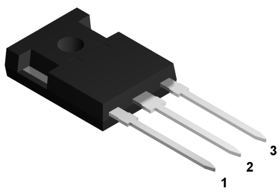
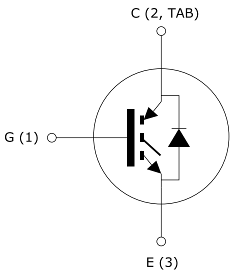
STGWA50M65DF2AG

Datasheet

Automotive-grade trench gate field-stop 650 V, 50 A low-loss M series IGBT in a TO-247 long leads package



TO-247 long leads



Features

- AEC-Q101 qualified
- Maximum junction temperature: T_J = 175 °C
- Low $V_{CE(sat)}$ = 1.7 V (typ.) @ I_C = 50 A
- Minimized tail current
- Tight parameter distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast-recovery antiparallel diode

Applications

- Automotive motor control
- E-compressor
- Heating system

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where the low-loss and the short-circuit functionality is essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and the tight parameter distribution result in safer paralleling operation.

Product status link
STGWA50M65DF2AG

Product summary	
Order code	STGWA50M65DF2AG
Marking	G50M65DF2AG
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)	650	V
I_C	Continuous collector current at T_C = 25 °C	119	A
	Continuous collector current at T_C = 100 °C	79	
I_{CP}(1)	Pulsed collector current	207	A
V_{GE}	Gate-emitter voltage	±20	V
	Transientgate-emitter voltage (t_p≤10 μs, D < 0.01)	±30	
I_F	Continuous forward current at T_C = 25 °C	103	A
	Continuous forward current at T_C = 100 °C	60	
I_{FP}(1)	Pulsed forward current (t_p≤1 ms, T_J<175 °C)	198	A
P_{TOT}	Total power dissipation at T_C = 25 °C	576	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	0.26	°C/W
	Thermal resistance, junction-to-case, diode	0.52	
R_{thJA}	Thermal resistance, junction-to-ambient	50	°C/W

2 Electrical characteristics

T_J = 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 = 250 µA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 50 A		1.7	2	V
		V_{GE} = 15 V, I_C = 50 A, T_J = 125 °C		1.9		
		V_{GE} = 15 V, I_C = 50 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 50 A		2.1	2.6	V
		I_F = 50 A, T_J = 125 °C		1.7		
		I_F = 50 A, T_J = 175 °C		1.55		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 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	-	4130	-	pF
C_{oes}	Output capacitance		-	256	-	nF
C_{res}	Reverse transfer capacitance		-	85	-	nF
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 50 A, V_{GE} = 0 to 15 V (see Figure 28. Gate charge test circuit)	-	147	-	nC
Q_{ge}	Gate-emitter charge		-	36	-	nC
Q_{gc}	Gate-collector charge		-	62	-	nC

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CC} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 6.8 Ω (see Figure 27. Test circuit for inductive load switching)	-	29.8	-	ns
t_r	Current rise time		-	30.8	-	ns
E_{on} (1)	Turn-on switching energy		-	1.4	-	mJ
$t_{d(off)}$	Turn-off delay time		-	143	-	ns
t_f	Current fall time		-	145	-	ns
E_{off} (2)	Turn-off switching energy		-	1.8	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CC} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 6.8 Ω, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)	-	28	-	ns
t_r	Current rise time		-	37	-	ns
E_{on} (1)	Turn-on switching energy		-	2.5	-	mJ
$t_{d(off)}$	Turn-off delay time		-	158	-	ns
t_f	Current fall time		-	255	-	ns
E_{off} (2)	Turn-off switching energy		-	2.6	-	mJ

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 = 50 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs (see Figure 27. Test circuit for inductive load switching)	-	121.6	-	ns
Q_{rr}	Reverse recovery charge		-	0.85	-	µC
I_{rrm}	Reverse recovery current		-	14.2	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	610	-	A/µs
E_{rr}	Reverse recovery energy		-	0.195	-	µJ
t_{rr}	Reverse recovery time	I_F = 75 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/µs, T_J = 175 °C (see Figure 27. Test circuit for inductive load switching)	-	214	-	ns
Q_{rr}	Reverse recovery charge		-	3.3	-	µC
I_{rrm}	Reverse recovery current		-	31	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	530	-	A/µs
E_{rr}	Reverse recovery energy		-	0.867	-	µJ

