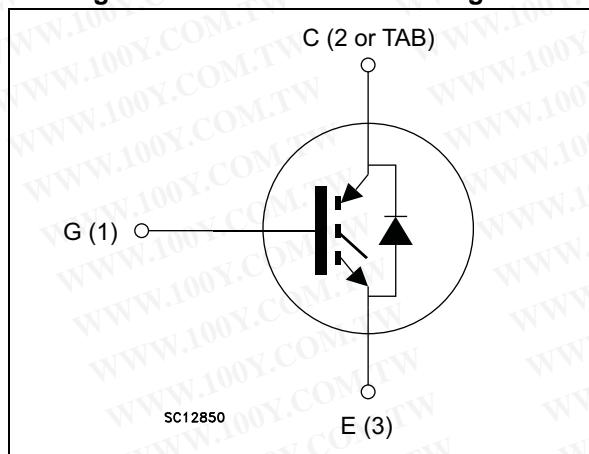


Figure 1. Internal schematic diagram



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Features

- Maximum junction temperature: $T_J = 175 \text{ }^{\circ}\text{C}$
- Tail-less switching off
- $V_{CE(\text{sat})} = 1.85 \text{ V (typ.)} @ I_C = 60 \text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode

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 of IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, a positive $V_{CE(\text{sat})}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW60V60DF	GW60V60DF	TO-247	Tube
STGWT60V60DF	GWT60V60DF	TO-3P	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 $T_C = 25^\circ\text{C}$	80 ⁽¹⁾	A
I_C	Continuous collector current at $T_C = 100^\circ\text{C}$	60	A
$I_{CP}^{(2)}$	Pulsed collector current	240	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25^\circ\text{C}$	80 ⁽¹⁾	A
I_F	Continuous forward current at $T_C = 100^\circ\text{C}$	60	A
$I_{FP}^{(2)}$	Pulsed forward current	240	A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	375	W
T_{STG}	Storage temperature range	- 55 to 150	$^\circ\text{C}$
T_J	Operating junction temperature	- 55 to 175	$^\circ\text{C}$

1. Current level is limited by bond wires
2. Pulse width limited by maximum junction temperature.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.4	$^\circ\text{C}/\text{W}$
R_{thJC}	Thermal resistance junction-case diode	1.14	$^\circ\text{C}/\text{W}$
R_{thJA}	Thermal resistance junction-ambient	50	$^\circ\text{C}/\text{W}$

2 Electrical characteristics

$T_J = 25^\circ\text{C}$ unless otherwise specified.

Table 4. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{CES}}$	Collector-emitter breakdown voltage ($V_{GE} = 0$)	$I_C = 2 \text{ mA}$	600			V
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 15 \text{ V}, I_C = 60 \text{ A}$		1.85	2.3	V
		$V_{GE} = 15 \text{ V}, I_C = 60 \text{ A}$ $T_J = 125^\circ\text{C}$		2.15		
		$V_{GE} = 15 \text{ V}, I_C = 60 \text{ A}$ $T_J = 175^\circ\text{C}$		2.35		
V_F	Forward on-voltage	$I_F = 60 \text{ A}$		2	2.6	V
		$I_F = 60 \text{ A}$ $T_J = 125^\circ\text{C}$		1.7		V
		$I_F = 60 \text{ A}$ $T_J = 175^\circ\text{C}$		1.6		V
$V_{GE(\text{th})}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1 \text{ mA}$	5	6	7	V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 600 \text{ V}$			25	μA
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 Figure 29	-	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
$t_{d(on)}$	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 28	-	60	-	ns
t_r	Current rise time		-	20	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2365	-	A/ μs
$t_{d(off)}$	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
$t_{d(on)}$	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 Figure 28	-	57	-	ns
t_r	Current rise time		-	23	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2191	-	A/ μs
$t_{d(off)}$	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

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 7. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	$I_F = 60 \text{ A}, V_R = 400 \text{ V}, V_{GE} = 15 \text{ V}, di_F/dt = 1000 \text{ A}/\mu\text{s}$, see Figure 28	-	74	-	ns
Q_{rr}	Reverse recovery charge		-	703	-	nC
I_{rrm}	Reverse recovery current		-	19	-	A
di_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	714	-	A/ μs
E_{rr}	Reverse recovery energy		-	184	-	μJ
t_{rr}	Reverse recovery time	$I_F = 60 \text{ A}, V_R = 400 \text{ V}, V_{GE} = 15 \text{ V}, di_F/dt = 1000 \text{ A}/\mu\text{s}$, $T_J = 175 \text{ }^\circ\text{C}$, see Figure 28	-	131	-	ns
Q_{rr}	Reverse recovery charge		-	2816	-	nC
I_{rrm}	Reverse recovery current		-	43	-	A
di_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	404	-	A/ μs
E_{rr}	Reverse recovery energy		-	821	-	μJ

