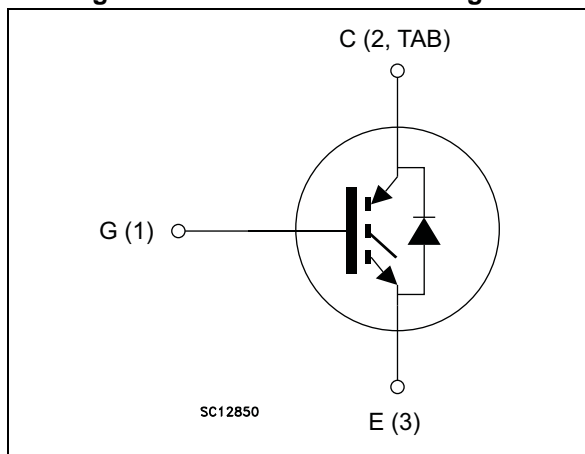


Figure 1. Internal schematic diagram



Features

- Maximum junction temperature: $T_J = 175\text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- Very low saturation voltage: $V_{CE(sat)} = 1.6\text{ V}$ (typ.) @ $I_C = 60\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode
- Lead free package

Applications

- Photovoltaic inverters
- High frequency converters

Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. The device is part of the new "HB" series of IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of any frequency converter. Furthermore, a slightly 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
STGW60H65DFB	GW60H65DFB	TO-247	Tube
STGWT60H65DFB	GWT60H65DFB	TO-3P	Tube

Contents

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	650	V
I_C	Continuous collector current at $T_C = 25\text{ °C}$	80 ⁽¹⁾	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	60	A
I_{CP} ⁽²⁾	Pulsed collector current	240	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	80 ⁽¹⁾	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	60	A
I_{FP} ⁽²⁾	Pulsed forward current	240	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	375	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature	- 55 to 175	°C

1. Current level is limited by bond wires.
2. Pulse width limited by maximum junction temperature.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.4	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.14	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	°C/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 ($V_{GE} = 0$)	$I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		1.60	2	V
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$ $T_J = 125\text{ °C}$		1.75		
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$ $T_J = 175\text{ °C}$		1.85		
V_F	Forward on-voltage	$I_F = 60\text{ A}$		2	2.6	V
		$I_F = 60\text{ A}, T_J = 125\text{ °C}$		1.7		V
		$I_F = 60\text{ A}, T_J = 175\text{ °C}$		1.6		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$		6.0		V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 650\text{ V}$			25	μA
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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	7792	-	pF
C_{oes}	Output capacitance		-	262	-	pF
C_{res}	Reverse transfer capacitance		-	158	-	pF
Q_g	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 60\text{ A},$ $V_{GE} = 15\text{ V},$ see Figure 28	-	306	-	nC
Q_{ge}	Gate-emitter charge		-	126	-	nC
Q_{gc}	Gate-collector charge		-	58	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 5\ \Omega$, $V_{GE} = 15\text{ V}$, see Figure 27	-	51		ns	
t_r	Current rise time		-	22	-	ns	
$(di/dt)_{on}$	Turn-on current slope		-	2218		A/ μ s	
$t_{d(off)}$	Turn-off delay time				160		ns
t_f	Current fall time		-	18	-	ns	
$E_{on}^{(1)}$	Turn-on switching losses		-	1086	-	μ J	
$E_{off}^{(2)}$	Turn-off switching losses		-	626	-	μ J	
E_{ts}	Total switching losses	-	1712	-	μ J		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 5\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$, see Figure 27	-	50		ns	
t_r	Current rise time		-	30	-	ns	
$(di/dt)_{on}$	Turn-on current slope		-	2050		A/ μ s	
$t_{d(off)}$	Turn-off delay time				184		ns
t_f	Current fall time		-	117	-	ns	
$E_{on}^{(1)}$	Turn-on switching losses		-	2350	-	μ J	
$E_{off}^{(2)}$	Turn-off switching losses		-	1017	-	μ J	
E_{ts}	Total switching losses	-	3367	-	μ 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	$I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{GE} = 15\text{ V}$, see Figure 27	-	60	-	ns
Q_{rr}	Reverse recovery charge		-	99	-	nC
I_{rrm}	Reverse recovery current		-	3.3	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	187	-	A/ μ s
E_{rr}	Reverse recovery energy		-	68	-	μ J
t_{rr}	Reverse recovery time	$I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$, see Figure 27	-	310	-	ns
Q_{rr}	Reverse recovery charge		-	1550	-	nC
I_{rrm}	Reverse recovery current		-	10	-	A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	59	-	A/ μ s
E_{rr}	Reverse recovery energy		-	674	-	μ J

2.1 Electrical characteristics (curve)

Figure 2. Output characteristics ($T_J = 25^\circ\text{C}$)

