

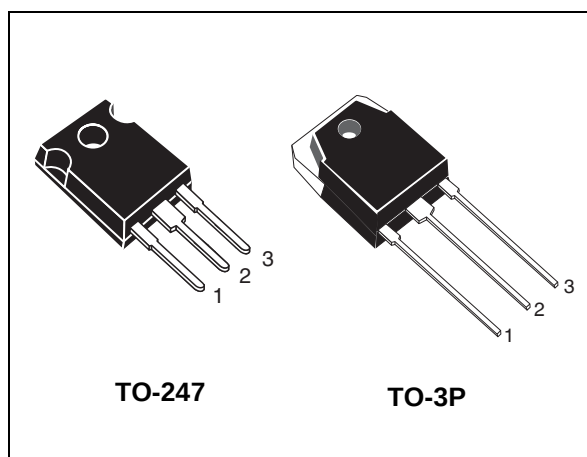
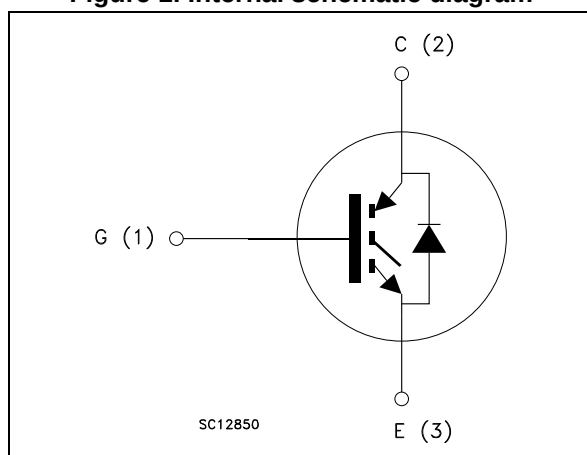


Figure 1. Internal schematic diagram



Features

- Designed for soft commutation only
- Maximum junction temperature: $T_J = 175\text{ }^{\circ}\text{C}$
- Very high speed switching series
- Tail-less switching off
- Low saturation voltage: $V_{CE(sat)} = 1.8\text{ V (typ.)}$
@ $I_C = 40\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Low V_F soft recovery co-packaged diode
- Lead free package

Applications

- Induction heating
- Microwave oven
- Resonant converters

Description

This device is an IGBT developed using an advanced proprietary trench gate and 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
STGW40V60DLF	GW40V60DLF	TO-247	Tube
STGWT40V60DLF	GWT40V60DLF	TO-3P	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 $T_C = 25\text{ °C}$	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	± 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 and turn-off within RBSOA

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	1.4	°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 ($V_{GE} = 0$)	$I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$		1.8	2.3	V
		$V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$ $T_J = 125\text{ °C}$		2.15		
		$V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$ $T_J = 175\text{ °C}$		2.35		
V_F	Forward on-voltage	$I_F = 40\text{ A}$		1.55	1.8	V
		$I_F = 40\text{ A}$ $T_J = 125\text{ °C}$		1.3		V
		$I_F = 40\text{ A}$ $T_J = 175\text{ °C}$		1.25		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	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	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$	-	5400	-	pF
C_{oes}	Output capacitance		-	220	-	pF
C_{res}	Reverse transfer capacitance		-	180	-	pF
Q_g	Total gate charge	$V_{CC} = 480\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$ (see Figure 27)	-	226	-	nC
Q_{ge}	Gate-emitter charge		-	38	-	nC
Q_{gc}	Gate-collector charge		-	95	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 25)		208		ns
t_f	Current fall time		-	20	-	ns
$E_{off}^{(1)}$	Turn-off switching losses		-	411	-	μJ
$t_{d(off)}$	Turn-off delay time	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 25)		220		ns
t_f	Current fall time		-	21	-	ns
$E_{off}^{(1)}$	Turn-off switching losses		-	560	-	μJ

1. Turn-off losses include also the tail of the collector current.

Table 7. IGBT switching characteristics (capacitive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{off}^{(1)}$	Turn-off switching losses	$V_{CC} = 320\text{ V}$, $R_G = 10\ \Omega$, $I_C = 40\text{ A}$, $L = 100\ \mu\text{H}$, $C_{snub} = 20\text{ nF}$ (see Figure 26)	-	147	-	μJ
		$V_{CC} = 320\text{ V}$, $R_G = 10\ \Omega$, $I_C = 40\text{ A}$, $L = 100\ \mu\text{H}$, $C_{snub} = 20\text{ nF}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 26)	-	303	-	

