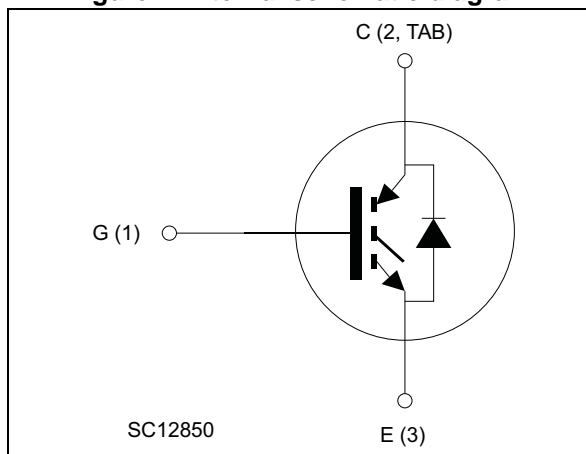


Figure 1. Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- Very low saturation voltage:  $V_{CE(sat)} = 1.60\text{ V}$  (typ.) @  $I_C = 40\text{ A}$
- 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 improved "H" series of IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of high frequency converters. Furthermore, a slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STGW40H65DFB	GW40H65DFB	TO-247	Tube
STGWT40H65DFB	GWT40H65DFB	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	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	40	A
$I_{CP}^{(1)}$	Pulsed collector current	160	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current at $T_C = 25\text{ °C}$	80	A
$I_F$	Continuous forward current at $T_C = 100\text{ °C}$	40	A
$I_{FP}^{(1)}$	Pulsed forward current	160	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	283	W
$T_{STG}$	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	0.53	°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	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$		1.60	2.3	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $T_J = 125\text{ °C}$		1.7		
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $T_J = 175\text{ °C}$		1.8		
$V_F$	Forward on-voltage	$I_F = 40\text{ A}$		1.7	2.45	V
		$I_F = 40\text{ A}, T_J = 125\text{ °C}$		1.4		
		$I_F = 40\text{ A}, T_J = 175\text{ °C}$		1.3		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 650\text{ V}$			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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	5412	-	pF
$C_{oes}$	Output capacitance		-	198	-	pF
$C_{res}$	Reverse transfer capacitance		-	107	-	pF
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 40\text{ A},$ $V_{GE} = 15\text{ V},$ see <a href="#">Figure 28</a>	-	210	-	nC
$Q_{ge}$	Gate-emitter charge		-	39	-	nC
$Q_{gc}$	Gate-collector charge		-	82	-	nC

**Table 6. IGBT switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 5\ \Omega$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 27</a>	-	40	-	ns
$t_r$	Current rise time		-	13	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2413	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	142	-	ns
$t_f$	Current fall time		-	27	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	498	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	363	-	$\mu$ J
$E_{ts}$	Total switching losses	-	861	-	$\mu$ J	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 5\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 27</a>	-	38	-	ns
$t_r$	Current rise time		-	14	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	2186	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	141	-	ns
$t_f$	Current fall time		-	61	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	1417	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	764	-	$\mu$ J
$E_{ts}$	Total switching losses	-	2181	-	$\mu$ 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	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $di/dt=100\text{ A}/\mu\text{s}$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 27</a>	-	62	-	ns
$Q_{rr}$	Reverse recovery charge		-	111	-	nC
$I_{rrm}$	Reverse recovery current		-	3	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	140	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	72	-	$\mu$ J
$t_{rr}$	Reverse recovery time	$I_F = 40\text{ A}$ , $V_R = 400\text{ V}$ , $di/dt=100\text{ A}/\mu\text{s}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 27</a>	-	341	-	ns
$Q_{rr}$	Reverse recovery charge		-	2216	-	nC
$I_{rrm}$	Reverse recovery current		-	13	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	70	-	A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	884	-	$\mu$ J

