

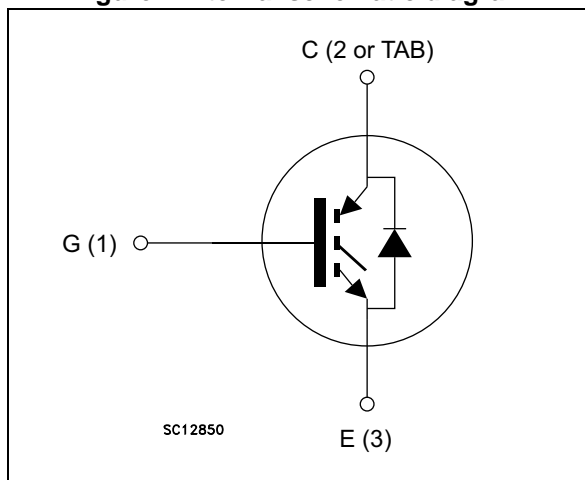
### Features

- 10  $\mu$ s of short-circuit withstand time
- $V_{CE(sat)} = 1.85$  V (typ.) @  $I_C = 40$  A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and fast recovery antiparallel diode

### Applications

- Industrial drives
- UPS
- Solar
- Welding

Figure 1. Internal schematic diagram



### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series of IGBTs, which represent an optimum compromise in performance to maximize the efficiency of inverter systems where low-loss and short circuit capability are essential. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW40M120DF3	G40M120DF3	TO-247	Tube
STGWA40M120DF3	G40M120DF3	TO-247 long leads	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	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	$\pm 20$	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 $T_C = 25\text{ °C}$	468	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature	- 55 to 175	°C

1. Pulse width limited by maximum junction temperature.

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.32	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	0.74	°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 ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$		1.85	2.3	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 125\text{ °C}$		2.2		
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175\text{ °C}$		2.3		
$V_F$	Forward on-voltage	$I_F = 40\text{ A}$		2.85	3.95	V
		$I_F = 40\text{ A}, T_J = 125\text{ °C}$		2.25		V
		$I_F = 40\text{ A}, T_J = 175\text{ °C}$		2.1		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$			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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0$	-	2500	-	pF
$C_{oes}$	Output capacitance		-	275	-	pF
$C_{res}$	Reverse transfer capacitance		-	95	-	pF
$Q_g$	Total gate charge	$V_{CC} = 960\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V},$ see <a href="#">Figure 30</a>	-	125	-	nC
$Q_{ge}$	Gate-emitter charge		-	15	-	nC
$Q_{gc}$	Gate-collector charge		-	75	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ see <a href="#">Figure 29</a>	-	35	-	ns
$t_r$	Current rise time		-	15	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2100	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	140	-	ns
$t_f$	Current fall time		-	135	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	1.5	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	2.25	-	mJ
$E_{ts}$	Total switching losses	-	3.75	-	mJ	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 29</a>	-	35	-	ns
$t_r$	Current rise time		-	18	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1800	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	150	-	ns
$t_f$	Current fall time		-	240	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	2.8	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	3.45	-	mJ
$E_{ts}$	Total switching losses	-	6.25	-	mJ	
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_{Jstart} = 150\text{ }^\circ\text{C}$	10		-	$\mu$ s

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	$I_F = 40\text{ A}$ , $V_R = 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 29</a> $di/dt = 1000\text{ A}/\mu\text{s}$	-	355	-	ns
$Q_{rr}$	Reverse recovery charge		-	2575	-	nC
$I_{rrm}$	Reverse recovery current		-	25	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	1110	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	1.12	-	mJ
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 29</a> $di/dt = 1000\text{ A}/\mu\text{s}$	-	667	-	ns
$Q_{rr}$	Reverse recovery charge		-	8500	-	nC
$I_{rrm}$	Reverse recovery current		-	37	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	450	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	3.9	-	mJ

## 2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

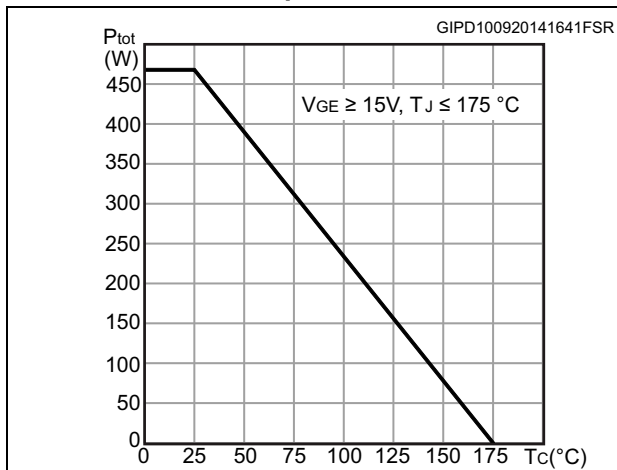


Figure 3. Collector current vs. case temperature

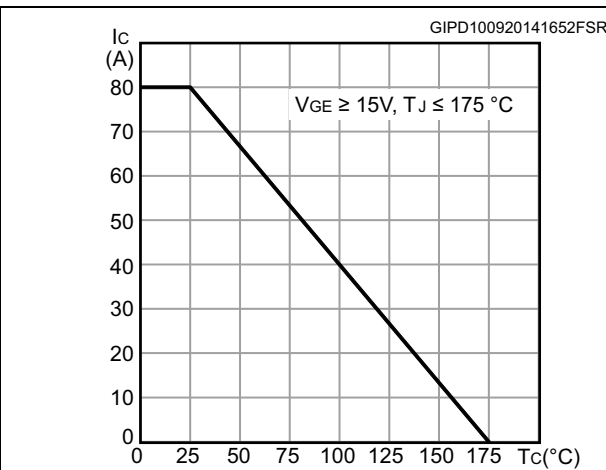


Figure 4. Output characteristics (T<sub>J</sub> = 25°C)