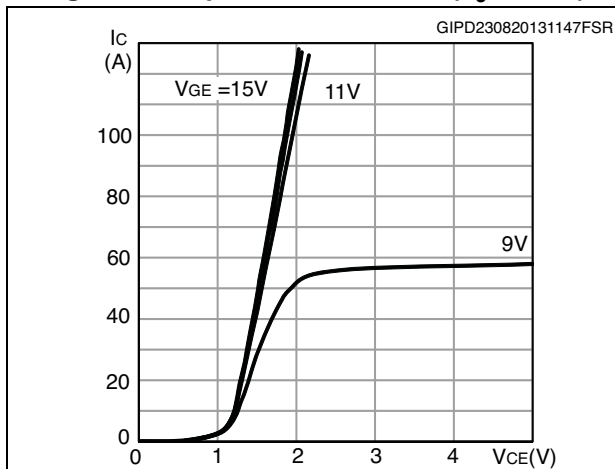


Figure 3. Output characteristics ($T_J = 175^\circ\text{C}$)

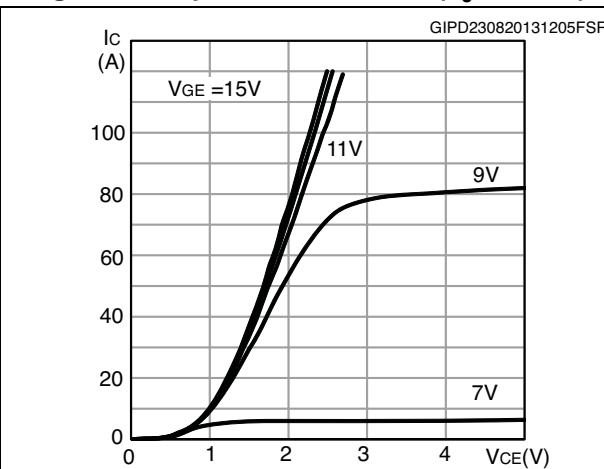


Figure 4. Transfer characteristics

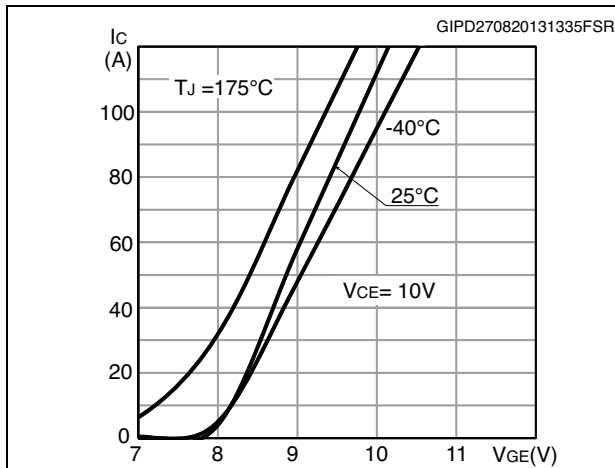


Figure 5. Collector current vs. case temperature

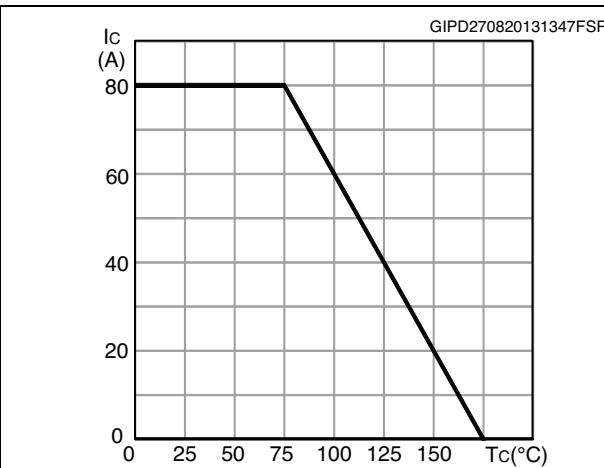


Figure 6. Power dissipation vs. case temperature

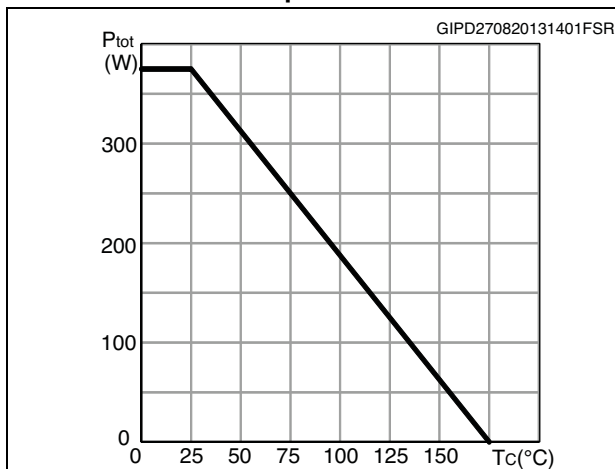


Figure 7. $V_{CE(sat)}$ vs. junction temperature

