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STGFW40V60DF, STGW40V60DF, STGWT40V60DF

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

Datasheet - production data

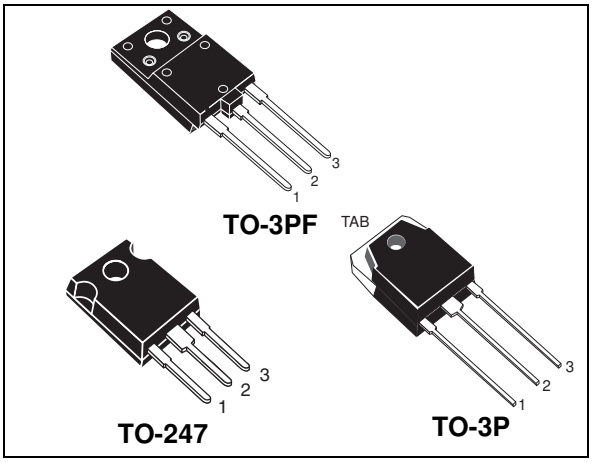
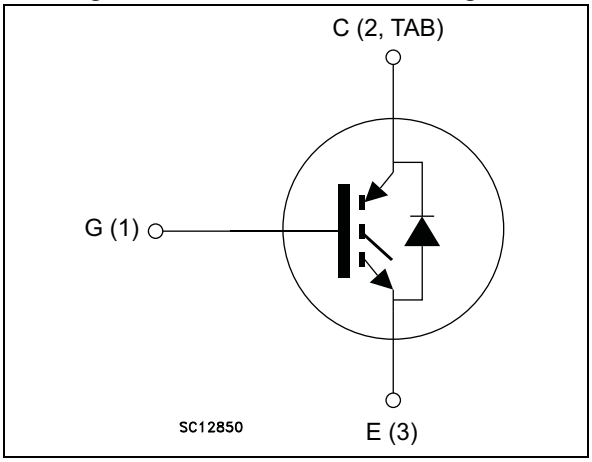


Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: T_J = 175 °C
- Tail-less switching off
- $V_{CE(sat)}$ = 1.8 V (typ.) @ I_C = 40 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
STGFW40V60DF	GFW40V60DF	TO-3PF	Tube
STGW40V60DF	GW40V60DF	TO-247	Tube
STGWT40V60DF	GWT40V60DF	TO-3P	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-247 TO-3P	TO-3PF	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600		V
I_C	Continuous collector current at T_C = 25 °C	80		A
I_C	Continuous collector current at T_C = 100 °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 °C	80		A
I_F	Continuous forward current at T_C = 100 °C	40		A
I_{FP}(1)	Pulsed forward current	160		A
P_{TOT}	Total dissipation at T_C = 25 °C	283	62.5	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; Tc = 25 °C)		3.5	kV
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
		TO-247 TO-3P	TO-3PF	
R_{thJC}	Thermal resistance junction-case IGBT	0.53	2.4	°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 = 40 A		1.8	2.3	V
		V_{GE} = 15 V, I_C = 40 A T_J = 125 °C		2.15		
		V_{GE} = 15 V, I_C = 40 A T_J = 175 °C		2.35		
V_F	Forward on-voltage	I_F = 40 A		1.7	2.45	V
		I_F = 40 A, T_J = 125 °C		1.4		V
		I_F = 40 A, T_J = 175 °C		1.3		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	-	5400	-	pF
C_{oes}	Output capacitance		-	220	-	pF
C_{res}	Reverse transfer capacitance		-	180	-	pF
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 40 A, V_{GE} = 15 V, see *Figure 34*	-	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 V, I_C = 40 A, R_G = 10 Ω, V_{GE} = 15 V, see *Figure 33*	-	52	-	ns
t_r	Current rise time		-	17	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1850	-	A/µs
$t_{d(off)}$	Turn-off delay time		-	208	-	ns
t_f	Current fall time		-	20	-	ns
E_{on} (1)	Turn-on switching losses		-	456	-	µJ
E_{off} (2)	Turn-off switching losses		-	411	-	µJ
E_{ts}	Total switching losses		-	867	-	µJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 40 A, R_G = 10 Ω, V_{GE} = 15 V, T_J = 175 °C, see *Figure 33*	-	52	-	ns
t_r	Current rise time		-	21	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1538	-	A/µs
$t_{d(off)}$	Turn-off delay time		-	220	-	ns
t_f	Current fall time		-	21	-	ns
E_{on} (1)	Turn-on switching losses		-	1330	-	µJ
E_{off} (2)	Turn-off switching losses		-	560	-	µJ
E_{ts}	Total switching losses		-	1890	-	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 = 40 A, V_R = 400 V, V_{GE} = 15 V, di/dt=1000 A/µs see *Figure 33*	-	41	-	ns
Q_{rr}	Reverse recovery charge		-	440	-	nC
I_{rrm}	Reverse recovery current		-	21.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	1363	-	A/µs
E_{rr}	Reverse recovery energy		-	151	-	µJ
t_{rr}	Reverse recovery time	I_F = 40 A, V_R = 400 V, V_{GE} = 15 V, di/dt=1000 A/µs T_J = 175 °C, see *Figure 33*	-	109	-	ns
Q_{rr}	Reverse recovery charge		-	2400	-	nC
I_{rrm}	Reverse recovery current		-	44.4	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	670	-	A/µs
E_{rr}	Reverse recovery energy		-	718	-	µJ

