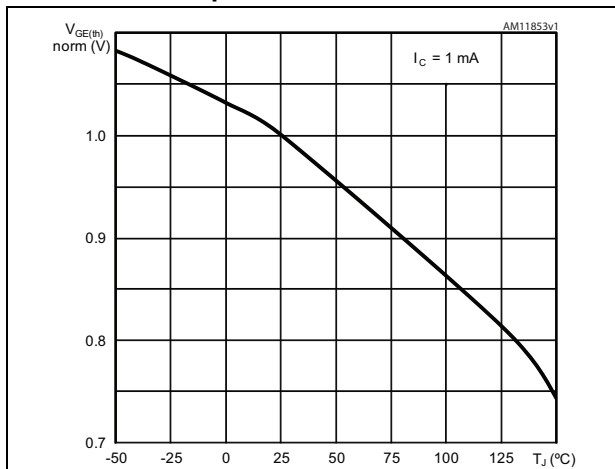


Figure 9. Gate charge vs. gate-emitter voltage

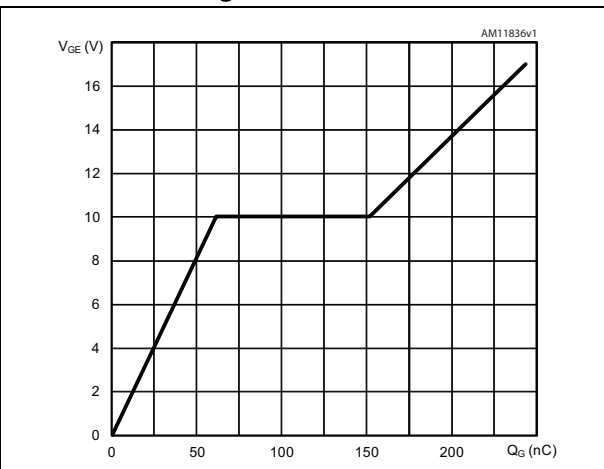


Figure 10. Capacitance variations ( $f = 1\text{ MHz}$ ,  $V_{GE} = 0$ )

