

## Trench gate field-stop IGBT, V series 600 V, 20 A very high speed

Datasheet - production data

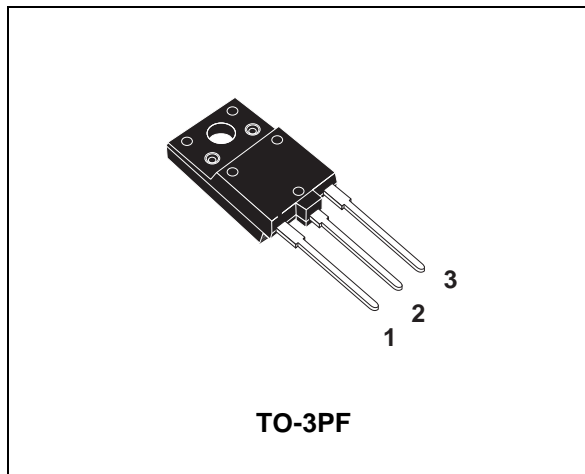
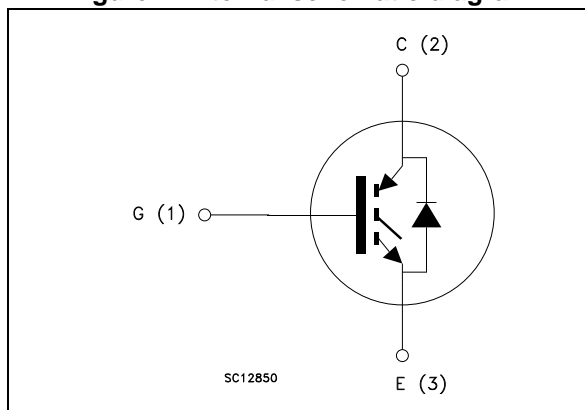


Figure 1. Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ °C}$
- Very high speed switching series
- Tail-less switching off
- $V_{CE(sat)} = 1.8\text{ V (typ.) @ } I_C = 20\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode
- 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 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
STGFW20V60DF	GFW20V60DF	TO-3PF	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	40	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	20	A
$I_{CP}^{(1)}$	Pulsed collector current	80	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current at $T_C = 25\text{ °C}$	40	A
$I_F$	Continuous forward current at $T_C = 100\text{ °C}$	20	A
$I_{FP(1)}$	Pulsed forward current	80	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	52	W
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ ; $T_c = 25\text{ °C}$ )	3.5	kV
$T_{STG}$	Storage temperature range	- 55 to 150	$^{\circ}\text{C}$
$T_J$	Operating junction temperature	- 55 to 175	$^{\circ}\text{C}$

1. Pulse width limited by maximum junction temperature.

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	2.9	$^{\circ}\text{C}/\text{W}$
$R_{thJC}$	Thermal resistance junction-case diode	3.4	$^{\circ}\text{C}/\text{W}$
$R_{thJA}$	Thermal resistance junction-ambient	50	$^{\circ}\text{C}/\text{W}$

## 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 ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$		1.8	2.2	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 125\text{ °C}$		2.15		
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 175\text{ °C}$		2.3		
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$		1.7	2.2	V
		$I_F = 20\text{ A}, T_J = 125\text{ °C}$		1.55		V
		$I_F = 20\text{ A}, T_J = 175\text{ °C}$		1.3		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	2800	-	pF
$C_{oes}$	Output capacitance		-	110	-	pF
$C_{res}$	Reverse transfer capacitance		-	64	-	pF
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}, I_C = 20\text{ A},$ $V_{GE} = 15\text{ V},$ see <a href="#">Figure 28</a>	-	116	-	nC
$Q_{ge}$	Gate-emitter charge		-	24	-	nC
$Q_{gc}$	Gate-collector charge		-	50	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 27</a>	-	38	-	ns
$t_r$	Current rise time		-	10	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1556	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	149	-	ns
$t_f$	Current fall time		-	15	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	200	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	130	-	$\mu$ J
$E_{ts}$	Total switching losses	-	330	-	$\mu$ J	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 27</a>	-	37	-	ns
$t_r$	Current rise time		-	12	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1340	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	150	-	ns
$t_f$	Current fall time		-	23	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	430	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	210	-	$\mu$ J
$E_{ts}$	Total switching losses	-	640	-	$\mu$ J	

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	$I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 27</a> $di/dt = 1000\text{ A}/\mu\text{s}$	-	40	-	ns
$Q_{rr}$	Reverse recovery charge		-	320	-	nC
$I_{rrm}$	Reverse recovery current		-	16	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	910	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	115	-	$\mu$ J
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 27</a> $di/dt = 1000\text{ A}/\mu\text{s}$	-	72	-	ns
$Q_{rr}$	Reverse recovery charge		-	930	-	nC
$I_{rrm}$	Reverse recovery current		-	26	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	530	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	307	-	$\mu$ J

