STGFW20V60F, STGW20V60F, STGWT20V60F

600 V, 20 A very high speed trench gate field-stop IGBT

Datasheet - production data

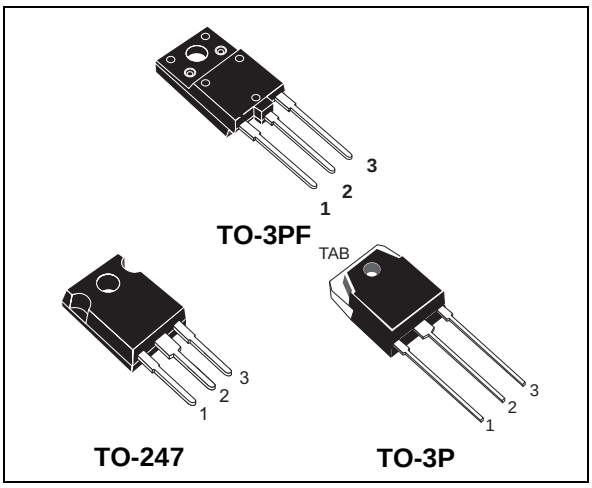
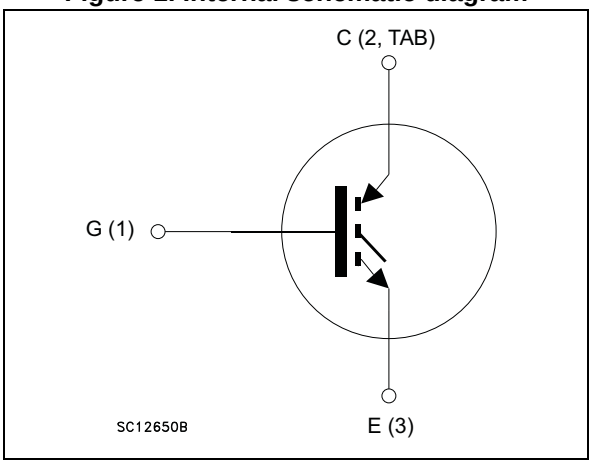


Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: T_J = 175 °C
- Very high speed switching series
- Tail-less switching off
- Low saturation voltage: $V_{CE(sat)}$ = 1.8 V (typ.) @ I_C = 20 A
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Lead free package

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 and 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
STGFW20V60F	GFW20V60F	TO-3PF	Tube
STGW20V60F	GW20V60F	TO-247	Tube
STGWT20V60F	GWT20V60F	TO-3P	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-3PF	TO-247	TO-3P	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600			V
I_C	Continuous collector current at T_C = 25 °C	40(1)	40		A
I_C	Continuous collector current at T_C = 100 °C	20(1)	20		A
I_{CP}(2)	Pulsed collector current	80(1)	80		A
V_{GE}	Gate-emitter voltage	±20			V
P_{TOT}	Total dissipation at T_C = 25 °C	52	167		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. Limited by maximum junction temperature.
2. Pulse width limited by maximum junction temperature

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-3PF	TO-247	TO-3P	
R_{thJC}	Thermal resistance junction-case	2.9	0.9		°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 = 20 A		1.8	2.2	V
		V_{GE} = 15 V, I_C = 20 A T_J = 125 °C		2.15		
		V_{GE} = 15 V, I_C = 20 A T_J = 175 °C		2.3		
$V_{GE(th)}$	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	-	2800	-	pF
C_{oes}	Output capacitance		-	110	-	pF
C_{res}	Reverse transfer capacitance		-	64	-	pF
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 20 A, V_{GE} = 15 V, see *Figure 26*	-	116	-	nC
Q_{ge}	Gate-emitter charge		-	24	-	nC
Q_{gc}	Gate-collector charge		-	50	-	nC

Table 6. 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 = 20 A, V_{GE} = 15 V, di/dt = 100 A/µs *see Figure 25*	-	38	-	ns
t_r	Current rise time		-	10	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1556	-	A/µs
$t_{d(off)}$	Turn-off delay time		-	149	-	ns
t_f	Current fall time		-	15	-	ns
E_{on} (1)	Turn-on switching losses		-	200	-	µJ
E_{off} (2)	Turn-off switching losses		-	130	-	µJ
E_{ts}	Total switching losses		-	330	-	µJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 20 A, di/dt = 100 A/µs, V_{GE} = 15 V, T_J = 175 °C, see *Figure 25*	-	37	-	ns
t_r	Current rise time		-	12	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1340	-	A/µs
$t_{d(off)}$	Turn-off delay time		-	150	-	ns
t_f	Current fall time		-	23	-	ns
E_{on} (1)	Turn-on switching losses		-	430	-	µJ
E_{off} (2)	Turn-off switching losses		-	210	-	µJ
E_{ts}	Total switching losses		-	640	-	µJ

1. Energy losses include reverse recovery of the external diode. The diode is the same of the copacked STGW20V60DF
2. Turn-off losses include also the tail of the collector current.

