

60 A, 650 V field stop trench gate IGBT with Ultrafast diode

Datasheet - production data

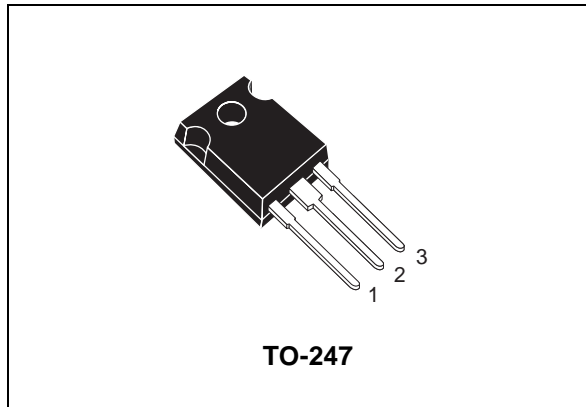
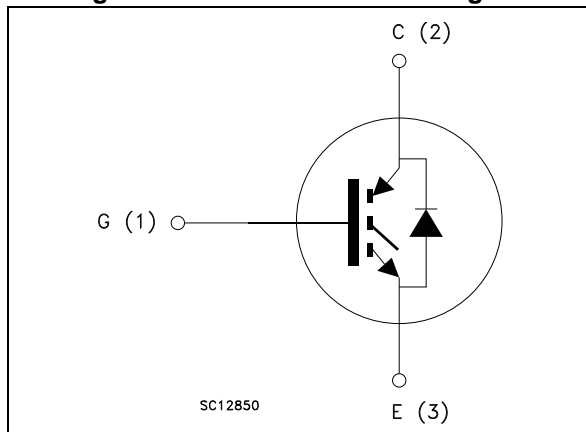


Figure 1. Internal schematic diagram



Applications

- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- High switching frequency converters

Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT is the result of a compromise between conduction and switching losses, maximizing the efficiency of high switching frequency converters. Furthermore, a slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Features

- Very high speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- 6 μ s short-circuit withstand time
- Ultrafast soft recovery antiparallel diode

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW60H65DRF	GW60H65DRF	TO-247	Tube

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 $T_C = 25\text{ °C}$	120	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	60	A
$I_{CP}^{(1)}$	Pulsed collector current	240	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	120	A
	Continuous forward current at $T_C = 100\text{ °C}$	60	
$I_{FP}^{(1)}$	Pulsed forward current	240	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	420	W
t_{SC}	Short-circuit withstand time at $V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$	6	μs
T_{STG}	Storage temperature range	- 55 to 175	$^{\circ}\text{C}$
T_J	Operating junction temperature		

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	0.35	$^{\circ}\text{C/W}$
R_{thJC}	Thermal resistance junction-case diode	1.38	$^{\circ}\text{C/W}$
R_{thJA}	Thermal resistance junction-ambient	50	$^{\circ}\text{C/W}$

2 Electrical characteristics

$T_J = 25\text{ °C}$ unless otherwise specified.

Table 4. Static

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	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		1.9	2.4	V
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}$ $T_J = 125\text{ °C}$		2.1		
$V_{GE(th)}$	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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	7150	-	pF
C_{oes}	Output capacitance			275		pF
C_{res}	Reverse transfer capacitance			140		pF
Q_g	Total gate charge	$V_{CC} = 400\text{ V}, I_C = 60\text{ A},$ $V_{GE} = 15\text{ V}$	-	217	-	nC
Q_{ge}	Gate-emitter charge		-	67	-	nC
Q_{gc}	Gate-collector charge		-	97	-	nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V}$	-	85	-	ns
t_r	Current rise time			33		ns
$(di/dt)_{on}$	Turn-on current slope			1800		A/ μs
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ °C}$	-	82	-	ns
t_r	Current rise time			35		ns
$(di/dt)_{on}$	Turn-on current slope			1680		A/ μs
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V}$	-	34	-	ns
$t_{d(off)}$	Turn-off delay time			178		ns
t_f	Current fall time			30		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V}$ $T_J = 125\text{ °C}$	-	45	-	ns
$t_{d(off)}$	Turn-off delay time			205		ns
t_f	Current fall time			70		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	0.94	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses			1.06		mJ
E_{ts}	Total switching losses			2.0		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ °C}$	-	1.48	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses			1.4		mJ
E_{ts}	Total switching losses			2.88		mJ

