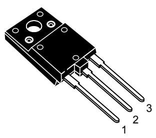
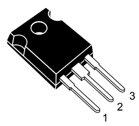
Datasheet

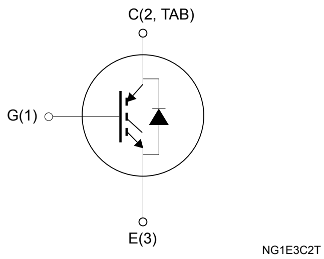
Trench gate field-stop IGBT, V series 600 V, 40 A very high speed



TO-3PF



TO-247



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

- Welding
- Power factor correction
- UPS
- Solar inverters
- Chargers

Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are 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.

Product status links
STGFW40V60DF
STGW40V60DF

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-247	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 power dissipation at T_C = 25 °C	283	98.5	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

1. *Pulse width is limited by maximum junction temperature.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		TO-247	TO-3PF	
R_{thJC}	Thermal resistance, junction-to-case IGBT	0.53	1.52	°C/W
R_{thJC}	Thermal resistance, junction-to-case diode	1.14	1.95	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	50		°C/W

2 Electrical characteristics

T_J = 25 °C unless otherwise specified

Table 3. 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} = 600 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ±20 V			±250	nA

Table 4. 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 34. Gate charge test circuit)	-	226	-	nC
Q_{ge}	Gate-emitter charge		-	38	-	nC
Q_{gc}	Gate-collector charge		-	95	-	nC

Table 5. 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. 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 33. 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

1. *Including the reverse recovery of the diode.*
2. *Including the tail of the collector current.*

Table 6. 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. 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 33. 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 1. Power dissipation vs case temperature for TO-247

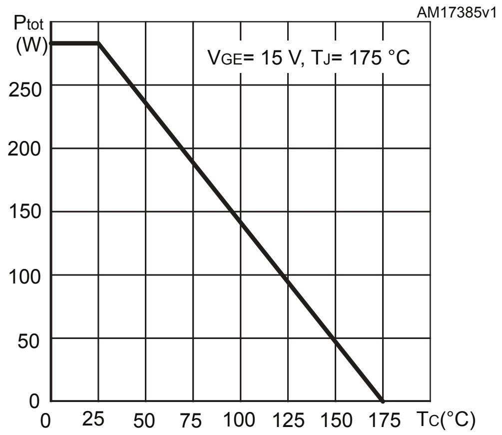


Figure 2. Collector current vs case temperature for TO-247

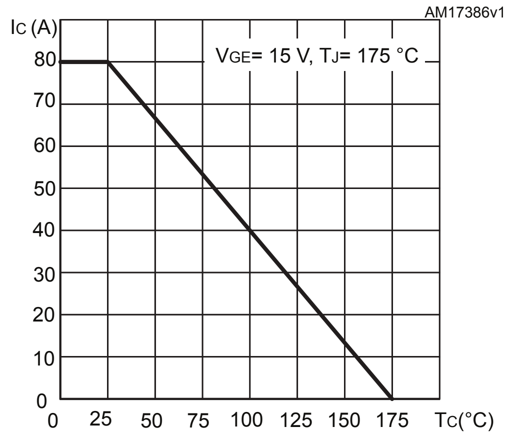


Figure 3. Power dissipation vs case temperature for TO-3PF

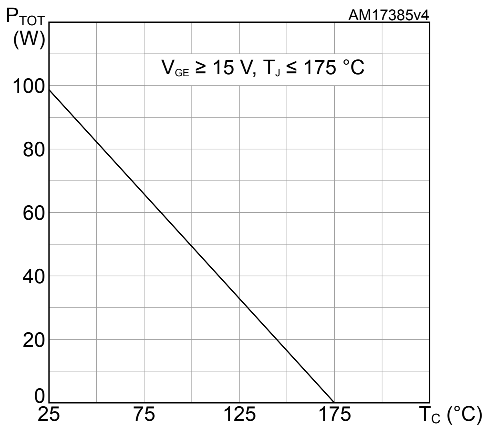


Figure 4. Collector current vs case temperature for TO-3PF

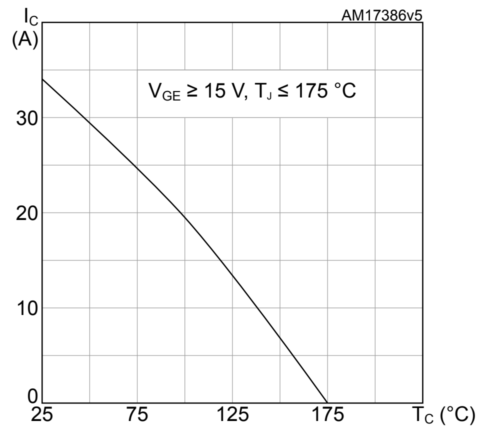


Figure 5. Output characteristics (T_J = 25 °C)

