STGW60H65DFB, STGWA60H65DFB
STGWT60H65DFB

Trench gate field-stop IGBT, HB series 650 V, 60 A high speed

Datasheet - production data

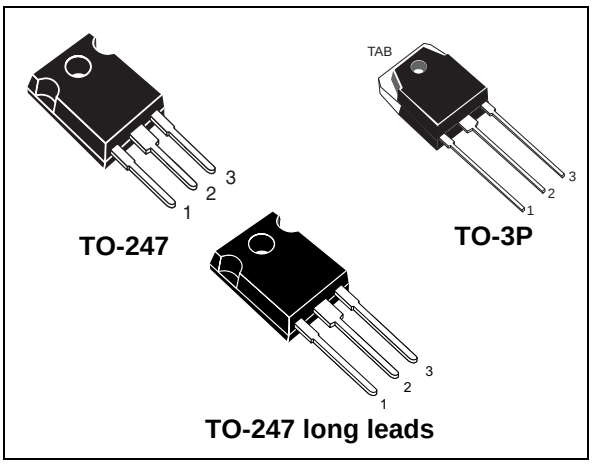
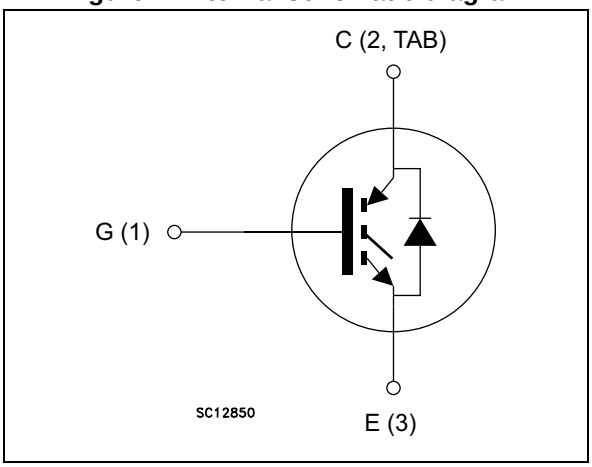


Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: T_J = 175 °C
- High speed switching series
- Minimized tail current
- $V_{CE(sat)}$ = 1.6 V (typ.) @ I_C = 60 A
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode

Applications

- Photovoltaic inverters
- High frequency converters

Description

These are IGBT devices developed using an advanced proprietary trench gate and field-stop structure. The devices are part of the new HB series of IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of any frequency converter. Furthermore, a slightly 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
STGW60H65DFB	GW60H65DFB	TO-247	Tube
STGWA60H65DFB	G60H65DFB	TO-247 long leads	Tube
STGWT60H65DFB	GWT60H65DFB	TO-3P	Tube

This is information on a product in full production. www.st.com

Contents

1 Electrical ratings 3

2 Electrical characteristics 4

2.1 Electrical characteristics (curves) 6

3 Test circuits 11

4 Package information 12

4.1 TO-247 package information 12

4.2 TO-247 long leads package information 14

4.3 TO-3P package information 16

5 Revision history 18

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	650	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
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	- 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	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 60 A		1.60	2	V
		V_{GE} = 15 V, I_C = 60 A T_J = 125 °C		1.75		
		V_{GE} = 15 V, I_C = 60 A T_J = 175 °C		1.85		
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} = 650 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	-	7792	-	pF
C_{oes}	Output capacitance		-	262	-	pF
C_{res}	Reverse transfer capacitance		-	158	-	pF
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 60 A, V_{GE} = 15 V, see *Figure 29*	-	306	-	nC
Q_{ge}	Gate-emitter charge		-	126	-	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 = 10 Ω, V_{GE} = 15 V, see *Figure 28*	-	66		ns
t_r	Current rise time		-	38	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1216		A/µs
$t_{d(off)}$	Turn-off delay time			210		ns
t_f	Current fall time		-	20	-	ns
E_{on}(1)	Turn-on switching losses		-	1590	-	µJ
E_{off}(2)	Turn-off switching losses		-	900	-	µJ
E_{ts}	Total switching losses		-	2490	-	µJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V, T_J = 175 °C, see *Figure 28*	-	59		ns
t_r	Current rise time		-	40	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1230		A/µs
$t_{d(off)}$	Turn-off delay time			242		ns
t_f	Current fall time		-	147	-	ns
E_{on}(1)	Turn-on switching losses		-	2860	-	µJ
E_{off}(2)	Turn-off switching losses		-	1255	-	µJ
E_{ts}	Total switching losses		-	4115	-	µJ

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 A, V_R = 400 V, di/dt = 100A/µs, V_{GE} = 15 V, see *Figure 28*	-	60	-	ns
Q_{rr}	Reverse recovery charge		-	99	-	nC
I_{rrm}	Reverse recovery current		-	3.3	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	187	-	A/µs
E_{rr}	Reverse recovery energy		-	68	-	µJ
t_{rr}	Reverse recovery time	I_F = 60 A, V_R = 400 V, di/dt = 100A/µs, V_{GE} = 15 V, T_J = 175 °C, see *Figure 28*	-	310	-	ns
Q_{rr}	Reverse recovery charge		-	1550	-	nC
I_{rrm}	Reverse recovery current		-	10	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	59	-	A/µs
E_{rr}	Reverse recovery energy		-	674	-	µJ

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics (T_J = 25°C)

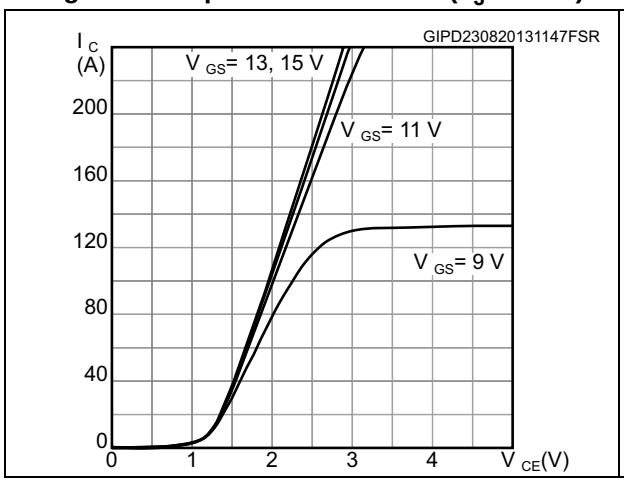


Figure 3. Output characteristics (T_J = 175°C)