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature for TO-247 and TO-3P

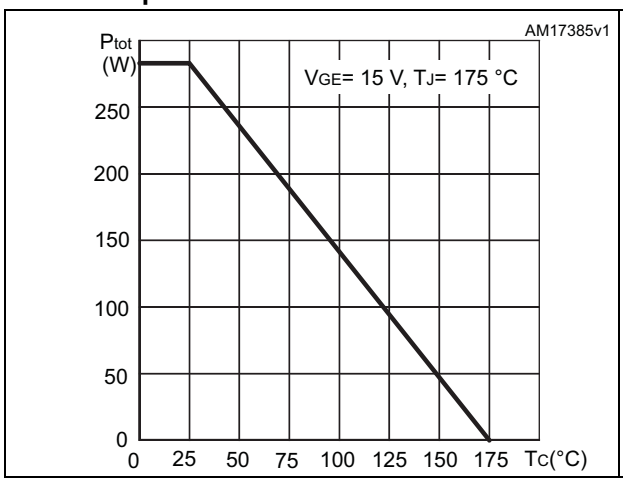


Figure 3. Collector current vs. case temperature for TO-247 and TO-3P

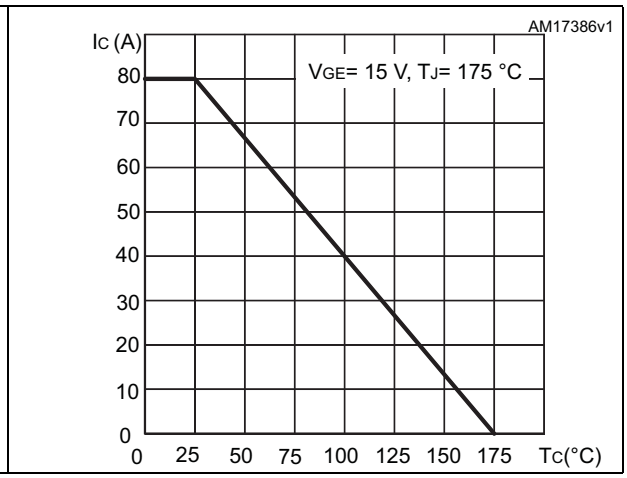


Figure 4. Power dissipation vs. case temperature for TO-3PF

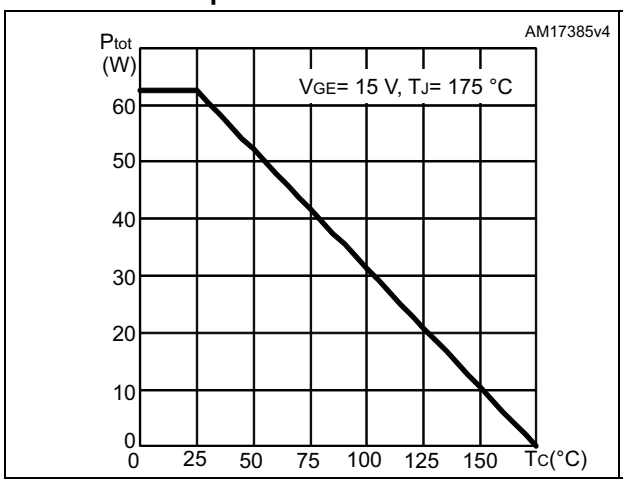


Figure 5. Collector current vs. case temperature for TO-3PF

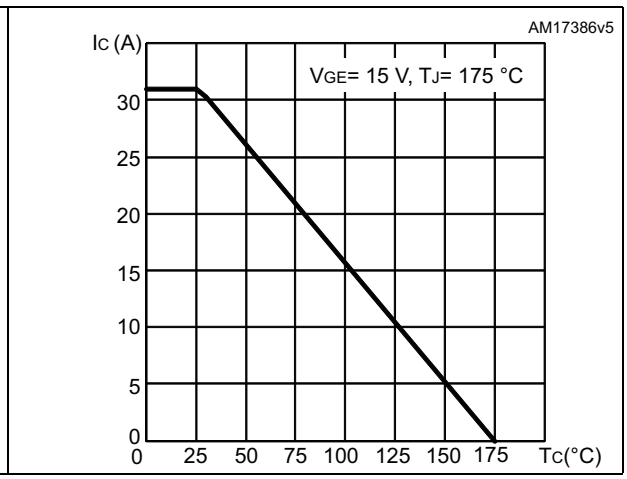


Figure 6. Output characteristics (T_J=25°C)

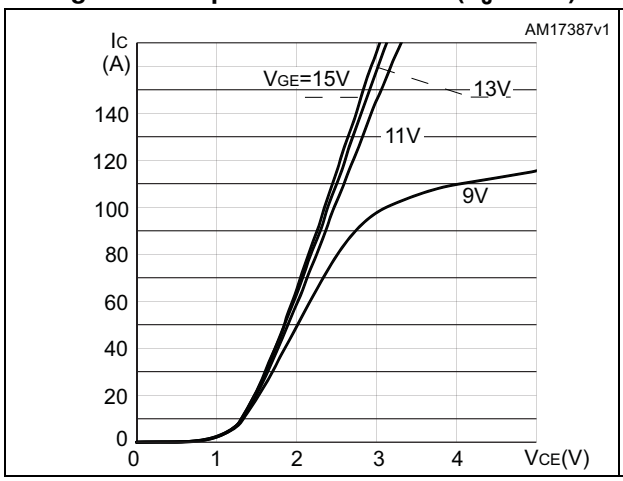


Figure 7. Output characteristics (T_J=175°C)