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in [Figure 23](#). If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature (25 °C and 125 °C).
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	$I_F = 60\text{ A}$ $I_F = 60\text{ A}$, $T_J = 150\text{ °C}$	-	3.7 2.2	4.8	V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $di/dt = 1700\text{ A}/\mu\text{s}$	-	19 200 15.5	-	ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $di/dt = 1630\text{ A}/\mu\text{s}$, $T_J = 125\text{ °C}$	-	34 780 46	-	ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ($T_J = -40^\circ\text{C}$)

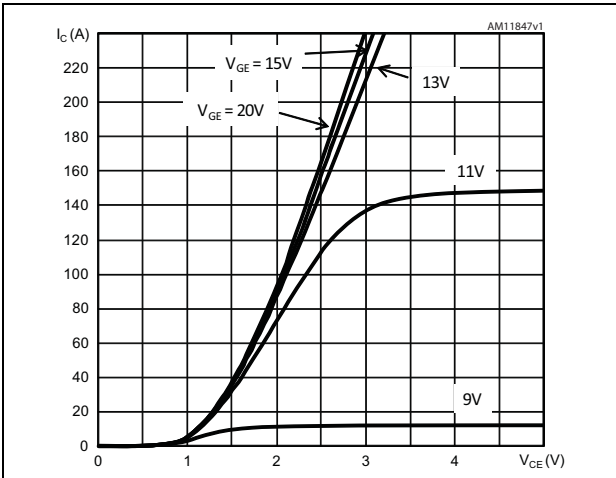


Figure 3. Output characteristics ($T_J = 25^\circ\text{C}$)

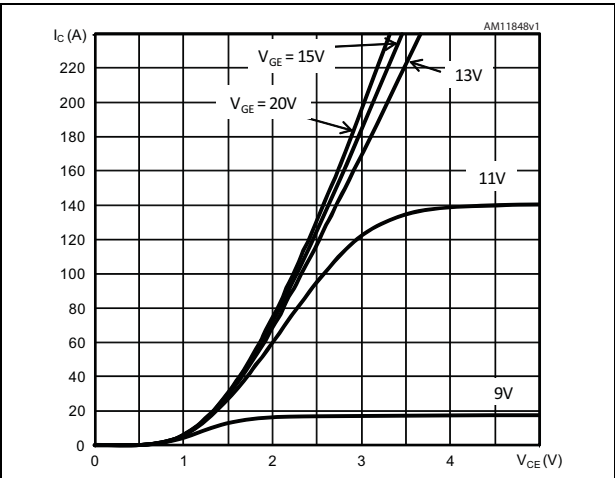


Figure 4. Output characteristics ($T_J = 150^\circ\text{C}$)