## 2.1 Electrical characteristics (curve)

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

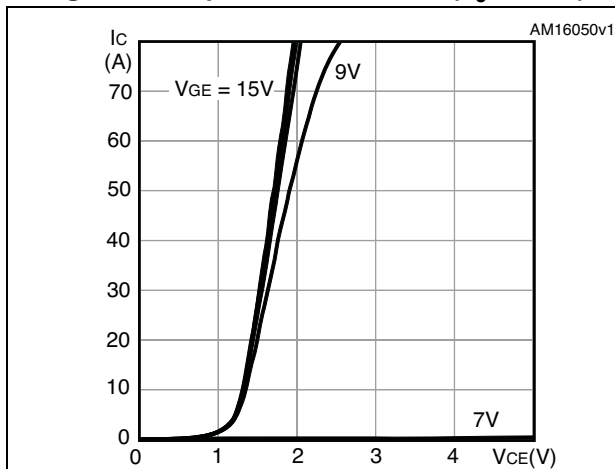


Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

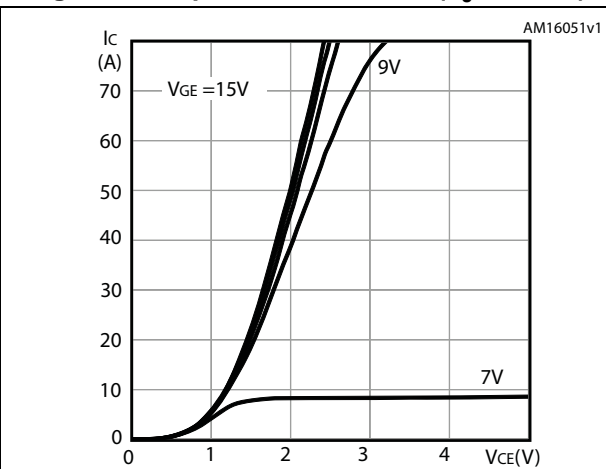


Figure 4. Transfer characteristics

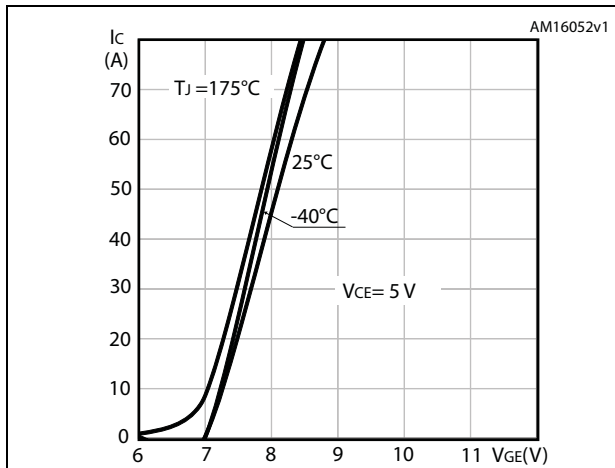


Figure 5. Collector current vs. case temperature

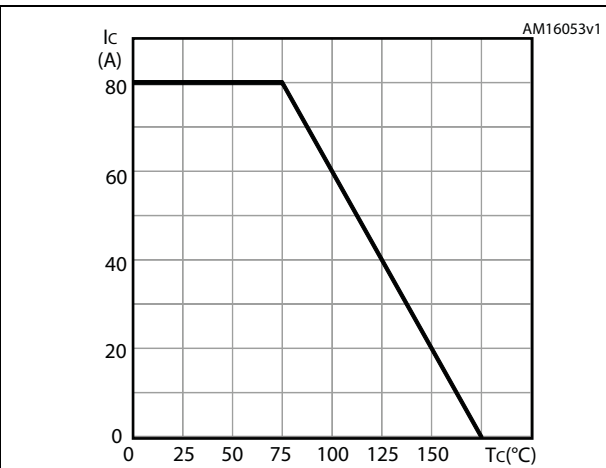


Figure 6. Power dissipation vs. case temperature