## 2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

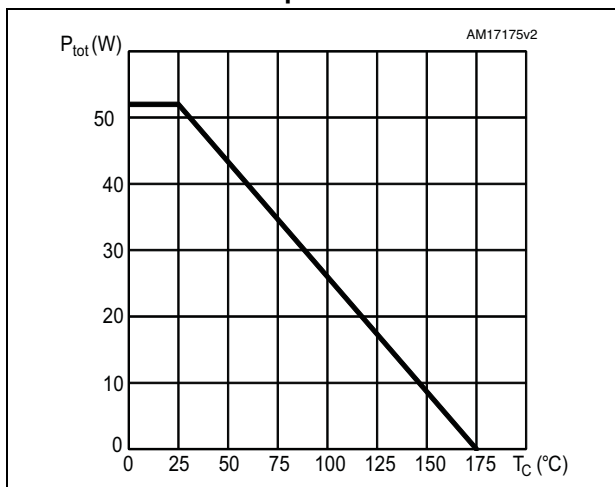


Figure 3. Collector current vs. case temperature

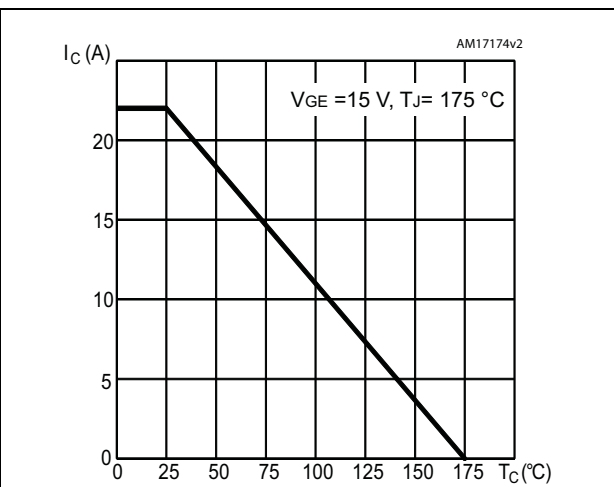


Figure 4. Output characteristics ( $T_J = 25$  °C)

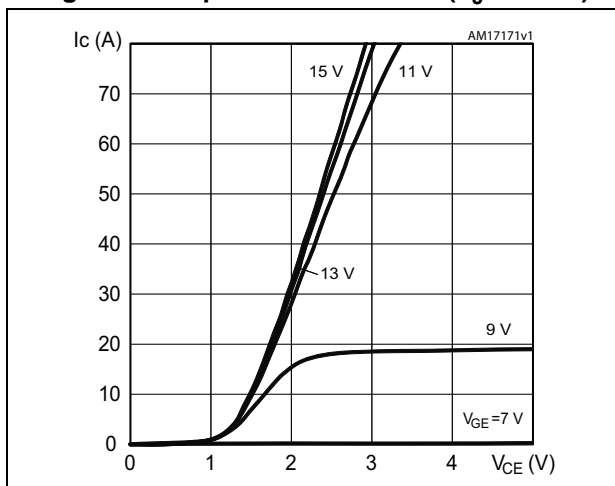


Figure 5. Output characteristics ( $T_J = 175$  °C)