2.1 Electrical characteristics (curves)

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

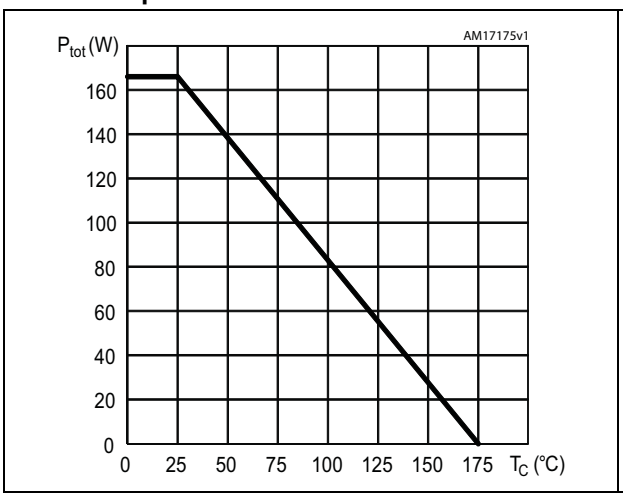


Figure 3. Collector current vs. case temperature for TO-247 and TO-3P

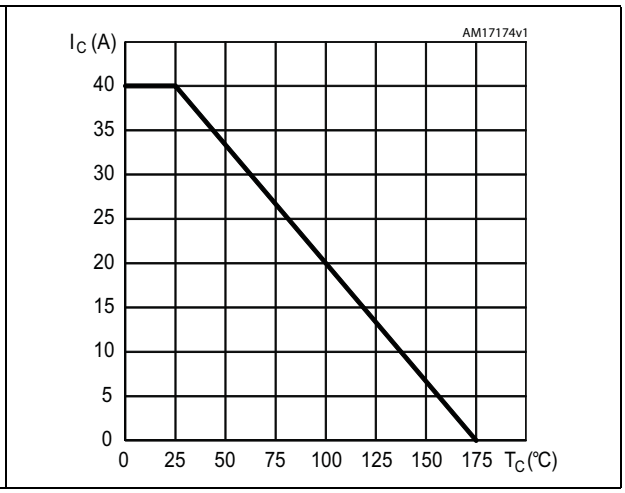


Figure 4. Power dissipation vs. case temperature for TO-3PF

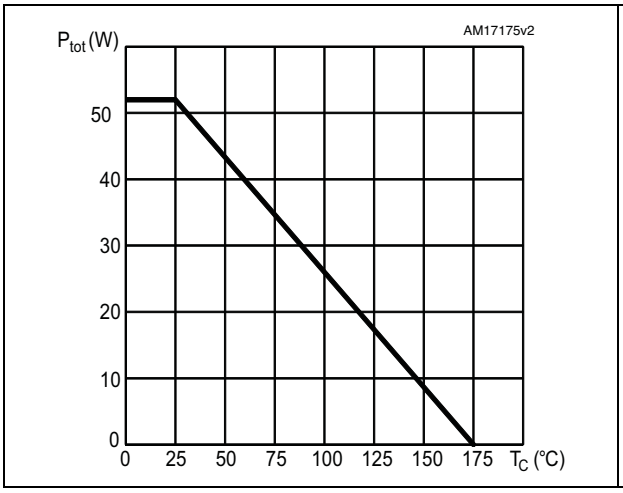


Figure 5. Collector current vs. case temperature for TO-3PF

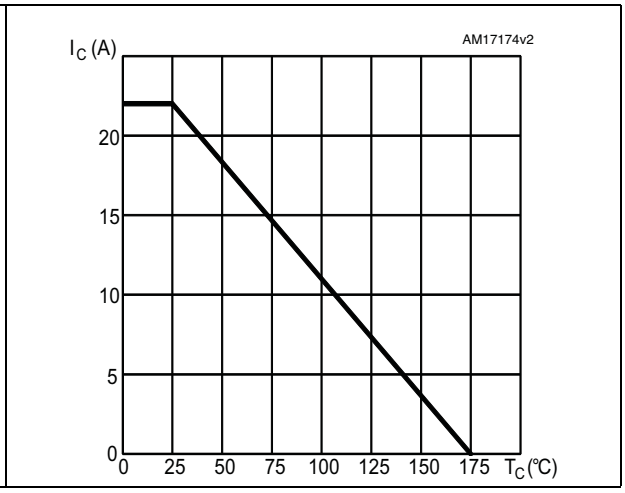


Figure 6. Output characteristics (T_J = 25 °C)

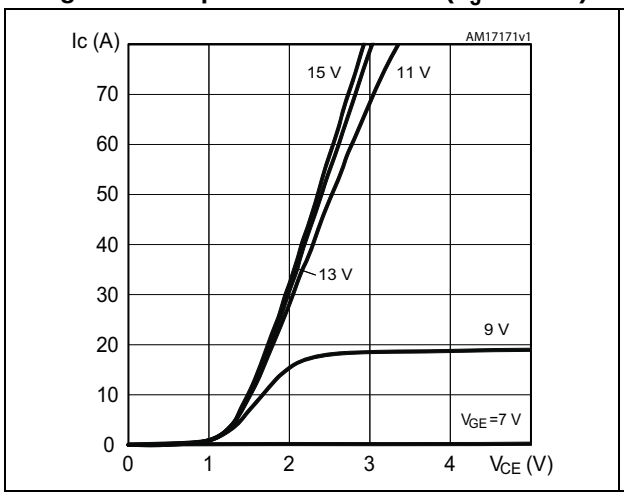


Figure 7. Output characteristics (T_J = 175 °C)

