STGFW40V60DF, STGW40V60DF, STGWT40V60DF

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

Datasheet - production data

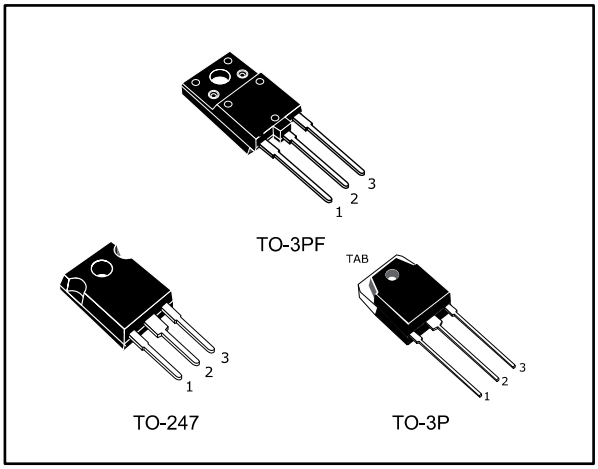
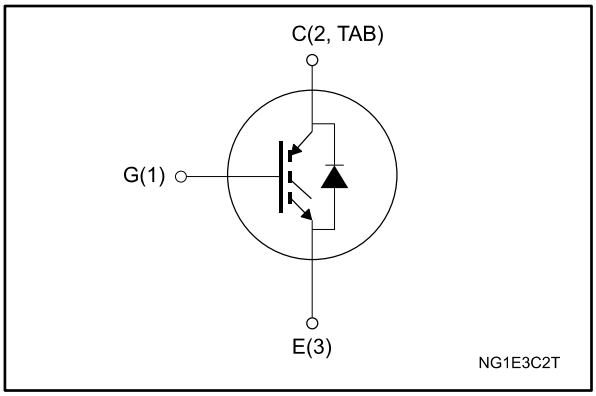


Figure 1: Internal schematic diagram



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 IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, the 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
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 V)	600		V
I_C	Continuous collector current at T_C = 25 °C	80		A
	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
	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, T_C = 25 °C)		3.5	kV
T_{STG}	Storage temperature range	-55 to 150		°C
T_J	Operating junction temperature range	-55 to 175		°C

Notes:

(1)Pulse width is 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	2.6	°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 V, 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		
		I_F = 40 A, T_J = 175 °C		1.3		
$V_{GE(th)}$	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, V_{CE} = 0 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, 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 V	-	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} = 0 to 15 V (see *Figure 35: " Gate charge test circuit"*)	-	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 34: " Test circuit for inductive load switching"*)	-	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 energy		-	456	-	µJ
E_{off} (2)	Turn-off switching energy		-	411	-	µJ
E_{ts}	Total switching energy		-	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 34: " Test circuit for inductive load switching"*)	-	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 energy		-	1330	-	µJ
E_{off} (2)	Turn-off switching energy		-	560	-	µJ
E_{ts}	Total switching energy		-	1890	-	µJ

Notes:

(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 = 40 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see *Figure 34: " Test circuit for inductive load switching"*)	-	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 34: " Test circuit for inductive load switching"*)	-	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

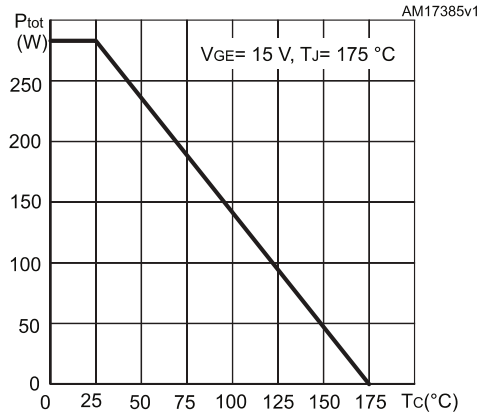


Figure 3: Collector current vs case temperature for TO-247 and TO-3P

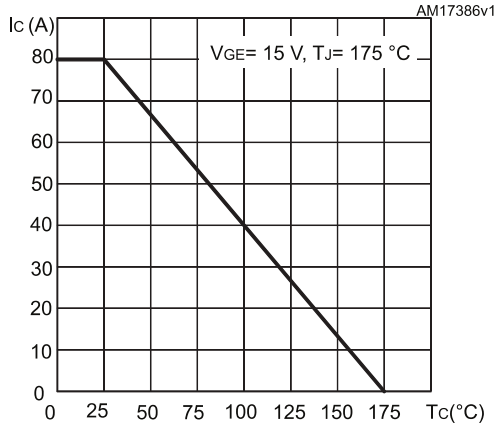


Figure 4: Power dissipation vs case temperature for TO-3PF

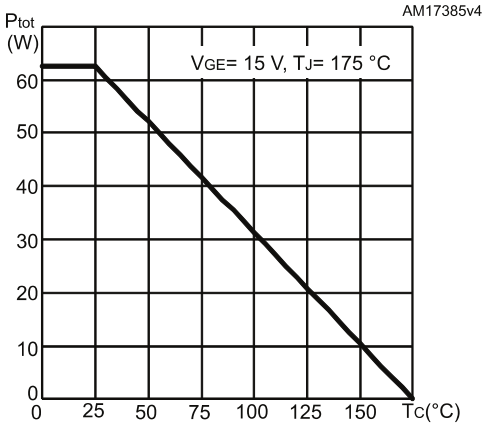


Figure 5: Collector current vs case temperature for TO-3PF

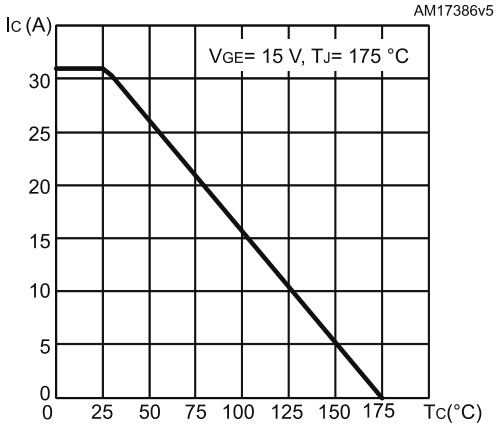


Figure 6: Output characteristics (T_J = 25 °C)