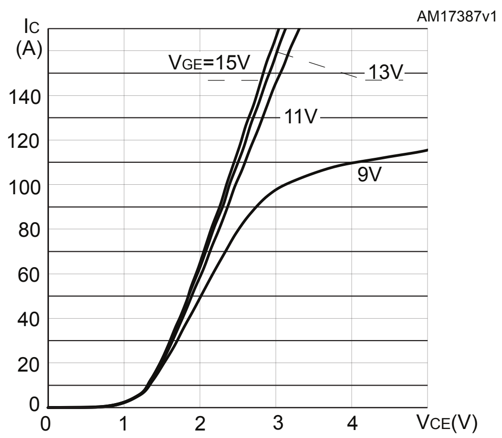


Figure 6. Output characteristics (T_J = 175 °C)

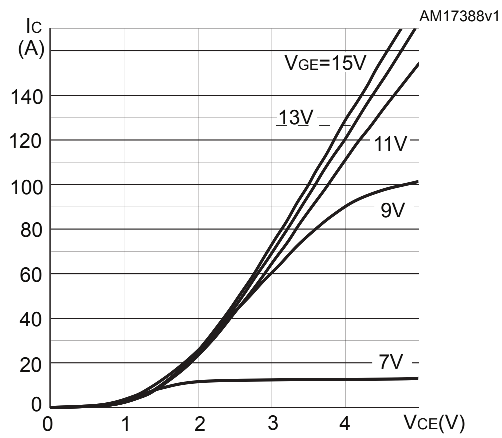


Figure 7. $V_{CE(sat)}$ **vs junction temperature**

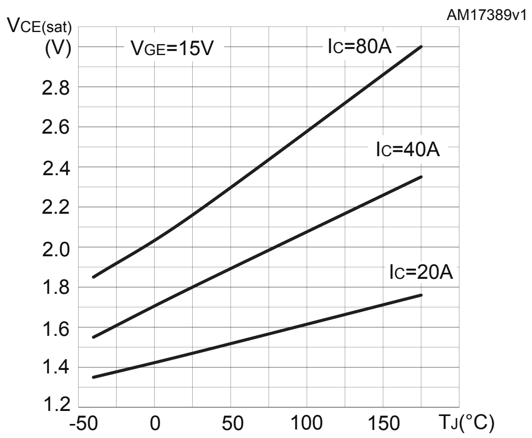


Figure 8. $V_{CE(sat)}$ **vs collector current**

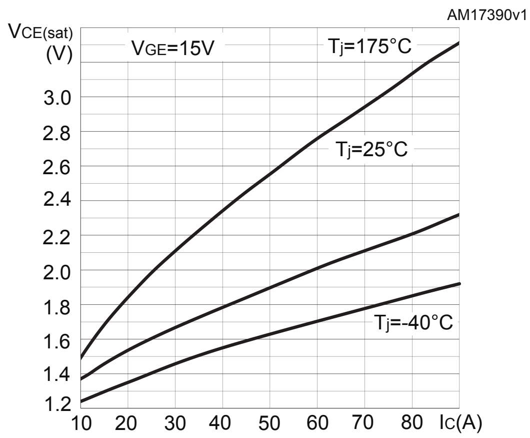


Figure 9. Collector current vs switching frequency for TO-247

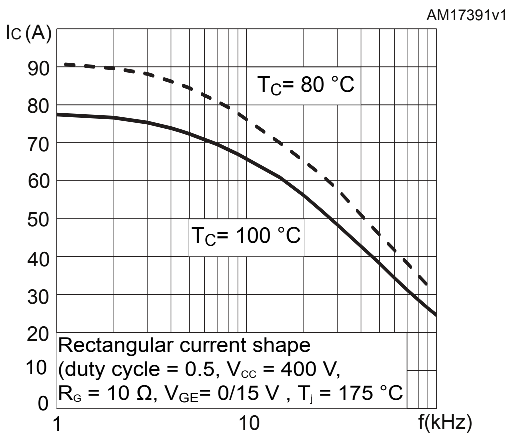


Figure 10. Collector current vs switching frequency for TO-3PF