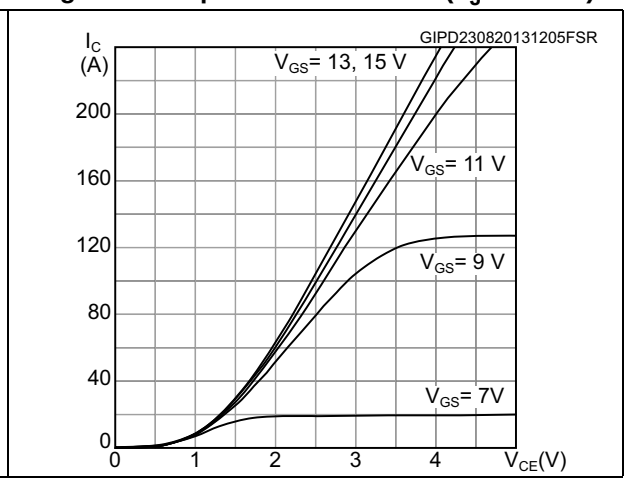


Figure 4. Transfer characteristics

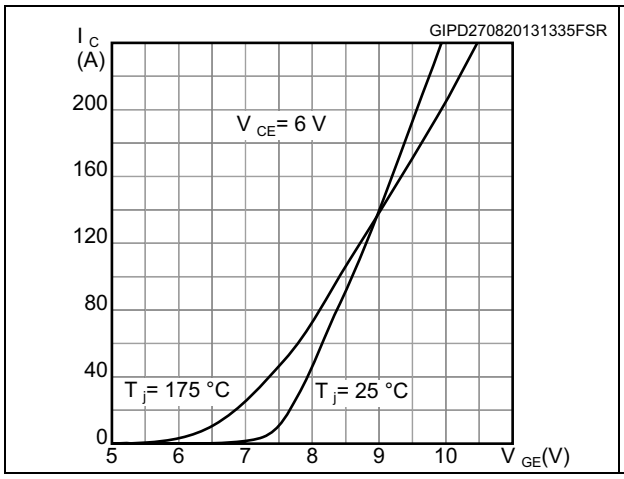


Figure 5. Collector current vs. case temperature

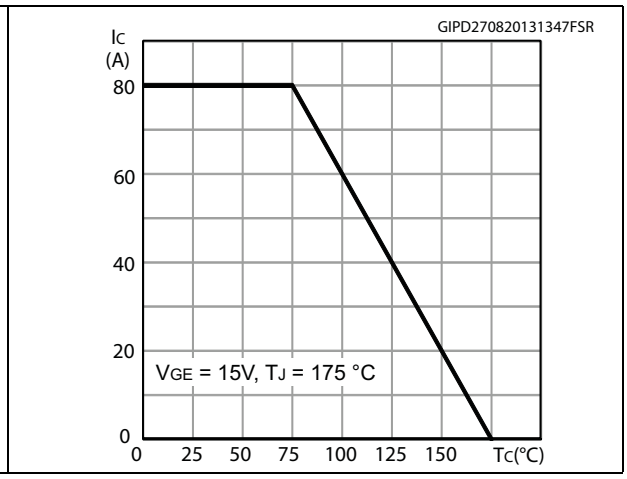


Figure 6. Power dissipation vs. case temperature

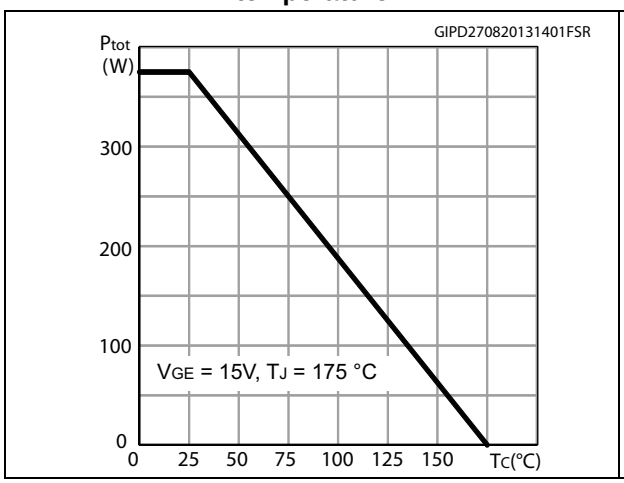


Figure 7. $V_{CE(sat)}$ vs. junction temperature

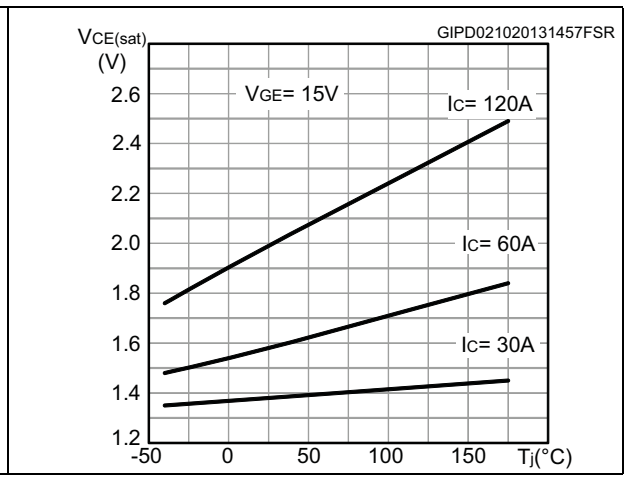


Figure 8. $V_{CE(sat)}$ vs. collector current

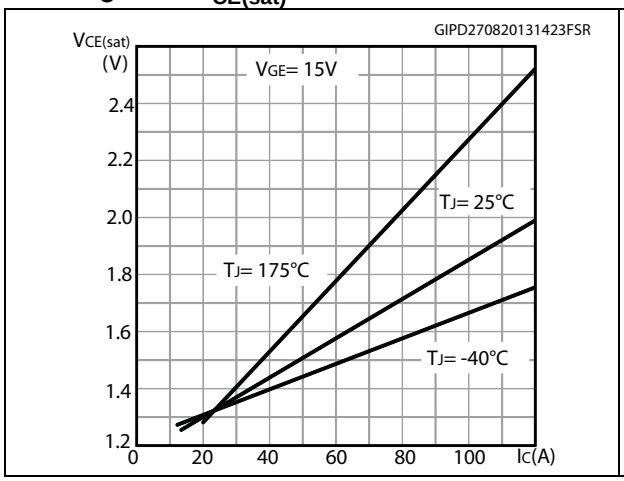


Figure 9. Forward bias safe operating area

