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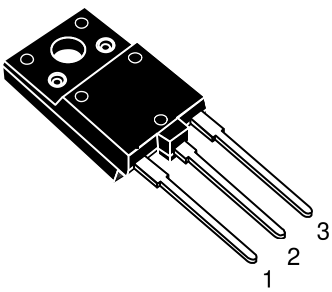
STGFW20V60DF

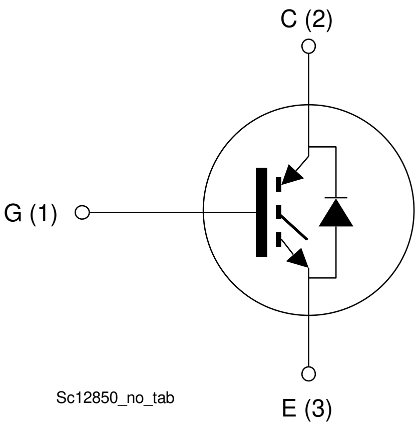
Trench gate field-stop IGBT, V series
600 V, 20 A very high speed

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 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
STGFW20V60DF	G20V60DF	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
	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
	Continuous forward current at T_C = 100 °C	20	A
I_{FP}[(1)]	Pulsed forward current	80	A
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)	3.5	kV
P_{TOT}	Total dissipation at T_C = 25 °C	52	W
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
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 V, 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		
		I_F = 20 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	µA

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	-	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} = 0 to 15 V (see *Figure 28: " Gate charge test circuit"*)	-	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: " Test circuit for inductive load switching"*)	-	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 energy		-	200	-	µJ
E_{off}(2)	Turn-off switching energy		-	130	-	µJ
E_{ts}	Total switching energy		-	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: " Test circuit for inductive load switching"*)	-	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 energy		-	430	-	µJ
E_{off}(2)	Turn-off switching energy		-	210	-	µJ
E_{ts}	Total switching energy		-	640	-	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 = 20 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see *Figure 27: " Test circuit for inductive load switching"*)	-	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, di/dt = 1000 A/µs (see *Figure 27: " Test circuit for inductive load switching"*)	-	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

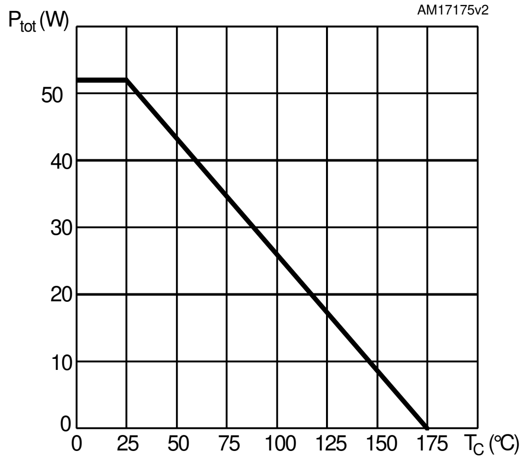


Figure 3: Collector current vs. case temperature

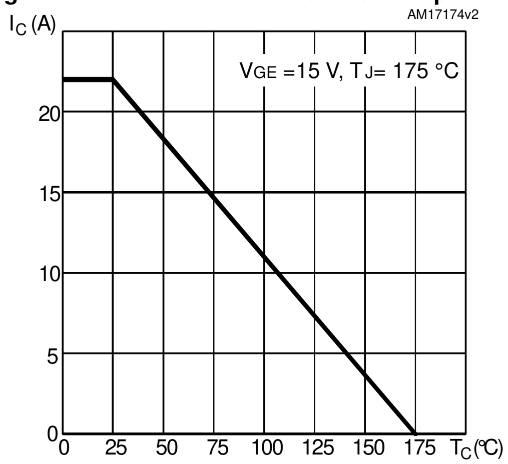


Figure 4: Output characteristics (T_J = 25 °C)