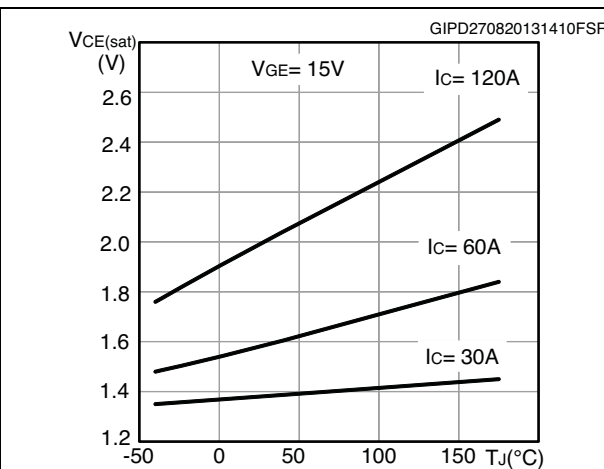


Figure 8. $V_{CE(sat)}$ vs. collector current

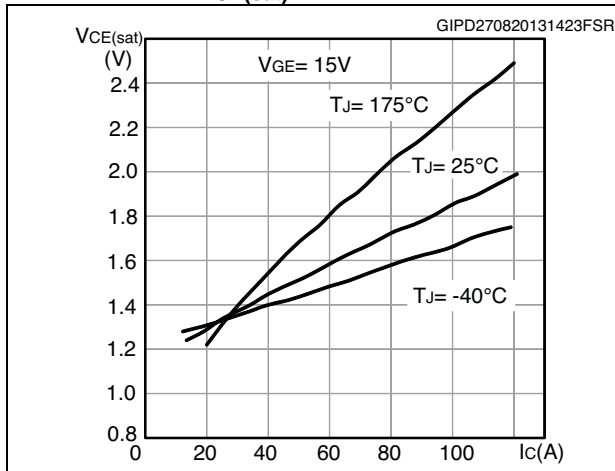


Figure 9. Forward bias safe operating area

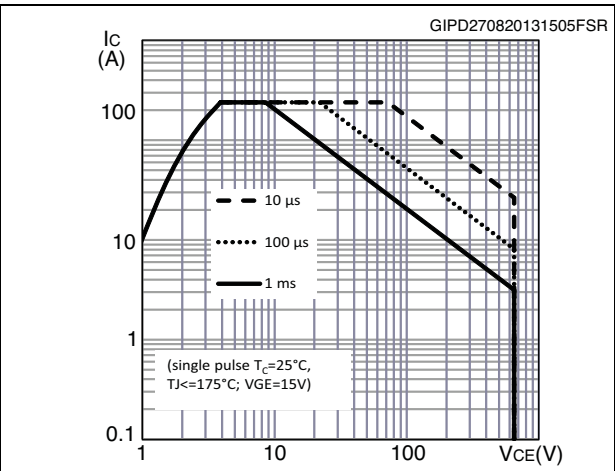


Figure 10. Diode V_F vs. forward current

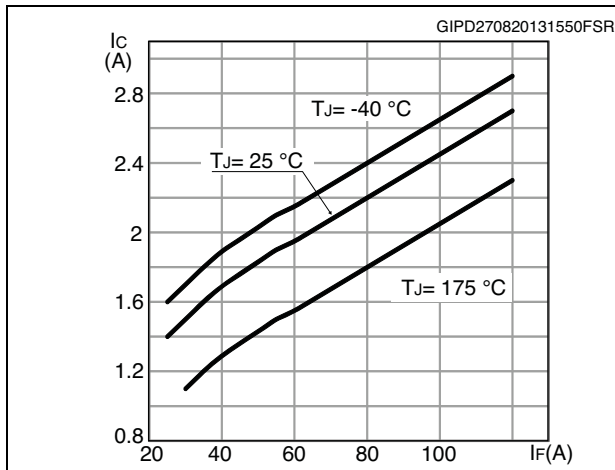


Figure 11. Normalized BV_{CES} vs. junction temperature

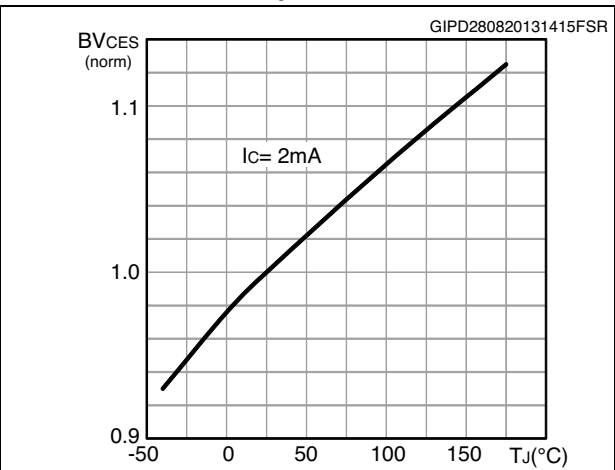


