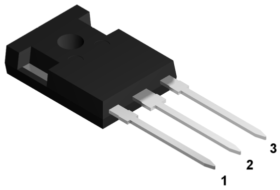
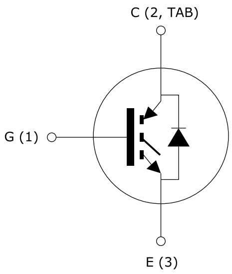
GWA40MS120DF4AG

Datasheet

Automotive-grade trench gate field-stop, 1200 V, 40 A, low-loss MS series IGBT in a TO-247 long leads package



TO-247 long leads



Features

- AEC-Q101 qualified
- 8 µs of short-circuit withstand time at V_{CC} = 800 V, V_{GE} = 15 V, T_J (start) = 175 °C
- $V_{CE(sat)}$ = 1.95 V (typ.) @ I_C = 40 A
- Tight parameter distribution
- Positive $V_{CE(sat)}$ temperature coefficient
- Low thermal resistance

Applications

- Auxiliary loads
- Thermal management
- PTC heaters

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the MS series IGBTs, which represent an evolution of low-loss M series specifically designed for inverter system thanks to the outstanding short-circuit capability at high bus voltage value. Furthermore, the slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Product status link
GWA40MS120DF4AG

Product summary	
Order code	GWA40MS120DF4AG
Marking	G40MS120DF4AG
Package	TO-247 long leads
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	1200	V
I_C	Continuous collector current at T_C = 25 °C	80	A
	Continuous collector current at T_C = 100 °C	40	
I_{CP} (1)	Pulsed collector current	120	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	80	A
	Continuous forward current at T_C = 100 °C	40	
I_{FP} (1)	Pulse forward current	120	A
P_{TOT}	Total power dissipation at T_C = 25 °C	536	W
T_{stg}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. *Pulse width is limited by maximum junction temperature.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case, IGBT	0.28	°C/W
	Thermal resistance, junction-to-case, diode	0.48	
R_{thJA}	Thermal resistance, junction-to-ambient	50	°C/W

2 Electrical characteristics

T_C = 25 °C unless otherwise specified.

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_C = 2 mA	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 40 A		1.95	2.3	V
		V_{GE} = 15 V, I_C = 40 A, T_J = 125 °C		2.25		
		V_{GE} = 15 V, I_C = 40 A, T_J = 175 °C		2.35		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 2 mA	5	6	7	V
V_F	Forward on-voltage	I_F = 40 A		2.4		V
		I_F = 40 A, T_J = 125 °C		1.85		
		I_F = 40 A, T_J = 175 °C		1.7		
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 1200 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ±20 V			250	nA

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	2700	-	pF
C_{oes}	Output capacitance		-	185	-	pF
C_{res}	Reverse transfer capacitance		-	101	-	pF
Q_g	Total gate charge	V_{CC} = 960 V, I_C = 40 A, V_{GE} = 0 to 15 V (see Figure 28. Gate charge test circuit)	-	147	-	nC
Q_{ge}	Gate-emitter charge		-	24	-	nC
Q_{gc}	Gate-collector charge		-	79.5	-	nC

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 40 A, V_{GE} = 15 V, R_G = 10 Ω (see Figure 27. Test circuit for inductive load switching)		35	-	ns
t_r	Current rise time			15	-	ns
$(di/dt)_{on}$	Turn-on current slope			2100	-	A/µs
$t_{d(off)}$	Turn-off delay time			140	-	ns
t_f	Current fall time			135	-	ns
E_{on} (1)	Turn-on switching energy			1.5	-	mJ
E_{off} (2)	Turn-off switching energy			3.3	-	mJ
E_{ts}	Total switching energy			4.8	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 40 A, V_{GE} = 15 V, R_G = 10 Ω, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)		35	-	ns
t_r	Current rise time			18	-	ns
$(di/dt)_{on}$	Turn-on current slope			1800	-	A/µs
$t_{d(off)}$	Turn-off delay time			150	-	ns
t_f	Current fall time			240	-	ns
E_{on} (1)	Turn-on switching energy			2.8	-	mJ
E_{off} (2)	Turn-off switching energy			5.2	-	mJ
E_{ts}	Total switching energy			8.0	-	mJ
t_{sc}	Short-circuit withstand time	V_{CE} = 800 V, V_{GE} = 15 V, T_J (start) = 175 °C	8		-	µs