1. Turn-off losses include also the tail of the collector current.

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

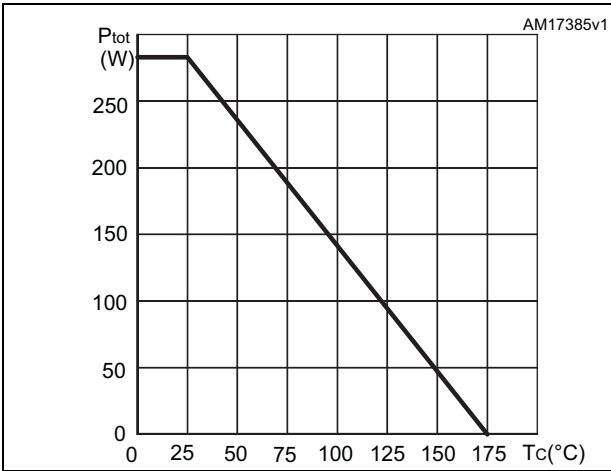


Figure 3. Collector current vs. case temperature

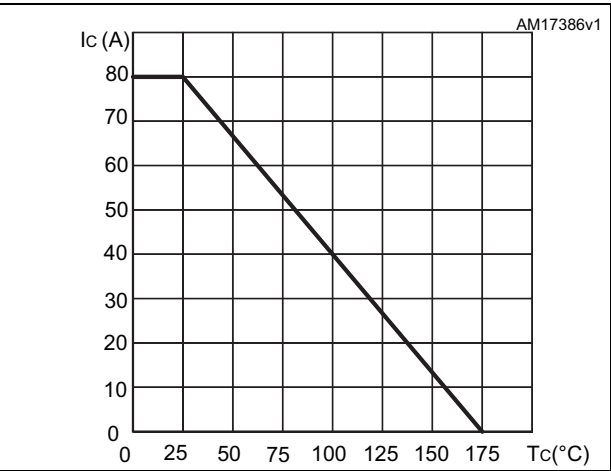


Figure 4. Output characteristics ($T_J=25^\circ\text{C}$)

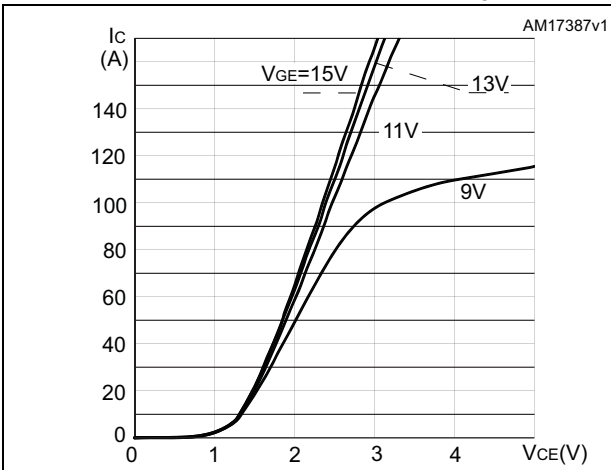


Figure 5. Output characteristics ($T_J=175^\circ\text{C}$)