Figure 12. Normalized $V_{GE(th)}$ vs. junction temperature

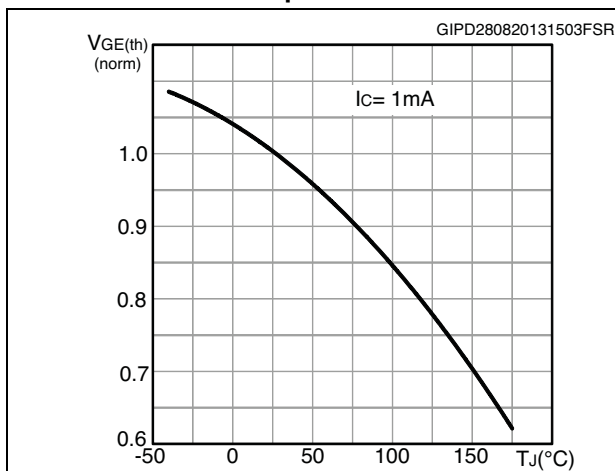


Figure 13. Gate charge vs. gate-emitter voltage

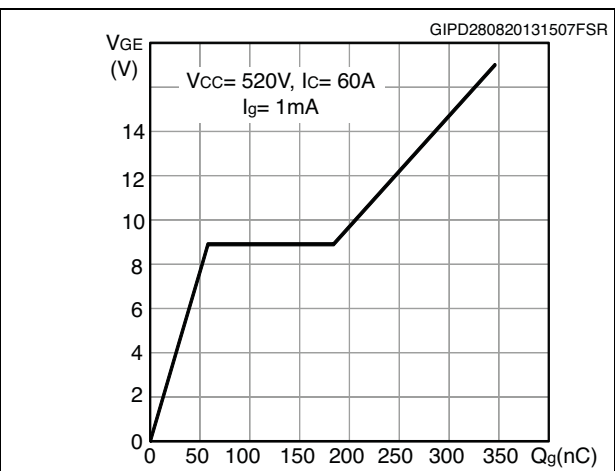


Figure 14. Switching losses vs temperature

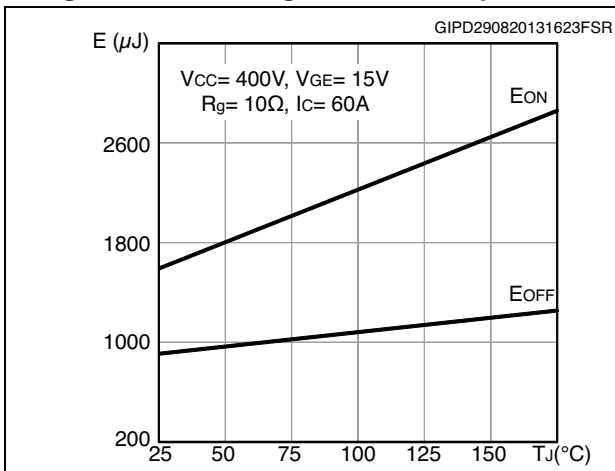


Figure 15. Switching losses vs gate resistance

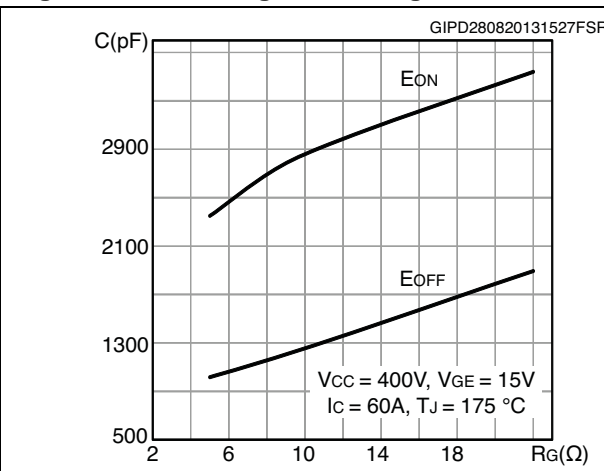


Figure 16. Switching losses vs collector current

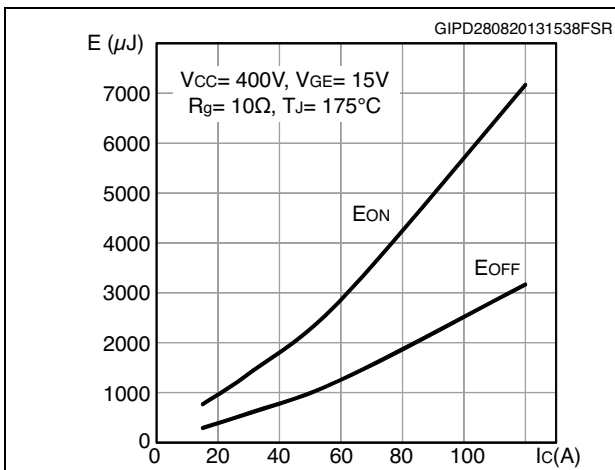


