STGW60V60DF, STGWA60V60DF
STGWT60V60DF

Trench gate field-stop IGBT, V series
600 V, 60 A very high speed

Datasheet - production data

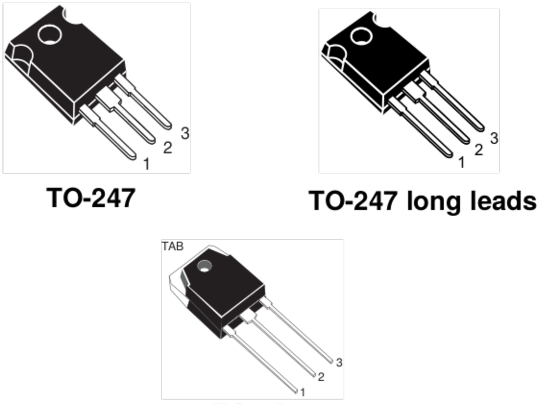
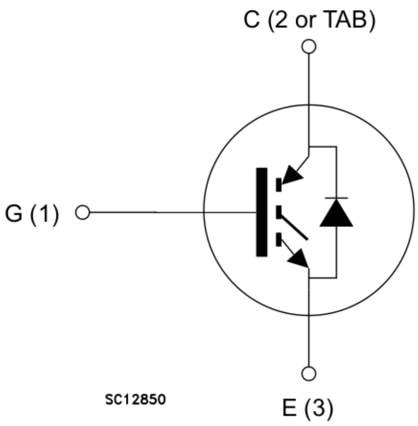


Figure 1. Internal schematic diagram



Features

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

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the V series of IGBTs, which represents 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	Packing
STGW60V60DF	GW60V60DF	TO-247	Tube
STGWA60V60DF	G60V60DF	TO-247 long leads	Tube
STGWT60V60DF	GWT60V60DF	TO-3P	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 °C	80[1]	A
I_C	Continuous collector current at T_C = 100 °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 °C	80[1]	A
I_F	Continuous forward current at T_C = 100 °C	60	A
I_{FP}[2]	Pulsed forward current	240	A
P_{TOT}	Total dissipation at T_C = 25 °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.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.4	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.14	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	°C/W

2 Electrical characteristics

T_J = 25 °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 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 60 A		1.85	2.3	V
		V_{GE} = 15 V, I_C = 60 A T_J = 125 °C		2.15		
		V_{GE} = 15 V, I_C = 60 A T_J = 175 °C		2.35		
V_F	Forward on-voltage	I_F = 60 A		2	2.6	V
		I_F = 60 A T_J = 125 °C		1.7		V
		I_F = 60 A T_J = 175 °C		1.6		V
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V			25	µA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ± 20 V			±250	nA

Table 5. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 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 V, I_C = 60 A, V_{GE} = 15 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 V, I_C = 60 A, R_G = 4.7 Ω, V_{GE} = 15 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 energy		-	0.75	-	mJ
E_{off}(2)	Turn-off switching energy		-	0.55	-	mJ
E_{ts}	Total switching energy		-	1.3	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 60 A, R_G = 4.7 Ω, V_{GE} = 15 V, T_J = 175 °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 energy		-	1.5	-	mJ
E_{off}(2)	Turn-off switching energy		-	0.8	-	mJ
E_{ts}	Total switching energy		-	2.3	-	mJ

1. Including the reverse recovery of the diode.
2. Including 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 A, V_R = 400 V, V_{GE} = 15 V, di_F/dt = 1000 A/µs 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 A, V_R = 400 V, V_{GE} = 15 V di_F/dt = 1000 A/µs T_J = 175 °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