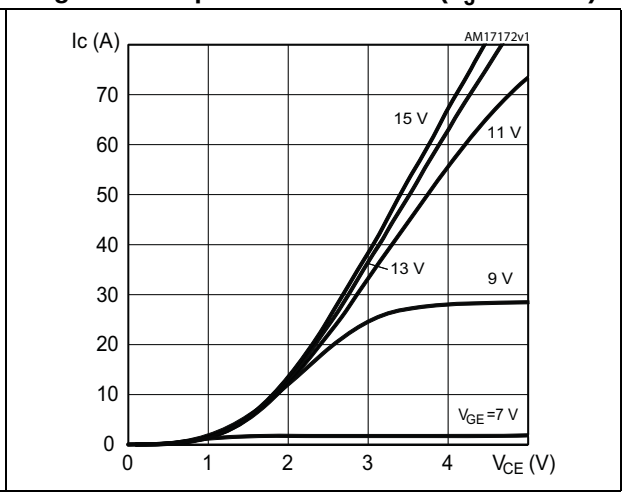


Figure 8. $V_{CE(SAT)}$ vs. junction temperature

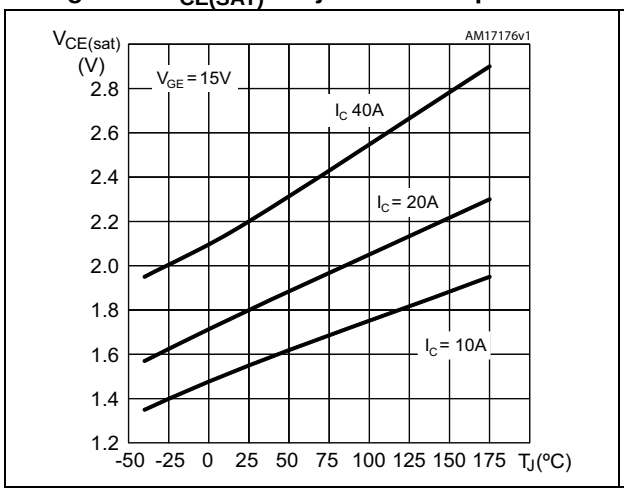


Figure 9. $V_{CE(SAT)}$ vs. collector current

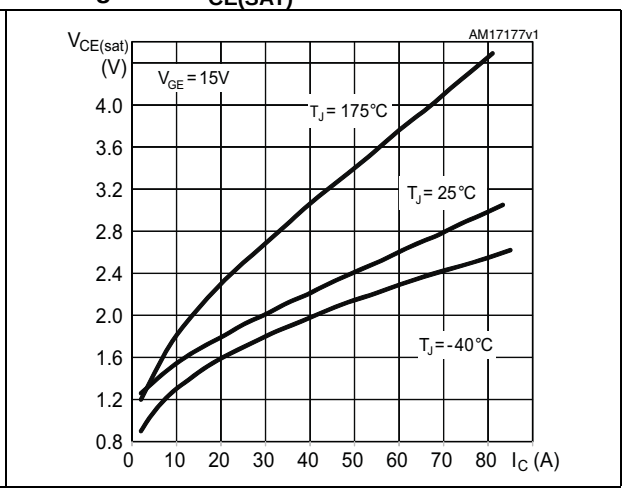


Figure 10. Safe operating area for TO-247 and TO-3P

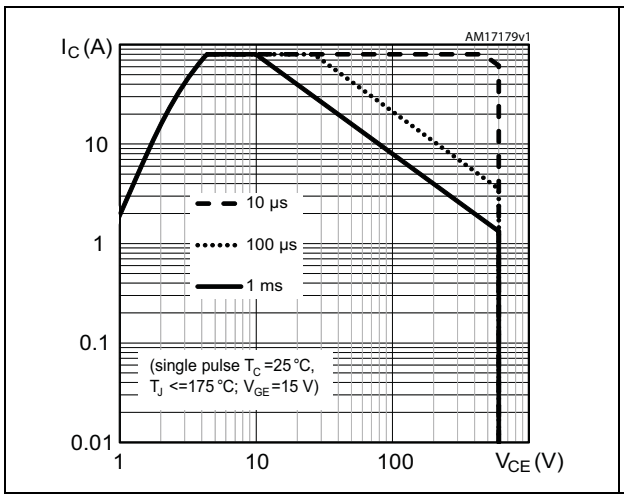


Figure 11. Safe operating area for TO-3PF

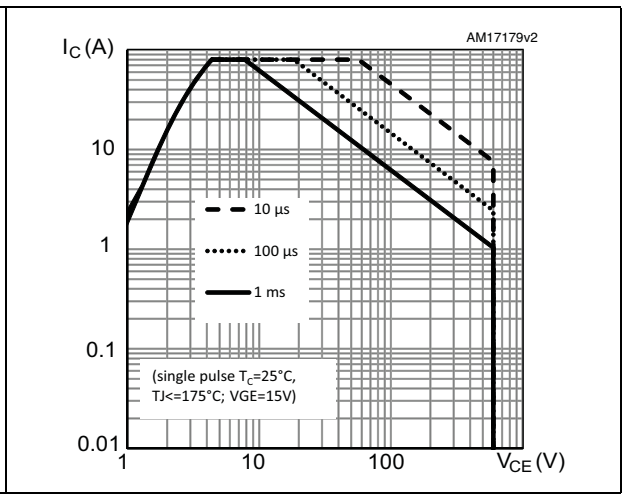


Figure 12. Normalized $V_{GE(th)}$ vs. junction temperature