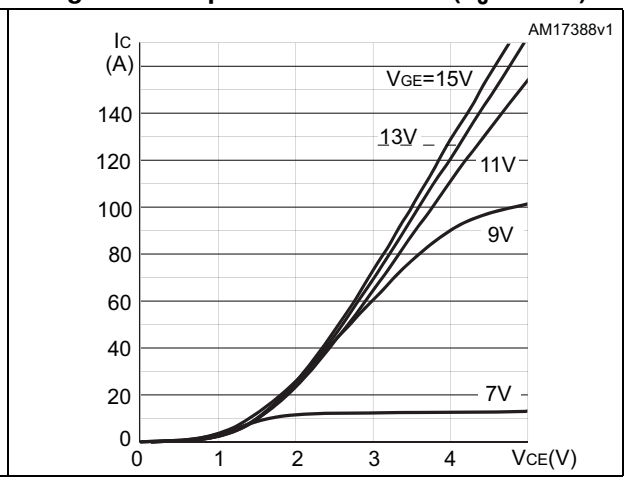


Figure 8. $V_{CE(sat)}$ vs. junction temperature

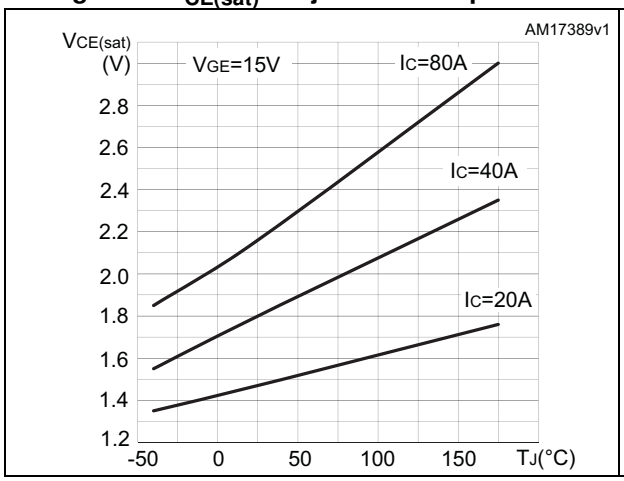


Figure 9. $V_{CE(sat)}$ vs. collector current

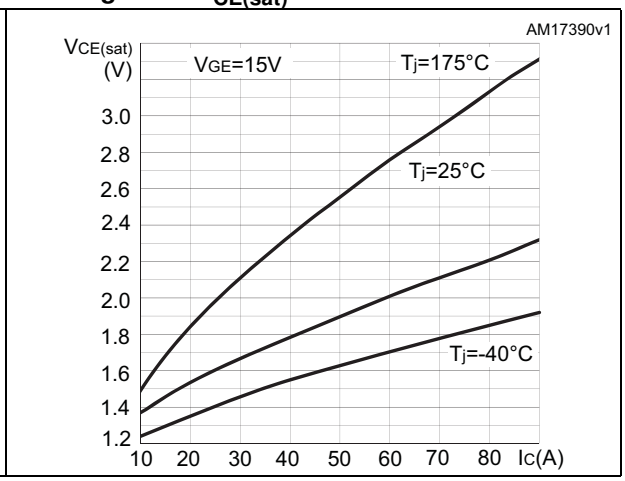


Figure 10. Collector current vs. switching frequency for TO-247 and TO-3P

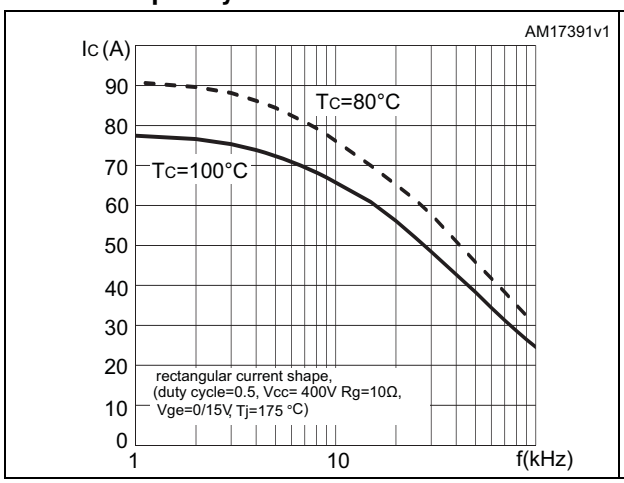


Figure 11. Collector current vs. switching frequency for TO-3PF

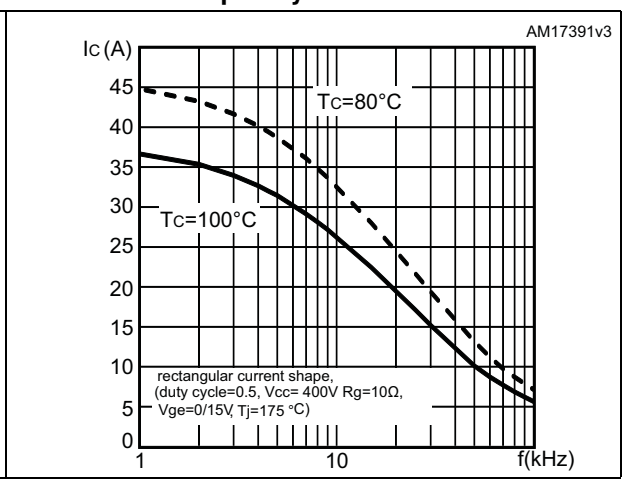


Figure 12. Forward bias safe operating area for TO-247 and TO-3P

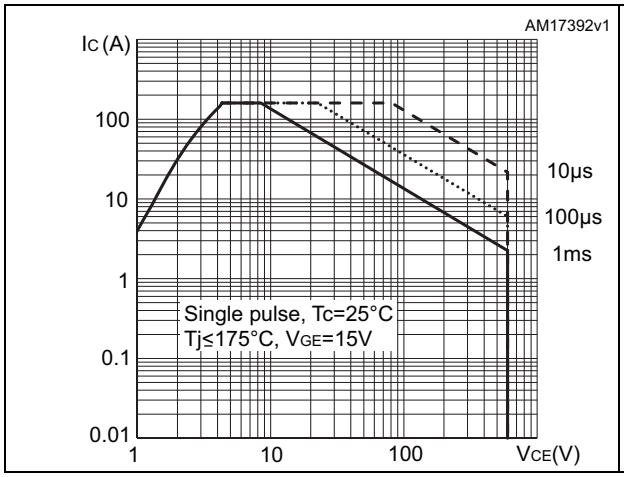


Figure 13. Forward bias safe operating area for TO-3PF