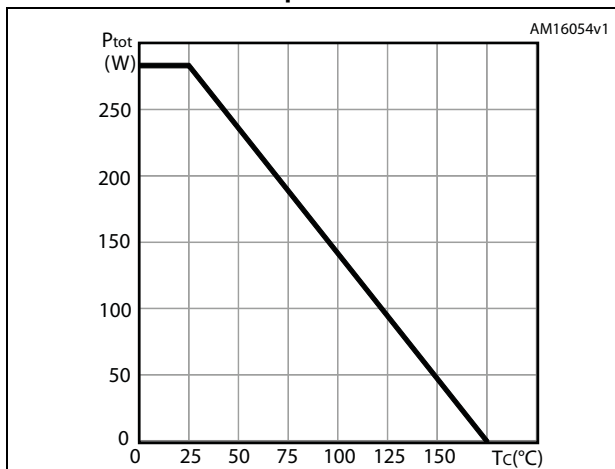


Figure 7.  $V_{CE(sat)}$  vs. junction temperature

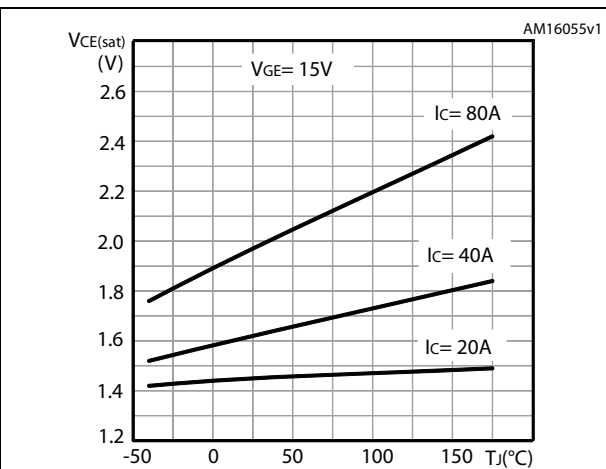


Figure 8.  $V_{CE(sat)}$  vs. collector current

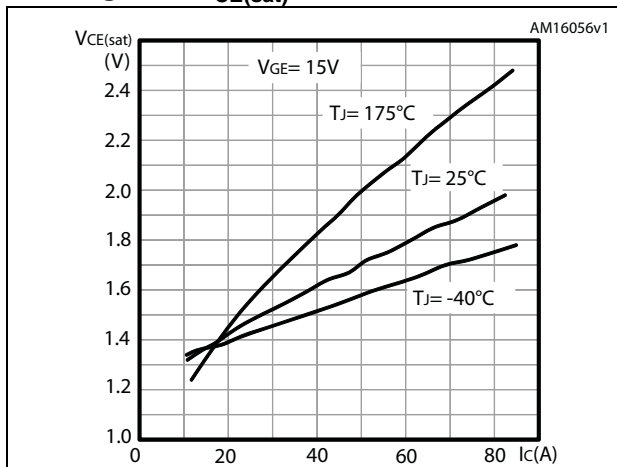


Figure 9. Forward bias safe operating area

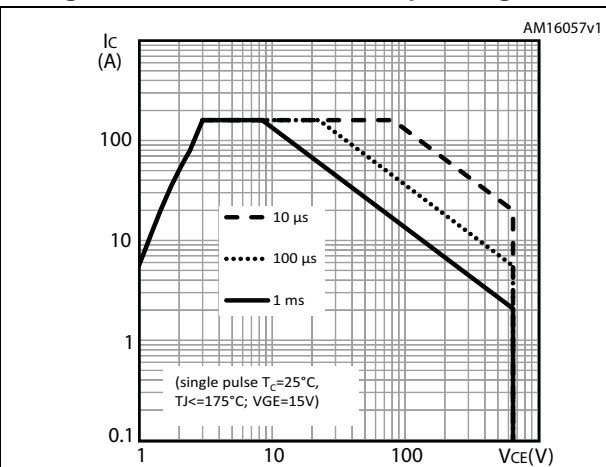


Figure 10. Thermal impedance for IGBT

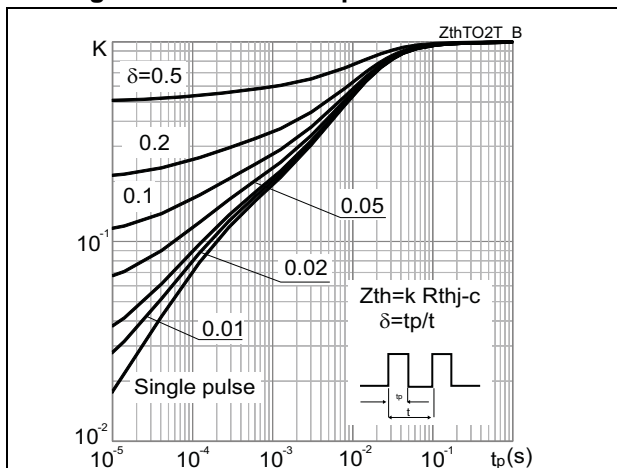


Figure 11. Thermal impedance for diode

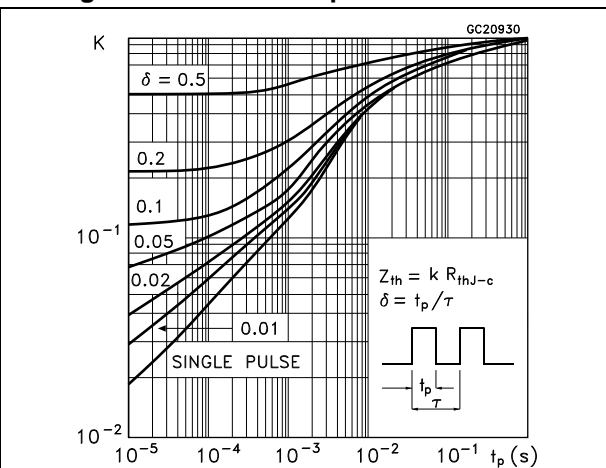