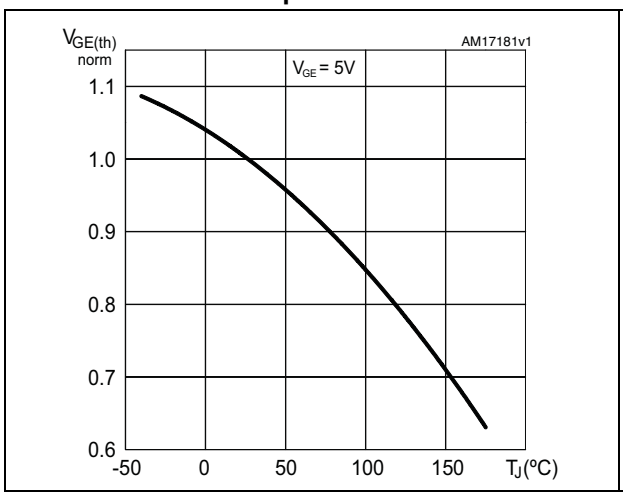


Figure 13. Normalized $V_{(BR)CES}$ vs. junction temperature

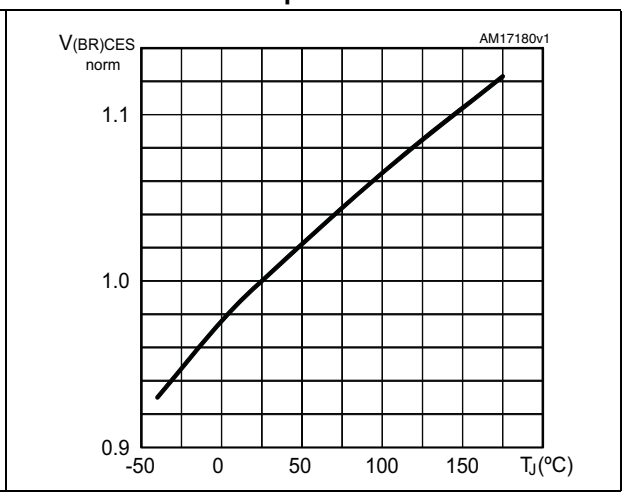


Figure 14. Capacitance variations

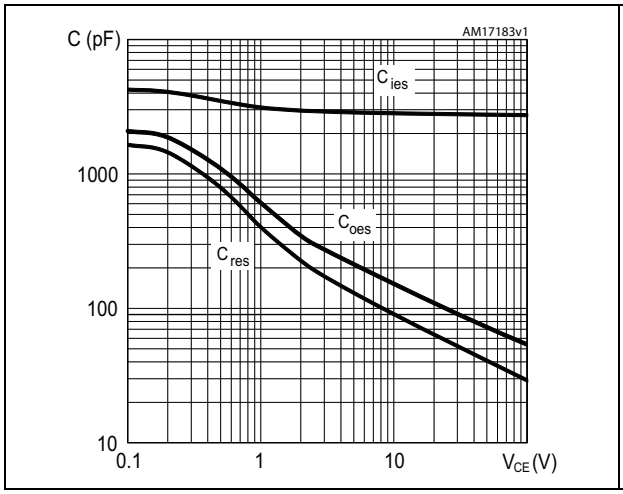


Figure 15. Gate charge vs. gate-emitter voltage

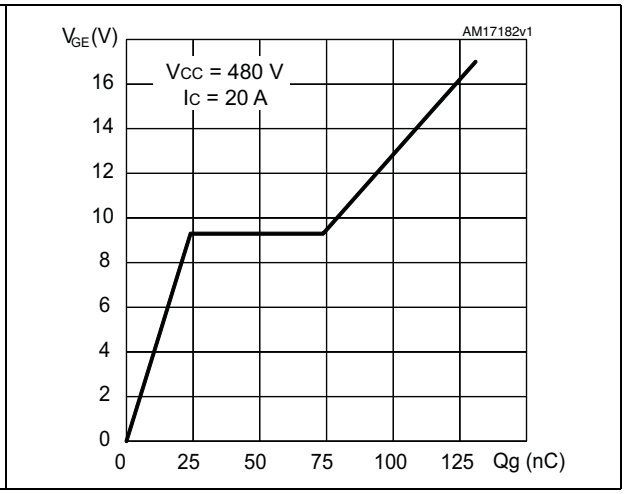


Figure 16. Switching losses vs. collector current

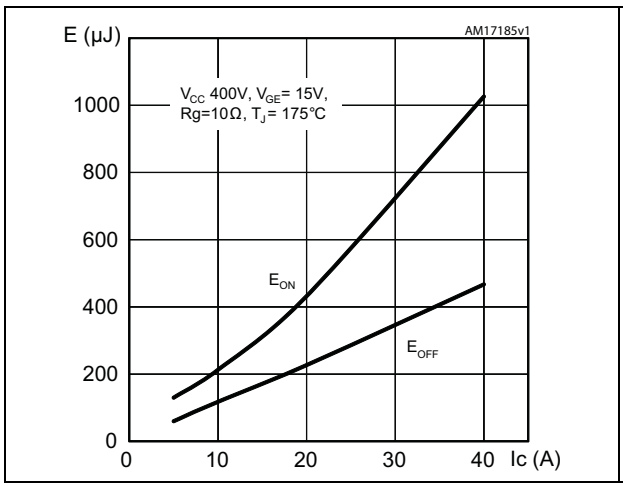


Figure 17. Switching losses vs. gate resistance