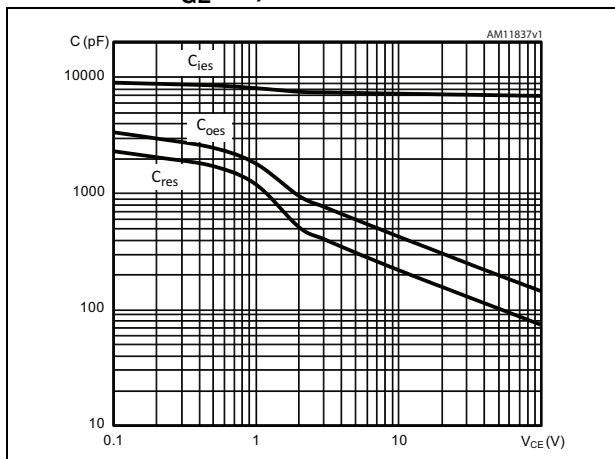


Figure 11. Switching losses vs. collector current

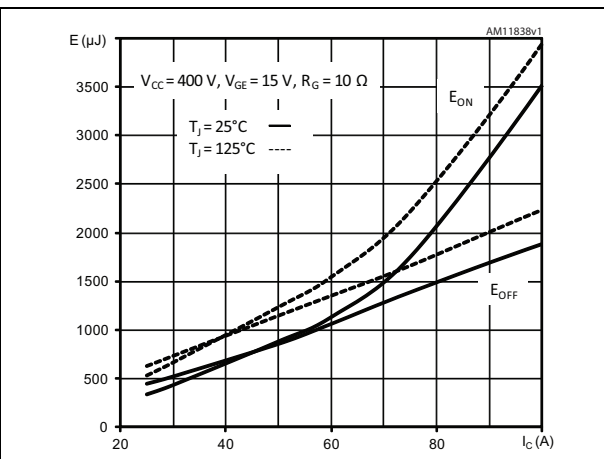


Figure 12. Switching losses vs. gate resistance

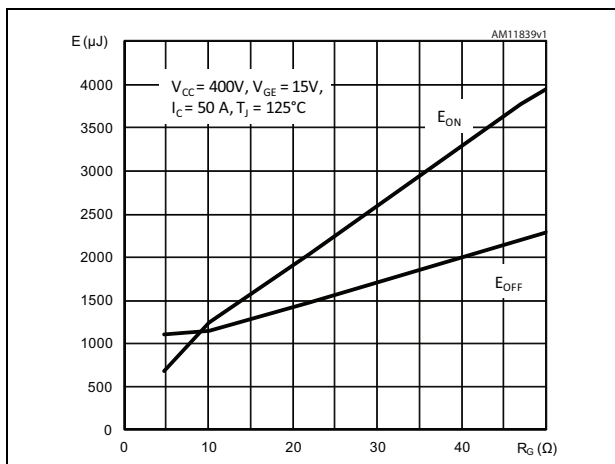


Figure 13. Switching losses vs. temperature

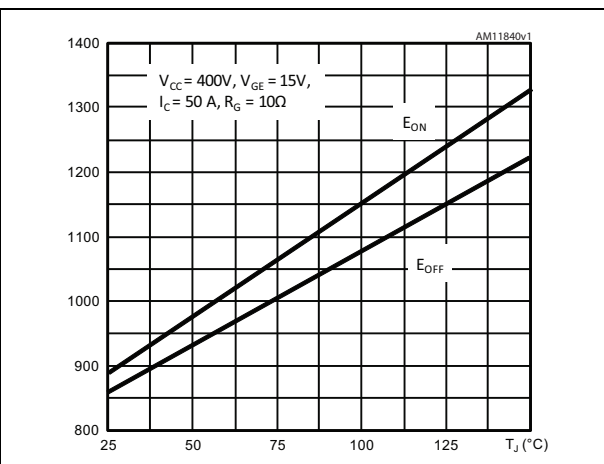


Figure 14. Turn-OFF SOA

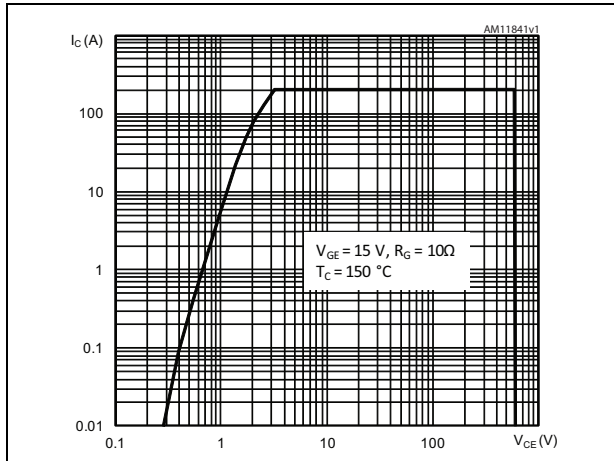


Figure 15. Short circuit time & current vs. Vge