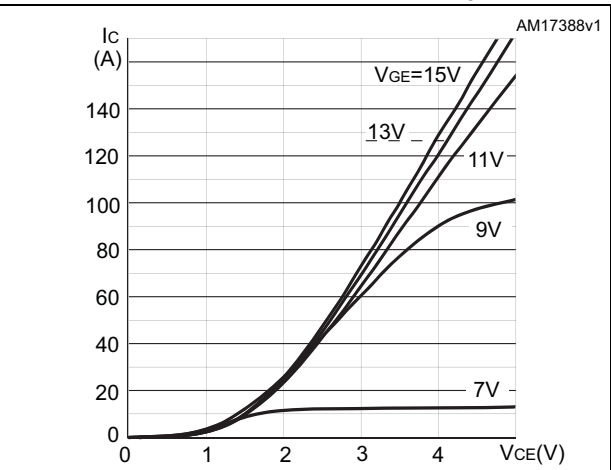


Figure 6. $V_{CE(sat)}$ vs. junction temperature

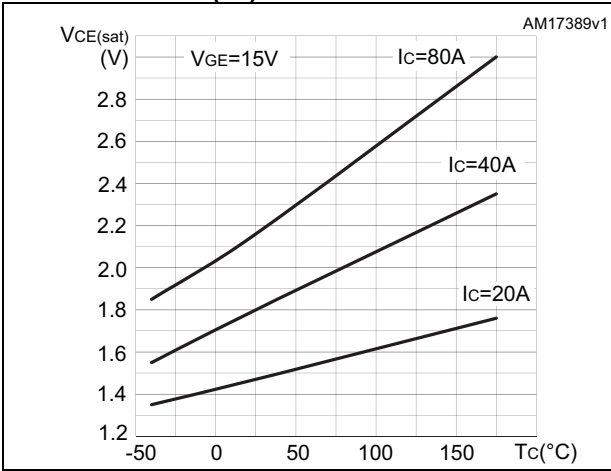


Figure 7. $V_{CE(sat)}$ vs. collector current

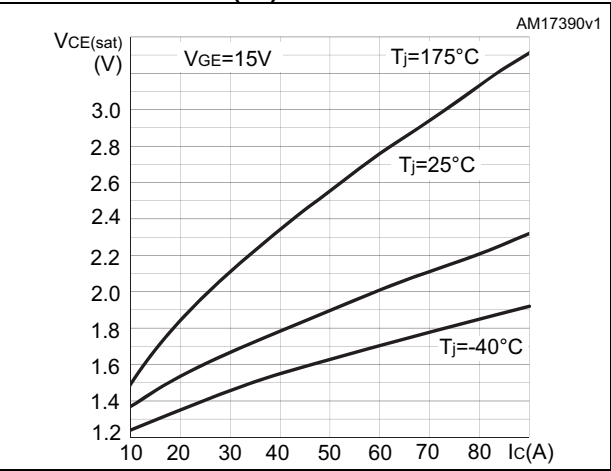


Figure 8. Collector current vs. switching frequency

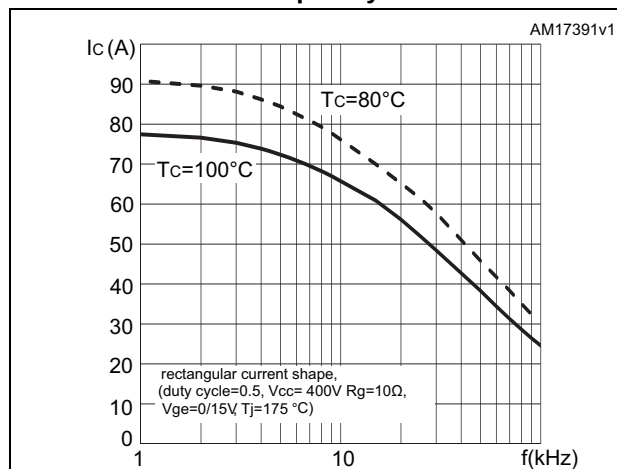


Figure 9. Forward bias safe operating area