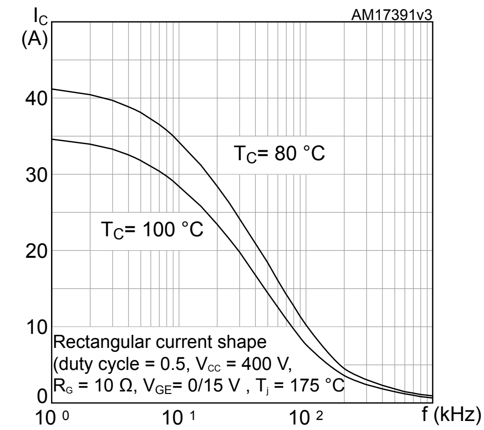


Figure 11. Forward bias safe operating area for TO-247

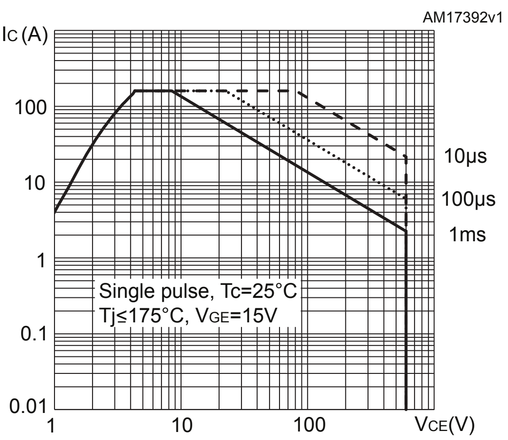


Figure 12. Forward bias safe operating area for TO-3PF

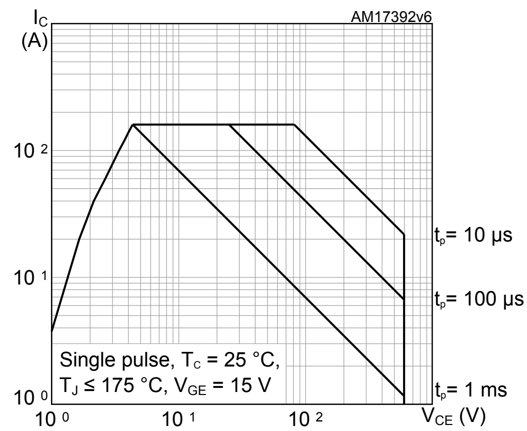


Figure 13. Transfer characteristics

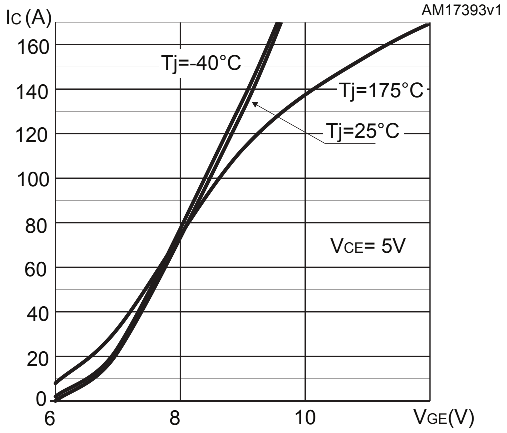


Figure 14. Diode V_F vs forward current

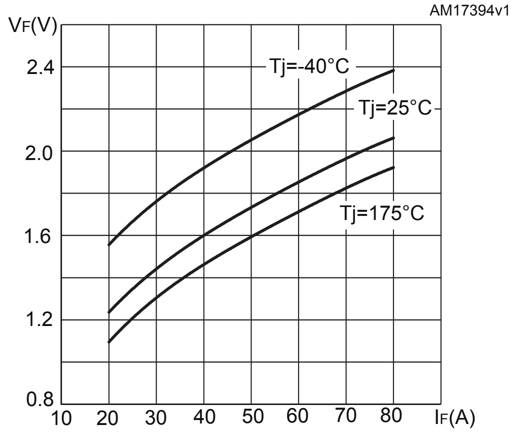


Figure 15. Normalized $V_{GE(th)}$ vs junction temperature

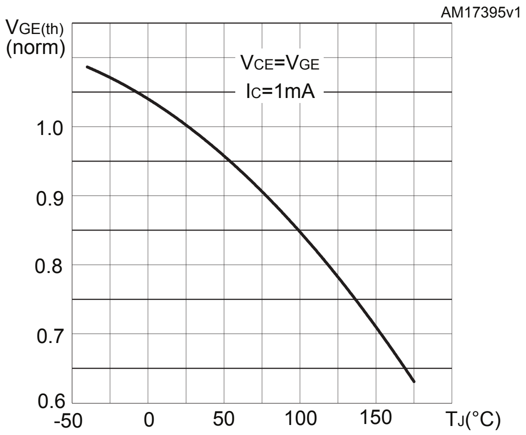


