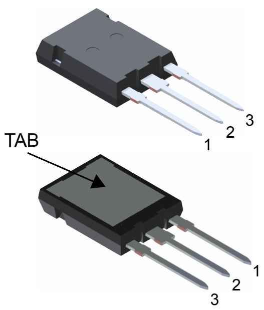
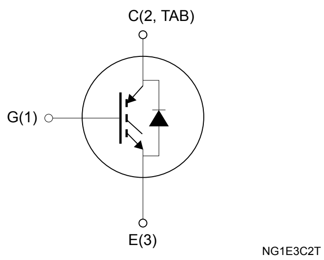
STGYA120M65DF2AG

Datasheet

Automotive-grade trench gate field-stop, 650 V, 120 A, low-loss, M series IGBT in a Max247 long leads package



Max247 long leads



STPOWER

Product status link
STGYA120M65DF2AG

Product summary	
Order code	STGYA120M65DF2AG
Marking	G120M65DF2AG
Package	Max247 long leads
Packing	Tube

Features

- AEC-Q101 qualified
- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.65 V (typ.) @ I_C = 120 A
- Tight parameter distribution
- Safer paralleling
- Positive $V_{CE(sat)}$ temperature coefficient
- Low thermal resistance
- Soft and very fast recovery antiparallel diode
- Maximum junction temperature: T_J = 175 °C

Applications

- Heating system
- HV battery disconnect and fire-off system
- Main inverter (electric traction)

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.

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 (1)	Continuous collector current at T_C = 25 °C	160	A
I_C	Continuous collector current at T_C = 100 °C	120	
I_{CP} (2)	Pulsed collector current	360	A
V_{GE}	Gate-emitter voltage	±20	V
I_F (1)	Continuous forward current at T_C = 25 °C	160	A
I_F	Continuous forward current at T_C = 100 °C	120	
I_{FP} (2)	Pulsed forward current	360	A
P_{TOT}	Total power dissipation at T_C = 25 °C	625	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	

1. *Current level is limited by bond wires.*
2. *Pulse width limited by maximum junction temperature.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-case IGBT	0.24	°C/W
R_{thJC}	Thermal resistance, junction-case diode	0.6	
R_{thJA}	Thermal resistance, junction-ambient	50	

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 = 250 µA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 120 A		1.65	2.15	V
		V_{GE} = 15 V, I_C = 120 A, T_J = 125 °C		1.95		
		V_{GE} = 15 V, I_C = 120 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 120 A		1.9	2.6	V
		I_F = 120 A, T_J = 125 °C		1.7		
		I_F = 120 A, T_J = 175 °C		1.6		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 2 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 V			100	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ± 20 V			± 250	µA

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	-	11000	-	pF
C_{oes}	Output capacitance		-	610	-	
C_{res}	Reverse transfer capacitance		-	250	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 120 A, V_{GE} = 0 to 15 V (see Figure 30. Gate charge test circuit)	-	420	-	nC
Q_{ge}	Gate-emitter charge		-	90	-	
Q_{gc}	Gate-collector charge		-	160	-	

Table 5. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 120 A, V_{GE} = 15 V, R_G = 4.7 Ω (see Figure 29. Test circuit for inductive load switching)		66	-	ns
t_r	Current rise time			38	-	ns
$(di/dt)_{on}$	Turn-on current slope			2500	-	A/μs
$t_{d(off)}$	Turn-off-delay time			185	-	ns
t_f	Current fall time			85	-	ns
E_{on}[(1)]	Turn-on switching energy			1.8	-	mJ
E_{off}[(2)]	Turn-off switching energy			4.41	-	mJ
E_{ts}	Total switching energy			6.21	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 120 A, V_{GE} = 15 V, R_G = 4.7 Ω, T_J = 175 °C (see Figure 29. Test circuit for inductive load switching)		62	-	ns
t_r	Current rise time			48	-	ns
$(di/dt)_{on}$	Turn-on current slope			2016	-	A/μs
$t_{d(off)}$	Turn-off-delay time			187	-	ns
t_f	Current fall time			164	-	ns
E_{on}[(1)]	Turn-on switching energy			4.4	-	mJ
E_{off}[(2)]	Turn-off switching energy			6.0	-	mJ
E_{ts}	Total switching energy			10.4	-	mJ
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 400 V, V_{GE} = 13 V, T_{Jstart} = 150 °C	10		-	μs
		V_{CC} ≤ 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	6		-	