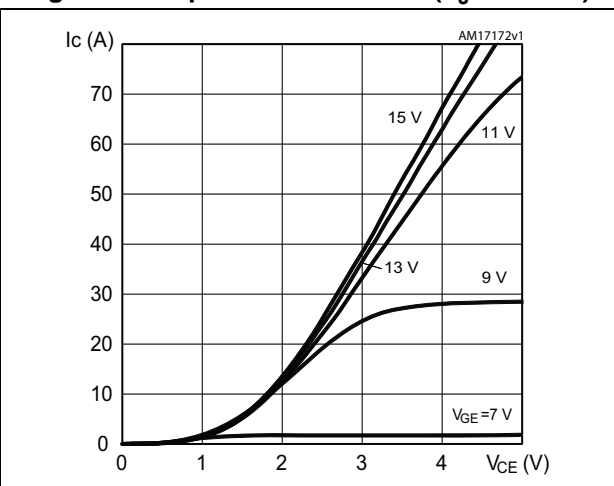


Figure 6.  $V_{CE(SAT)}$  vs. junction temperature

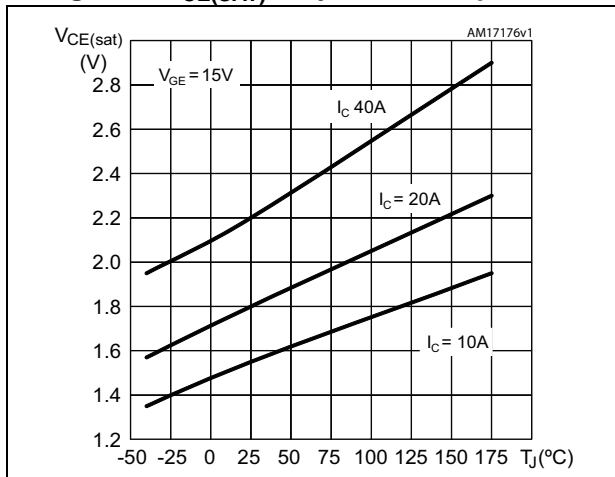


Figure 7.  $V_{CE(SAT)}$  vs. collector current

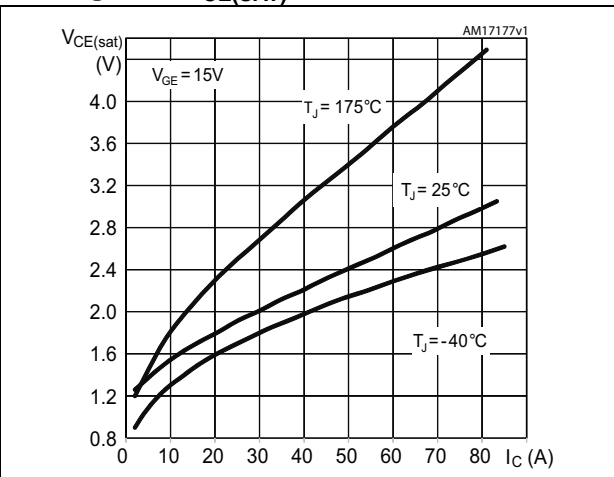


Figure 8. Transfer characteristics

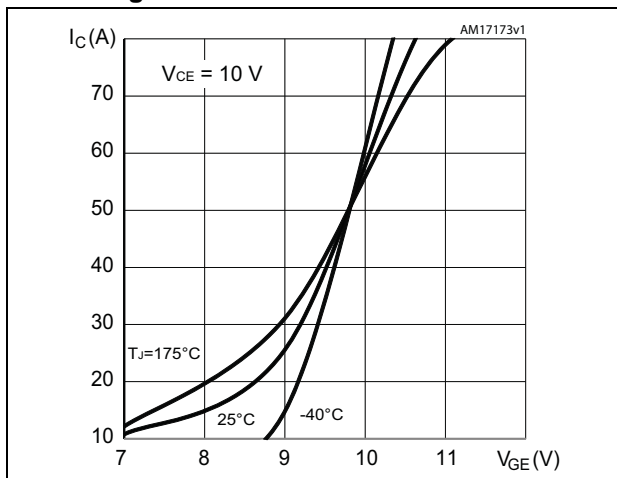


Figure 9. Diode  $V_F$  vs. forward current

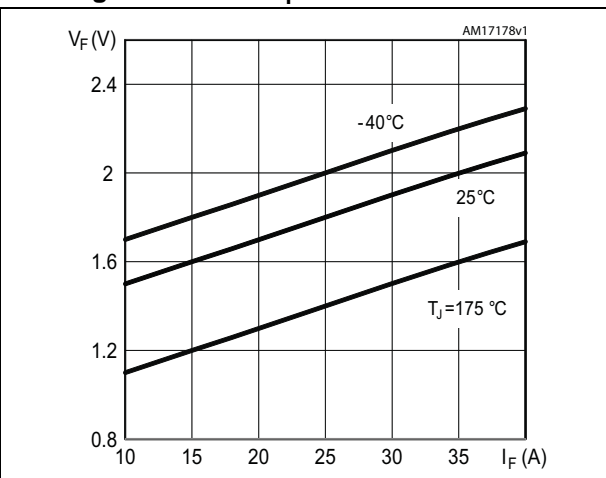