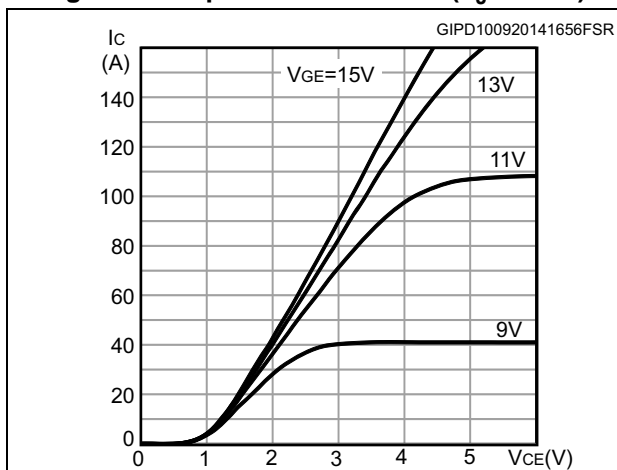


Figure 5. Output characteristics (T<sub>J</sub> = 175°C)

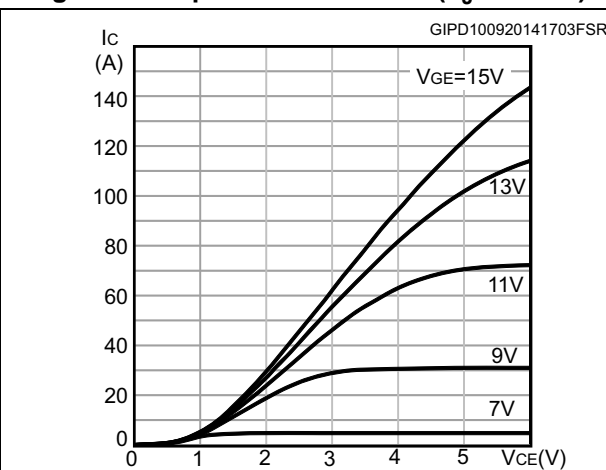


Figure 6. V<sub>CE(sat)</sub> vs. junction temperature

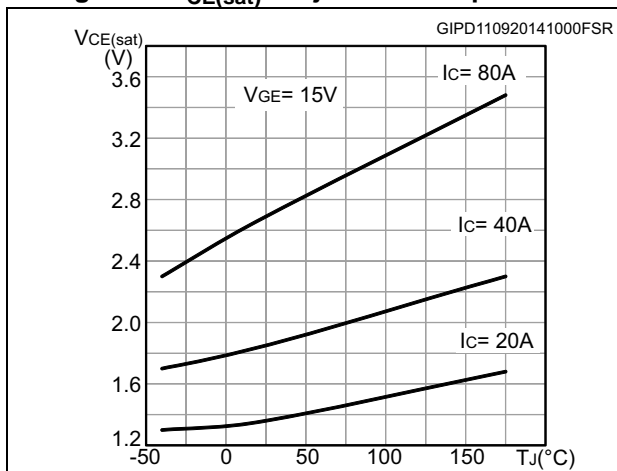


Figure 7. V<sub>CE(sat)</sub> vs. collector current

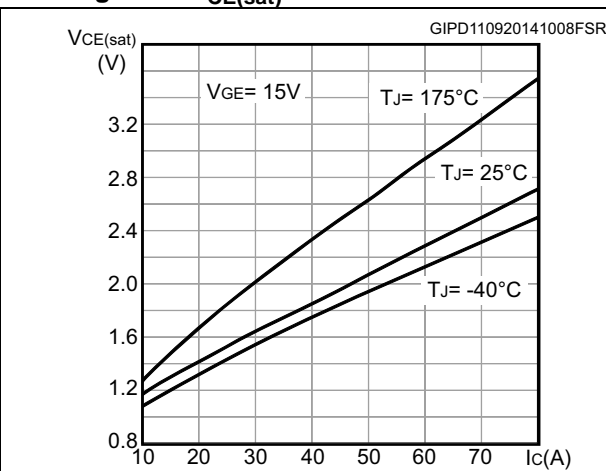


Figure 8. Collector current vs. switching frequency

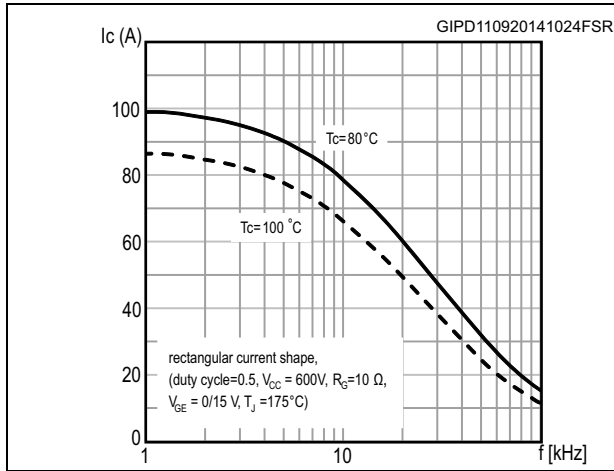


Figure 9. Forward bias safe operating area

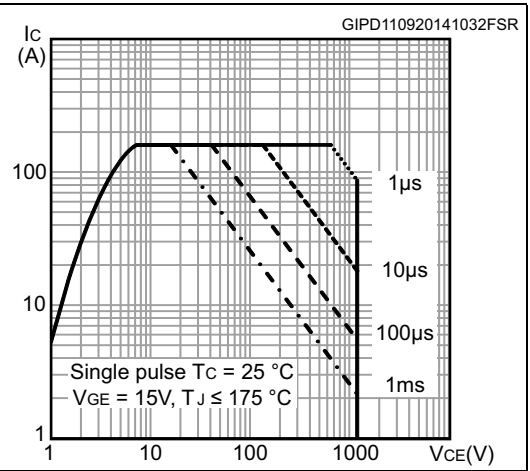