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 = 120 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/μs (see Figure 29. Test circuit for inductive load switching)	-	202	-	ns
Q_{rr}	Reverse recovery charge		-	2.9	-	μC
I_{rrm}	Reverse recovery current		-	32.5	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	500	-	A/μs
E_{rr}	Reverse recovery energy		-	500	-	μJ
t_{rr}	Reverse recovery time	I_F = 120 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 1000 A/μs, T_J = 175 °C (see Figure 29. Test circuit for inductive load switching)	-	320	-	ns
Q_{rr}	Reverse recovery charge		-	11.2	-	μC
I_{rrm}	Reverse recovery current		-	62	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	270	-	A/μs
E_{rr}	Reverse recovery energy		-	1710	-	μJ

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

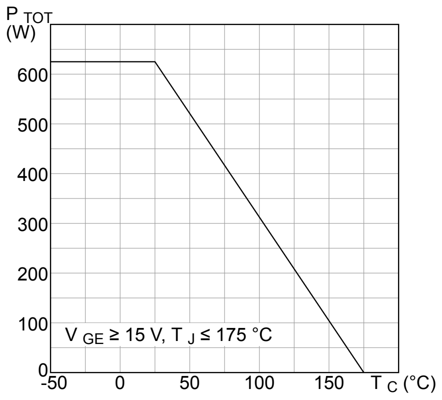


Figure 2. Collector current vs case temperature

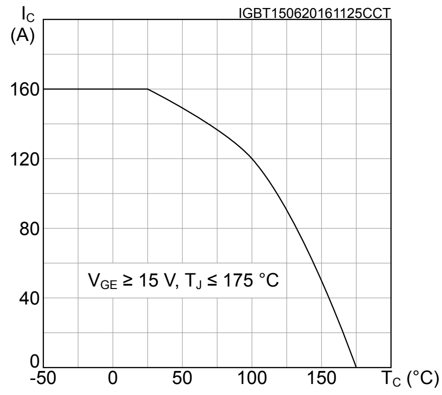


Figure 3. Output characteristics (T_J = 25 °C)

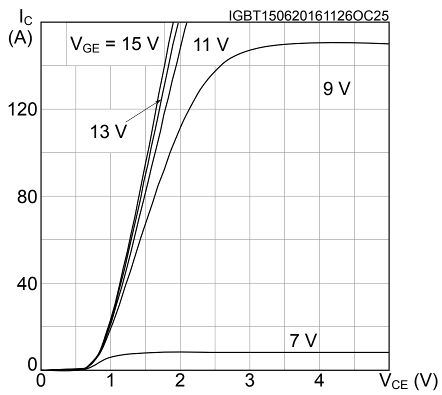


Figure 4. Output characteristics (T_J = 175 °C)