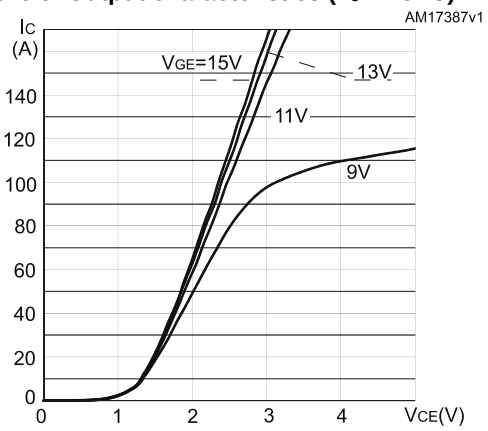


Figure 7: Output characteristics (T_J = 175 °C)

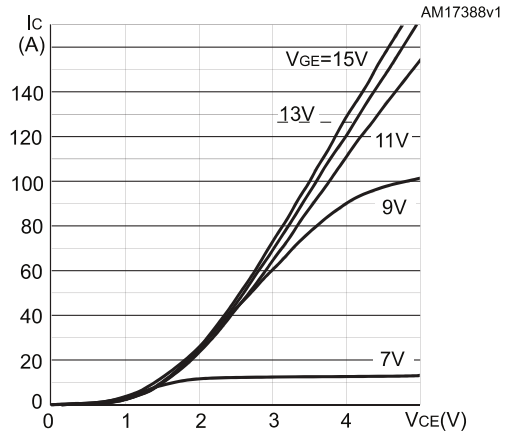


Figure 8: $V_{CE(sat)}$ vs junction temperature

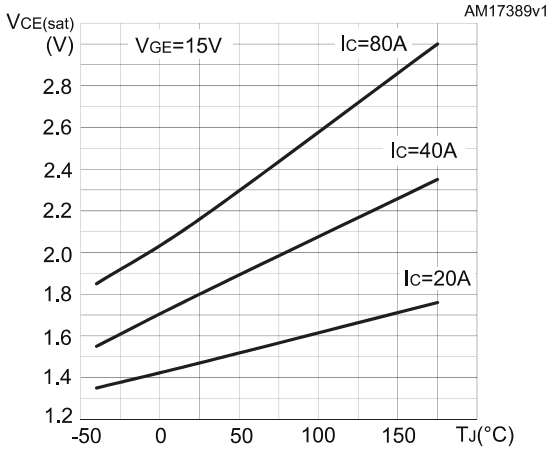


Figure 9: $V_{CE(sat)}$ vs collector current

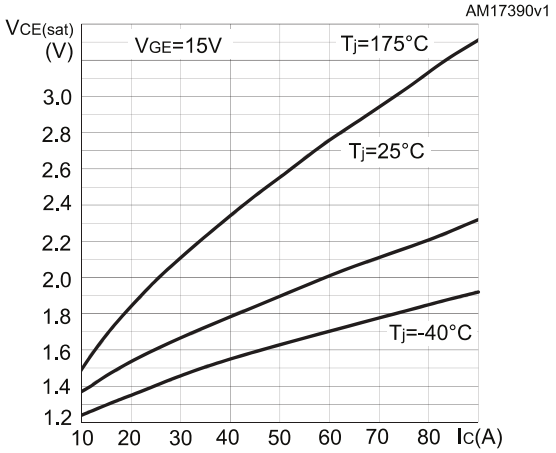


Figure 10: Collector current vs switching frequency for TO-247 and TO-3P

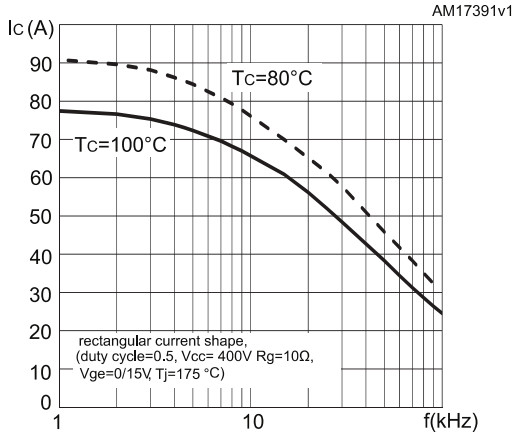


Figure 11: Collector current vs switching frequency for TO-3PF

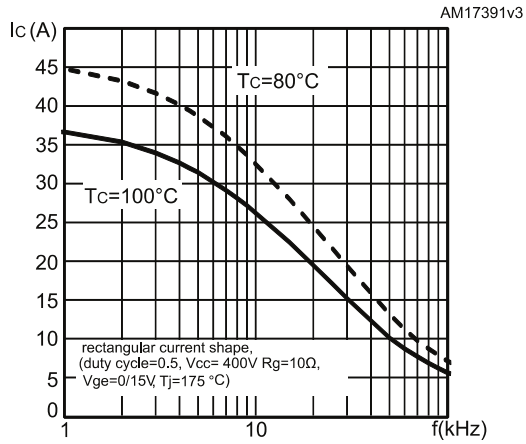


Figure 12: Forward bias safe operating area for TO-247 and TO-3P

