

Trench gate field-stop IGBT, V series 600 V, 40 A very high speed

Datasheet - production data

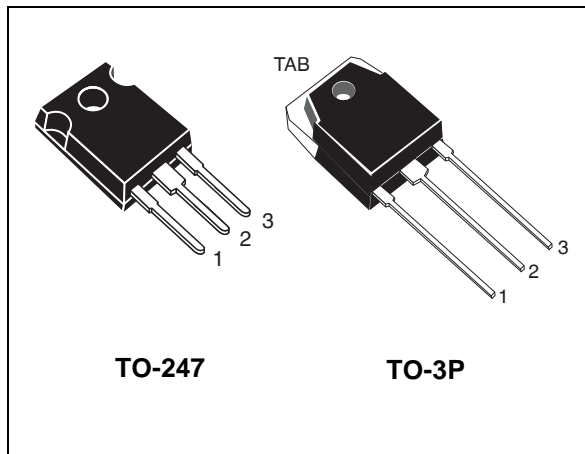
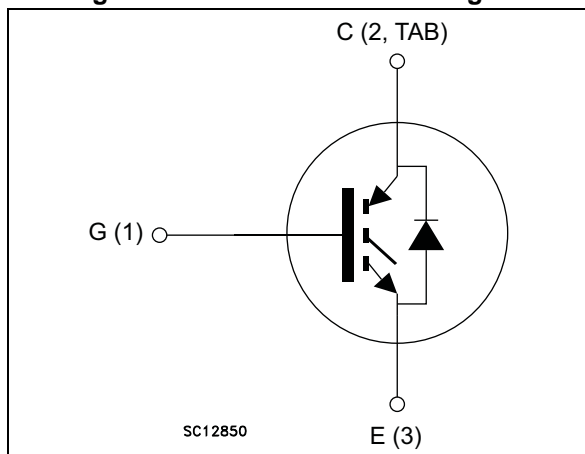


Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: $T_J = 175\text{ °C}$
- Tail-less switching off
- $V_{CE(sat)} = 1.8\text{ V (typ.) @ } I_C = 40\text{ A}$
- 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 $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW40V60DF	GW40V60DF	TO-247	Tube
STGWT40V60DF	GWT40V60DF	TO-3P	Tube

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
	2.1 Electrical characteristics (curves)	6
3	Test circuits	11
4	Package mechanical data	12
5	Revision history	16

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	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	40	A
$I_{CP}^{(1)}$	Pulsed collector current	160	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	80	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	40	A
$I_{FP}^{(1)}$	Pulsed forward current	160	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	283	W
T_{STG}	Storage temperature range	- 55 to 150	$^{\circ}\text{C}$
T_J	Operating junction temperature	- 55 to 175	$^{\circ}\text{C}$

1. Pulse width limited by maximum junction temperature

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.53	$^{\circ}\text{C/W}$
R_{thJC}	Thermal resistance junction-case diode	1.14	$^{\circ}\text{C/W}$
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 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	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$		1.8	2.3	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $T_J = 125\text{ °C}$		2.15		
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $T_J = 175\text{ °C}$		2.35		
V_F	Forward on-voltage	$I_F = 40\text{ A}$		1.7	2.45	V
		$I_F = 40\text{ A}, T_J = 125\text{ °C}$		1.4		V
		$I_F = 40\text{ A}, T_J = 175\text{ °C}$		1.3		V
$V_{GE(th)}$	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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	5400	-	pF
C_{oes}	Output capacitance		-	220	-	pF
C_{res}	Reverse transfer capacitance		-	180	-	pF
Q_g	Total gate charge	$V_{CC} = 480\text{ V}, I_C = 40\text{ A},$ $V_{GE} = 15\text{ V},$ see Figure 29	-	226	-	nC
Q_{ge}	Gate-emitter charge		-	38	-	nC
Q_{gc}	Gate-collector charge		-	95	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, see Figure 28	-	52	-	ns
t_r	Current rise time		-	17	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1850	-	A/ μ s
$t_{d(off)}$	Turn-off delay time		-	208	-	ns
t_f	Current fall time		-	20	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	456	-	μ J
$E_{off}^{(2)}$	Turn-off switching losses		-	411	-	μ J
E_{ts}	Total switching losses	-	867	-	μ J	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$, see Figure 28	-	52	-	ns
t_r	Current rise time		-	21	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1538	-	A/ μ s
$t_{d(off)}$	Turn-off delay time		-	220	-	ns
t_f	Current fall time		-	21	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	1330	-	μ J
$E_{off}^{(2)}$	Turn-off switching losses		-	560	-	μ J
E_{ts}	Total switching losses	-	1890	-	μ J	

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	$I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt=100\text{ A}/\mu\text{s}$ see Figure 28	-	41	-	ns
Q_{rr}	Reverse recovery charge		-	440	-	nC
I_{rrm}	Reverse recovery current		-	21.6	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	1363	-	A/ μ s
E_{rr}	Reverse recovery energy		-	151	-	μ J
t_{rr}	Reverse recovery time	$I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt=100\text{ A}/\mu\text{s}$ $T_J = 175\text{ }^\circ\text{C}$, see Figure 28	-	109	-	ns
Q_{rr}	Reverse recovery charge		-	2400	-	nC
I_{rrm}	Reverse recovery current		-	44.4	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	670	-	A/ μ s
E_{rr}	Reverse recovery energy		-	718	-	μ J

