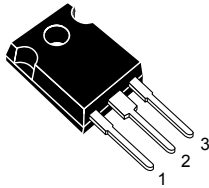
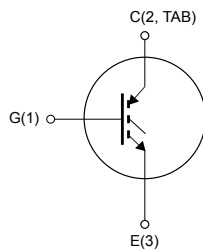


## Trench gate field-stop, 600 V, 60 A, very high speed, V series IGBT in a TO-247 package


**TO-247**


G1C2TE3

### Features

- Maximum junction temperature:  $T_J = 175\text{ °C}$
- Tail-less switching off
- $V_{CE(sat)} = 1.85\text{ V (typ.) @ } I_C = 60\text{ A}$
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance

### Applications

- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- Very high frequency converters

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the V series IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, the positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

#### Product status link

[STGW60V60F](#)

#### Product summary

<b>Order code</b>	STGW60V60F
<b>Marking</b>	GW60V60F
<b>Package</b>	TO-247
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0\text{ V}$ )	600	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	80 <sup>(1)</sup>	A
	Continuous collector current at $T_C = 100\text{ °C}$	60	
$I_{CP}^{(2)}$	Pulsed collector current	240	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	375	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	°C

1. Current level is limited by bond wires.

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

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.4	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	50	°C/W

## 2 Electrical characteristics

$T_J = 25\text{ °C}$  unless otherwise specified

**Table 3. Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		1.85	2.3	V
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 125\text{ °C}$		2.15		
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 175\text{ °C}$		2.35		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5.0	6.0	7.0	V
$I_{CES}$	Collector cut-off current	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$			$\pm 250$	nA

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	8000	-	pF
$C_{oes}$	Output capacitance		-	280	-	pF
$C_{res}$	Reverse transfer capacitance		-	170	-	pF
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}, I_C = 60\text{ A}, V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 22. Gate charge test circuit)	-	334	-	nC
$Q_{ge}$	Gate-emitter charge		-	130	-	nC
$Q_{gc}$	Gate-collector charge		-	58	-	nC

**Table 5. IGBT switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}^{(1)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A}, R_G = 4.7\ \Omega, V_{GE} = 15\text{ V}$ (see Figure 21. Test circuit for inductive load switching)	-	60	-	ns
$t_r^{(1)}$	Current rise time		-	20	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope		-	2365	-	A/ $\mu\text{s}$
$t_{d(off)}$	Turn-off delay time		-	208	-	ns
$t_f$	Current fall time		-	14	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	0.75	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.55	-	mJ
$E_{ts}$	Total switching energy		-	1.3	-	mJ

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}^{(1)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 60\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 21. Test circuit for inductive load switching</a> )	-	57	-	ns
$t_r^{(1)}$	Current rise time		-	23	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope		-	2191	-	A/ $\mu\text{s}$
$t_{d(off)}$	Turn-off delay time		-	216	-	ns
$t_f$	Current fall time		-	27	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	1.5	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.8	-	mJ
$E_{ts}$	Total switching energy		-	2.3	-	mJ

1. Switching-on times and energy have been calculated applying the STGW60V60DF's co-pack diode in the high side of the test circuit shown in [Figure 21. Test circuit for inductive load switching](#). Both the IGBT and the diode are at the same temperature. The turn-on switching energies include the reverse recovery of the diode.
2. Including the tail of the collector current.

