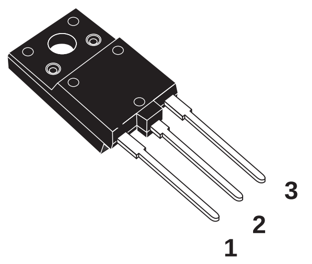
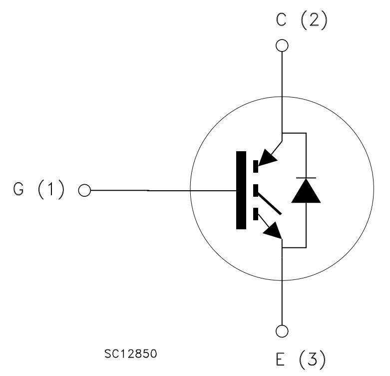
Trench gate field-stop IGBT, V series 600 V, 20 A very high speed

Datasheet - production data



TO-3PF

Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: T_J = 175 °C
- Very high speed switching series
- Tail-less switching off
- $V_{CE(sat)}$ = 1.8 V (typ.) @ I_C = 20 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

Contents

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 °C	40	A
I_C	Continuous collector current at T_C = 100 °C	20	A
I_{CP}(1)	Pulsed collector current	80	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	40	A
I_F	Continuous forward current at T_C = 100 °C	20	A
$I_{FP(1)}$	Pulsed forward current	80	A
P_{TOT}	Total dissipation at T_C = 25 °C	52	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
R_{thJC}	Thermal resistance junction-case IGBT	2.9	°C/W
R_{thJC}	Thermal resistance junction-case diode	3.4	°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_F	Forward on-voltage	I_F = 20 A		1.7	2.2	V
		I_F = 20 A T_J = 125 °C		1.55		V
		I_F = 20 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	-	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 28*	-	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 V, I_C = 20 A, V_{GE} = 15 V, see *Figure 27*	-	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, V_{GE} = 15 V, T_J = 175 °C, see *Figure 27*	-	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 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 A, V_R = 400 V, V_{GE} = 15 V, see *Figure 27* di/dt = 1000 A/µs	-	40	-	ns
Q_{rr}	Reverse recovery charge		-	320	-	nC
I_{rrm}	Reverse recovery current		-	16	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	910	-	A/µs
E_{rr}	Reverse recovery energy		-	115	-	µJ
t_{rr}	Reverse recovery time	I_F = 20 A, V_R = 400 V, V_{GE} = 15 V, T_J = 175 °C, see *Figure 27* di/dt = 1000 A/µs	-	72	-	ns
Q_{rr}	Reverse recovery charge		-	930	-	nC
I_{rrm}	Reverse recovery current		-	26	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	530	-	A/µs
E_{rr}	Reverse recovery energy		-	307	-	µJ

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

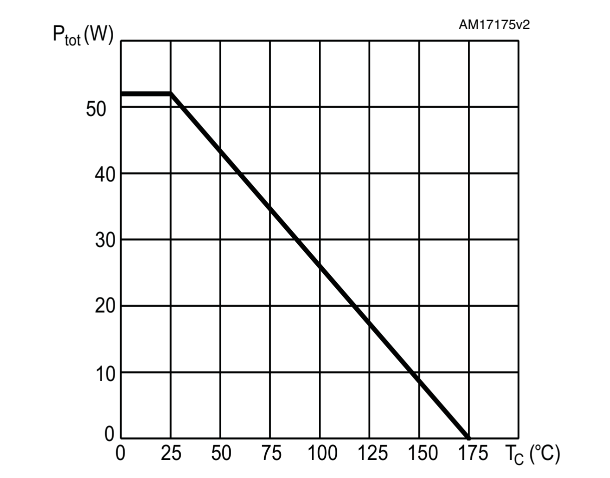


Figure 3. Collector current vs. case temperature

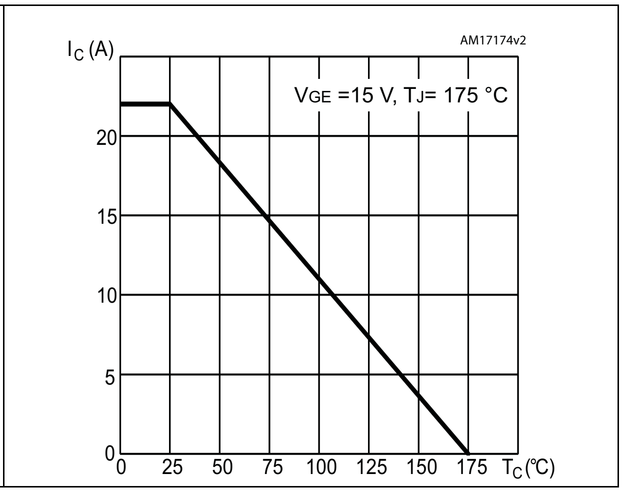


Figure 4. Output characteristics (T_J = 25 °C)