Figure 16. Normalized $V_{(BR)CES}$ vs junction temperature

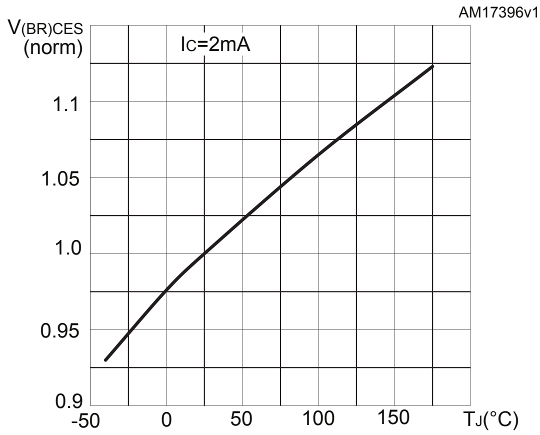


Figure 17. Capacitance variations

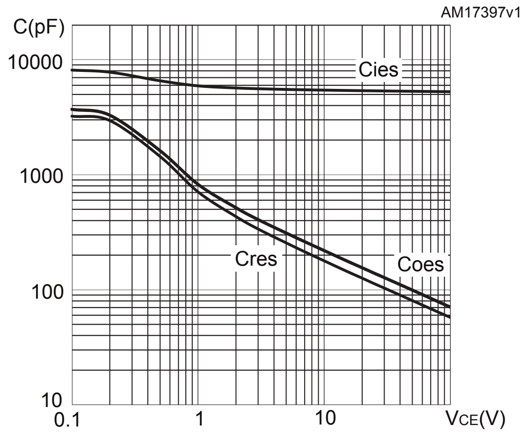


Figure 18. Gate charge vs gate-emitter voltage

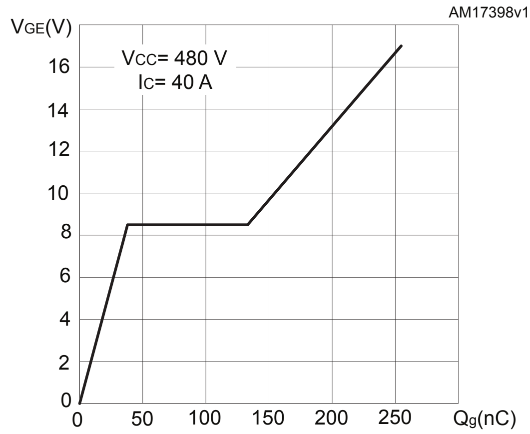


Figure 19. Switching energy vs collector current

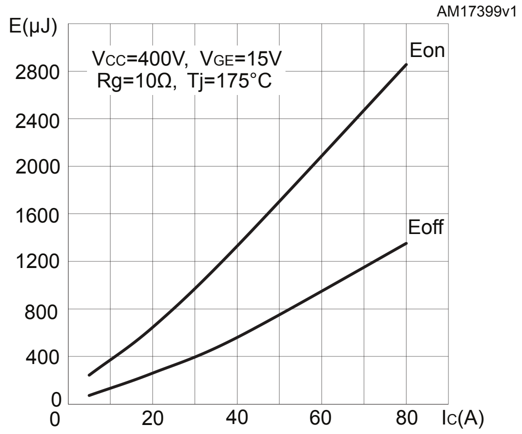


Figure 20. Switching energy vs gate resistance

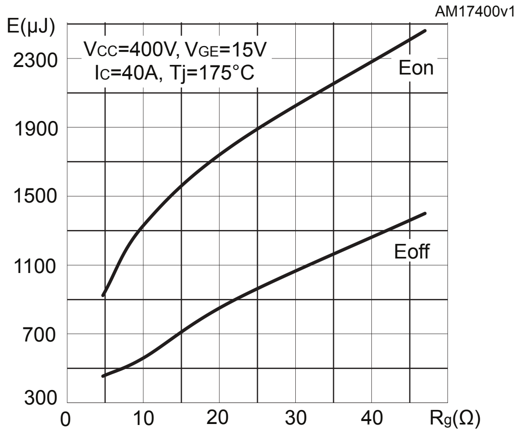


Figure 21. Switching energy vs junction temperature

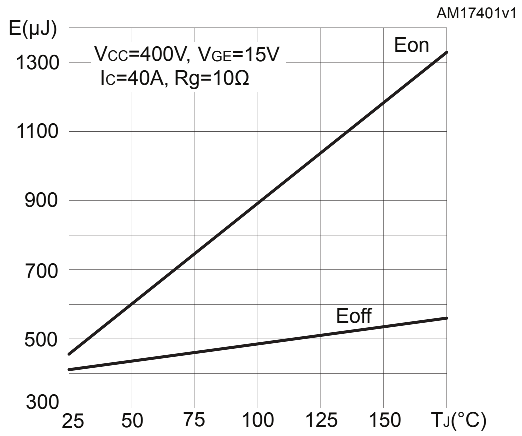