## 2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

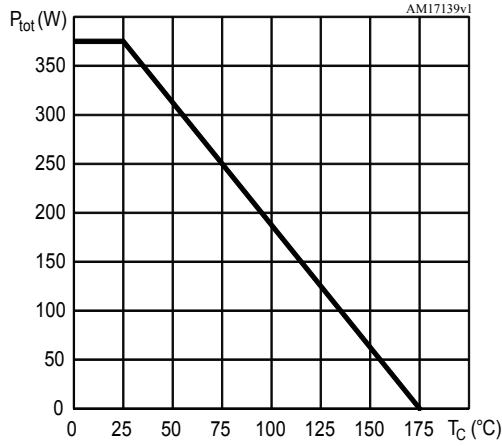


Figure 2. Collector current vs case temperature

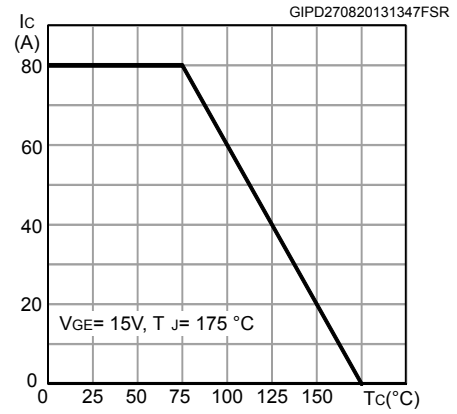


Figure 3. Output characteristics ( $T_J = 25^\circ\text{C}$ )

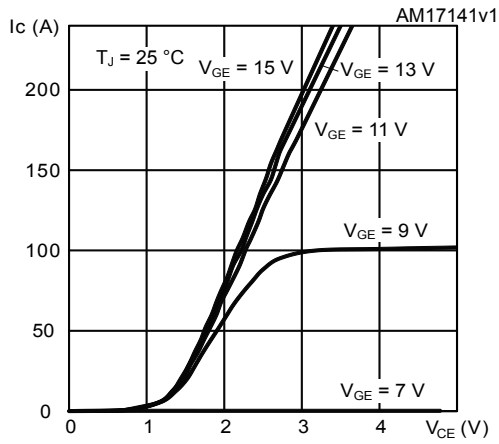


Figure 4. Output characteristics ( $T_J = 175^\circ\text{C}$ )

