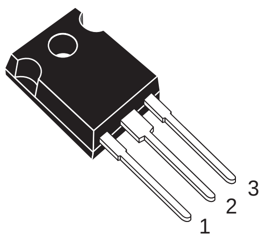
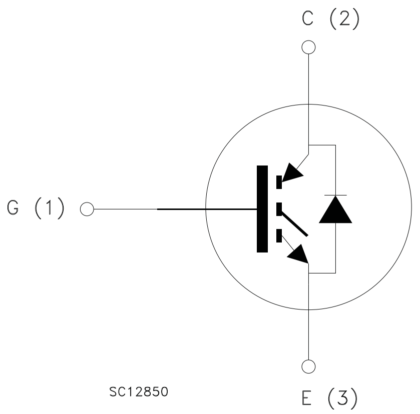
60 A, 650 V field stop trench gate IGBT with Ultrafast diode

Datasheet - production data



TO-247

Figure 1. Internal schematic diagram



Features

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

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.

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 °C	120	A
I_C	Continuous collector current at T_C = 100 °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 °C	120	A
	Continuous forward current at T_C = 100 °C	60	
I_{FP} (1)	Pulsed forward current	240	A
P_{TOT}	Total dissipation at T_C = 25 °C	420	W
t_{SC}	Short-circuit withstand time at V_{CC} = 400 V, V_{GE} = 15 V	6	µs
T_{STG}	Storage temperature range	- 55 to 175	°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	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.38	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	°C/W

2 Electrical characteristics

T_J = 25 °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 mA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 60 A		1.9	2.4	V
		V_{GE} = 15 V, I_C = 60 A T_J = 125 °C		2.1		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA		6.0		V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 650 V			25	µA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ± 20 V			250	nA

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0	-	7150 275 140	-	pF pF pF
Q_g	Total gate charge	V_{CC} = 400 V, I_C = 60 A, V_{GE} = 15 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
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V	-	85 33 1800	-	ns ns A/µs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V T_J = 125 °C	-	82 35 1680	-	ns ns A/µs
$t_{r(Voff)}$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V	-	34 178 30	-	ns ns ns
$t_{r(Voff)}$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V T_J = 125 °C	-	45 205 70	-	ns ns ns

Table 7. Switching energy (inductive load)

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

1. Eon 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 A I_F = 60 A, T_J = 150 °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 A, V_R = 400 V, di/dt = 1700 A/µs	-	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 A, V_R = 400 V, di/dt = 1630 A/µs T_J = 125 °C	-	34 780 46	-	ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics (T_J = - 40 °C)

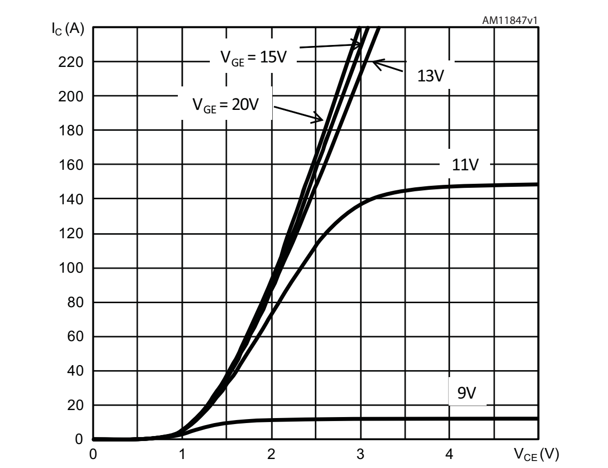


Figure 3. Output characteristics (T_J = 25 °C)

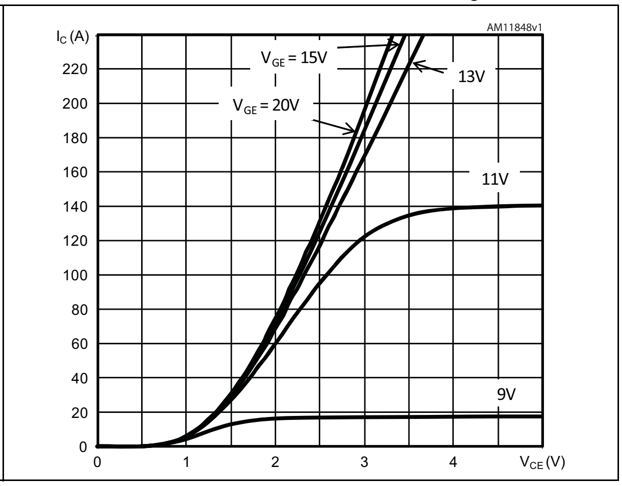


Figure 4. Output characteristics (T_J = 150 °C)