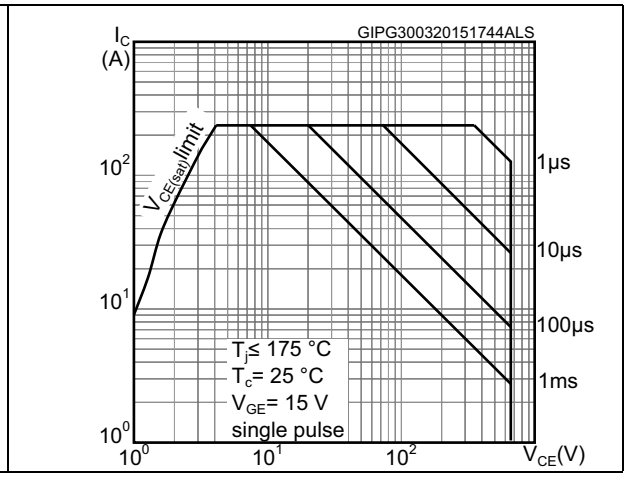


Figure 10. Diode V_F vs. forward current

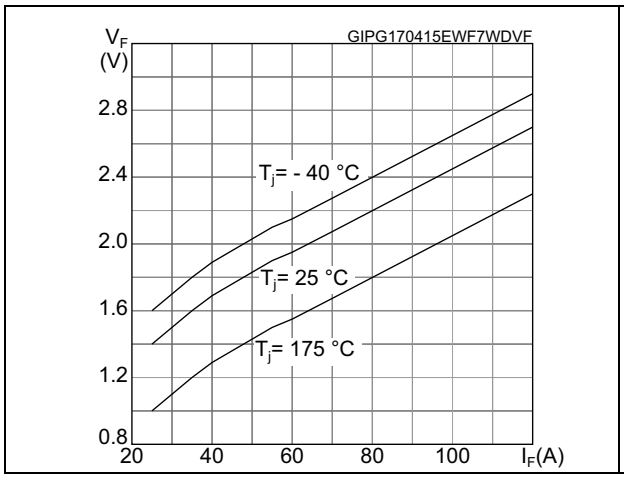


Figure 11. Normalized $V_{(BR)CES}$ vs. junction temperature

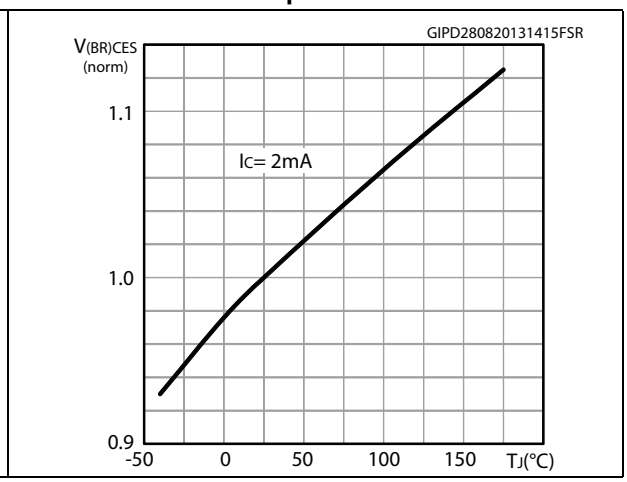


Figure 12. Normalized $V_{GE(th)}$ vs. junction temperature

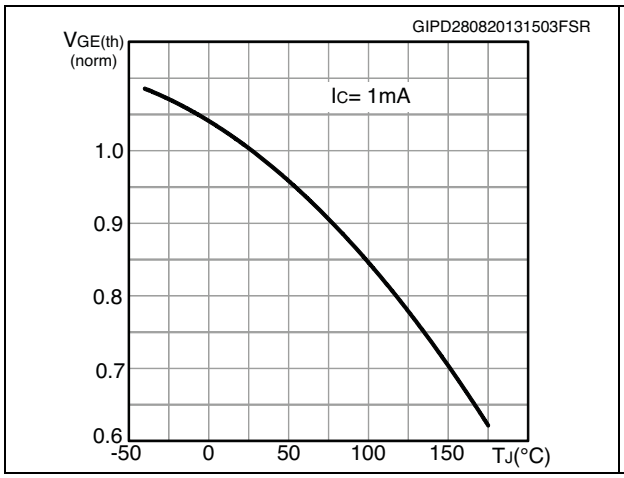


Figure 13. Gate charge vs. gate-emitter voltage

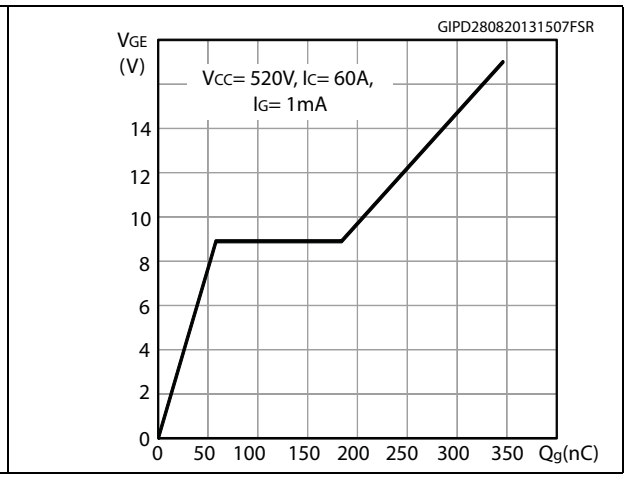


Figure 14. Switching losses vs temperature

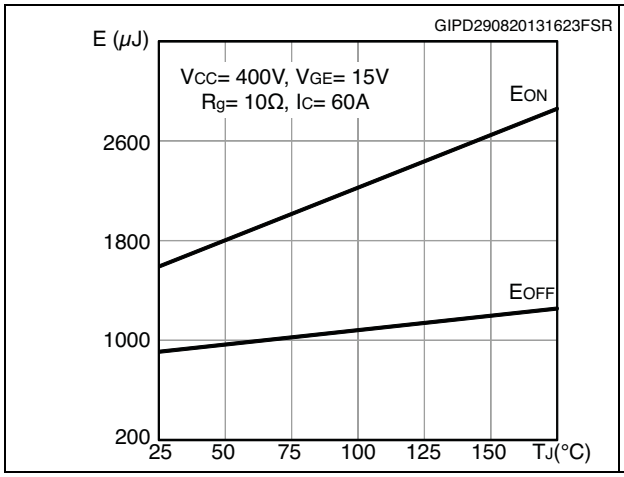