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

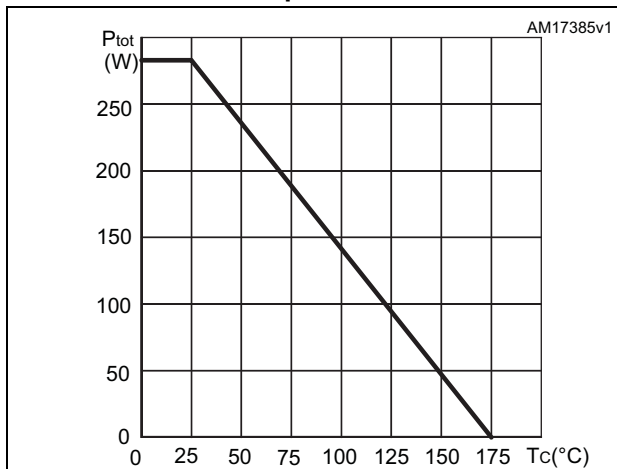


Figure 3. Collector current vs. case temperature

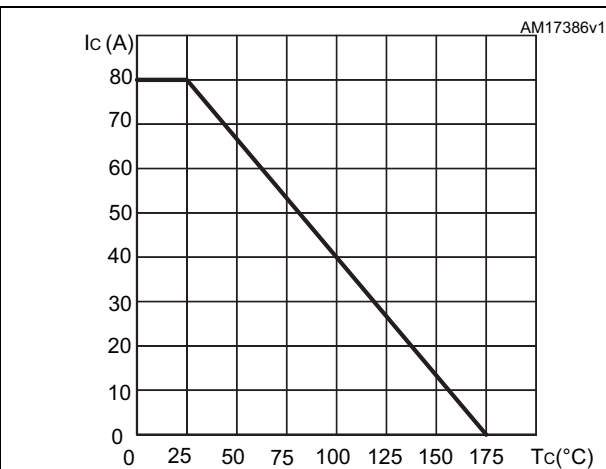


Figure 4. Output characteristics (T_J=25°C)

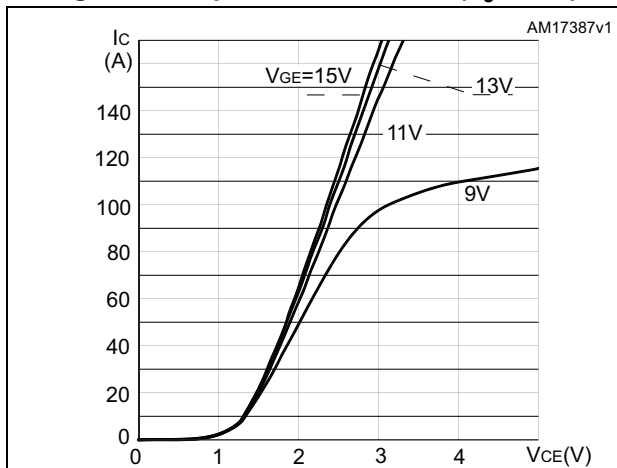


Figure 5. Output characteristics (T_J=175°C)