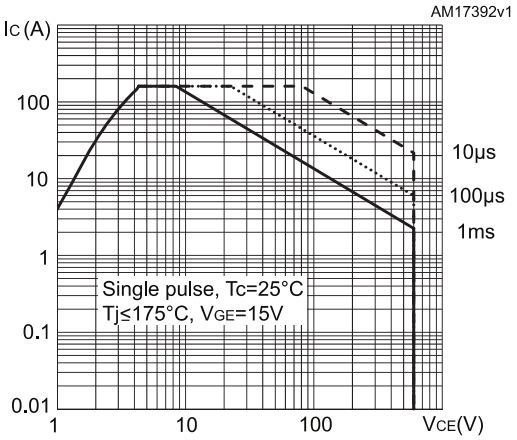


Figure 13: Forward bias safe operating area for TO-3PF

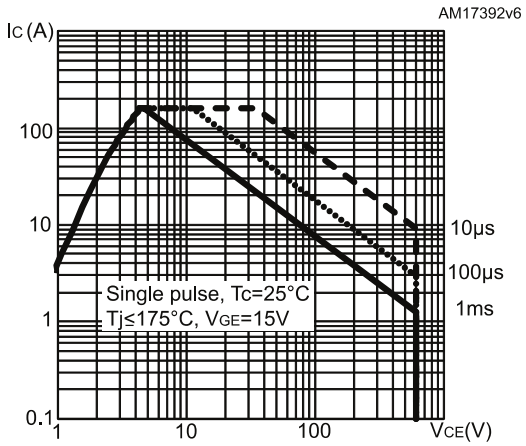


Figure 14: Transfer characteristics

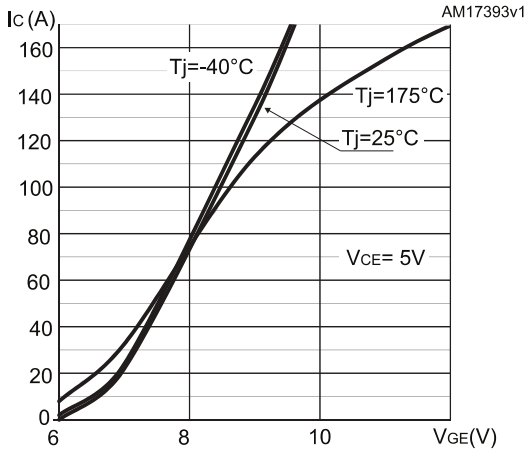


Figure 15: Diode V_F vs forward current

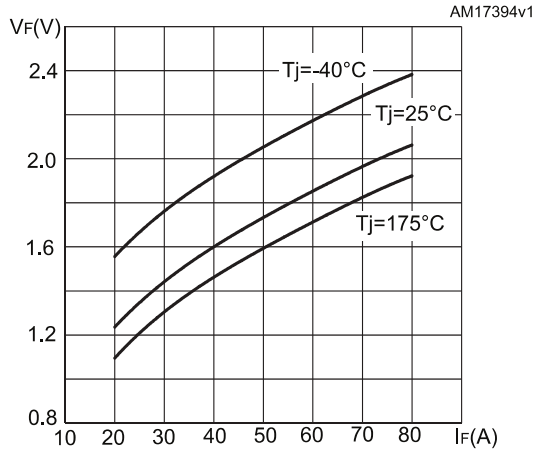


Figure 16: Normalized $V_{GE(th)}$ vs junction temperature

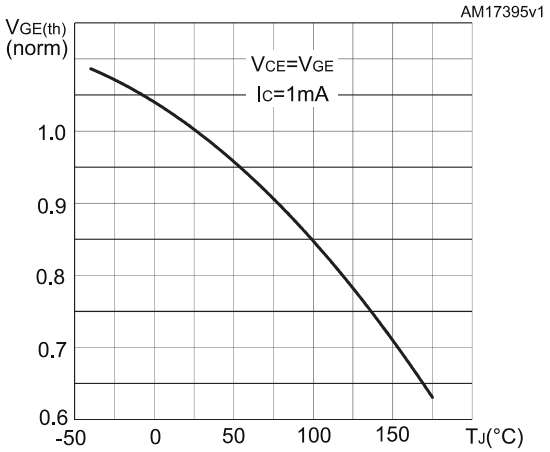


Figure 17: Normalized $V_{(BR)CES}$ vs junction temperature

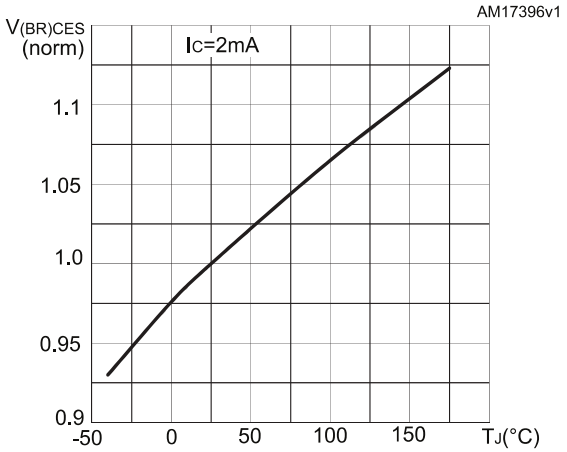


Figure 18: Capacitance variations

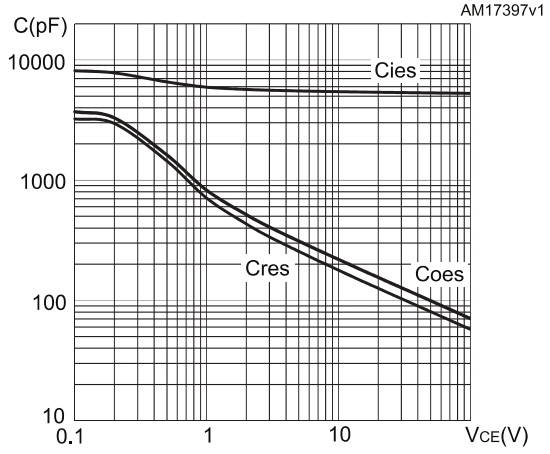