Figure 15. Switching losses vs gate resistance

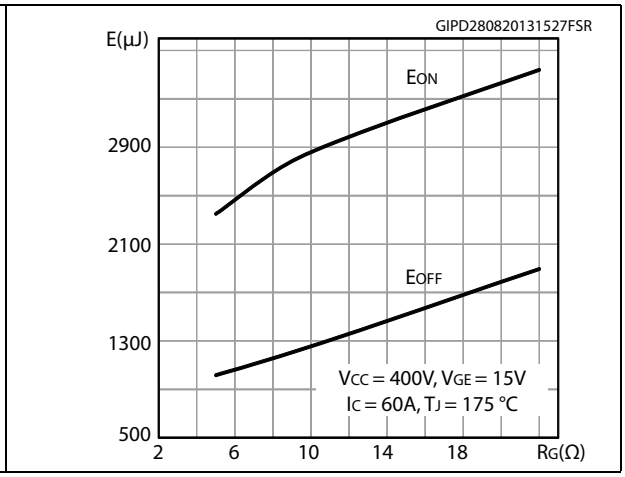


Figure 16. Switching losses vs collector current

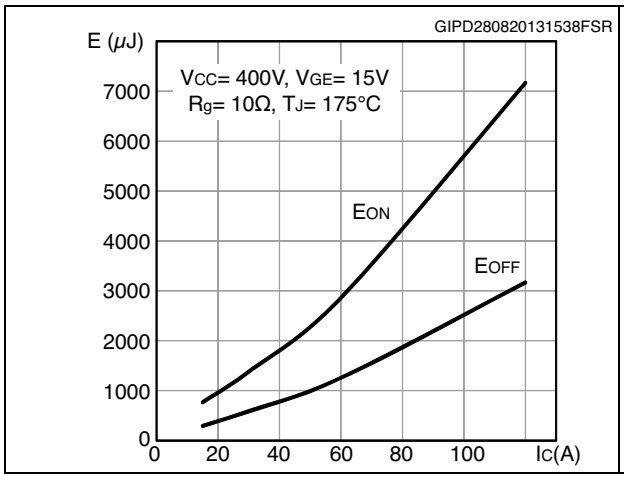


Figure 17. Switching losses vs collector emitter voltage

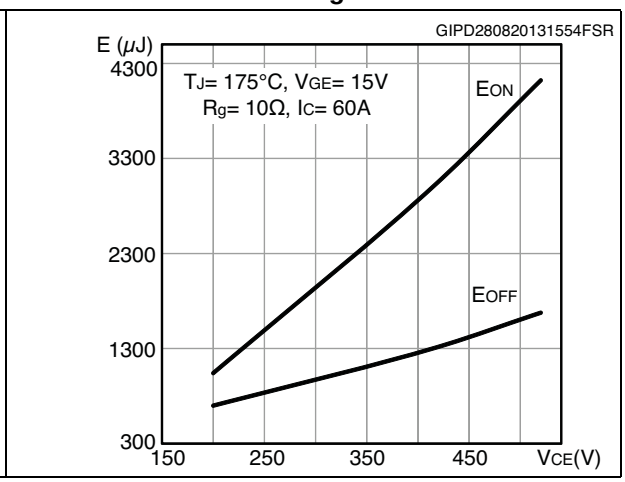


Figure 18. Switching times vs collector current

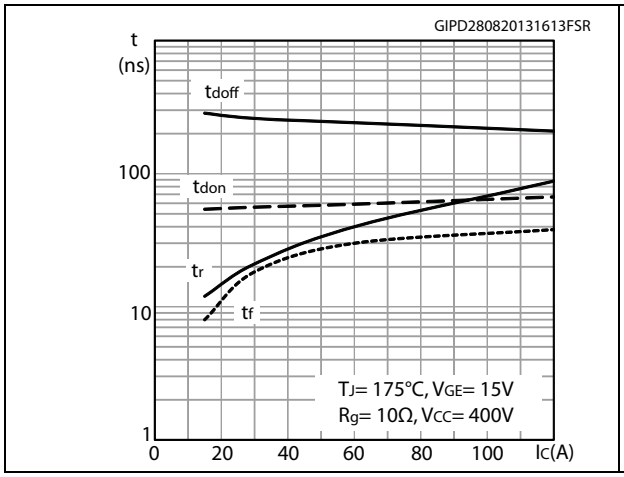


Figure 19. Switching times vs gate resistance

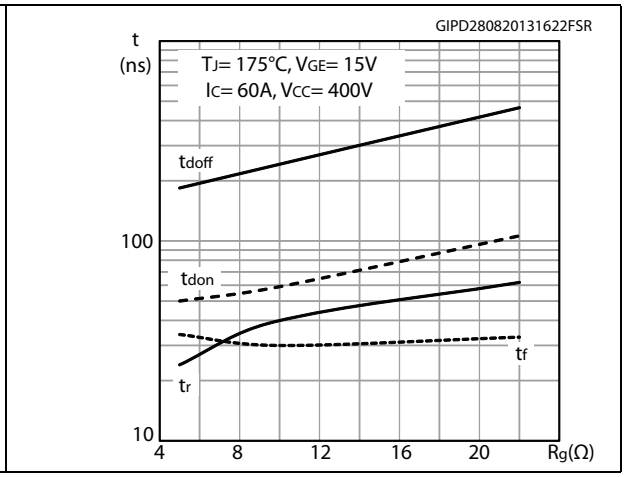