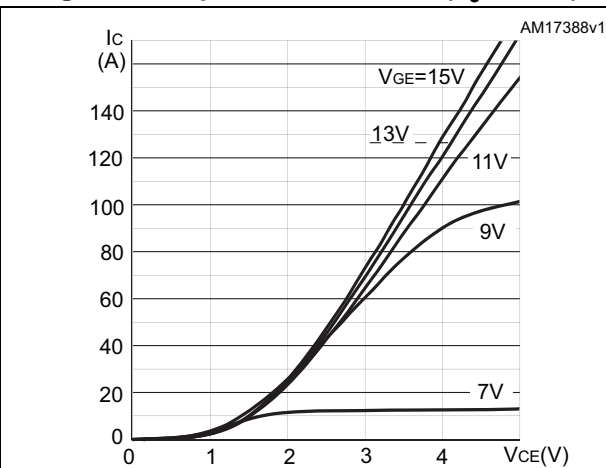


Figure 6. V_{CE(sat)} vs. junction temperature

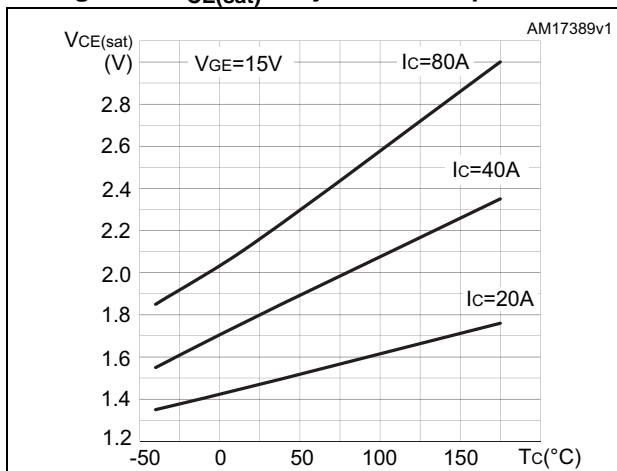


Figure 7. V_{CE(sat)} vs. collector current

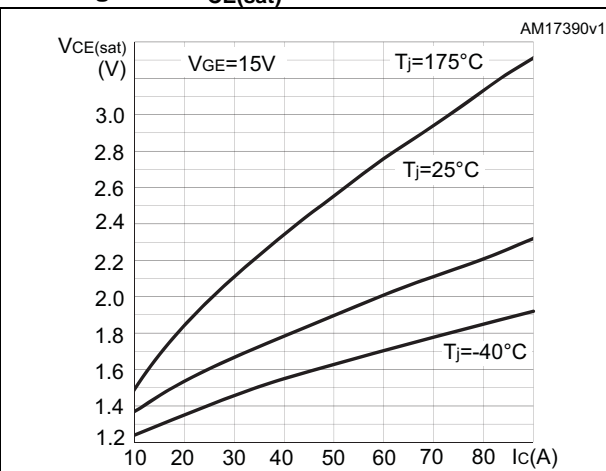


Figure 8. Collector current vs. switching frequency

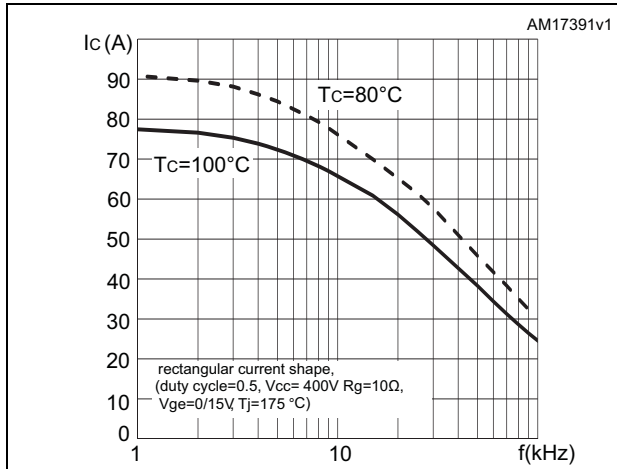


Figure 9. Forward bias safe operating area

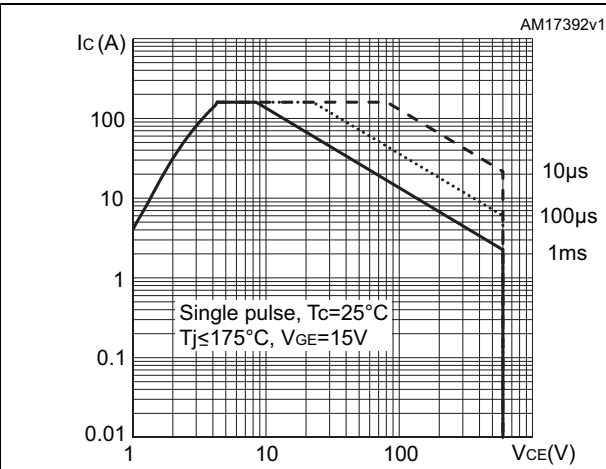


Figure 10. Transfer characteristics

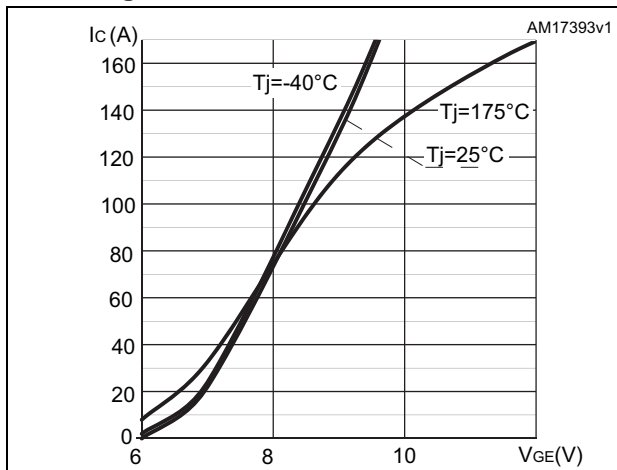


Figure 11. Diode V_F vs. forward current