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

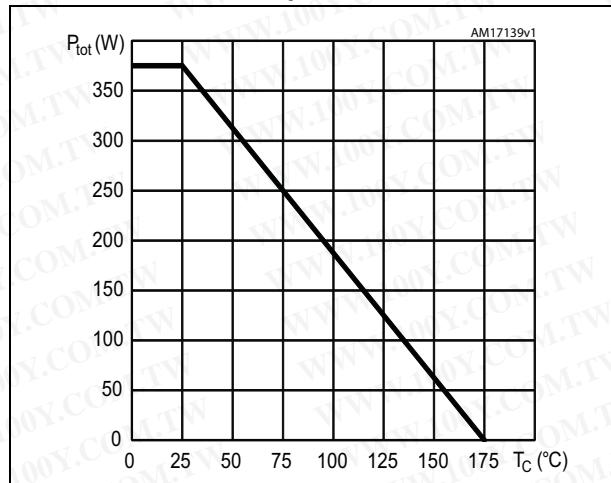


Figure 3. Collector current vs. temperature case

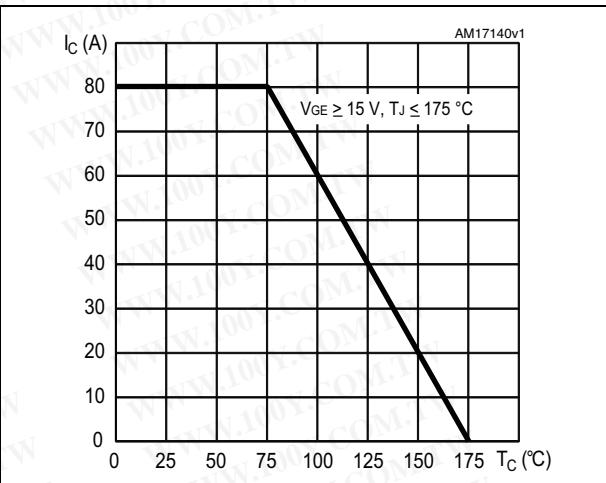


Figure 4. Output characteristics @ 25 °C

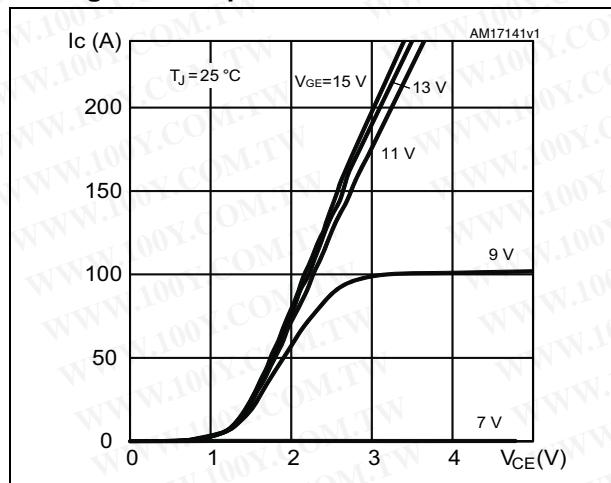


Figure 5. Output characteristics @ 175 °C

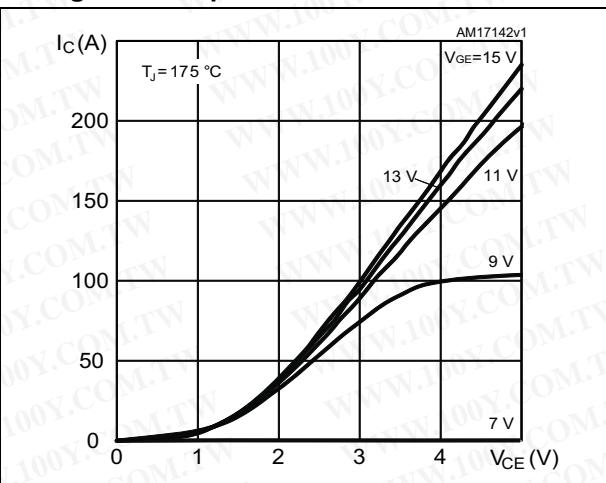


Figure 6. V_{CE(SAT)} vs. junction temperature

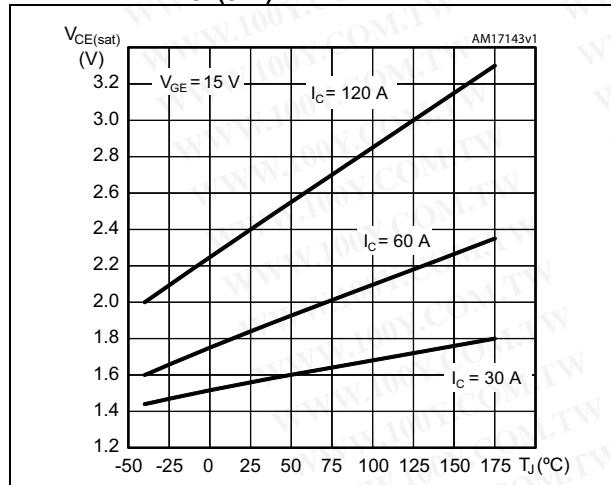


Figure 7. V_{CE(SAT)} vs. collector current

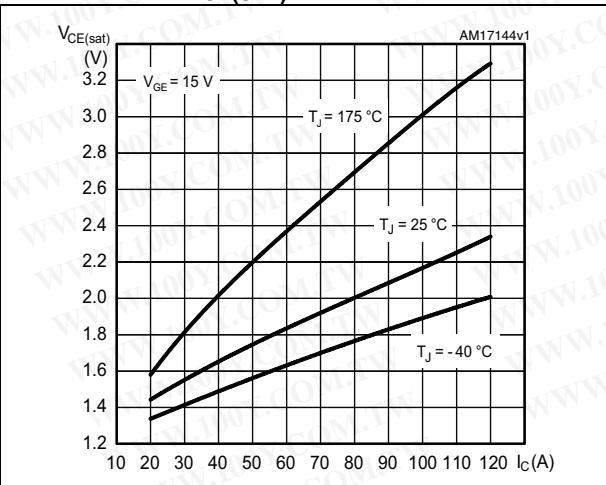