Figure 20. Reverse recovery current vs. diode current slope

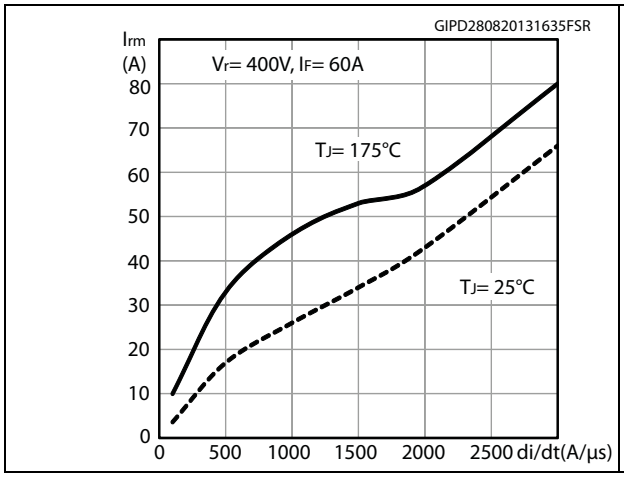


Figure 21. Reverse recovery time vs. diode current slope

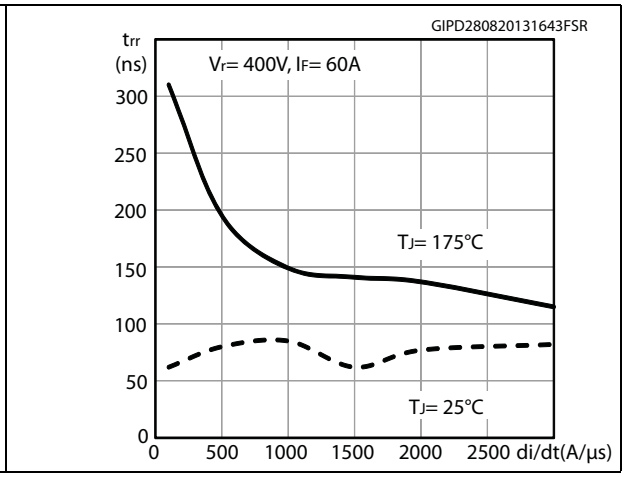


Figure 22. Reverse recovery charge vs. diode current slope

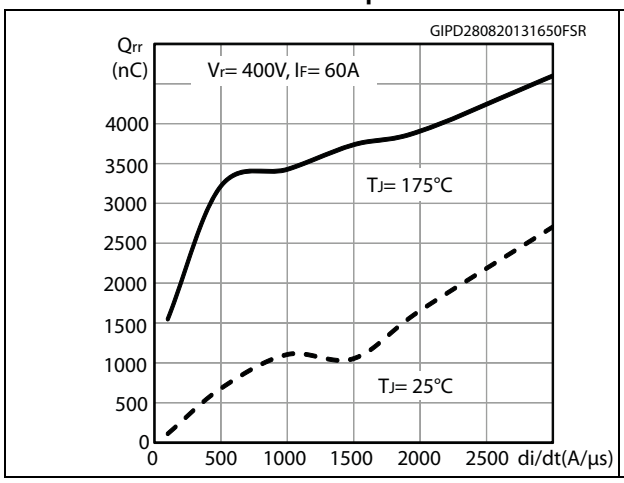


Figure 23. Reverse recovery energy vs. diode current slope

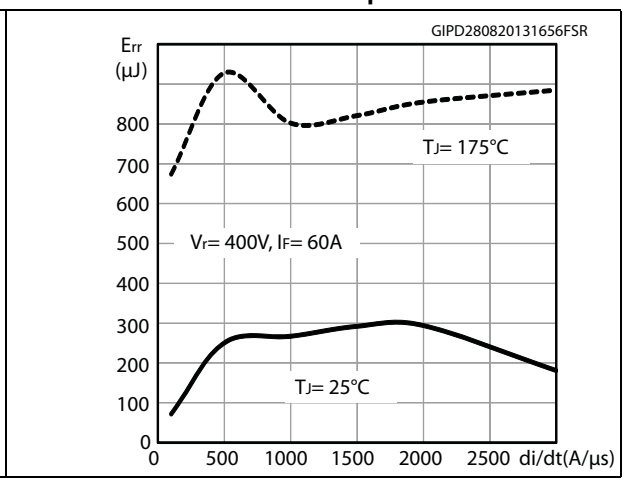


Figure 24. Capacitance variations

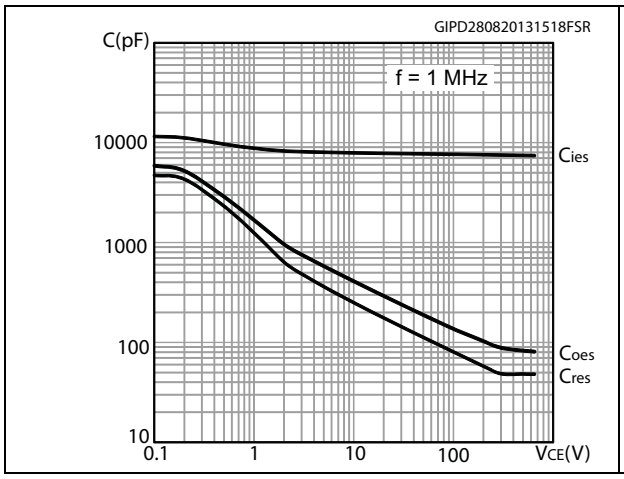


Figure 25. Collector current vs. switching frequency