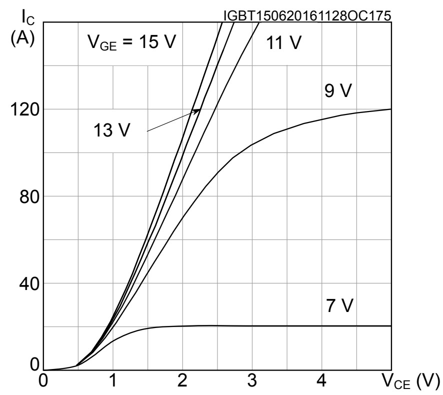


Figure 5. $V_{CE(sat)}$ vs junction temperature

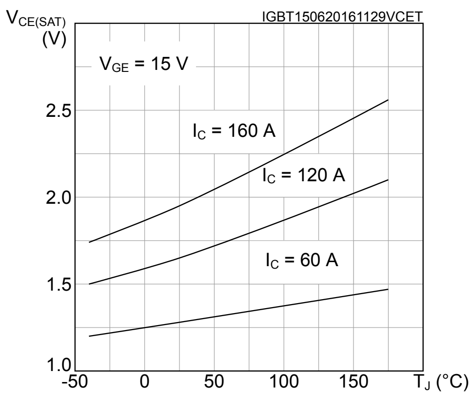


Figure 6. $V_{CE(sat)}$ vs collector current

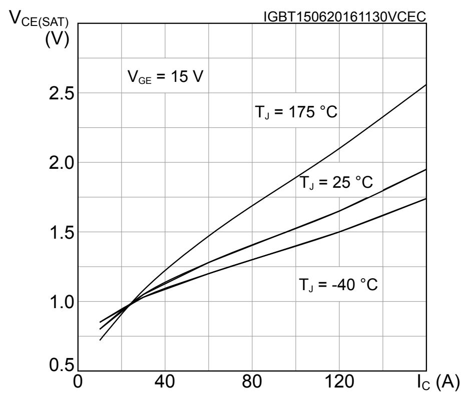


Figure 7. **Collector current vs switching frequency**

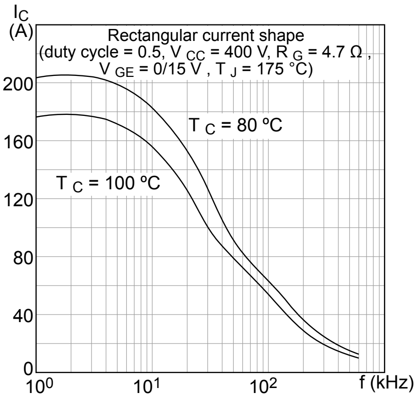


Figure 8. **Forward bias safe operating area**

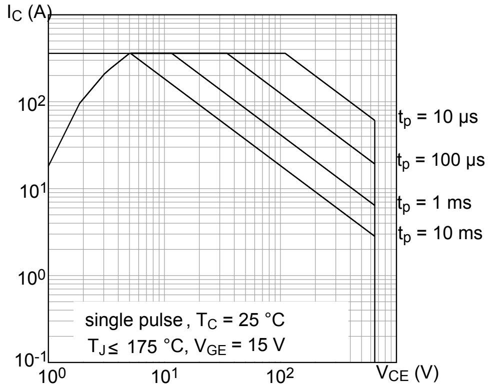


Figure 9. **Transfer characteristics**