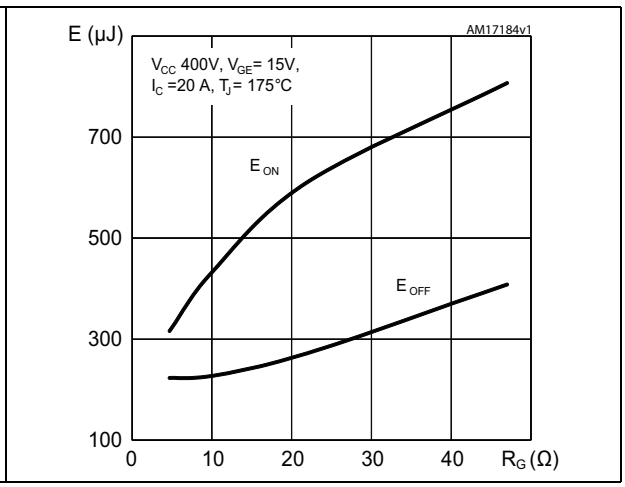


Figure 18. Switching losses vs. junction temperature

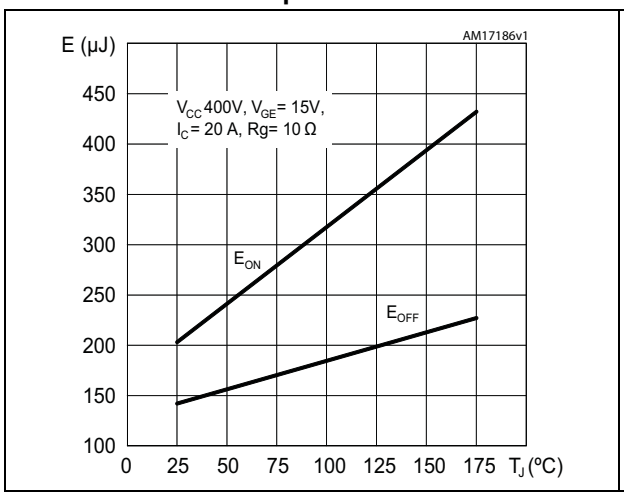


Figure 19. Switching losses vs. collector emitter voltage

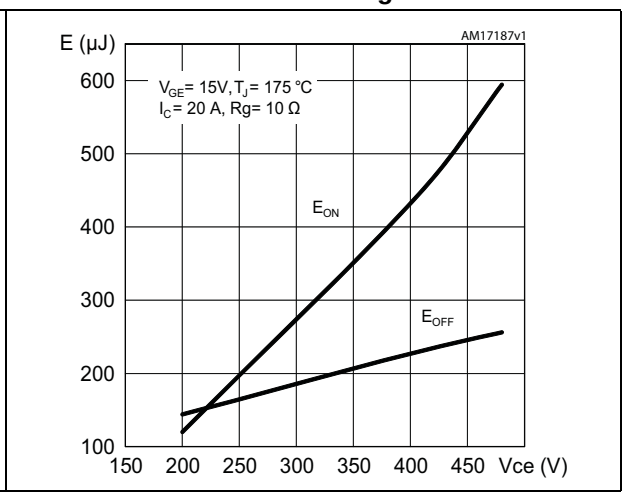


Figure 20. Switching times vs. collector current

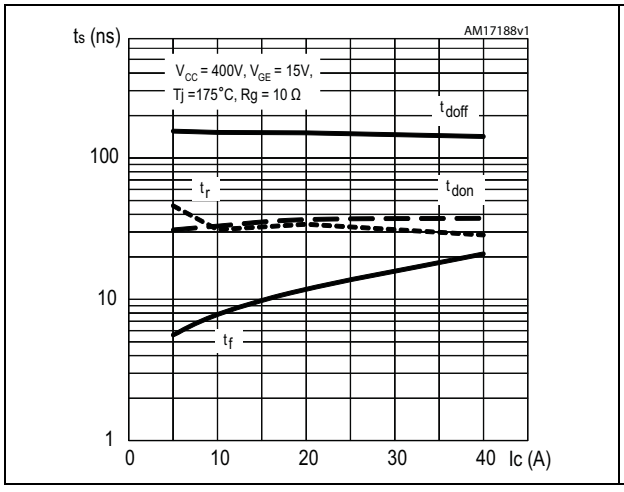


Figure 21. Switching times vs. gate resistance

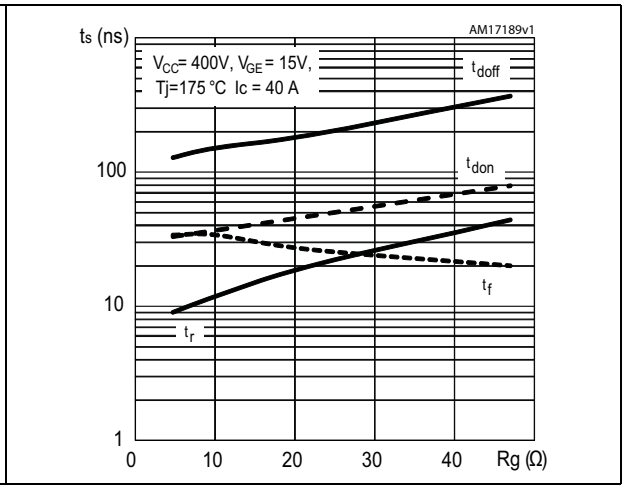


Figure 22. Transfer characteristics