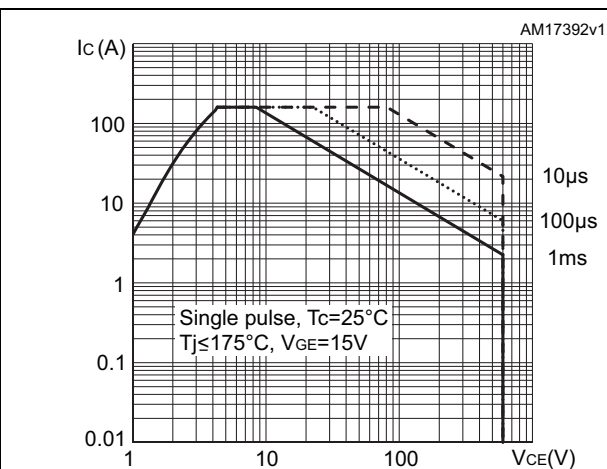


Figure 10. Transfer characteristics

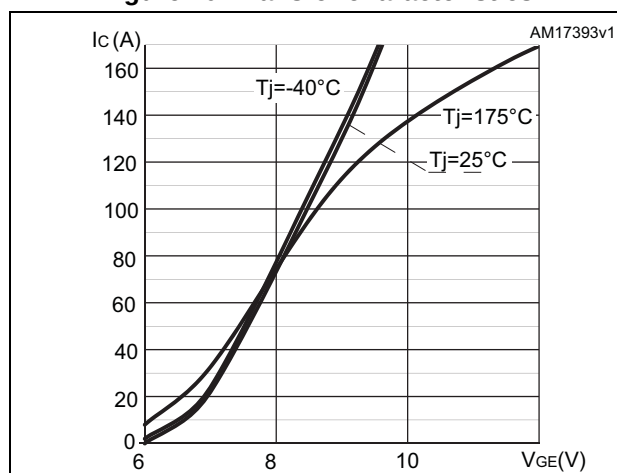
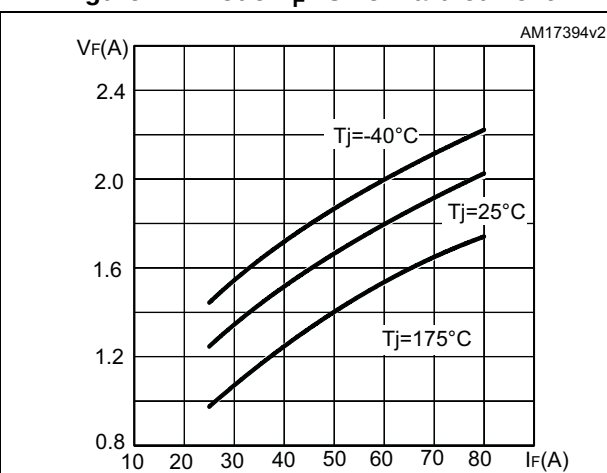
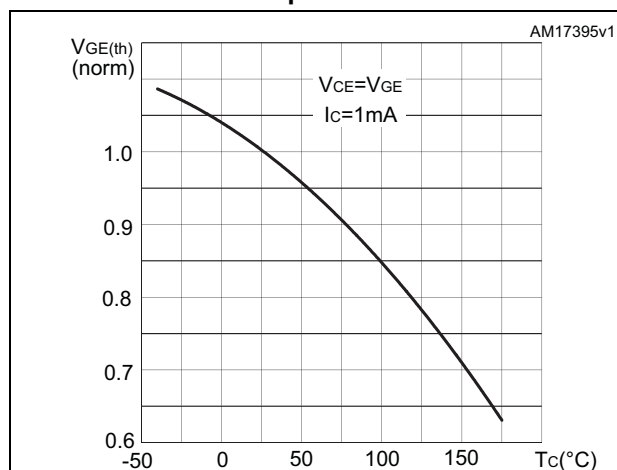
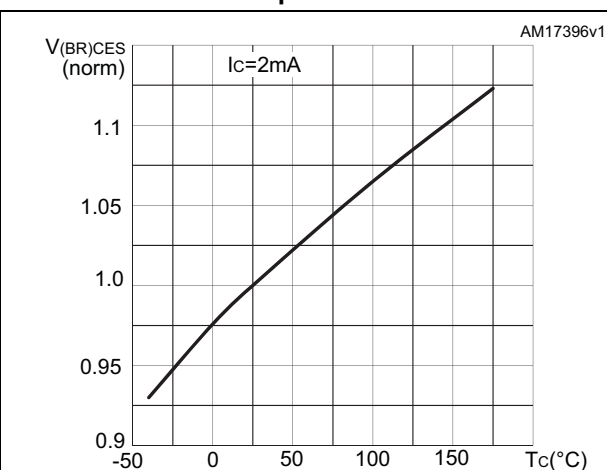
Figure 11. Diode V_F vs. forward currentFigure 12. Normalized $V_{GE(th)}$ vs junction temperatureFigure 13. Normalized $V_{(BR)CES}$ vs. junction temperature

