

## 600 V, 60 A very high speed trench gate field-stop IGBT

Datasheet - production data

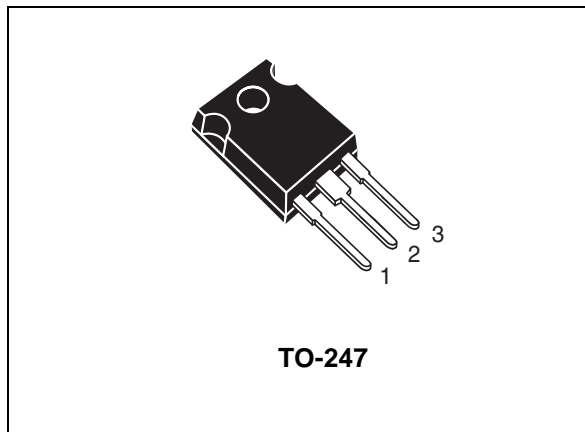
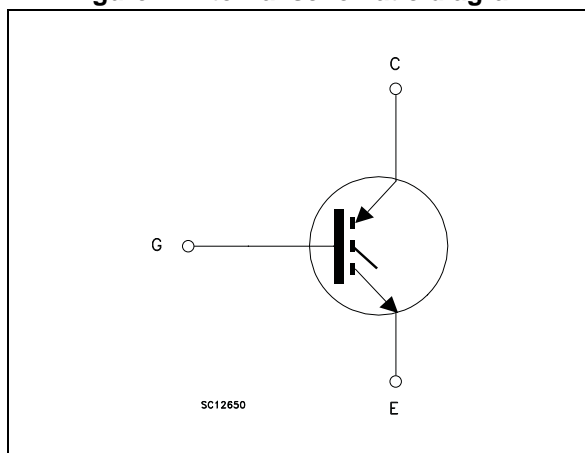


Figure 1. Internal schematic diagram



### Features

- Very high speed switching series
- Maximum junction temperature:  $T_J = 175\text{ }^\circ\text{C}$
- Tail-less switching off
- Low saturation voltage:  $V_{CE(sat)} = 1.85\text{ V (typ.)}$  @  $I_C = 60\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Lead free package

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

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW60V60F	GW60V60F	TO-247	Tube

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# 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 $T_C = 25\text{ °C}$	80 <sup>(1)</sup>	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	60	A
$I_{CP}$ <sup>(2)</sup>	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	- 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 3. 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 4. Static characteristics**

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	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		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 ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	8000	-	pF
$C_{oes}$	Output capacitance		-	280	-	pF
$C_{res}$	Reverse transfer capacitance		-	170	-	pF
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}, I_C = 60\text{ A},$ $V_{GE} = 15\text{ V},$ see <a href="#">Figure 23</a>	-	334	-	nC
$Q_{ge}$	Gate-emitter charge		-	130	-	nC
$Q_{gc}$	Gate-collector charge		-	58	-	nC

Table 6. 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 <a href="#">Figure 22</a>	-	60	-	ns
$t_r^{(1)}$	Current rise time		-	20	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope		-	2365	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	208	-	ns
$t_f$	Current fall time		-	14	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	0.75	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	0.55	-	mJ
$E_{ts}$	Total switching losses		-	1.3	-	mJ
$t_{d(on)}^{(1)}$	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 22</a>	-	57	-
$t_r^{(1)}$	Current rise time	-		23	-	ns
$(di/dt)_{on}^{(1)}$	Turn-on current slope	-		2191	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time	-		216	-	ns
$t_f$	Current fall time	-		27	-	ns
$E_{on}^{(1)}$	Turn-on switching losses	-		1.5	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses	-		0.8	-	mJ
$E_{ts}$	Total switching losses	-		2.3	-	mJ

- Switching-on times and energy have been calculated applying the STGW60V60DF's co-pack diode in the high side of the test circuit in [Figure 22](#). Both IGBT and diode are at the same temperature. Energy losses include reverse recovery of the diode.
- Turn-off losses include also the tail of the collector current.