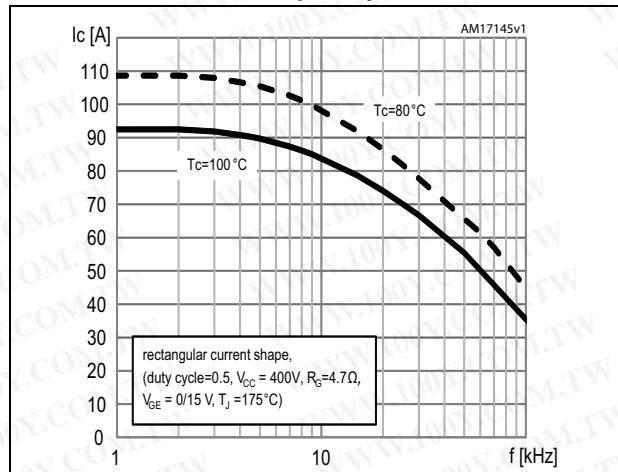
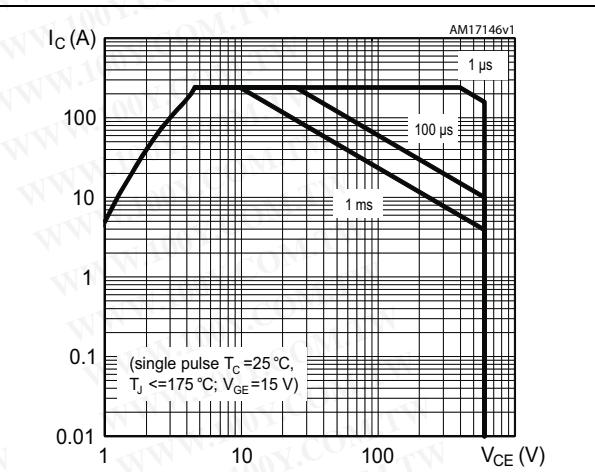
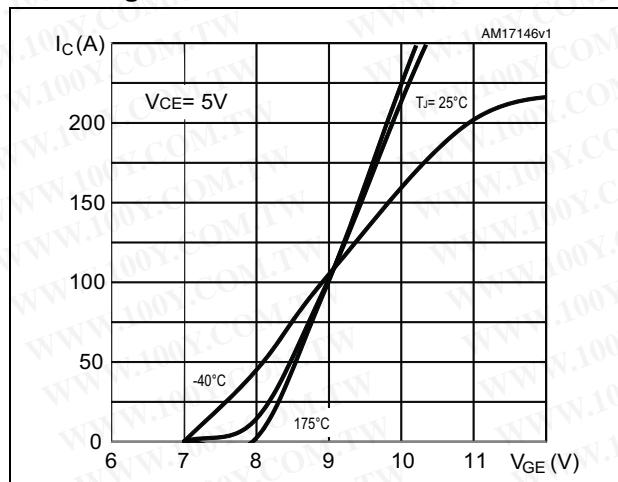
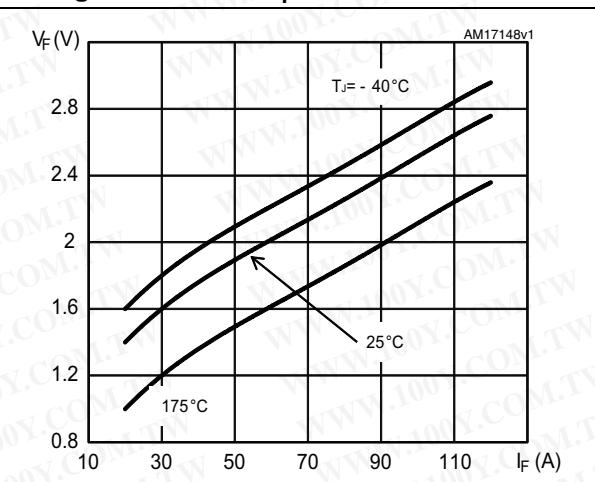
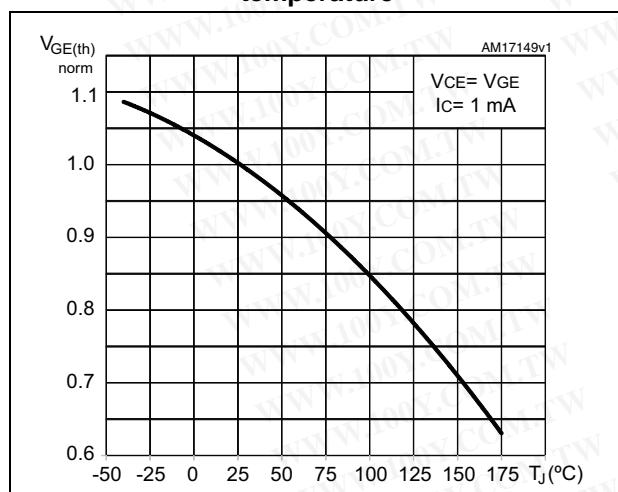
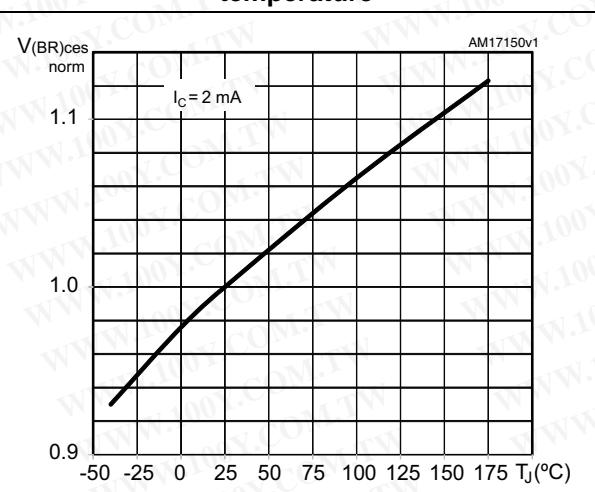
Figure 8. Collector current vs. switching frequency**Figure 9. Safe operating area****Figure 10. Transfer characteristics****Figure 11. Diode V_F vs. forward current****Figure 12. Normalized $V_{GE(th)}$ vs. junction temperature****Figure 13. Normalized $V_{(BR)CES}$ vs. junction temperature**