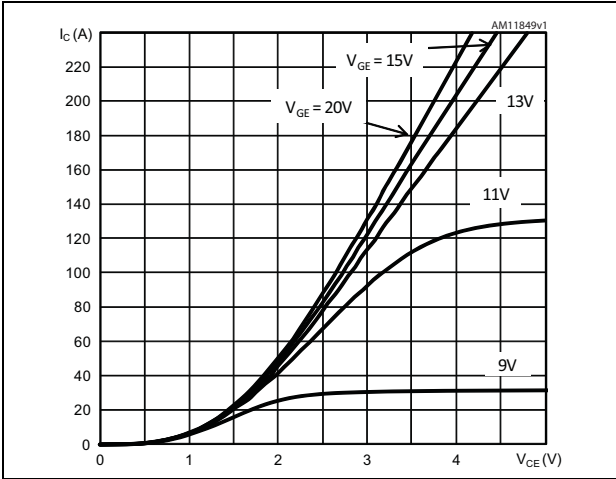


Figure 5. Transfer characteristics

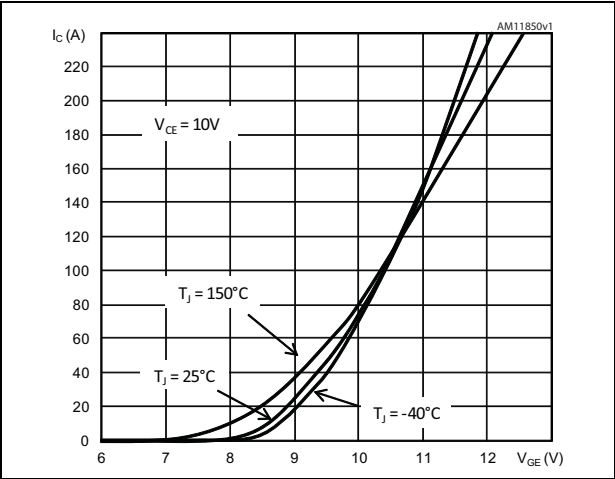


Figure 6. $V_{CE(SAT)}$ vs. junction temperature

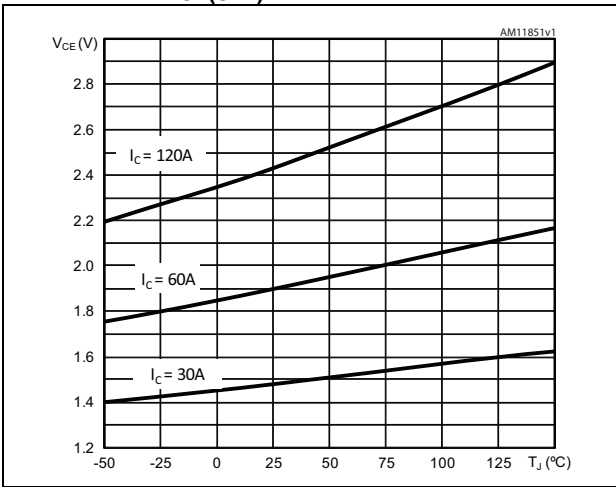


Figure 7. $V_{CE(SAT)}$ vs. collector current

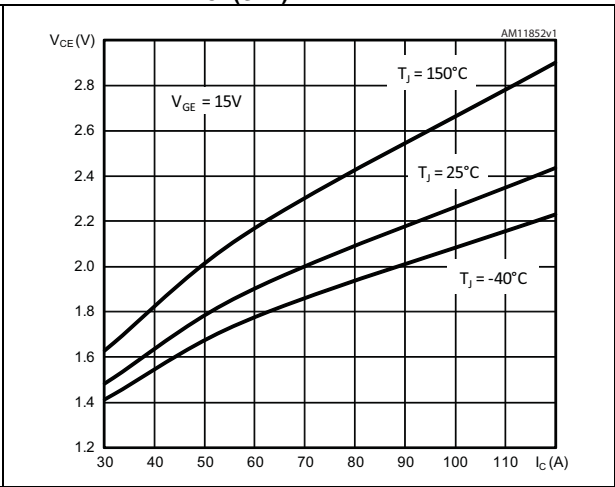


Figure 8. Normalized $V_{GE(th)}$ vs. junction temperature

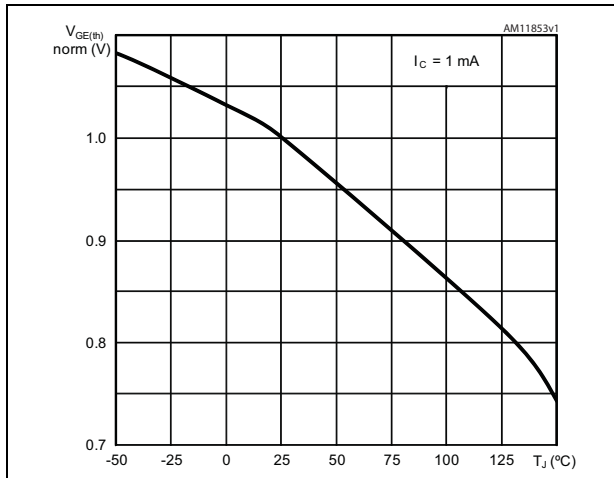


Figure 9. Gate charge vs. gate-emitter voltage

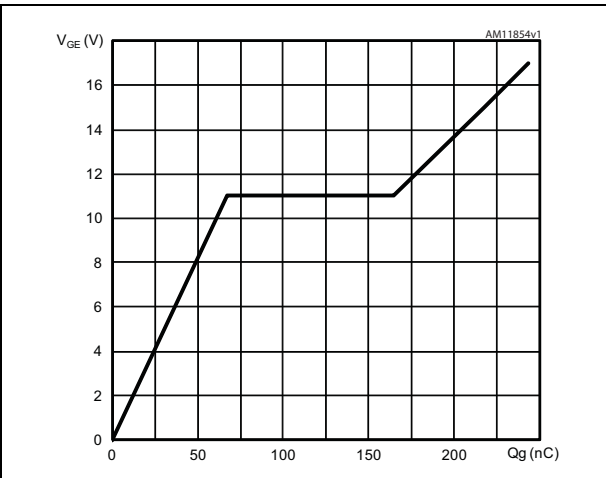


Figure 10. Capacitance variations ($f = 1$ MHz, $V_{GE} = 0$)