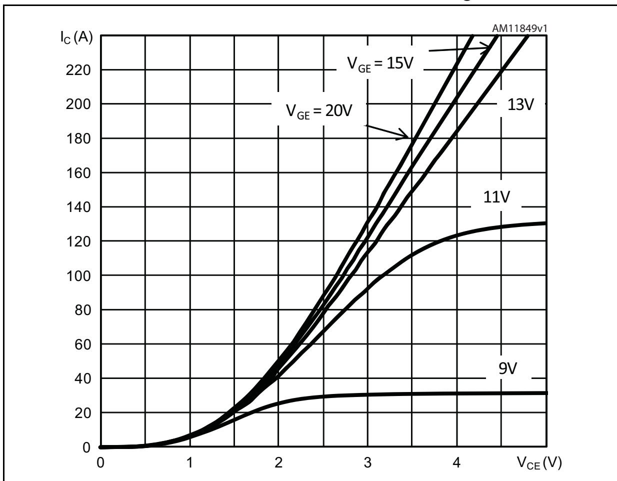


Figure 5. Transfer characteristics

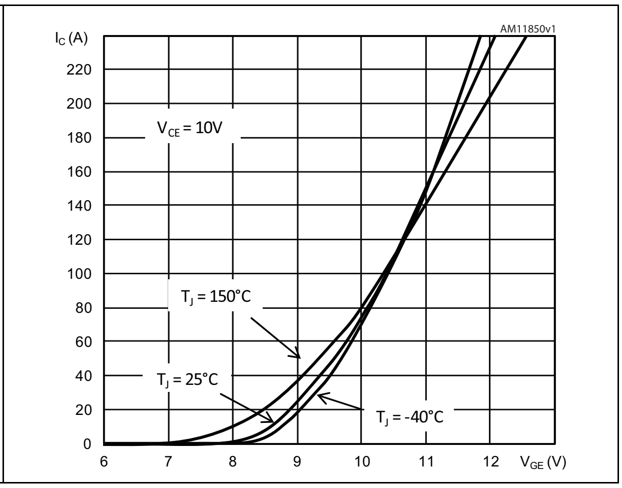


Figure 6. $V_{CE(SAT)}$ vs. junction temperature

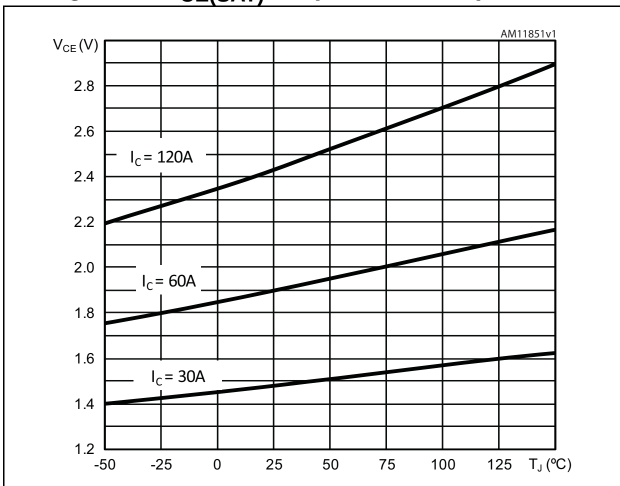


Figure 7. $V_{CE(SAT)}$ vs. collector current