Figure 19: Gate charge vs gate-emitter voltage

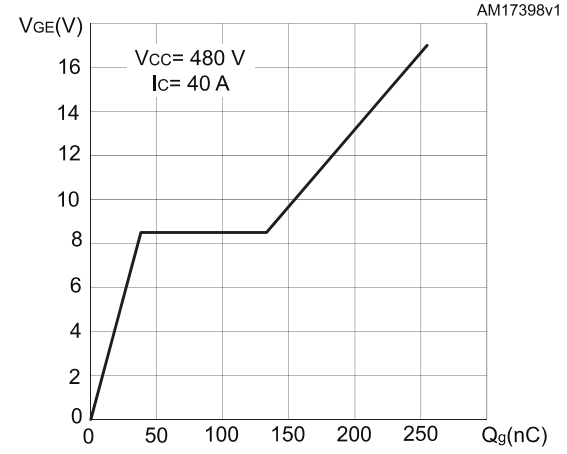


Figure 20: Switching energy vs collector current

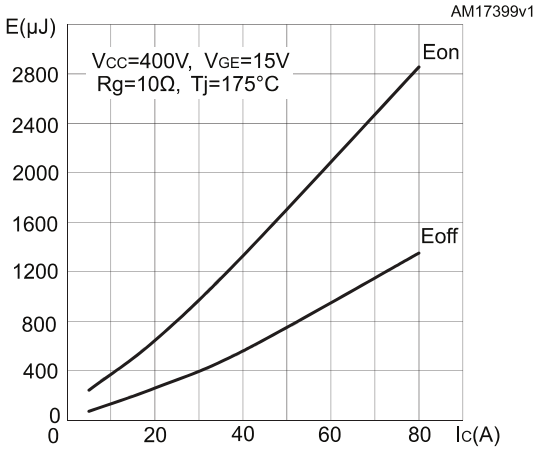


Figure 21: Switching energy vs gate resistance

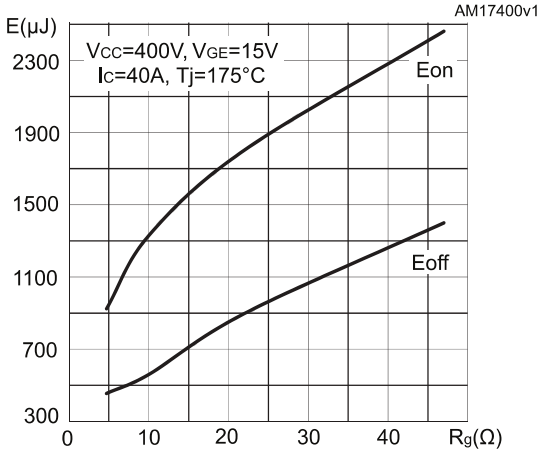


Figure 22: Switching energy vs junction temperature

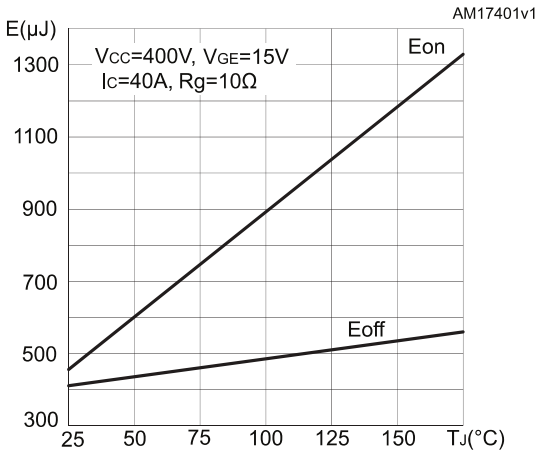


Figure 23: Switching energy vs collector emitter voltage

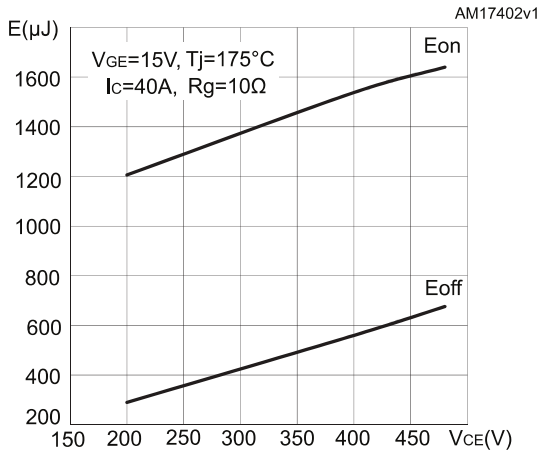


Figure 24: Switching times vs collector current

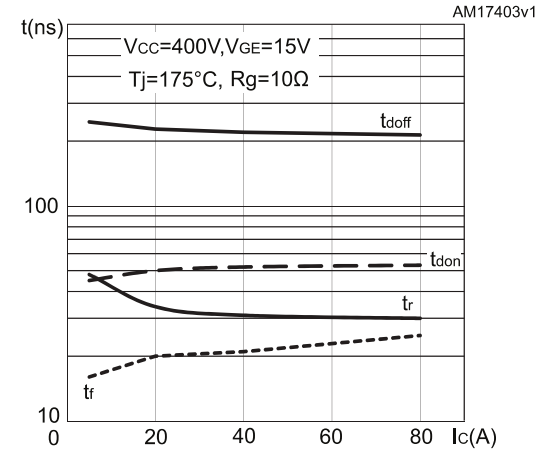