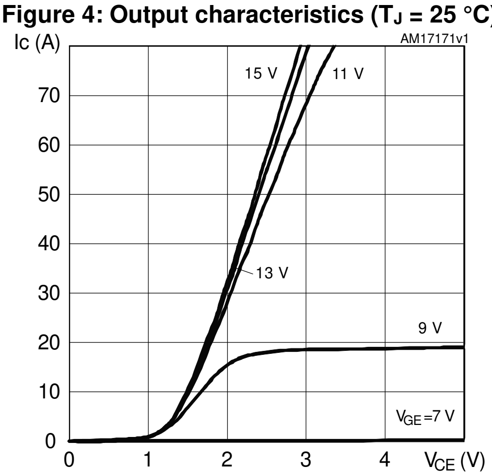


Figure 5: Output characteristics (T_J = 175 °C)

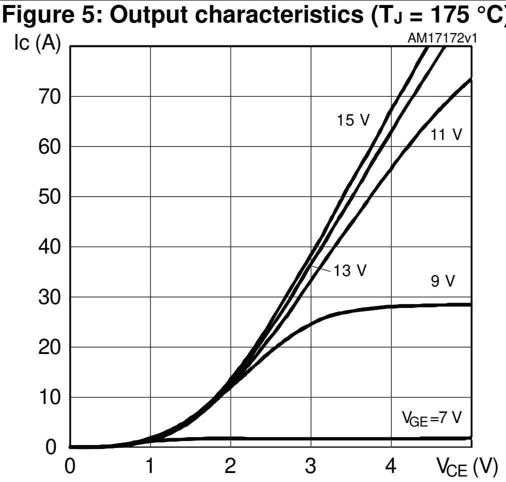


Figure 6: $V_{CE(sat)}$ vs. junction temperature

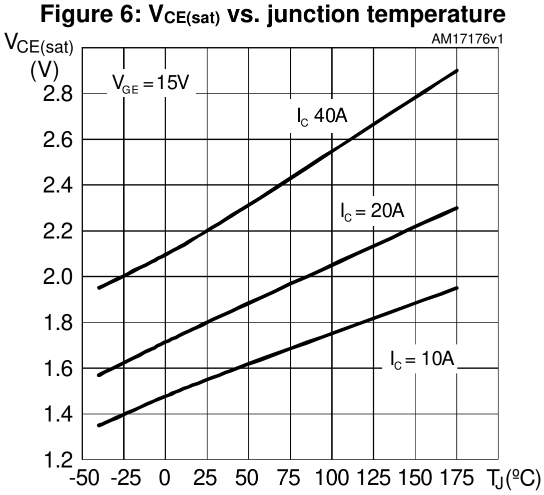


Figure 7: $V_{CE(sat)}$ vs. collector current

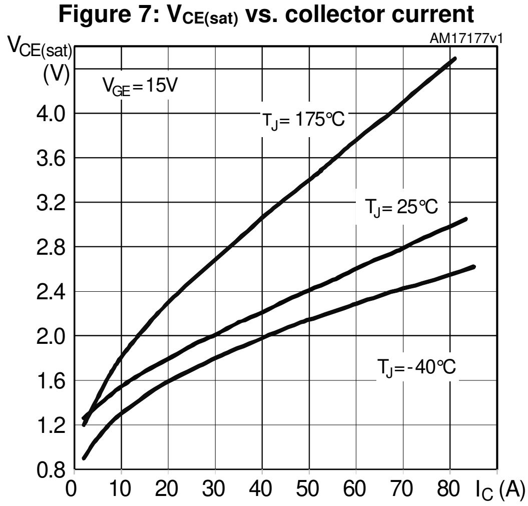


Figure 8: Transfer characteristics

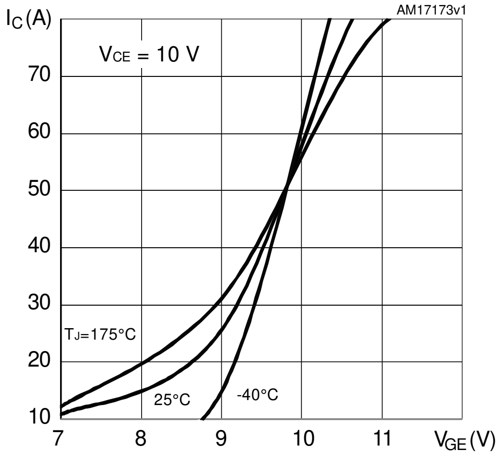