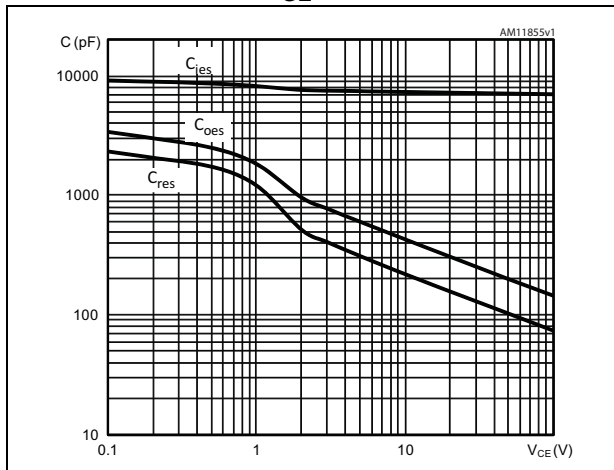


Figure 11. Switching losses vs. collector current

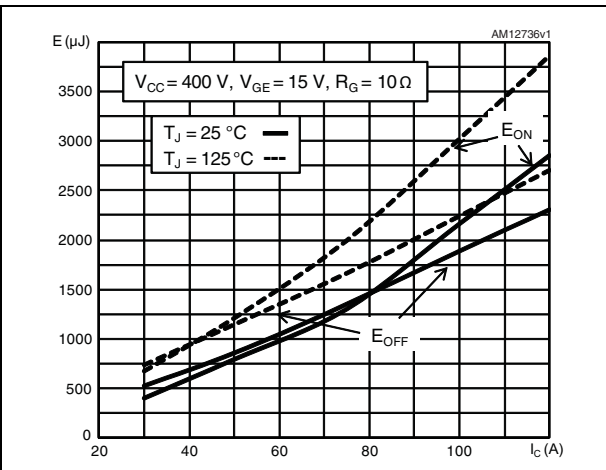


Figure 12. Switching losses vs. gate resistance

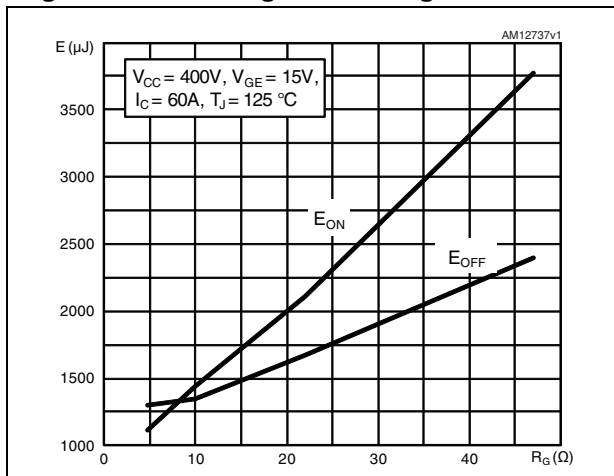


Figure 13. Switching losses vs. temperature

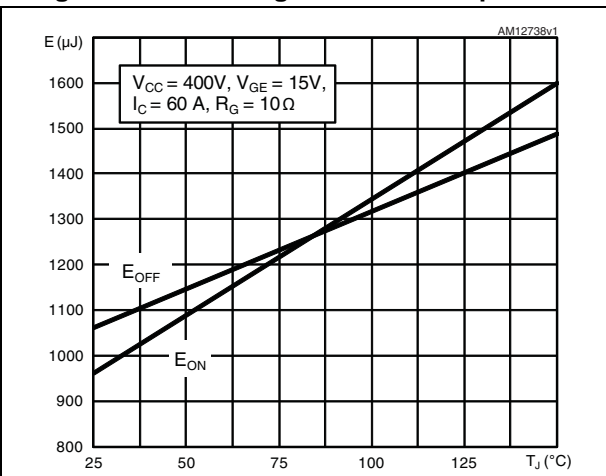


Figure 14. Turn-OFF SOA

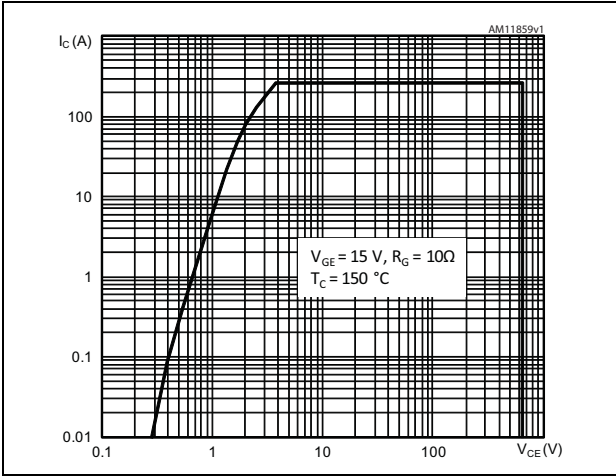