Figure 25: Switching times vs gate resistance

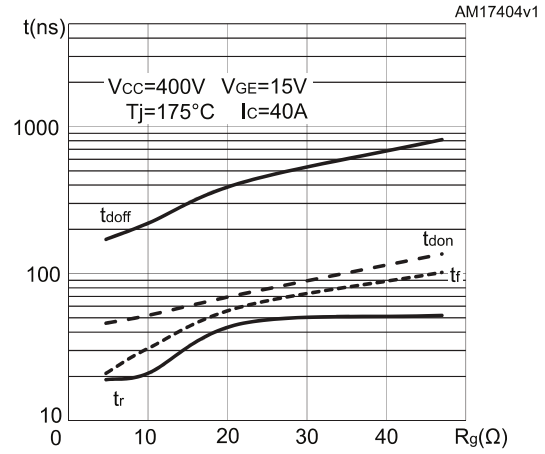


Figure 26: Reverse recovery current vs diode current slope

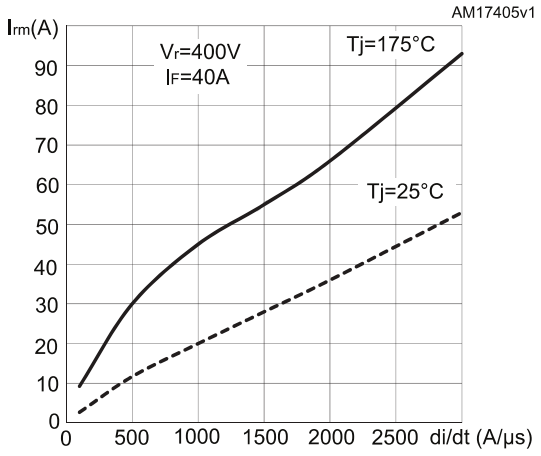


Figure 27: Reverse recovery time vs diode current slope

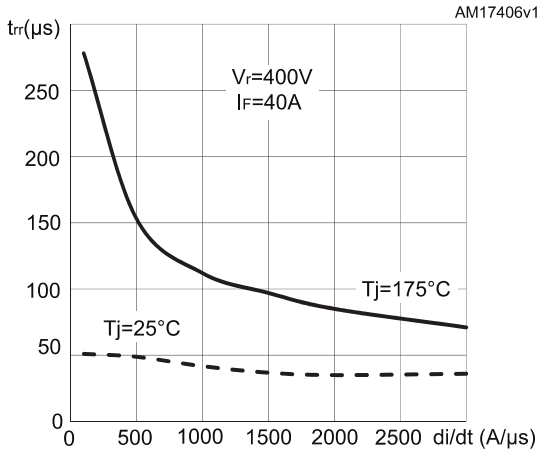


Figure 28: Reverse recovery charge vs diode current slope

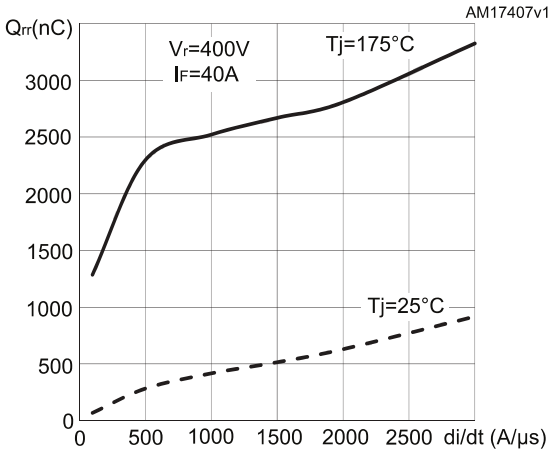


Figure 29: Reverse recovery energy vs diode current slope

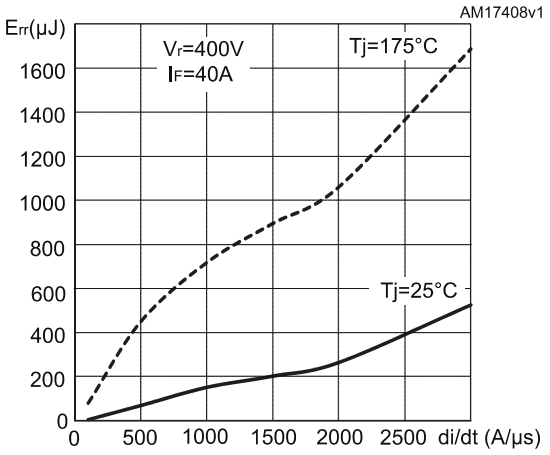


Figure 30: Thermal impedance for IGBT in TO-247 and TO-3P

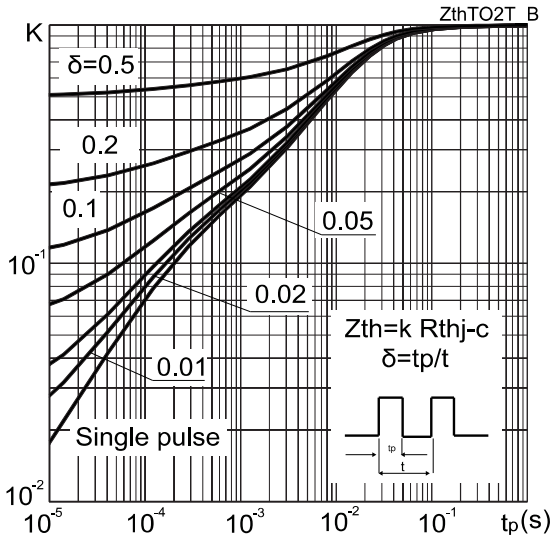