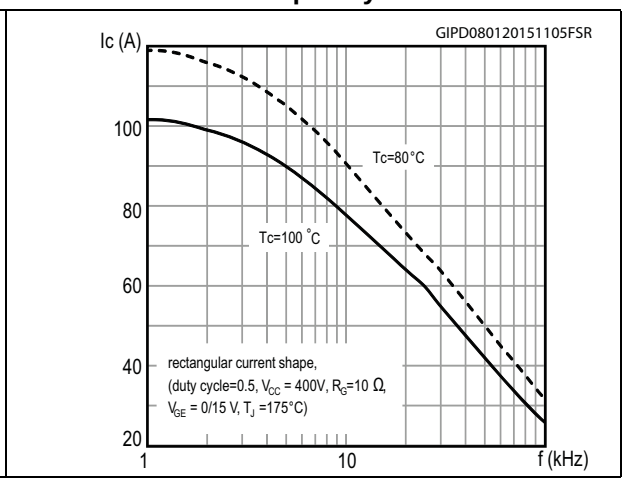


Figure 26. Thermal impedance for IGBT

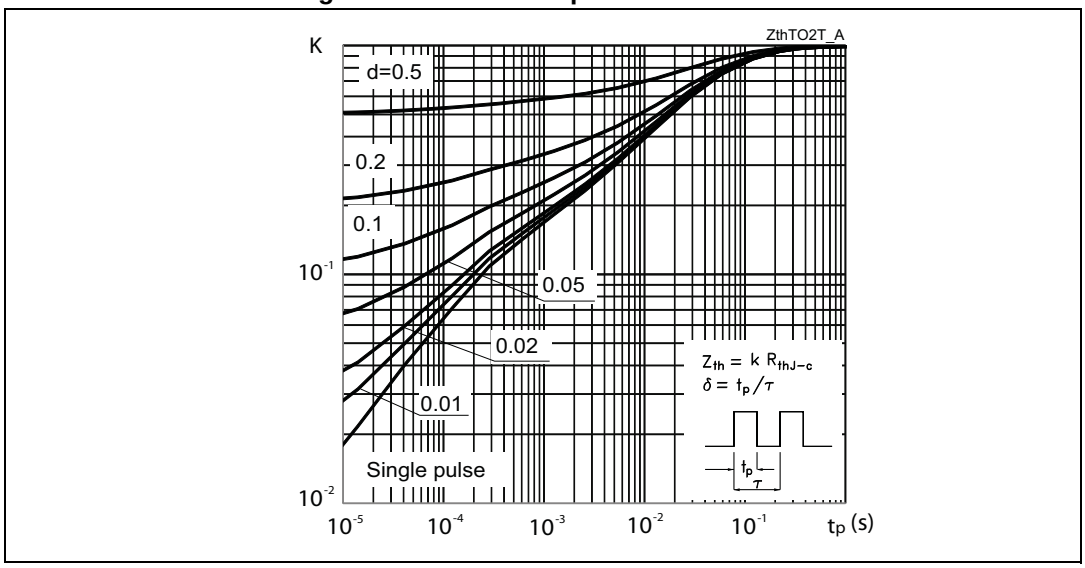
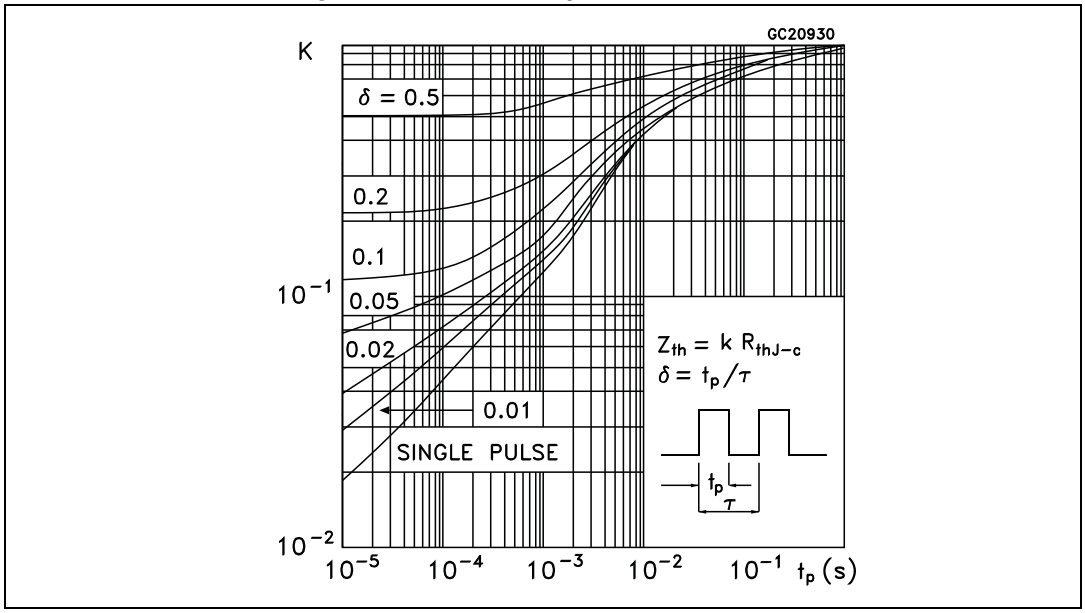


Figure 27. Thermal impedance for diode



3 Test circuits

Figure 28. Test circuit for inductive load switching

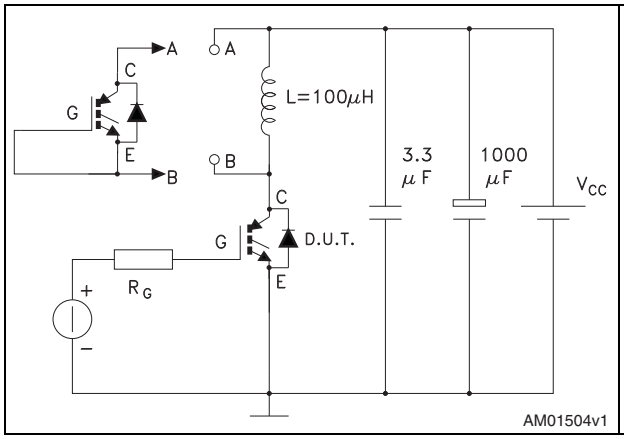


Figure 29. Gate charge test circuit

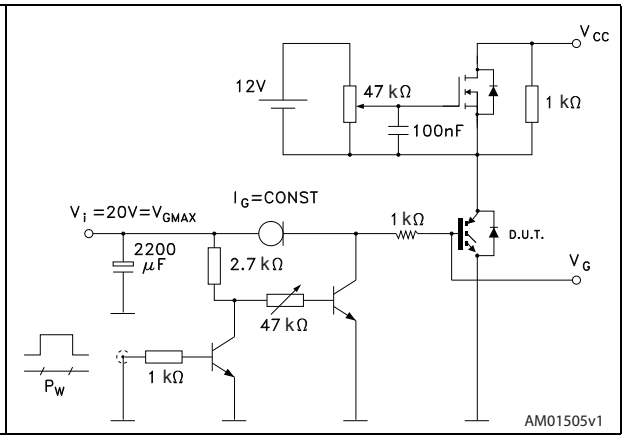


Figure 30. Switching waveform

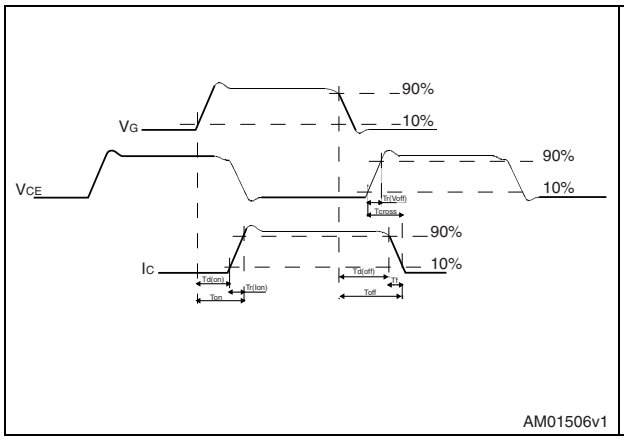
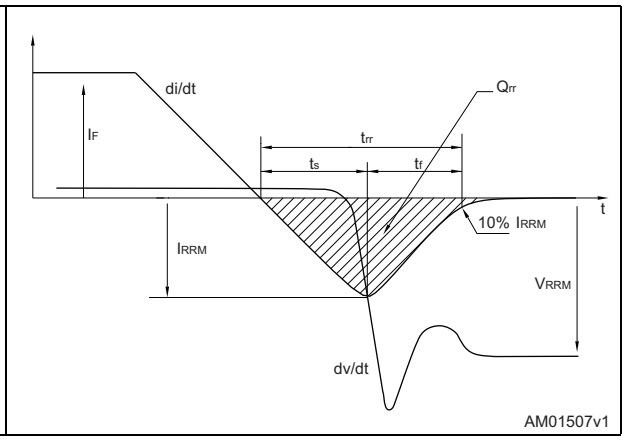