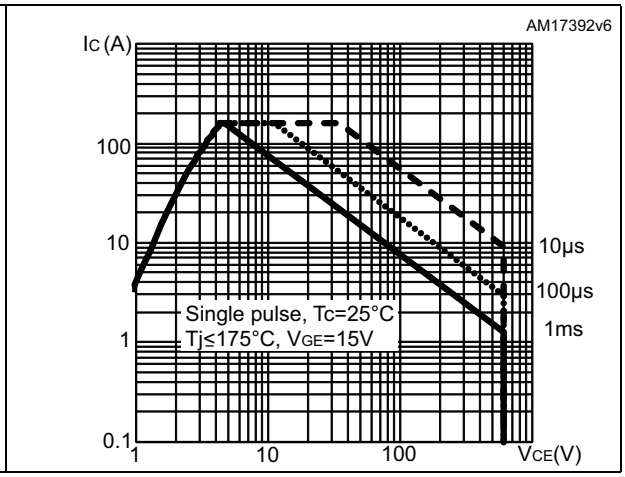


Figure 14. Transfer characteristics

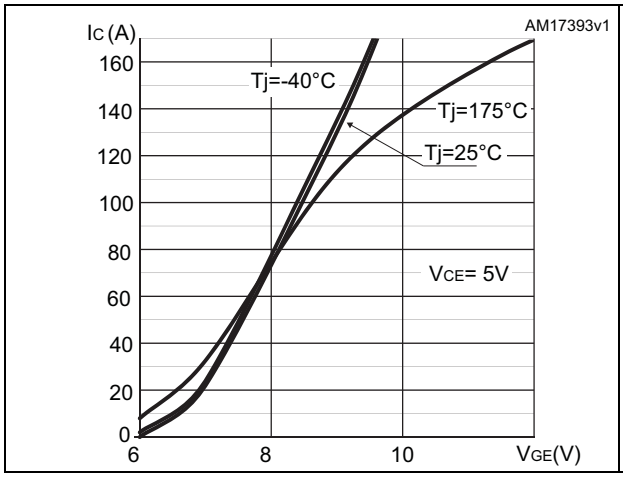


Figure 15. Diode V_F vs. forward current

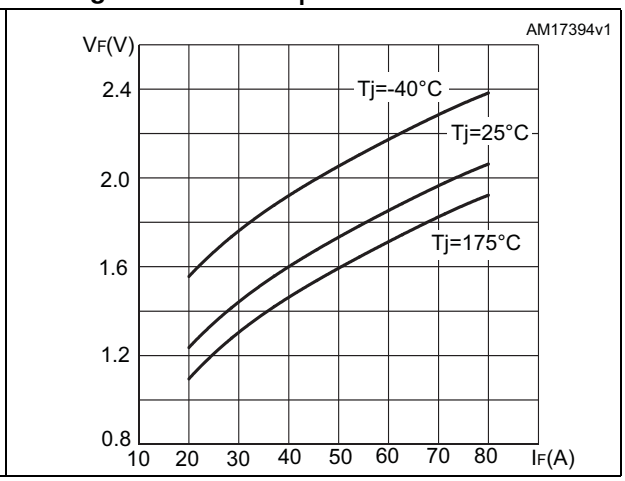


Figure 16. Normalized $V_{GE(th)}$ vs junction temperature

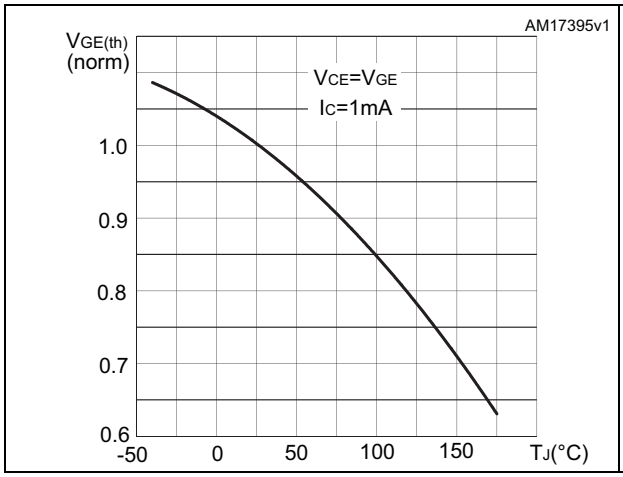


Figure 17. Normalized $V_{(BR)CES}$ vs. junction temperature

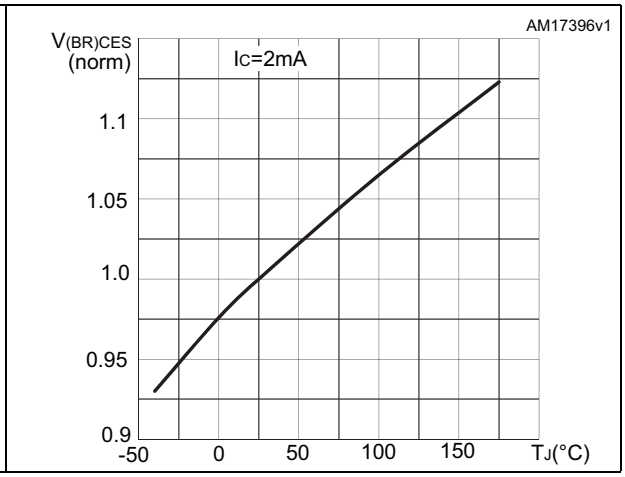


Figure 18. Capacitance variations

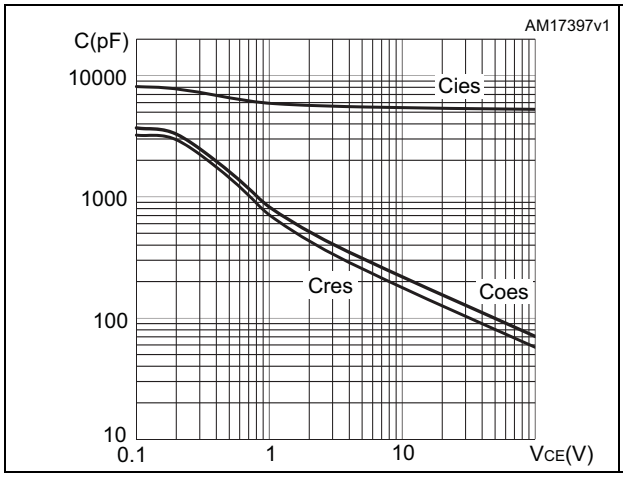


Figure 19. Gate charge vs. gate-emitter voltage

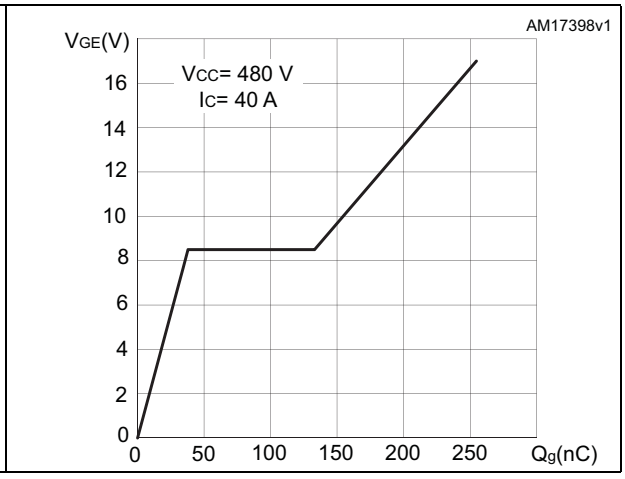