2.1 Electrical characteristics (curves)

Figure 1. Total power dissipation vs temperature

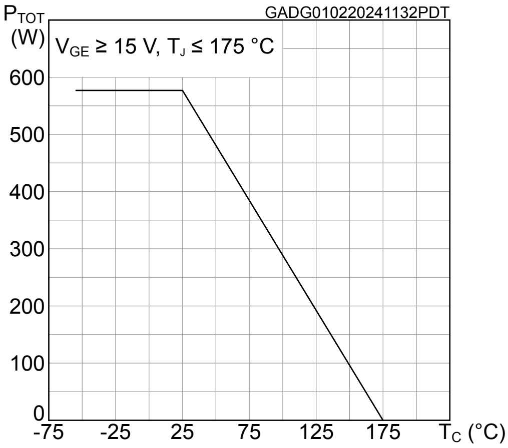


Figure 2. Collector current vs temperature

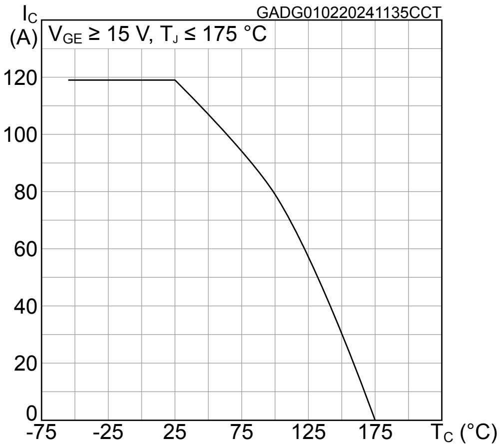


Figure 3. Typical output characteristics (T_J = 25 °C)

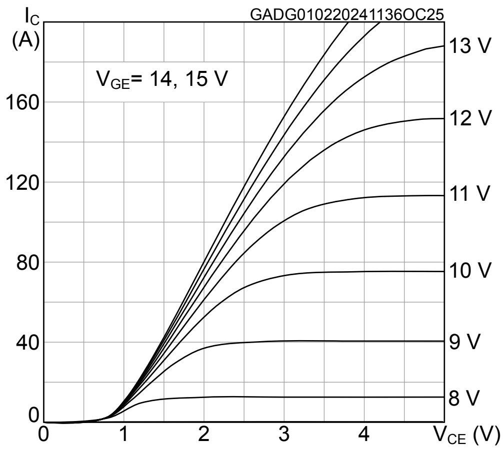


Figure 4. Typical output characteristics (T_J = 175 °C)