Figure 9: Diode VF vs. forward current

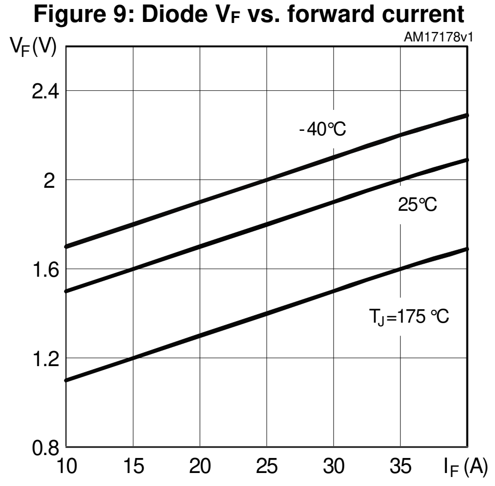


Figure 10: Normalized $V_{GE(th)}$ vs. junction temperature

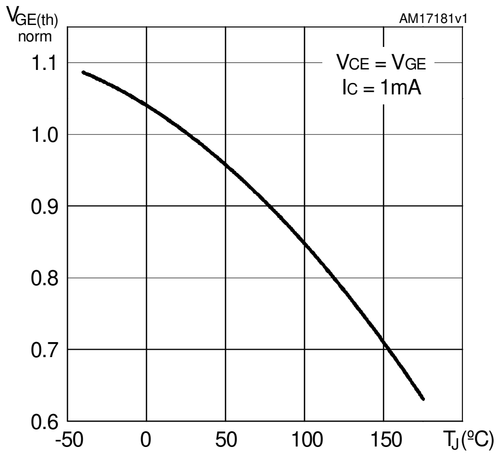


Figure 11: Normalized $V_{(BR)CES}$ vs. junction temperature

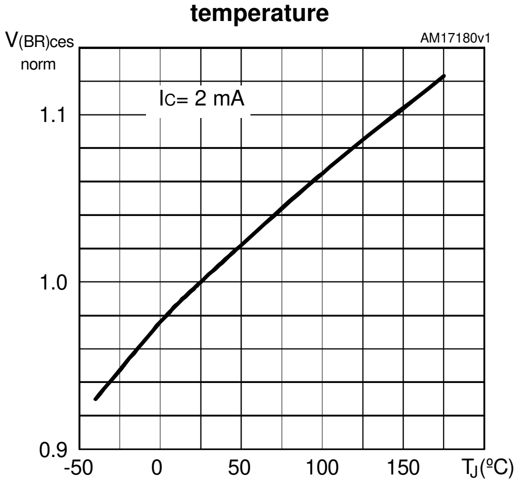


Figure 12: Capacitance variations

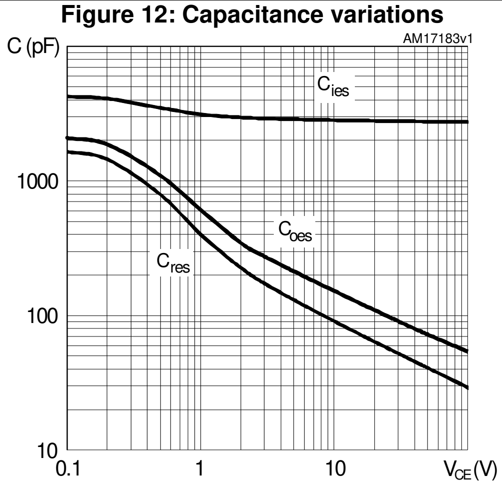


Figure 13: Gate charge vs. gate-emitter voltage