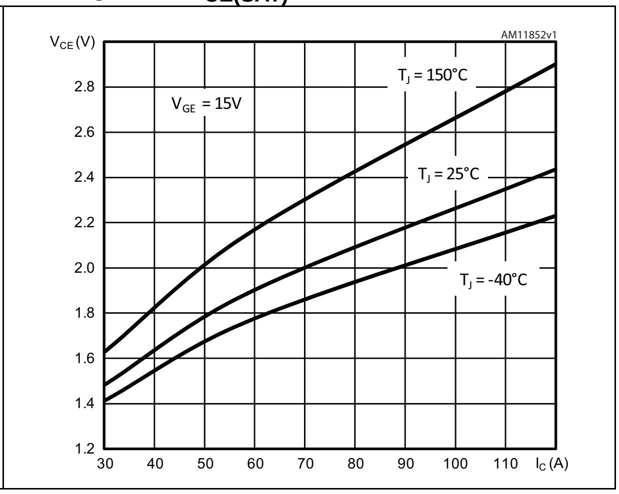


Figure 8. Normalized $V_{GE(th)}$ vs. junction temperature

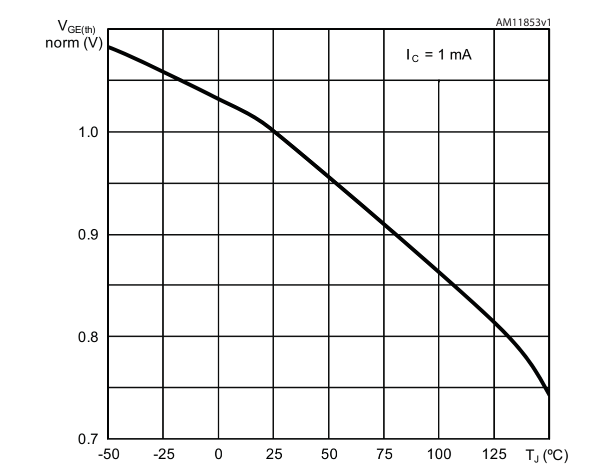


Figure 9. Gate charge vs. gate-emitter voltage

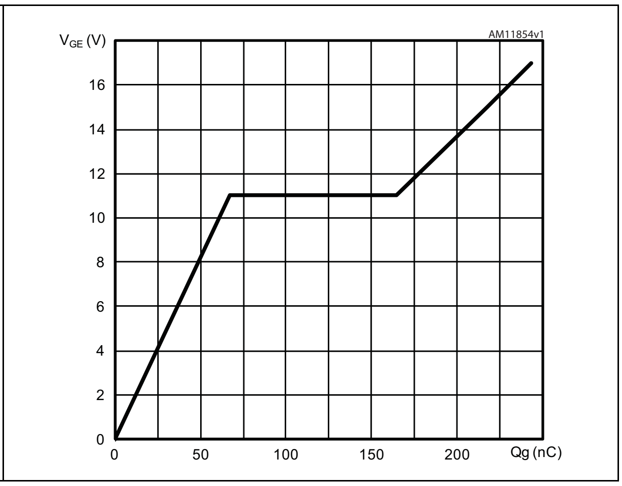


Figure 10. Capacitance variations (f = 1 MHz, V_{GE} = 0)