Figure 20. Switching losses vs. collector current

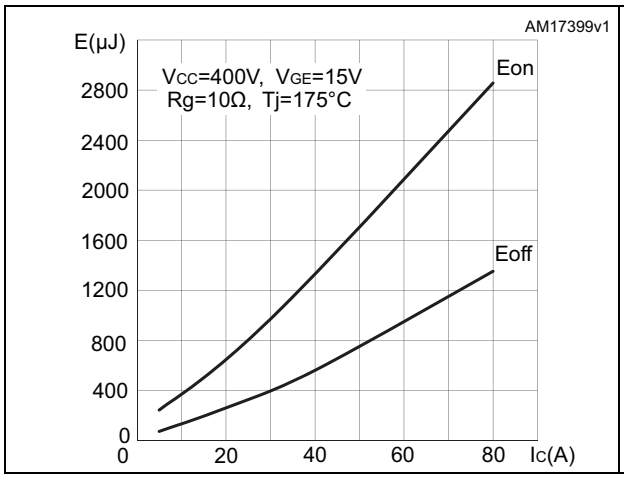


Figure 21. Switching losses vs. gate resistance

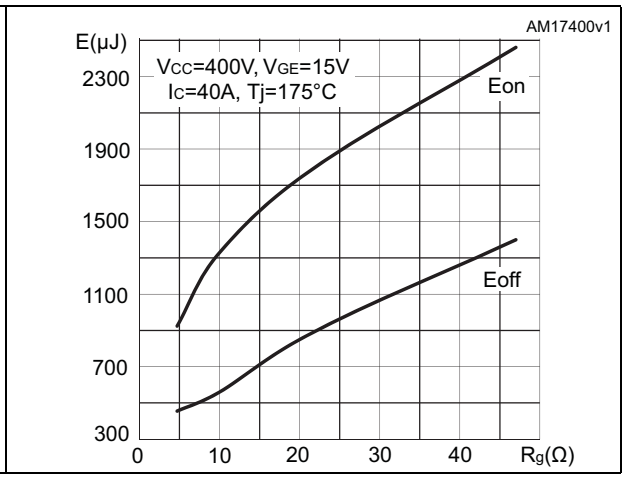


Figure 22. Switching losses vs. junction temperature

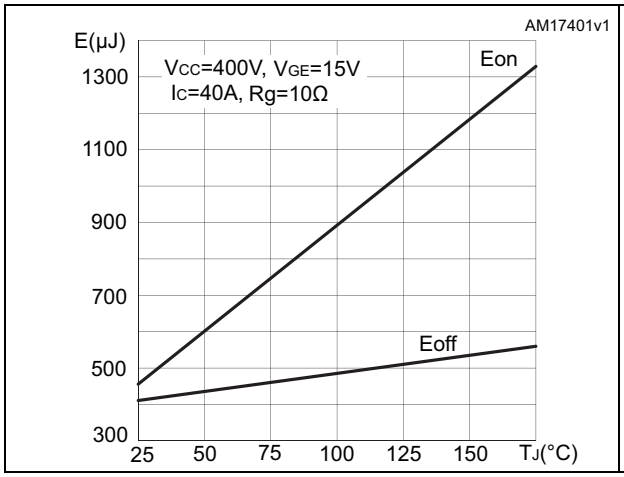


Figure 23. Switching losses vs. collector emitter voltage

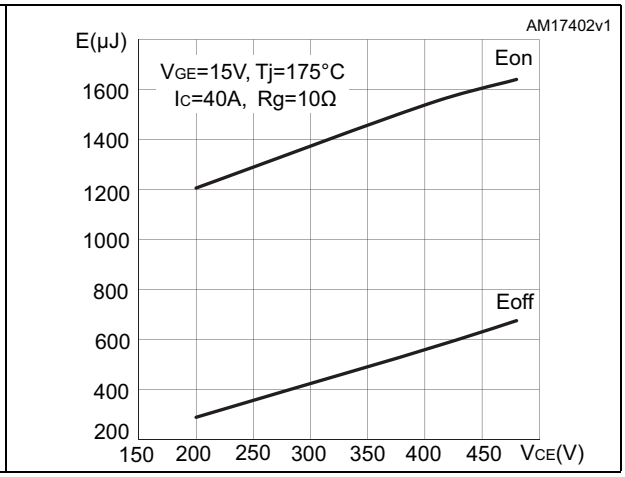


Figure 24. Switching times vs. collector current

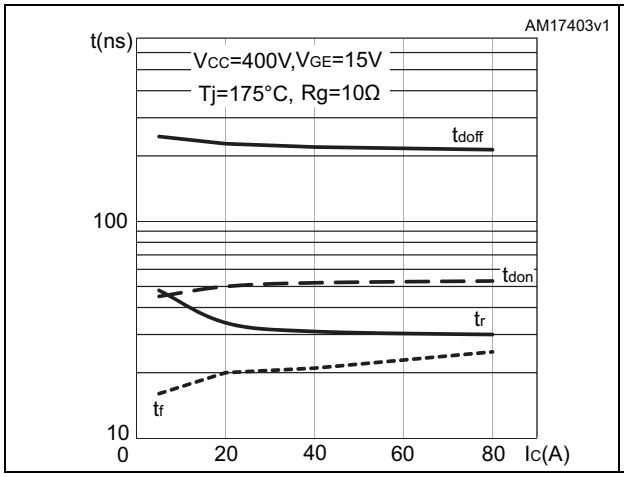


Figure 25. Switching times vs. gate resistance

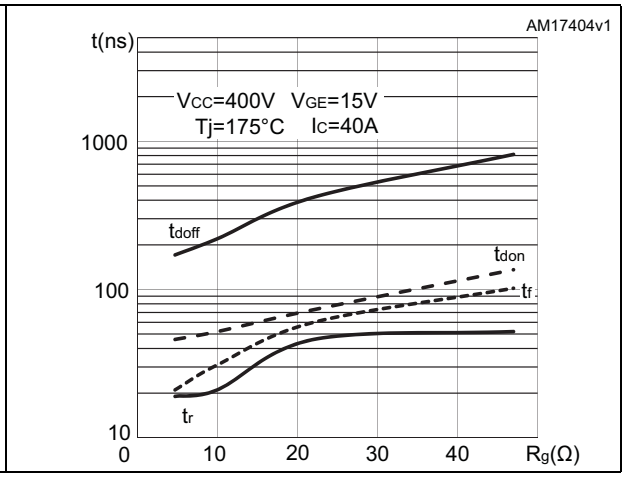


Figure 26. Reverse recovery current vs. diode current slope