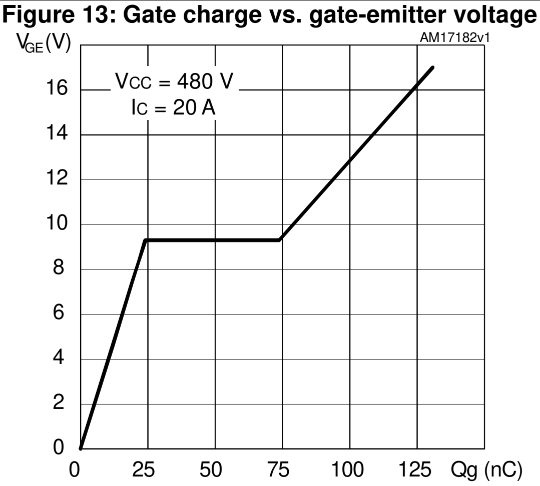


Figure 14: Switching energy vs. collector current

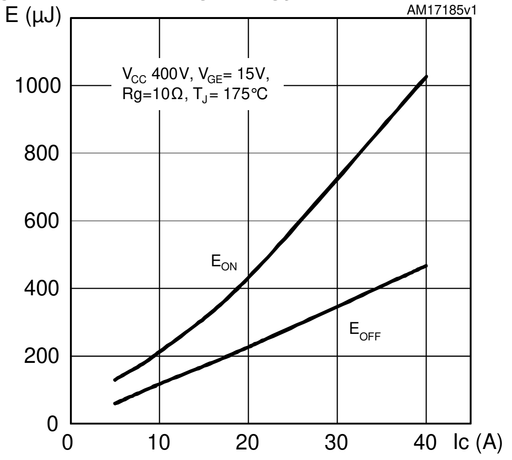


Figure 15: Switching energy vs. gate resistance

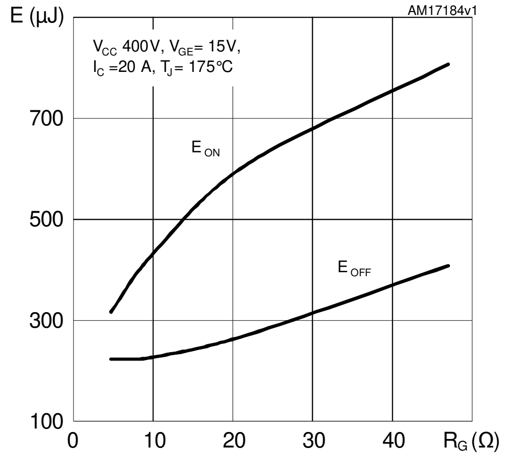


Figure 16: Switching energy vs. junction temperature

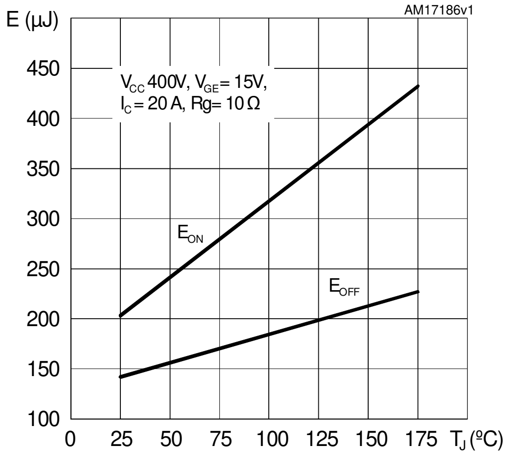


Figure 17: Switching energy vs. collector emitter voltage