## 2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

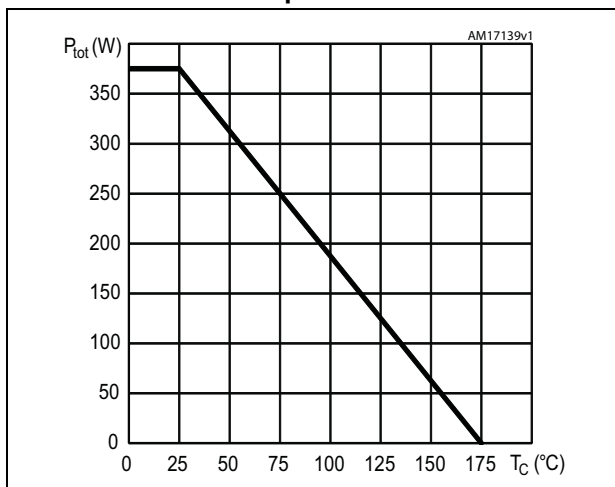


Figure 3. Collector current vs. temperature case

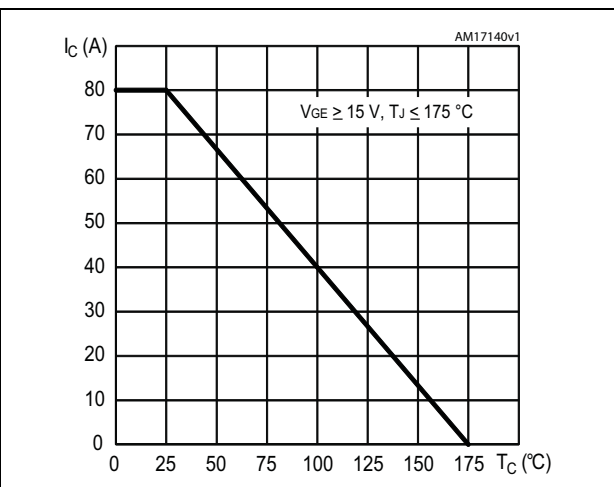


Figure 4. Output characteristics @ 25 °C

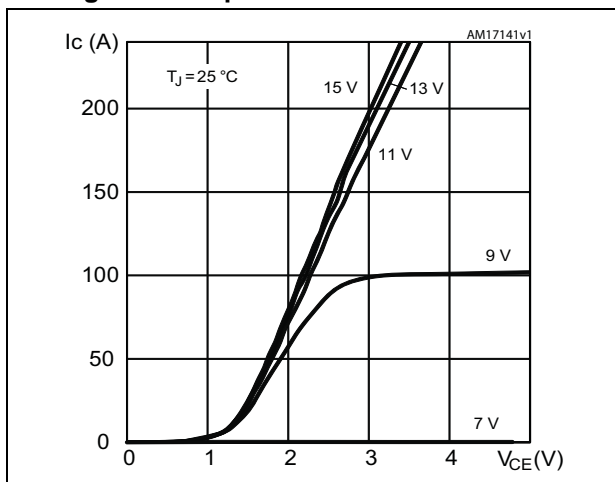


Figure 5. Output characteristics @ 175 °C

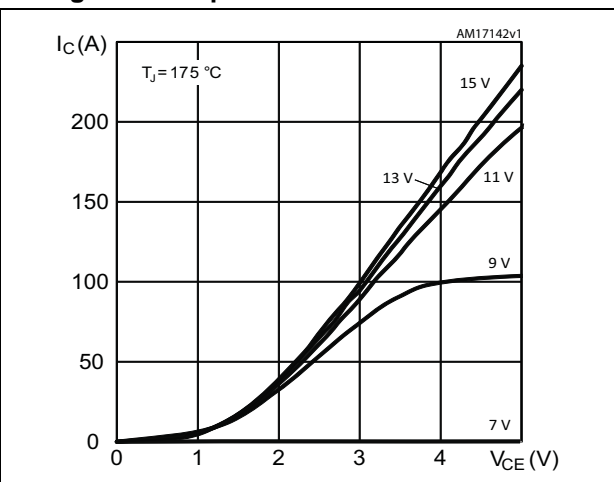


Figure 6. V\_CE(SAT) vs. junction temperature