Figure 31: Thermal impedance for IGBT in TO-3PF

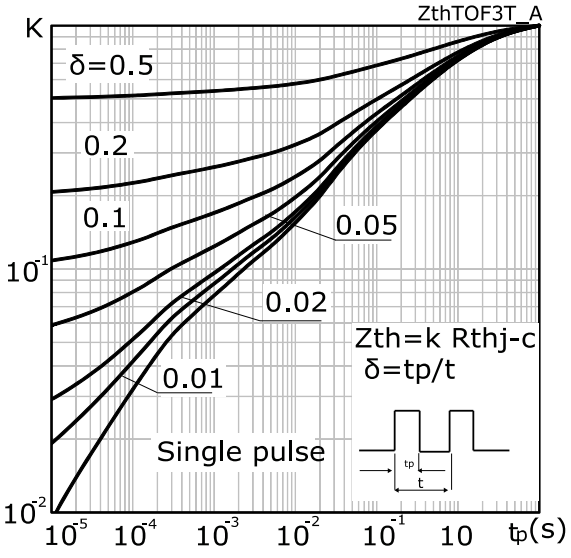


Figure 32: Thermal impedance for diode in TO-247 and TO-3P

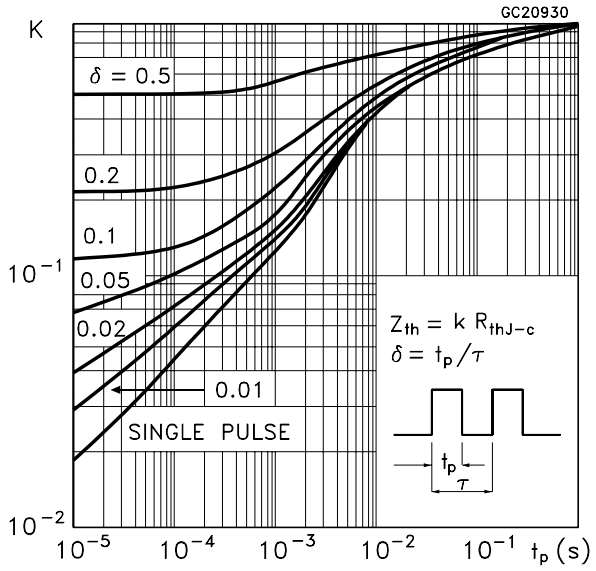
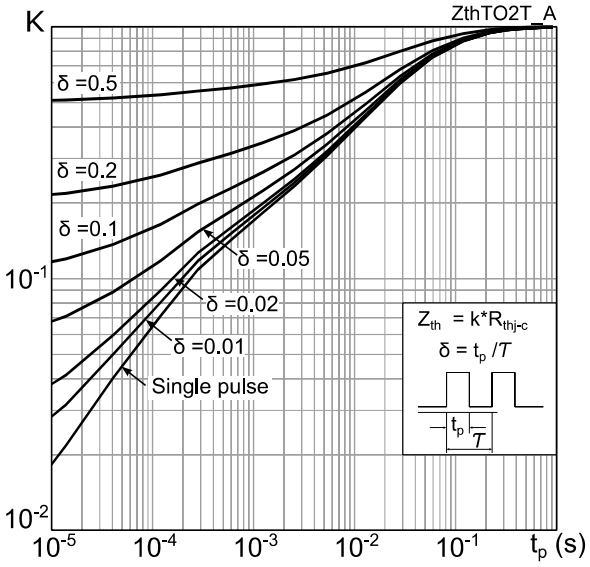


Figure 33: Thermal impedance for diode in TO-3PF



3 Test circuits

Figure 34: Test circuit for inductive load switching

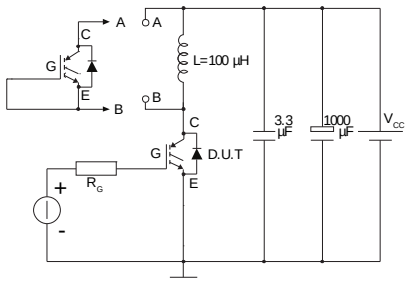


Figure 35: Gate charge test circuit

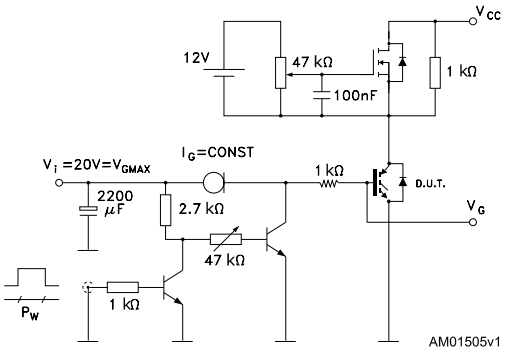


Figure 36: Switching waveform

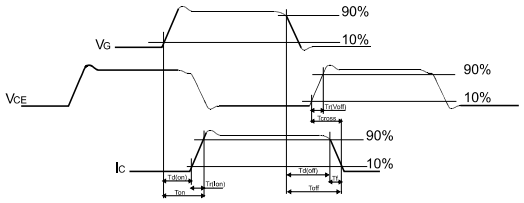
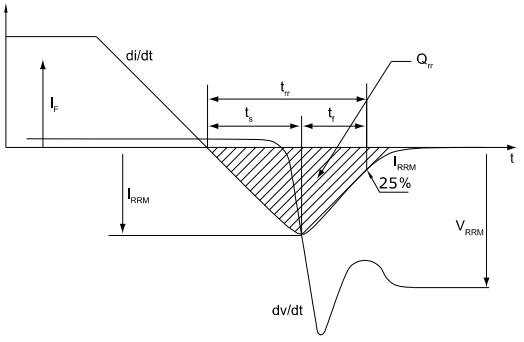