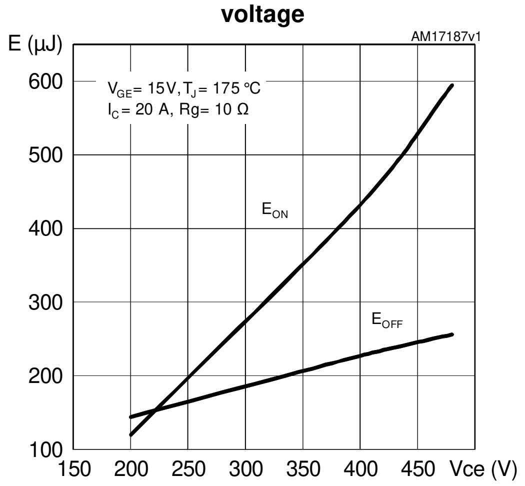


Figure 18: Switching times vs. collector current

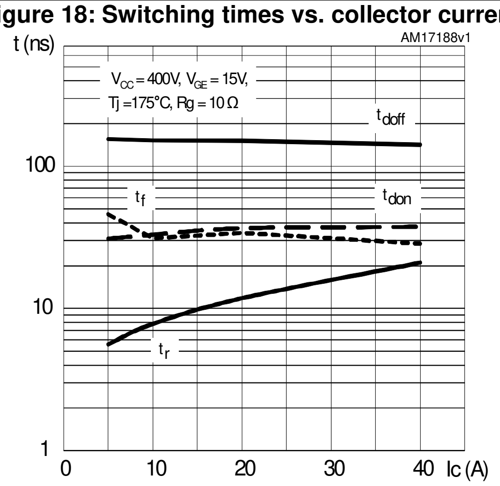


Figure 19: Switching times vs. gate resistance

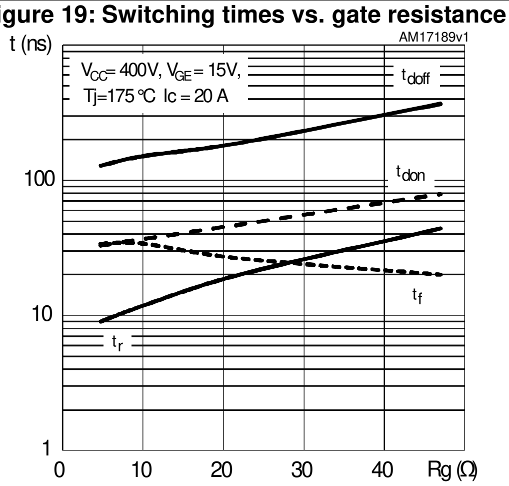


Figure 20: Reverse recovery current vs. diode current slope

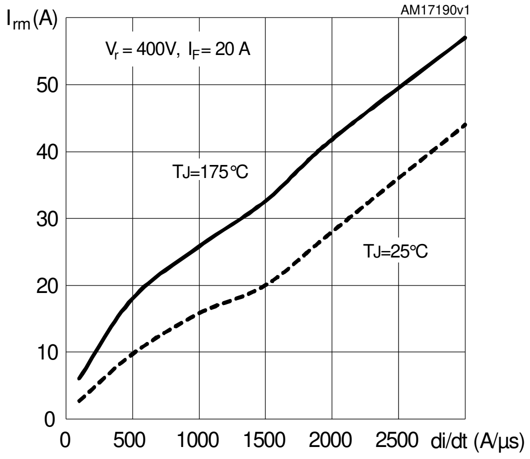


Figure 21: Reverse recovery time vs. diode current slope