Figure 31. Diode reverse recovery waveform



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

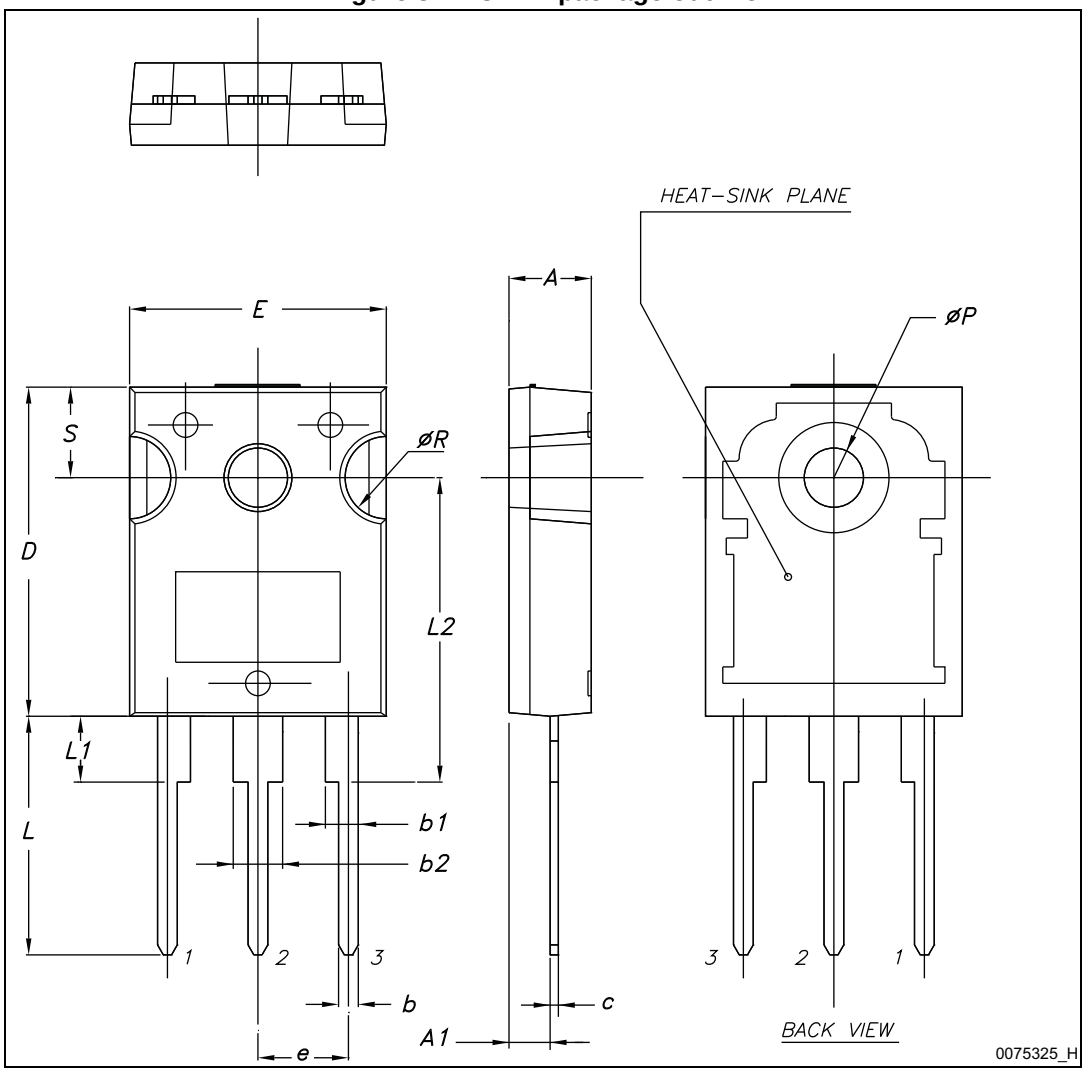


Table 8. TO-247 mechanical data

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

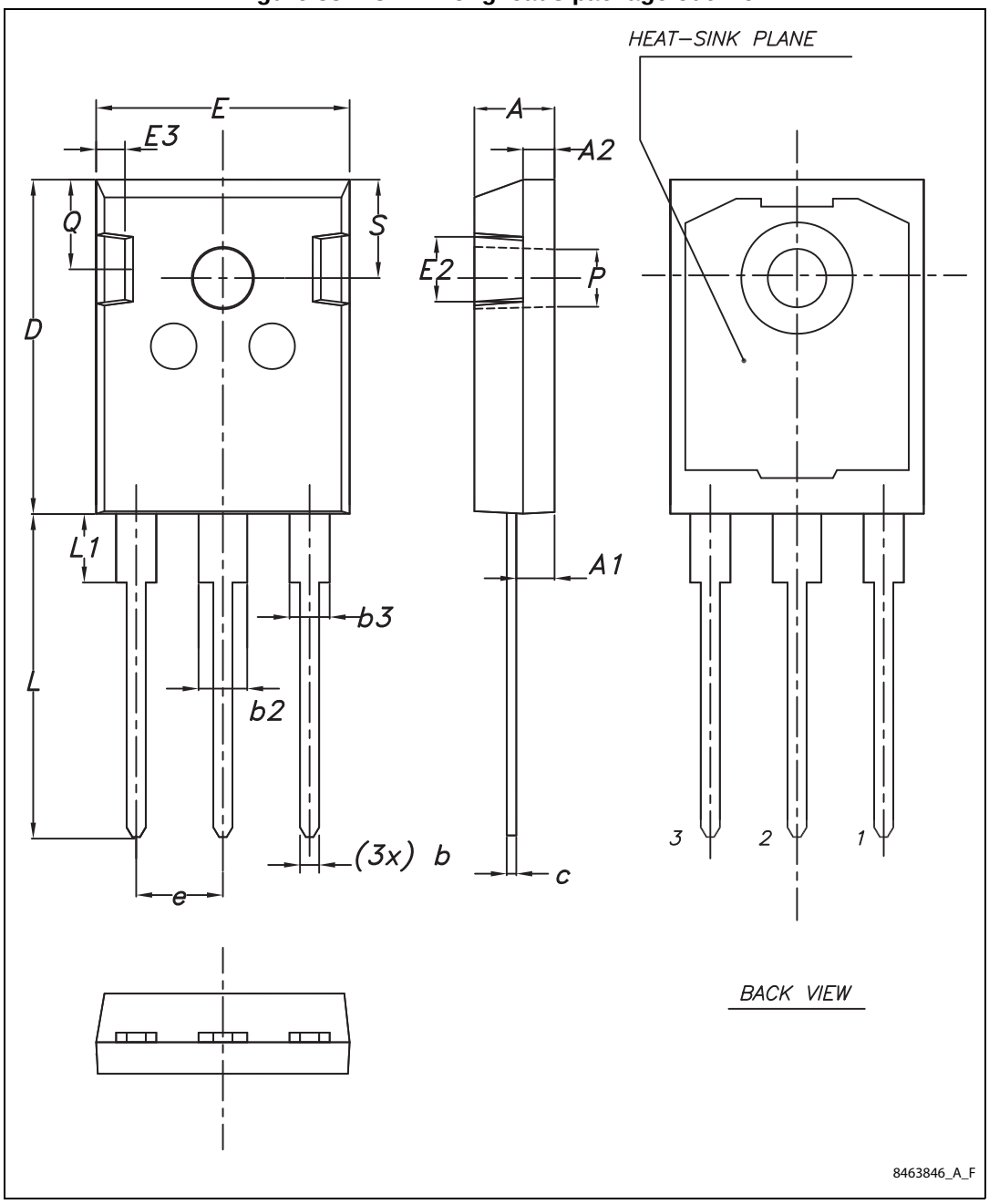


Table 9. TO-247 long leads mechanical data

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

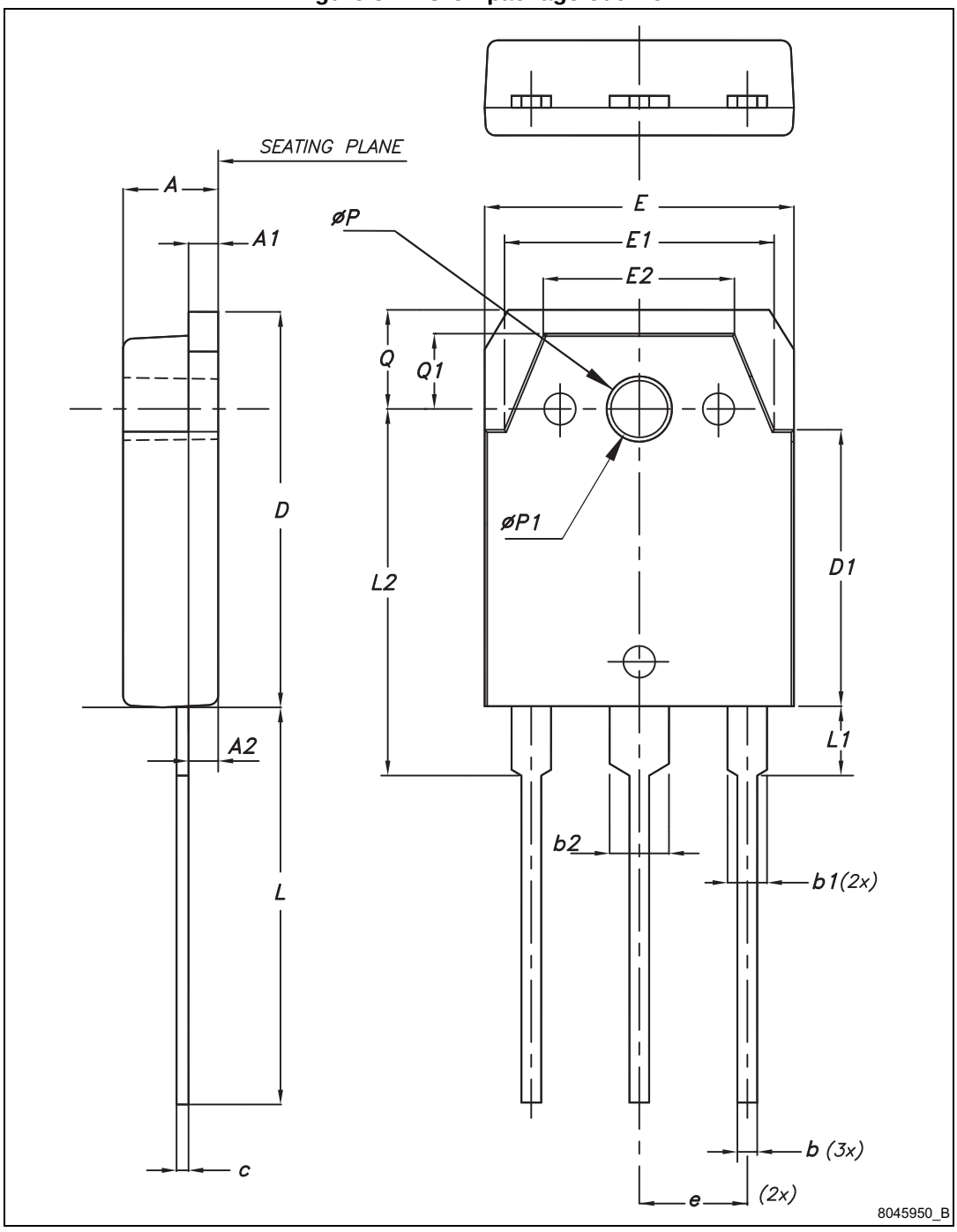


Table 10. TO-3P mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.80	5
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1.00	1.20
b1	1.80	2.00	2.20
b2	2.80	3.00	3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1	13.70	13.90	14.10
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	9.40	9.60	9.90
e	5.15	5.45	5.75
L	19.80	20	20.20
L1	3.30	3.50	3.70
L2	18.20	18.40	18.60
øP	3.30	3.40	3.50
øP1	3.10	3.20	3.30
Q	4.80	5	5.20
Q1	3.60	3.80	4

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
12-Mar-2013	1	Initial release.
30-Aug-2013	2	Document status promoted from preliminary to production data. Added *Section 2.1: Electrical characteristics (curves)*.
31-Oct-2013	3	Updated $V_{CE(sat)}$ in *Table 4: Static characteristics*.
24-Feb-2014	4	Updated title and description in cover page.
09-Jan-2015	5	Updated features in cover page, *Table 2: Absolute maximum ratings*, and *Table 6: IGBT switching characteristics (inductive load)*. Updated *Figure 5: Collector current vs. case temperature*, *Figure 6: Power dissipation vs. case temperature*, *Figure 8: $V_{CE(sat)}$ vs. collector current*, *Figure 18: Switching times vs collector current*, *Figure 19: Switching times vs gate resistance* and *Figure 20: Reverse recovery current vs. diode current slope*. Added *Figure 25: Collector current vs. switching frequency*. Updated *Section 4: Package information*. Minor text changes.
23-Mar-2015	6	Text edits throughout document. In document, added new order code STGWA60H65DFB in TO-247 long leads package, with accompanying information and data. In *Section 2.1: Electrical characteristics (curves)*: - updated *Figure 2*, *Figure 3*, *Figure 4*, *Figure 7*, *Figure 9*
17-Apr-2015	7	Text edits throughout document. In *Section 2: Electrical characteristics*: - updated *Table 4: Static characteristics* - updated *Table 6: IGBT switching characteristics (inductive load)* In *Section 2.1: Electrical characteristics (curves)*: - updated *Figure 3* and *Figure 9*

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