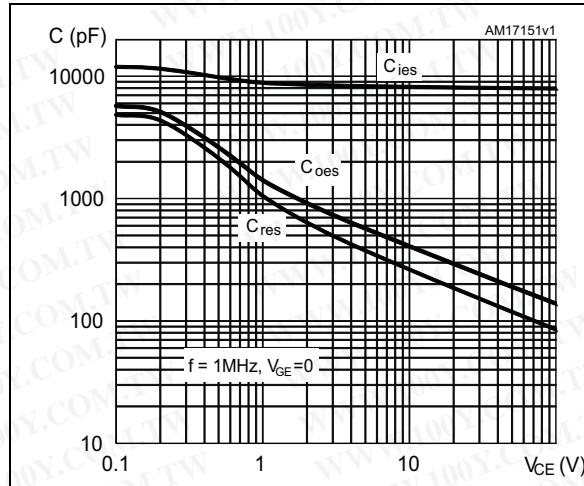
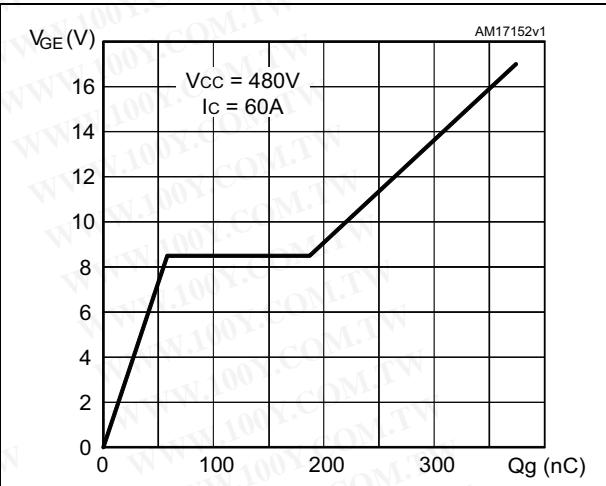
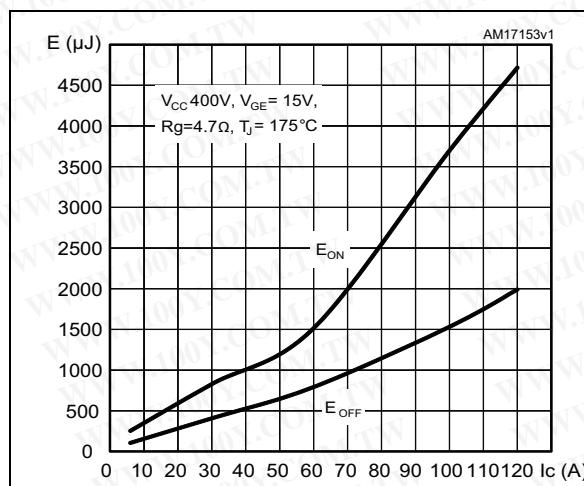
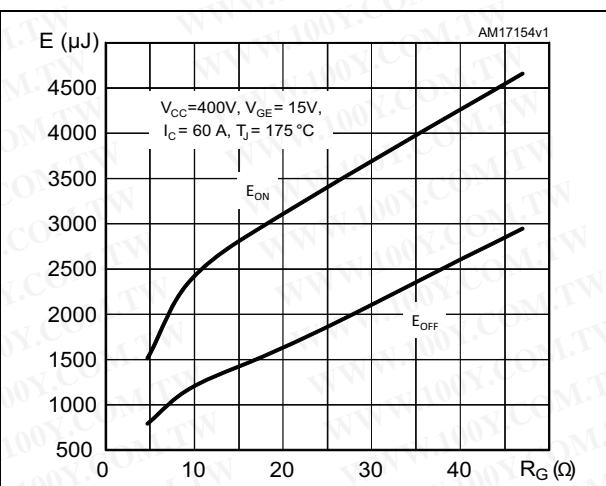
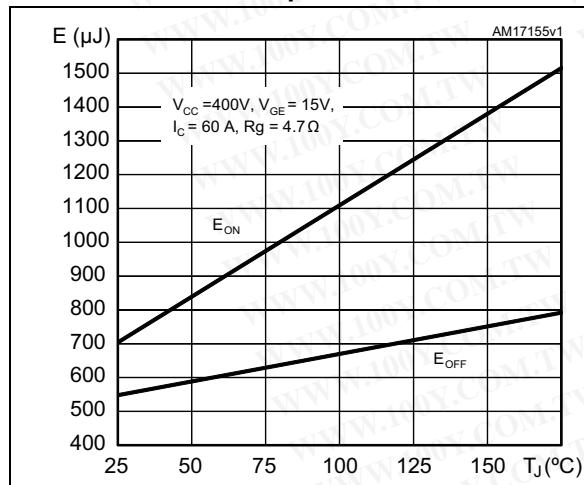
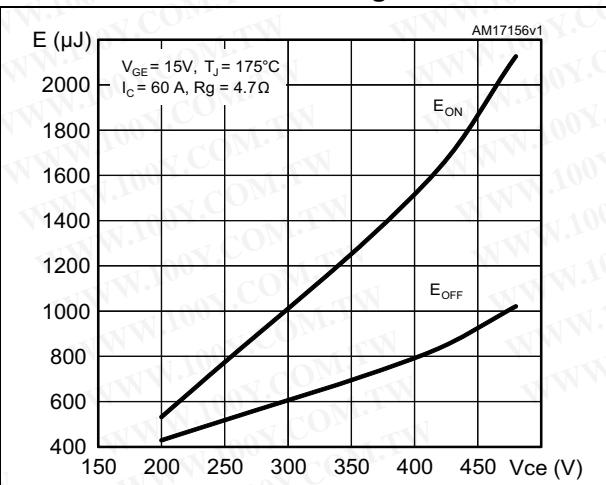
Figure 14. Capacitance variations**Figure 15. Gate charge vs. gate-emitter voltage****Figure 16. Switching losses vs. collector current****Figure 17. Switching losses vs. gate resistance****Figure 18. Switching losses vs. junction temperature****Figure 19. Switching losses vs. collector-emitter voltage**