Figure 15. Short circuit time & current vs. V_{GE}

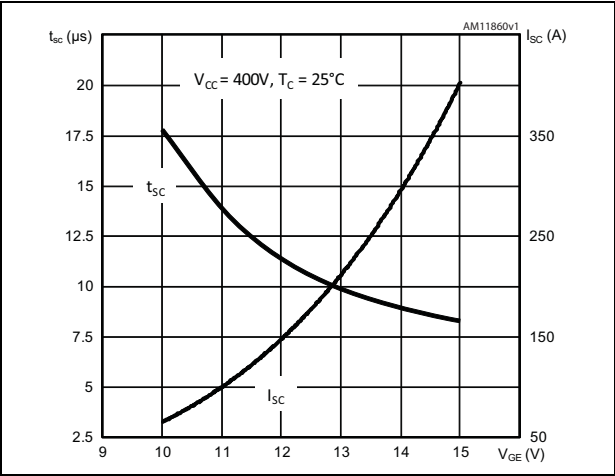


Figure 16. Diode forward current vs. forward voltage

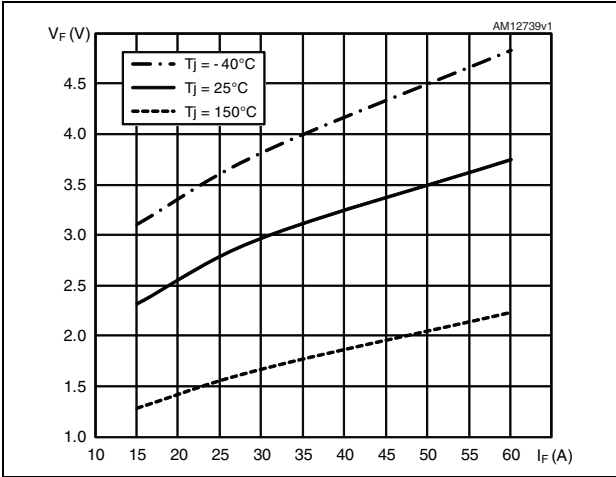


Figure 17. Diode forward current vs. junction temperature

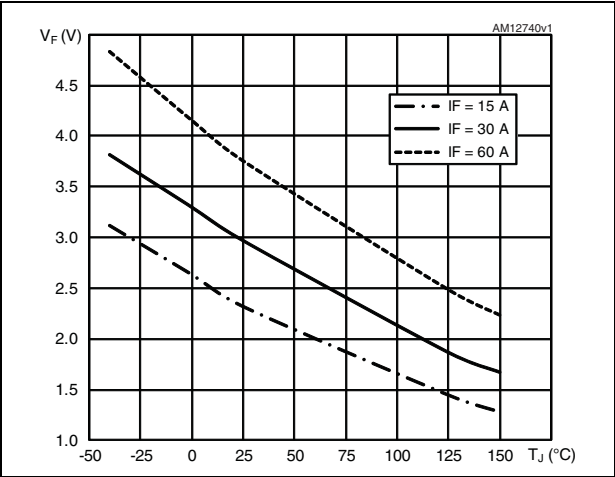


Figure 18. Reverse recovery current as a function of diode current slope

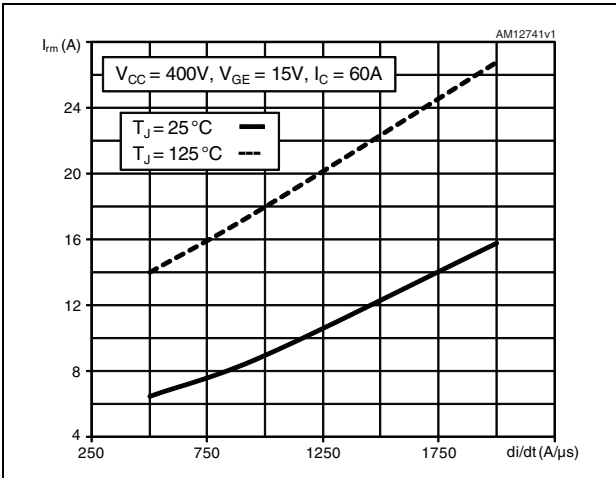