Figure 22. Switching energy vs collector emitter voltage

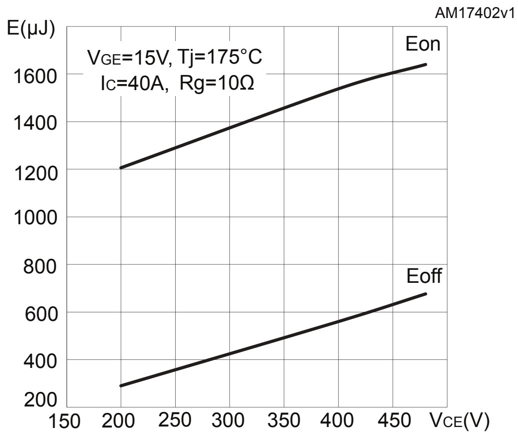


Figure 23. Switching times vs collector current

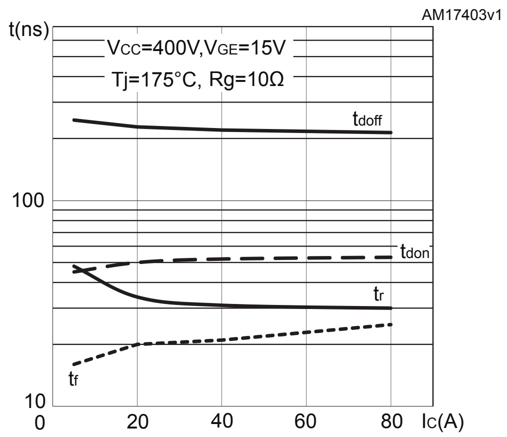


Figure 24. Switching times vs gate resistance

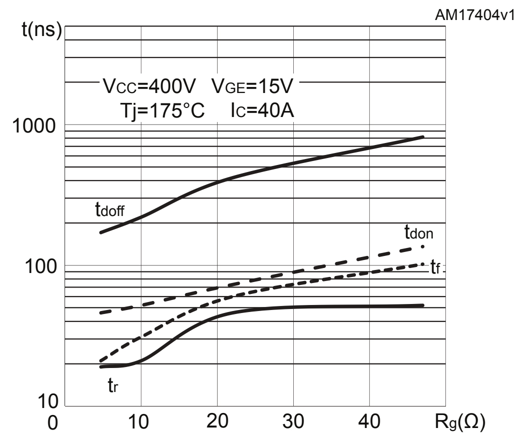


Figure 25. Reverse recovery current vs diode current slope

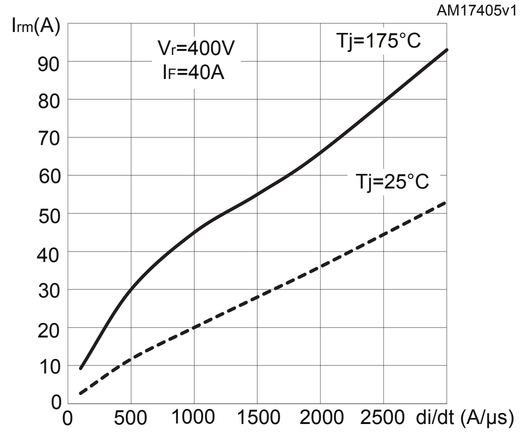


Figure 26. Reverse recovery time vs diode current slope

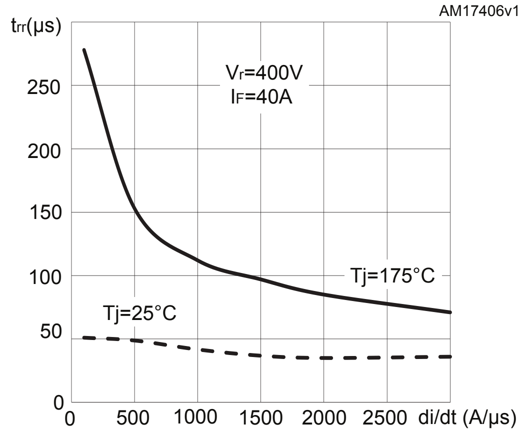