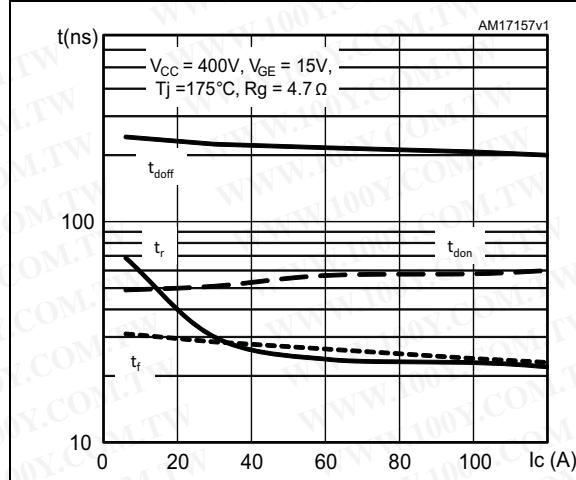
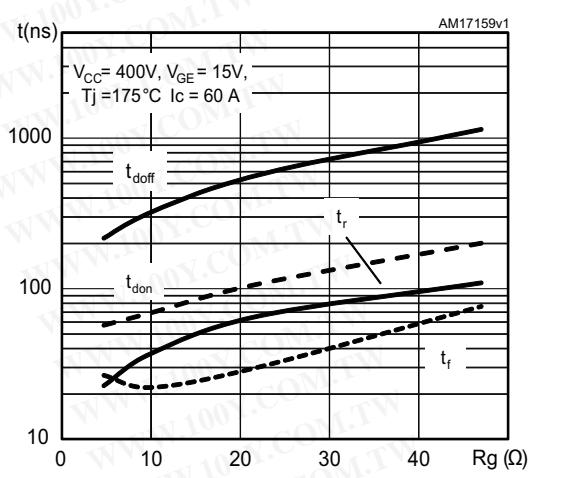
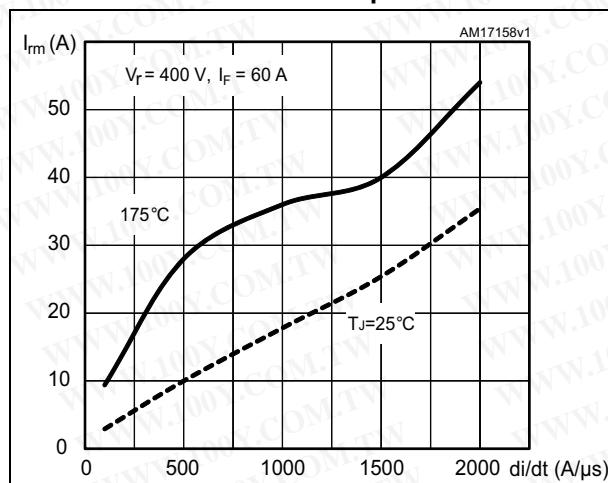
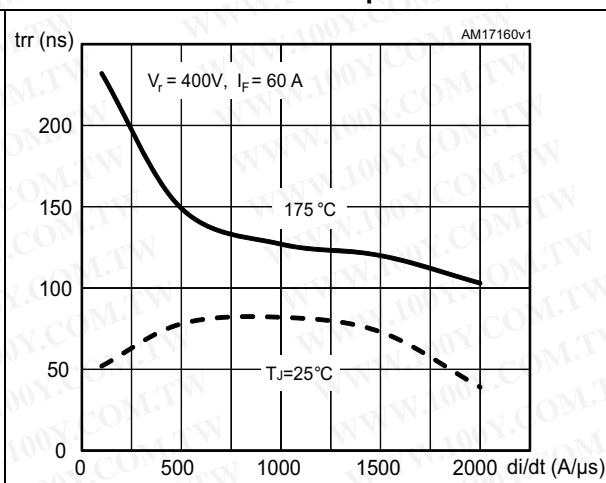
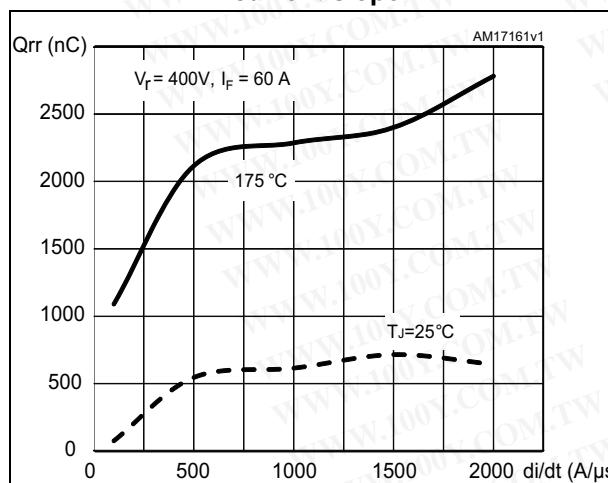
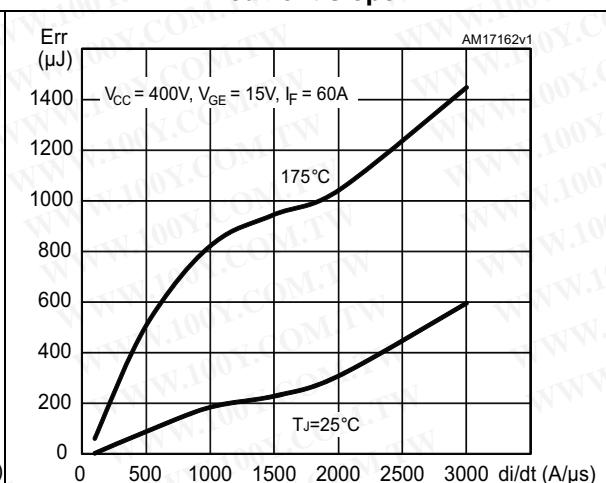
Figure 20. Switching times vs. collector current**Figure 21. Switching times vs. gate resistance****Figure 22. Reverse recovery current vs. diode current slope****Figure 23. Reverse recovery time vs. diode current slope****Figure 24. Reverse recovery charge vs. diode current slope****Figure 25. Reverse recovery energy vs. diode current slope**