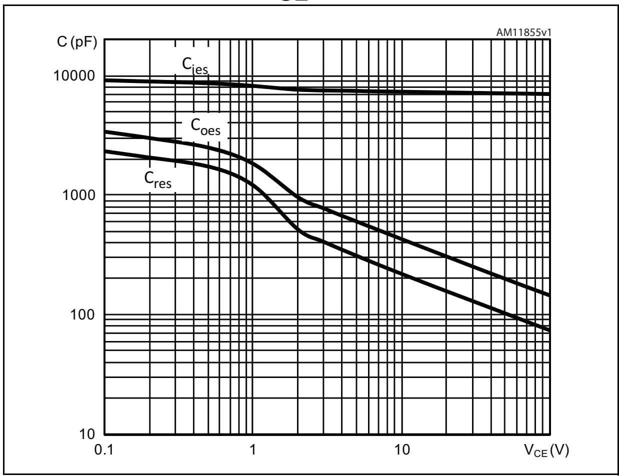


Figure 11. Switching losses vs. collector current

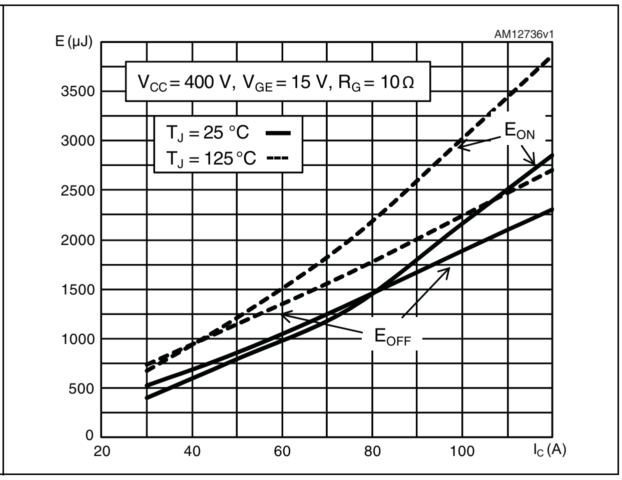


Figure 12. Switching losses vs. gate resistance

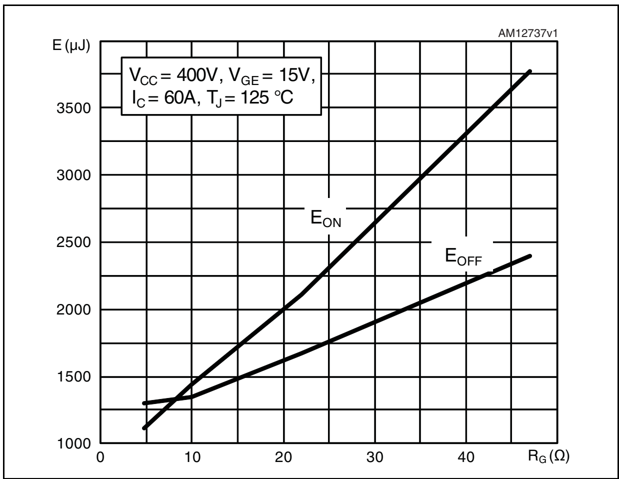


Figure 13. Switching losses vs. temperature

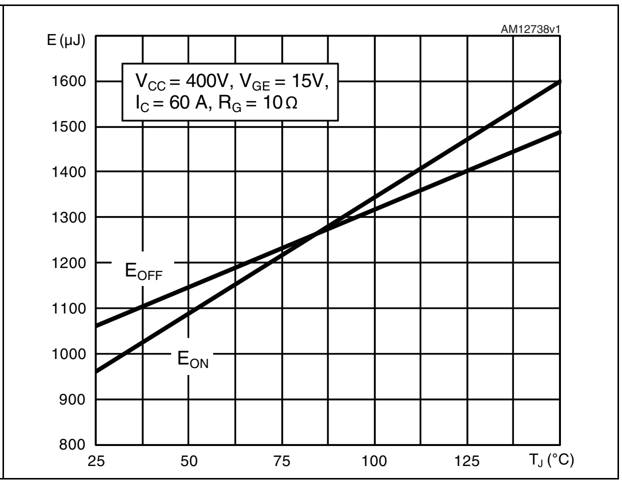


Figure 14. Turn-OFF SOA

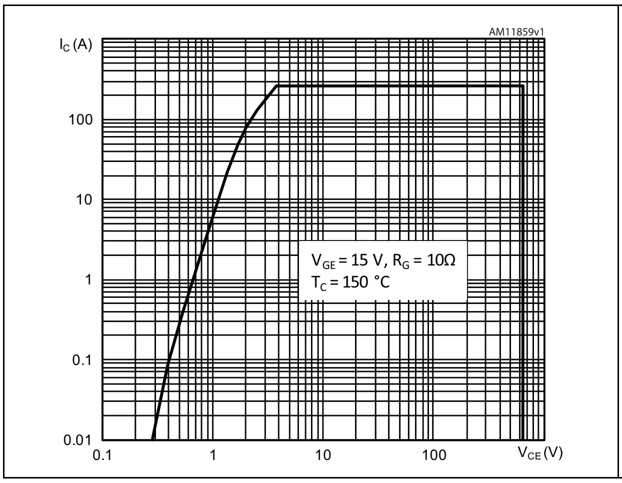