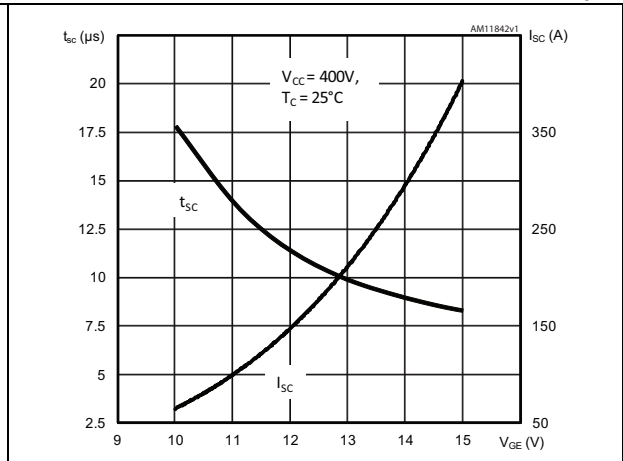


Figure 16. Diode forward current vs. forward voltage

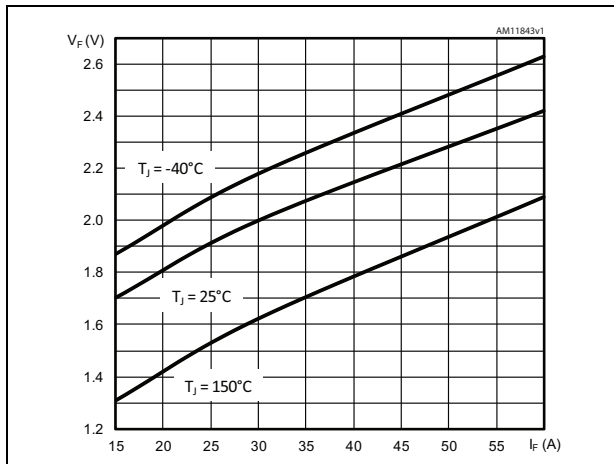


Figure 17. Diode forward current vs. junction temperature

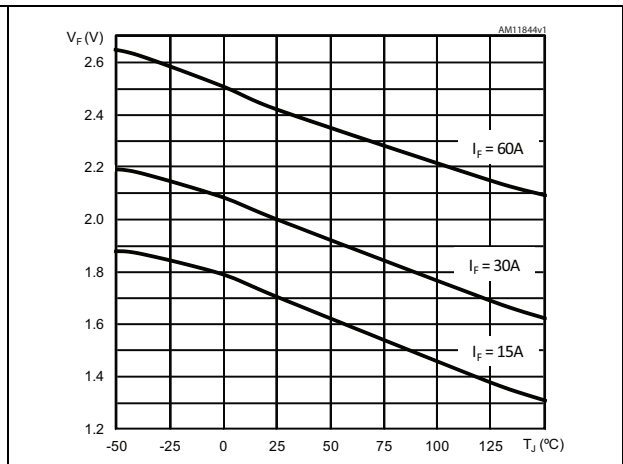


Figure 18. Maximum normalized Zth junction to case (IGBT)

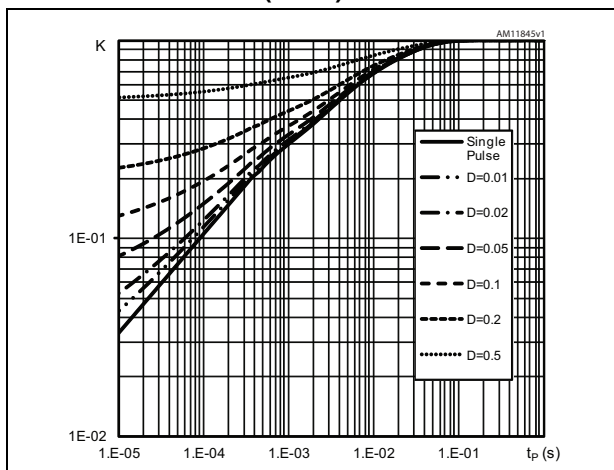
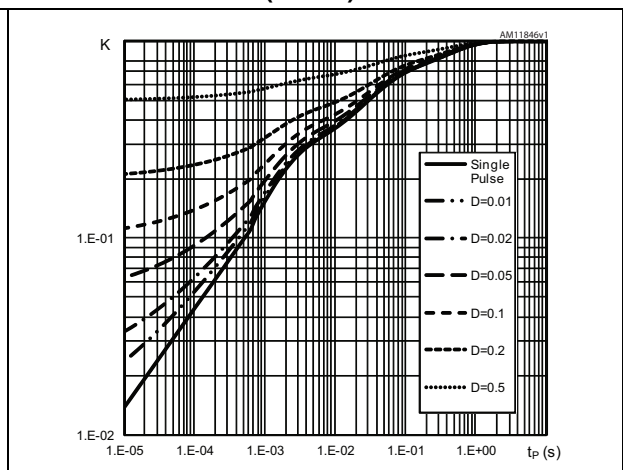


Figure 19. Maximum normalized Zth junction to case (Diode)