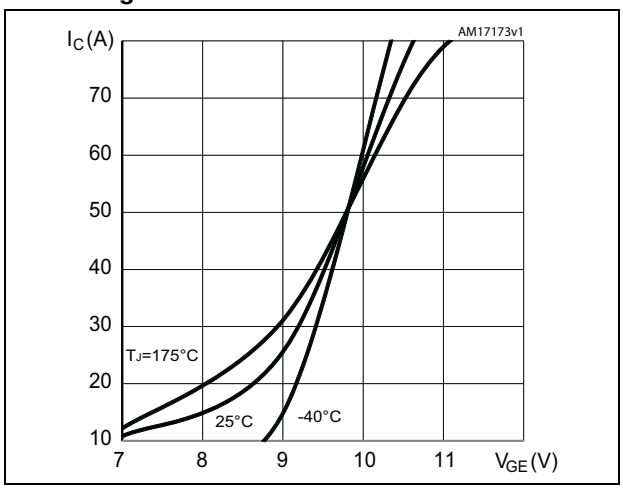


Figure 23. Thermal data for TO-3PF

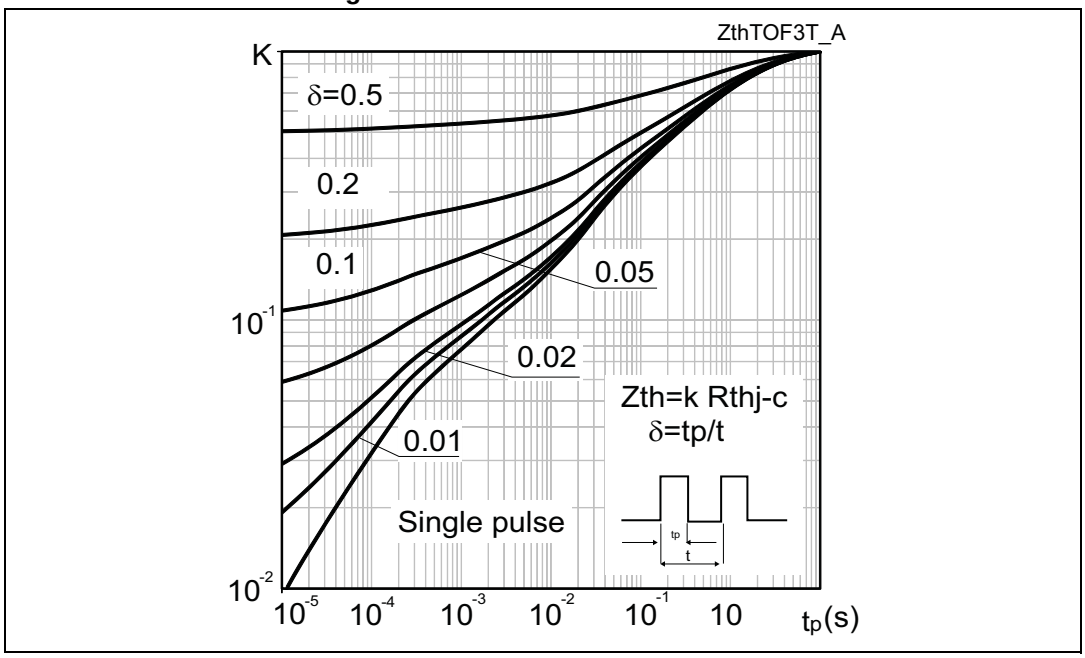
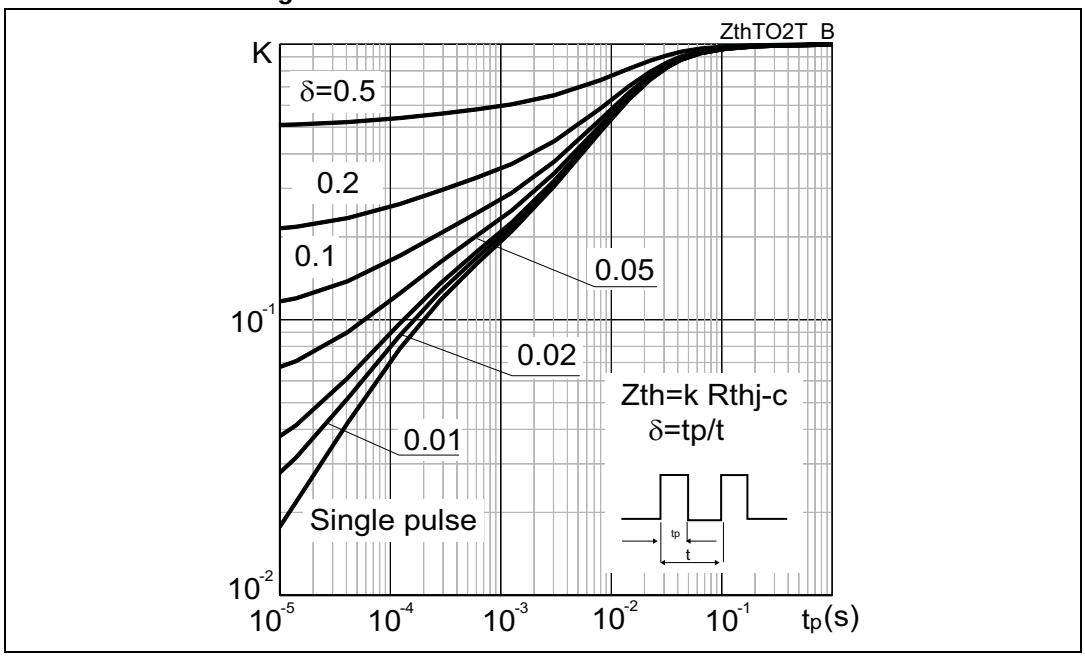


Figure 24. Thermal data for TO-3P and TO-247



3 Test circuits

Figure 25. Test circuit for inductive load switching

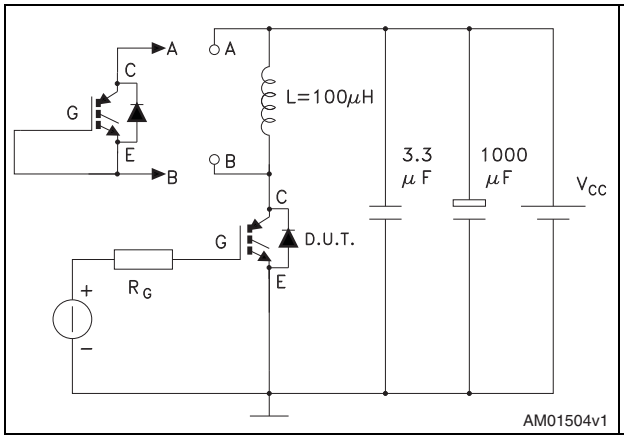


Figure 26. Gate charge test circuit

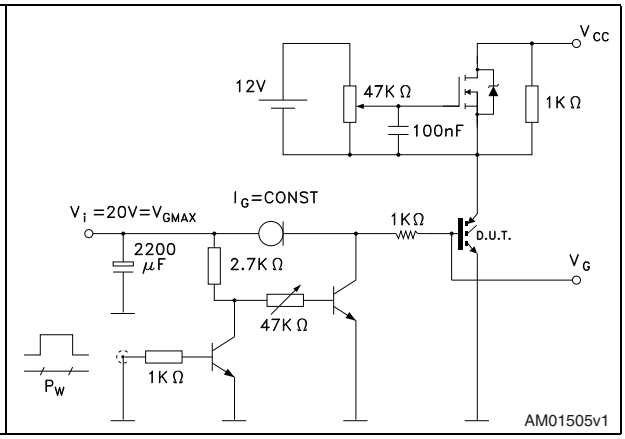
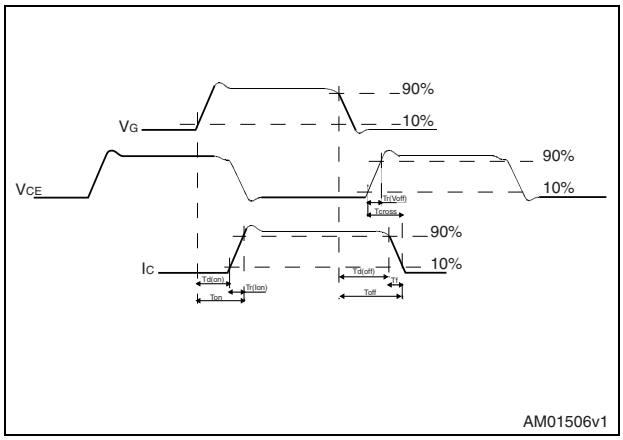