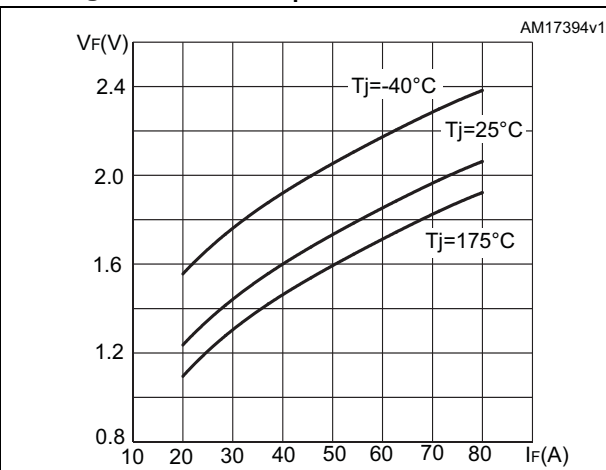


Figure 12. Normalized V_{GE(th)} vs junction temperature

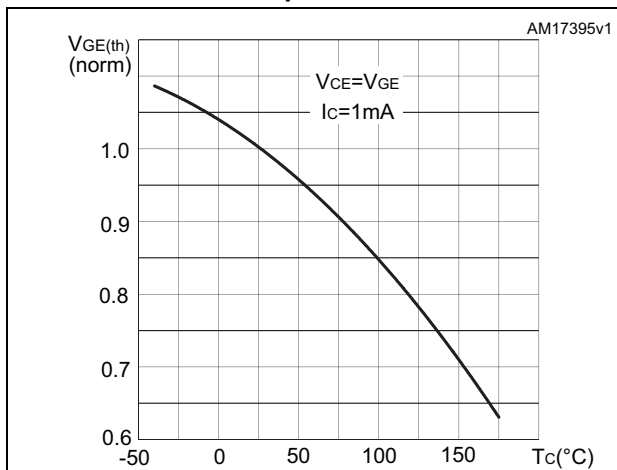


Figure 13. Normalized V_{(BR)CES} vs. junction temperature

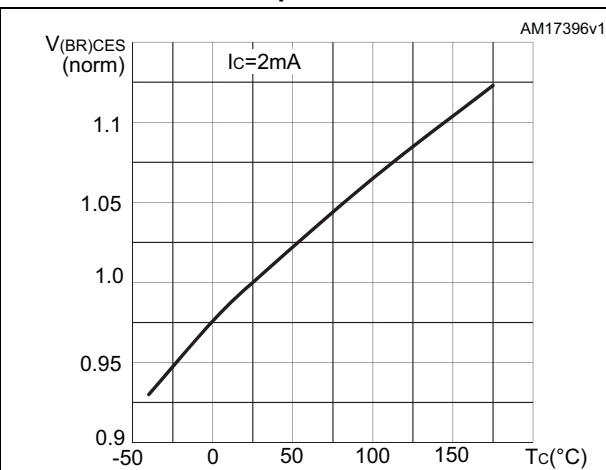


Figure 14. Capacitance variations

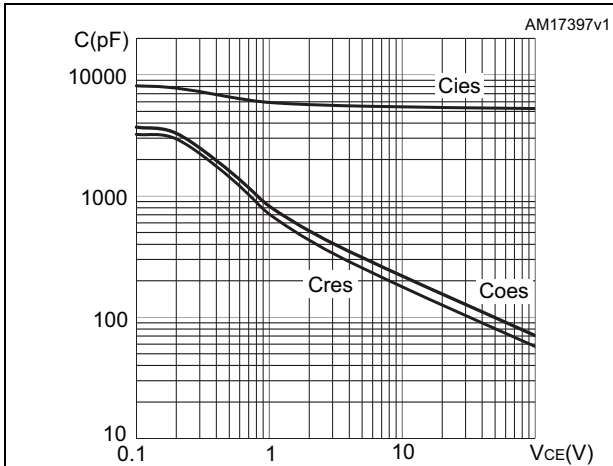


Figure 15. Gate charge vs. gate-emitter voltage

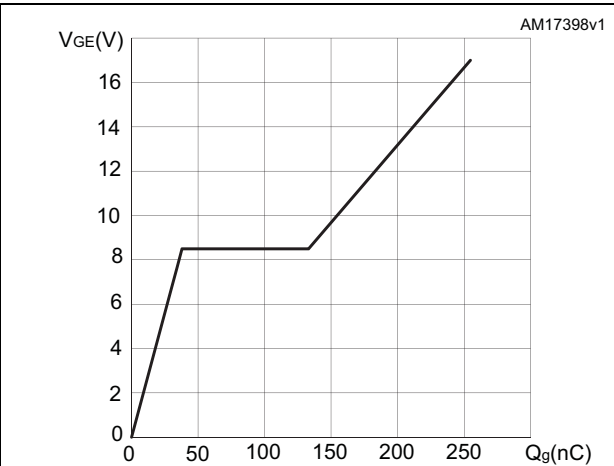


Figure 16. Switching losses vs. collector current

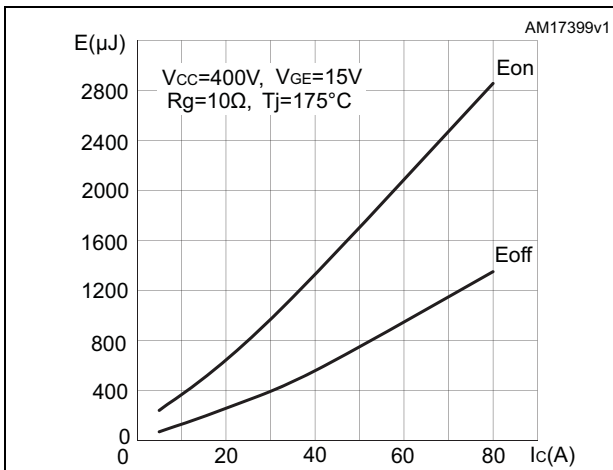