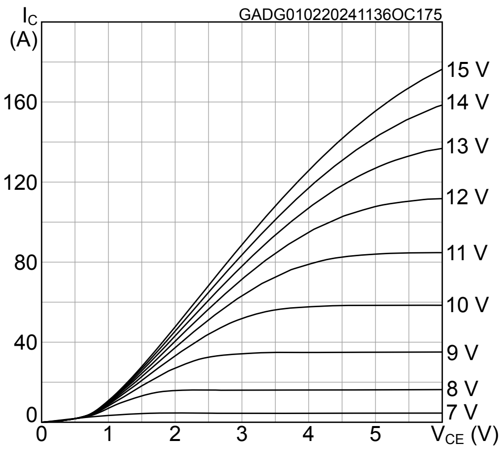


Figure 5. Typical transfer characteristics

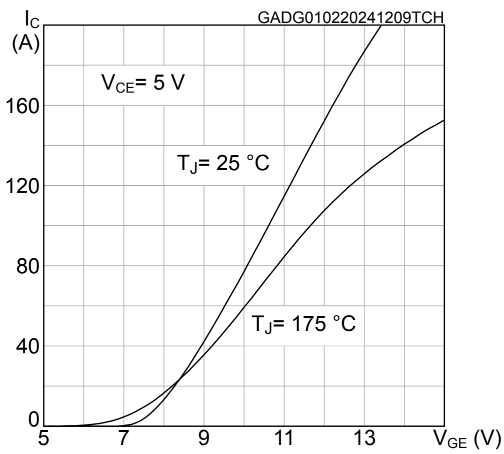


Figure 6. Typical $V_{CE(sat)}$ vs temperature

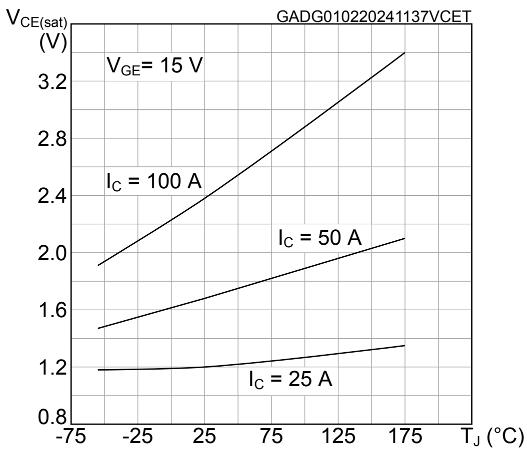


Figure 7. Typical $V_{CE(sat)}$ vs collector current

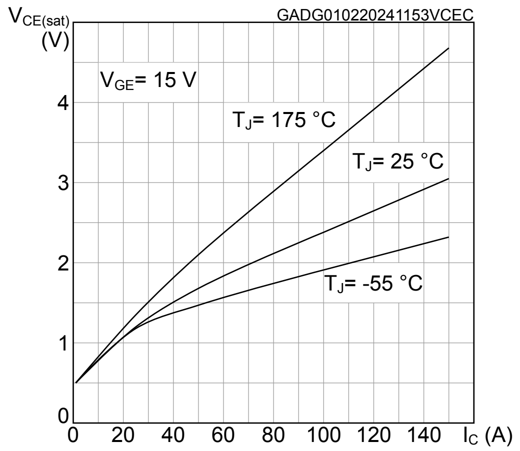


Figure 8. Forward bias safe operating area

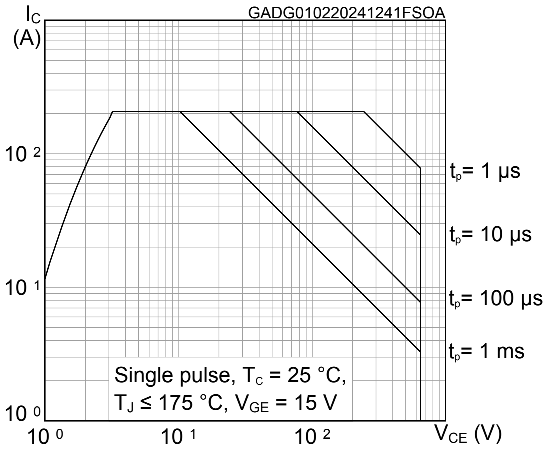


Figure 9. Diode typical V_F vs forward current

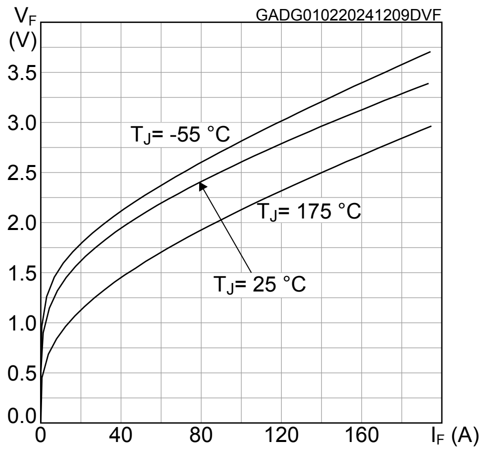