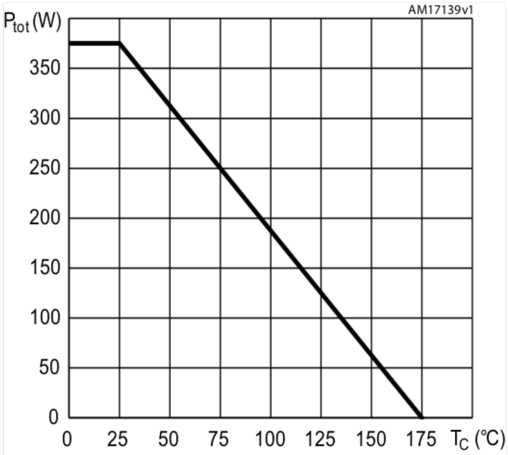


Figure 3. Collector current vs. temperature case

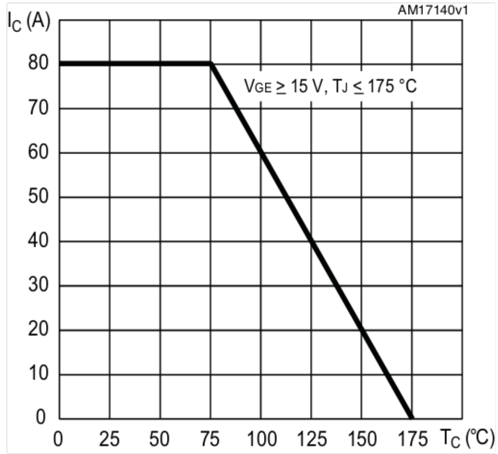


Figure 4. Output characteristics @ 25 °C

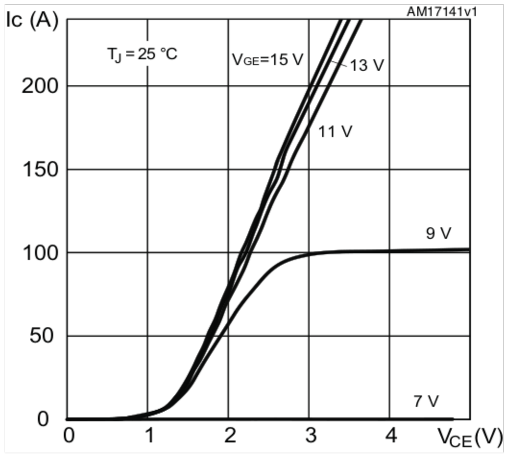


Figure 5. Output characteristics @ 175 °C

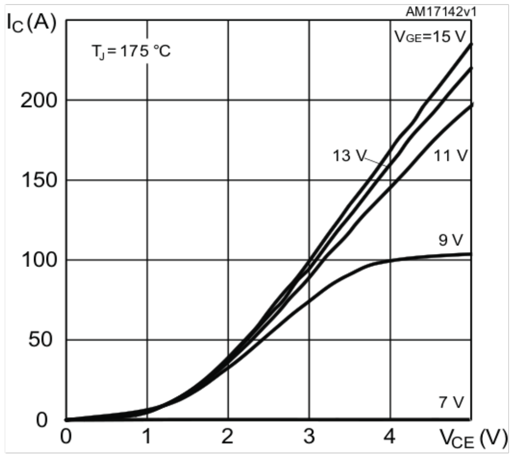


Figure 6. $V_{CE(SAT)}$ vs. junction temperature

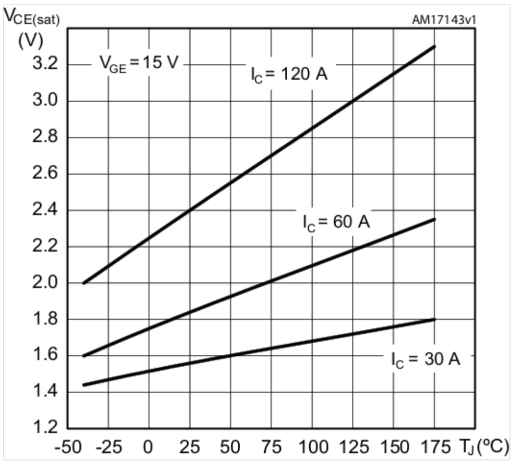


Figure 7. $V_{CE(SAT)}$ vs. collector current

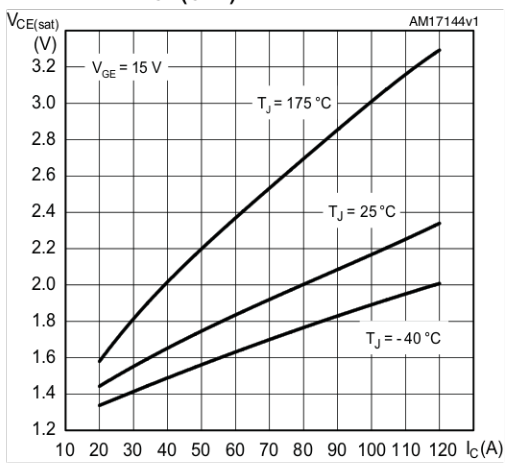


Figure 8. Collector current vs. switching frequency

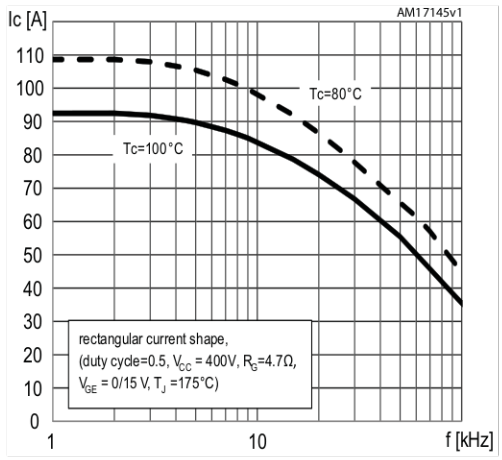