Figure 10. Transfer characteristics

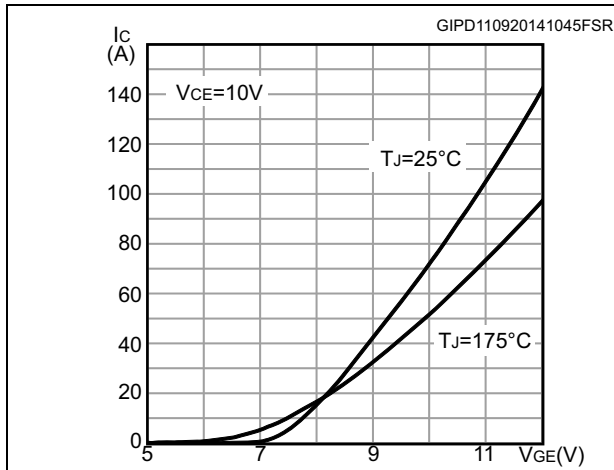


Figure 11. Diode VF vs. forward current

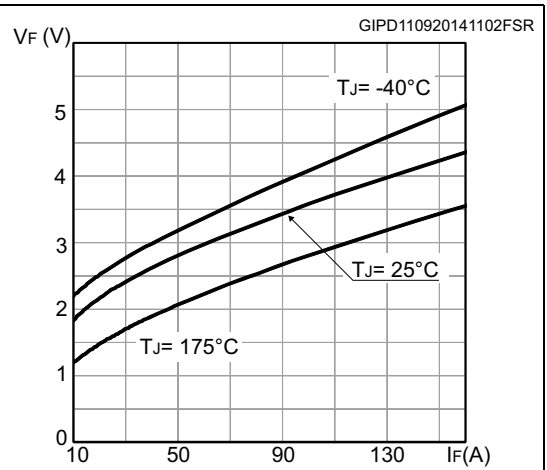


Figure 12. Normalized  $V_{GE(th)}$  vs junction temperature

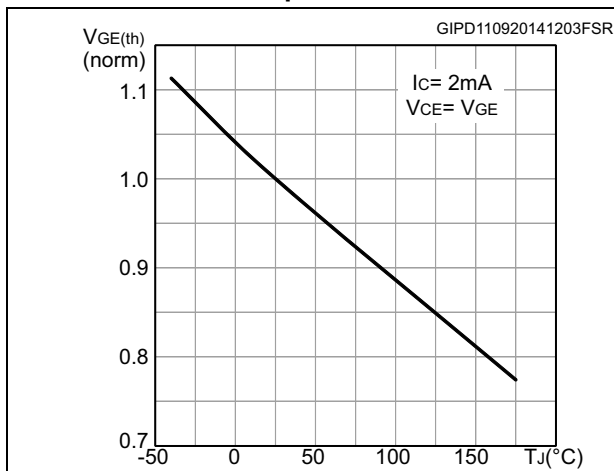


Figure 13. Normalized  $V_{(BR)CES}$  vs. junction temperature

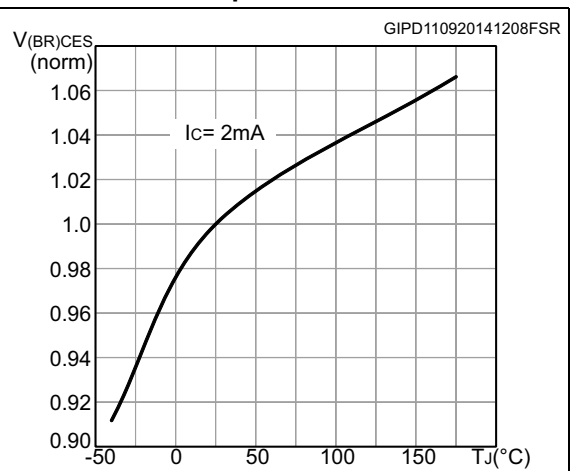


Figure 14. Capacitance variation

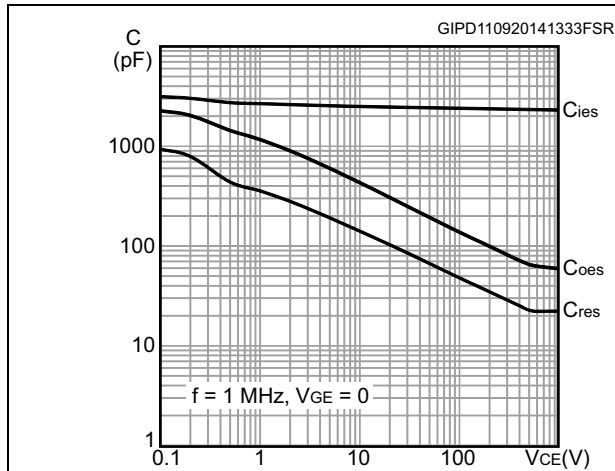


Figure 15. Gate charge vs. gate-emitter voltage