1. *Including the reverse recovery of the diode.*
2. *Including the tail of the collector current.*

Table 6. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	I_F = 40 A, V_R = 600 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see Figure 30. Diode reverse recovery waveform)	-	465	-	ns
Q_{rr}	Reverse recovery charge		-	2.8	-	µC
I_{rrm}	Reverse recovery current		-	21	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	1110	-	A/µs
E_{rr}	Reverse recovery energy		-	1.31	-	mJ
t_{rr}	Reverse recovery time	I_F = 40 A, V_R = 600 V, V_{GE} = 15 V, T_J = 175 °C, di/dt = 1000 A/µs (see Figure 30. Diode reverse recovery waveform)	-	750	-	ns
Q_{rr}	Reverse recovery charge		-	9.45	-	µC
I_{rrm}	Reverse recovery current		-	31.2	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	450	-	A/µs
E_{rr}	Reverse recovery energy		-	3.9	-	mJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

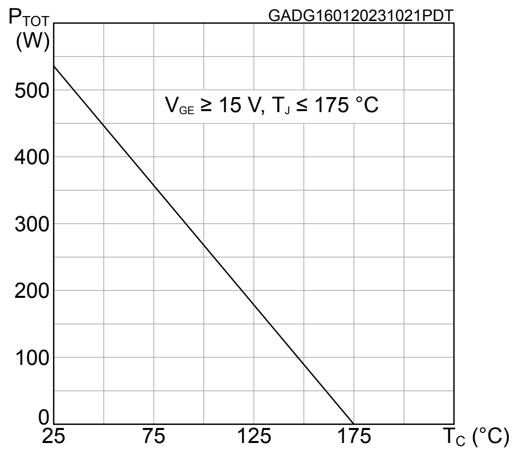


Figure 2. Collector current vs case temperature

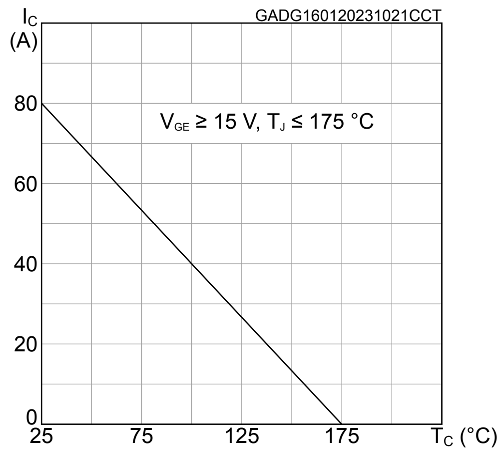


Figure 3. Output characteristics (T_J = 25 °C)

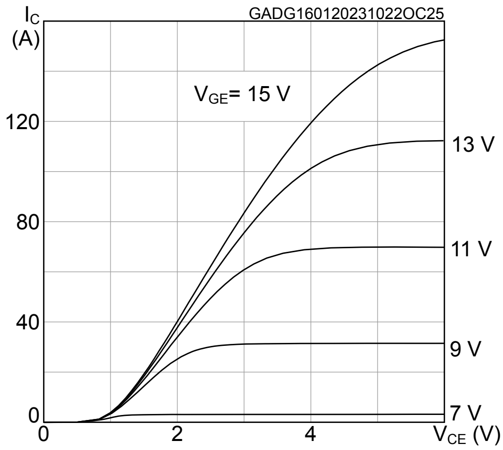


Figure 4. Output characteristics (T_J = 175 °C)