### 3 Test circuits

Figure 20. Test circuit for inductive load switching

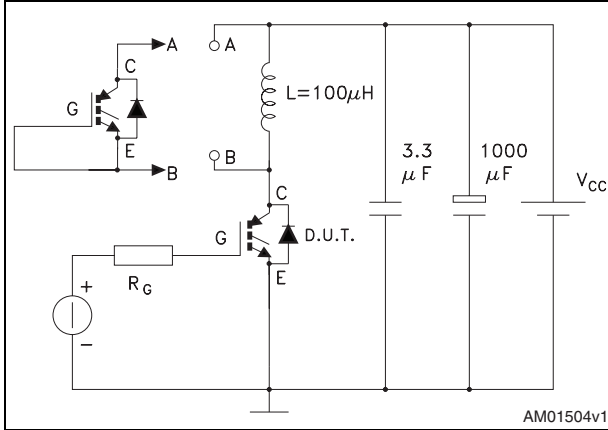


Figure 21. Gate charge test circuit

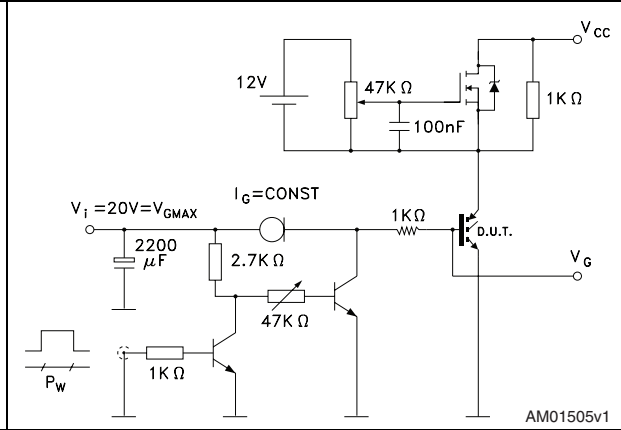


Figure 22. Switching waveform

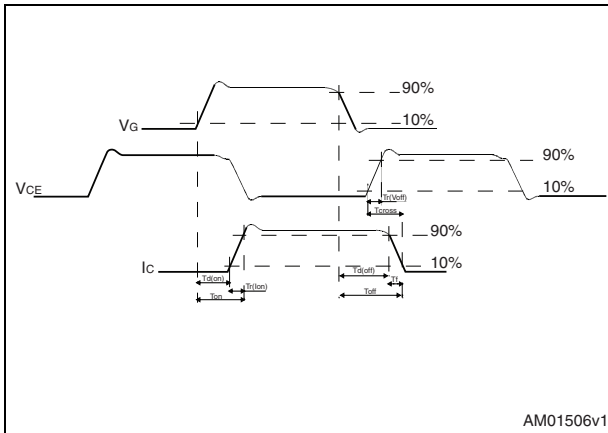
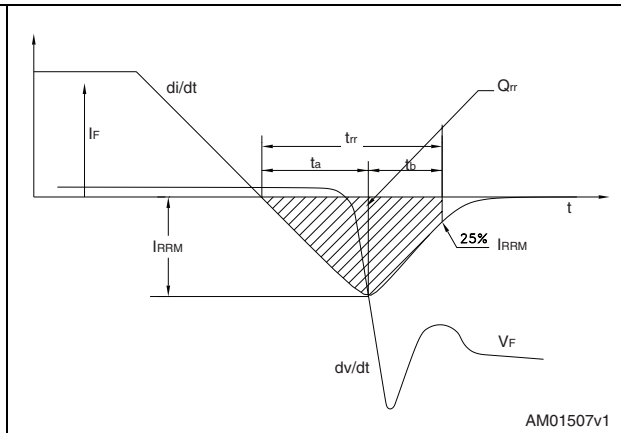