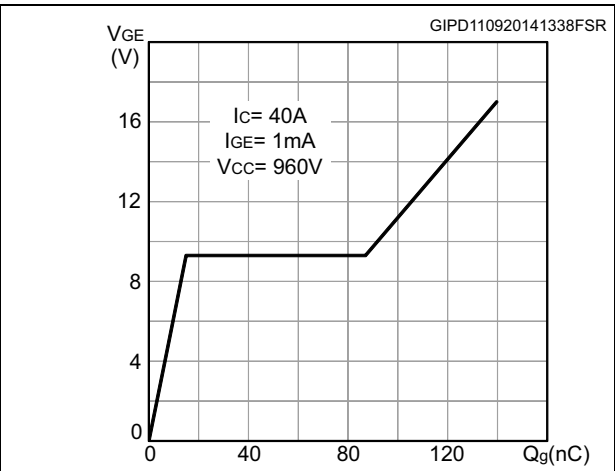


Figure 16. Switching loss vs collector current

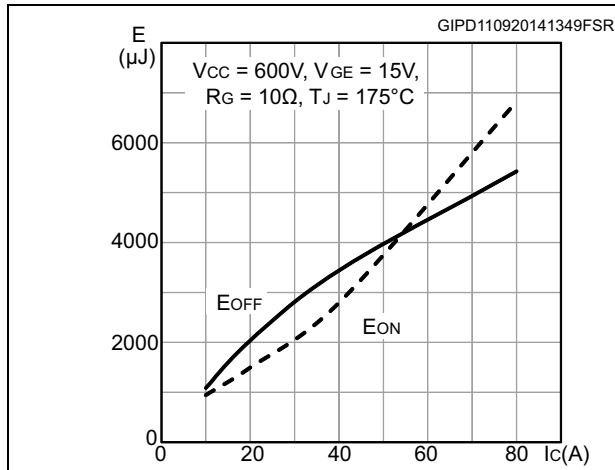


Figure 17. Switching loss vs gate resistance

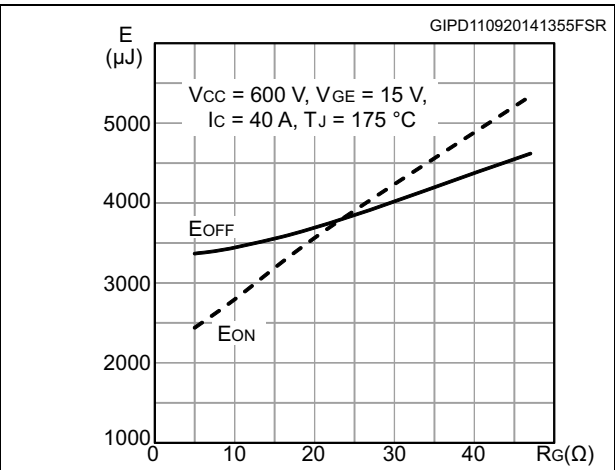


Figure 18. Switching loss vs temperature

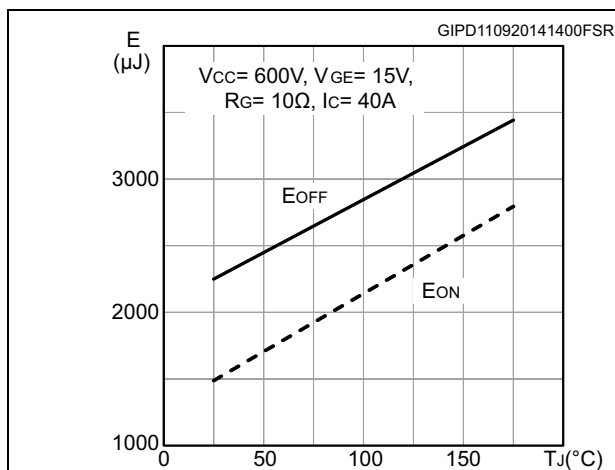


Figure 19. Switching loss vs collector-emitter voltage

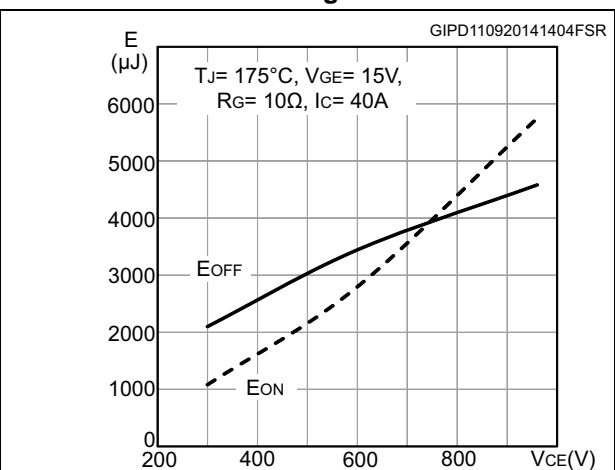




Figure 20. Short circuit time and current vs  $V_{GE}$  Figure 21. Switching times vs collector current