Figure 9. Safe operating area

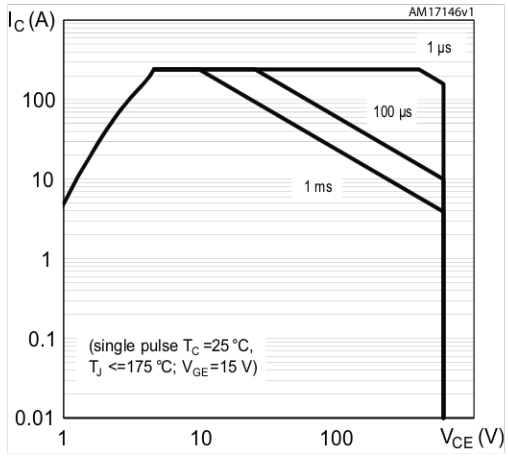


Figure 10. Transfer characteristics

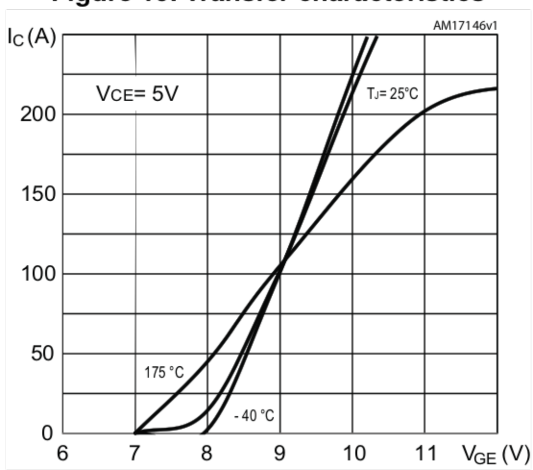


Figure 11. Diode V_F vs. forward current

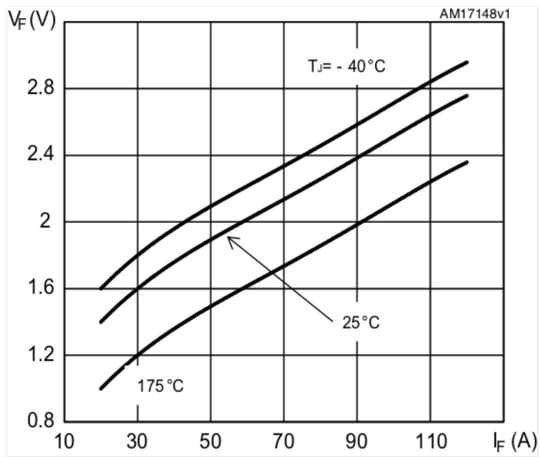


Figure 12. Normalized $V_{GE(th)}$ vs. junction temperature

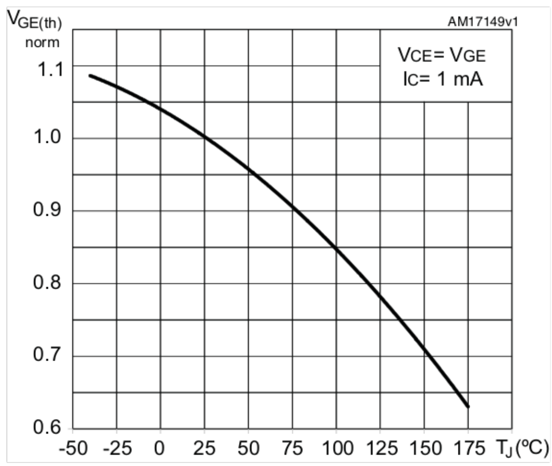


Figure 13. Normalized $V_{(BR)CES}$ vs. junction temperature

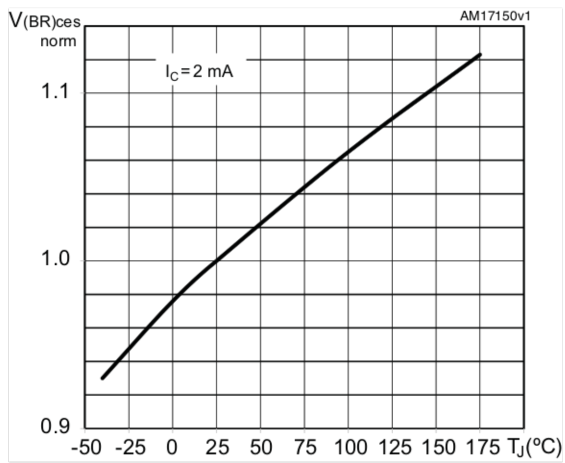


Figure 14. Capacitance variations

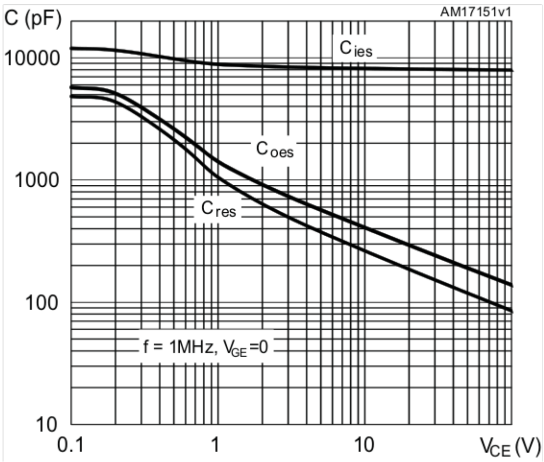


Figure 15. Gate charge vs. gate-emitter voltage