Figure 14. Capacitance variations

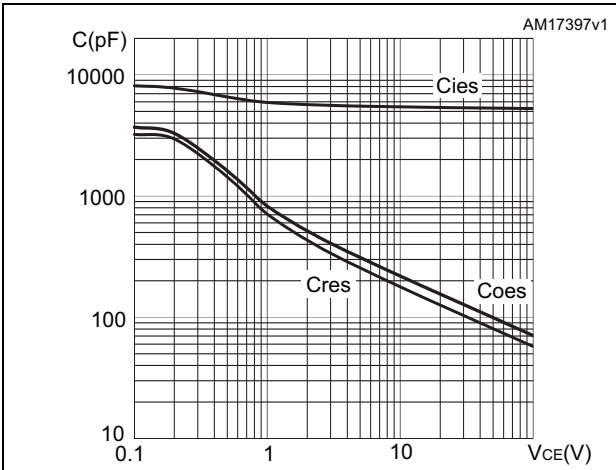


Figure 15. Gate charge vs. gate-emitter voltage

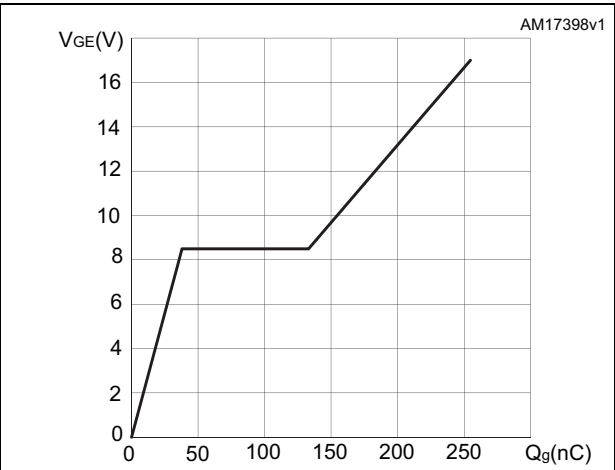


Figure 16. Switching-off losses vs. collector current

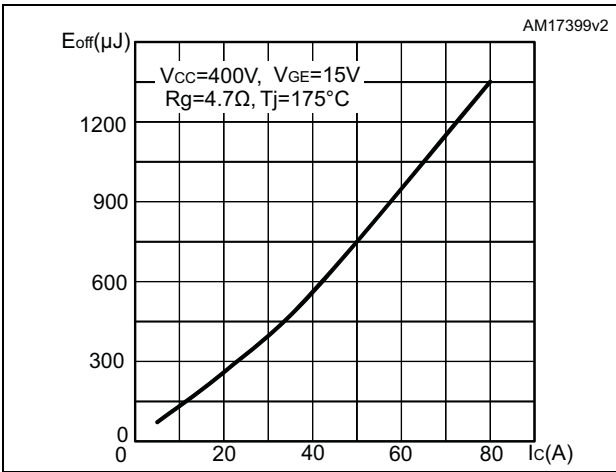


Figure 17. Switching-off losses vs. gate resistance

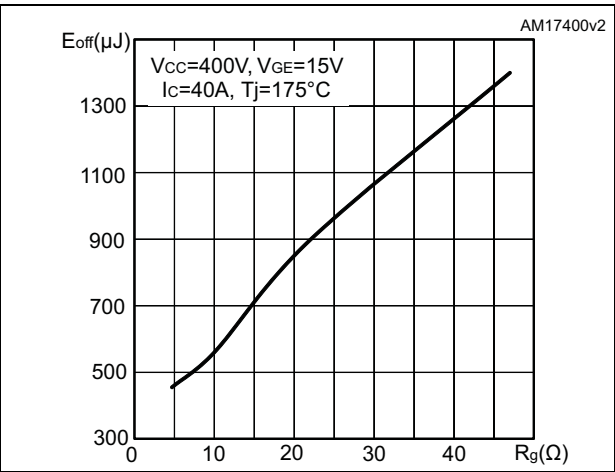


Figure 18. Switching-off losses vs. junction temperature

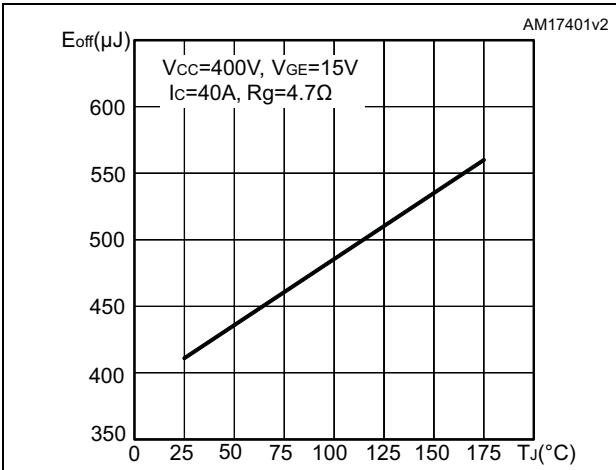