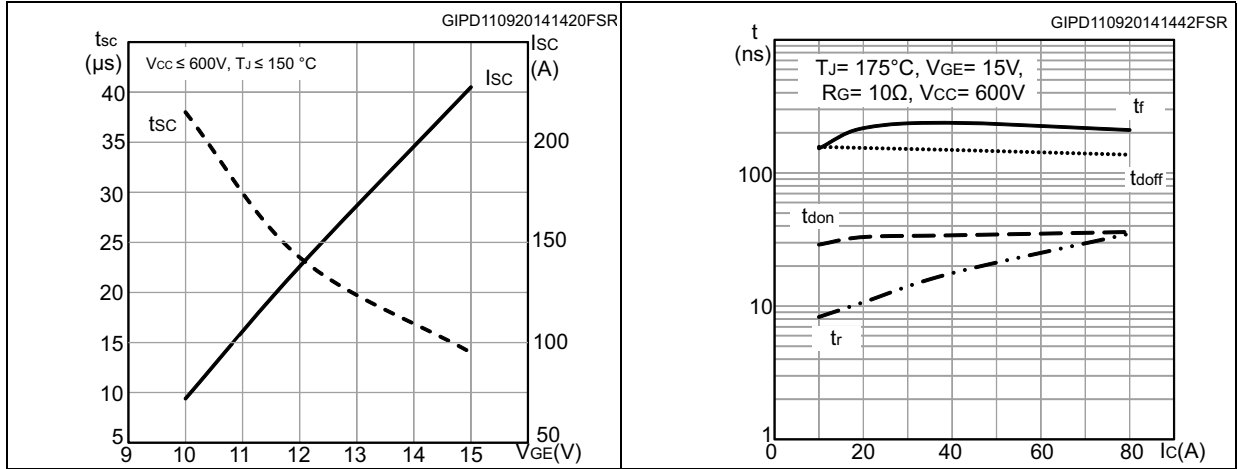


Figure 22. Switching times vs. gate resistance Figure 23. Reverse recovery current vs. diode current slope

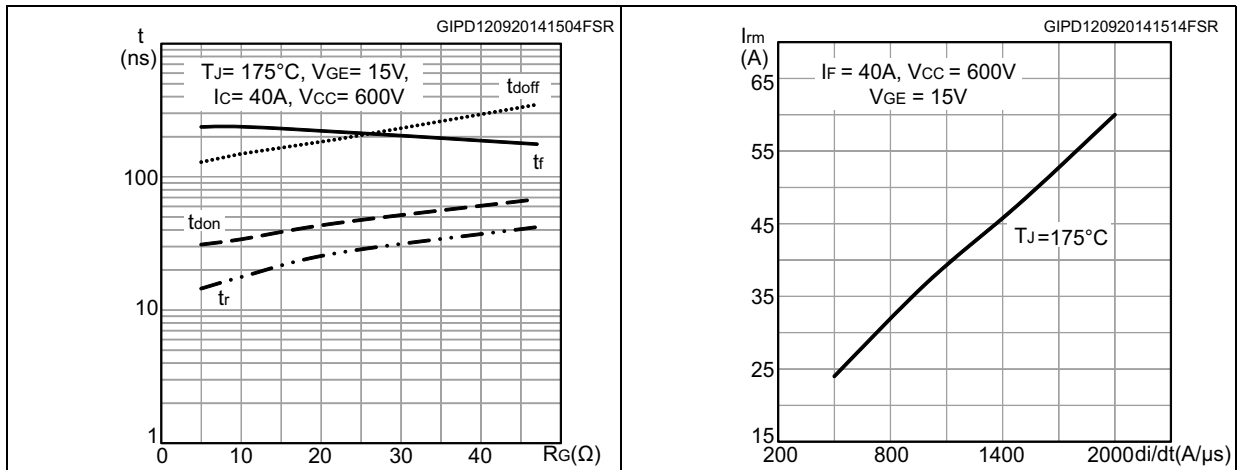


Figure 24. Reverse recovery time vs. diode current slope Figure 25. Reverse recovery charge vs. diode current slope