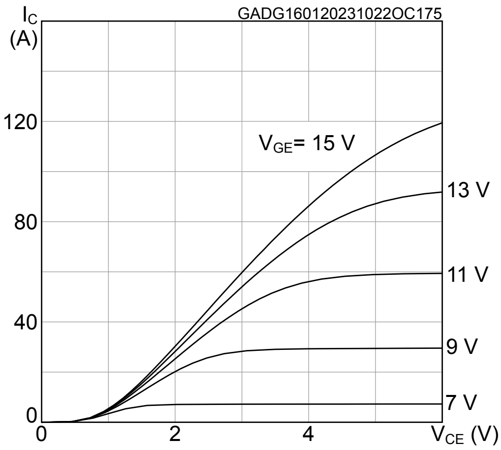


Figure 5. $V_{CE(sat)}$ vs junction temperature

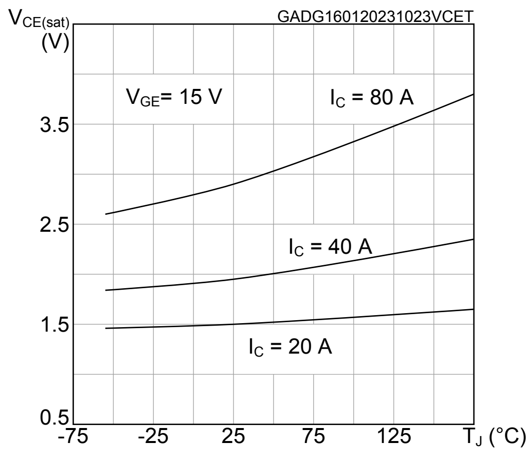


Figure 6. $V_{CE(sat)}$ vs collector current

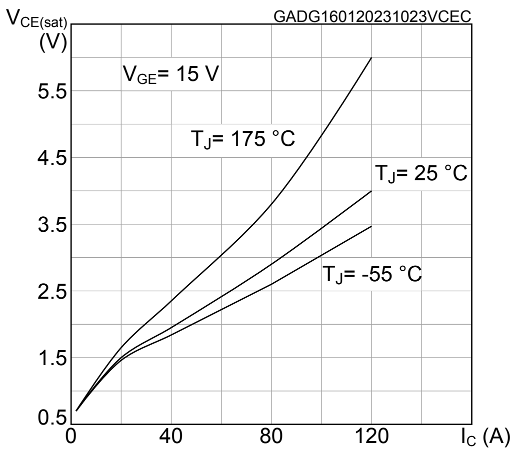


Figure 7. Collector current vs switching frequency

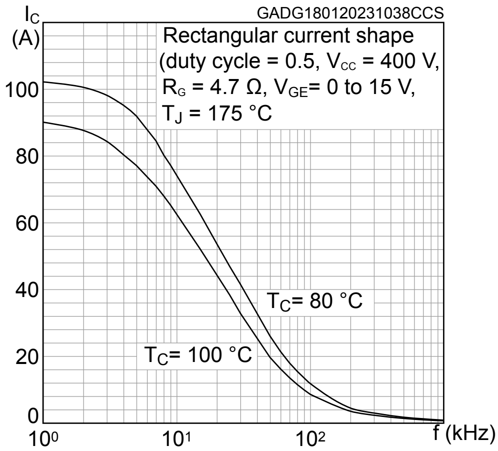


Figure 8. Forward bias safe operating area

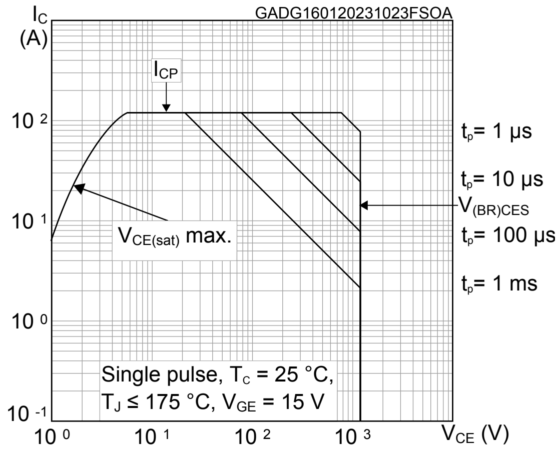


Figure 9. Transfer characteristics

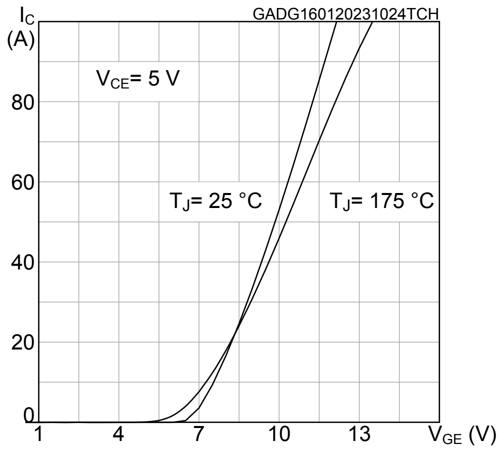


Figure 10. Diode V_F vs forward current