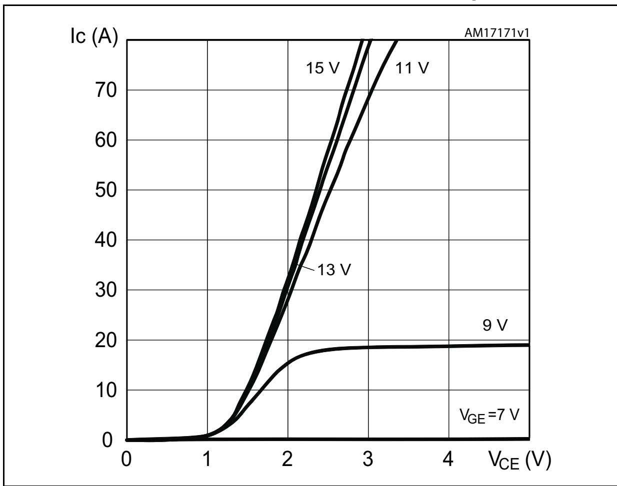


Figure 5. Output characteristics (T_J = 175 °C)

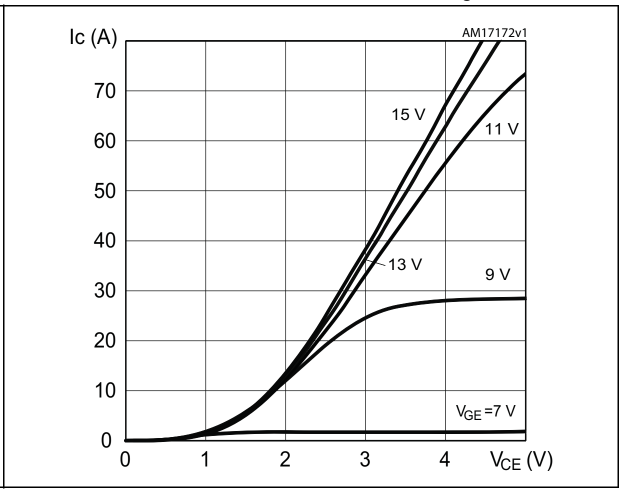


Figure 6. $V_{CE(SAT)}$ vs. junction temperature

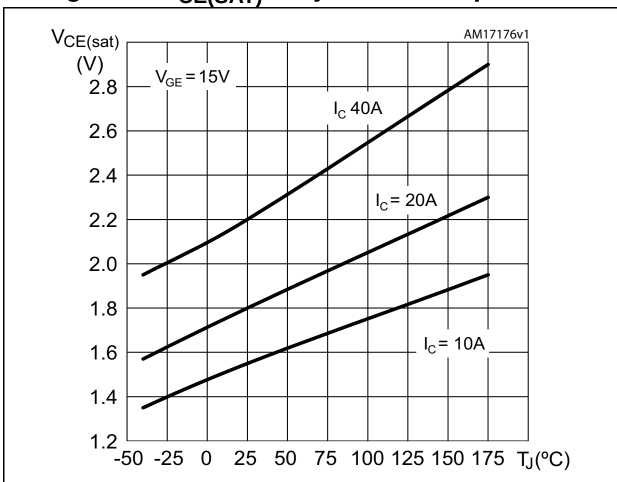


Figure 7. $V_{CE(SAT)}$ vs. collector current

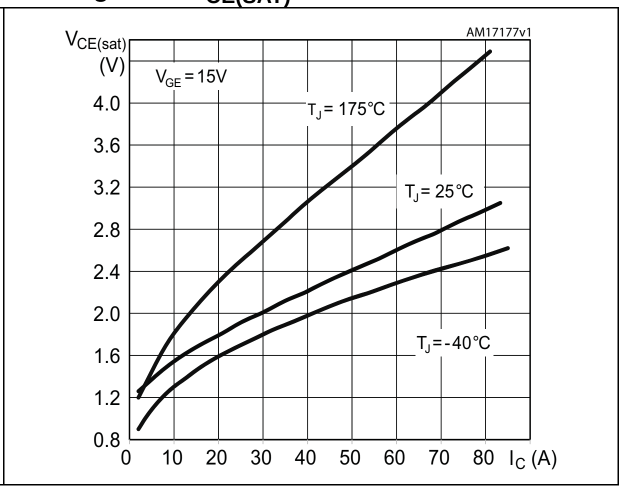


Figure 8. Transfer characteristics

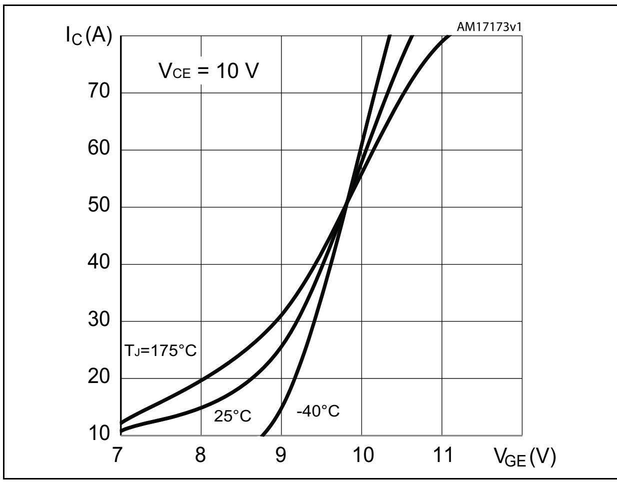