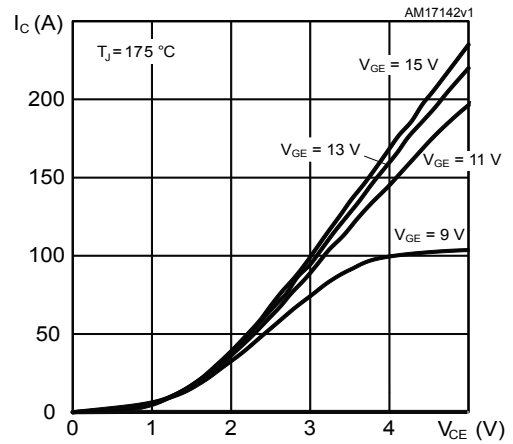


Figure 5.  $V_{CE(sat)}$  vs junction temperature

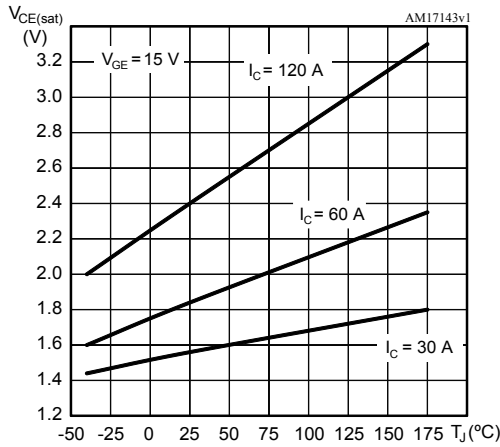


Figure 6.  $V_{CE(sat)}$  vs collector current

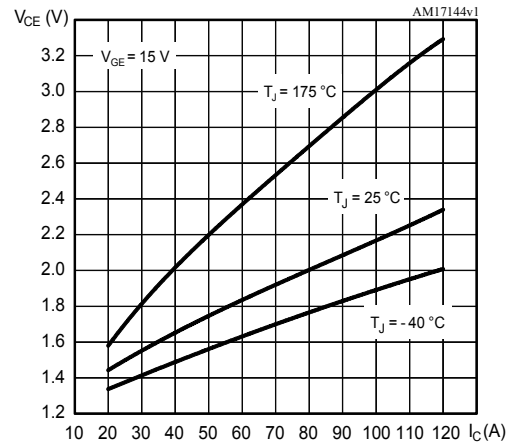


Figure 7. Collector current vs switching frequency

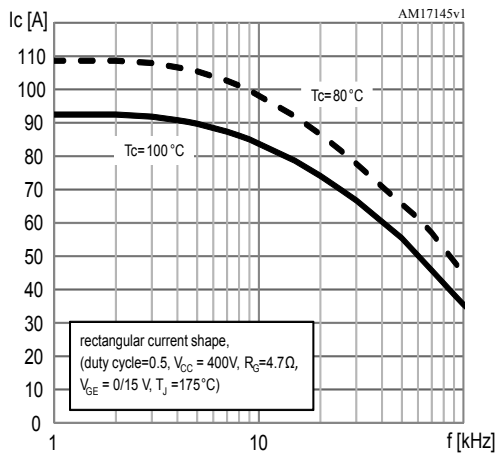


Figure 8. Forward bias safe operating area

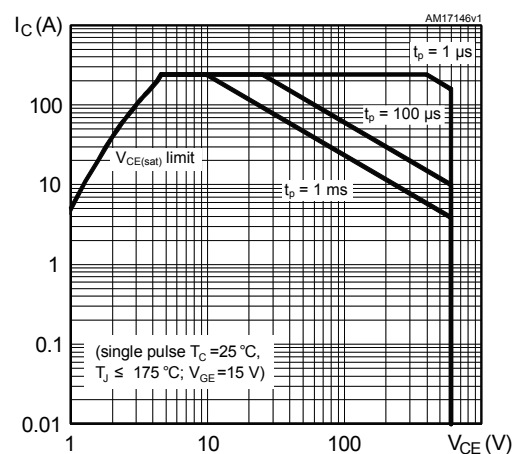


Figure 9. Transfer characteristics

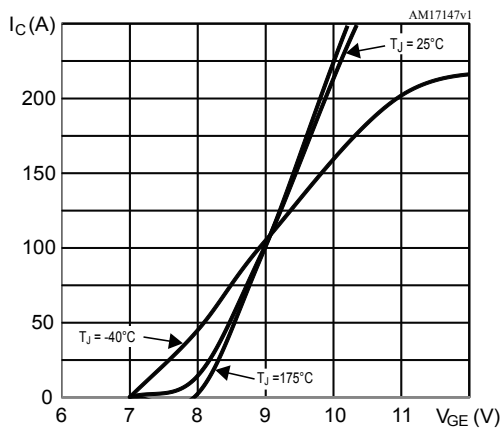
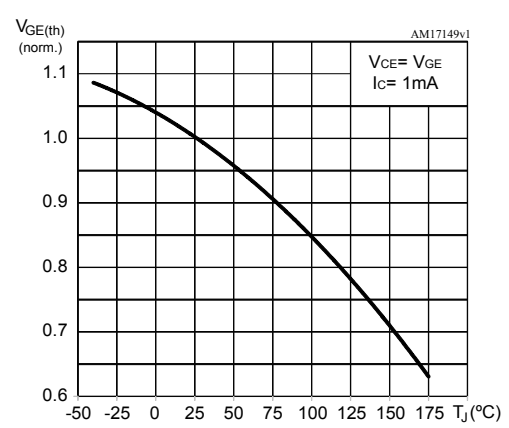
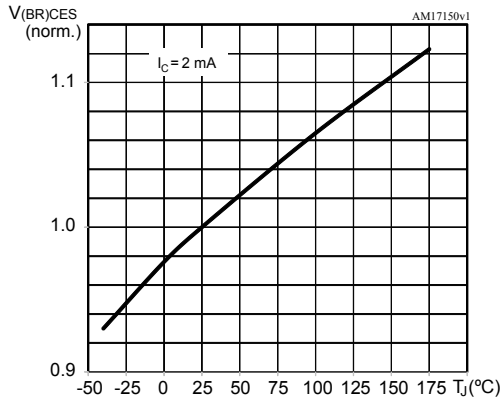