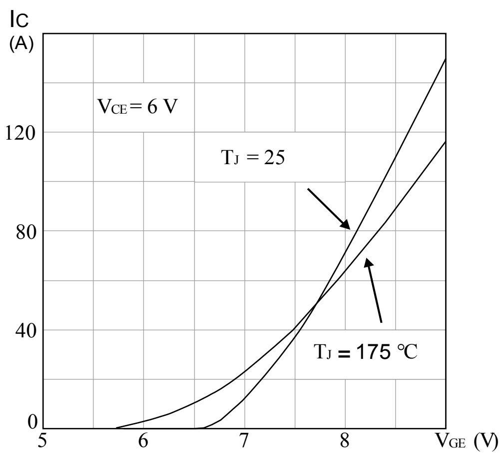


Figure 10. **Diode V_F vs forward current**

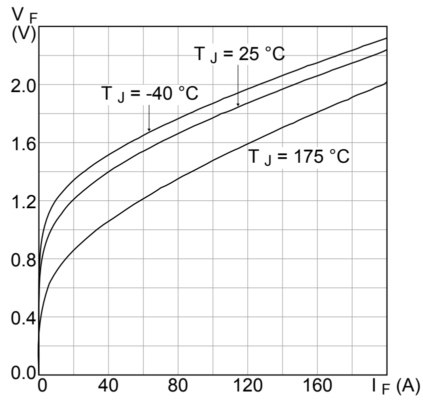


Figure 11. **Normalized $V_{GE(th)}$ vs junction temperature**

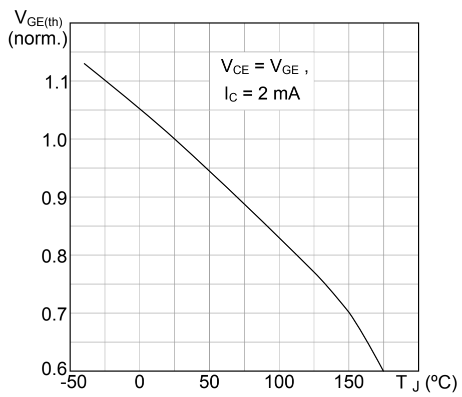


Figure 12. **Normalized $V_{(BR)CES}$ vs junction temperature**

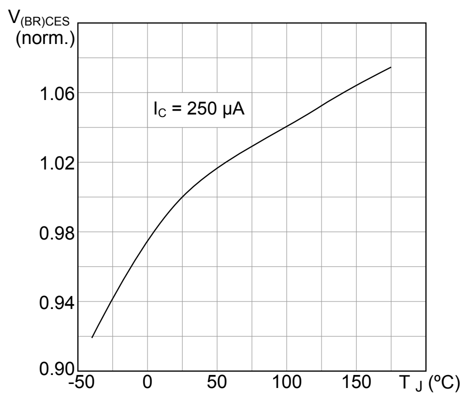


Figure 13. Capacitance variations

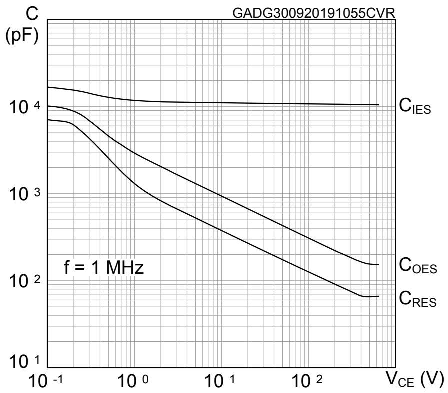


Figure 14. Gate charge vs gate-emitter voltage