Figure 10. Normalized  $V_{GE(th)}$  vs. junction temperature

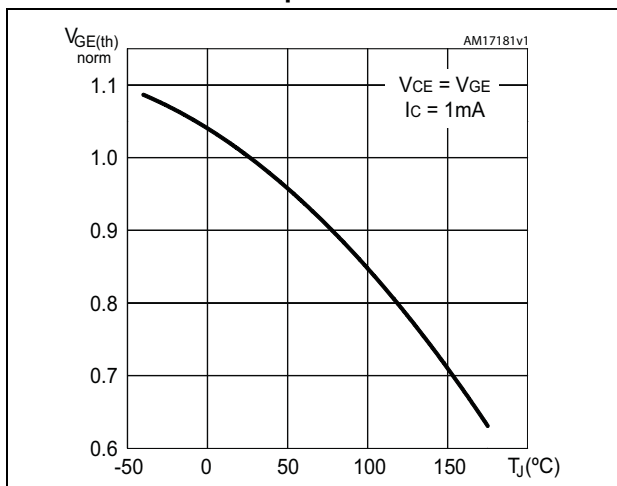


Figure 11. Normalized  $V_{(BR)CES}$  vs. junction temperature

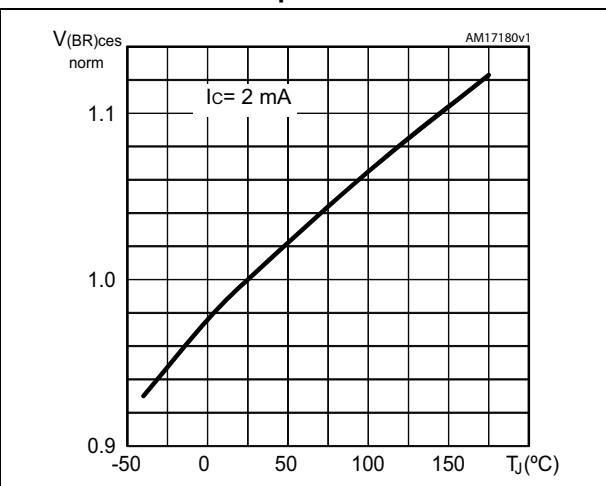


Figure 12. Capacitance variations

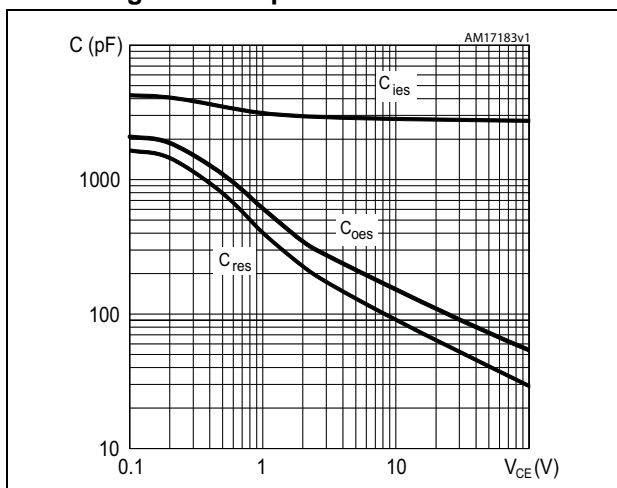


Figure 13. Gate charge vs. gate-emitter voltage

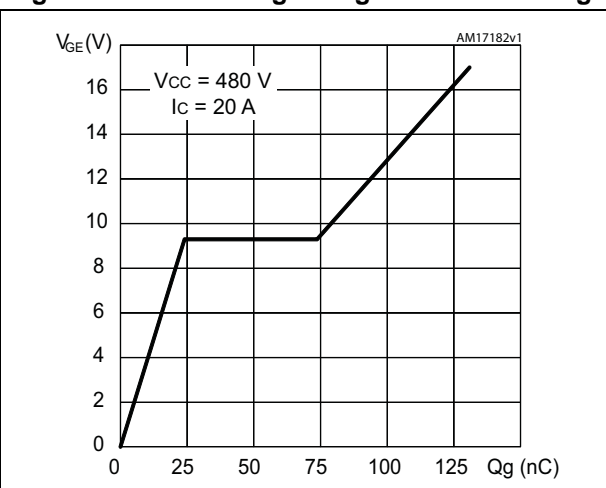