Figure 17. Switching losses vs collector emitter voltage

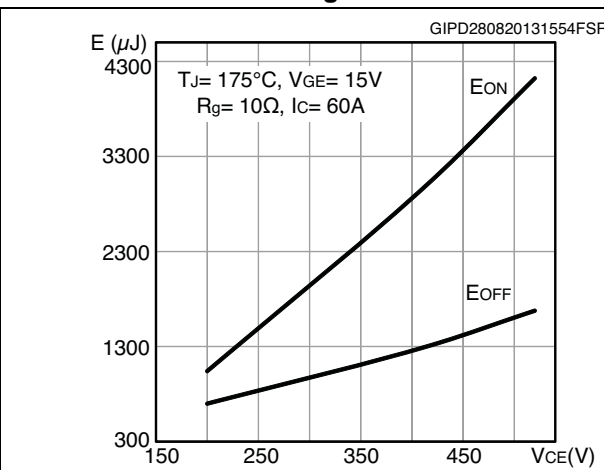


Figure 18. Switching times vs collector current

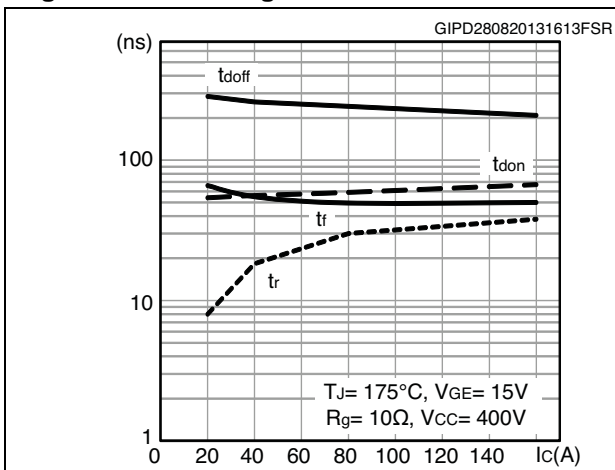


Figure 19. Switching times vs gate resistance

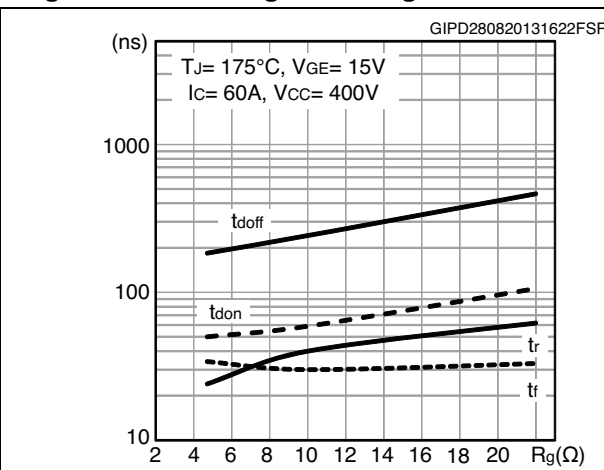


Figure 20. Reverse recovery current vs. diode current slope

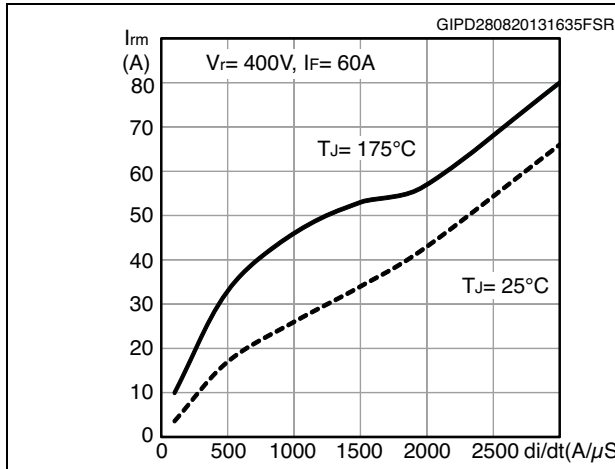


Figure 21. Reverse recovery time vs. diode current slope