Figure 12. Diode  $V_F$  vs. forward current

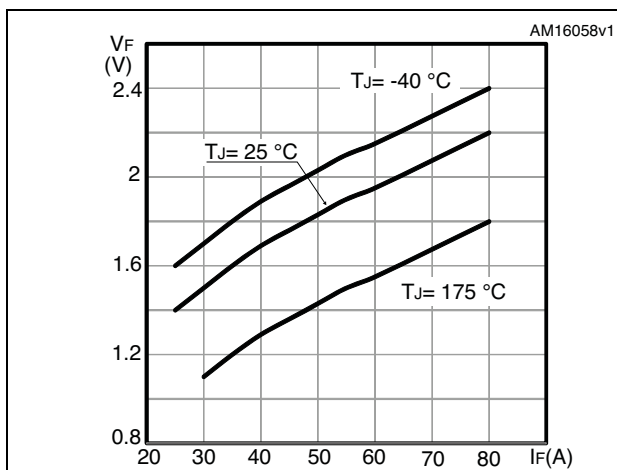


Figure 13. Normalized  $V_{(BR)CES}$  vs. junction temperature

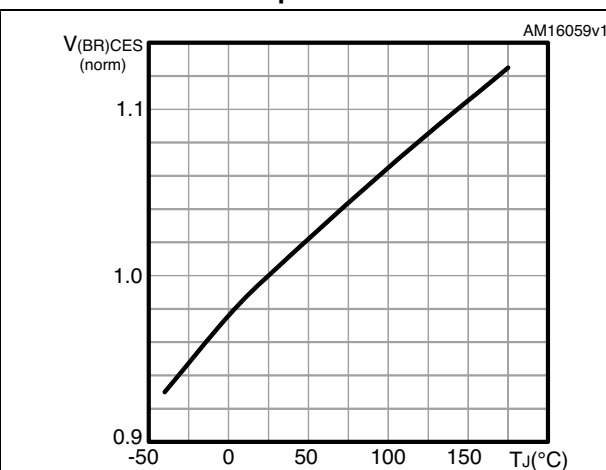


Figure 14. Normalized  $V_{GE(th)}$  vs. junction temperature

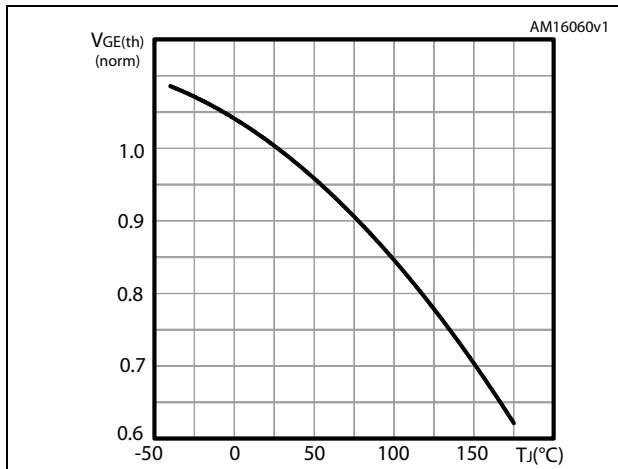


Figure 15. Gate charge vs. gate-emitter voltage

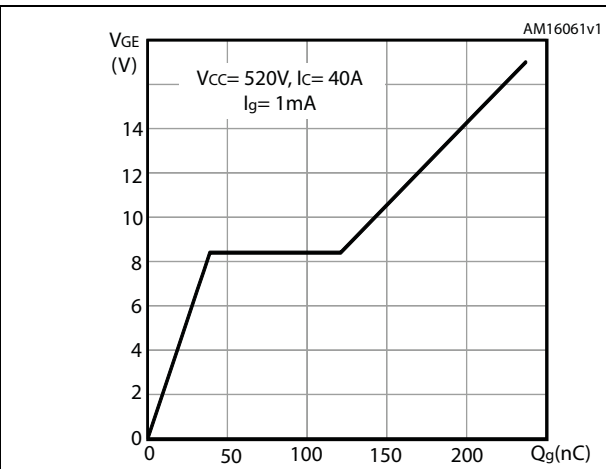


Figure 16. Switching losses vs temperature

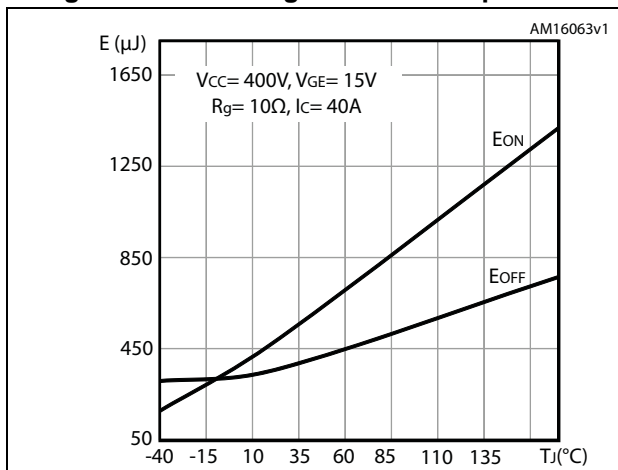