Figure 14. Switching losses vs. collector current

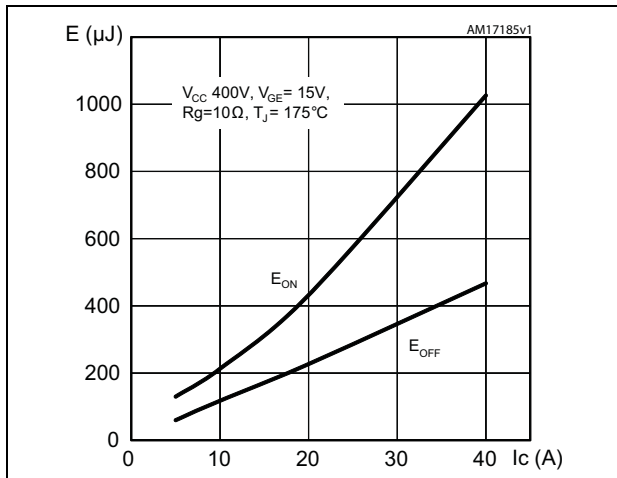


Figure 15. Switching losses vs. gate resistance

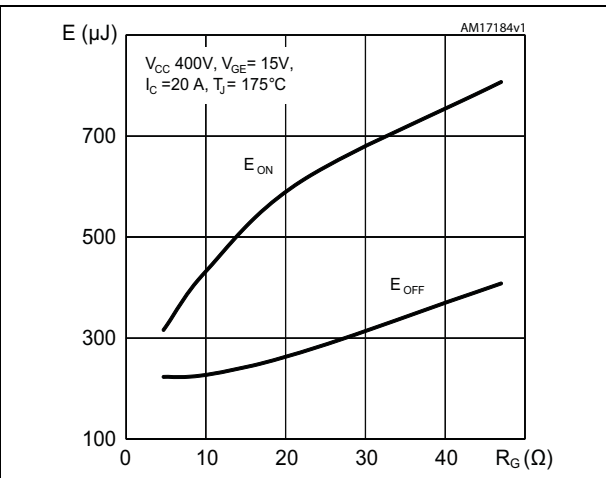


Figure 16. Switching losses vs. junction temperature

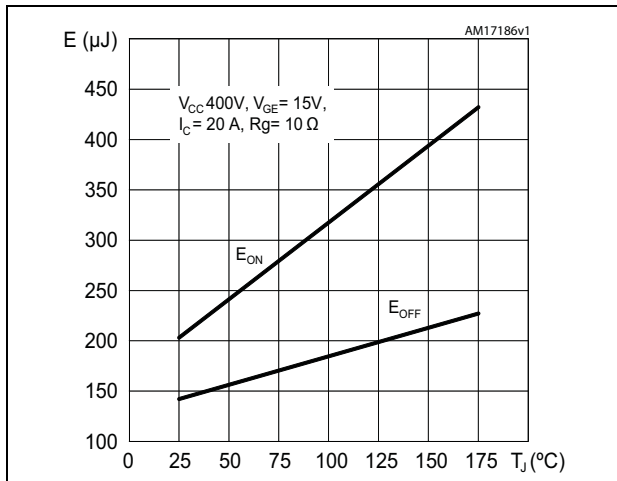


Figure 17. Switching losses vs. collector emitter voltage

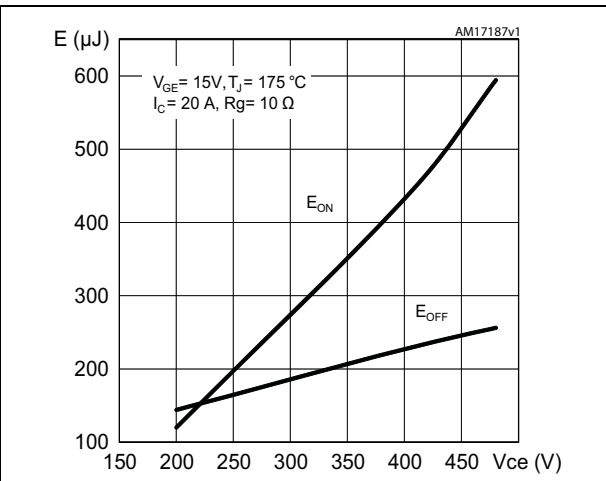