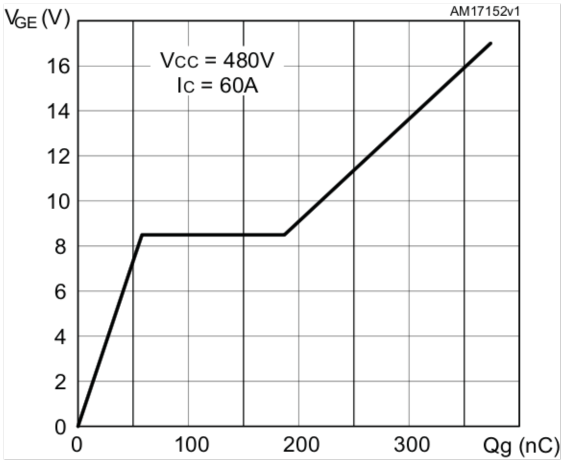


Figure 16. Switching energy vs. collector current

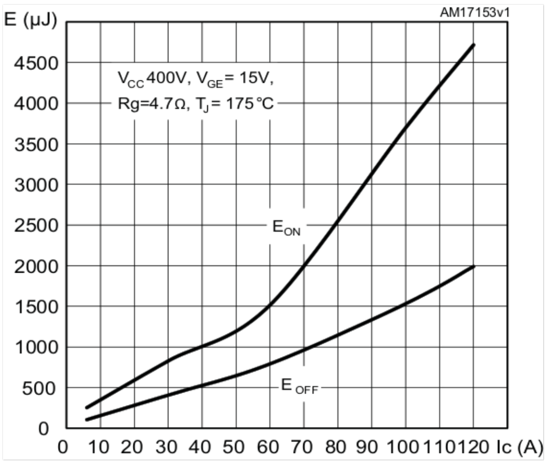


Figure 17. Switching energy vs. gate resistance

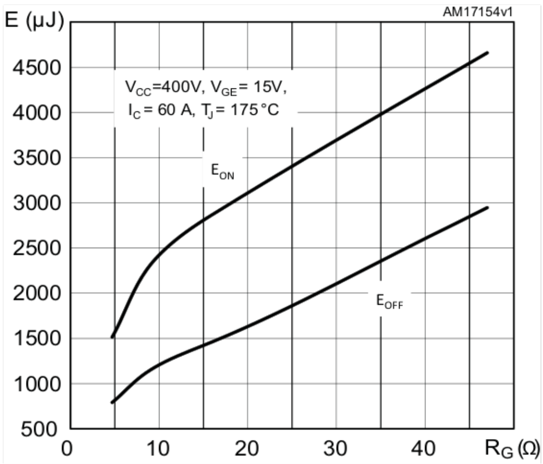


Figure 18. Switchng energy vs.junction temperature

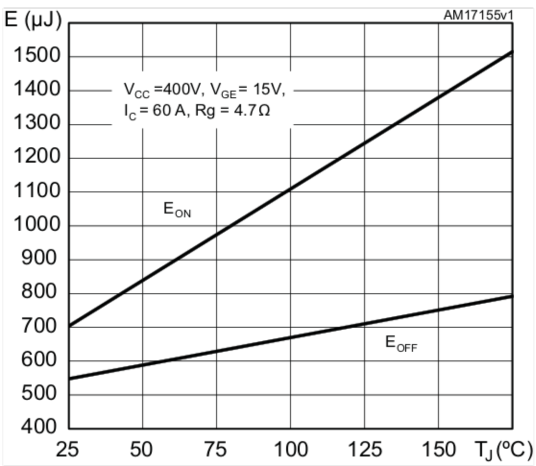


Figure 19. Switching energy vs. collector emitter voltage

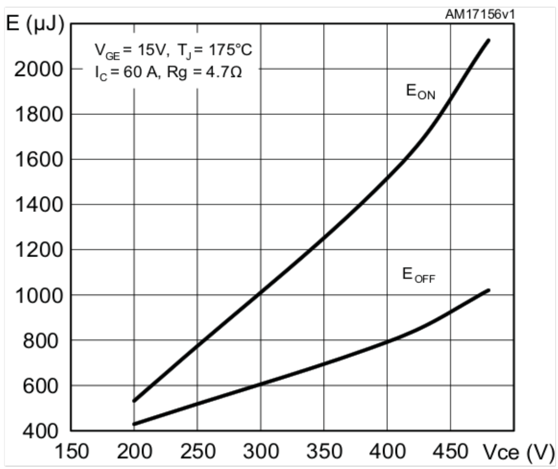


Figure 20. Switching times vs. collector current

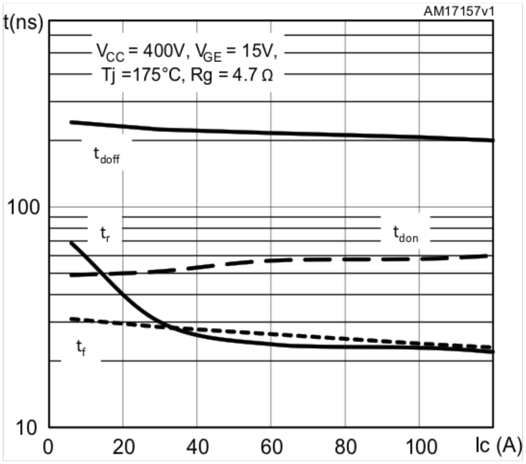


Figure 21. Switching times vs. gate resistance