Figure 17. Switching losses vs gate resistance

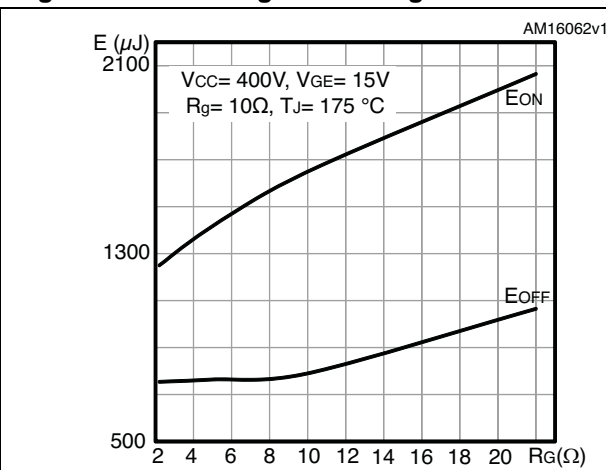


Figure 18. Switching losses vs collector current

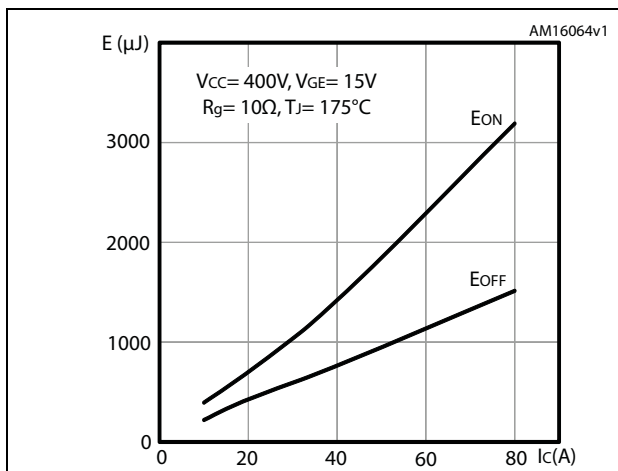


Figure 19. Switching losses vs collector emitter voltage

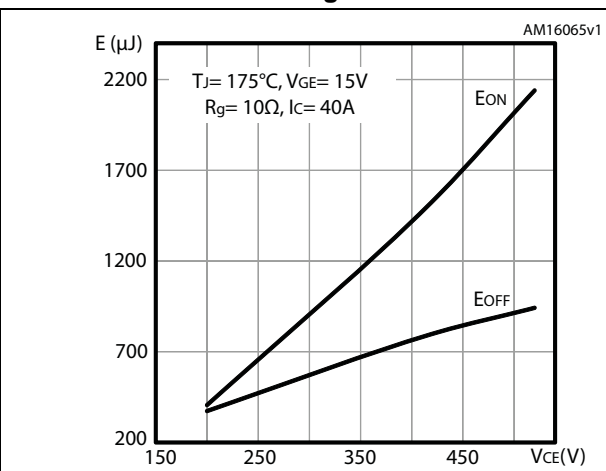




Figure 20. Switching times vs collector current

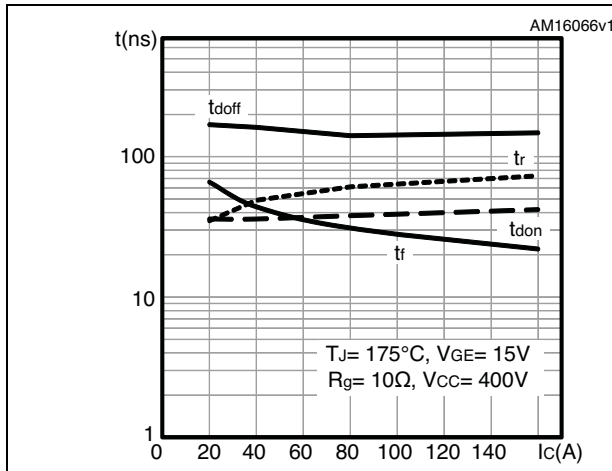


Figure 21. Switching times vs gate resistance

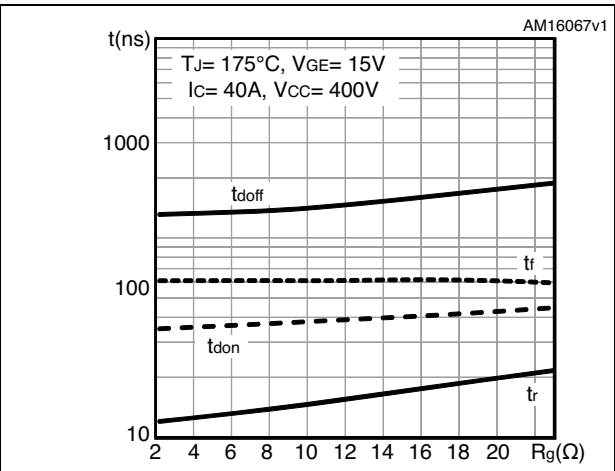