Figure 26. Thermal data for IGBT

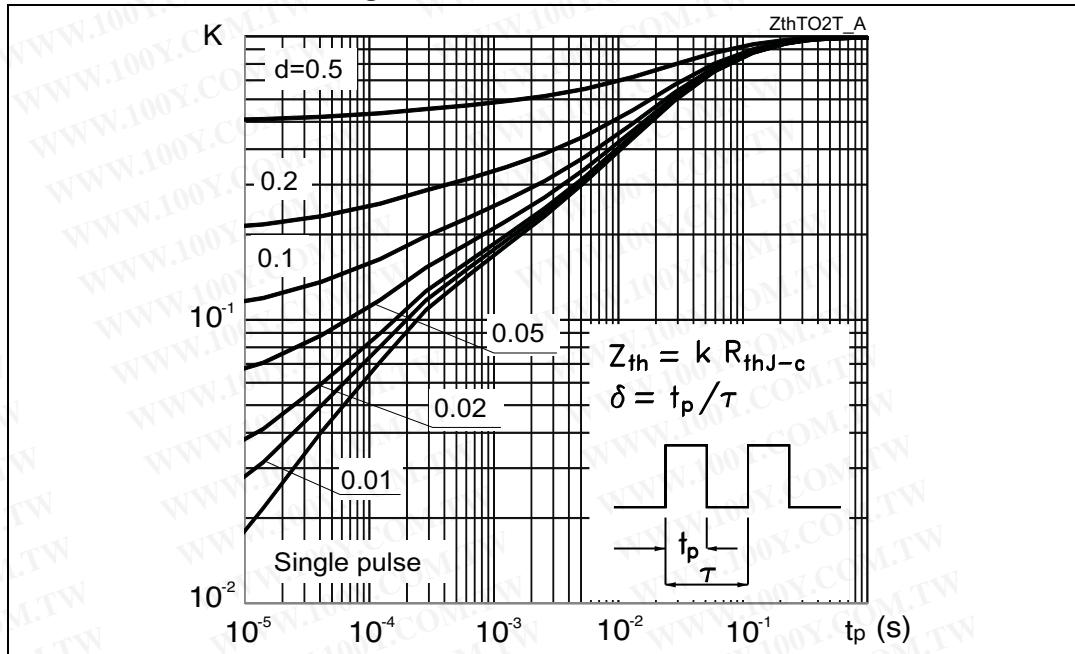
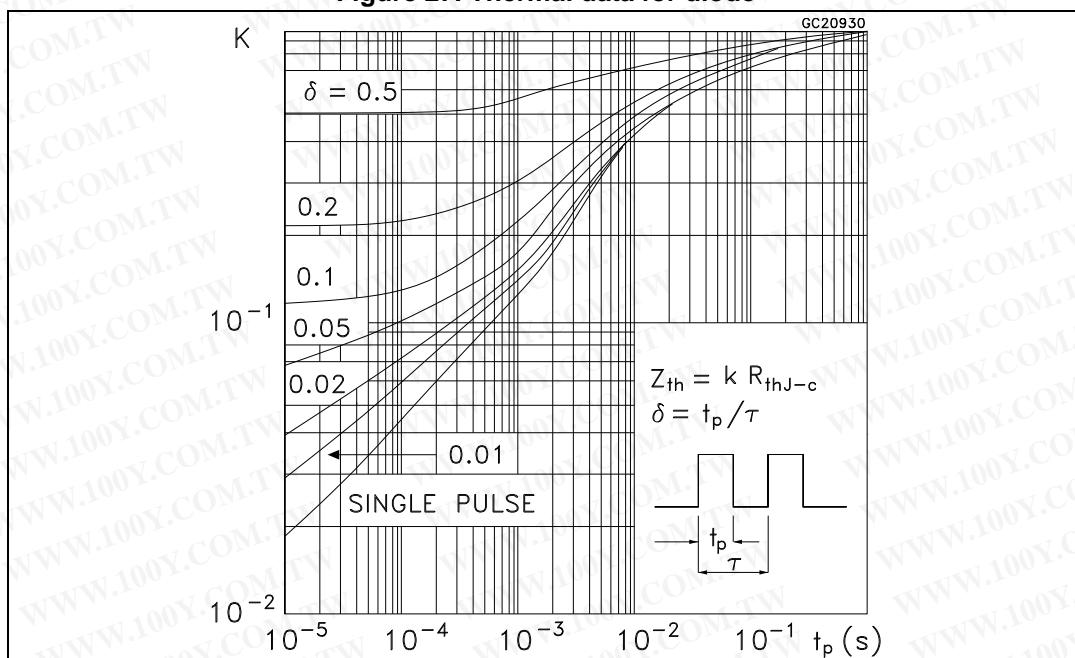