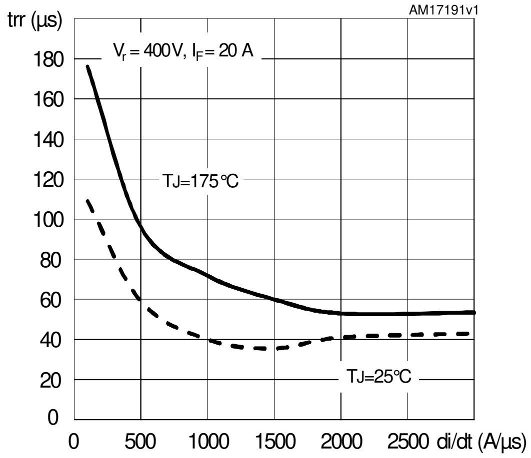


Figure 22: Reverse recovery charge vs. diode current slope

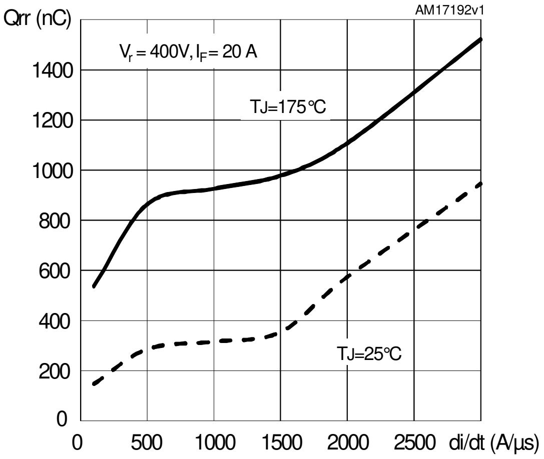


Figure 23: Reverse recovery energy vs. diode current slope

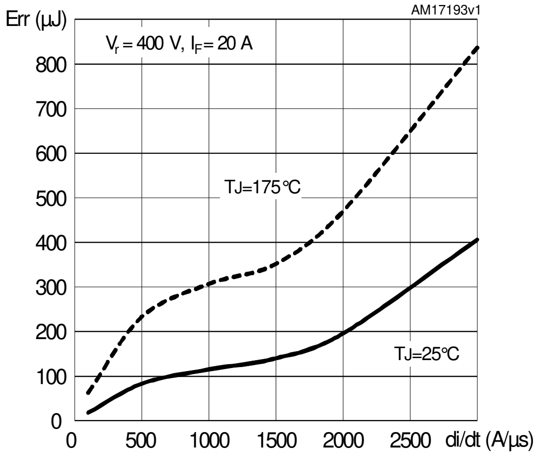


Figure 24: Safe operating area

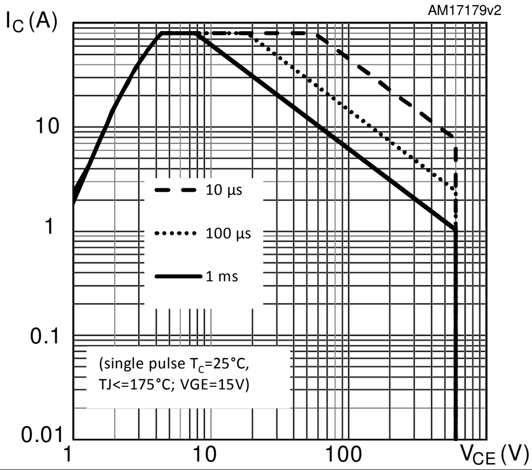


Figure 25: Thermal impedance for IGBT

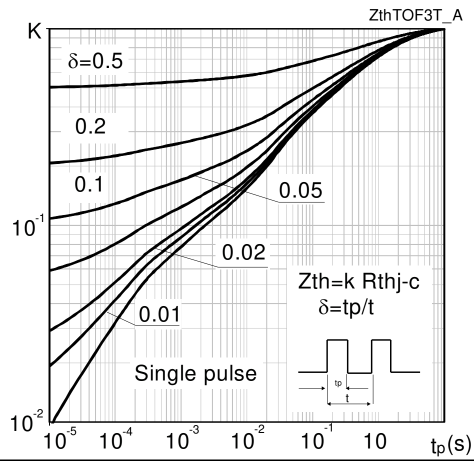