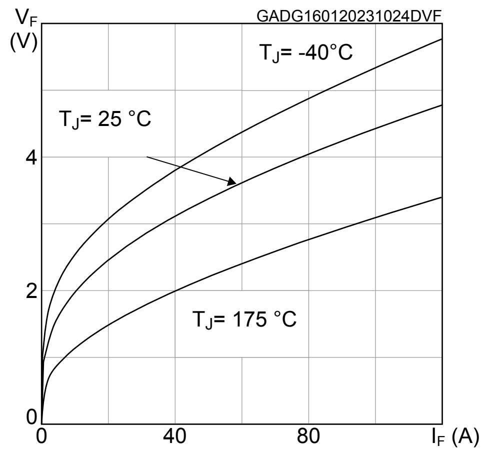


Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

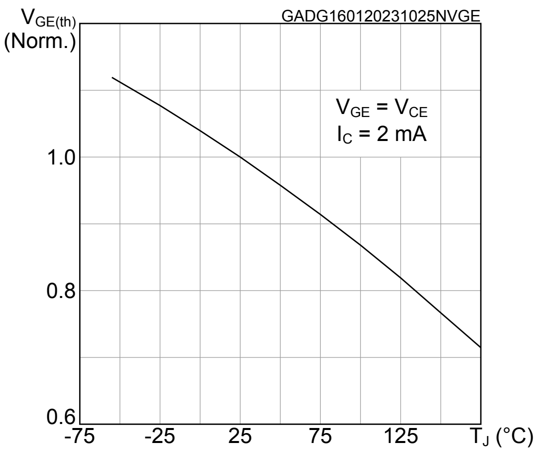


Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature

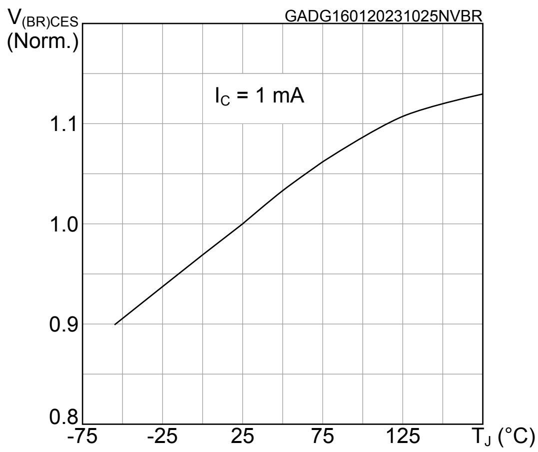


Figure 13. Capacitance variations

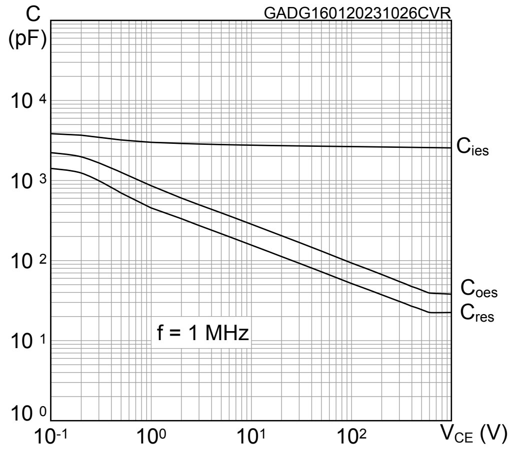


Figure 14. Gate charge vs gate-emitter voltage

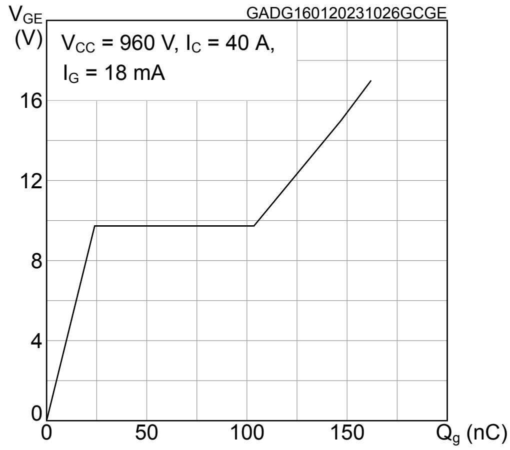


Figure 15. Switching energy vs collector current

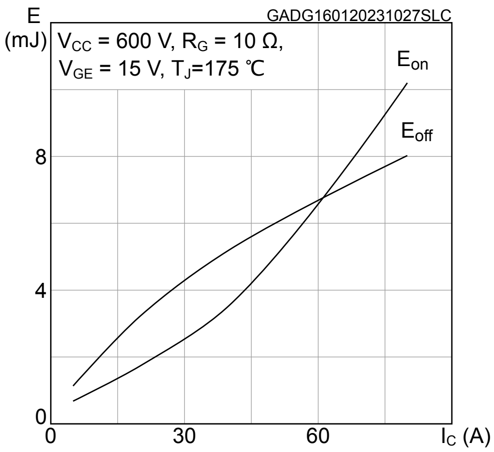