Figure 10. Typical I_C vs switching frequency

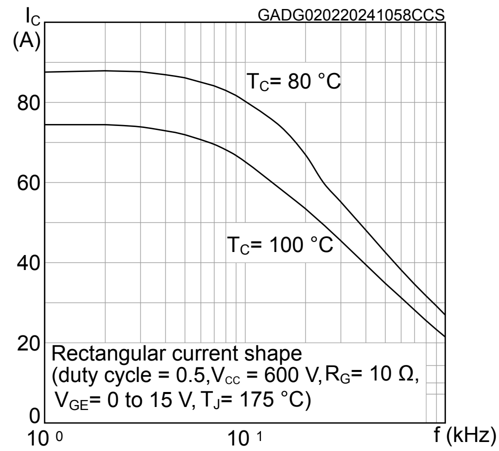


Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

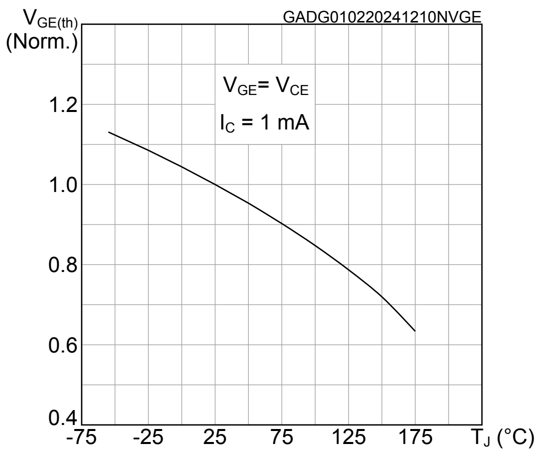


Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature

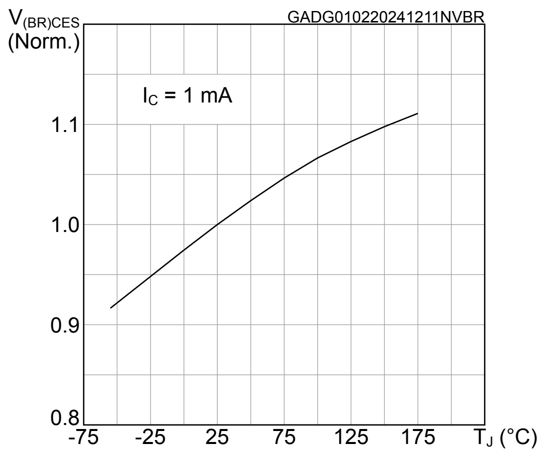


Figure 13. Typical capacitance characteristics

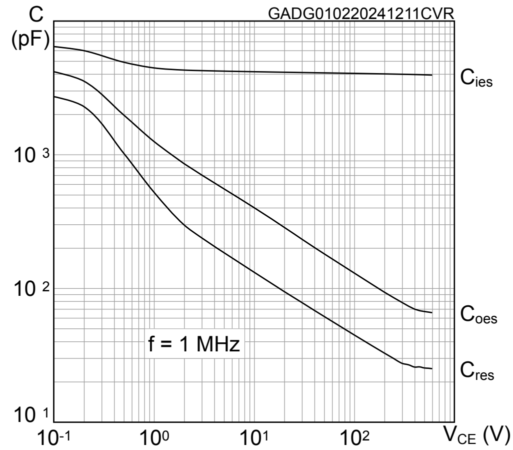


Figure 14. Typical gate charge characteristics

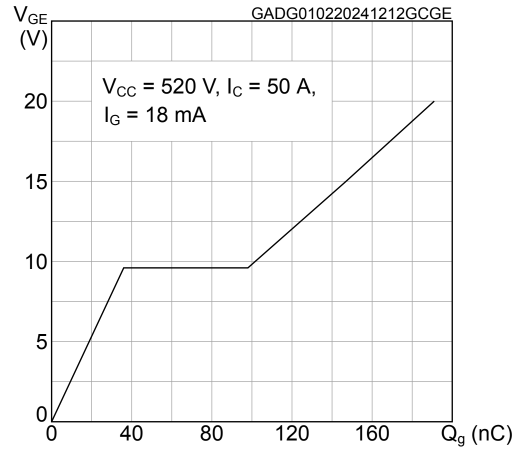


Figure 15. Typical switching energy vs collector current