Figure 23. Diode recovery time waveform





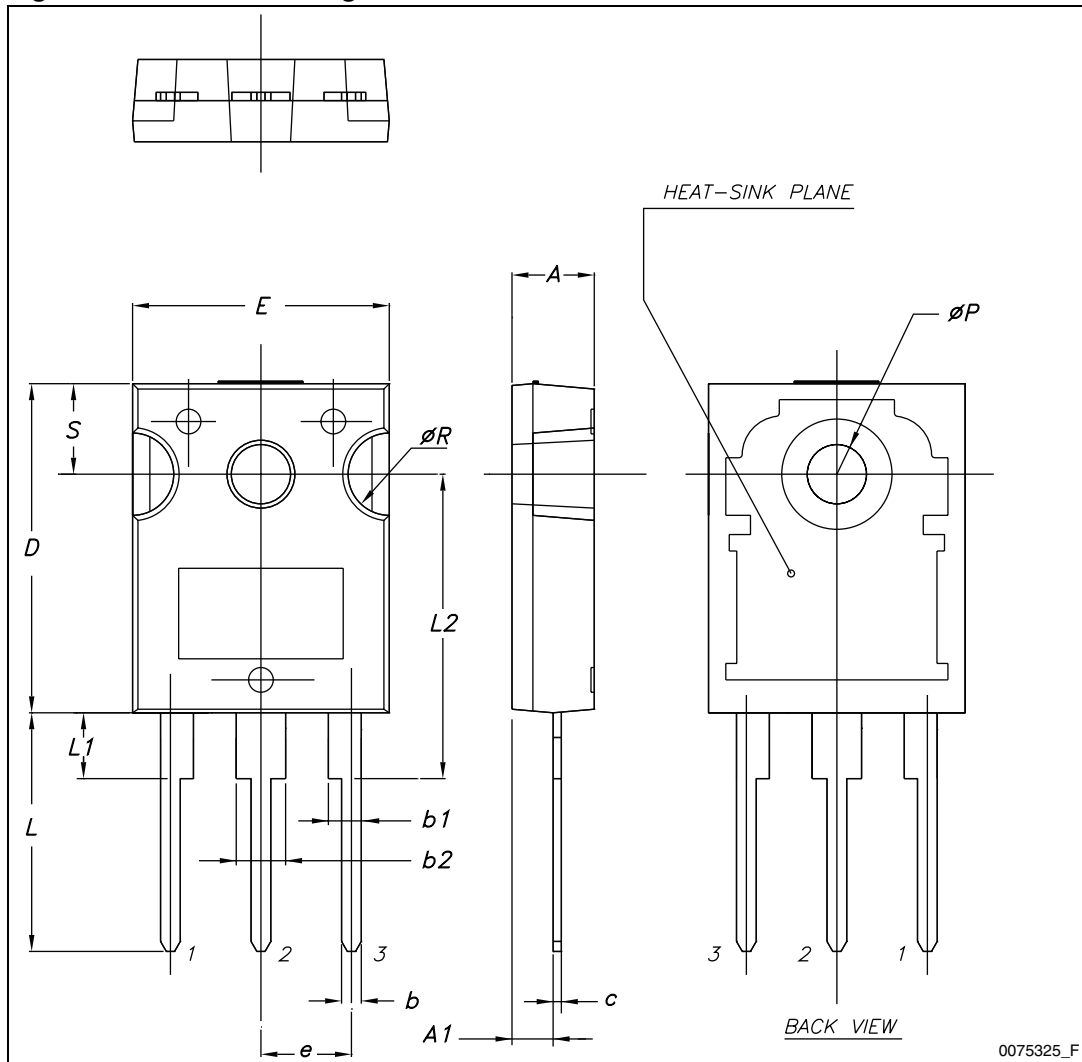
## 4 Package mechanical data

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		5.45	
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 24. TO-247 drawing



0075325\_F

## 5 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
28-Apr-2011	1	Initial release.
26-Jul-2011	2	Added: $t_{SC}$ and $T_{STG}$ <a href="#">Table 2 on page 2</a> . Updated: <a href="#">Table 4</a> , <a href="#">Table 5</a> , <a href="#">Table 6 on page 3</a> and <a href="#">Table 7 on page 4</a> .
12-Jan-2012	3	Document status promoted from preliminary data to datasheet.
10-Feb-2012	4	Added: <a href="#">Section 2.1: Electrical characteristics (curves)</a> .
26-Jul-2012	5	Modified: <a href="#">Figure 8 on page 6</a> .

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