Figure 19. Switching-off losses vs. collector emitter voltage

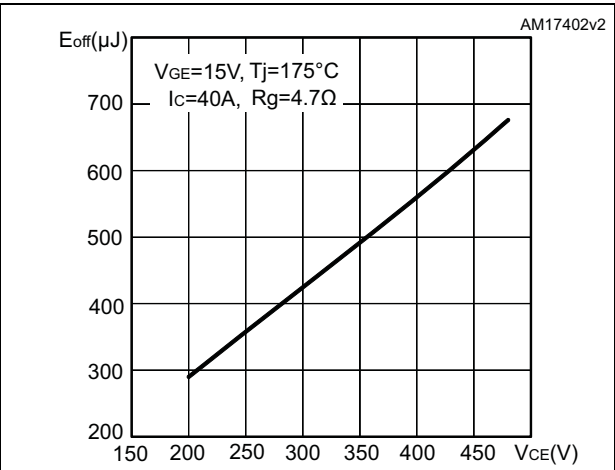


Figure 20. Switching times vs. collector current

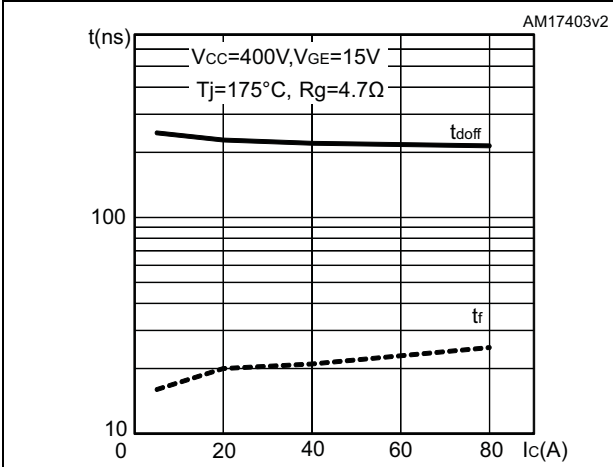


Figure 21. Switching times vs. gate resistance

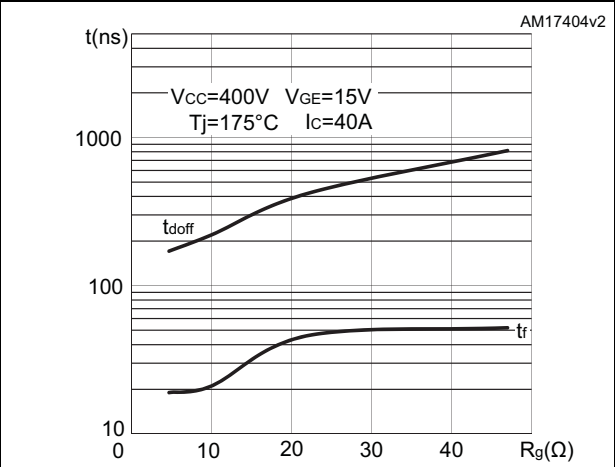


Figure 22. Switching-off losses vs. capacitive load

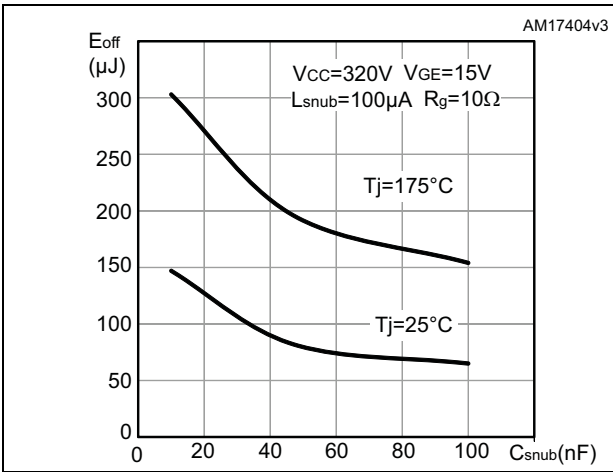


Figure 23. Thermal data for IGBT

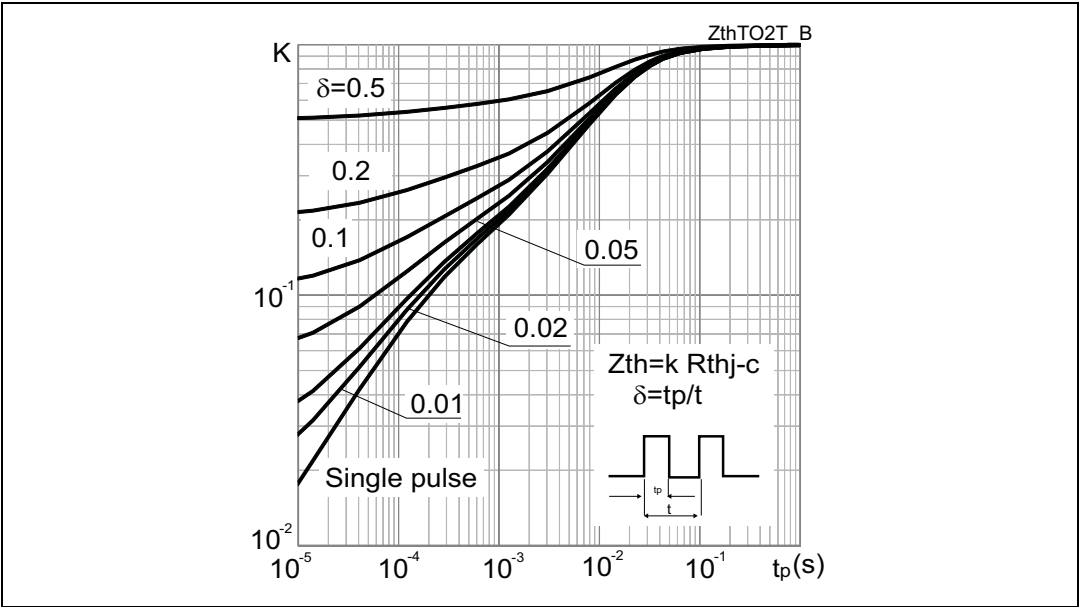
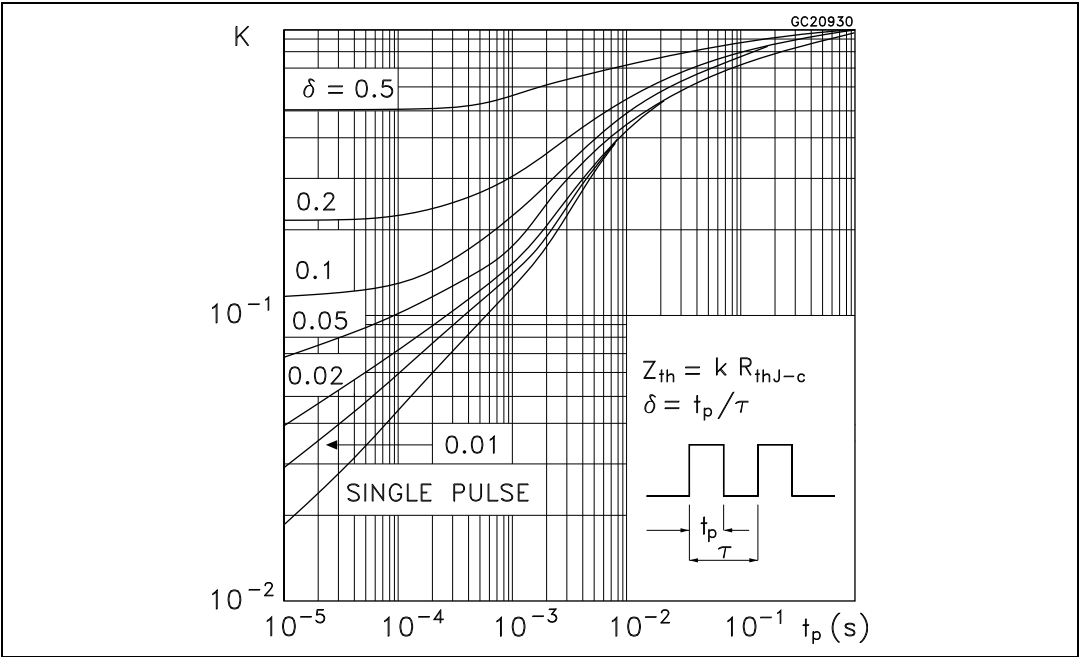