Figure 19. Reverse recovery time as a function of diode current slope

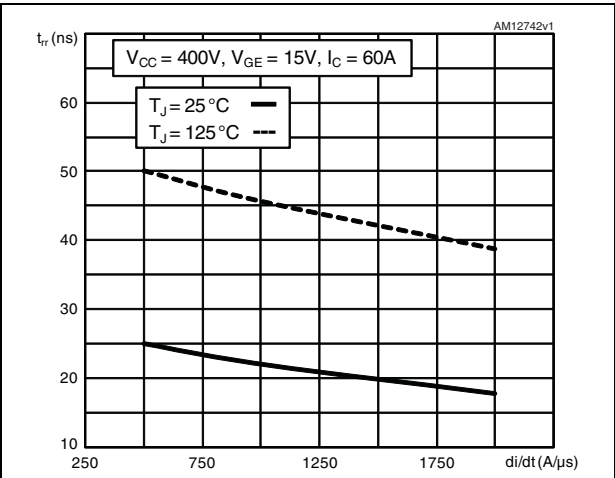


Figure 20. Reverse recovery charge as a function of diode current slope

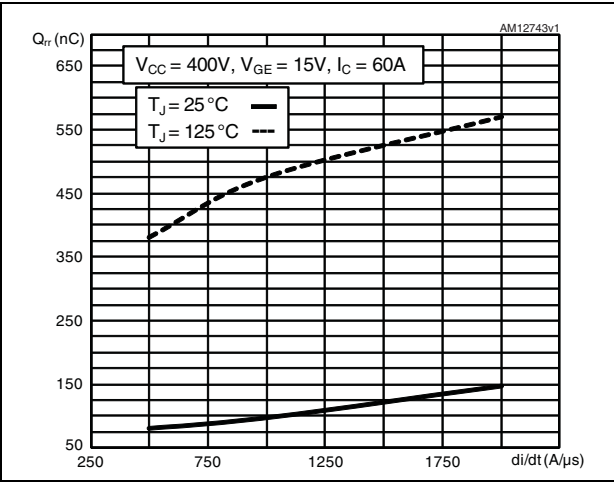


Figure 21. Maximum normalized Z_{th} junction to case (IGBT)

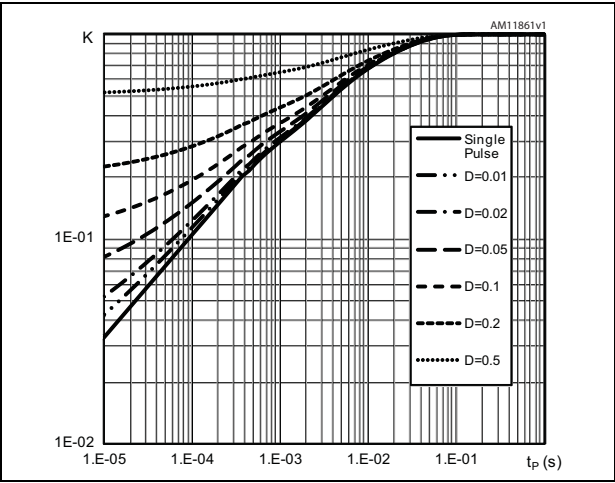
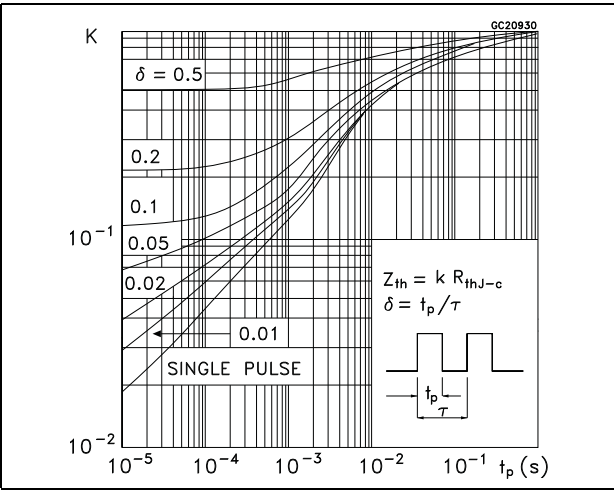