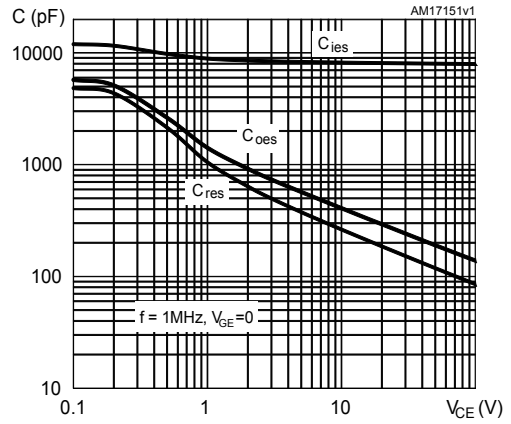
Figure 10. Normalized  $V_{GE(th)}$  vs junction temperature



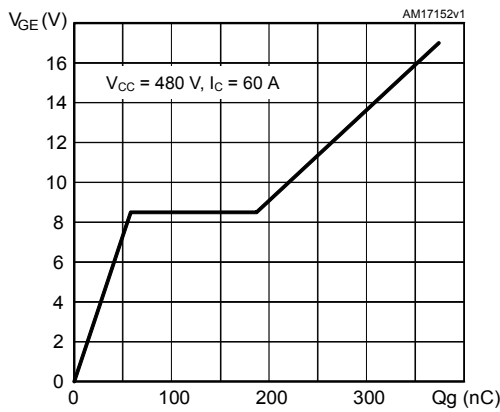
**Figure 11. Normalized  $V_{(BR)CES}$  vs junction temperature**



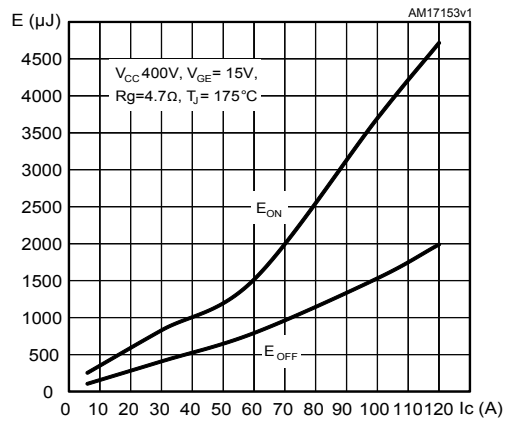
**Figure 12. Capacitance variation**



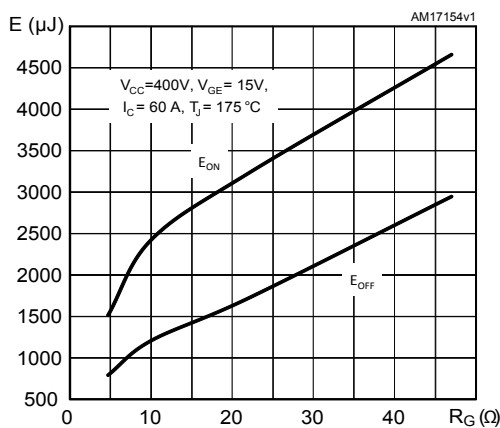
**Figure 13. Gate charge vs gate-emitter voltage**