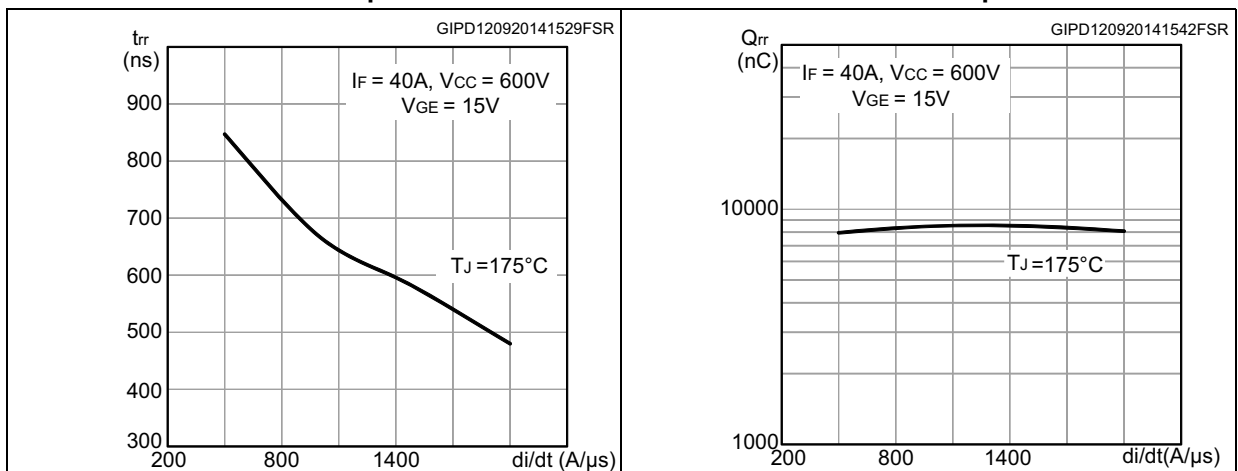


Figure 26. Reverse recovery energy vs. diode current slope

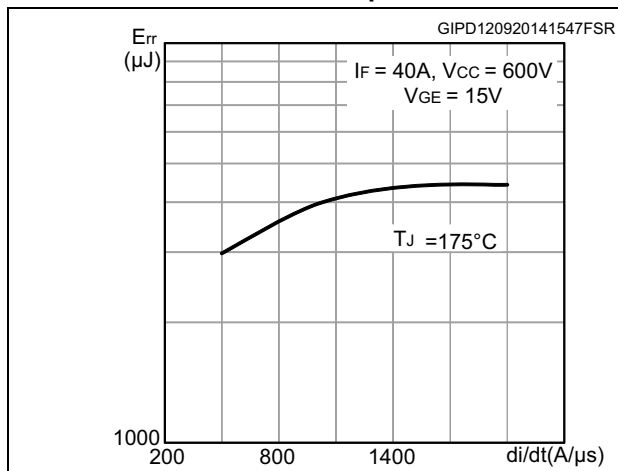


Figure 27. Thermal data for IGBT

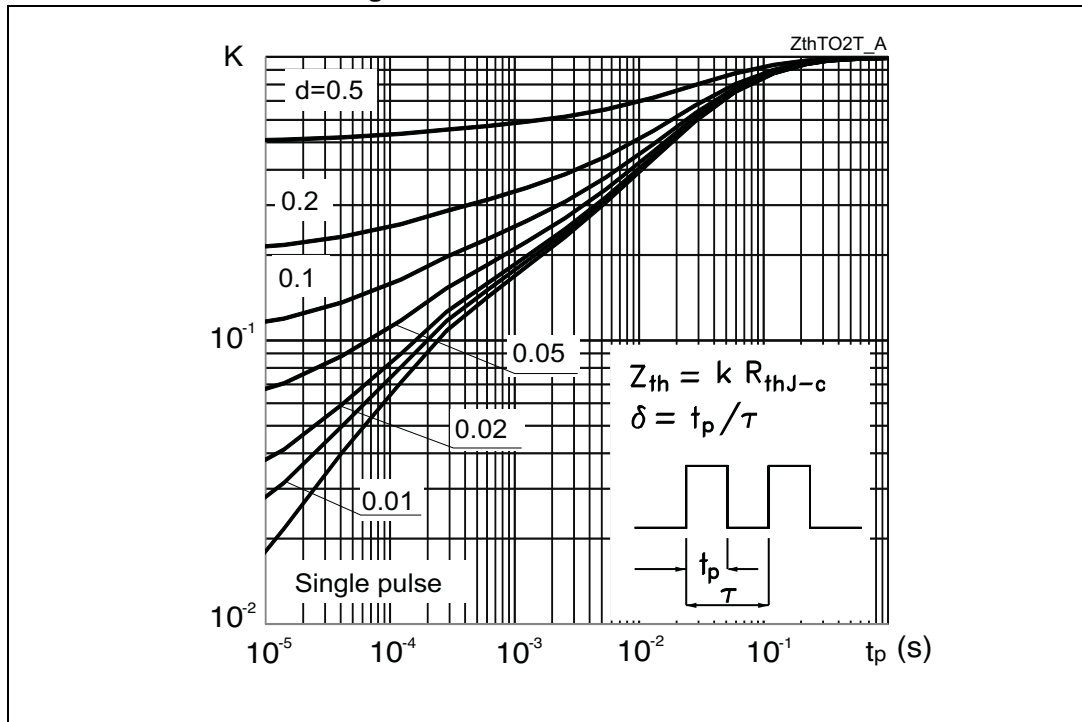
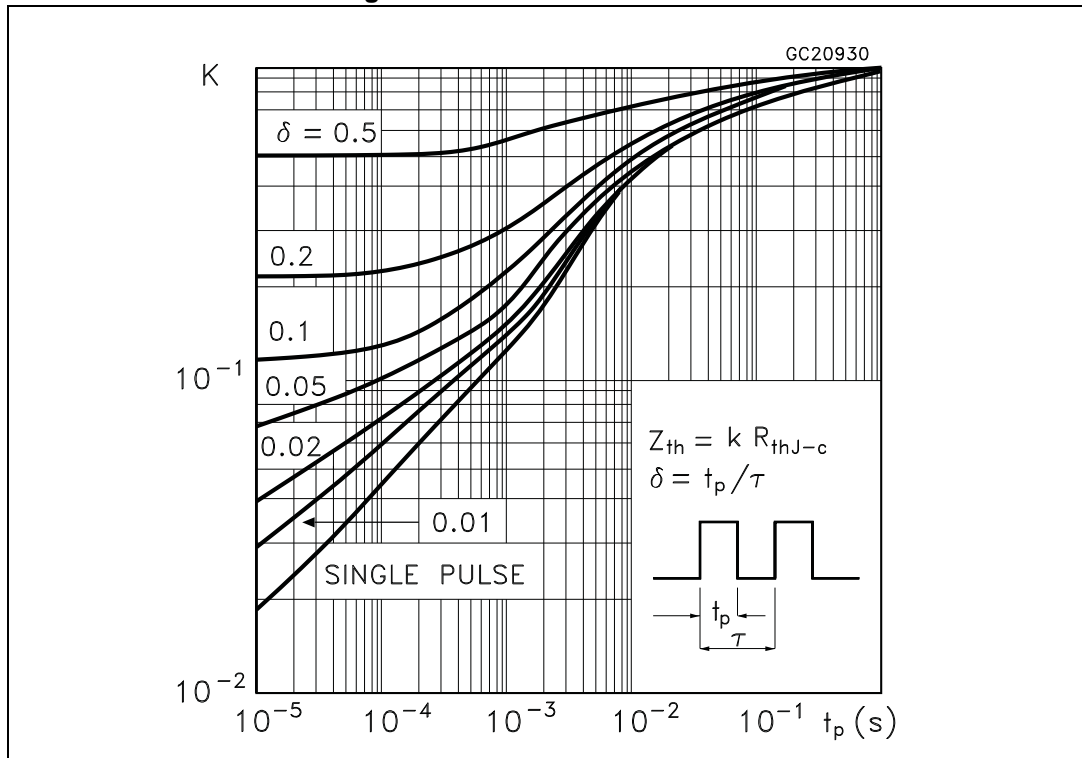