Figure 9. Diode V_F vs. forward current

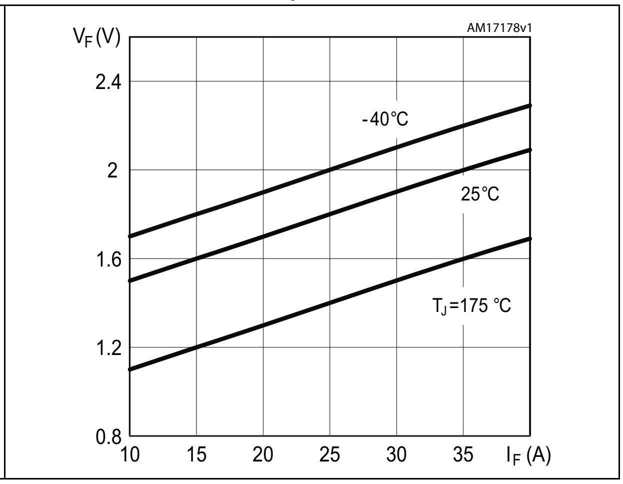


Figure 10. Normalized $V_{GE(th)}$ vs. junction temperature

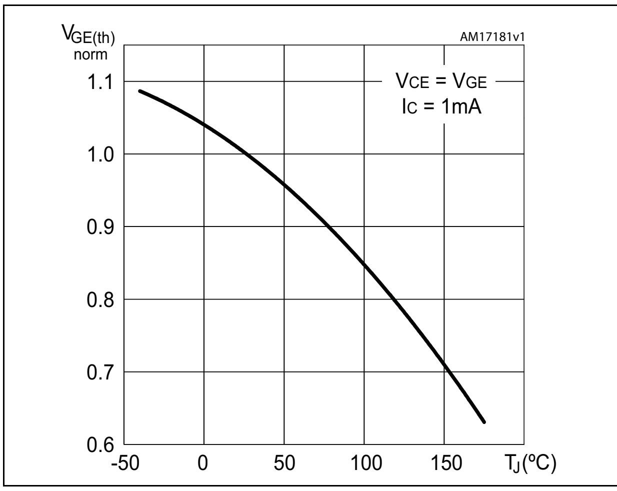


Figure 11. Normalized $V_{(BR)CES}$ vs. junction temperature

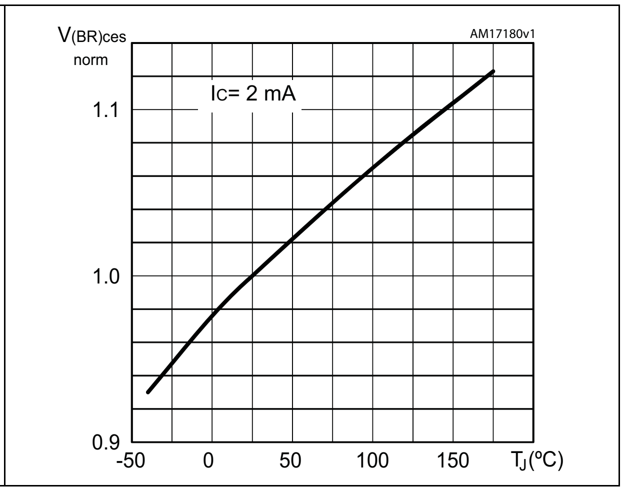


Figure 12. Capacitance variations

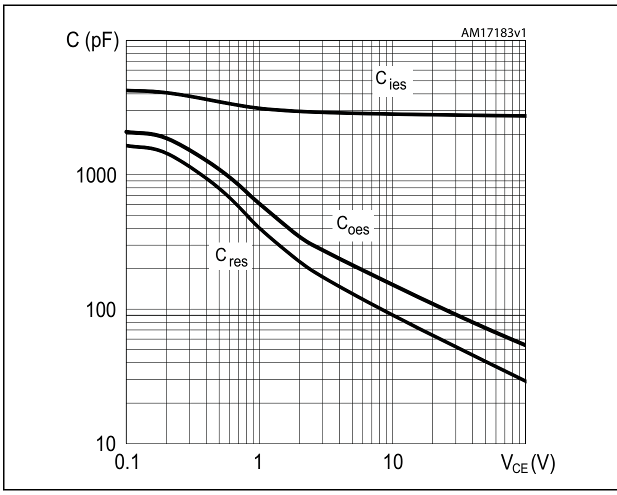


Figure 13. Gate charge vs. gate-emitter voltage