Figure 27. Reverse recovery charge vs diode current slope

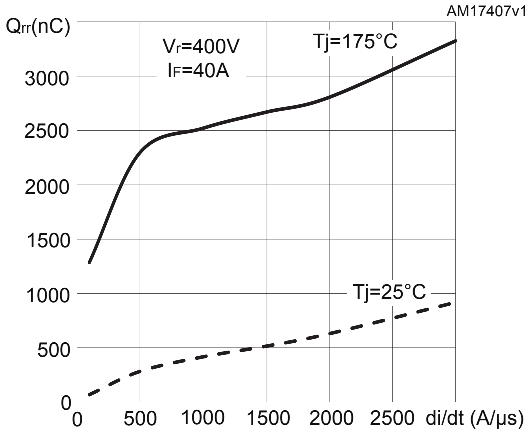


Figure 28. Reverse recovery energy vs diode current slope

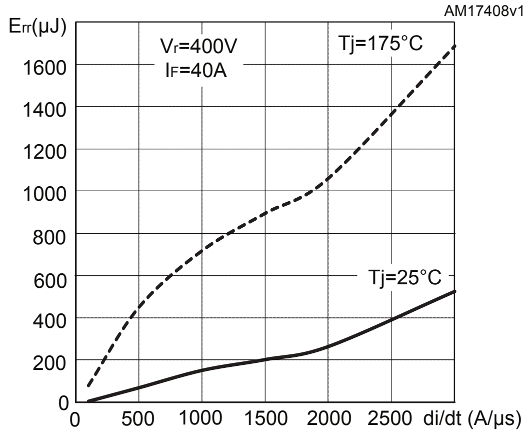


Figure 29. Thermal impedance for IGBT in TO-247

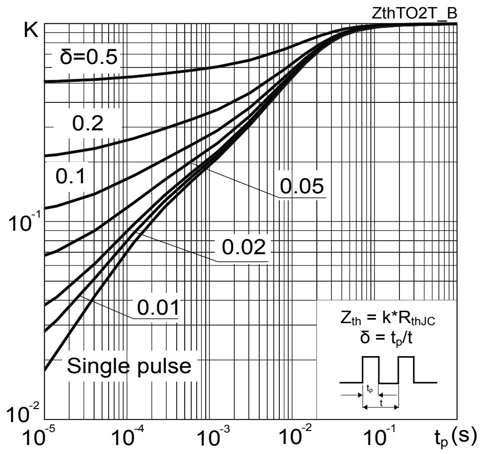


Figure 30. Thermal impedance for IGBT in TO-3PF

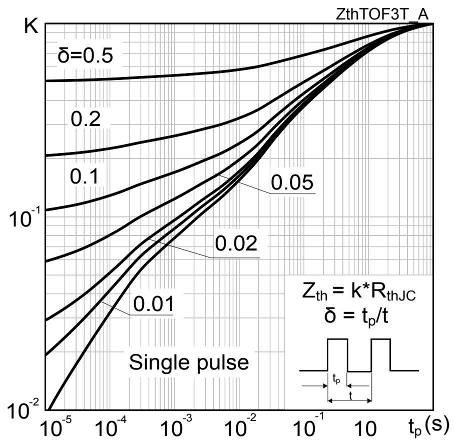


Figure 31. Thermal impedance for diode in TO-247

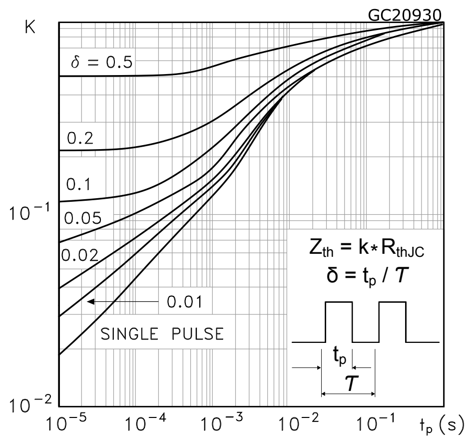
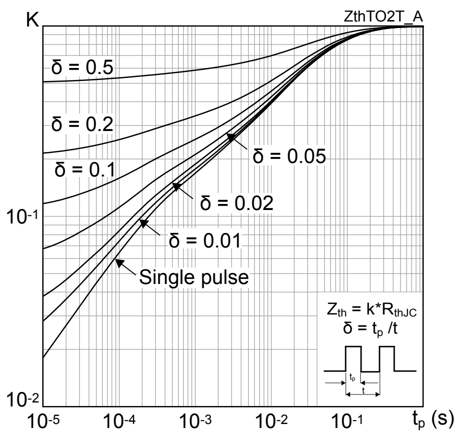