Figure 15. Short circuit time & current vs. V_{GE}

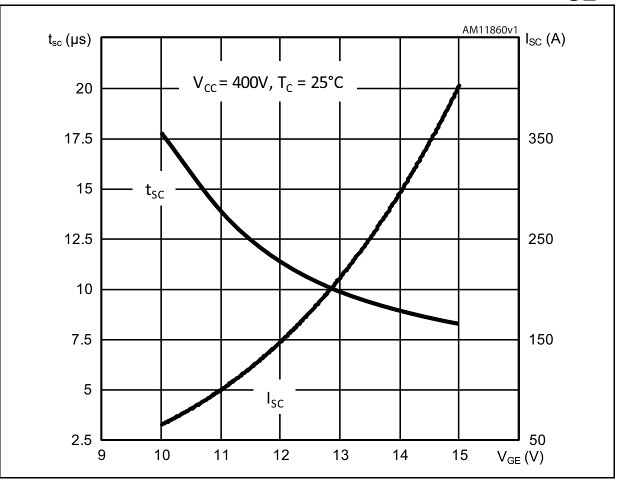


Figure 16. Diode forward current vs. forward voltage

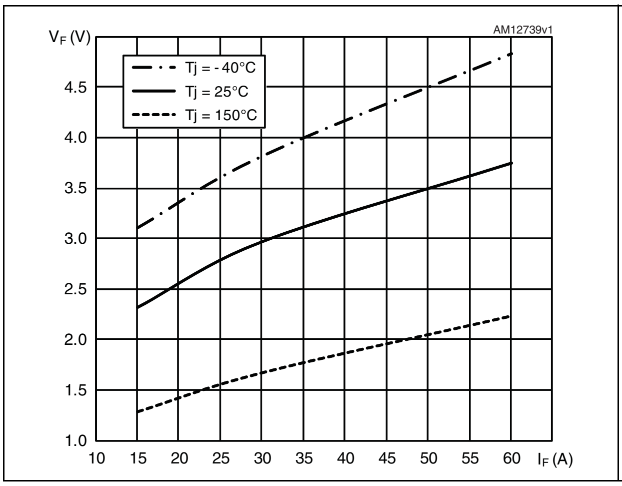


Figure 17. Diode forward current vs. junction temperature

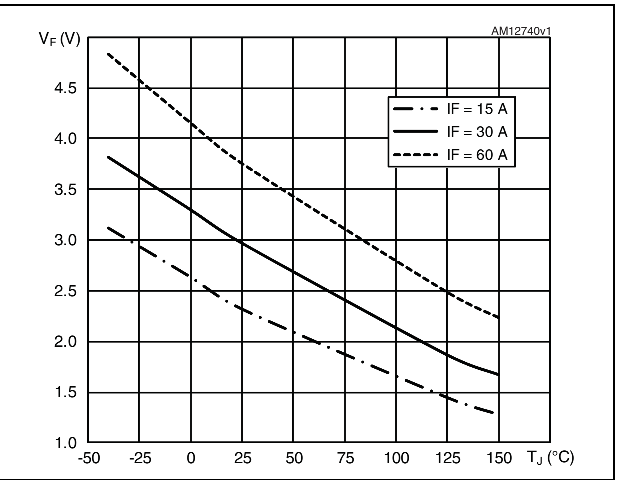


Figure 18. Reverse recovery current as a function of diode current slope

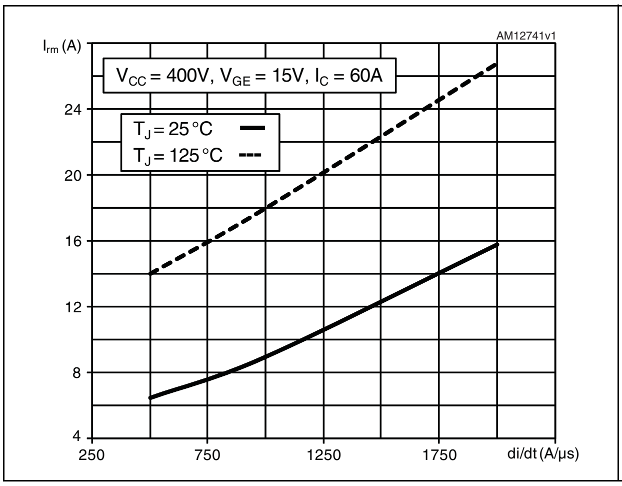