Figure 22. Reverse recovery current vs. diode current slope

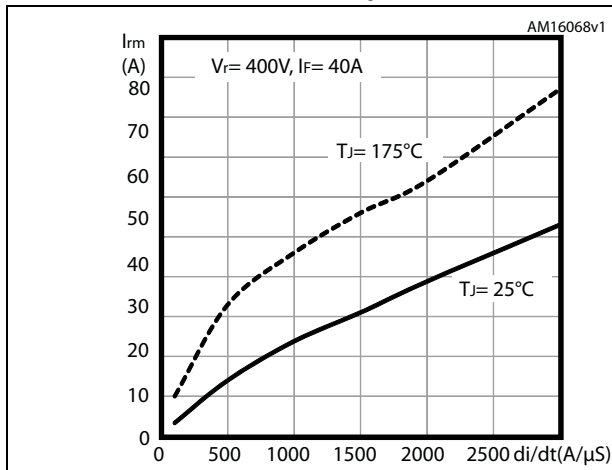


Figure 23. Reverse recovery time vs. diode current slope

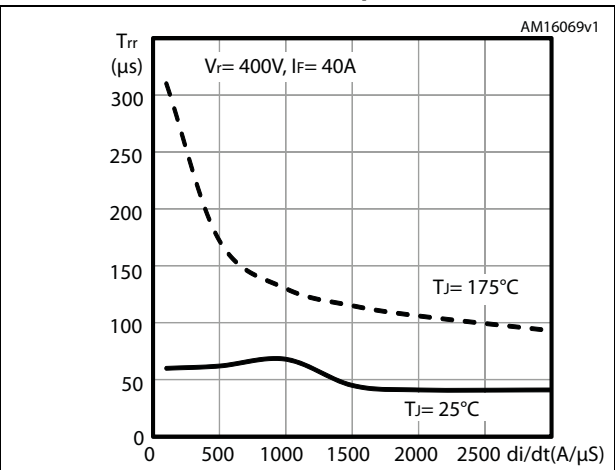


Figure 24. Reverse recovery charge vs. diode current slope

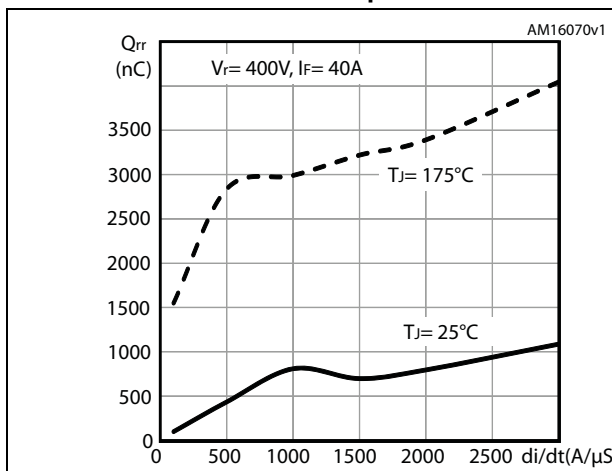


Figure 25. Reverse recovery energy vs. diode current slope

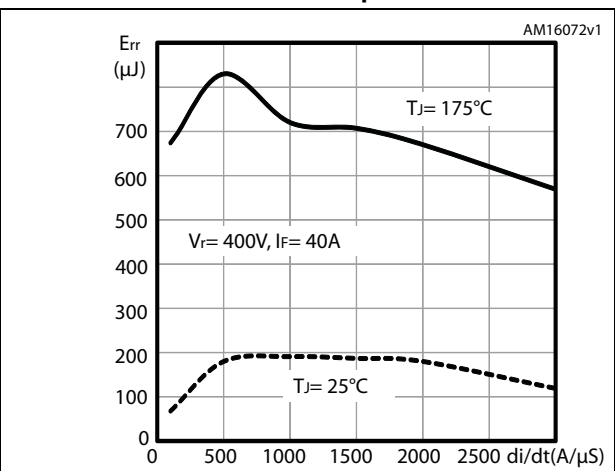
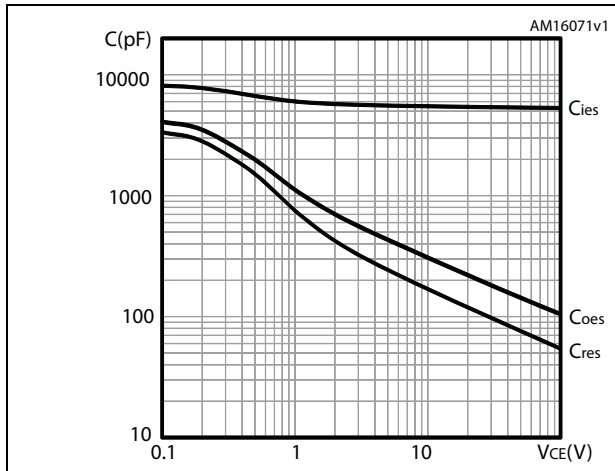