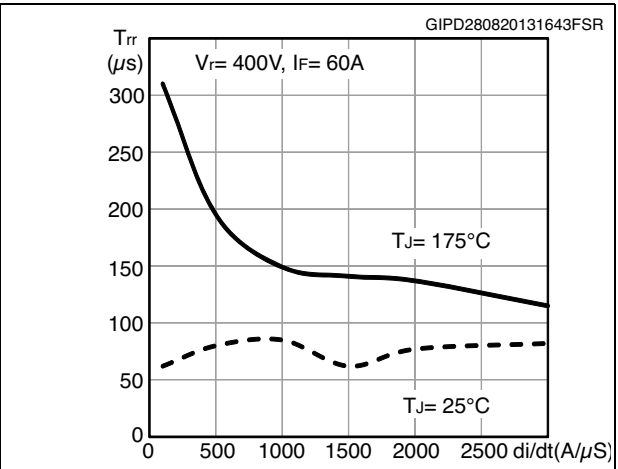


Figure 22. Reverse recovery charge vs. diode current slope

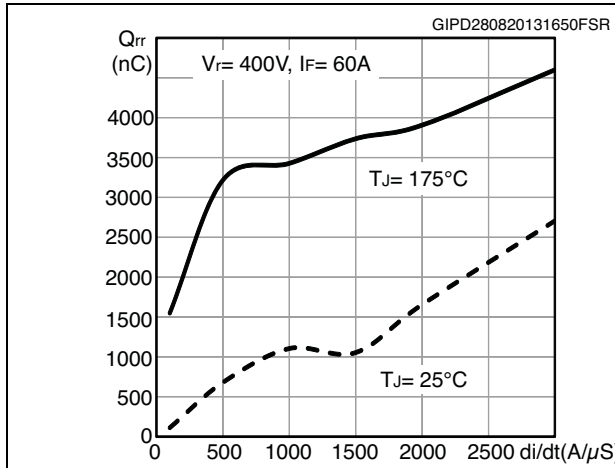


Figure 23. Reverse recovery energy vs. diode current slope

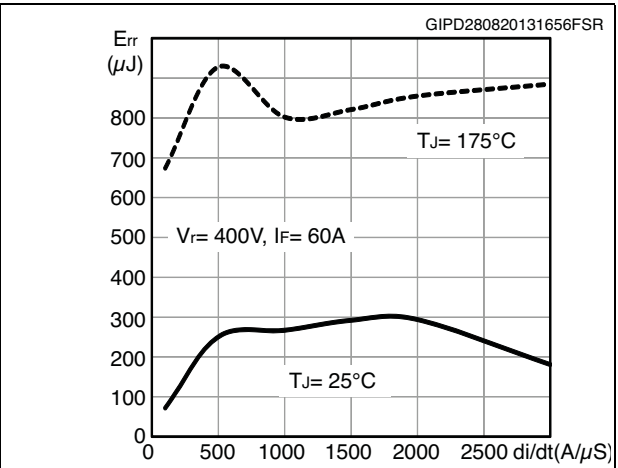


Figure 24. Capacitance variations

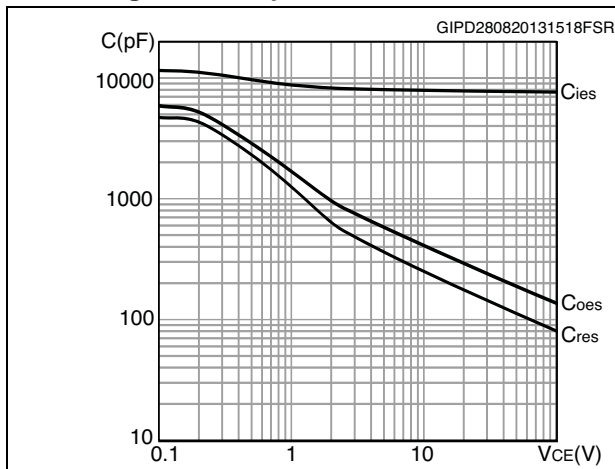


Figure 25. Thermal impedance

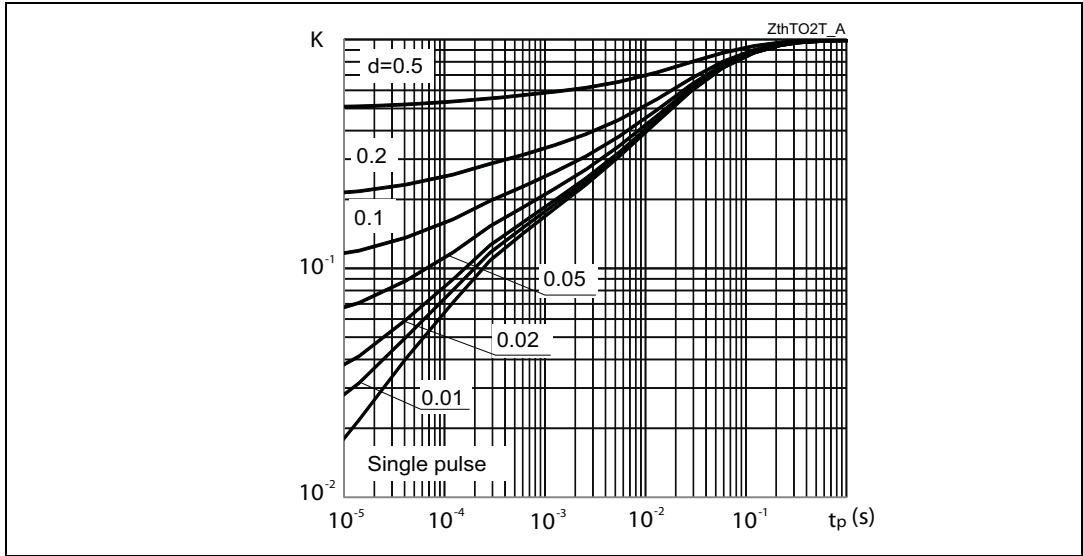
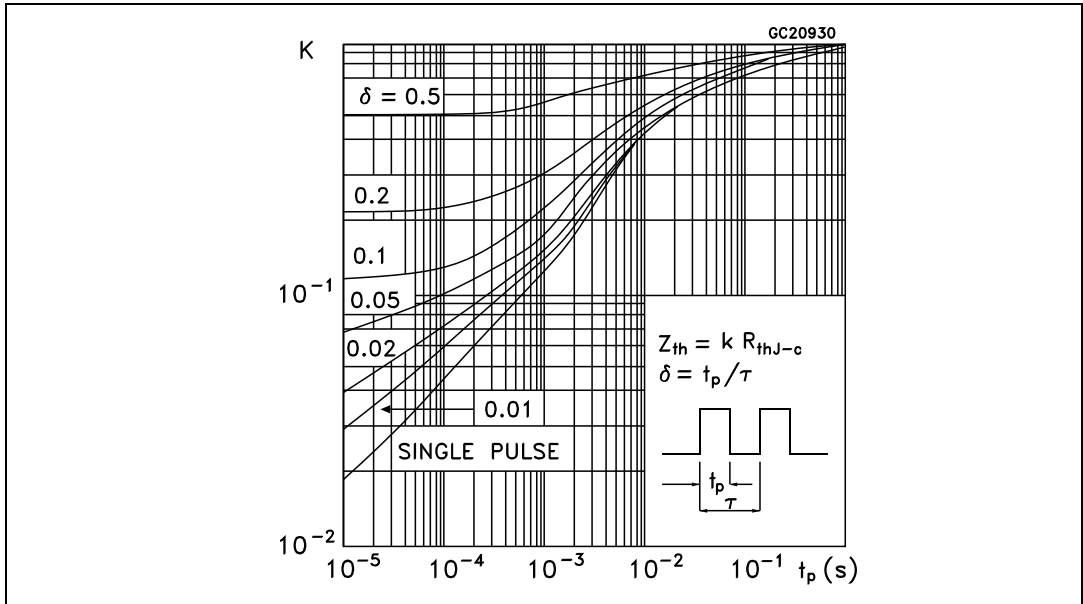