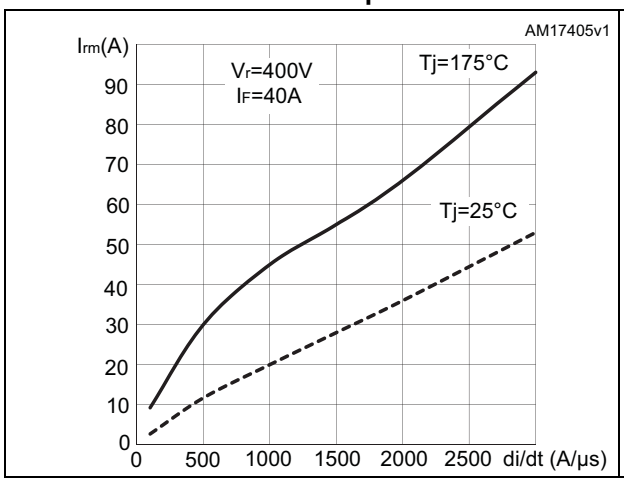


Figure 27. Reverse recovery time vs. diode current slope

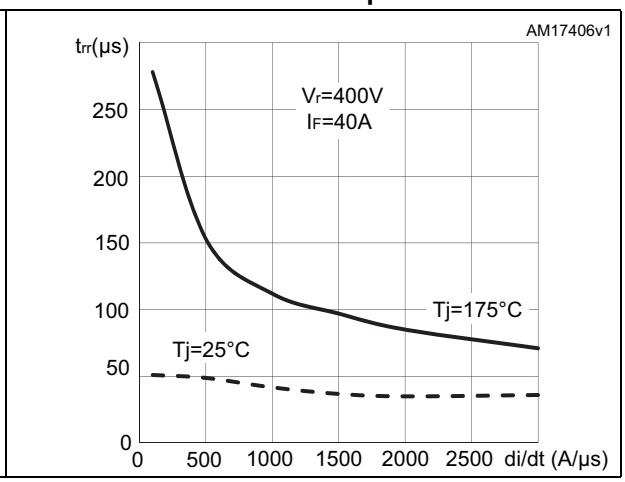


Figure 28. Reverse recovery charge vs. diode current slope

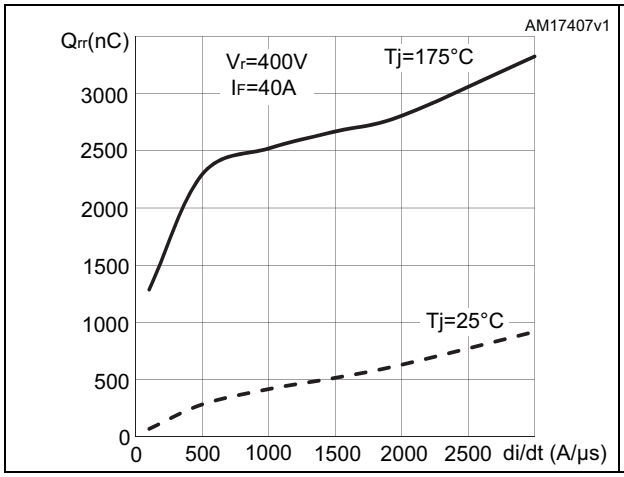


Figure 29. Reverse recovery energy vs. diode current slope

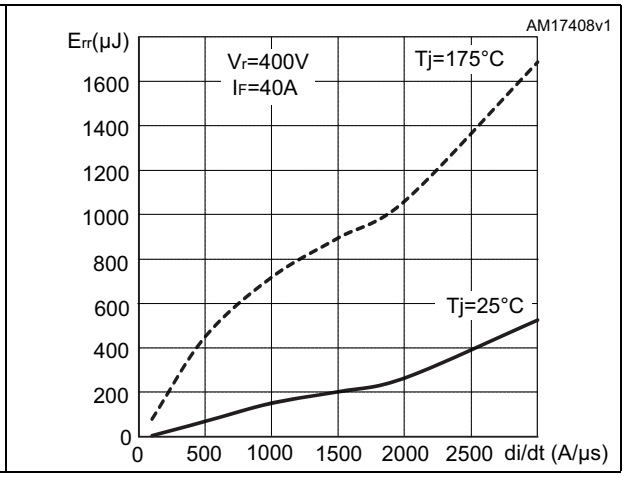


Figure 30. Thermal data for IGBT in TO-247 and TO-3P

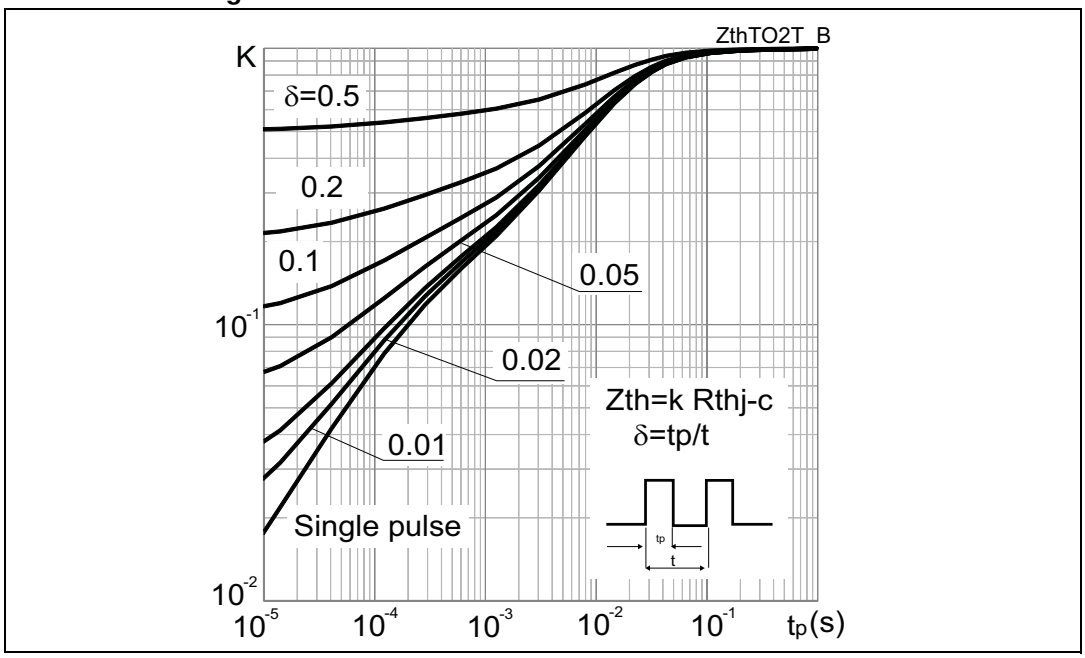


Figure 31. Thermal data for IGBT in TO-3PF

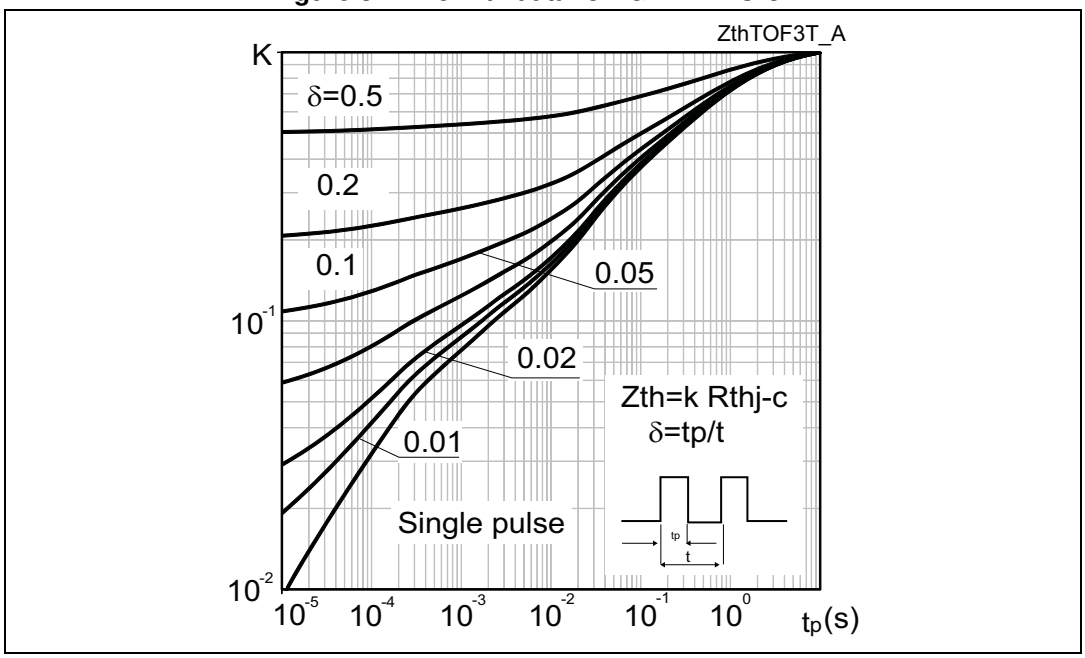
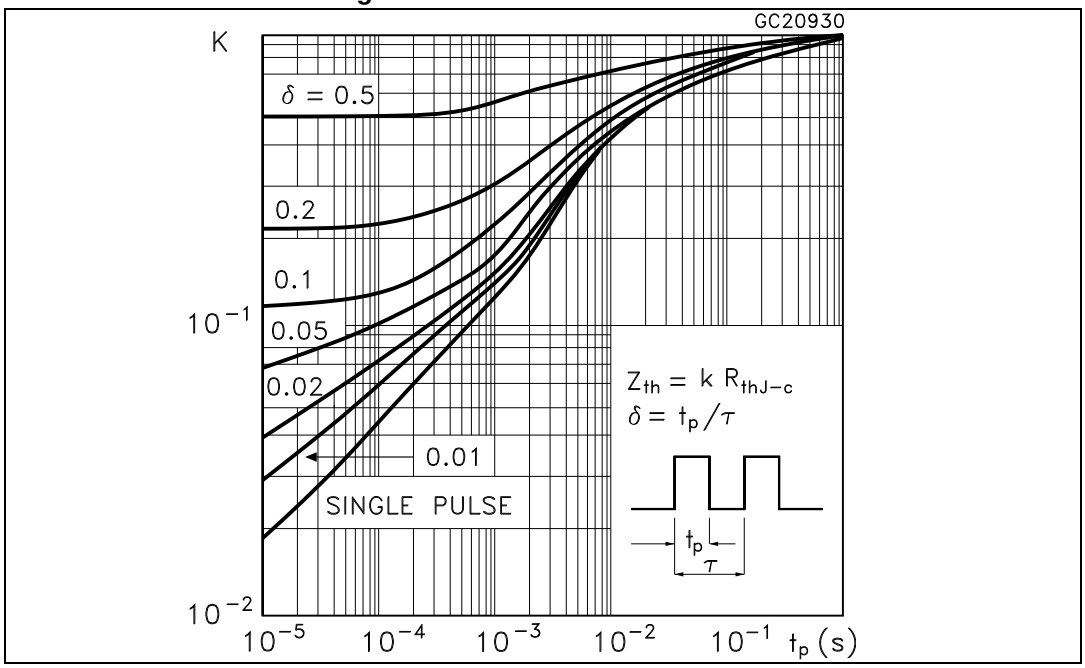