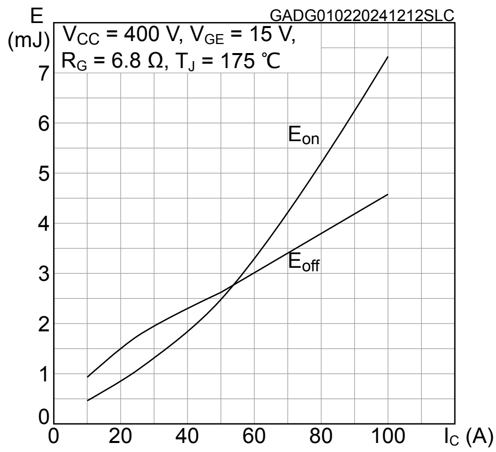


Figure 16. Typical switching energy vs temperature

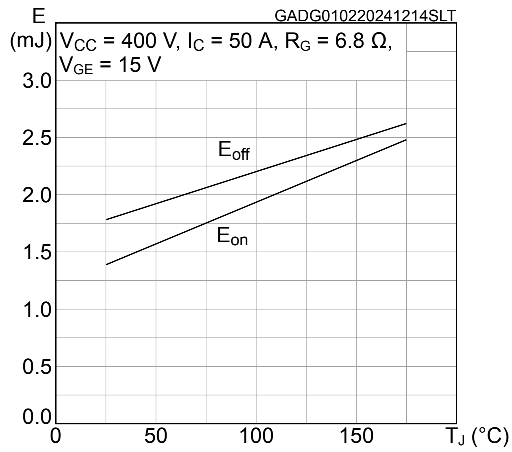


Figure 17. Typical switching energy vs supply voltage

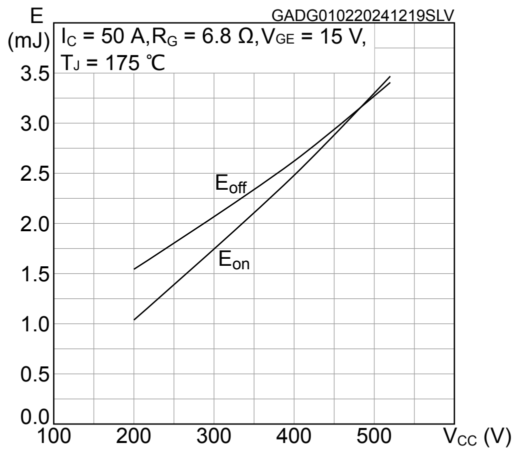


Figure 18. Typical switching energy vs gate resistance

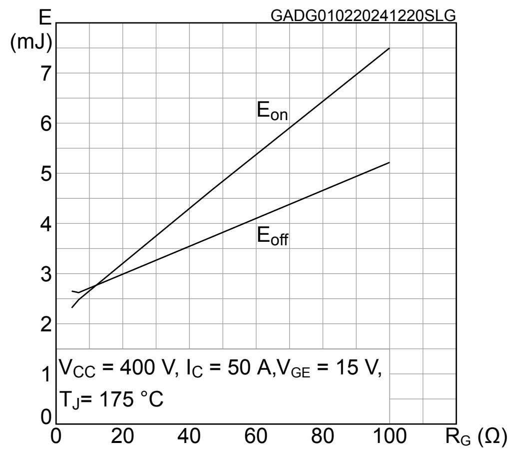


Figure 19. Typical switching times vs collector current

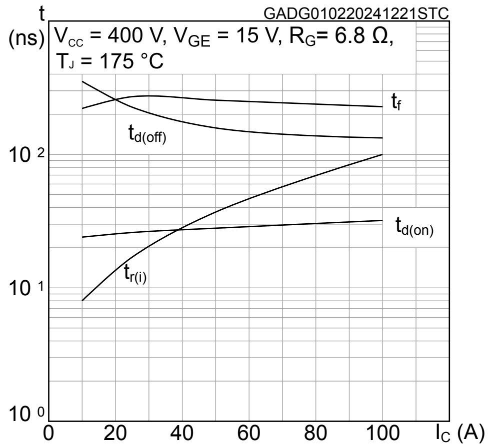


Figure 20. Typical switching times vs gate resistance