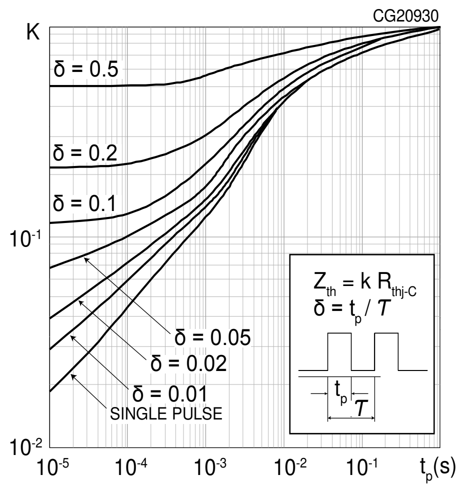


Figure 26: Thermal impedance for diode



3 Test circuits

Figure 27: Test circuit for inductive load switching

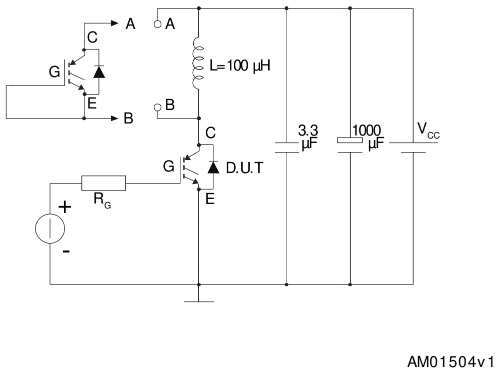


Figure 28: Gate charge test circuit

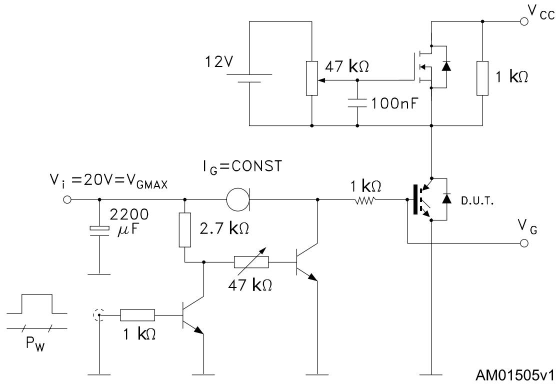


Figure 29: Switching waveform

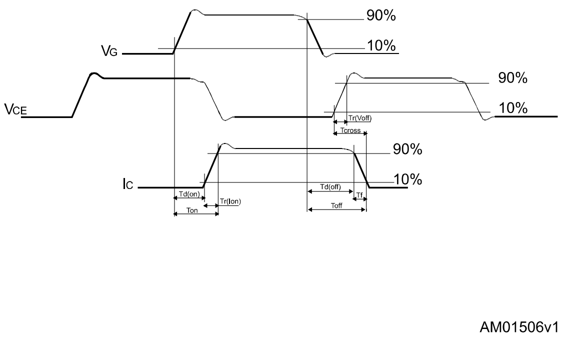
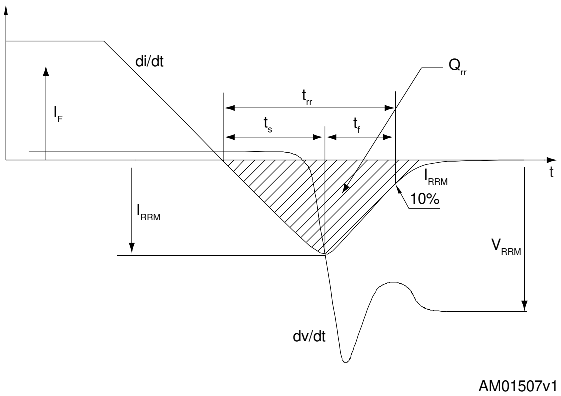