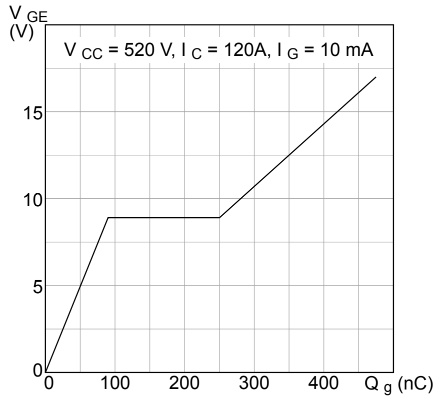


Figure 15. Switching energy vs collector current

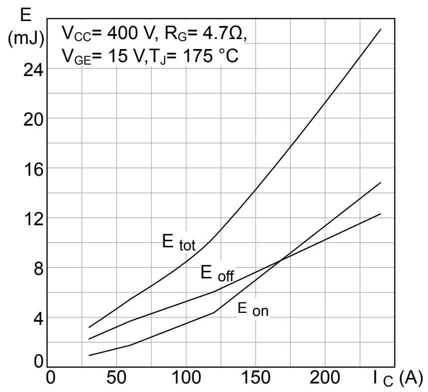


Figure 16. Switching energy vs gate resistance

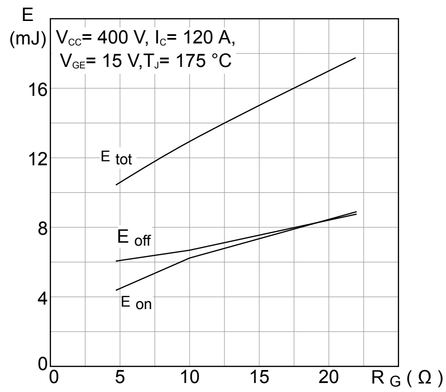


Figure 17. Switching energy vs temperature

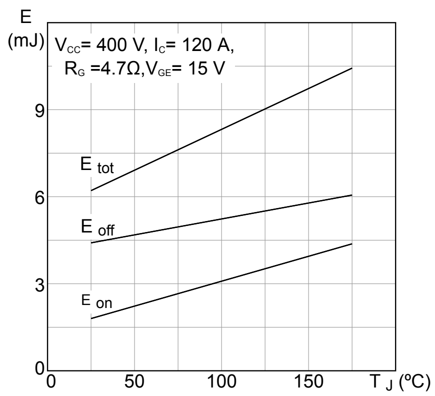


Figure 18. Switching energy vs collector emitter voltage

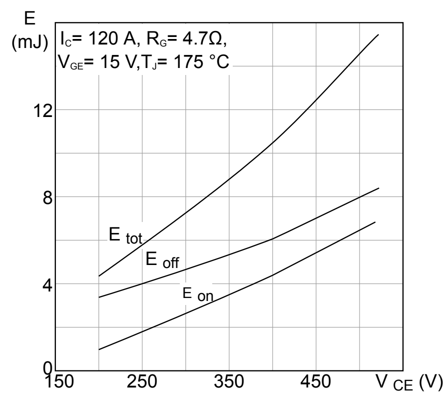


Figure 19. Short circuit time and current vs V_{GE}