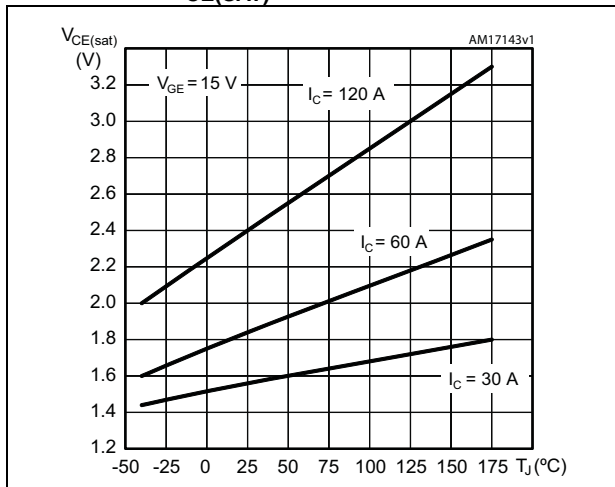


Figure 7. V\_CE(SAT) vs. collector current

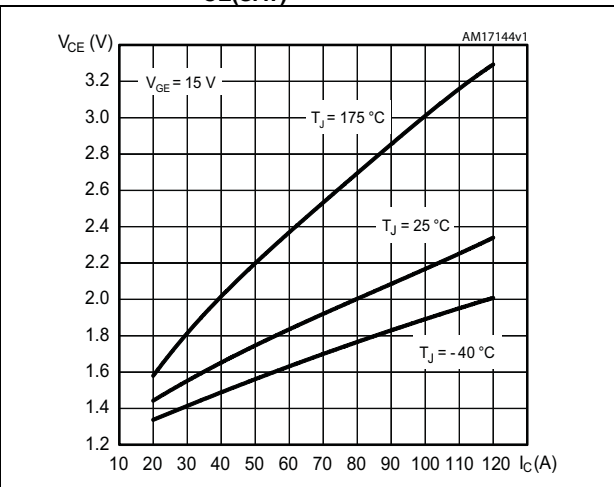


Figure 8. Collector current vs. switching frequency

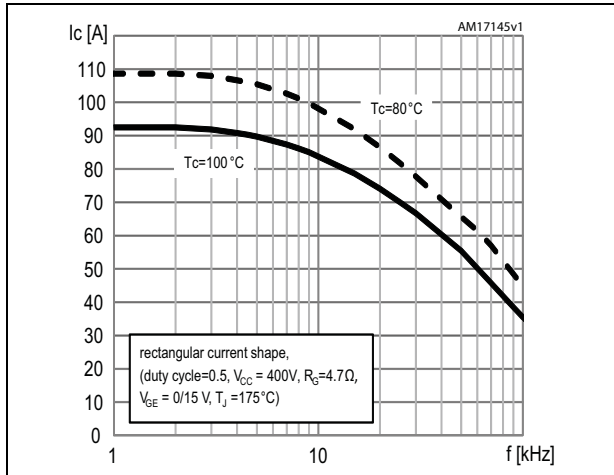


Figure 9. Forward bias safe operating area for TO-247

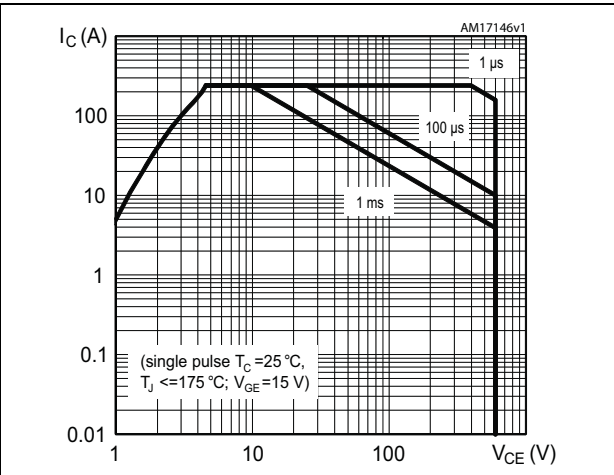


Figure 10. Normalized  $V_{GE(th)}$  vs. junction temperature