Figure 28. Thermal data for diode



### 3 Test circuits

Figure 29. Test circuit for inductive load switching



Figure 30. Gate charge test circuit

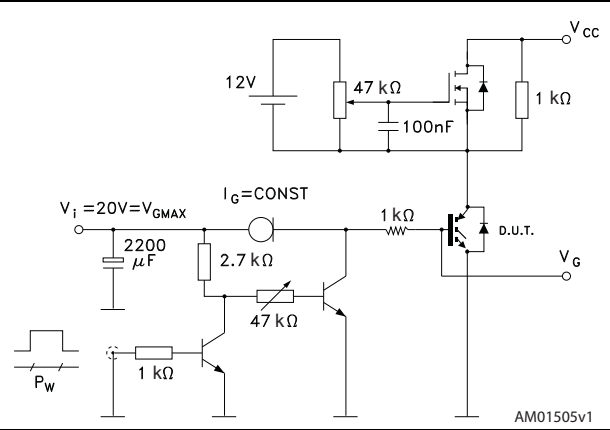


Figure 31. Switching waveform

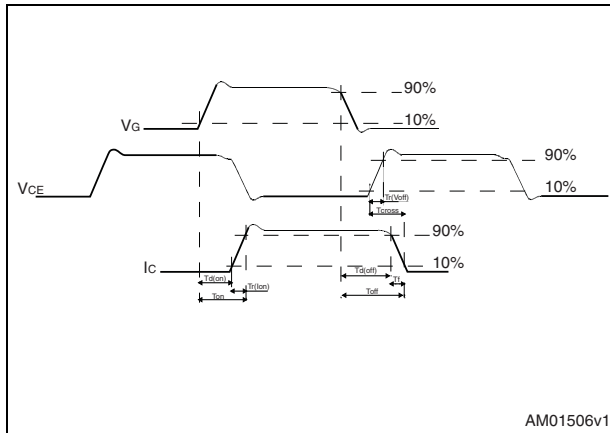
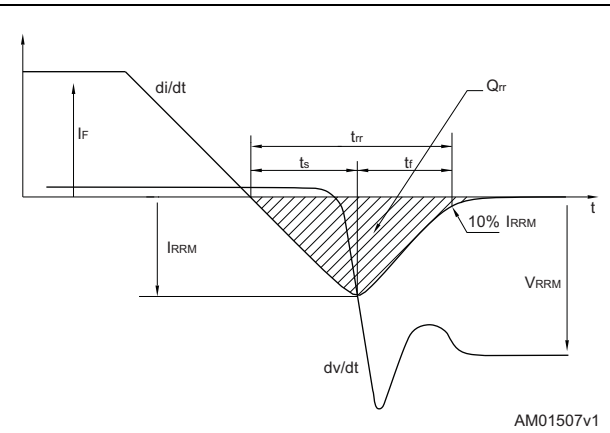