Figure 27. Switching waveform



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.

Table 7. 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

Figure 28. TO-3PF drawing

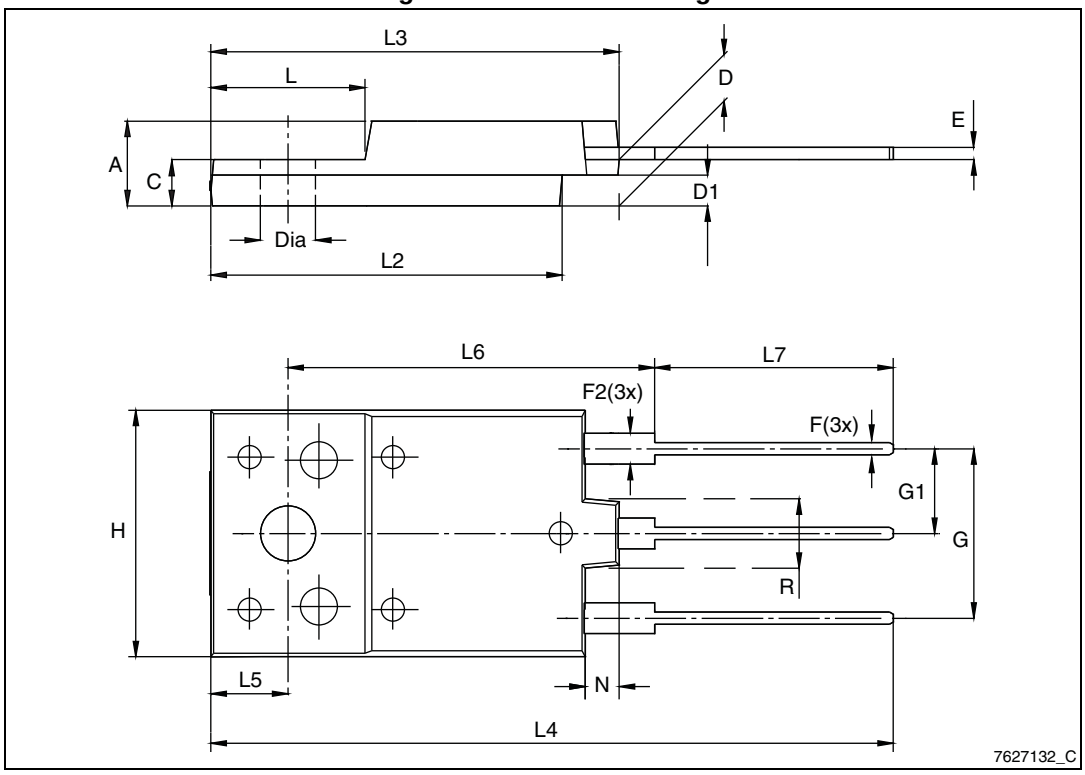


Table 8. TO-247 mechanical data

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