Figure 22. Maximum normalized Z_{th} junction to case (Diode)



3 Test circuits

Figure 23. Test circuit for inductive load switching

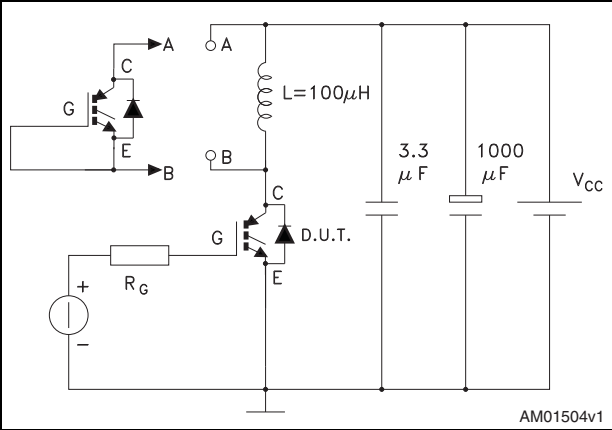


Figure 24. Gate charge test circuit

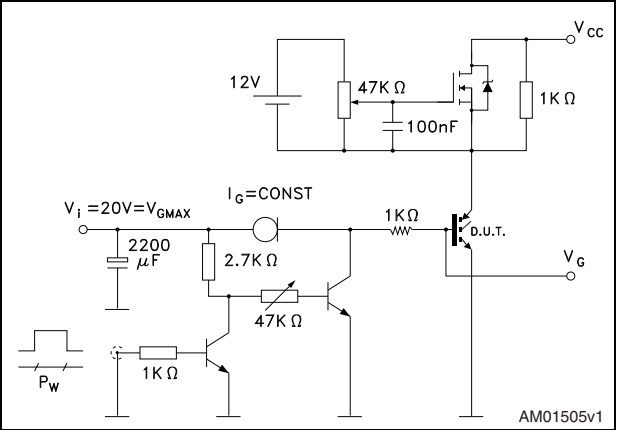


Figure 25. Switching waveform

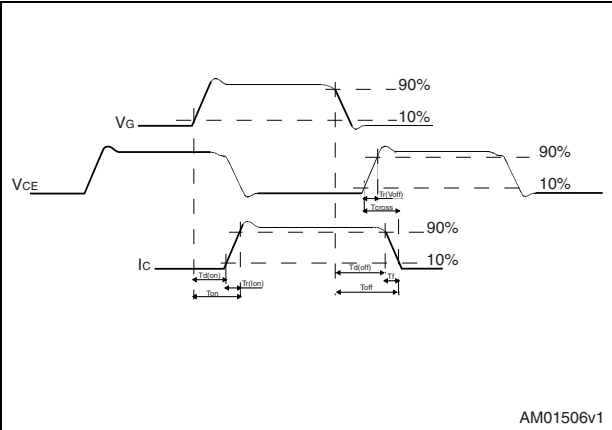
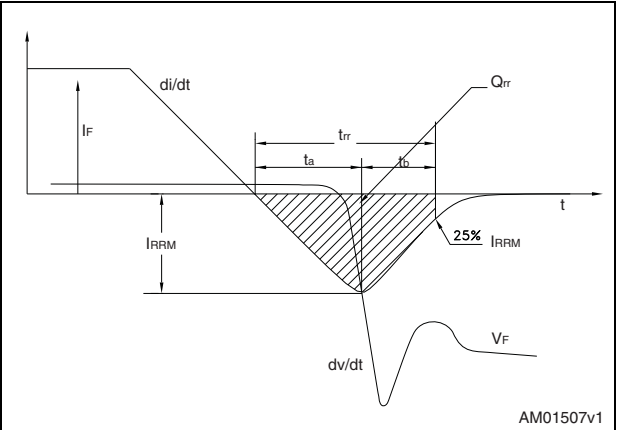