Figure 32. Diode recovery times waveform



## 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.

### 4.1 TO-247, STGW40M120DF3

Figure 33. TO-247 drawing

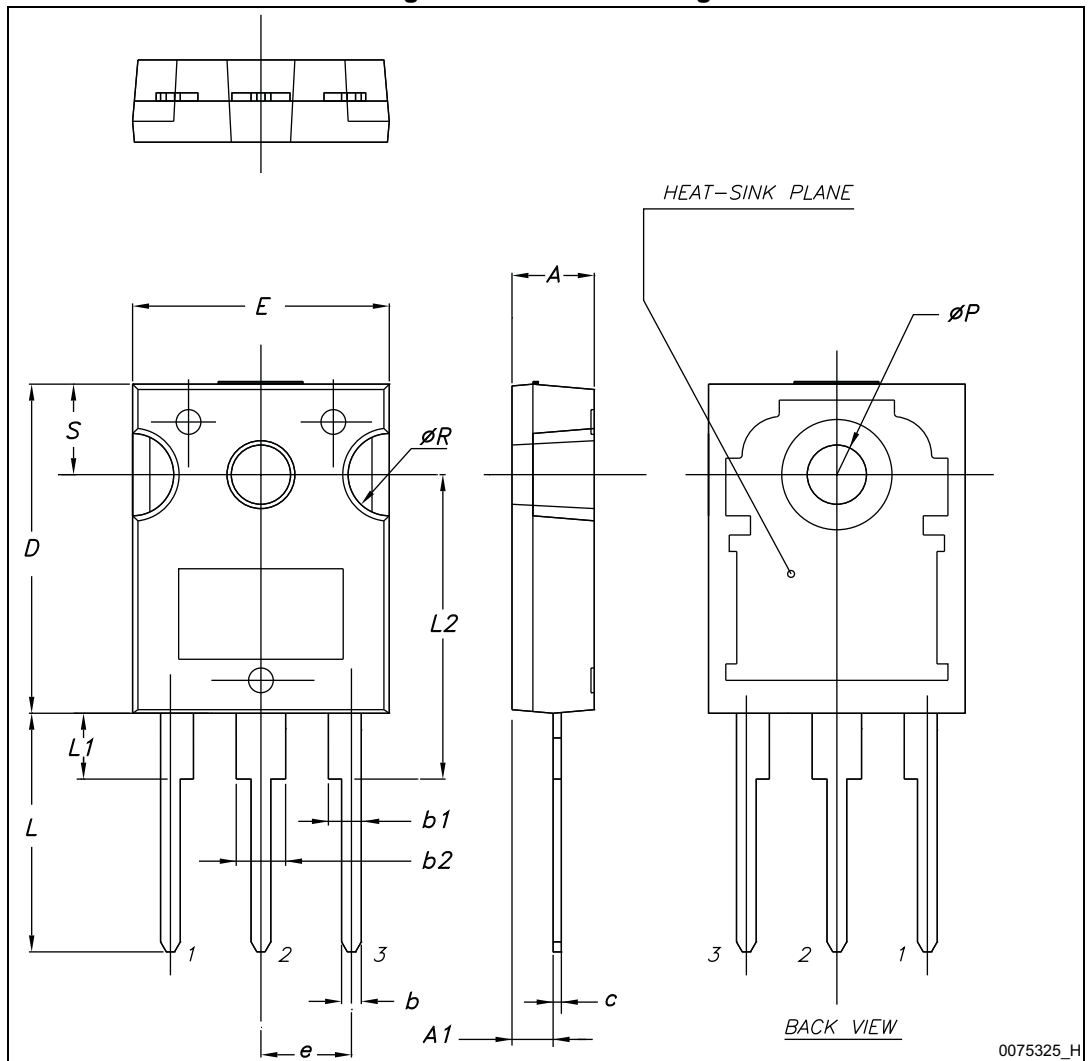


Table 8. TO-247 mechanical data

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

### 4.2 TO-247 long leads, STGWA40M120DF3

Figure 34. TO-247 long leads drawing

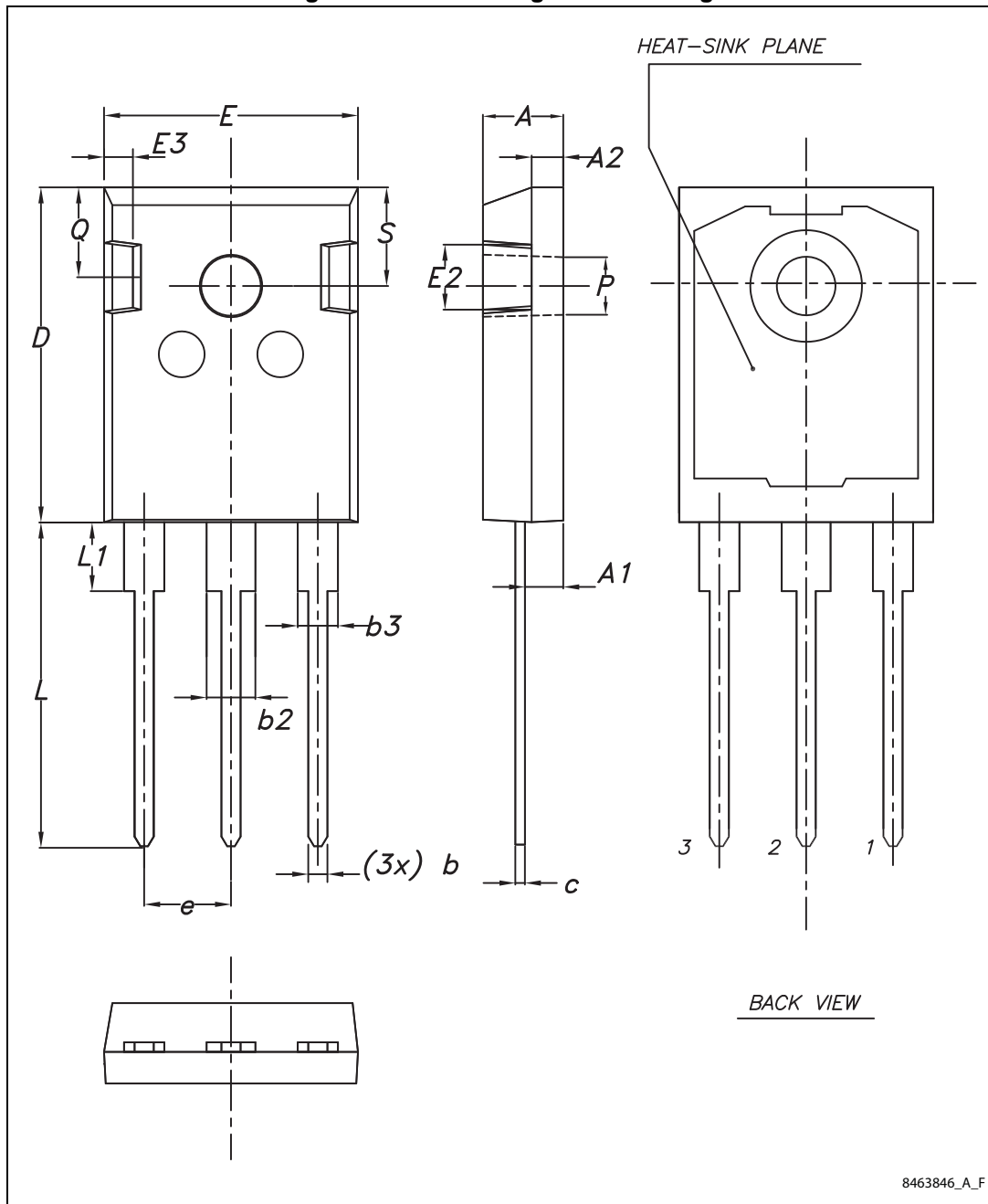


Table 9. TO-247 long leads mechanical data

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



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
22-Apr-2014	1	Initial release.
16-Sep-2014	2	Document status promoted from preliminary to production data. Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> .
10-Nov-2014	3	Updated $V_F$ value in <a href="#">Table 4: Static characteristics</a> and <a href="#">Figure 32: Diode recovery times waveform</a> . Minor text changes.

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