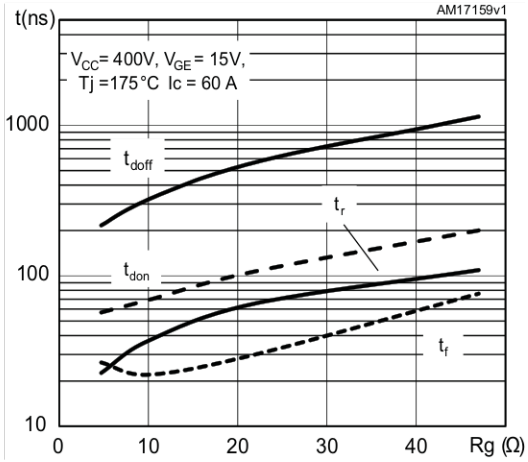


Figure 22. Reverse recovery current vs. diode current slope

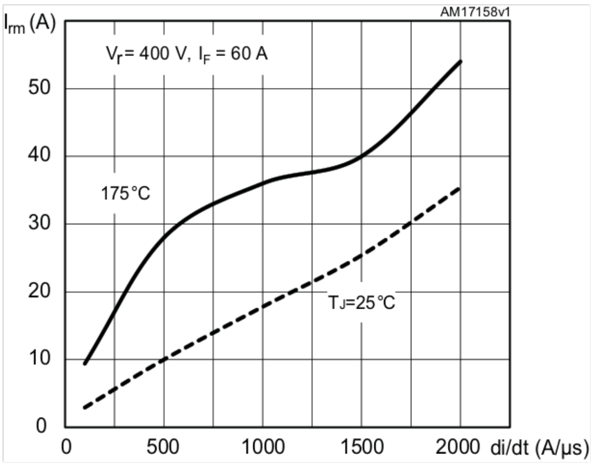


Figure 23. Reverse recovery time vs. diode current slope

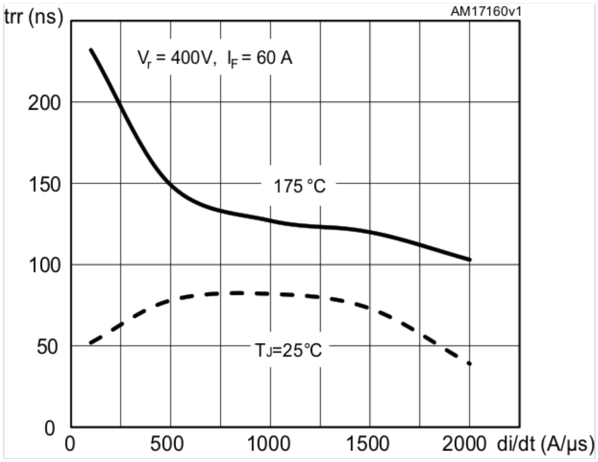


Figure 24. Reverse recovery charge vs. diode current slope

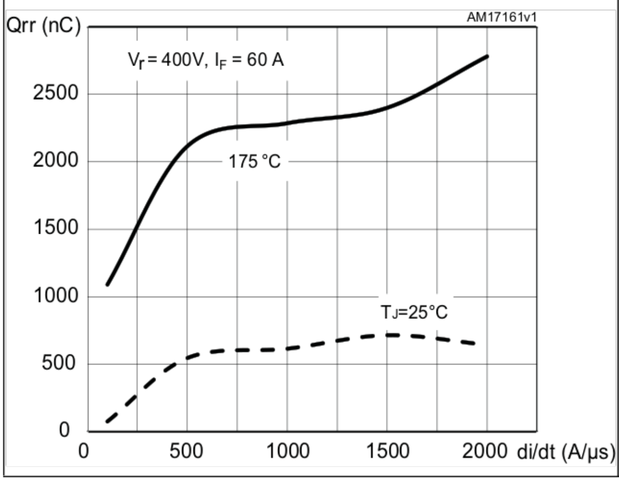


Figure 25. Reverse recovery energy vs. diode current slope

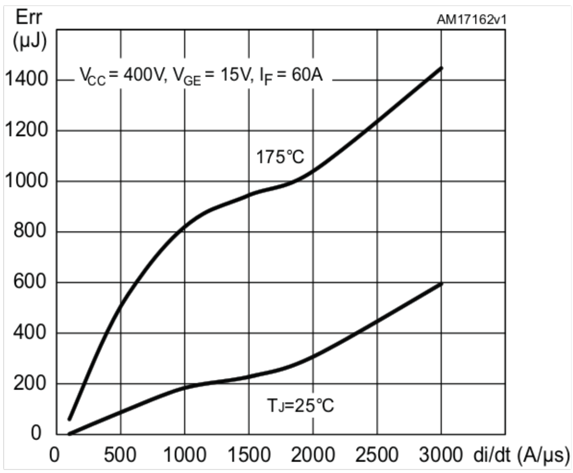


Figure 26. Thermal data for IGBT

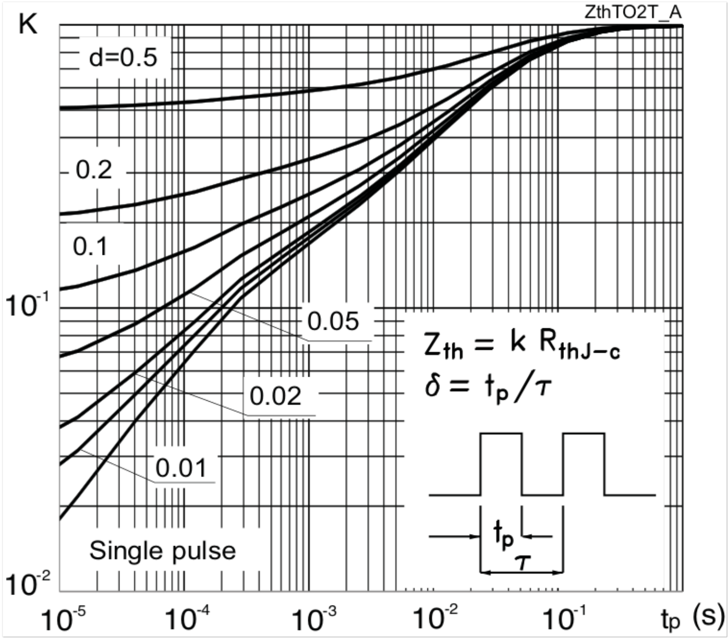
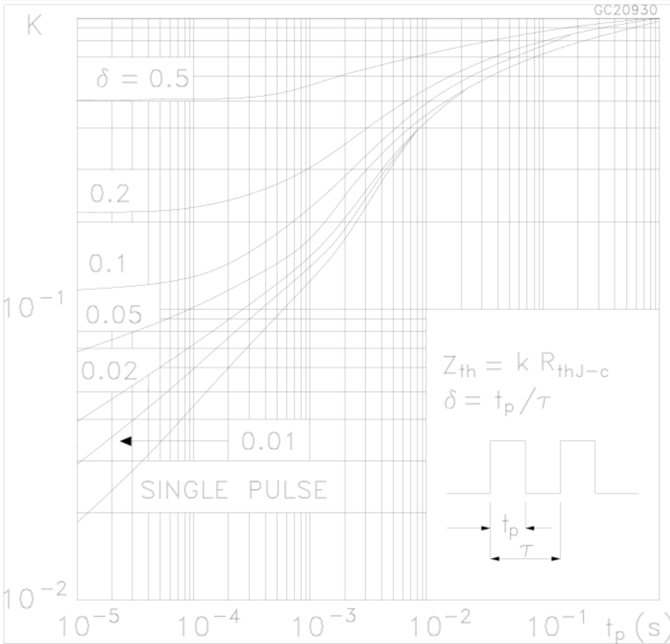