Figure 19. Reverse recovery time as a function of diode current slope

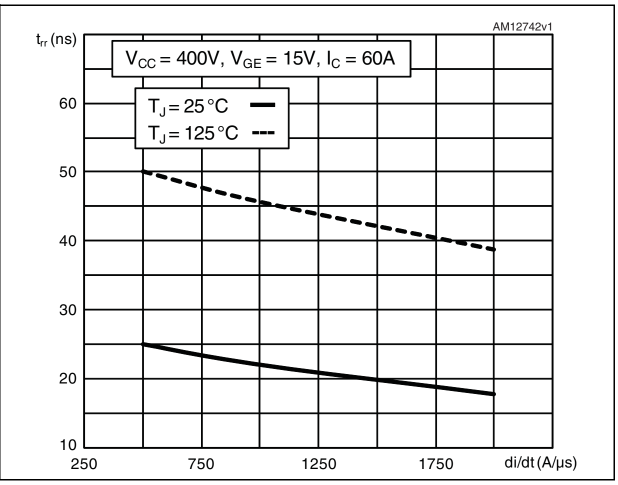


Figure 20. Reverse recovery charge as a function of diode current slope

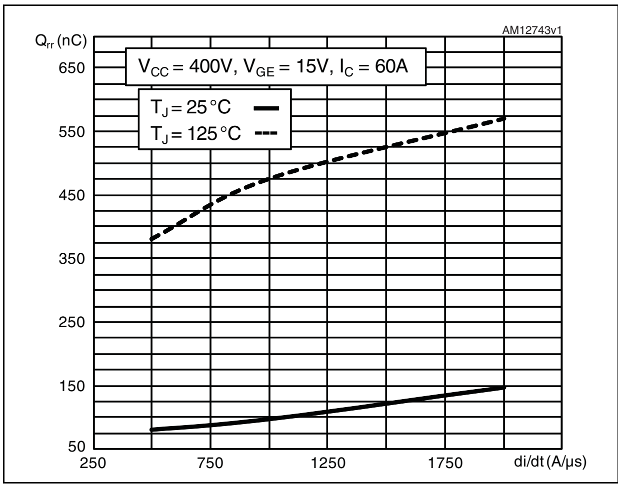


Figure 21. Maximum normalized Z_{th} junction to case (IGBT)

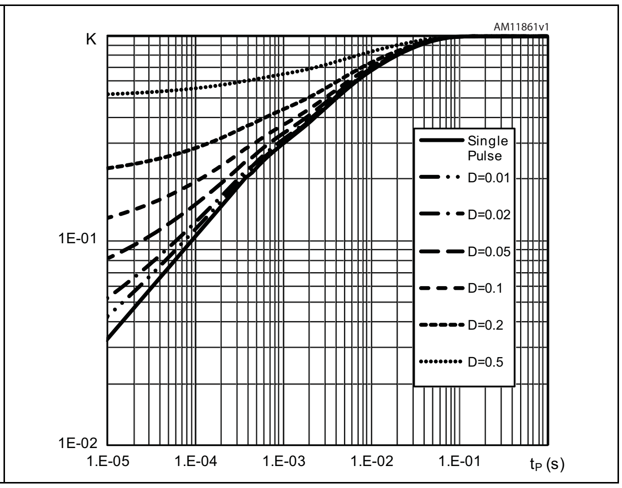
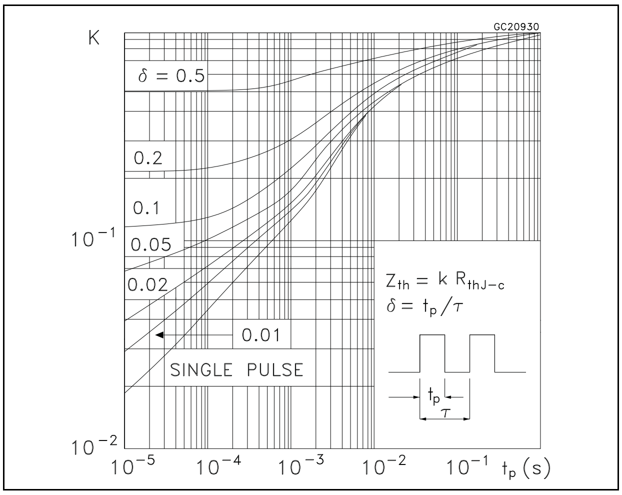