Figure 16. Switching energy vs gate resistance

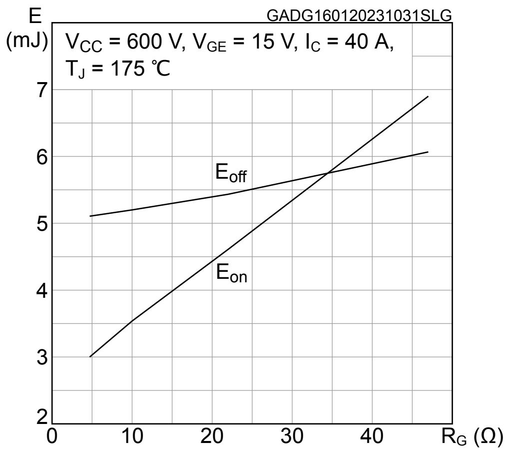


Figure 17. Switching energy vs temperature

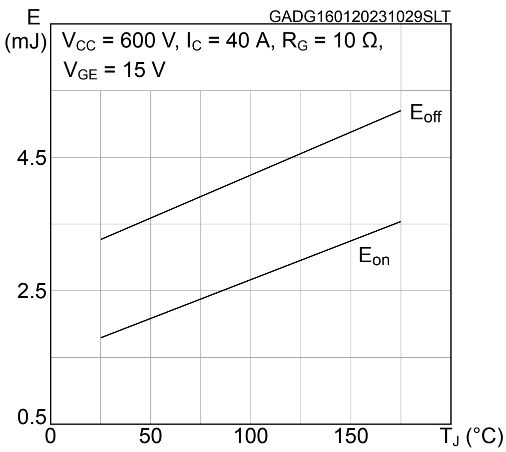


Figure 18. Switching energy vs collector emitter voltage

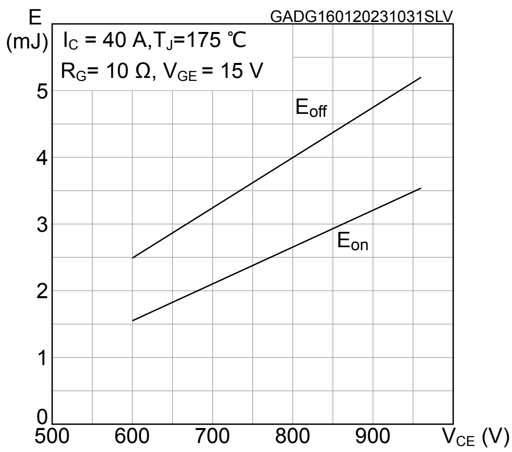


Figure 19. Switching times vs collector current

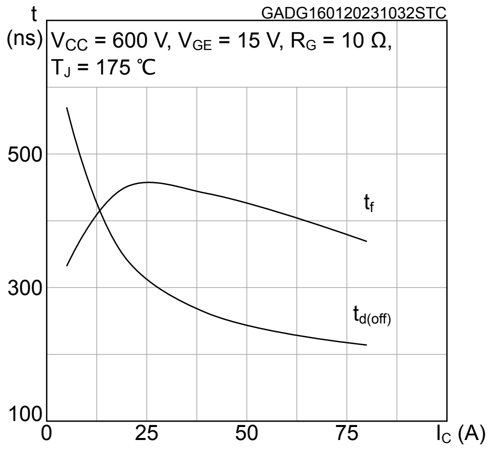


Figure 20. Switching times vs gate resistance

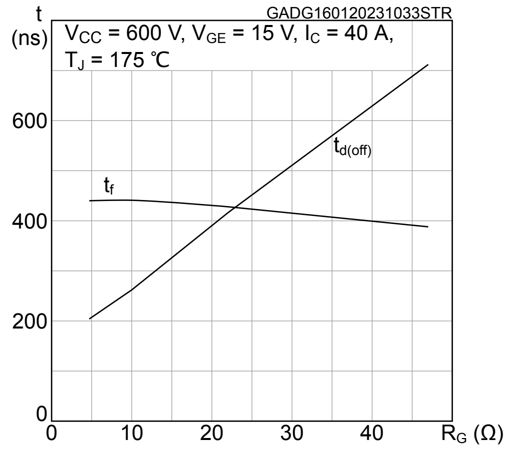