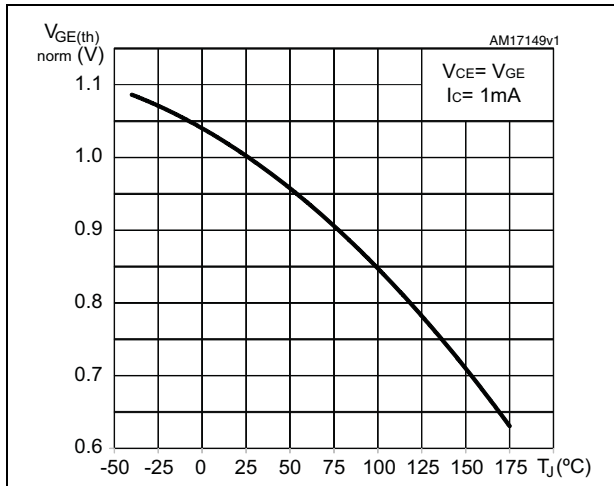


Figure 11. Normalized  $BV_{CES}$  vs. junction temperature

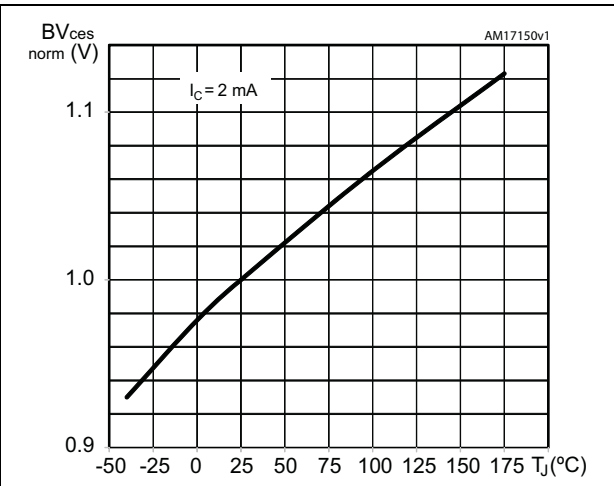


Figure 12. Capacitance variations

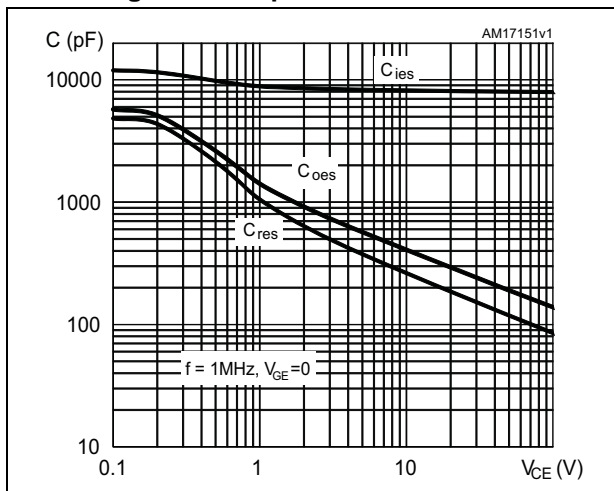


Figure 13. Gate charge vs. gate-emitter voltage

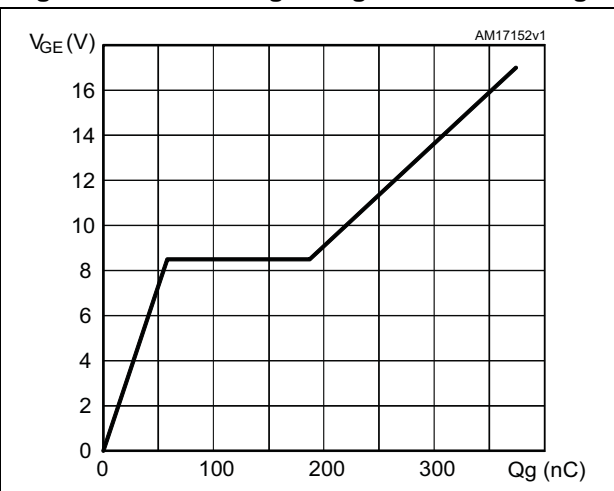


Figure 14. Switching losses vs. collector current

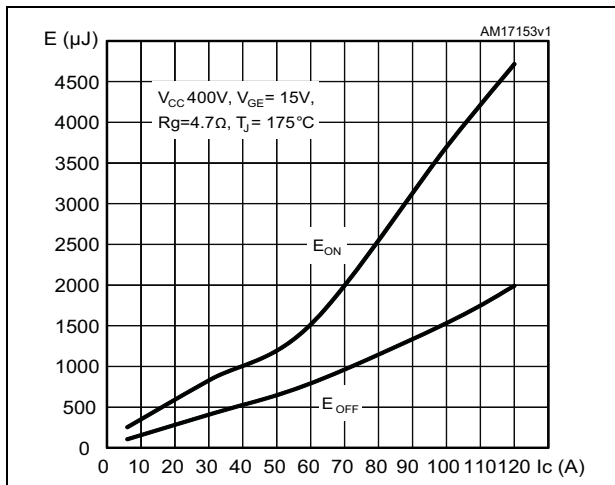