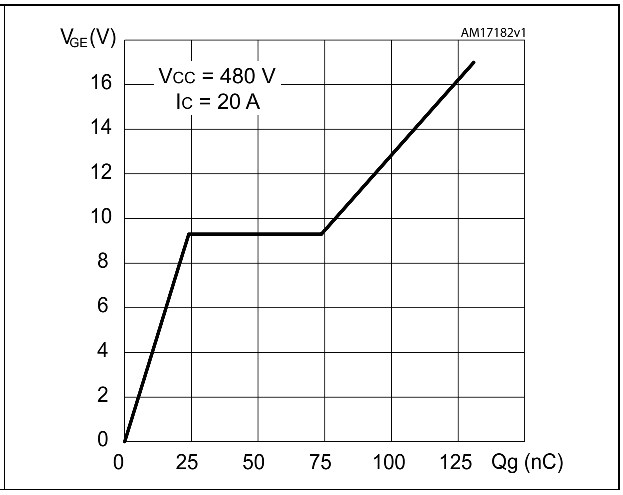


Figure 14. Switching losses vs. collector current

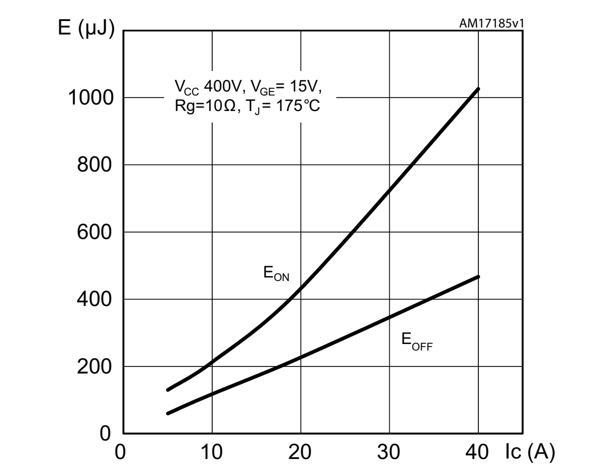


Figure 15. Switching losses vs. gate resistance

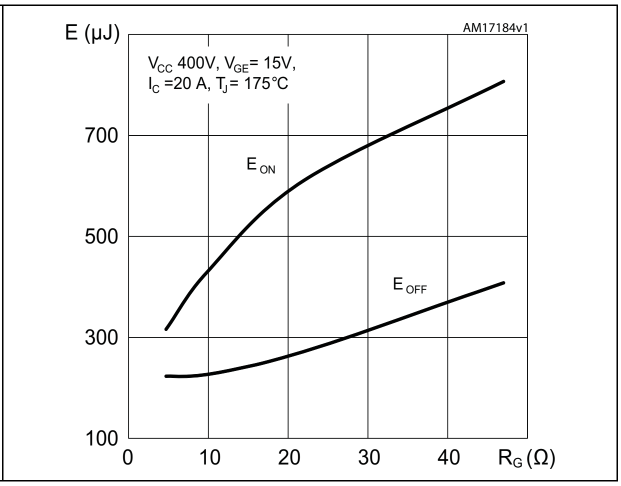


Figure 16. Switching losses vs. junction temperature

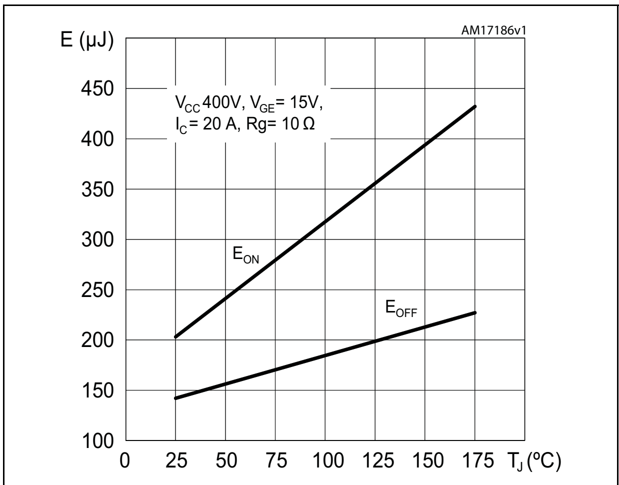


Figure 17. Switching losses vs. collector emitter voltage