Figure 26. Capacitance variations



### 3 Test circuits

Figure 27. Test circuit for inductive load switching

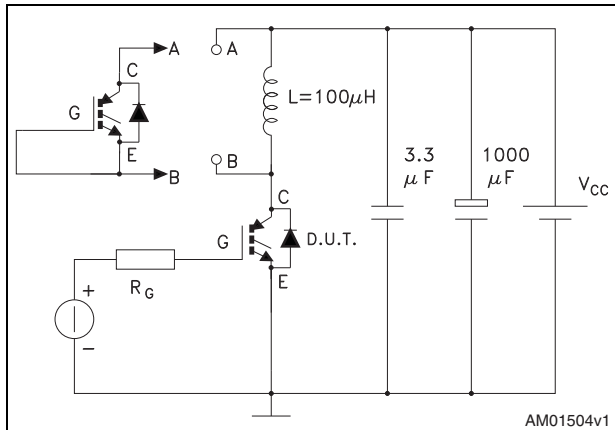


Figure 28. Gate charge test circuit

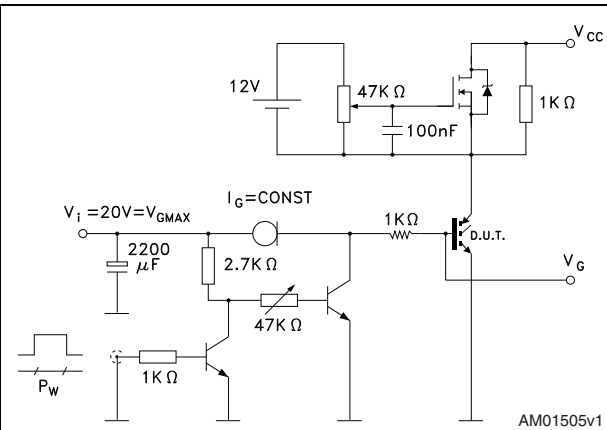


Figure 29. Switching waveform

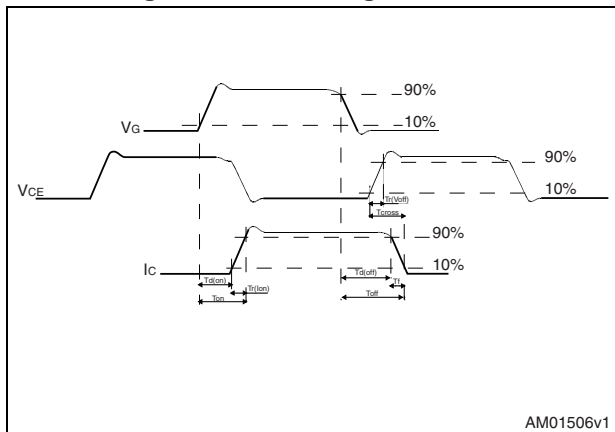
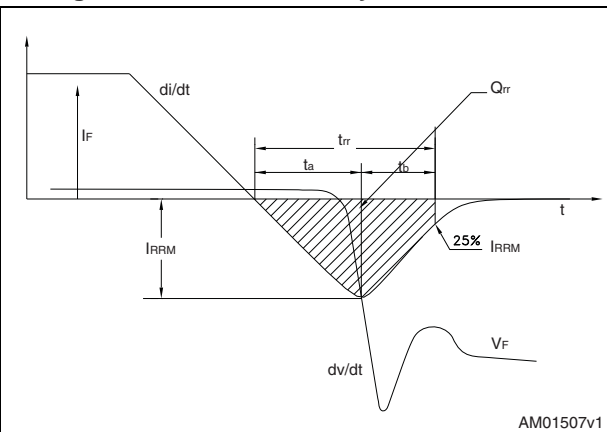