Figure 30: Diode reverse recovery waveform



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 31: TO-3PF package outline

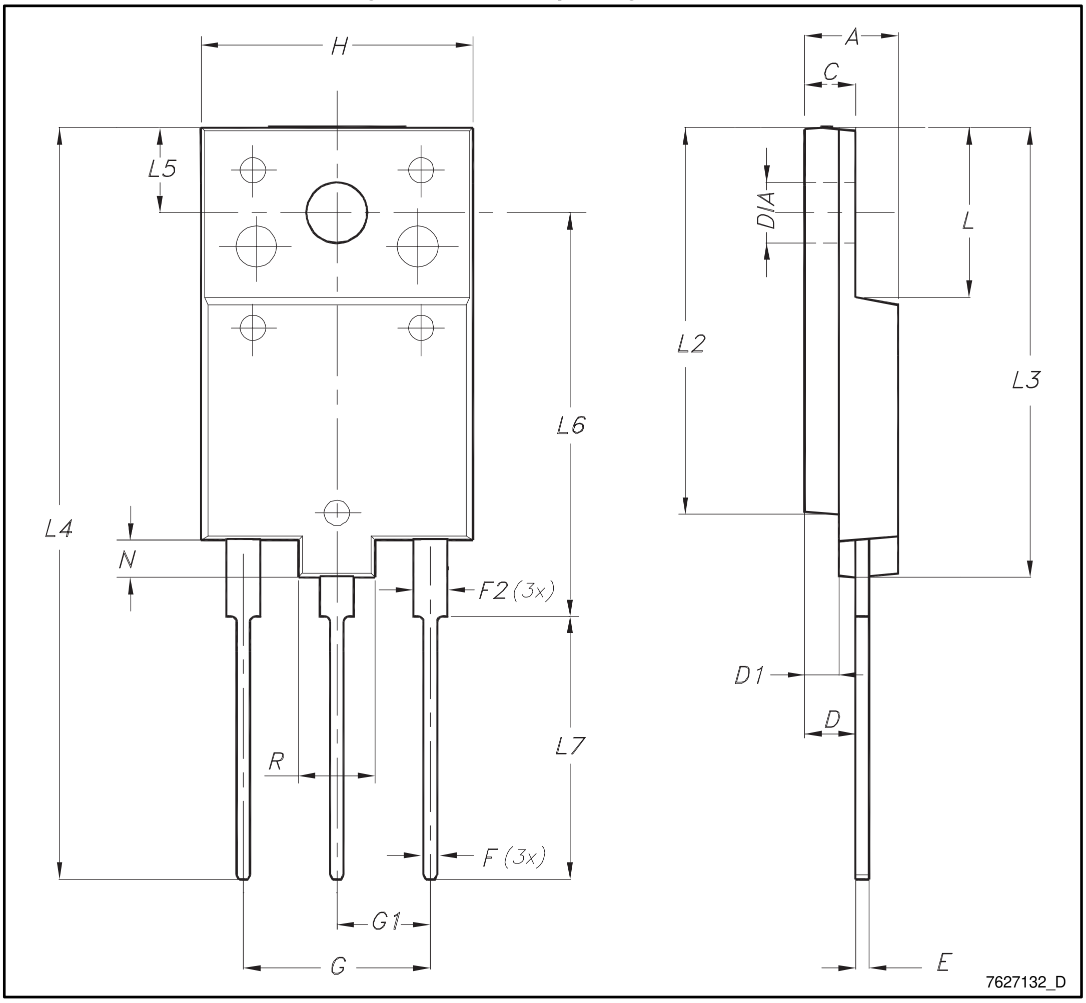


Table 8: TO-3PF mechanical data

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

5 Revision history

Table 9: Document revision history

Date	Revision	Changes
28-Mar-2014	1	Initial release
14-Feb-2017	2	Updated *Table 1: "Device summary"*. Minor text changes