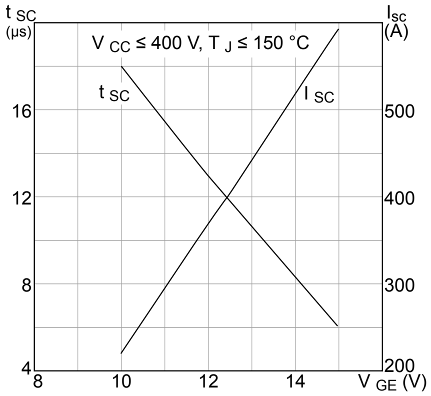


Figure 20. Switching times vs collector current

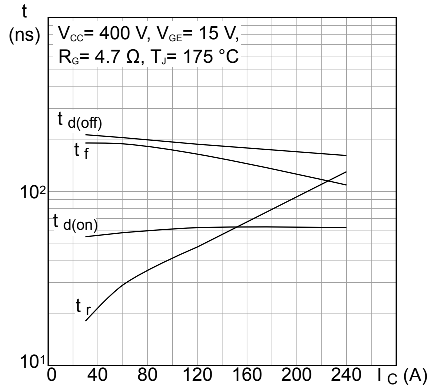


Figure 21. Switching times vs gate resistance

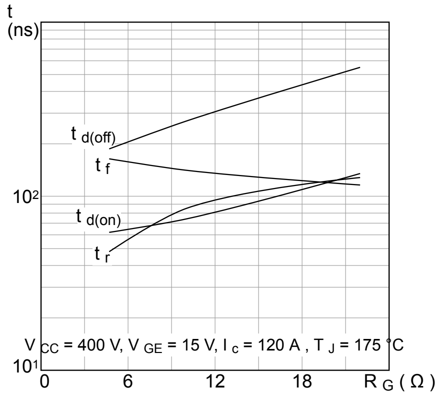


Figure 22. Reverse recovery current vs diode current slope

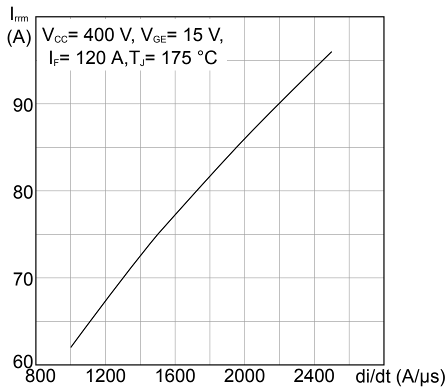


Figure 23. Reverse recovery time vs diode current slope

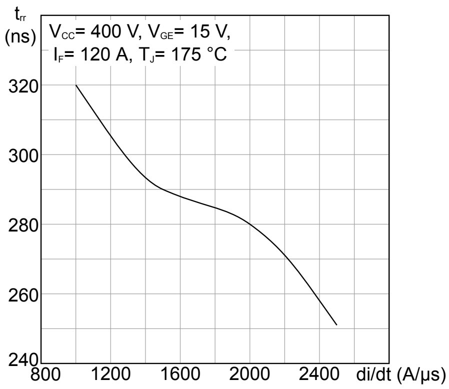
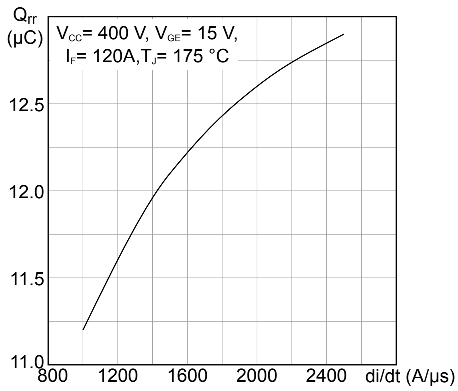