Figure 21. Reverse recovery current vs diode current slope

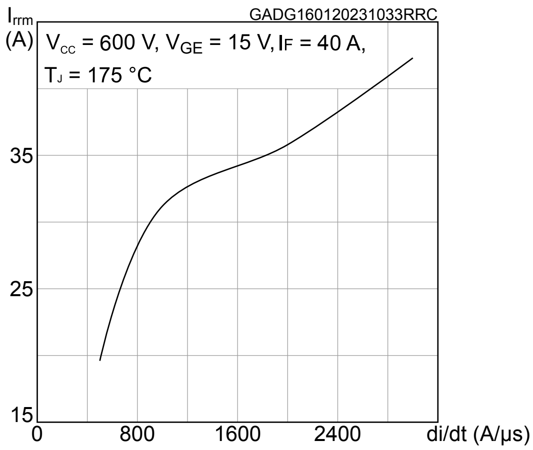


Figure 22. Reverse recovery time vs diode current slope

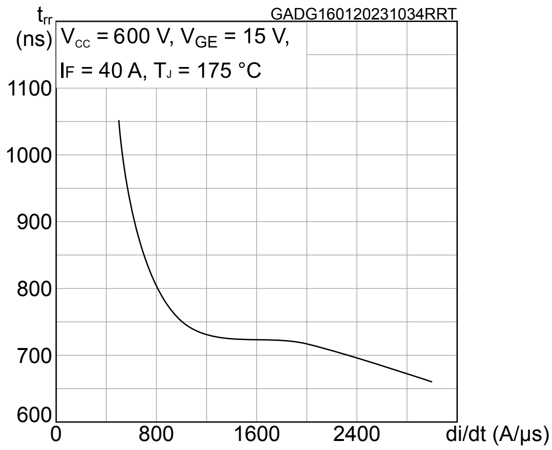


Figure 23. Reverse recovery charge vs diode current slope

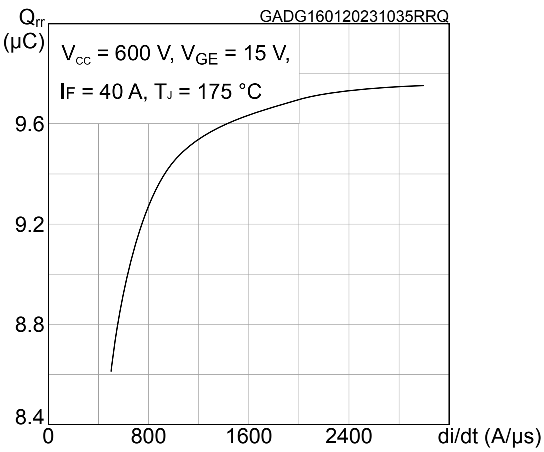


Figure 24. Reverse recovery energy vs diode current slope

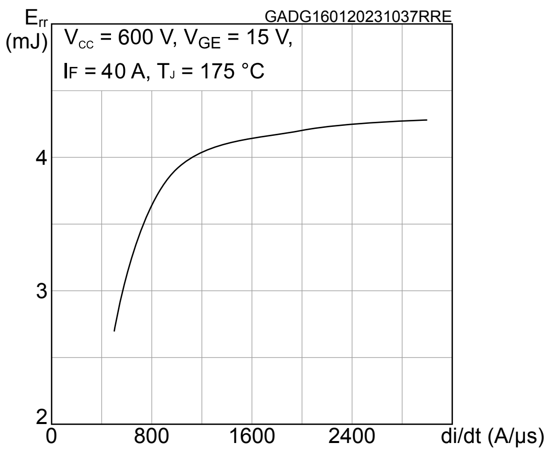


Figure 25. Maximum transient thermal impedance for IGBT

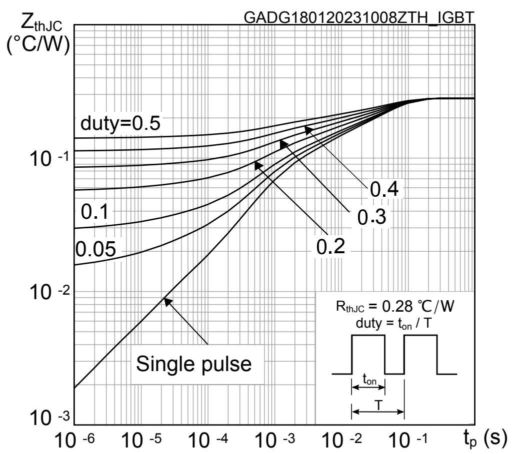
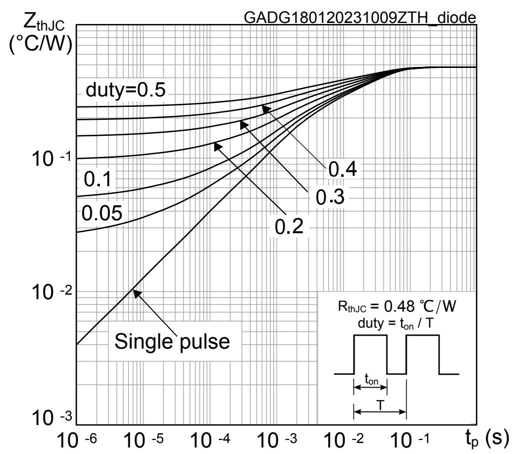