**Figure 14. Switching energy vs collector current**



**Figure 15. Switching energy vs gate resistance**



**Figure 16. Switching energy vs temperature**

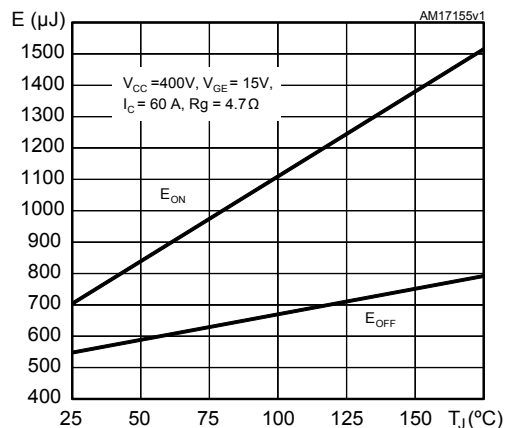


Figure 17. Switching energy vs collector-emitter voltage

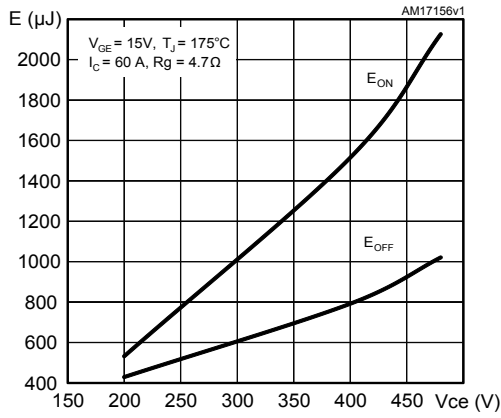