Figure 32. Thermal impedance for diode in TO-3PF



3 Test circuits

Figure 33. Test circuit for inductive load switching

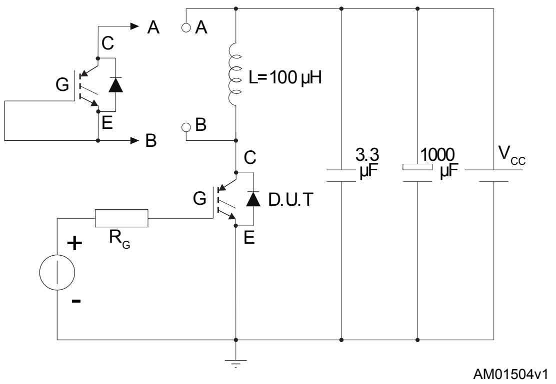


Figure 34. Gate charge test circuit

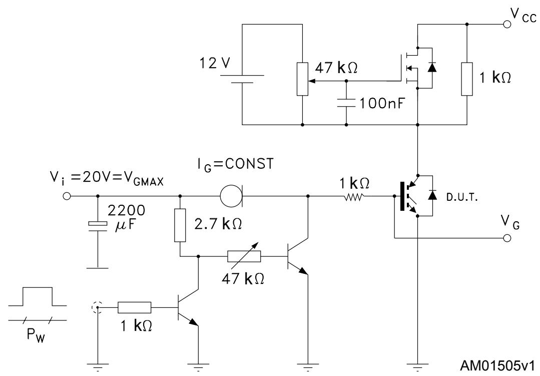


Figure 35. Switching waveform

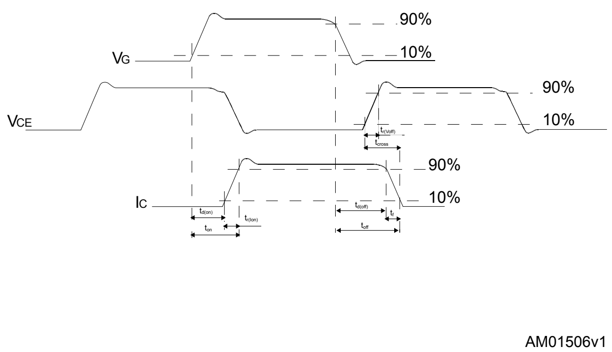
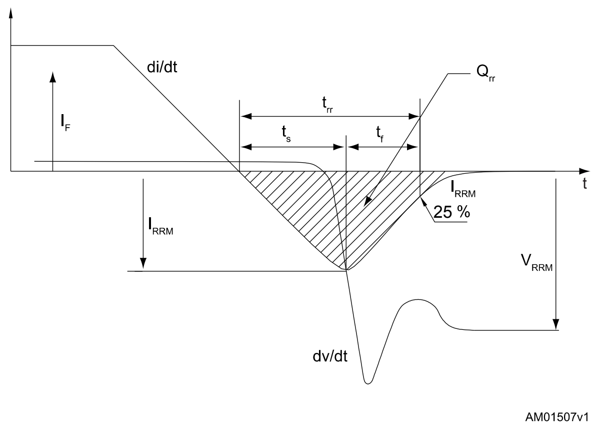


Figure 36. Diode reverse recovery waveform



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 37. TO-3PF package outline

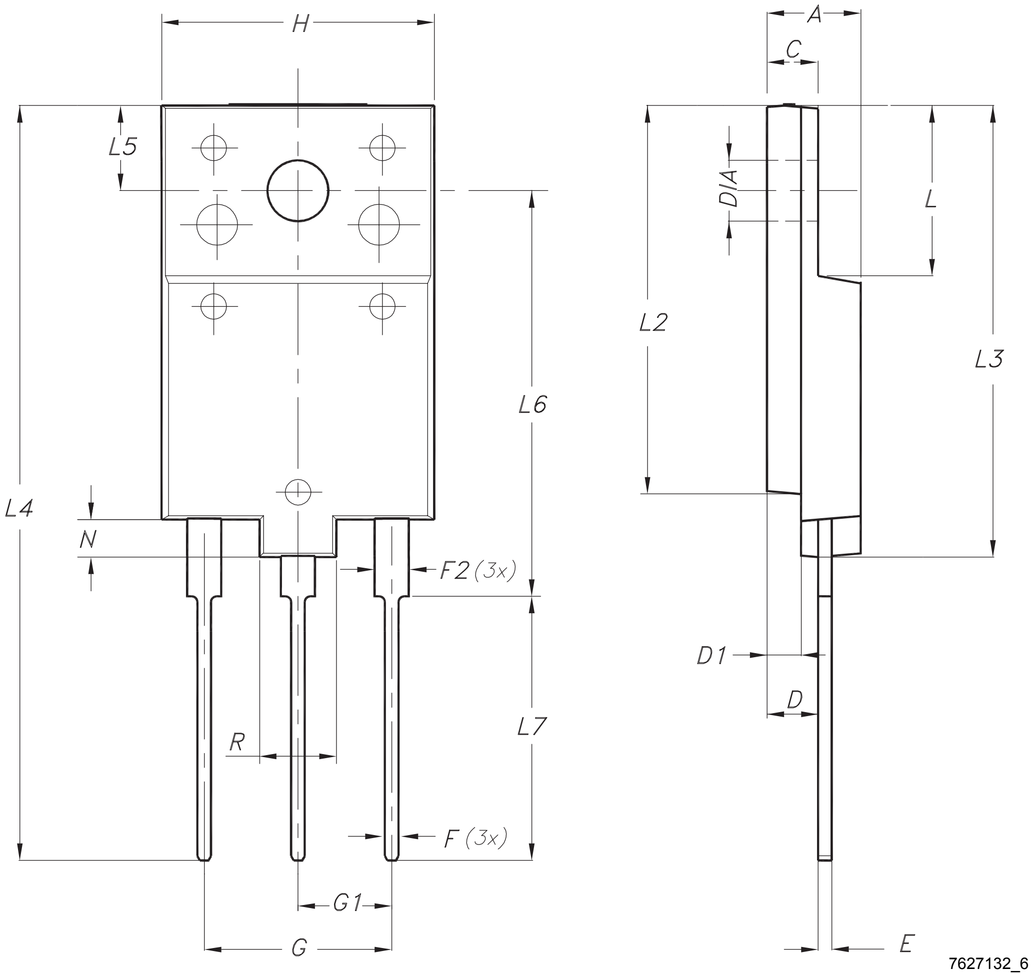


Table 7. TO-3PF mechanical data

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	10.00	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		15.00
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