Figure 24. Reverse recovery charge vs diode current slope



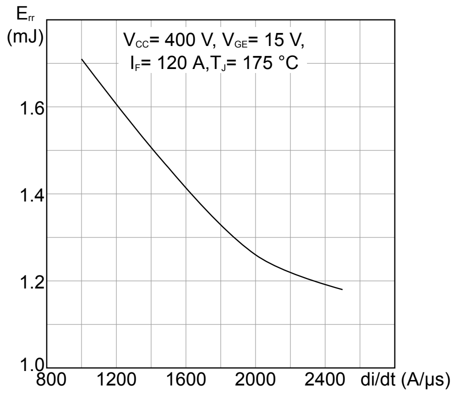


Figure 25. Reverse recovery energy vs diode current slope

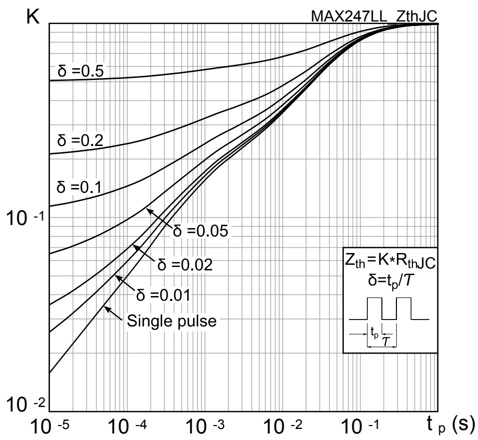


Figure 26. Thermal impedance for IGBT

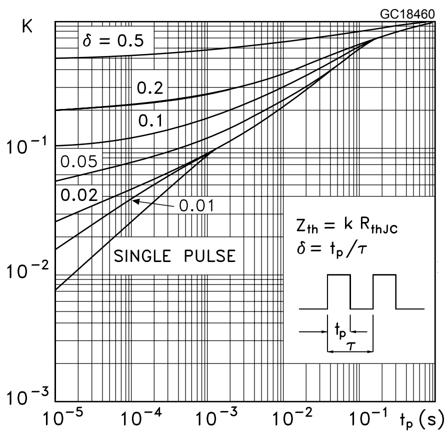


Figure 27. Thermal impedance for diode

3 Test circuits

Figure 28. Test circuit for inductive load switching

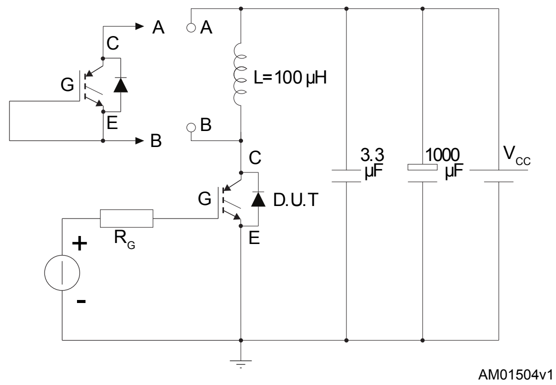


Figure 29. Gate charge test circuit

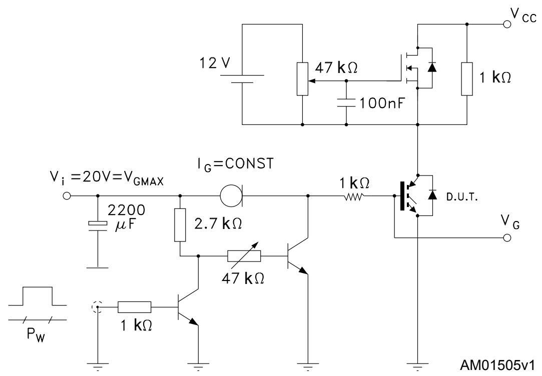


Figure 30. Switching waveform

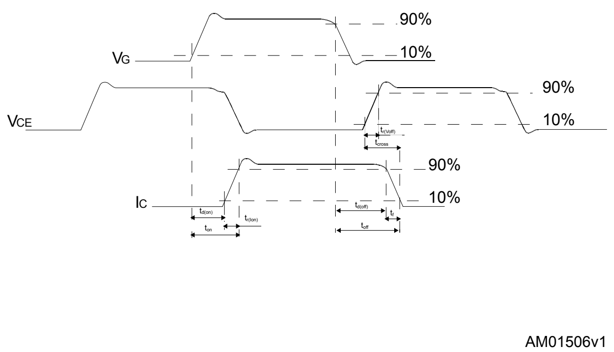
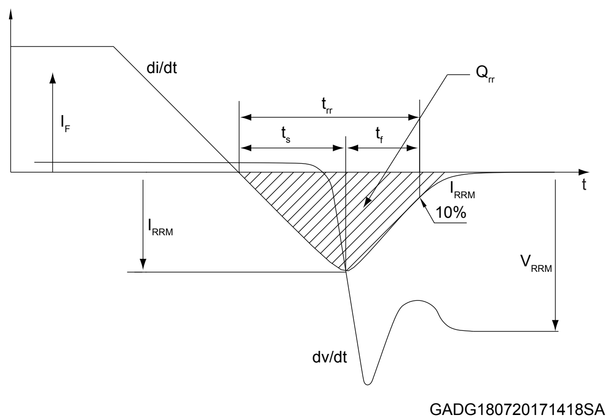


Figure 31. Diode reverse recovery waveform



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 Max247 long leads package information