Figure 24. Thermal data for diode



3 Test circuits

Figure 25. Test circuit for inductive load switching

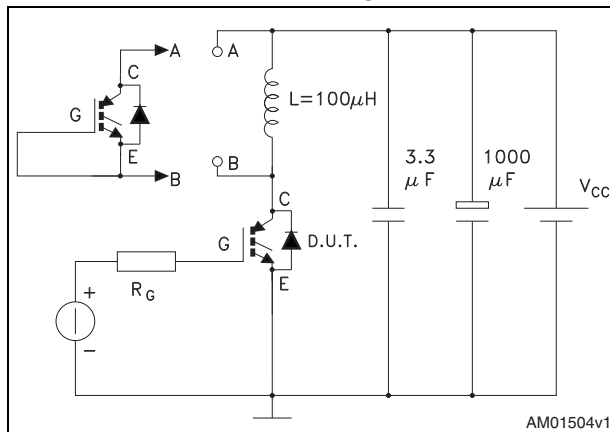


Figure 26. Test circuit for capacitive load switching

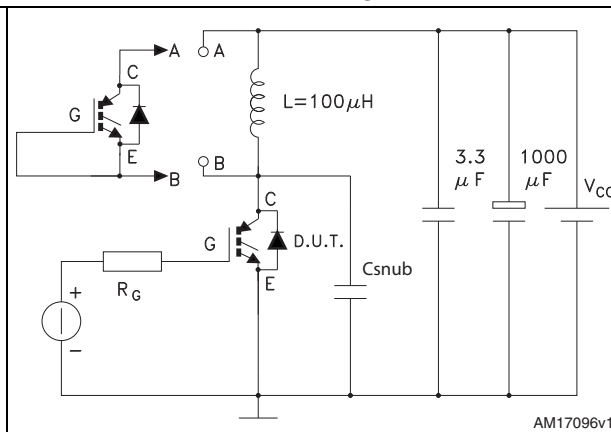


Figure 27. Gate charge test circuit

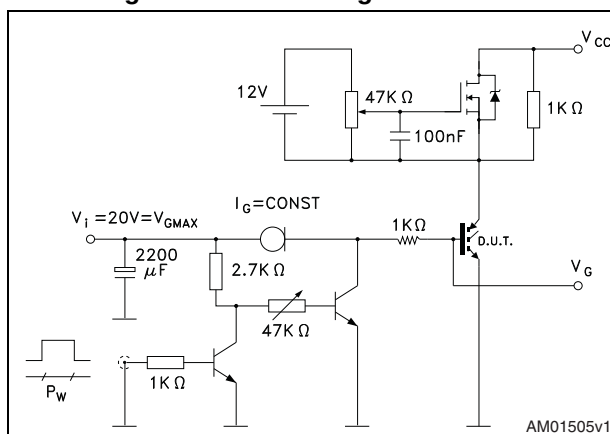


Figure 28. Switching waveform

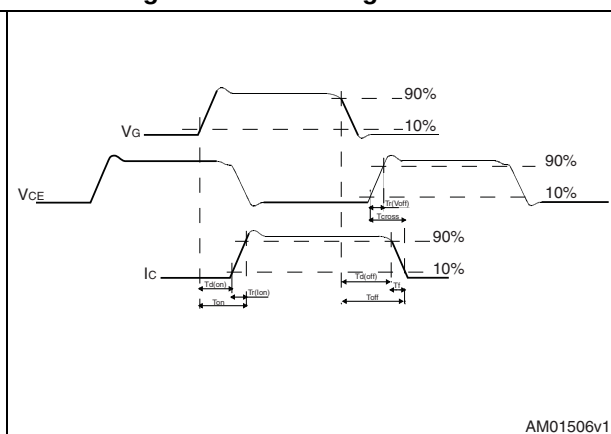
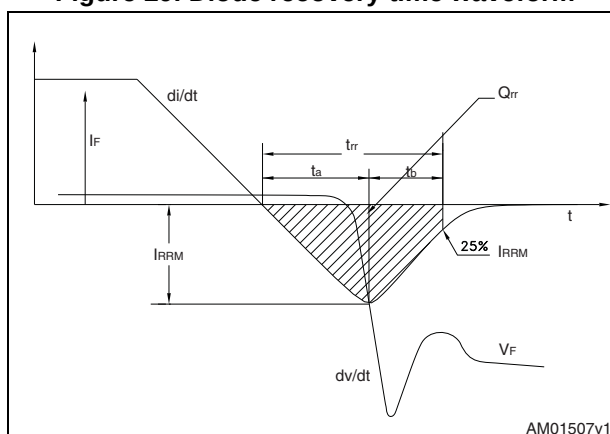


Figure 29. Diode recovery time waveform



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.