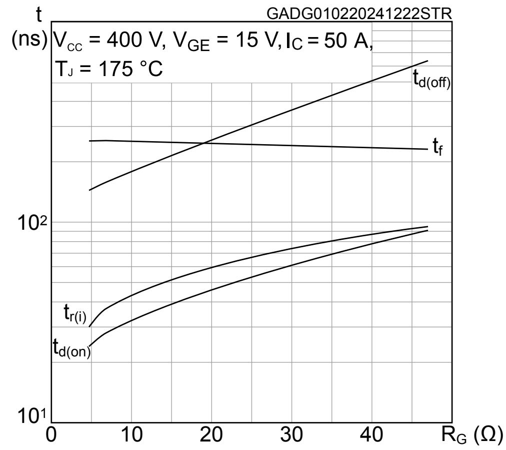


Figure 21. Typical reverse recovery current vs diode current slope

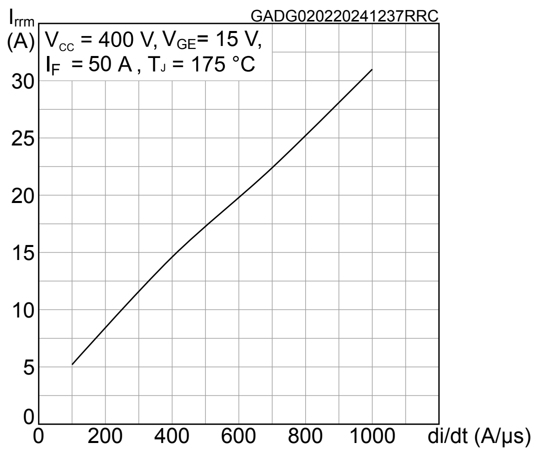


Figure 22. Typical reverse recovery time vs diode current slope

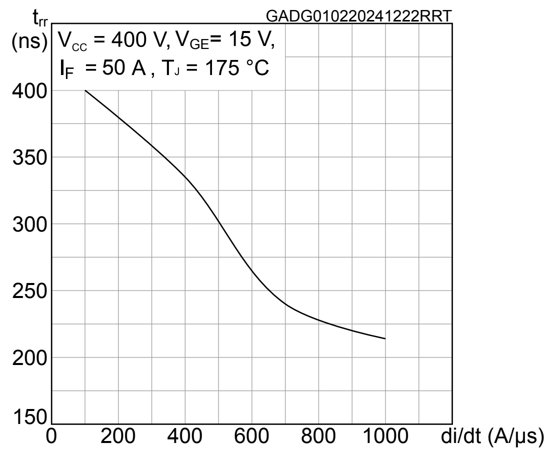


Figure 23. Typical reverse recovery charge vs diode current slope

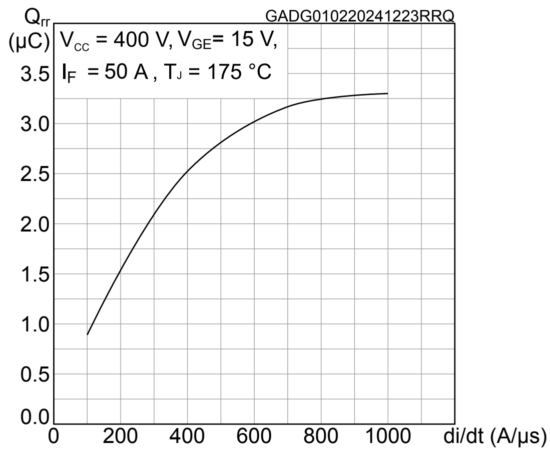


Figure 24. Typical reverse recovery energy vs diode current slope

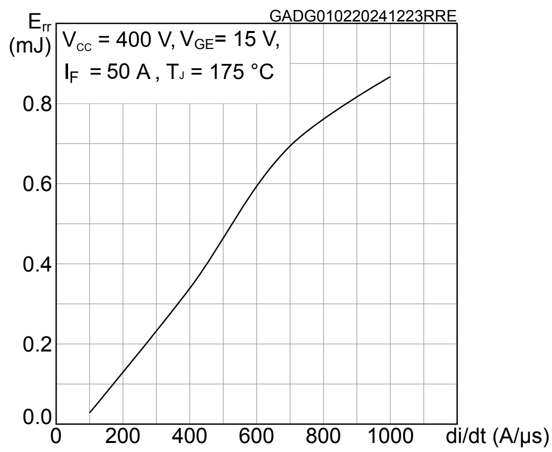