Figure 26. Thermal impedance for diode



3 Test circuits

Figure 27. Test circuit for inductive load switching

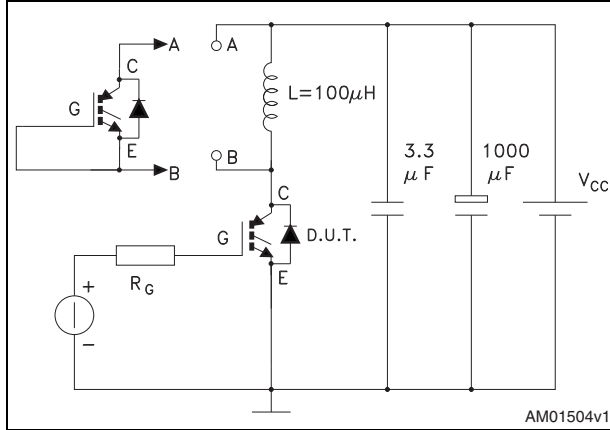


Figure 28. Gate charge test circuit

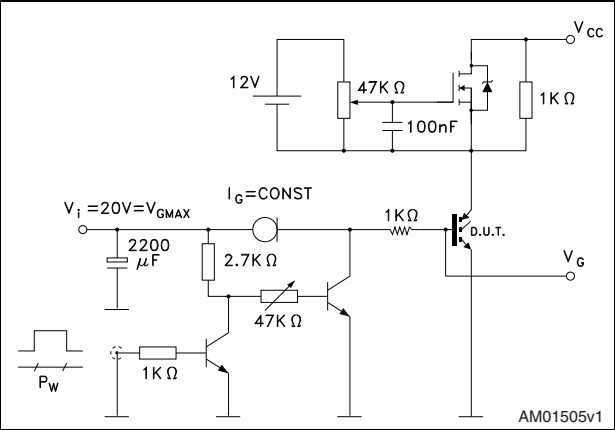


Figure 29. Switching waveform

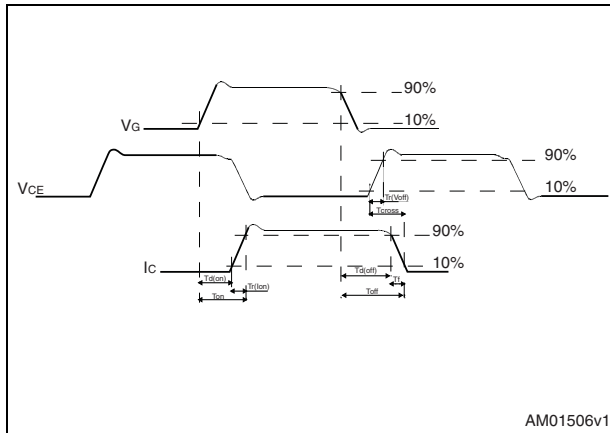
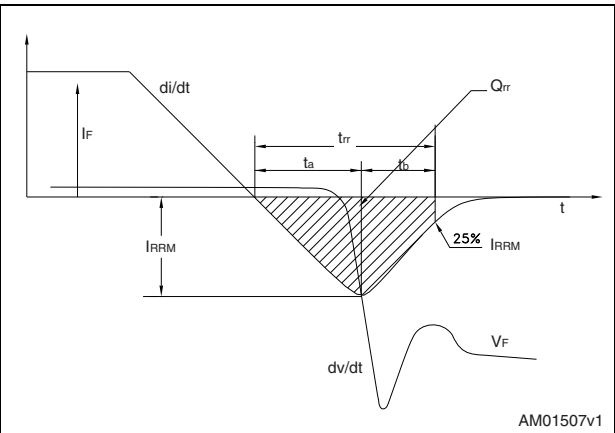