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 30. TO-247 drawing

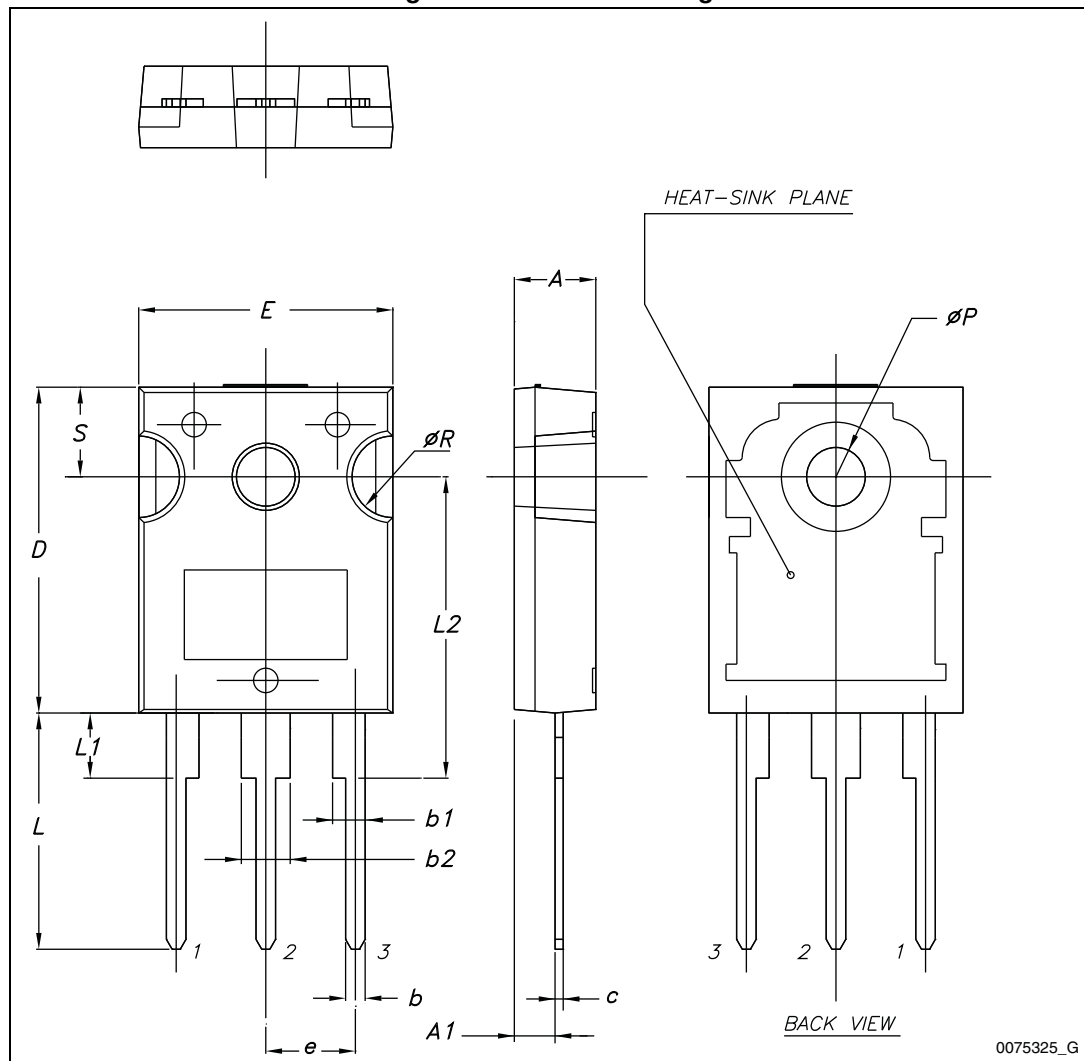
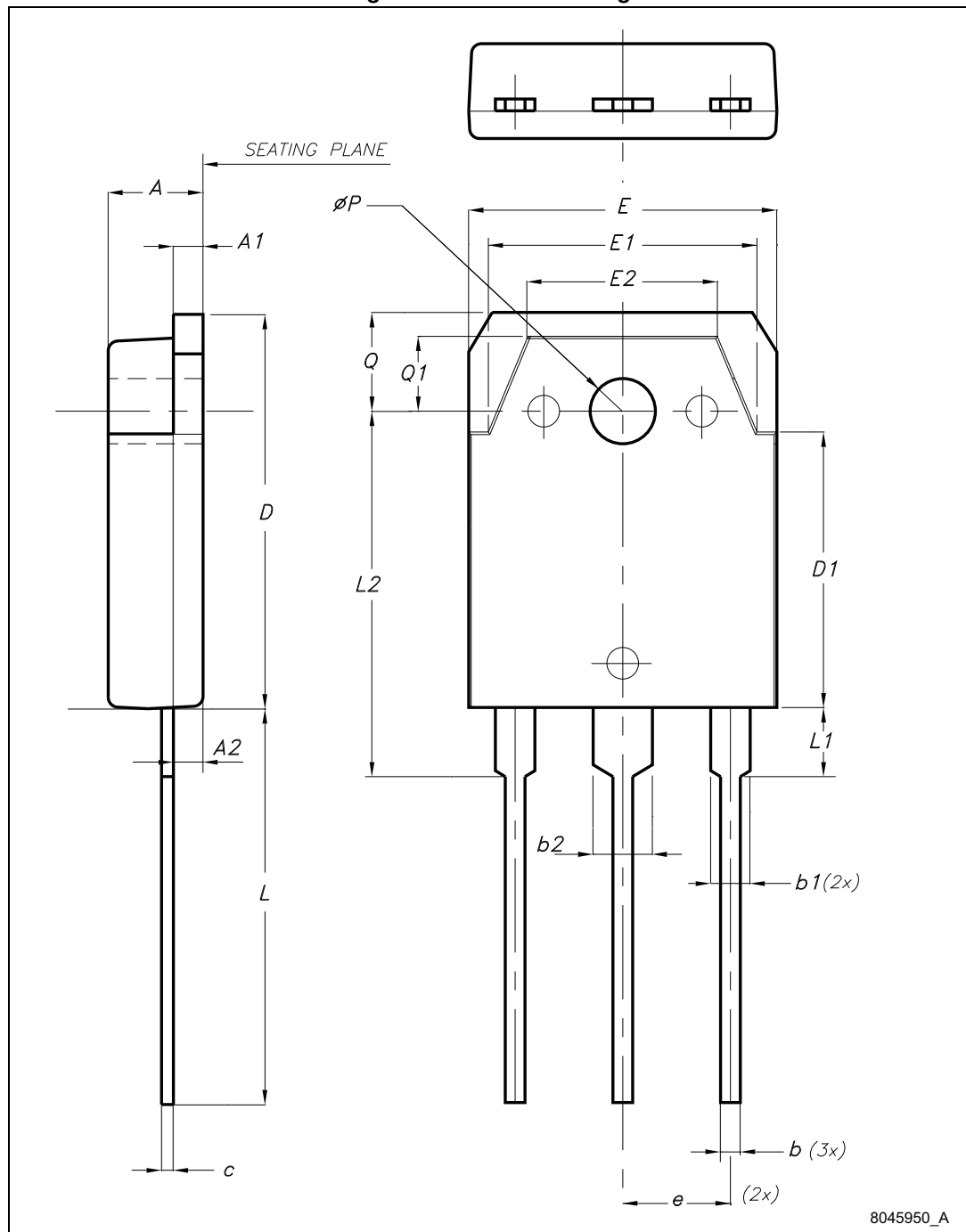


Table 9. TO-3P mechanical data

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 31. TO-3P drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
07-Feb-2013	1	Initial release.
17-Jun-2013	2	Document status promoted from preliminary to production data.
01-Jul-2013	3	Updated Section 2.1: Electrical characteristics (curves) and Section Table 7.: IGBT switching characteristics (capacitive load)

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