Figure 27. Thermal data for diode



3 Test circuits

Figure 28. Test circuit for inductive load switching

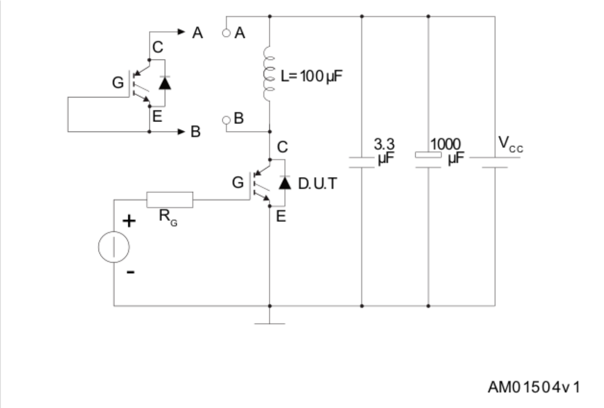


Figure 29. Gate charge test circuit

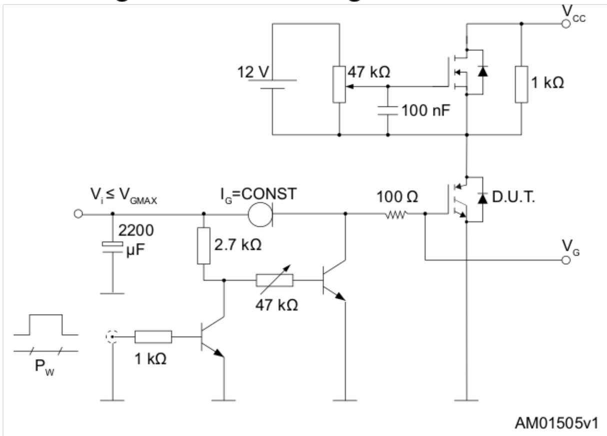


Figure 30. Switching waveform

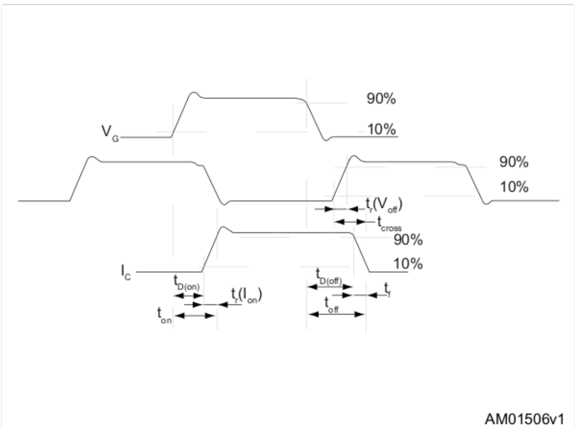
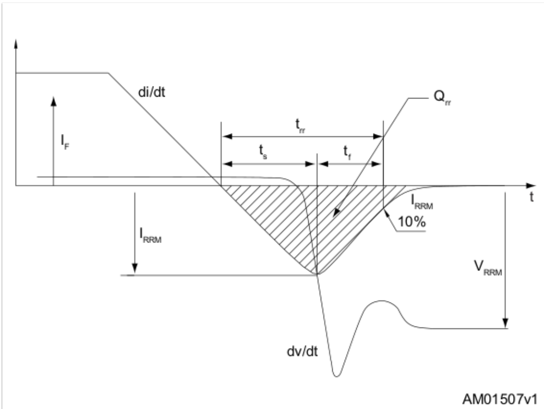


Figure 31. Diode recovery time waveform



4 Package information

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.