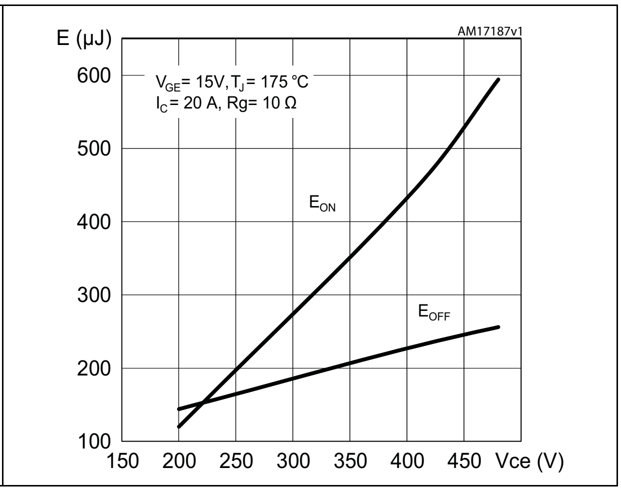


Figure 18. Switching times vs. collector current

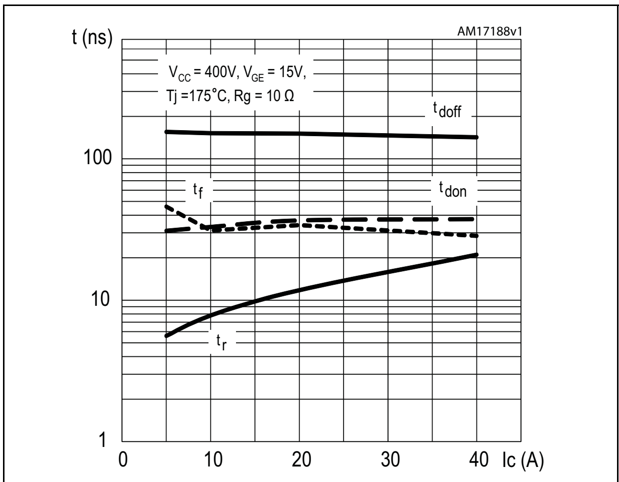


Figure 19. Switching times vs. gate resistance

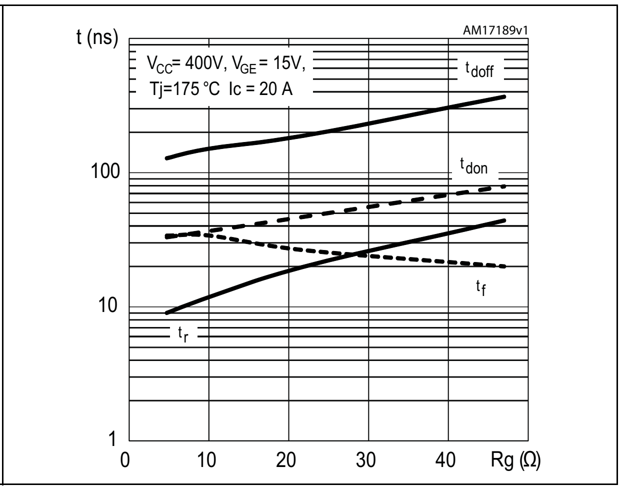


Figure 20. Reverse recovery current vs. diode current slope

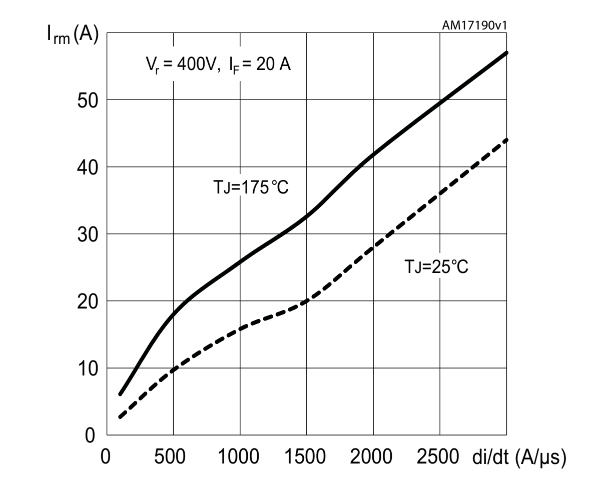


Figure 21. Reverse recovery time vs. diode current slope

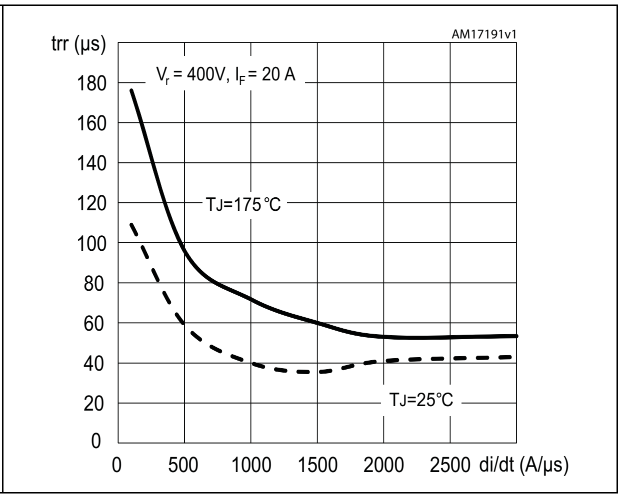