Figure 26. Maximum transient thermal impedance for diode



3 Test circuits

Figure 27. Test circuit for inductive load switching

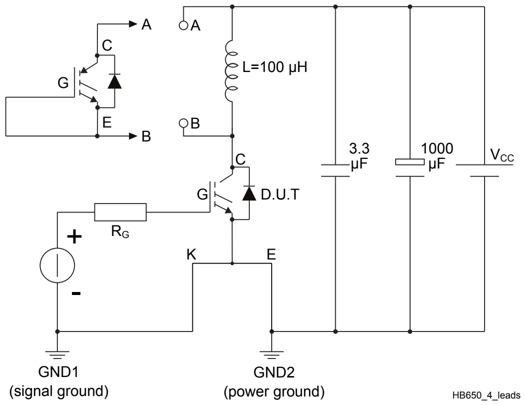


Figure 28. Gate charge test circuit

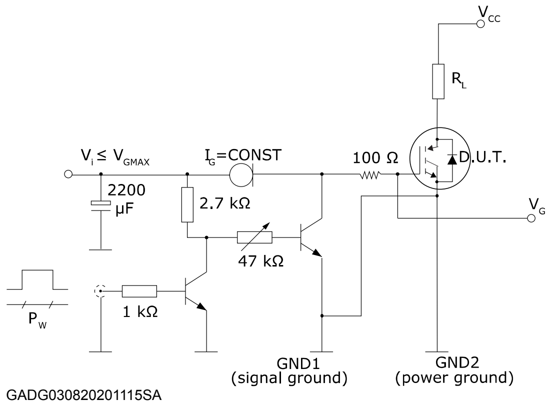


Figure 29. Switching waveform

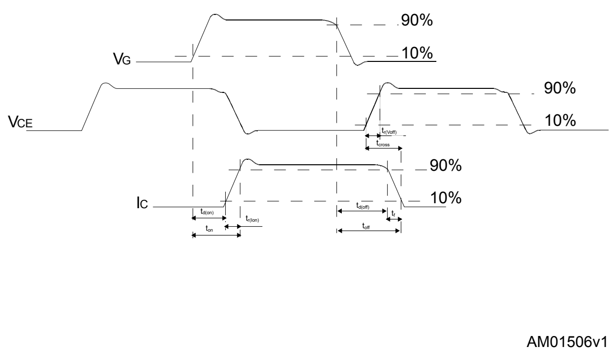
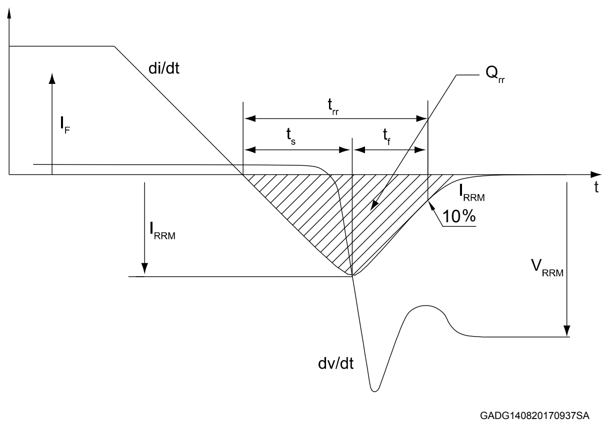


Figure 30. Diode reverse recovery waveform



4 Package information

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.