4.1 TO-247 package information

Figure 32. TO-247 package outline

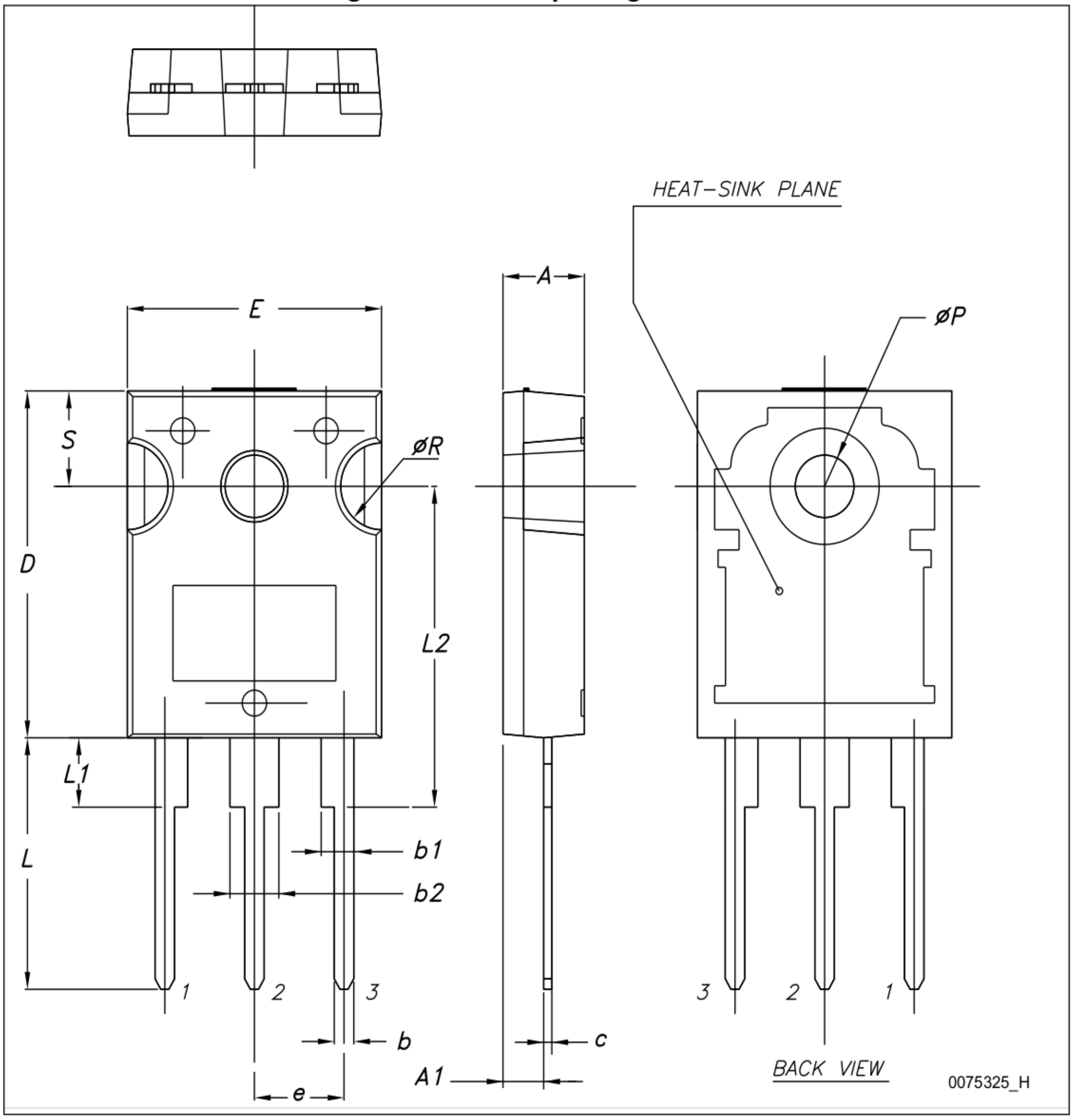


Table 8. TO-247 package mechanical data

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	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

4.2 TO-247 long leads package information

Figure 33. TO-247 long leads package outline

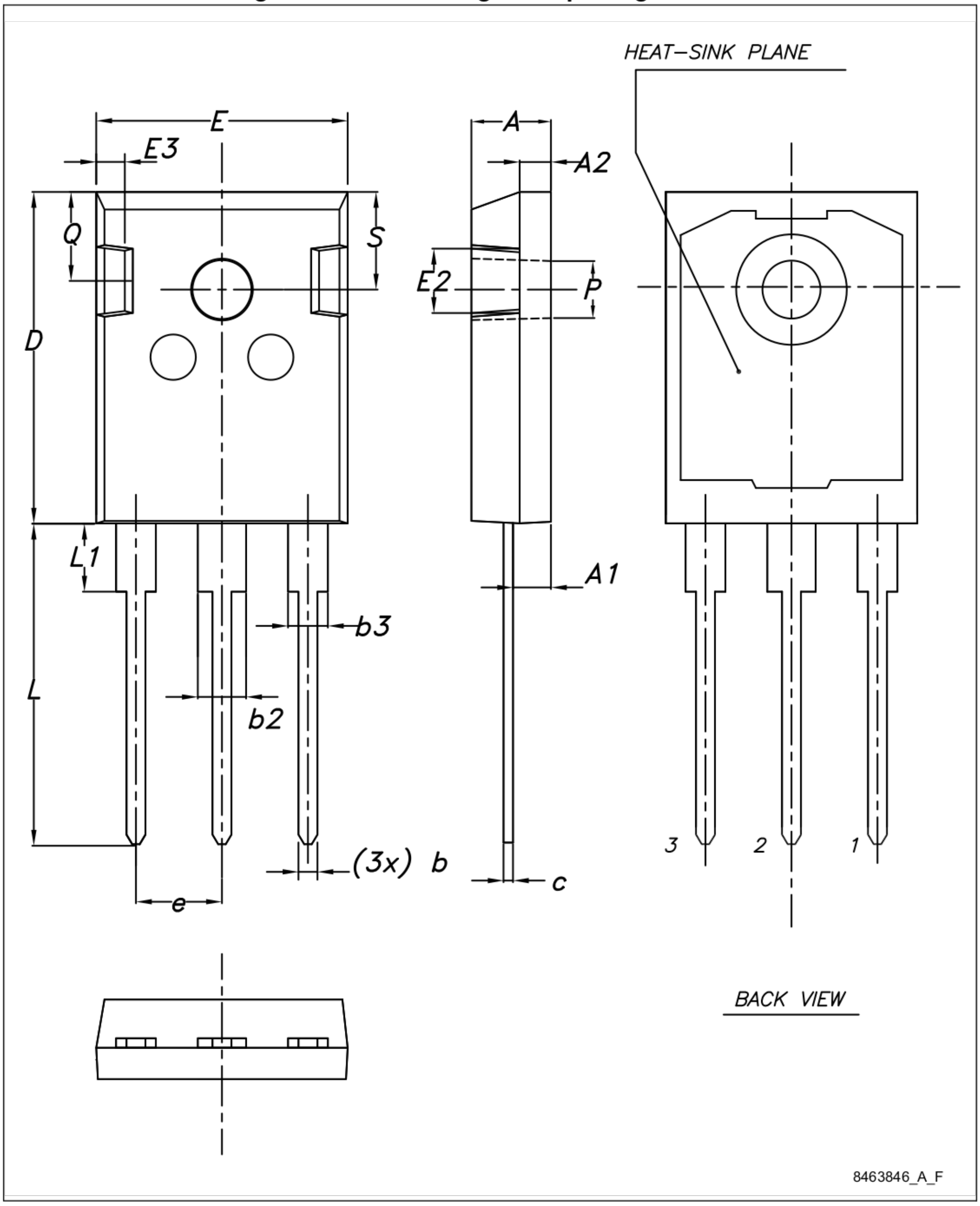


Table 9. TO-247 long leads package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25