Figure 18. Switching times vs. collector current

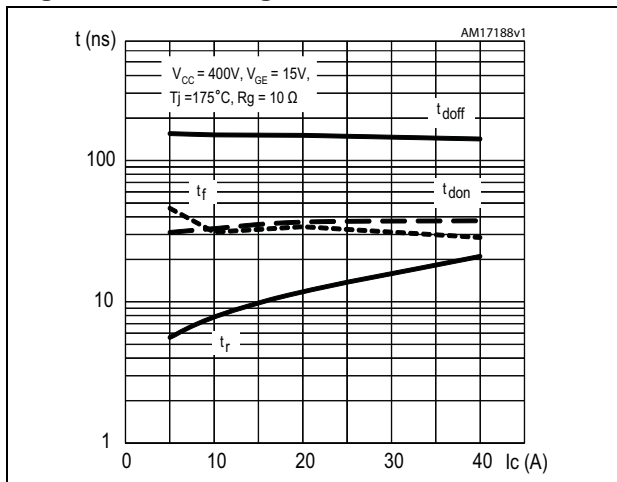


Figure 19. Switching times vs. gate resistance

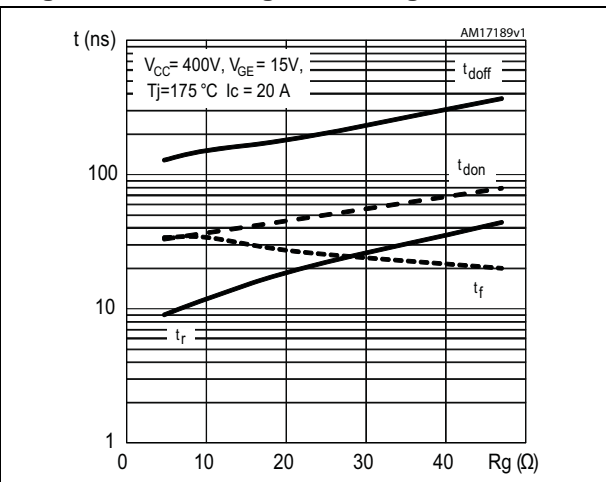




Figure 20. Reverse recovery current vs. diode current slope

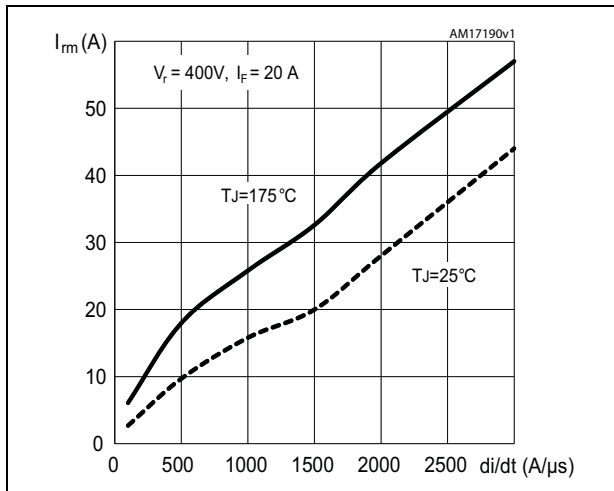


Figure 21. Reverse recovery time vs. diode current slope

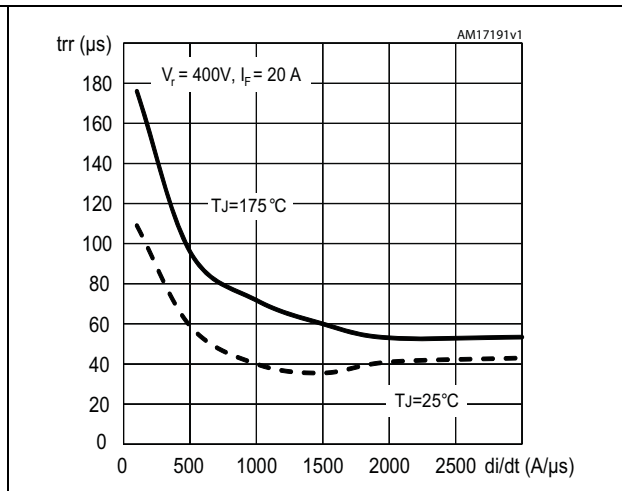