Figure 30. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

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 31. TO-247 drawing

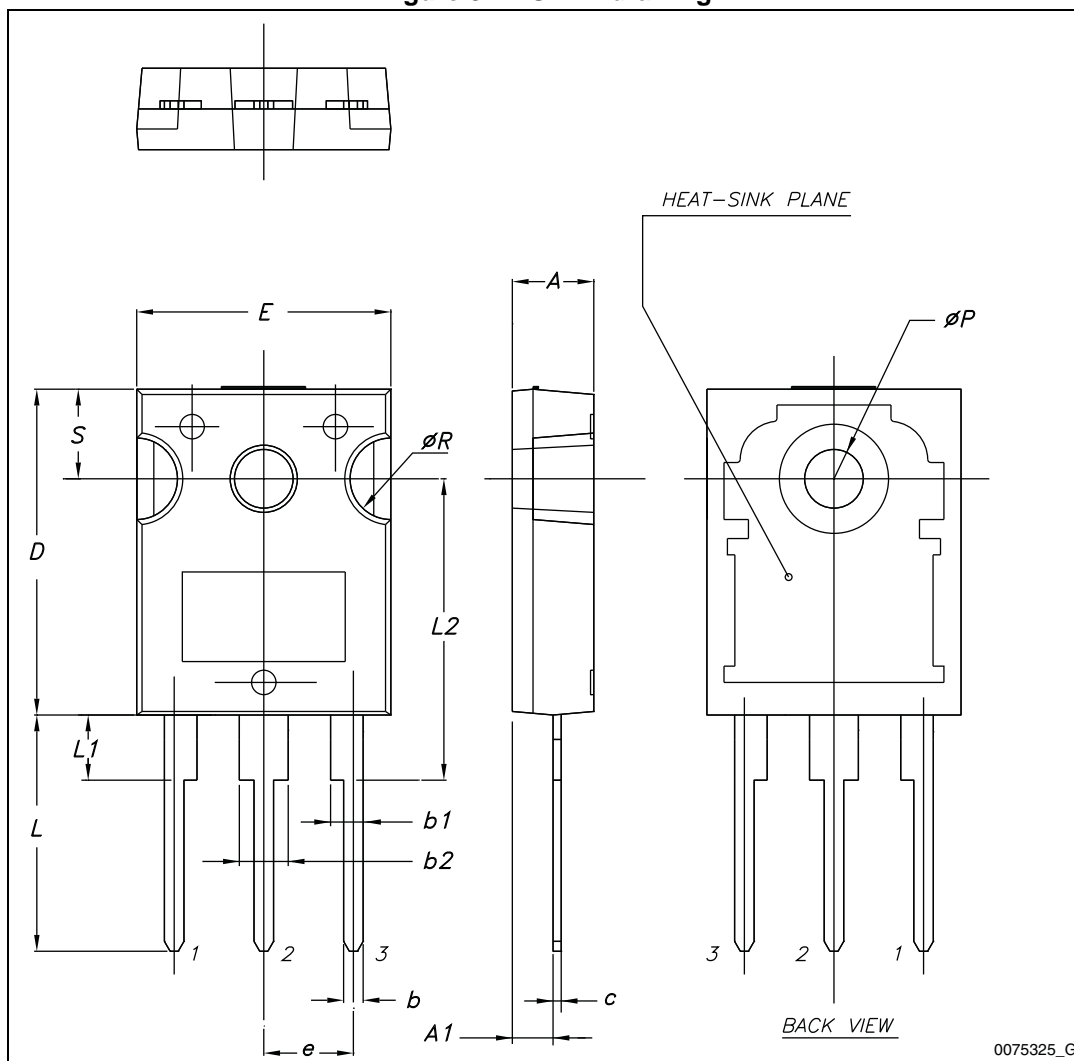
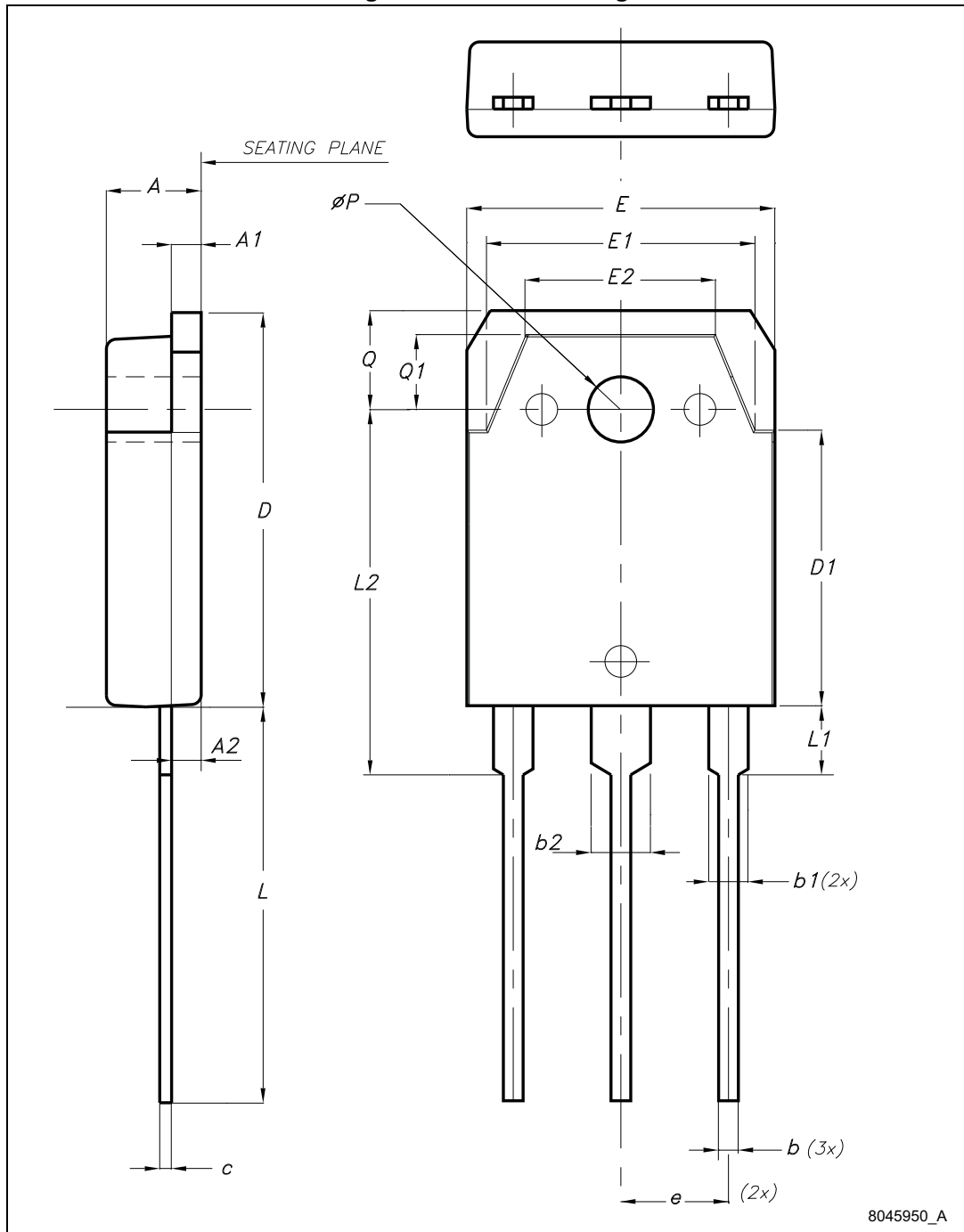


Table 9. TO-3P mechanical data

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	

Figure 32. TO-3P drawing



8045950\_A



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
12-Mar-2013	1	Initial release.
09-Sep-2013	2	<ul style="list-style-type: none"><li>– Modified: <math>V_{CE(sat)}</math> values in cover page</li><li>– Modified: <math>V_{CE(sat)}</math>, <math>V_F</math> and <math>V_{GE(th)}</math> typical and max values in <a href="#">Table 4</a></li><li>– Modified: entire typical values in <a href="#">Table 5</a>, <a href="#">6</a> and <a href="#">7</a></li><li>– Minor text changes</li><li>– Added: <a href="#">Section 2.1: Electrical characteristics (curve)</a></li></ul>
11-Sep-2013	3	<ul style="list-style-type: none"><li>– Updated <math>T_{STG}</math> value in <a href="#">Table 2: Absolute maximum ratings</a>.</li></ul>
23-Sep-2013	4	<ul style="list-style-type: none"><li>– Updated units in <a href="#">Table 6: IGBT switching characteristics (inductive load)</a>.</li></ul>

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