Figure 22. Reverse recovery charge vs. diode current slope

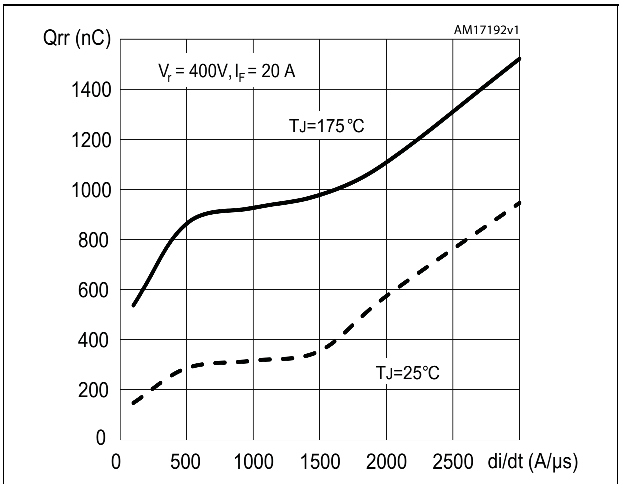


Figure 23. Reverse recovery energy vs. diode current slope

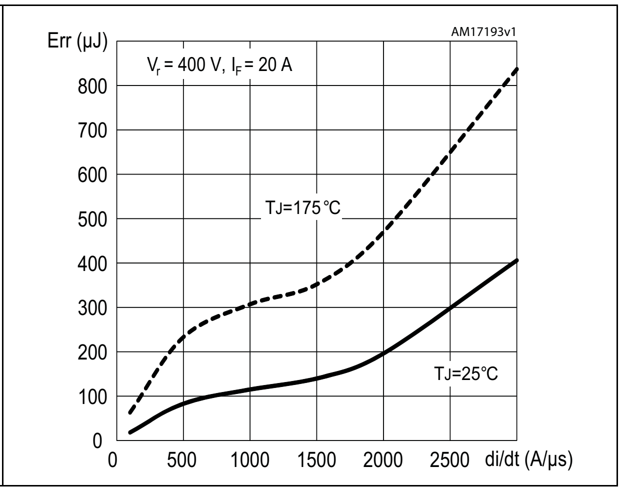


Figure 24. Safe operating area

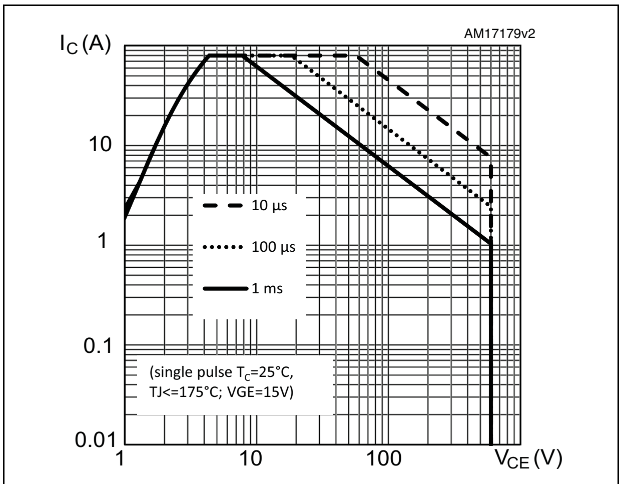


Figure 25. Thermal data for IGBT

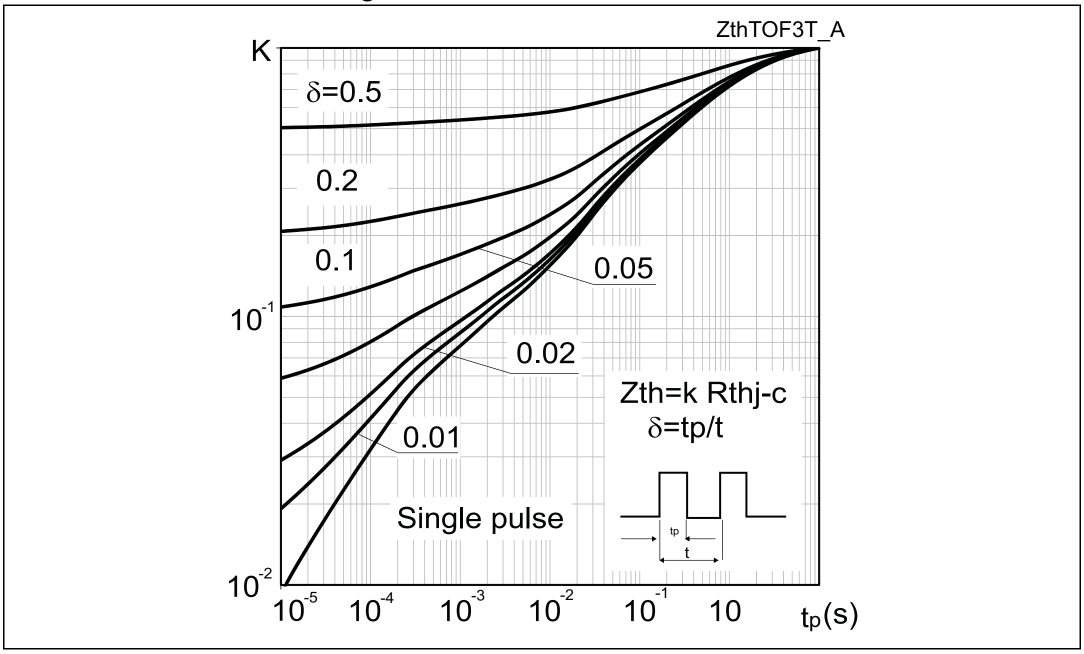
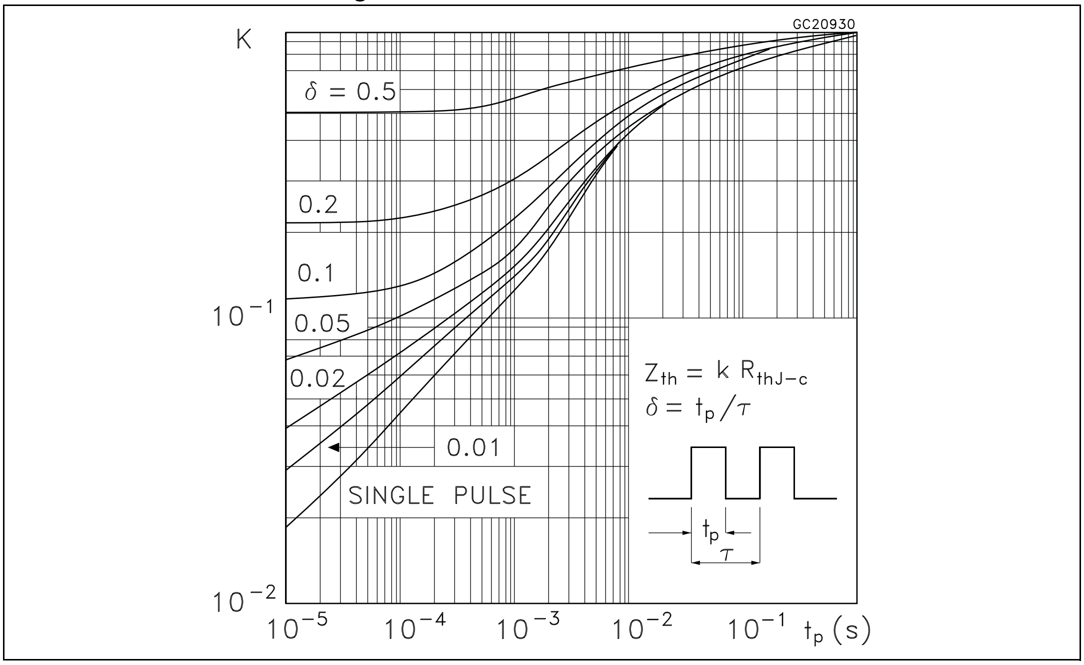