Figure 15. Switching losses vs. gate resistance

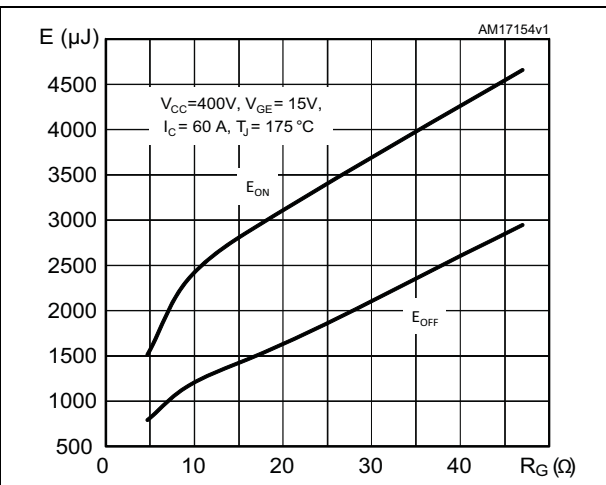


Figure 16. Switching losses vs. junction temperature

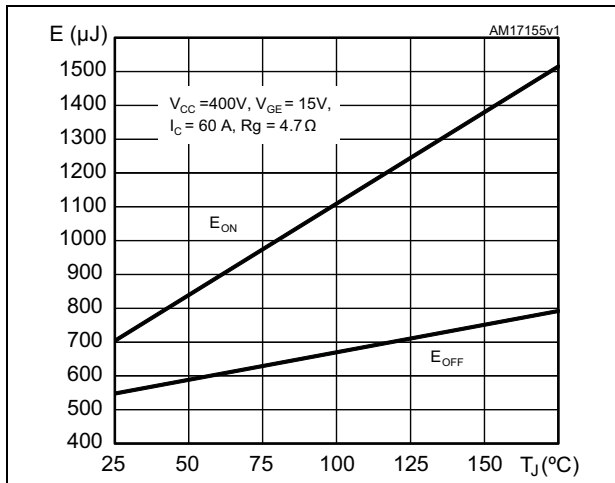


Figure 17. Switching losses vs. collector emitter voltage

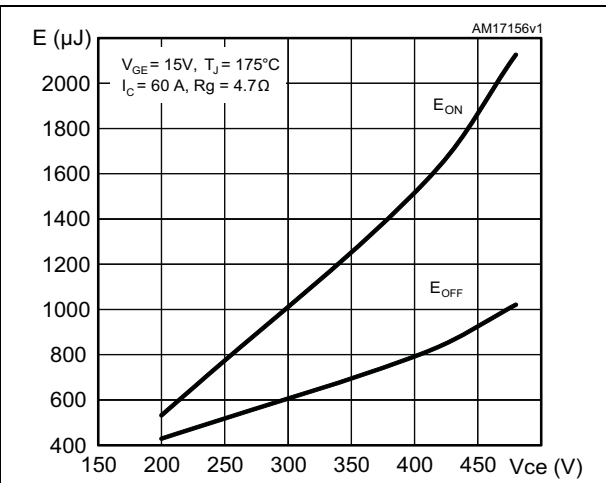


Figure 18. Switching times vs. collector current

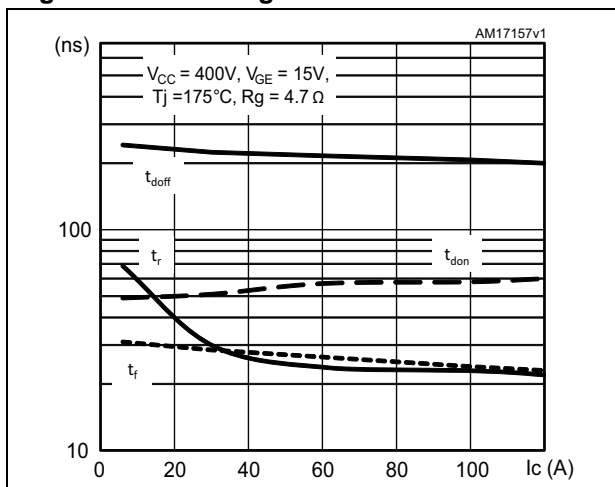


Figure 19. Switching times vs. gate resistance