4.2 TO-247 package information

Figure 38. TO-247 package outline

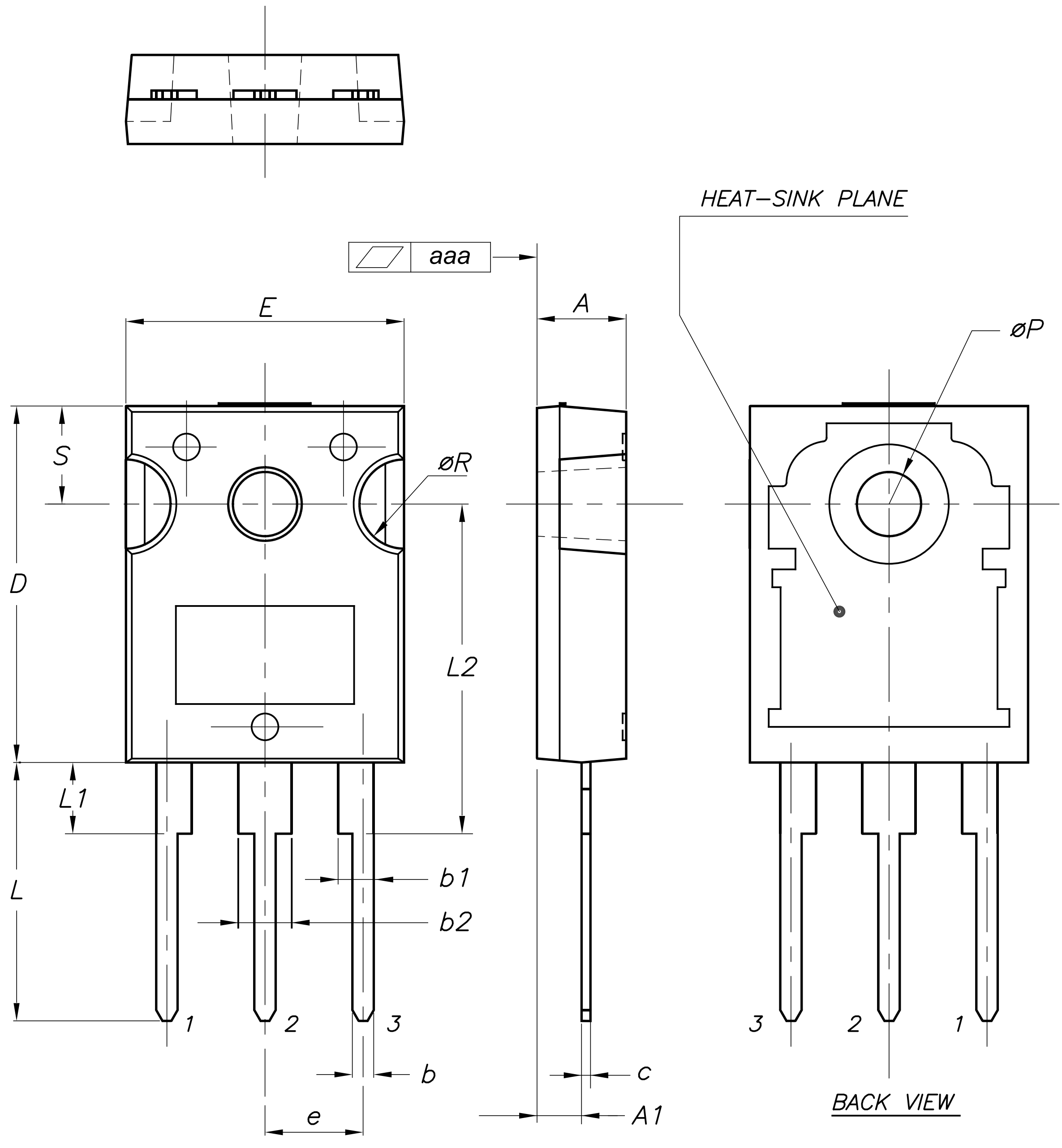


Table 8. **TO-247 package mechanical data**

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
aaa		0.04	0.10

5 Ordering information

Table 9. **Order codes**

Order code	Marking	Package	Packing
STGFW40V60DF	G40V60DF	TO-3PF	Tube
STGW40V60DF	GW40V60DF	TO-247	

Revision history

Table 10. **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
06-Mar-2020	10	Updated *Section 5 Ordering information*. Minor text changes.
17-Feb-2021	11	Modified *Figure 3. Power dissipation vs case temperature for TO-3PF*, *Figure 4. Collector current vs case temperature for TO-3PF, Figure 10. Collector current vs switching frequency for TO-3PF* and *Figure 12. Forward bias safe operating area for TO-3PF*. Minor text changes.
06-Jun-2022	12	The part number STGWT40V60DF has been removed and the document has been updated accordingly. Updated test conditions for the I_{CES} in Table 3. Static characteristics. Updated Section 4.2 TO-247 package information. Minor text changes.

Contents