4.1 TO-247 long leads package information

Figure 31. TO-247 long leads package outline

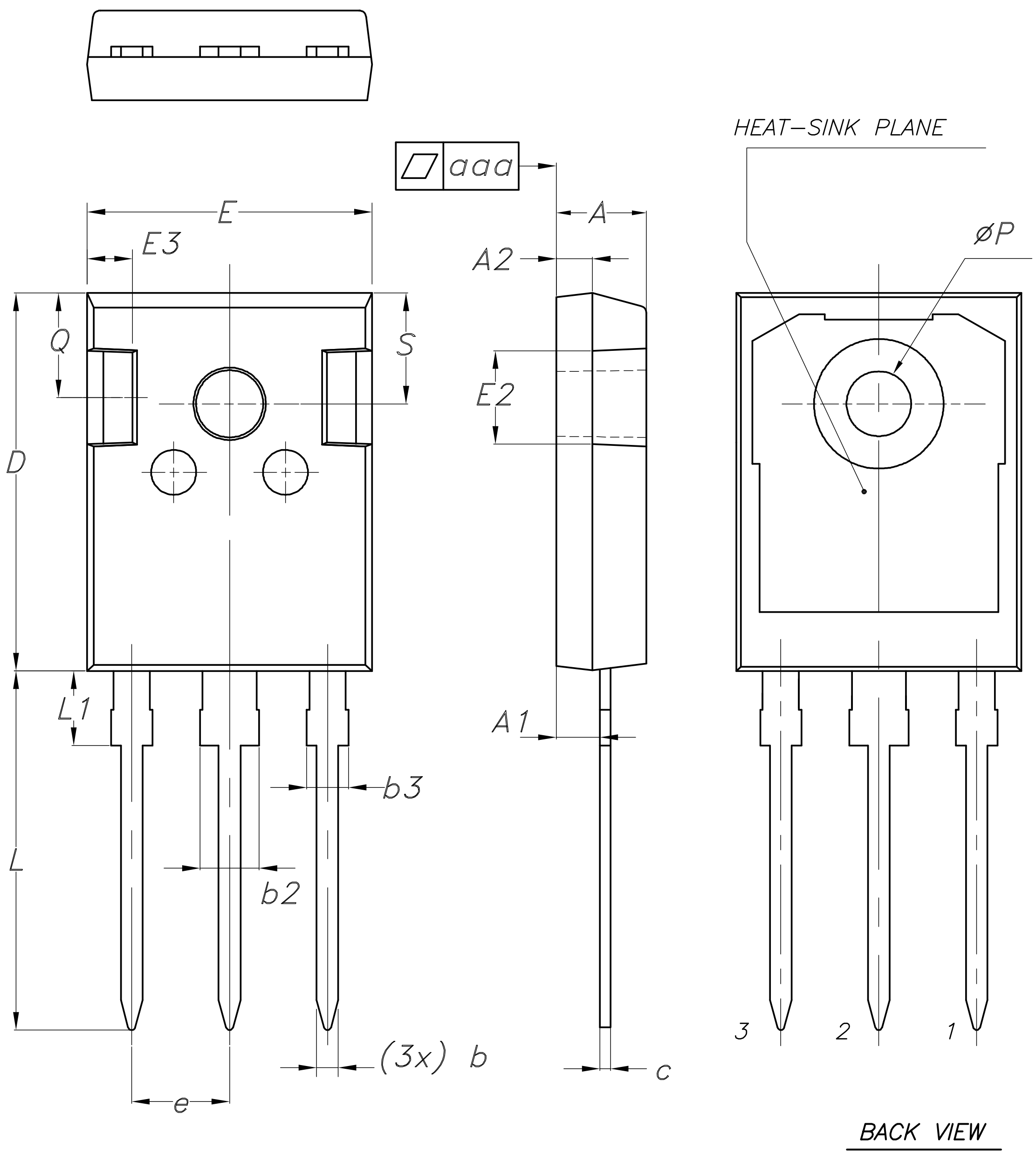


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Table 7. **TO-247 long leads package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
24-Jan-2023	1	First release.
01-Feb-2023	2	Modified Table 5. Switching characteristics (inductive load) and Table 6. Diode switching characteristics (inductive load).

Contents