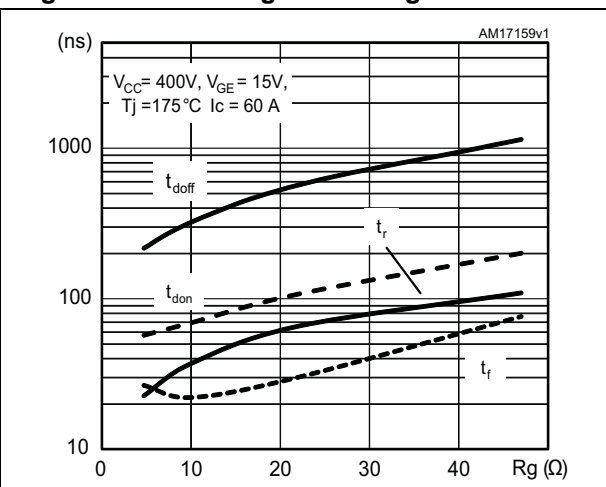




Figure 20. Transfer characteristics

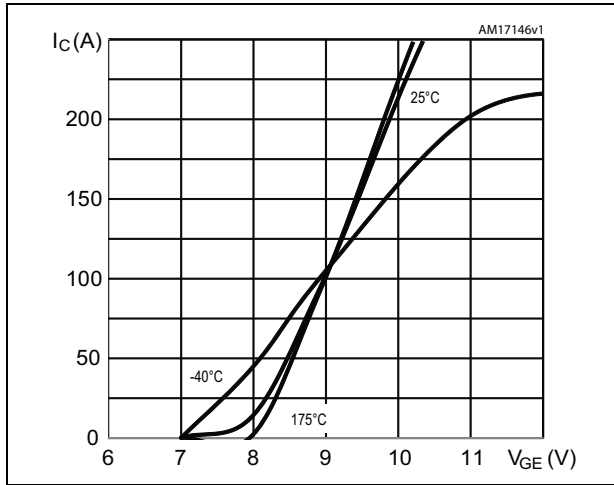
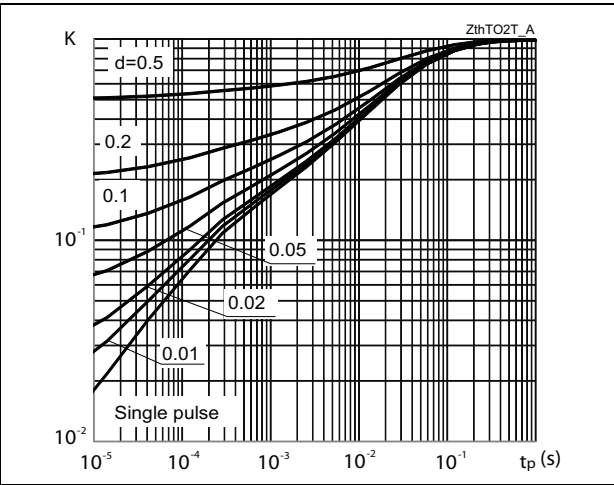


Figure 21. Thermal data



### 3 Test circuits

Figure 22. Test circuit for inductive load switching



Figure 23. Gate charge test circuit

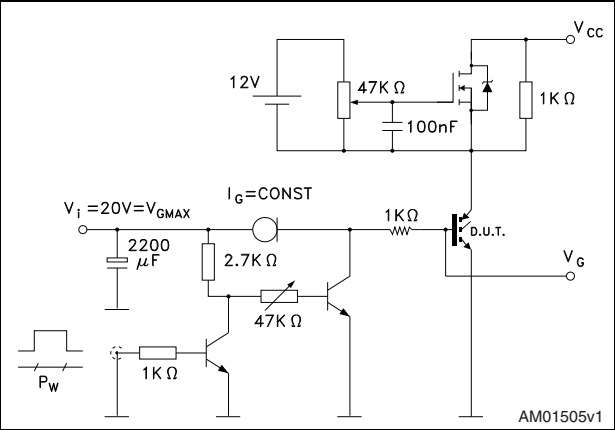
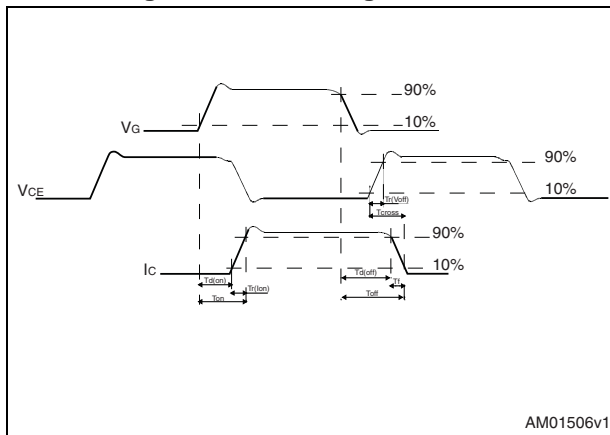