Figure 22. Maximum normalized Z_{th} junction to case (Diode)



3 Test circuits

Figure 23. Test circuit for inductive load switching

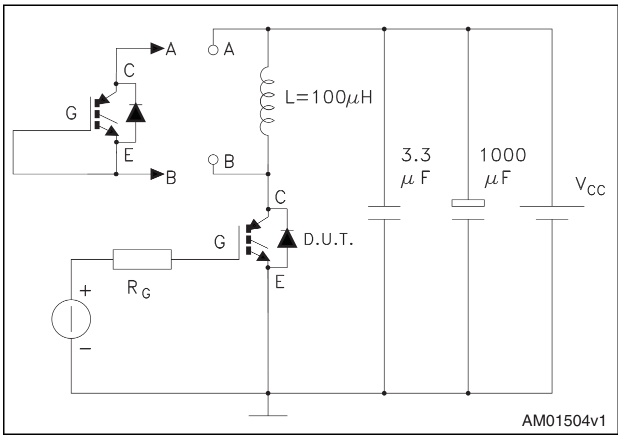


Figure 24. Gate charge test circuit

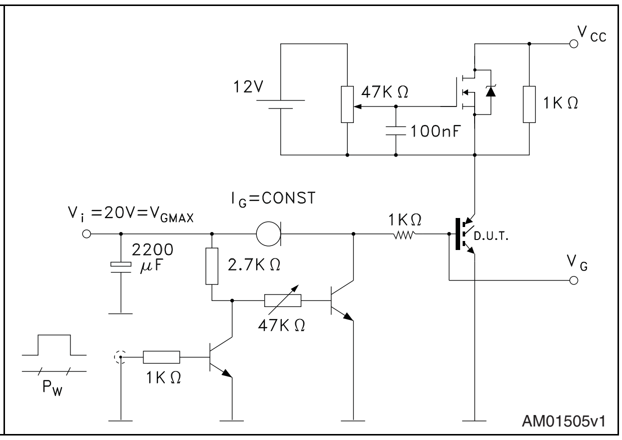


Figure 25. Switching waveform

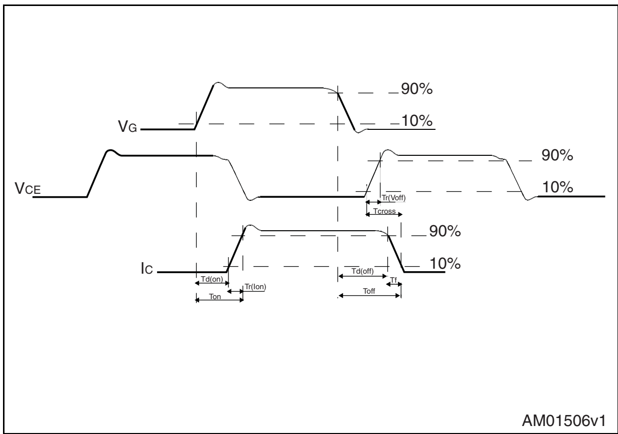
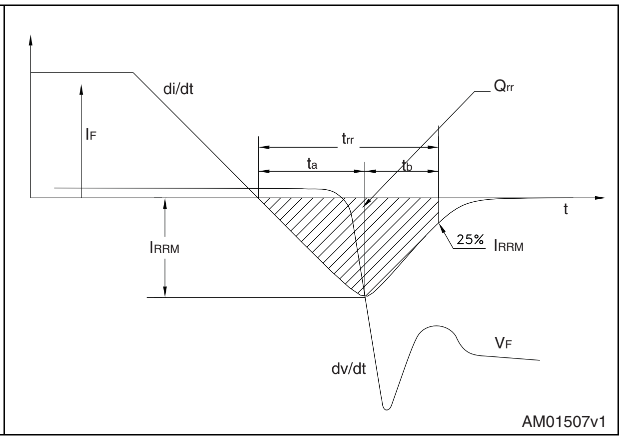