Figure 27. Thermal data for diode



3 Test circuits

Figure 28. Test circuit for inductive load switching

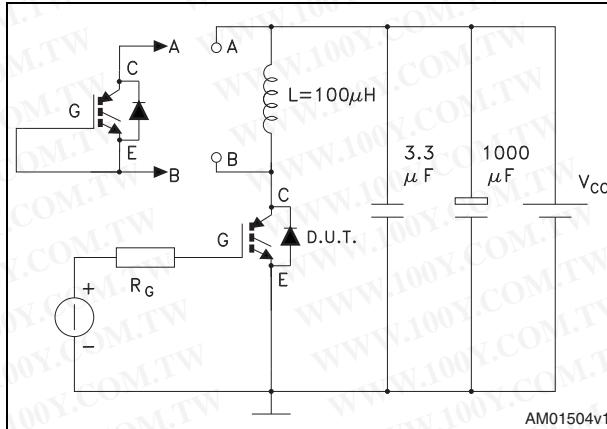


Figure 29. Gate charge test circuit

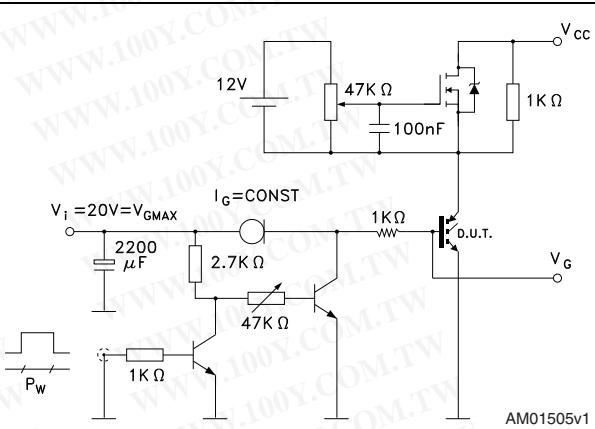


Figure 30. Switching waveform

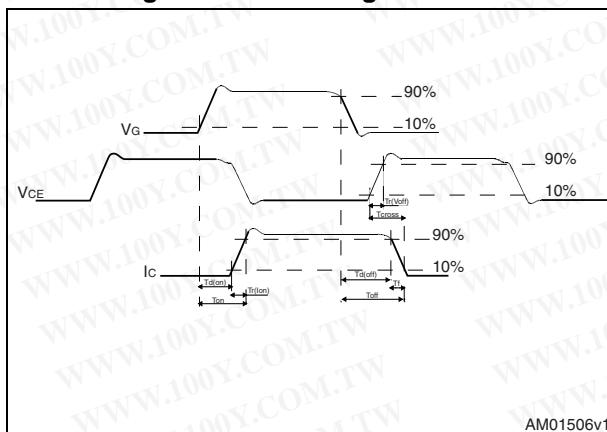
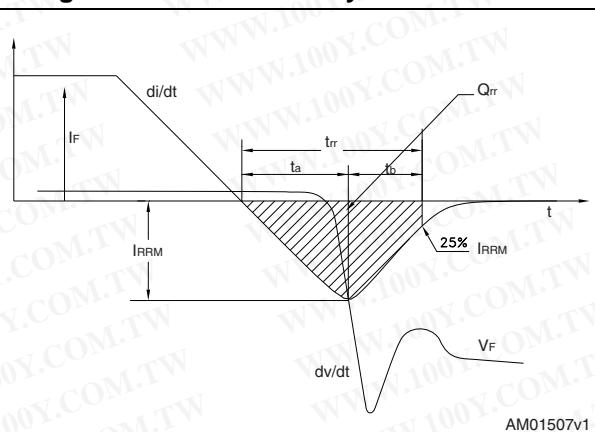


Figure 31. Diode recovery time waveform



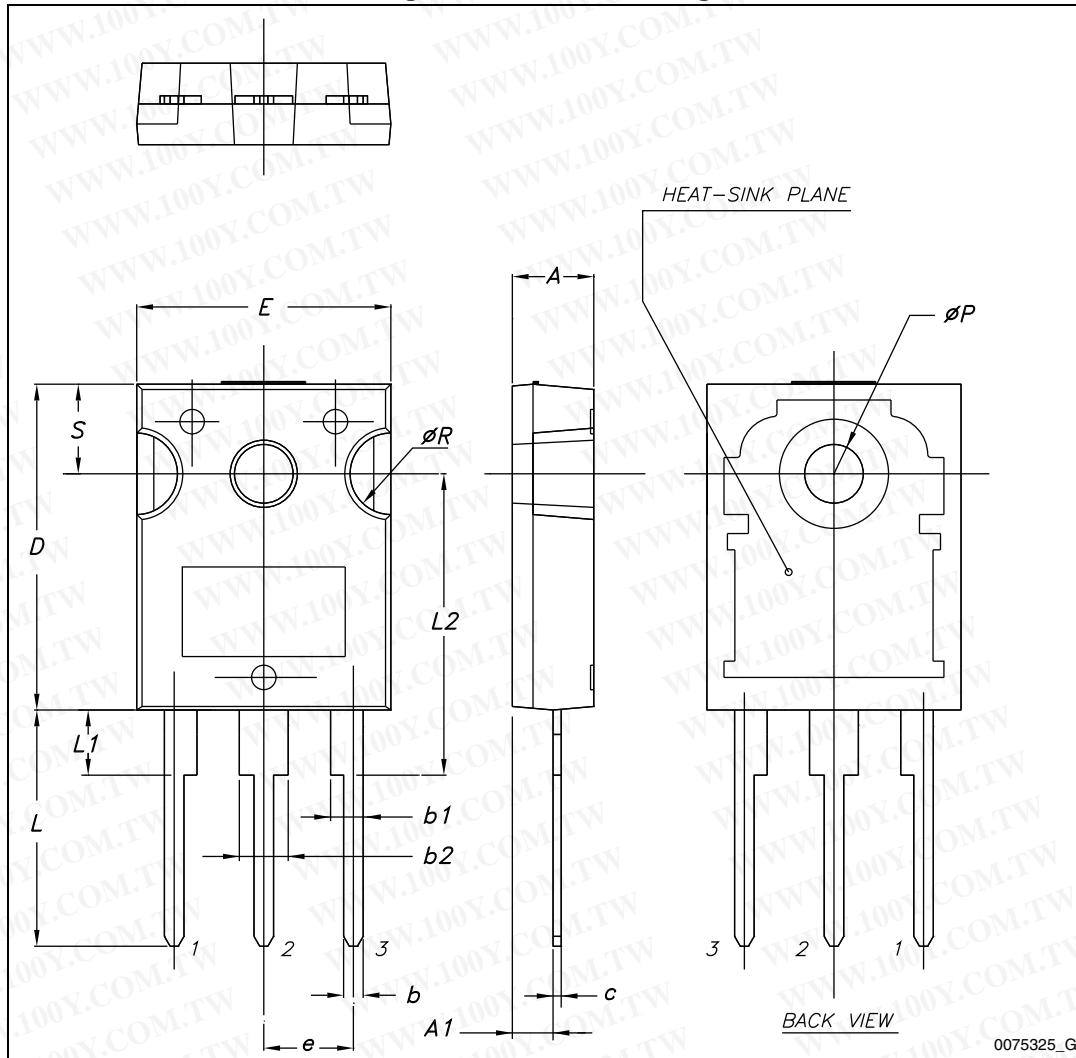
4 Package mechanical data

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.
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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	5.30	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 32. TO-247 drawing