Figure 37: Diode reverse recovery waveform



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-3PF package information

Figure 38: TO-3PF package outline

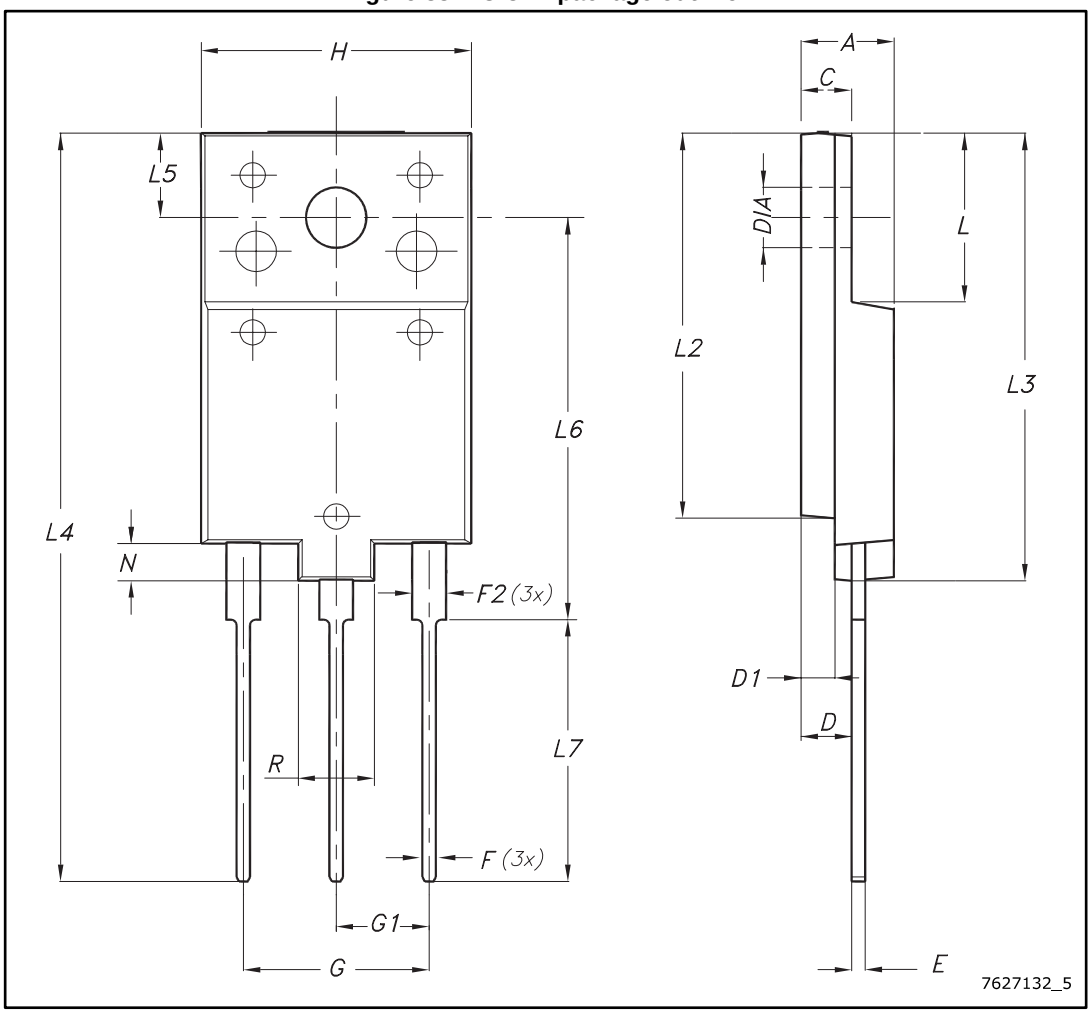


Table 8: TO-3PF mechanical data

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 package information

Figure 39: TO-247 package outline

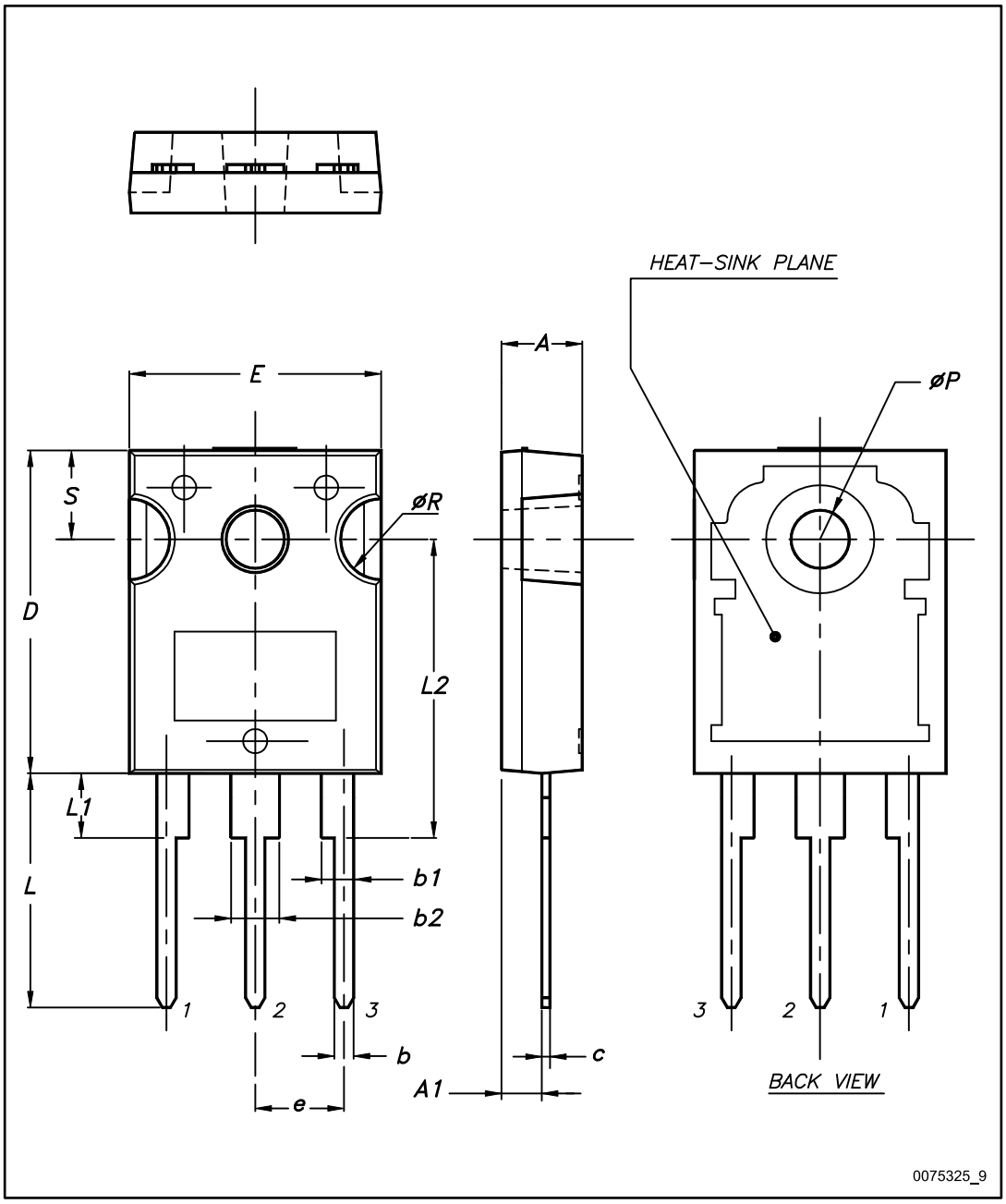


Table 9: TO-247 package mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

4.3 TO-3P package information

Figure 40: TO-3P package outline