Figure 22. Reverse recovery charge vs. diode current slope

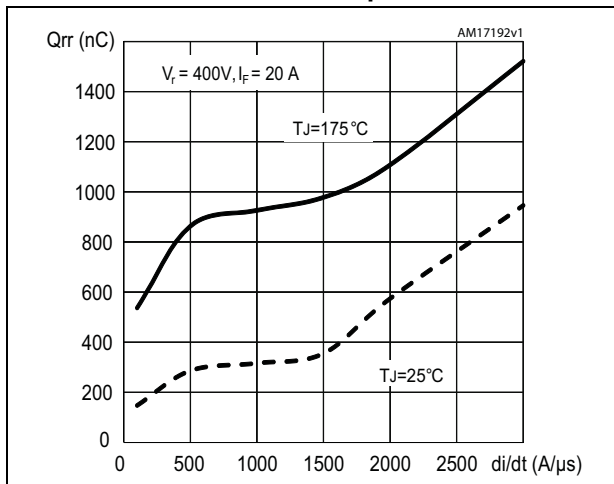


Figure 23. Reverse recovery energy vs. diode current slope

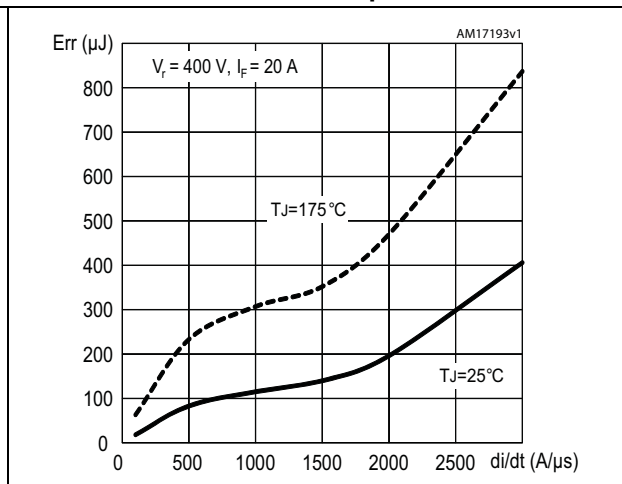


Figure 24. Safe operating area

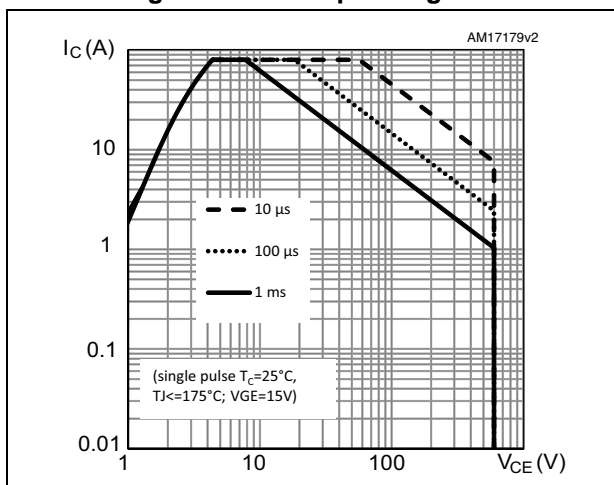


Figure 25. Thermal data for IGBT

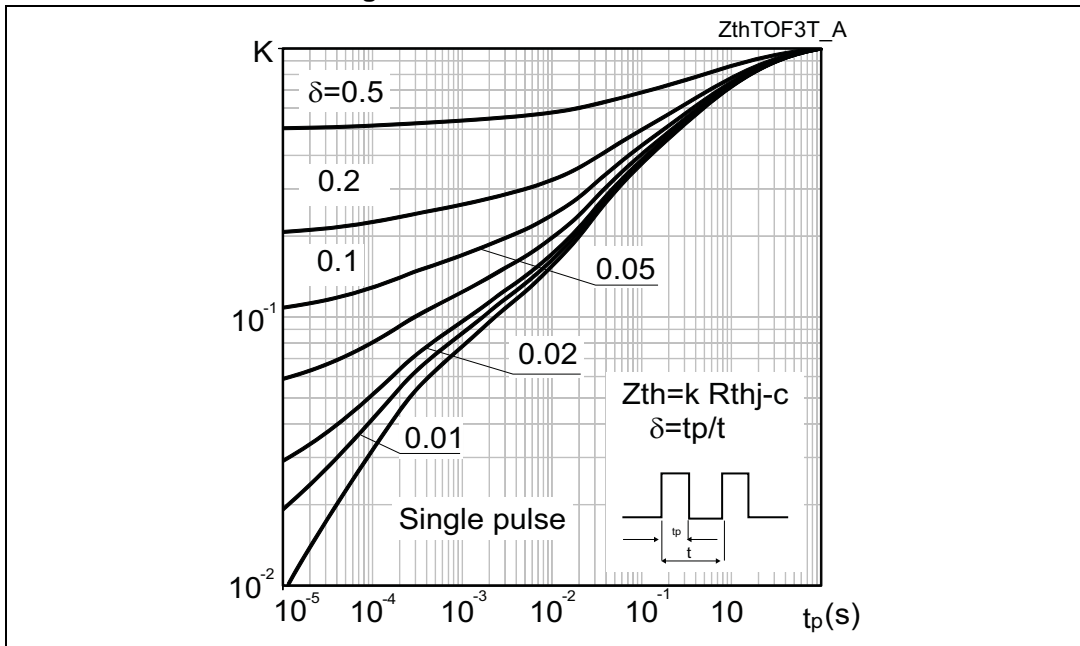
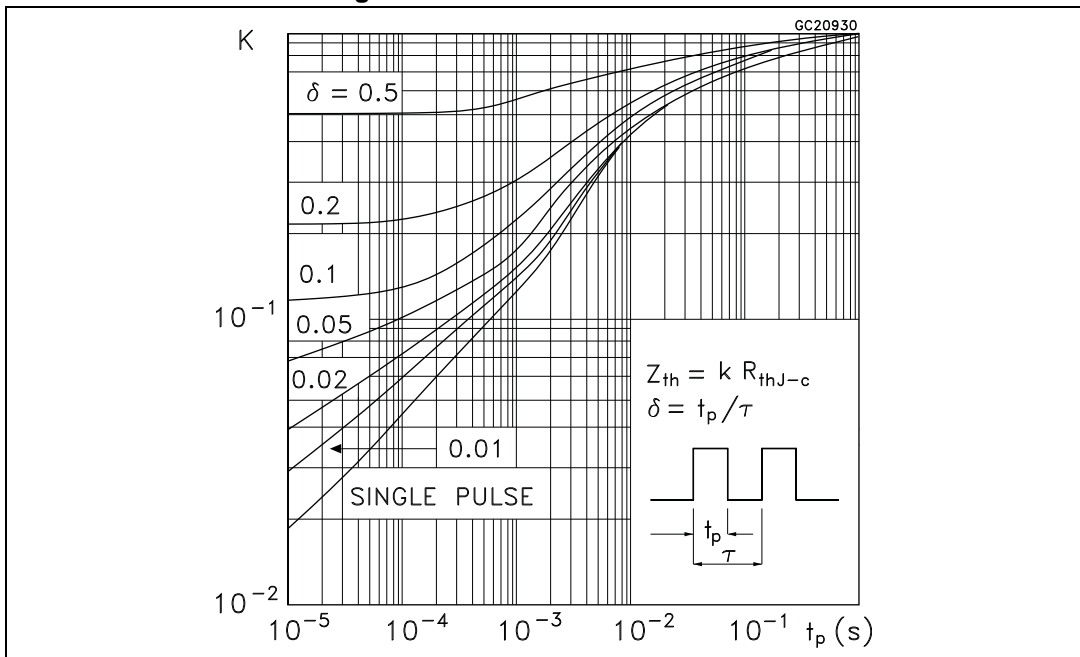