Figure 26. Diode recovery time waveform



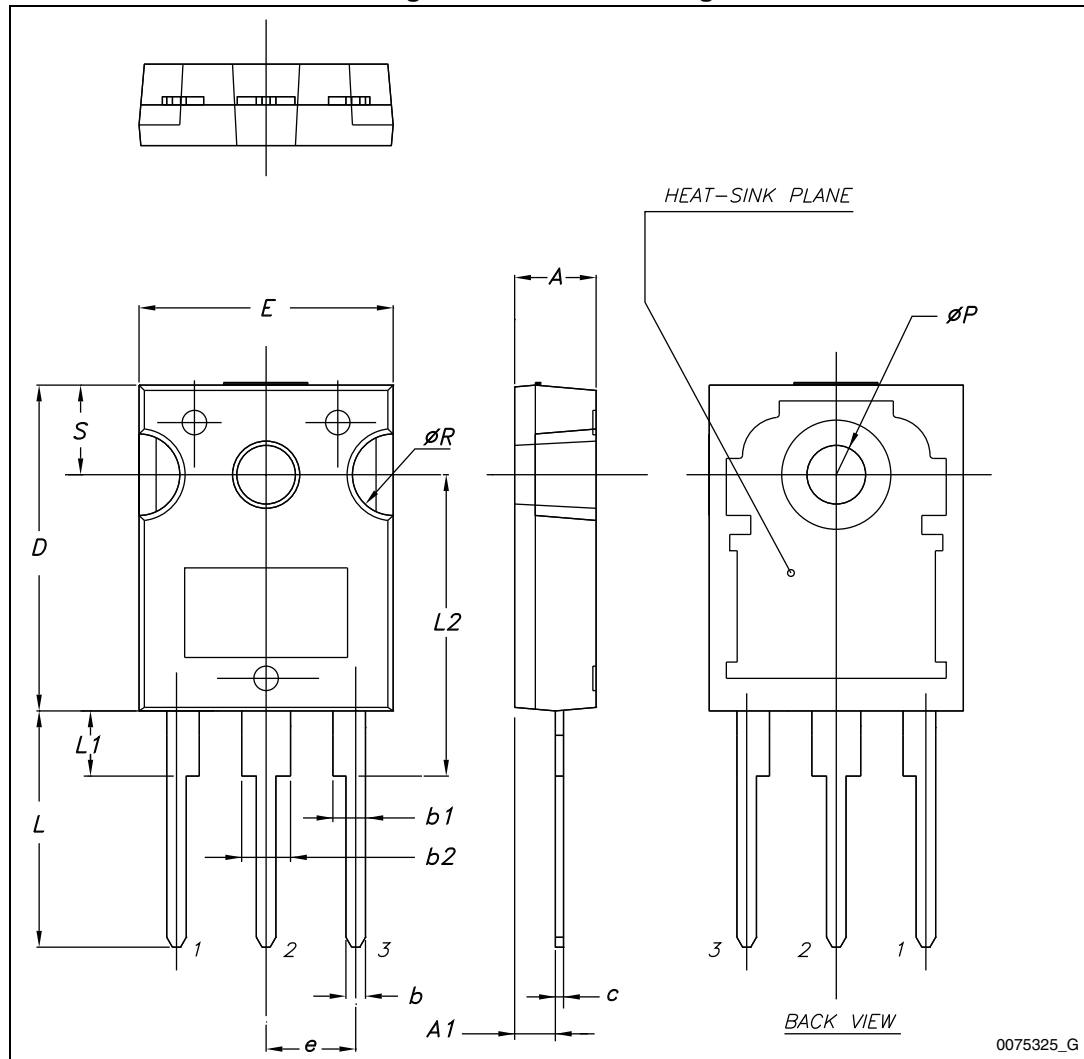
4 Package mechanical data

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 9. 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 27. TO-247 drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
11-Oct-2011	1	Initial release.
06-Jun-2012	2	Document status promoted from preliminary data production data. Added: Section 2.1: Electrical characteristics (curves) on page 5.
19-Jun-2012	3	Updated parameters in Table 2.
26-Jul-2012	4	Updated parameters in Table 2.
21-Jan-2013	5	Modified V_F test conditions, typ. and max values Table 8 on page 4.
02-Apr-2013	6	Modified: <ul style="list-style-type: none">– P_{TOT} value Table 2 on page 2.– E_{on} and E_{ts} typical values Table 7 on page 4.

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