Figure 26. Thermal data for diode



3 Test circuits

Figure 27. Test circuit for inductive load switching

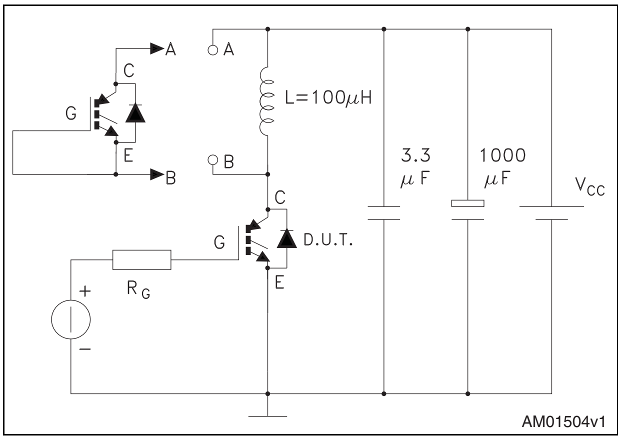


Figure 28. Gate charge test circuit

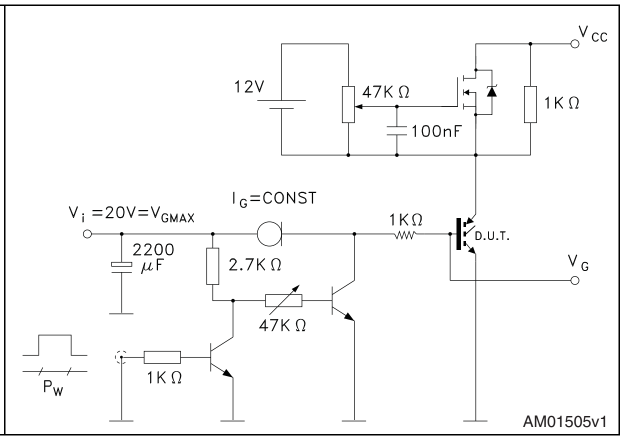


Figure 29. Switching waveform

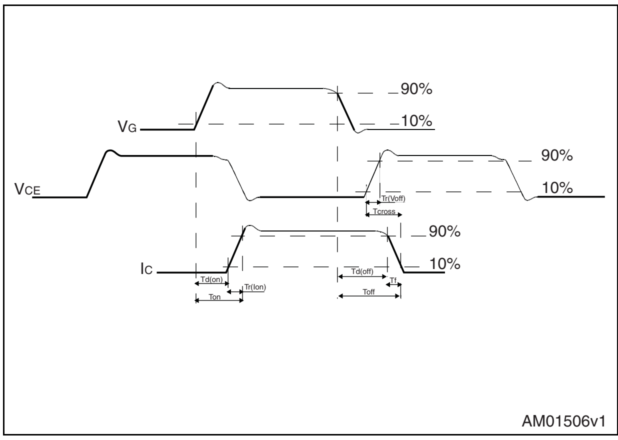
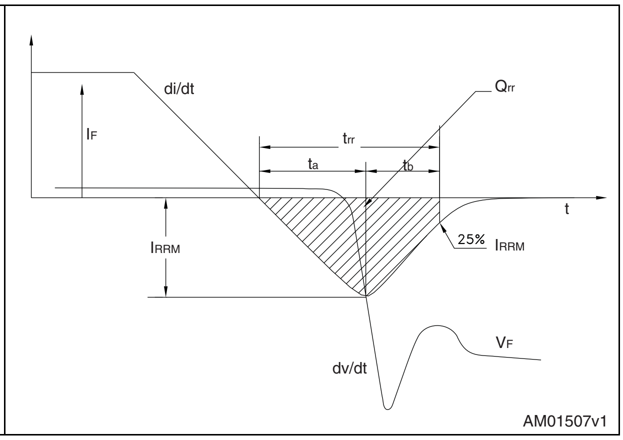


Figure 30. Diode recovery time waveform