Figure 26. Thermal data for diode



### 3 Test circuits

Figure 27. Test circuit for inductive load switching



Figure 28. Gate charge test circuit

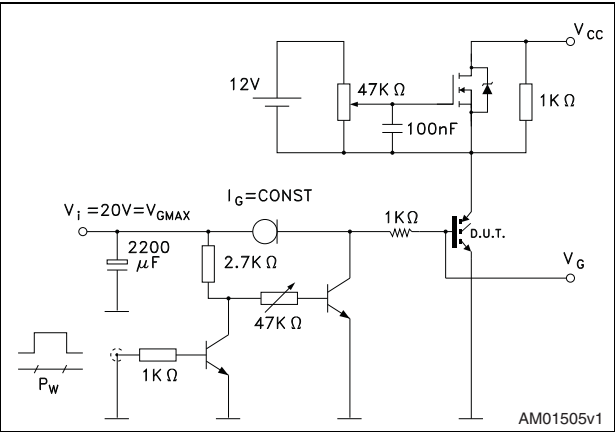
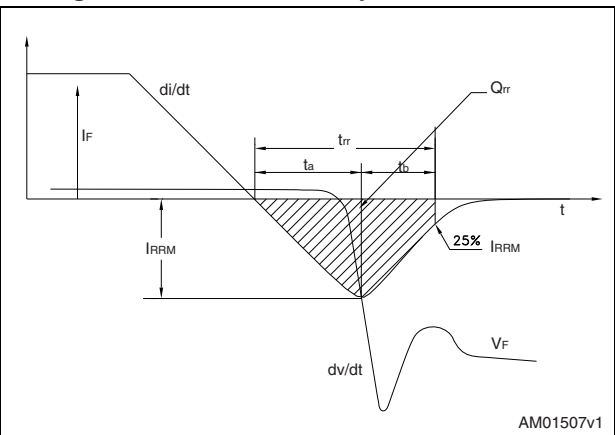


Figure 29. Switching waveform



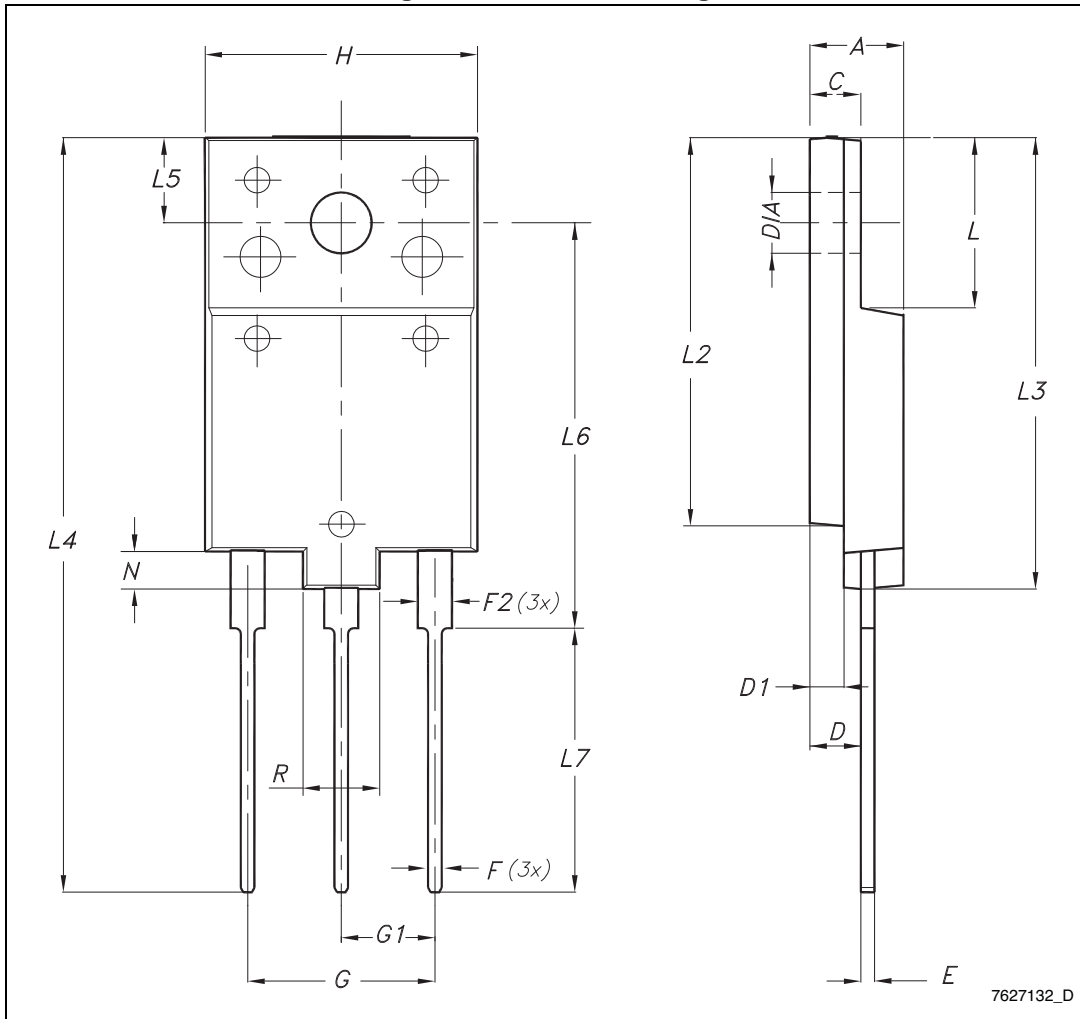
Figure 30. Diode recovery time waveform



## 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](http://www.st.com). ECOPACK is an ST trademark.

Figure 31. TO-3PF drawing



7627132\_D

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

## 5 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
28-Mar-2014	1	Initial release.

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