Figure 32. Thermal data for diode



3 Test circuits

Figure 33. Test circuit for inductive load switching

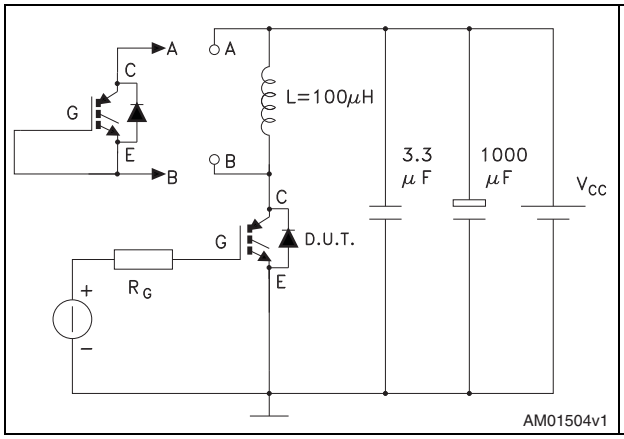


Figure 34. Gate charge test circuit

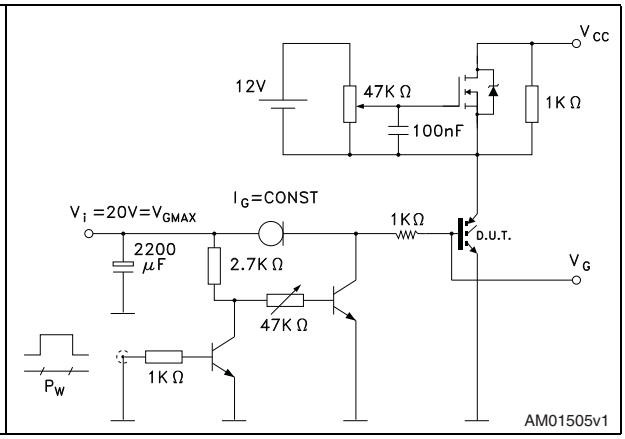


Figure 35. Switching waveform

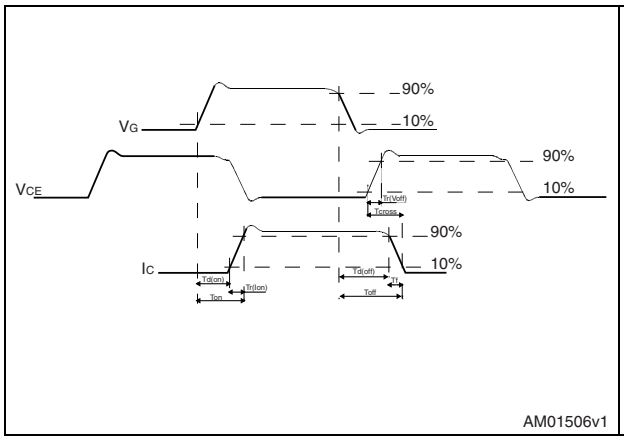
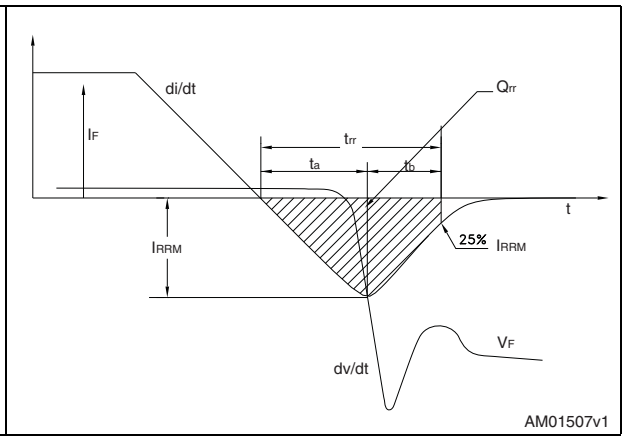


Figure 36. Diode recovery time waveform



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. ECOPACK is an ST trademark.