Figure 29. TO-247 drawing

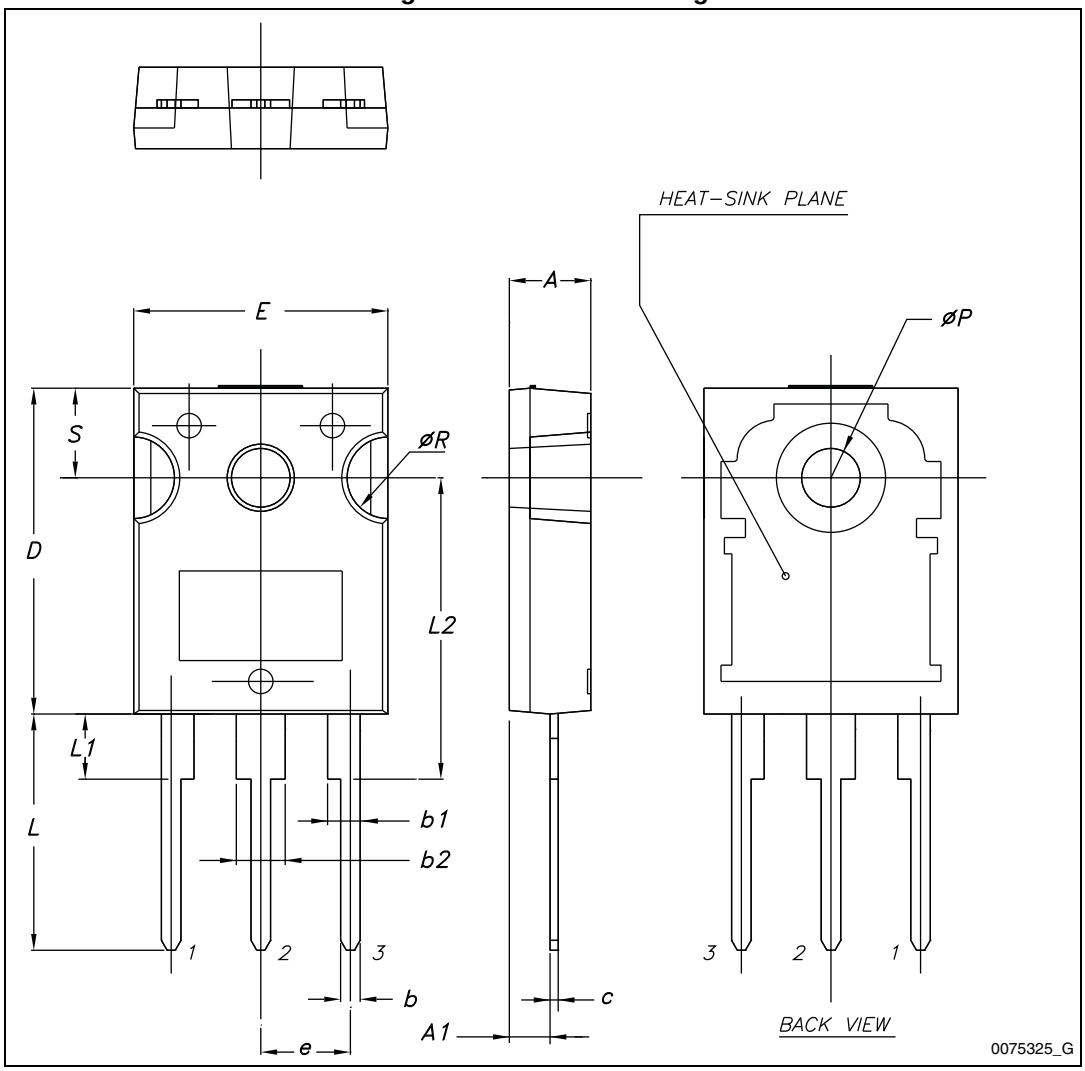
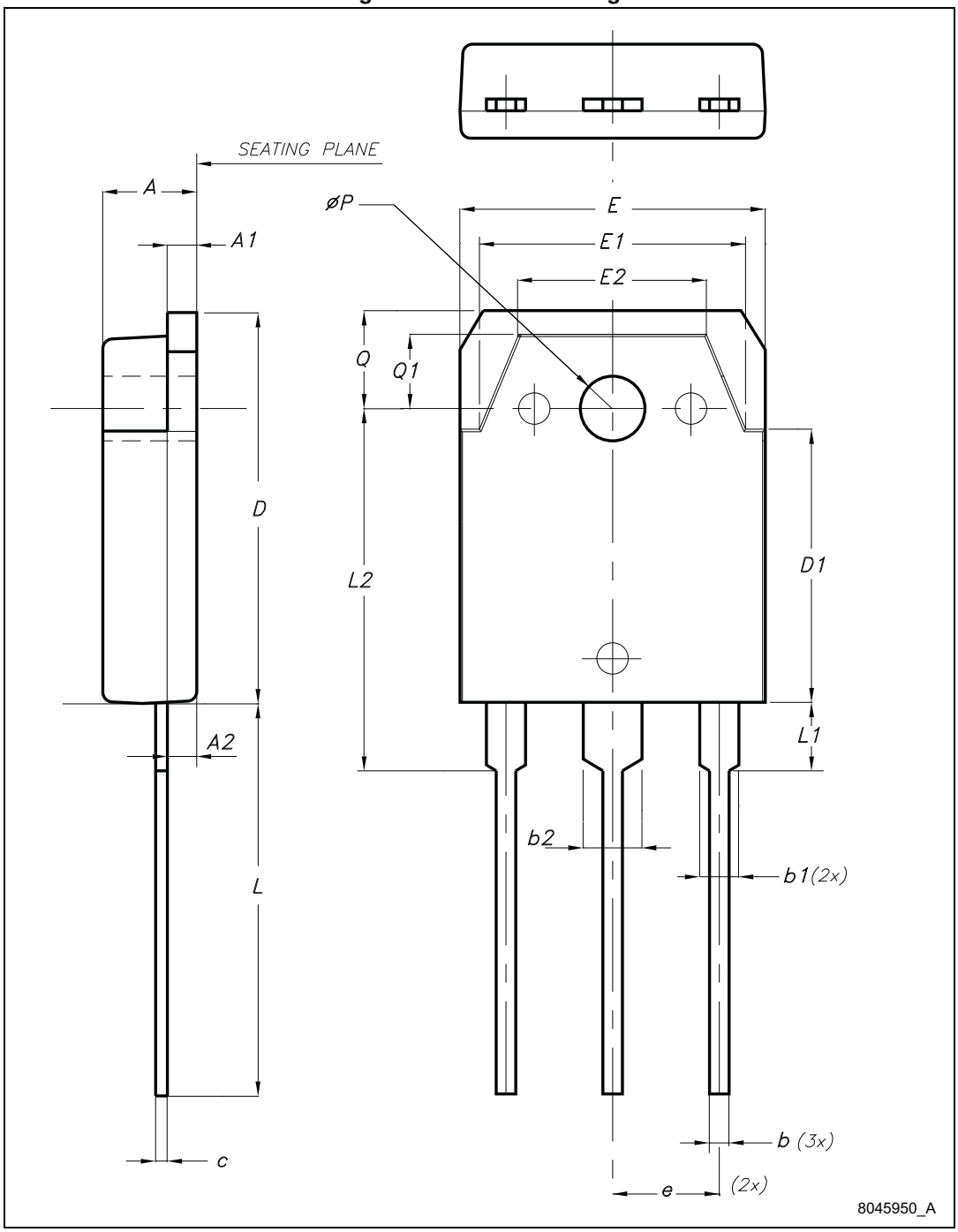


Table 9. TO-3P mechanical data

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 30. TO-3P drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
11-Jul-2013	1	Initial release.