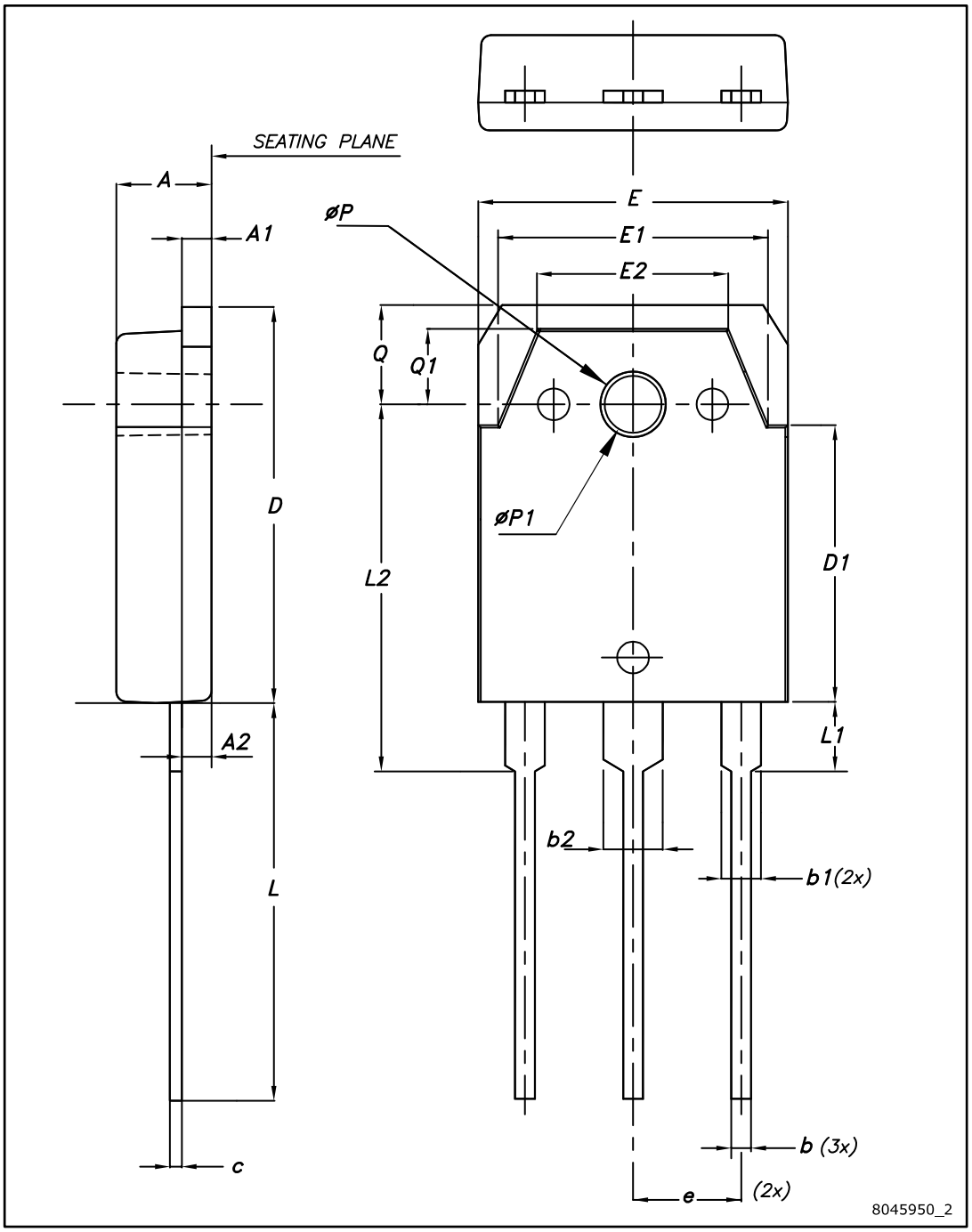


Table 10: TO-3P package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.80	5.00
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	20.00	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	5.00	5.20
Q1	3.60	3.80	4

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.
27-Oct-2017	9	Updated *Table 3: "Thermal data"*. Added *Figure 33: "Thermal impedance for diode in TO-3PF"*. Updated *Section 4: "Package information"*. Minor text changes

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