4.1 TO-3PF, STGFW40V60DF

Figure 37. TO-3PF drawing

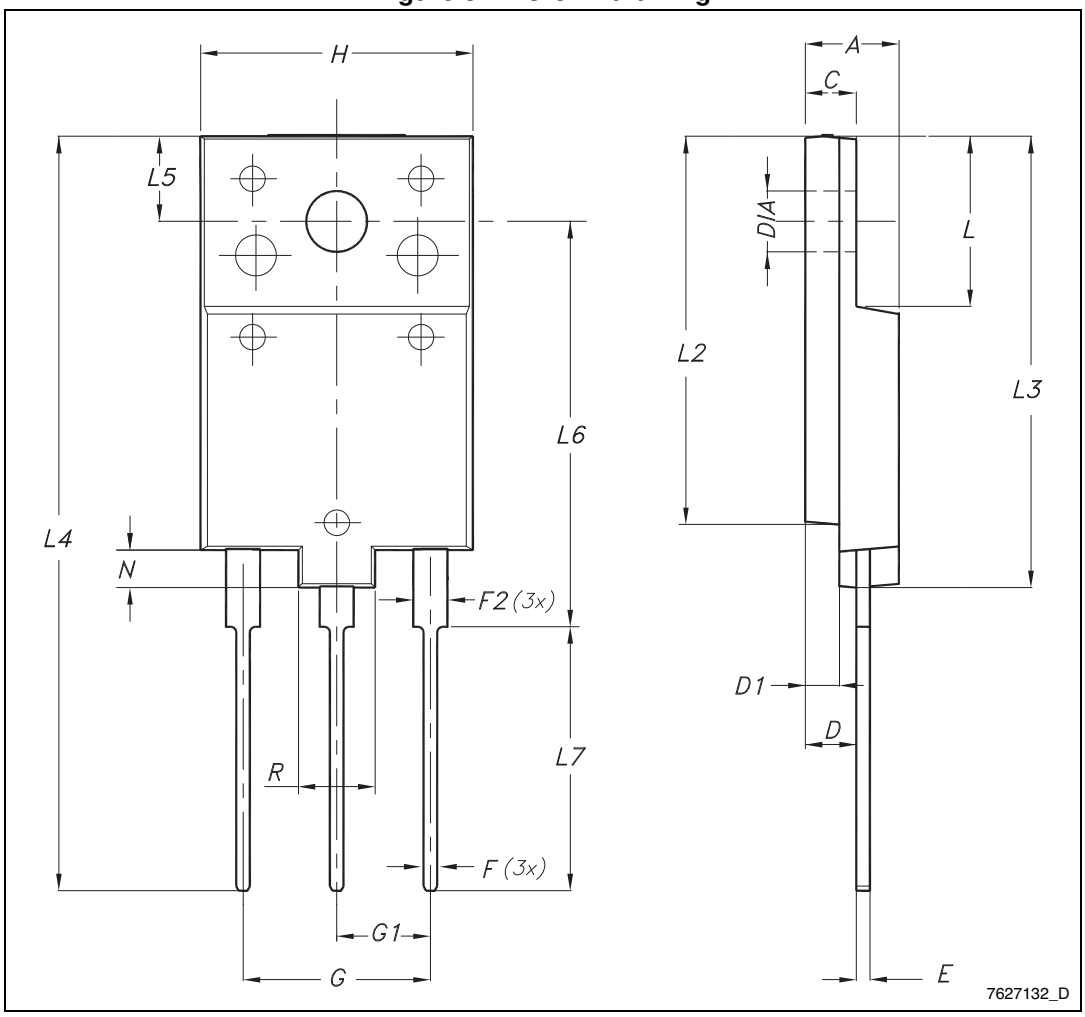


Table 8. TO-3PF mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

4.2 TO-247, STGW40V60DF

Figure 38. TO-247 drawing

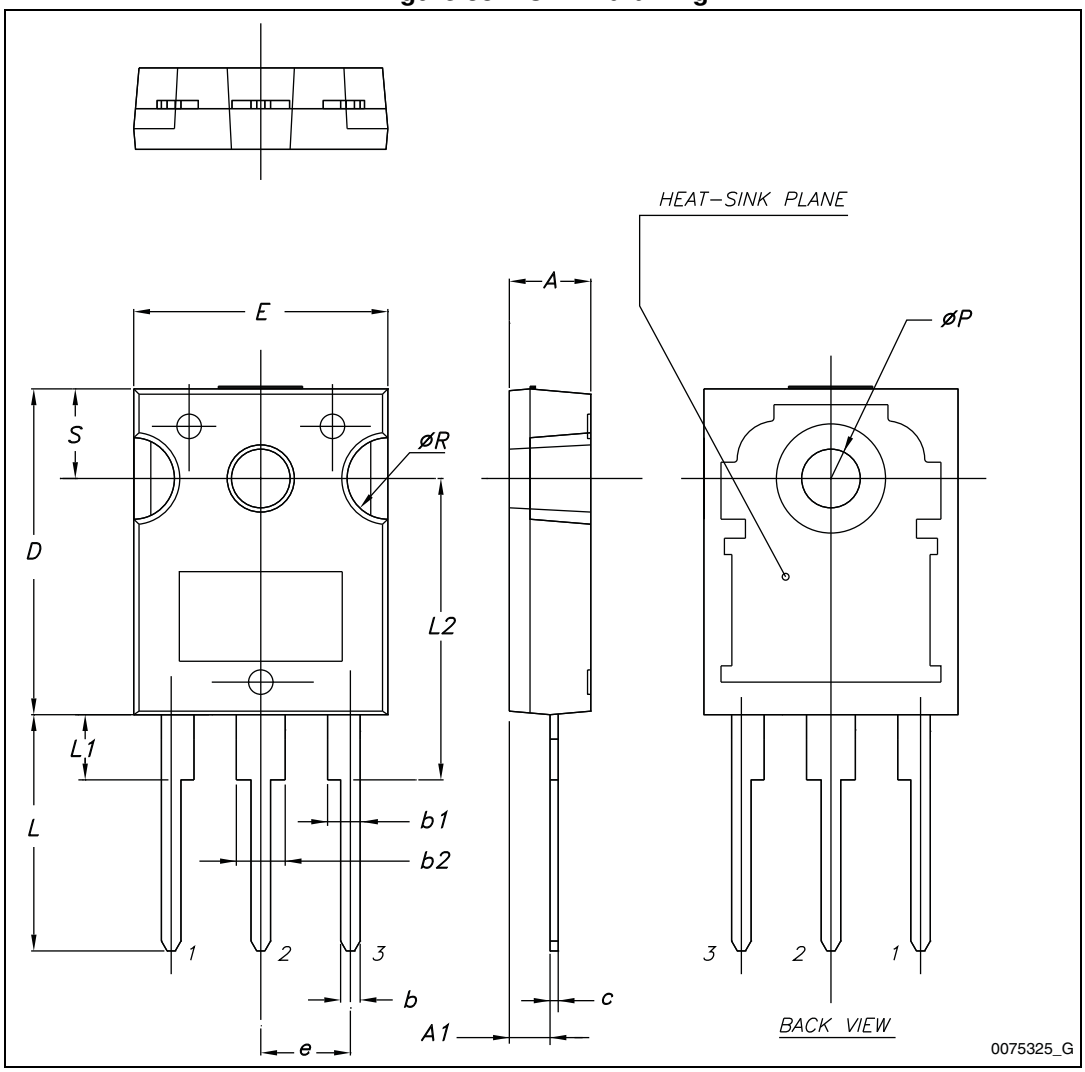


Table 9. TO-247 mechanical data

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

4.3 TO-3P, STGWT40V60DF

Figure 39. TO-3P drawing

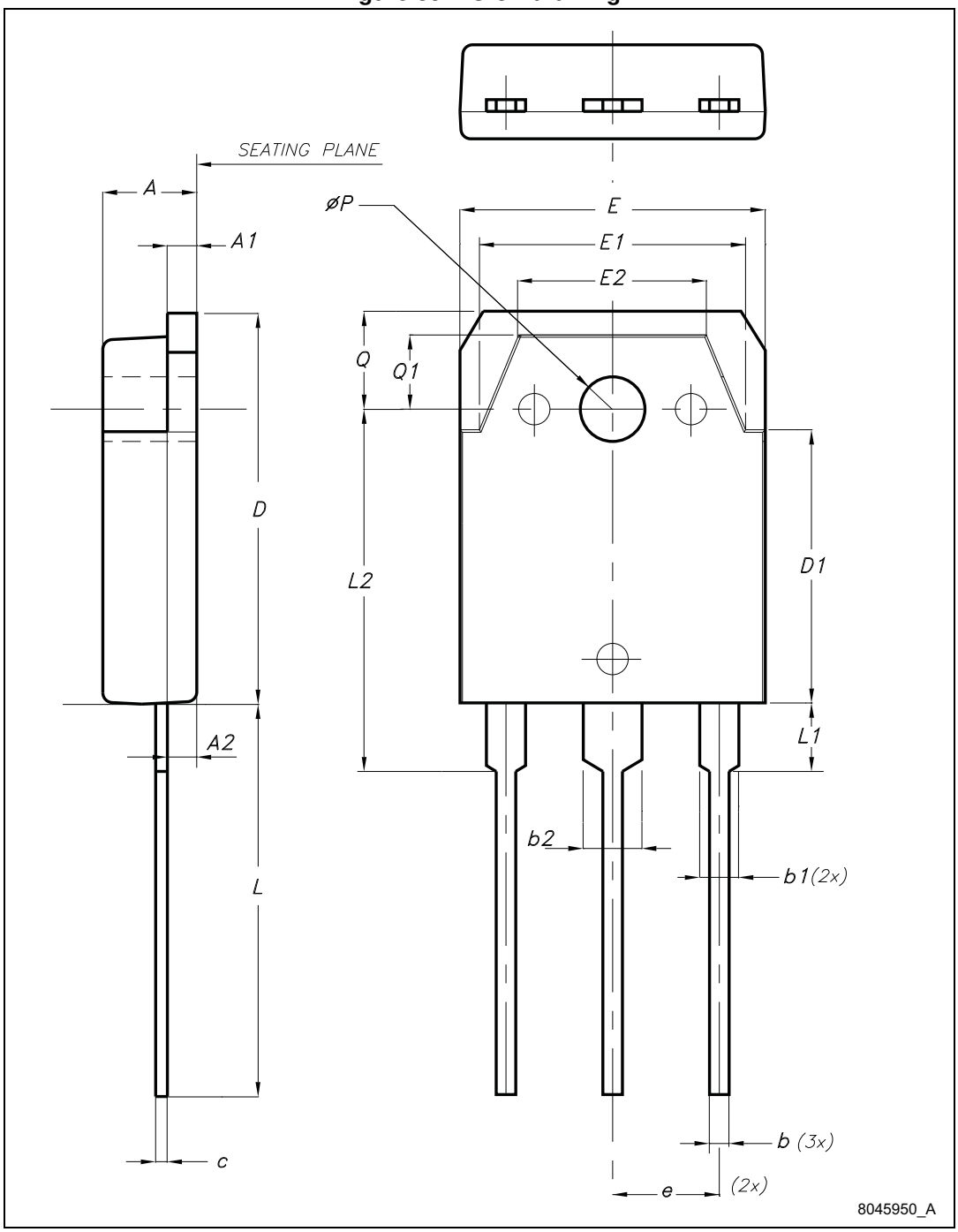


Table 10. TO-3P mechanical data

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
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.
10-Jan-2014	6	Updated *Figure 8: $V_{CE(sat)}$ vs. junction temperature*, *Figure 15: Diode V_F vs. forward current* and *Figure 16: Normalized $V_{GE(th)}$ vs junction temperature*.
03-Mar-2014	7	Updated test conditions in *Table 7: Diode switching characteristics (inductive load)*.
23-Apr-2014	8	Added new device in TO-3PF. Updated *Table 1: Device summary*, *Table 2: Absolute maximum ratings Table 3: Thermal data* and *Section 4: Package mechanical data*. Added *Figure 4: Power dissipation vs. case temperature for TO-3PF*, *Figure 5: Collector current vs. case temperature for TO-3PF*, *Figure 11: Collector current vs. switching frequency for TO-3PF* and *Figure 12: Forward bias safe operating area for TO-247 and TO-3P*. Minor text changes.

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