Figure 18. Switching times vs collector current

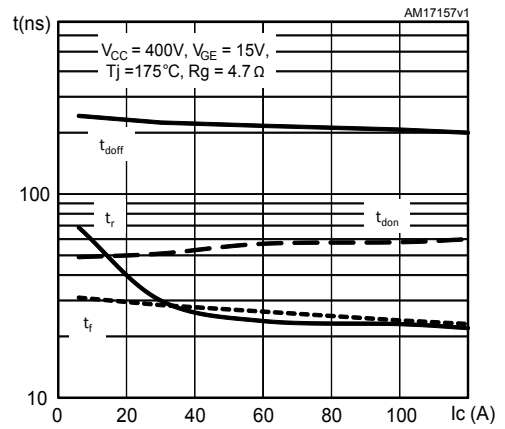


Figure 19. Switching times vs gate resistance

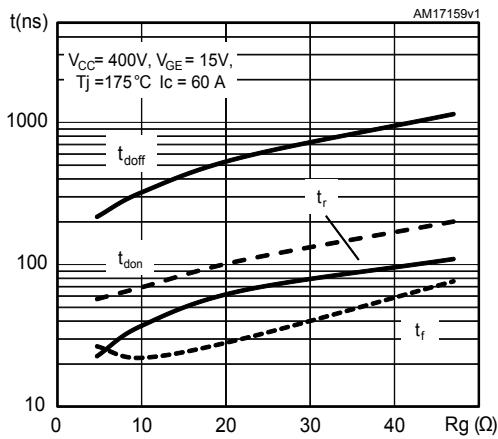
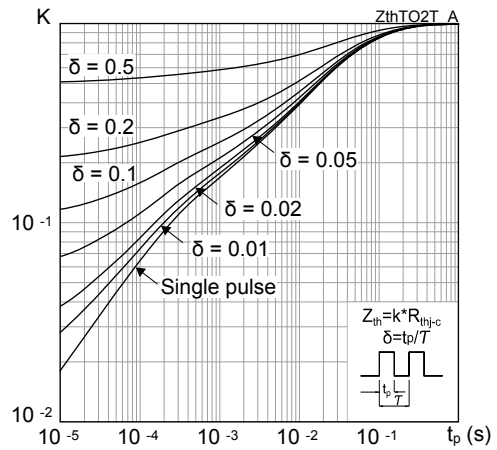
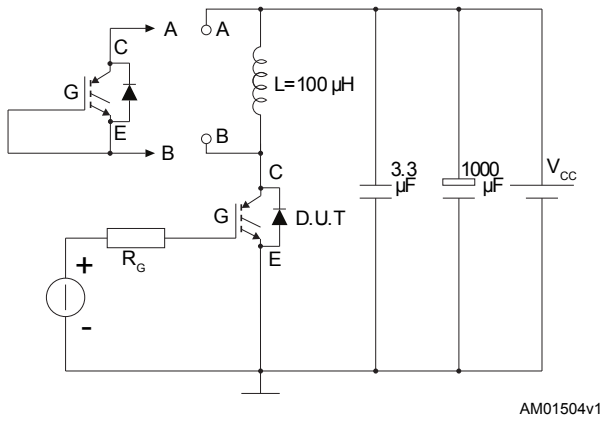
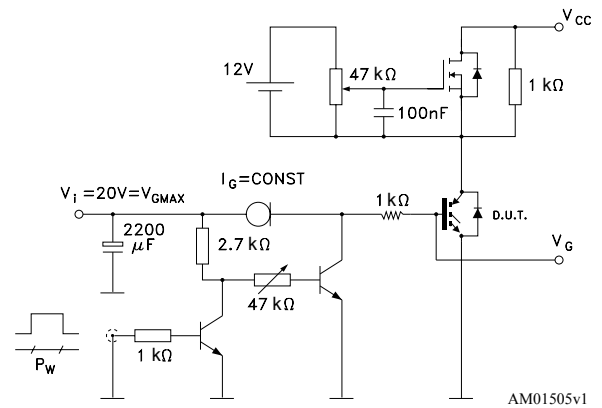
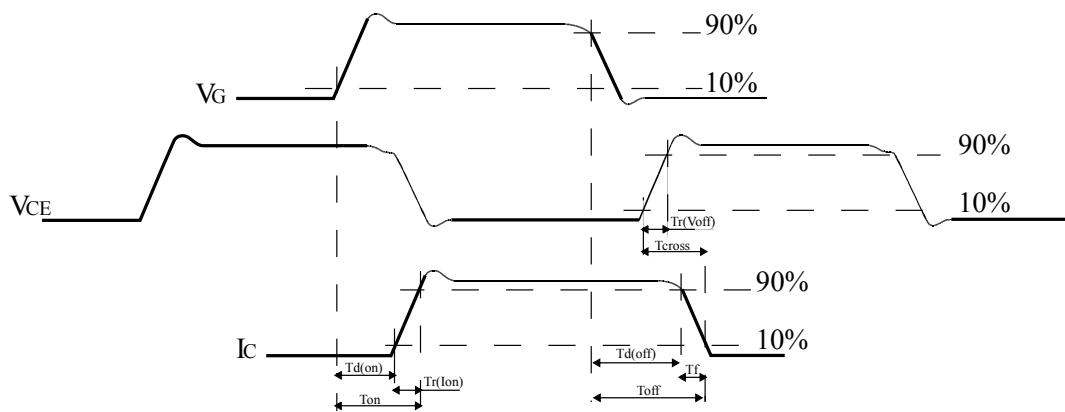