Figure 24. Switching waveform



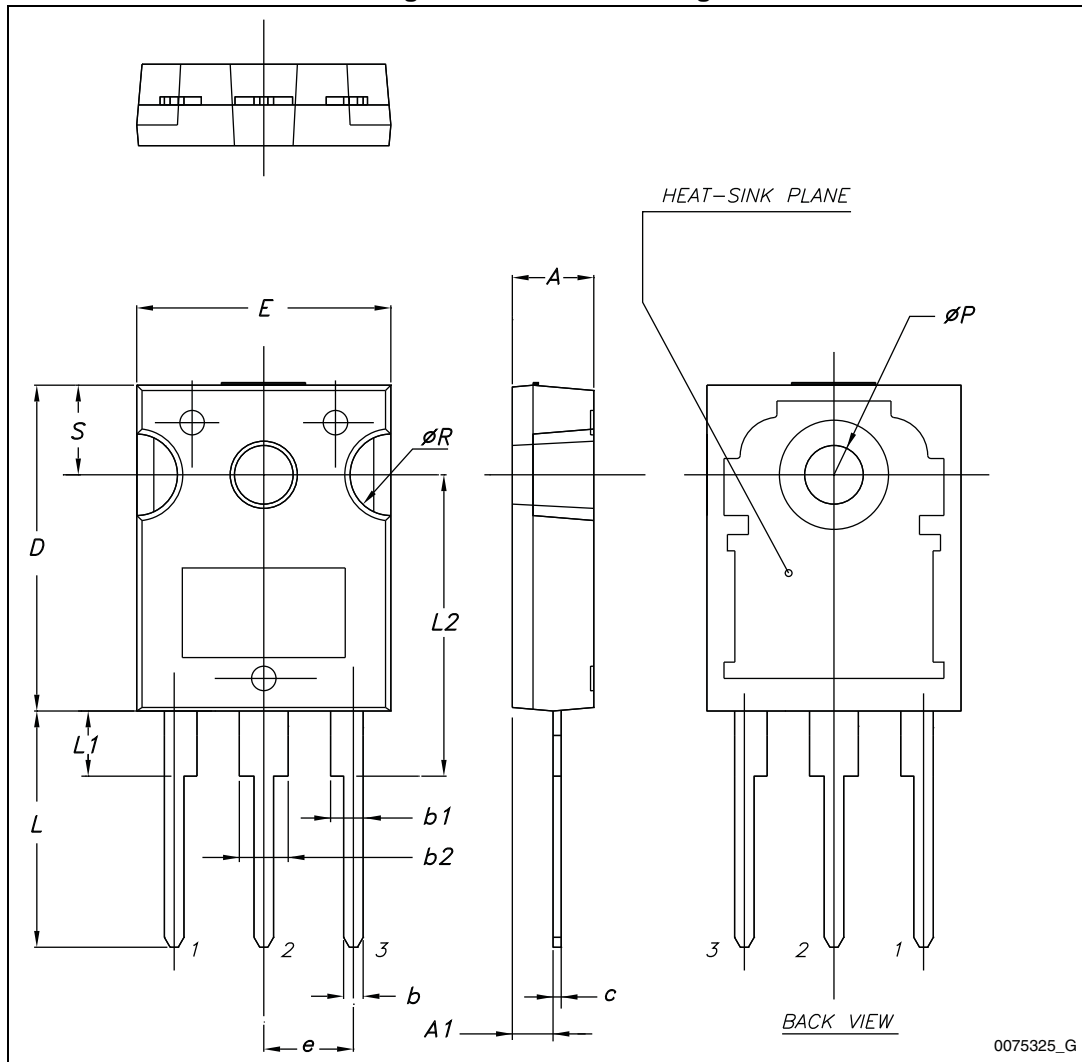
## 4 Package mechanical data

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 7. 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	5.30	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

Figure 25. TO-247 drawing



## 5 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
04-Jun-2013	1	Initial release.

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