Figure 32. Max247 long leads package outline

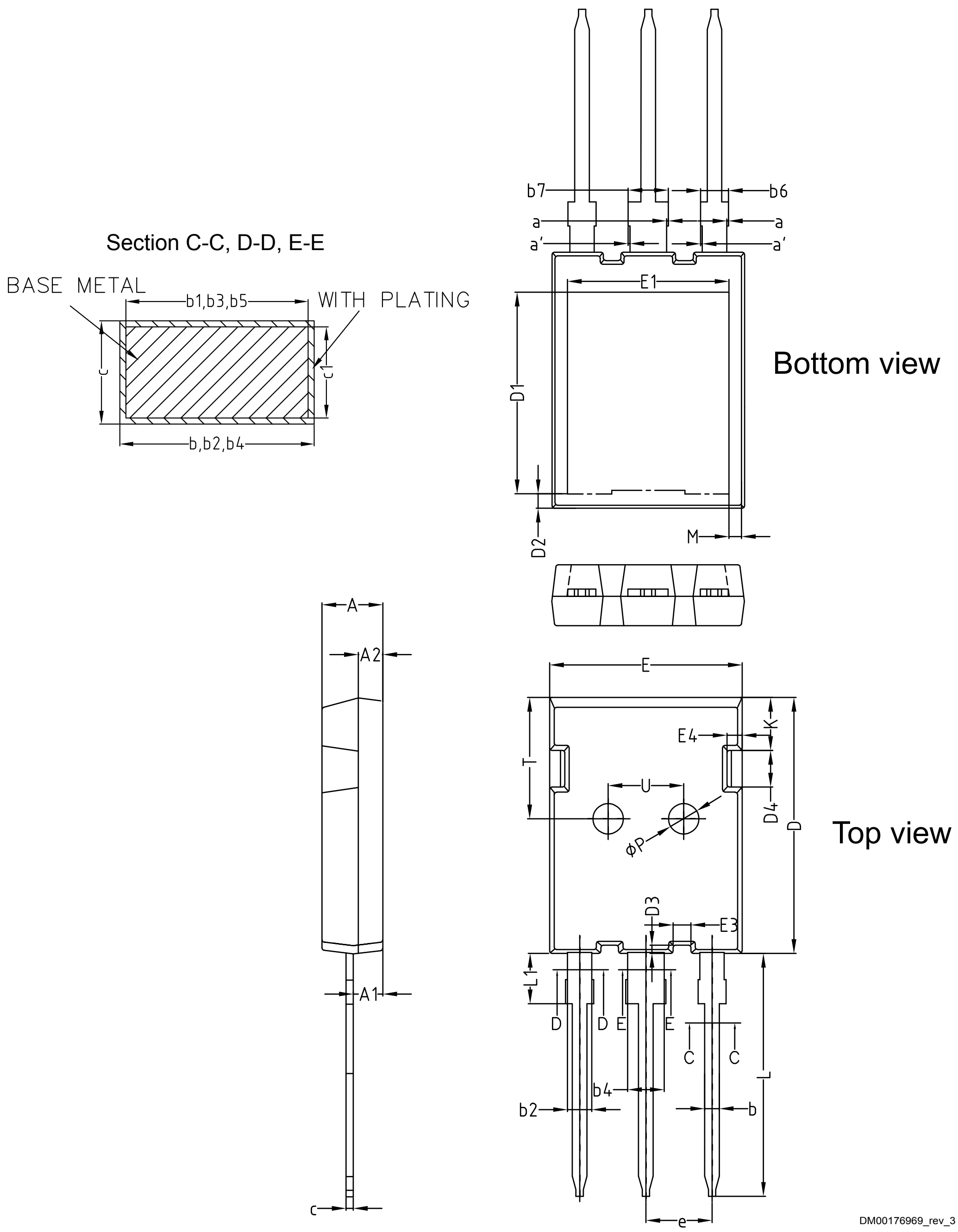


Table 7. **Max247 long leads package mechanical data**

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
a	0		0.15
a'	0		0.15
b	1.16		1.26
b1	1.15	1.20	1.22
b2	1.96		2.06
b3	1.95	2.00	2.02
b4	2.96		3.06
b5	2.95	3.00	3.02
b6			2.25
b7			3.25
c	0.59		0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.17	1.35
D3	0.58	0.68	0.78
D4	2.90	3.00	3.10
E	15.70	15.80	15.90
E1	13.10	13.26	13.50
E3	1.35	1.45	1.55
E4	1.14	1.24	1.34
e	5.34	5.44	5.54
K	4.25	4.35	4.45
L	19.80	19.92	20.10
L1	3.90		4.30
M	0.70		1.30
P	2.40	2.50	2.60
T	9.80		10.20
U	6.00		6.40

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
12-Aug-2016	1	First release.
12-Dec-2016	2	Document status promoted from preliminary to production data. Minor text changes.
24-Aug-2017	3	Updated features and title in cover page. Updated *Table 4: "Static characteristics"*. Minor text changes.
08-Oct-2019	4	Updated *Table 4. Dynamic characteristics.* Updated *Figure 9. Forward bias safe operating area* and *Figure 14. Capacitance variations.* Minor text changes
16-Nov-2022	5	Updated Section 4.1 Max247 long leads package information. Minor text changes.