Figure 26. Diode recovery time waveform



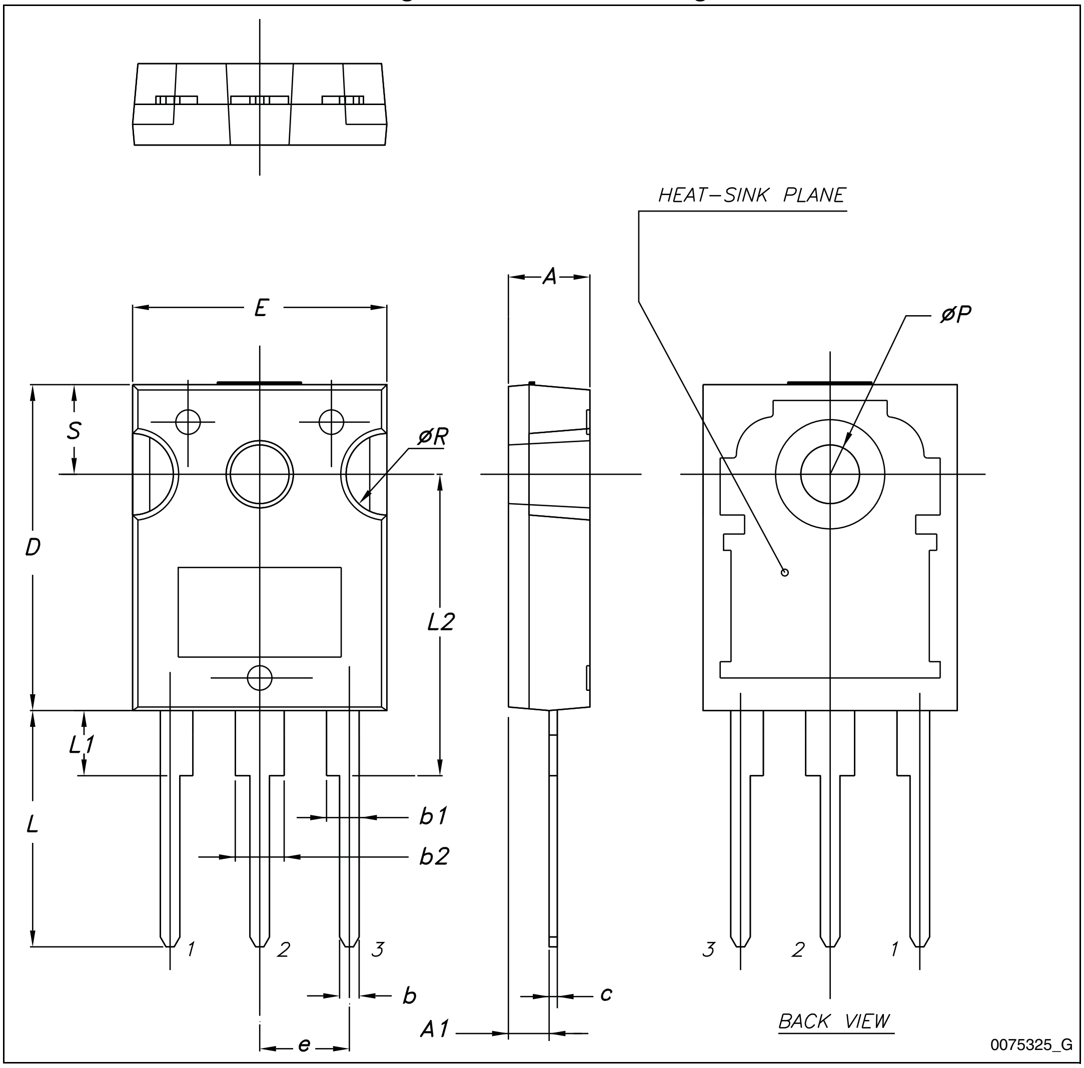
4 Package mechanical data

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	
∅P	3.55		3.65
∅R	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: – P_{TOT} value *Table 2 on page 2*. – E_{on} and E_{ts} typical values *Table 7 on page 4*.