Figure 17. Switching losses vs. gate resistance

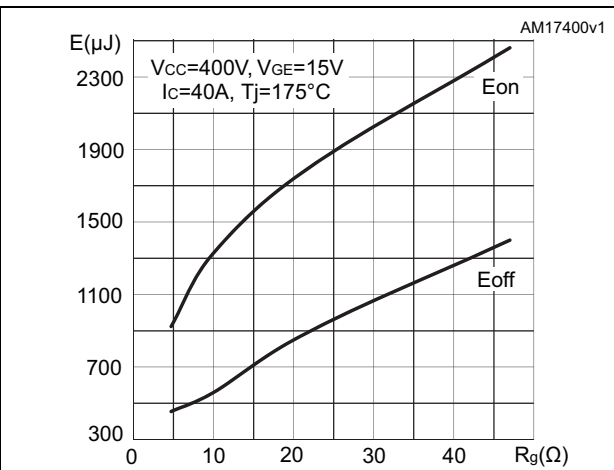


Figure 18. Switching losses vs. junction temperature

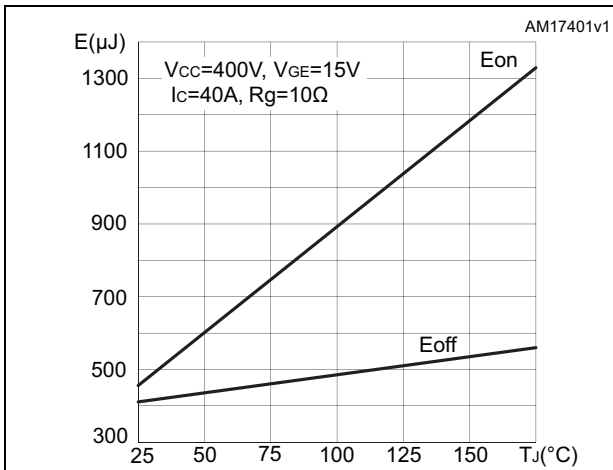


Figure 19. Switching losses vs. collector emitter voltage

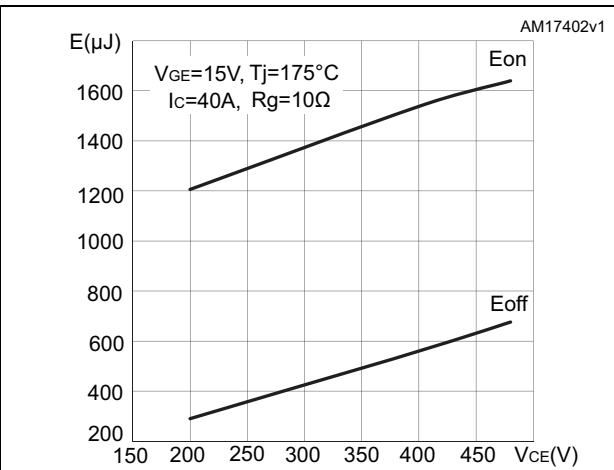


Figure 20. Switching times vs. collector current

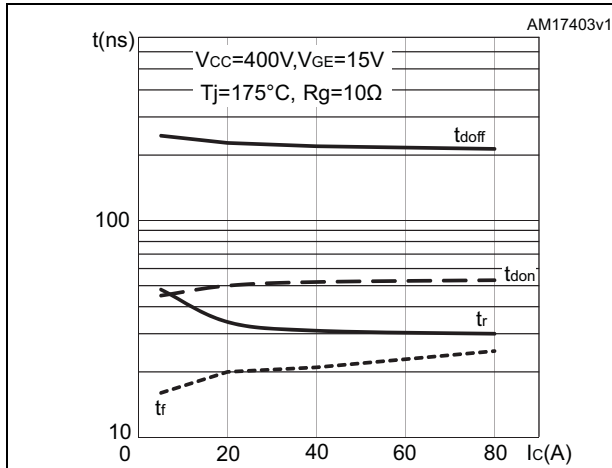


Figure 21. Switching times vs. gate resistance

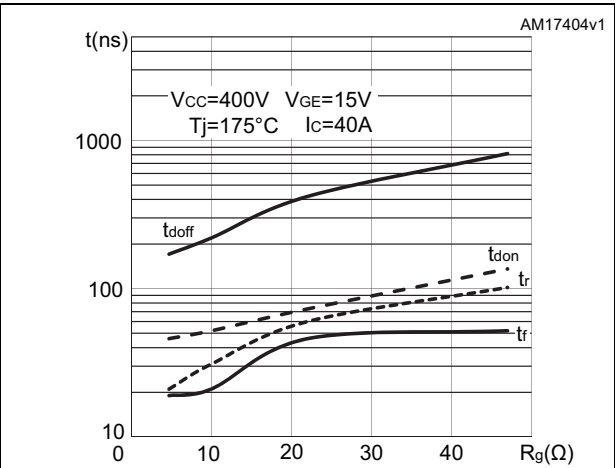


Figure 22. Reverse recovery current vs. diode current slope