Figure 30. Diode recovery time waveform



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-247 drawing

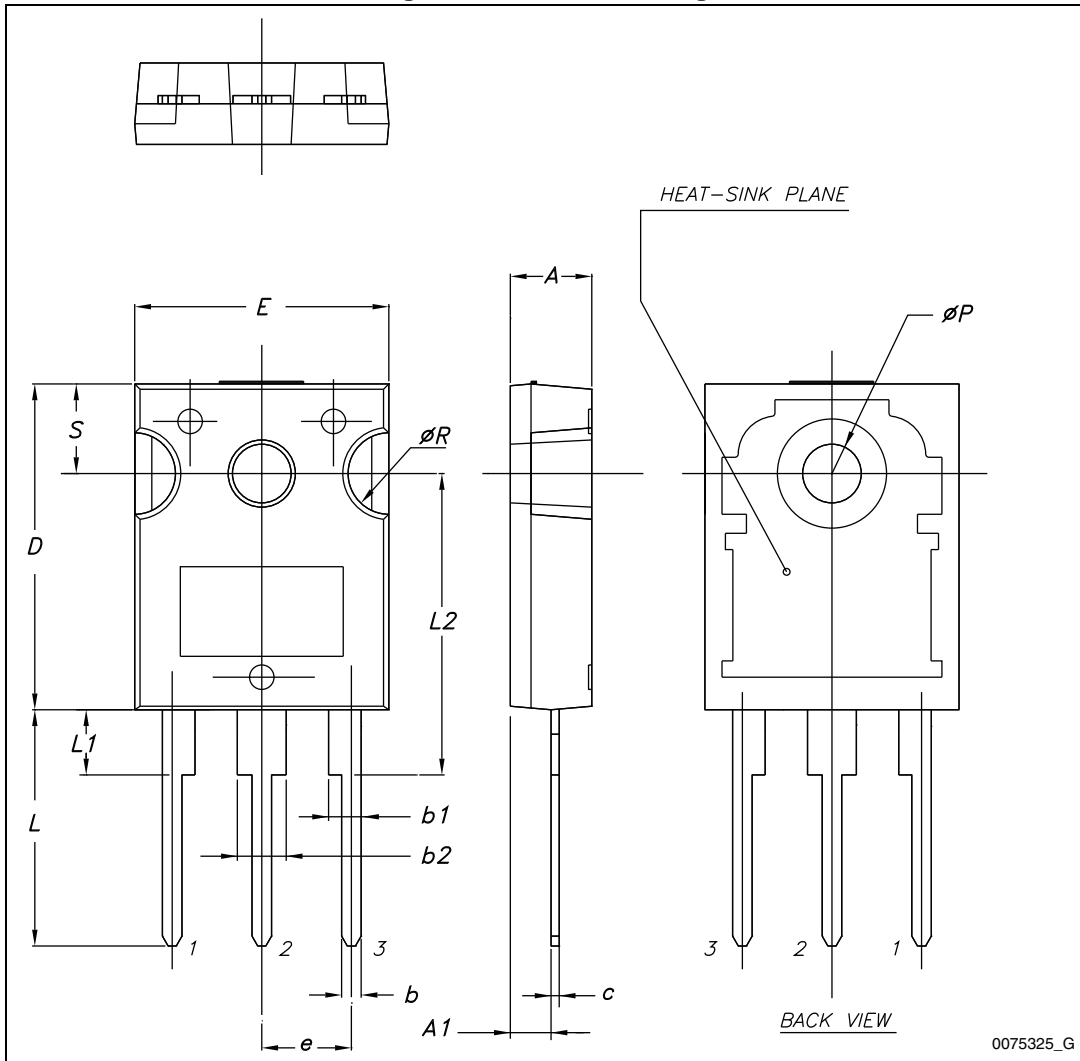


Table 8. TO-247 mechanical data

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

Figure 32. TO-3P drawing



Table 9. TO-3P mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60		5
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1	1.20
b1	1.80		2.20
b2	2.80		3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1		13.90	
E	15.40		15.80
E1		13.60	
E2		9.60	
e	5.15	5.45	5.75
L	19.50	20	20.50
L1		3.50	
L2	18.20	18.40	18.60
øP	3.10		3.30
Q		5	
Q1		3.80	

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
12-Mar-2013	1	Initial release.
30-Aug-2013	2	Document status promoted from preliminary to production data. Added Section 2.1: Electrical characteristics (curve) .
31-Oct-2013	3	Updated $V_{CE(sat)}$ in Table 4: Static characteristics .
24-Feb-2014	4	Updated title and description in cover page.

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