Figure 25. **IGBT maximum transient thermal impedance**

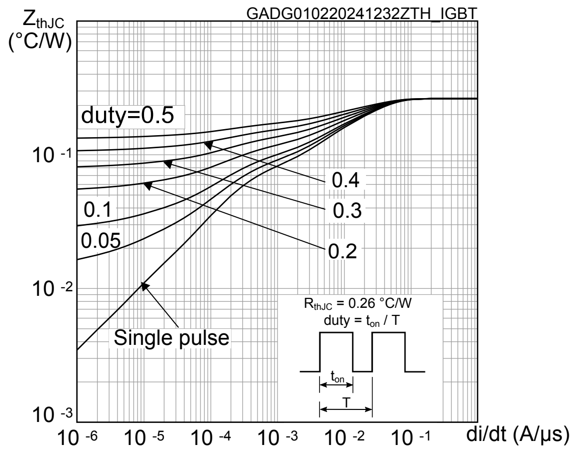
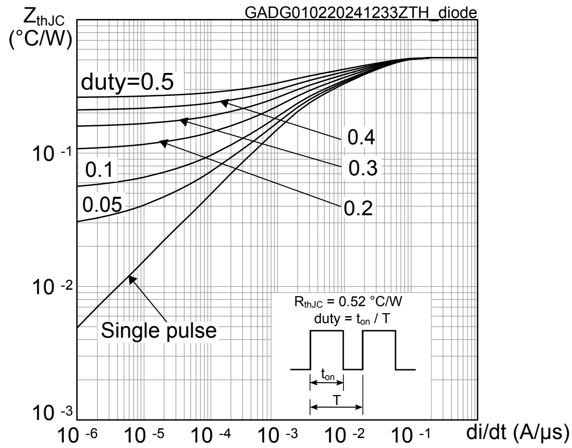


Figure 26. **Diode maximum transient thermal impedance**



3 Test circuits

Figure 27. Test circuit for inductive load switching

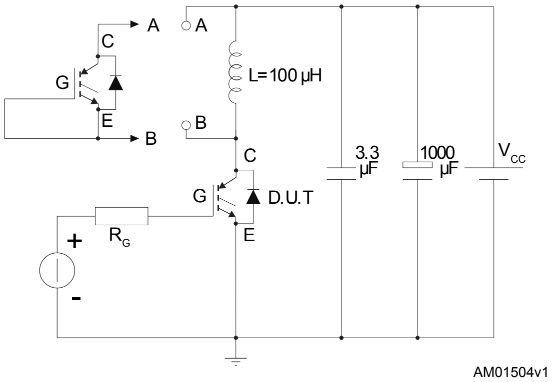


Figure 28. Gate charge test circuit

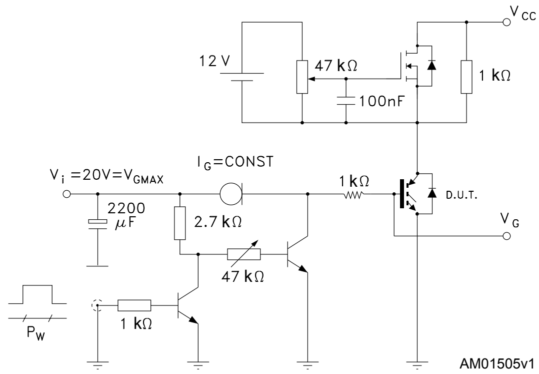


Figure 29. Switching waveform

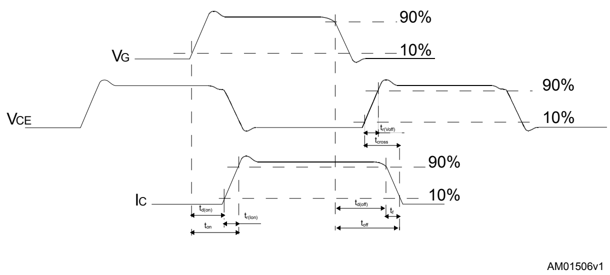
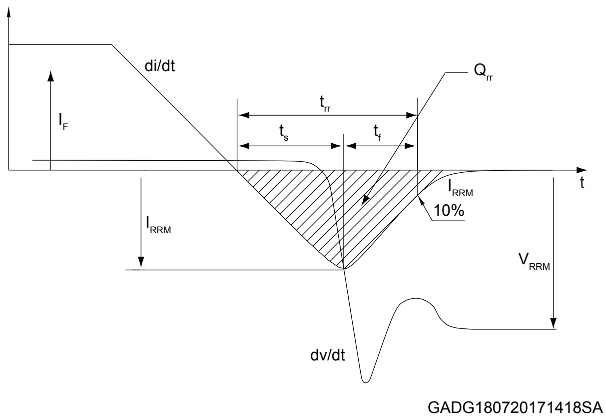