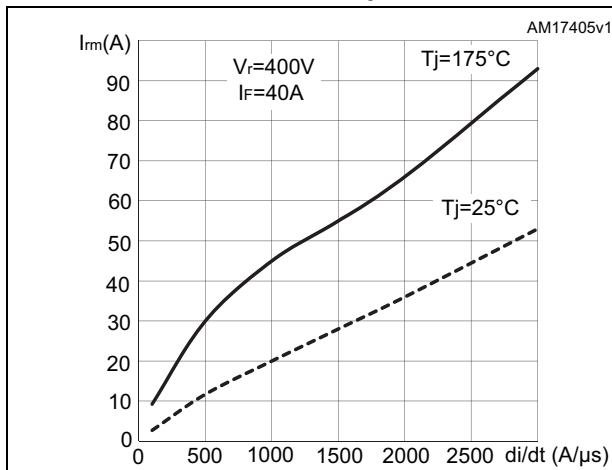


Figure 23. Reverse recovery time vs. diode current slope

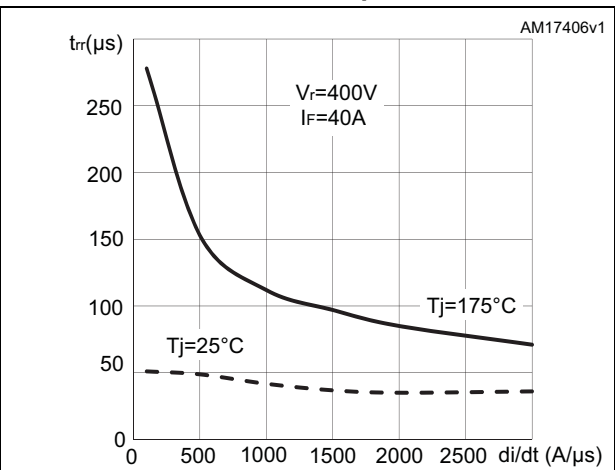


Figure 24. Reverse recovery charge vs. diode current slope

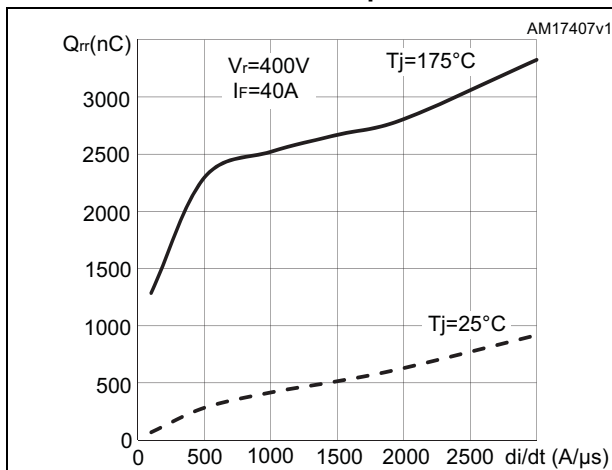


Figure 25. Reverse recovery energy vs. diode current slope

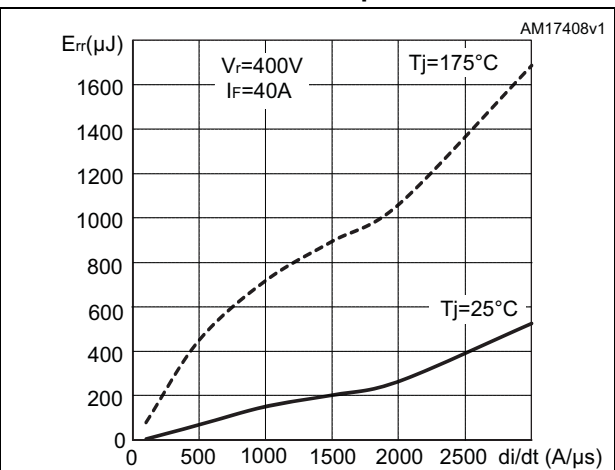


Figure 26. Thermal data for IGBT

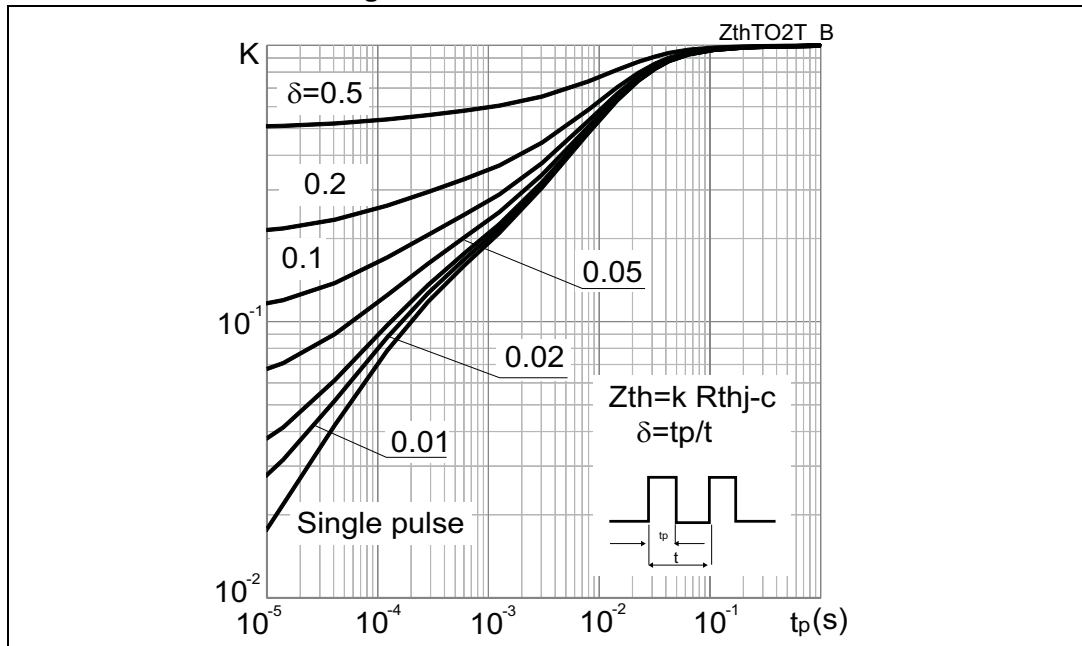
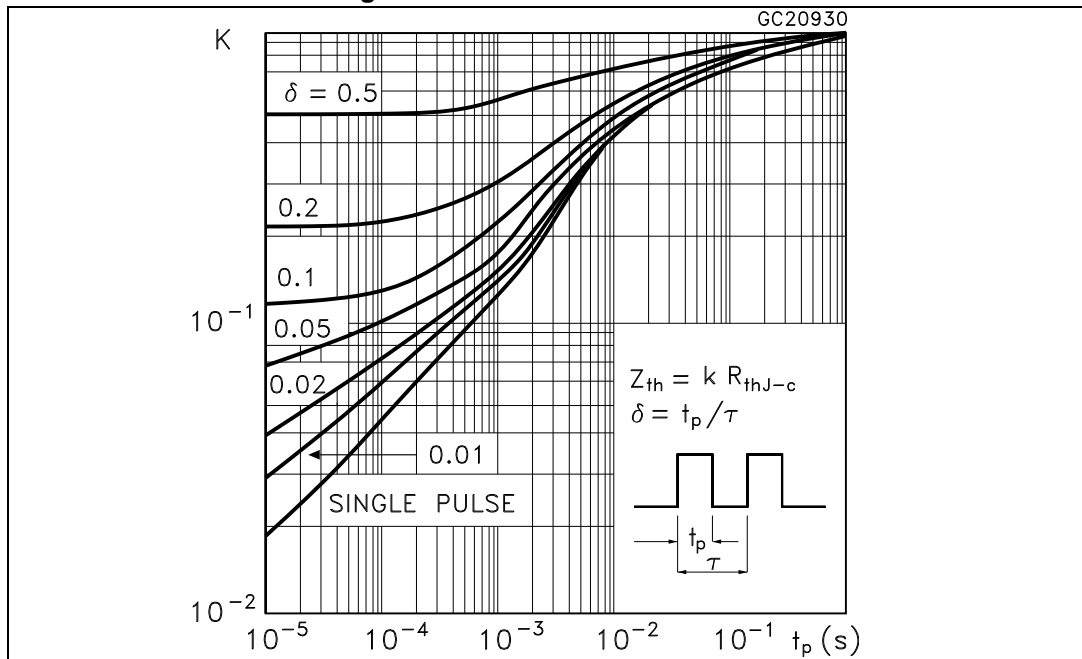
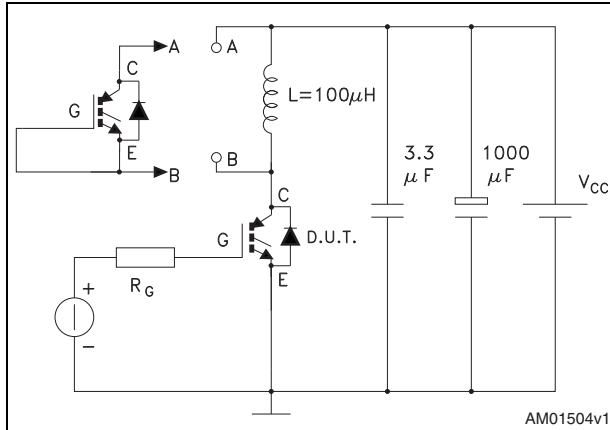