4.3 TO-3P package information

Figure 34. TO-3P package outline

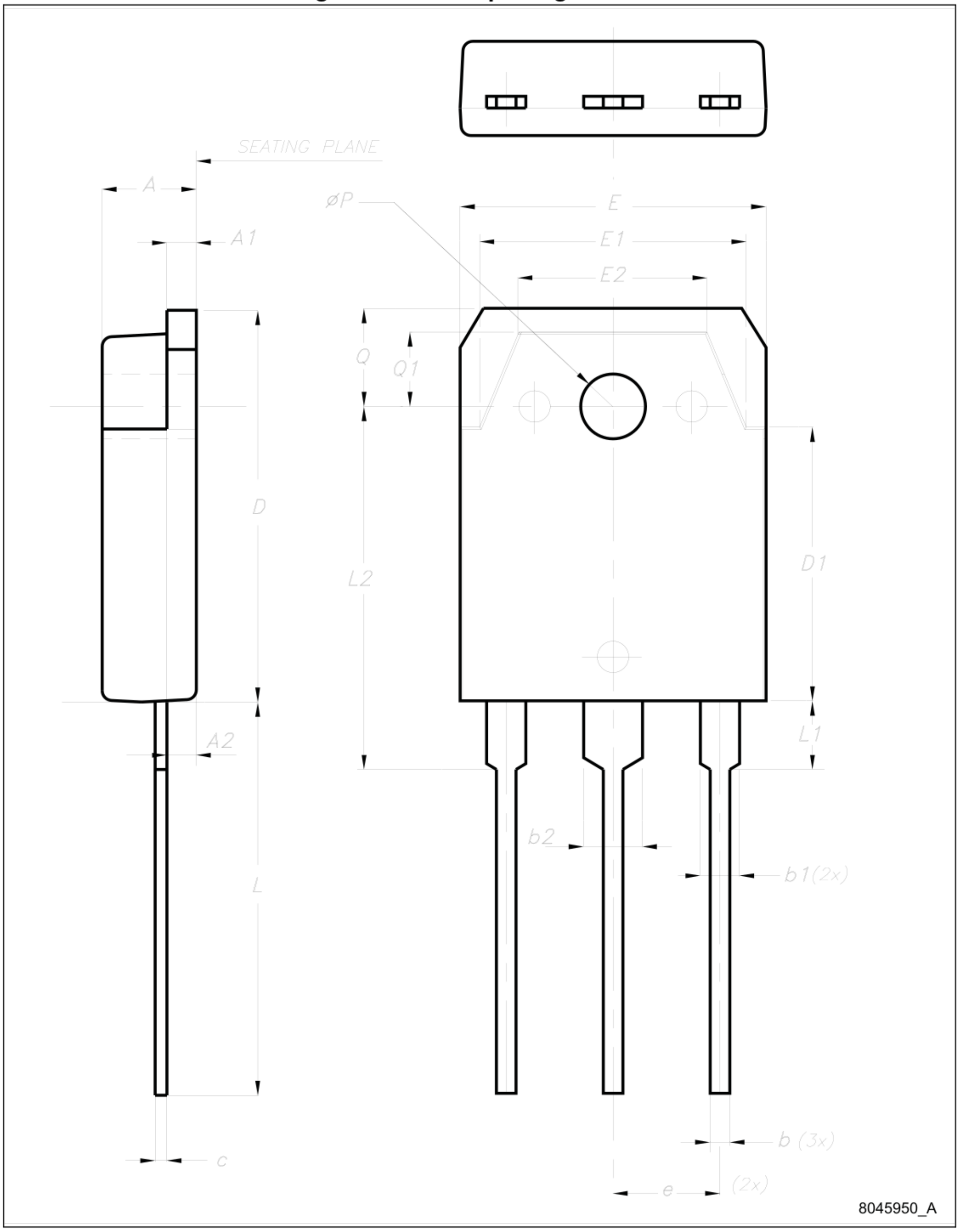


Table 10. TO-3P mechanical data

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	

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
15-Jan-2013	1	Initial release.
23-Apr-2013	2	Added: – New order code STGWT60V60DF and new package mechanical data TO-3P *Table 9 on page 16, Figure 33 on page 15*. – *Section 2.1: Electrical characteristics (curves) on page 6*.
04-Jun-2013	3	Updated *Table 4: Static characteristics* and *Figure 12 on page 7*. Document status changed from preliminary to production data.
21-Jun-2013	4	Updated *Figure 3: Collector current vs. temperature case*.
12-Jul-2013	5	Updated R_{thJC} value for Diode in *Table 3: Thermal data*.
21-Oct-2013	6	Updated title, features and description in cover page.
28-Sep-2016	7	Added part number STGWA60V60DF and *TO-247 long leads package information*. Updated *Table 2 Table 4* and *Table 6*. Updated *Figure 10: Transfer characteristics.* Minor text changes.