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. ECOPACK is an ST trademark.

Figure 31. TO-3PF drawing

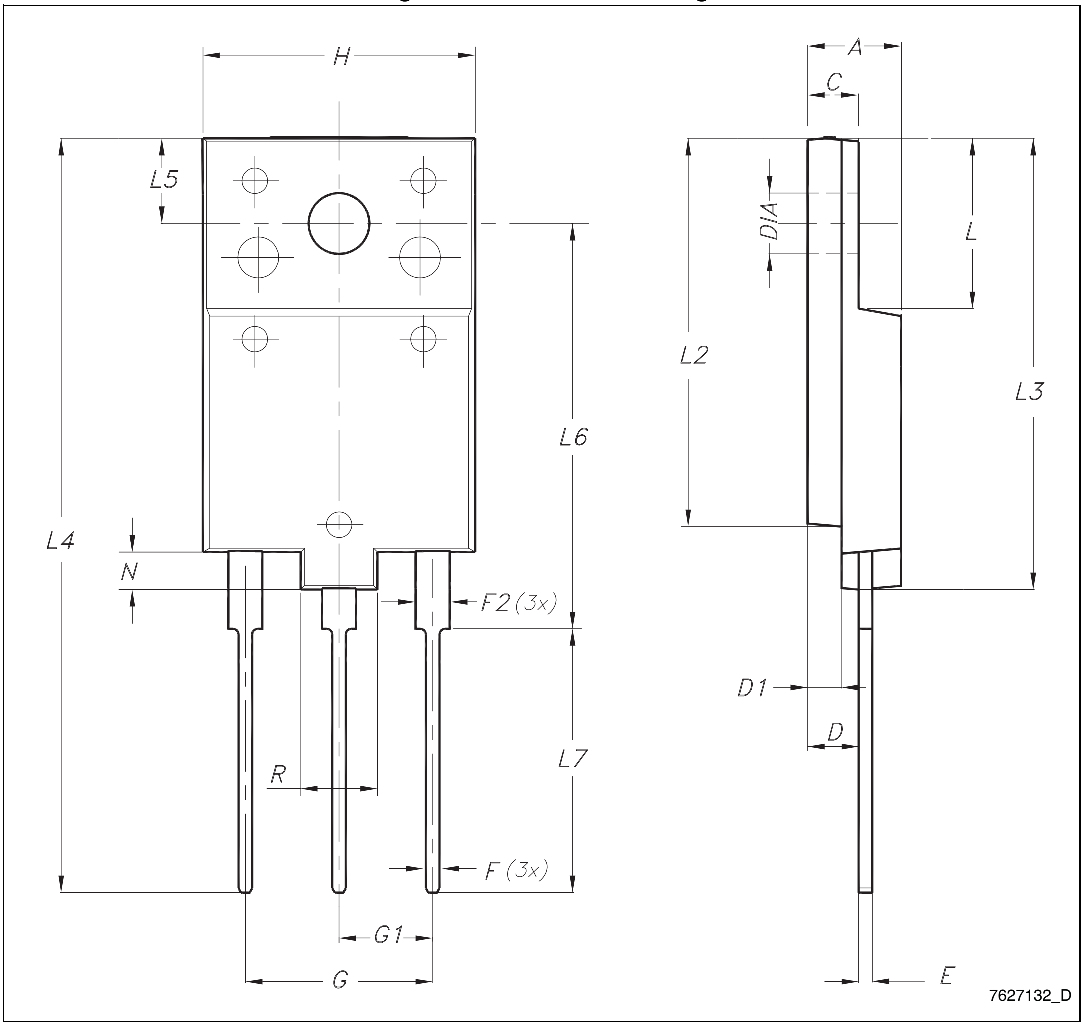


Table 8. TO-3PF mechanical data

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

5 Revision history

Table 9. Document revision history

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