Figure 20. Thermal impedance





### 3 Test circuits

**Figure 21. Test circuit for inductive load switching**

**Figure 22. Gate charge test circuit**

**Figure 23. Switching waveform**


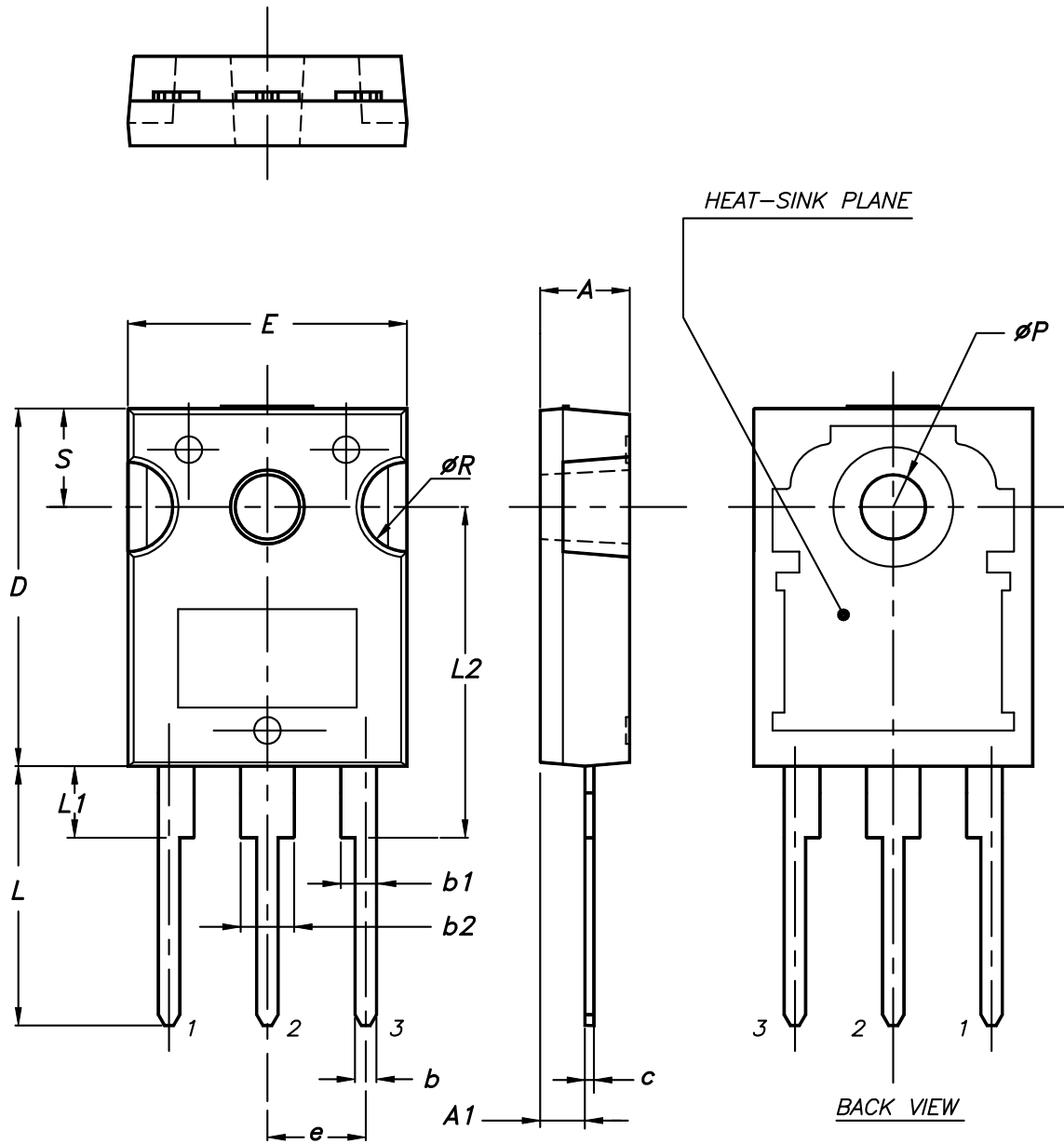
## 4 Package information

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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.

## 4.1 TO-247 package information

Figure 24. TO-247 package outline



0075325\_9

**Table 6. TO-247 package 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	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

## Revision history

**Table 7. Document revision history**

Date	Revision	Changes
04-Jun-2013	1	First release
06-Feb-2014	2	Updated <i>Figure 1: Internal schematic diagram</i> . Updated title, features and description in cover page. Minor text changes.
21-Jun-2017	3	Modified title, features and internal schematic on cover page. Modified <i>Table 3. Static characteristics</i> and <i>Table 5. IGBT switching characteristics (inductive load)</i> . Updated Package information. Minor text changes.
17-Sep-2018	4	Updated <a href="#">Section 2.1 Electrical characteristics (curves)</a> . Minor text changes

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