Figure 27. Thermal data for diode



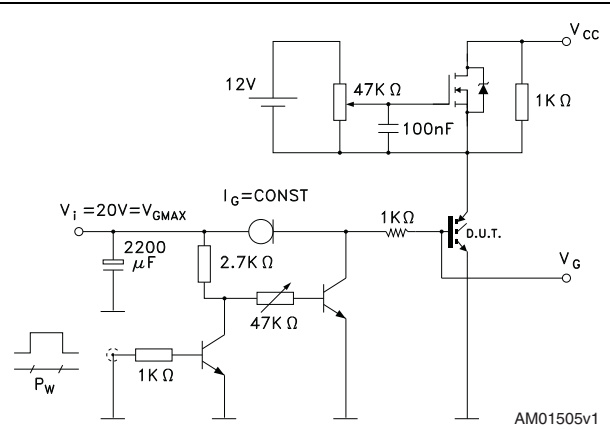
3 Test circuits

Figure 28. Test circuit for inductive load switching



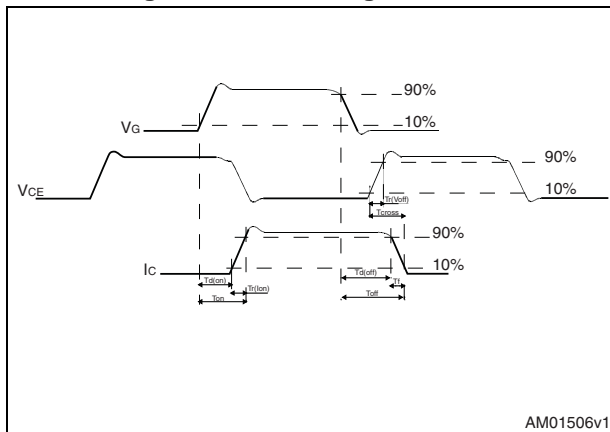
AM01504v1

Figure 29. Gate charge test circuit



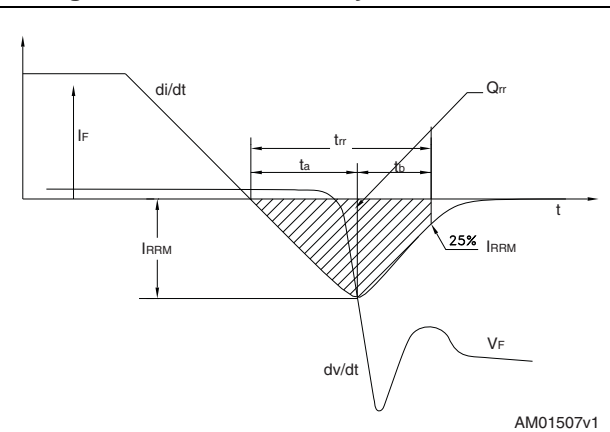
AM01505v1

Figure 30. Switching waveform



AM01506v1

Figure 31. Diode recovery time waveform



AM01507v1

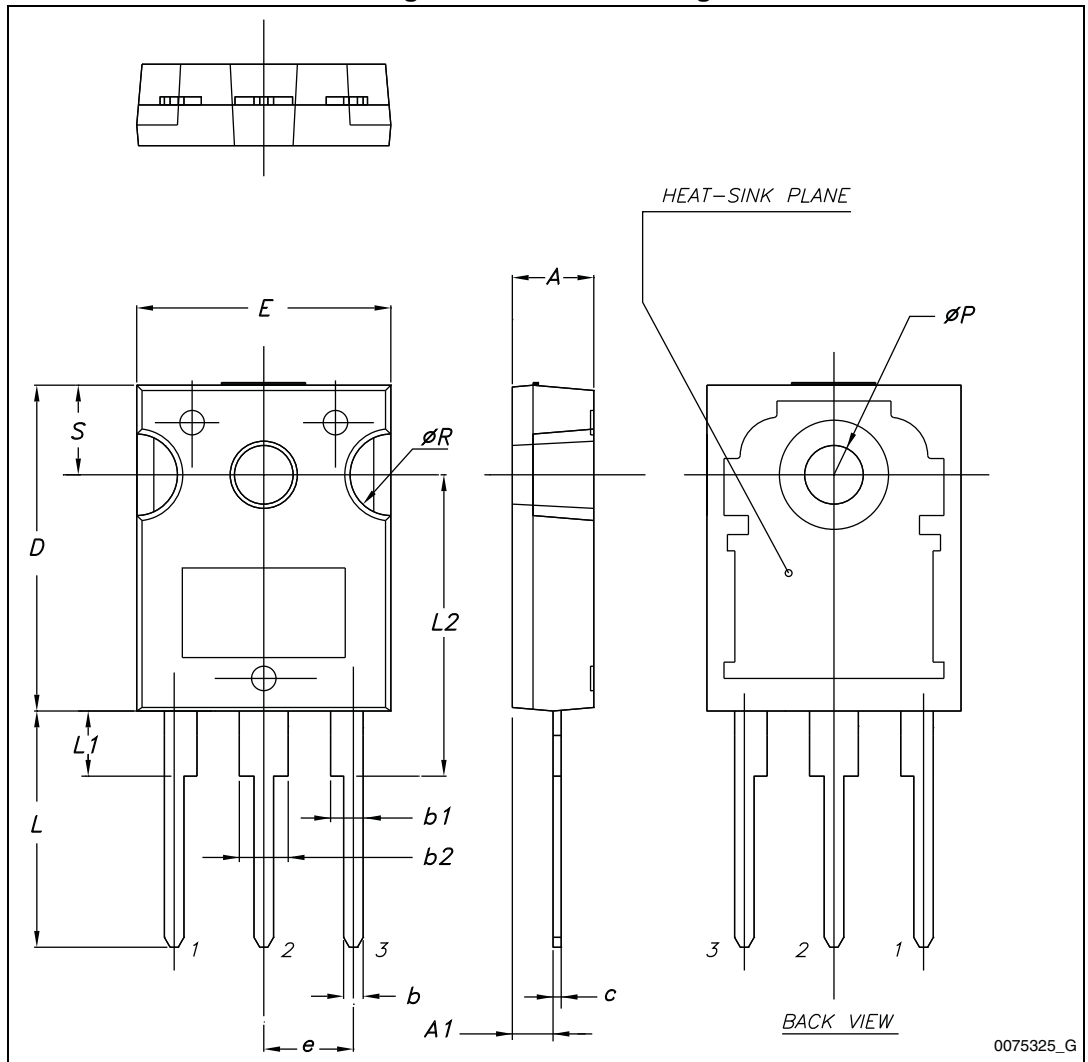
4 Package mechanical data

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. ECOPACK 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	5.30	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