Figure 30. Diode reverse recovery waveform

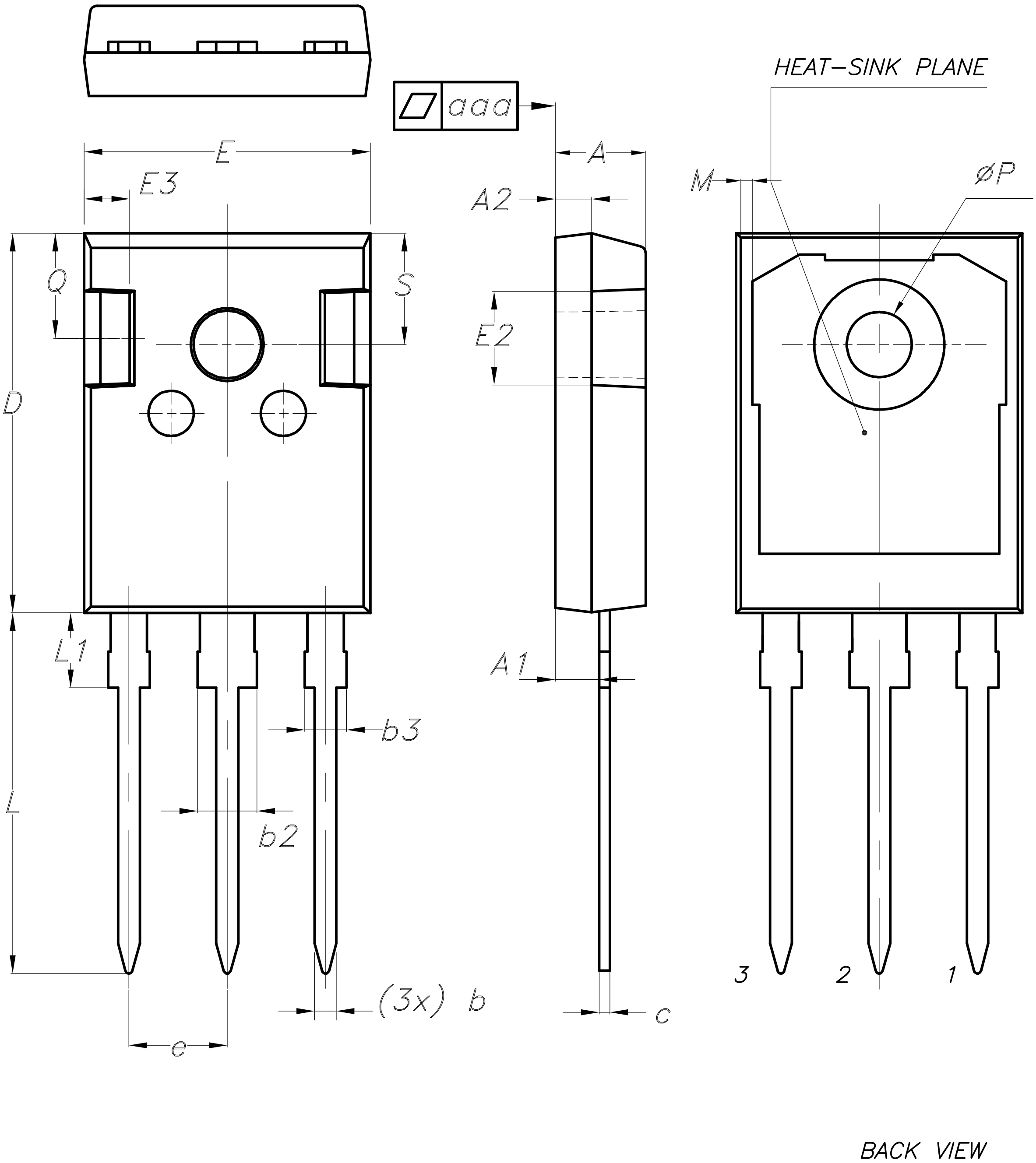


4 Package information

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



8463846_5

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
M	0.35		0.95
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
06-Feb-2024	1	First release.
07-Feb-2024	2	Modified title on cover page.

Contents