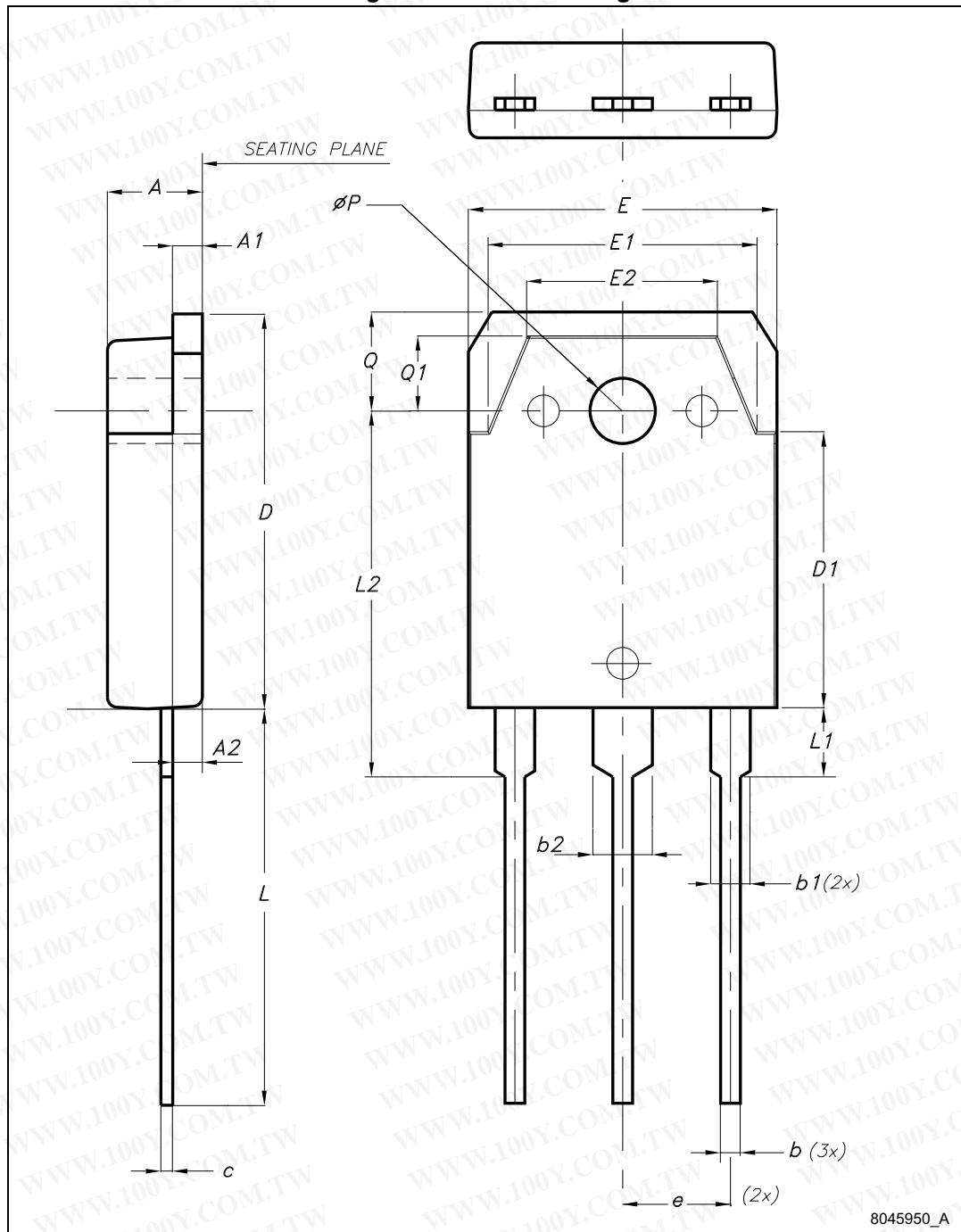


0075325_G

Table 9. TO-3P mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60		5
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1	1.20
b1	1.80		2.20
b2	2.80		3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1		13.90	
E	15.40		15.80
E1		13.60	
E2		9.60	
e	5.15	5.45	5.75
L	19.50	20	20.50
L1		3.50	
L2	18.20	18.40	18.60
øP	3.10		3.30
Q		5	
Q1		3.80	

Figure 33. TO-3P drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
15-Jan-2013	1	Initial release.
23-Apr-2013	2	<p>Added:</p> <ul style="list-style-type: none">– New order code STGWT60V60DF and new package mechanical data TO-3P <i>Table 9 on page 13, Figure 33 on page 14</i>.– <i>Section 2.1: Electrical characteristics (curves) on page 5</i>.
04-Jun-2013	3	<p>Updated <i>Table 4: Static characteristics</i> and <i>Figure 12 on page 6</i>.</p> <p>Document status changed from preliminary to production data.</p>
21-Jun-2013	4	Updated <i>Figure 3: Collector current vs. temperature case</i> .
12-Jul-2013	5	Updated R_{thJC} value for Diode in <i>Table 3: Thermal data</i> .
21-Oct-2013	6	Updated title, features and description in cover page.

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