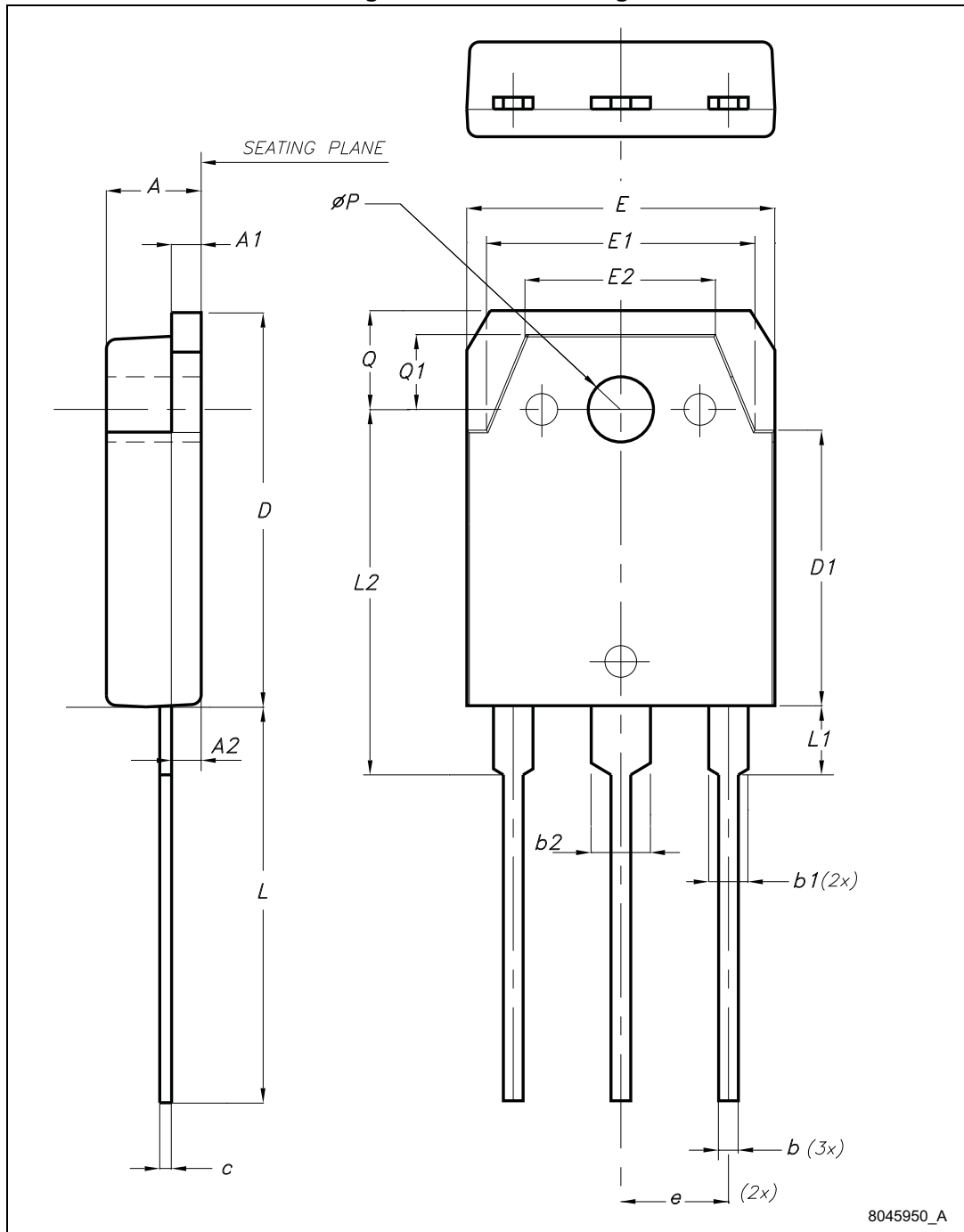


0075325_G

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



8045950_A

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
20-Mar-2013	1	Initial release.
17-Apr-2013	2	Document status promoted from preliminary data to production data. Added: Section 2.1: Electrical characteristics (curves)
04-Jun-2013	3	Added minimum and maximum values for $V_{GE(th)}$ in Table 4: Static characteristics .
11-Sep-2013	4	Updated V_F value in Table 4: Static characteristics .
08-Oct-2013	5	Updated title, features and description in cover page.

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