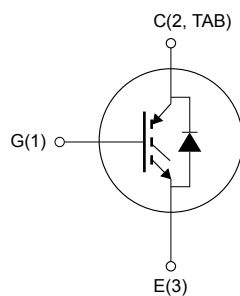
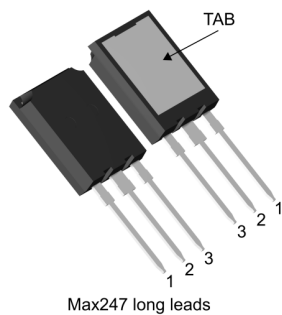


Automotive-grade trench gate field-stop, 650 V, 120 A, low-loss, M series IGBT in a Max247 long leads package



Features

- AEC-Q101 qualified 
- 6 μ s 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

- Motor control
- UPS
- PFC
- General purpose inverters

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

[STGYA120M65DF2AG](#)

Product summary

Order code	STGYA120M65DF2AG
Marking	G120M65DF2AG
Package	Max247 long leads
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0\text{ V}$)	650	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	160	A
I_C	Continuous collector current at $T_C = 100\text{ °C}$	120	
$I_{CP}^{(2)}$	Pulsed collector current	360	A
V_{GE}	Gate-emitter voltage	± 20	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25\text{ °C}$	160	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	120	
$I_{FP}^{(2)}$	Pulsed forward current	360	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ °C}$	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

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

Table 3. Static characteristics

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

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	11000	-	pF
C_{oes}	Output capacitance		-	610	-	
C_{res}	Reverse transfer capacitance		-	250	-	
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 120\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (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	$V_{CE} = 400\text{ V}$, $I_C = 120\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 4.7\ \Omega$ (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/ μ s
$t_{d(off)}$	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	$V_{CE} = 400\text{ V}$, $I_C = 120\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 4.7\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (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/ μ s
$t_{d(off)}$	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	$V_{CC} \leq 400\text{ V}$, $V_{GE} = 13\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	10		-	μ s
		$V_{CC} \leq 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	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	$I_F = 120\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 29. Test circuit for inductive load switching)	-	202	-	ns
Q_{rr}	Reverse recovery charge		-	2.9	-	μ C
I_{rrm}	Reverse recovery current		-	32.5	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	500	-	A/ μ s
E_{rr}	Reverse recovery energy		-	500	-	μ J
t_{rr}	Reverse recovery time	$I_F = 120\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29. Test circuit for inductive load switching)	-	320	-	ns
Q_{rr}	Reverse recovery charge		-	11.2	-	μ C
I_{rrm}	Reverse recovery current		-	62	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	270	-	A/ μ s
E_{rr}	Reverse recovery energy		-	1710	-	μ J

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

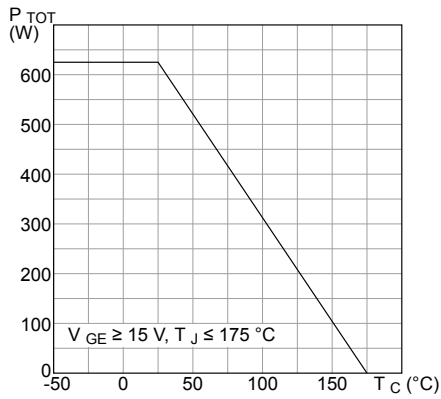


Figure 2. Collector current vs case temperature

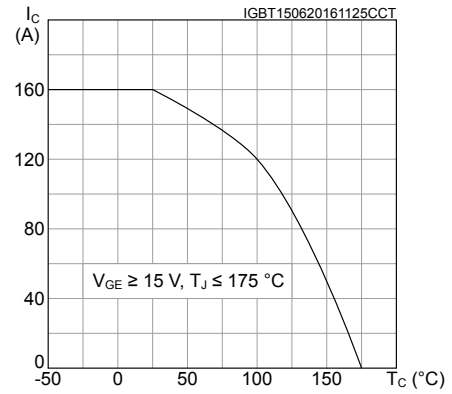


Figure 3. Output characteristics (T_J = 25 °C)

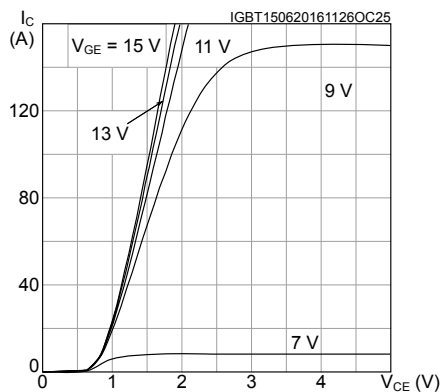


Figure 4. Output characteristics (T_J = 175 °C)

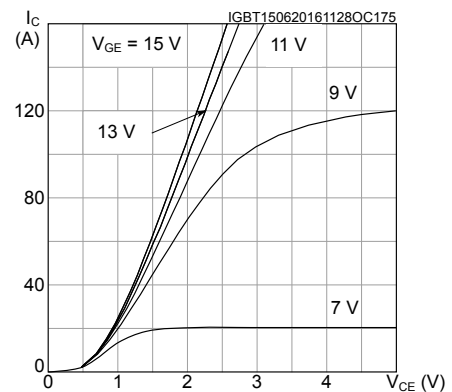


Figure 5. V_CE(sat) vs junction temperature

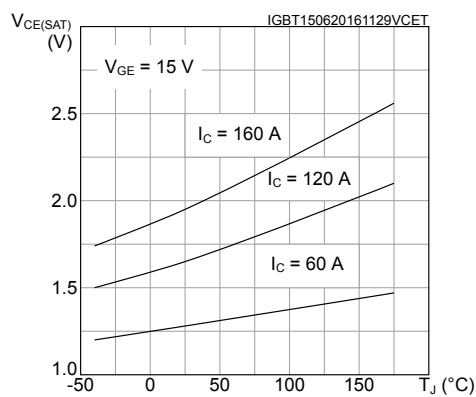


Figure 6. V_CE(sat) vs collector current

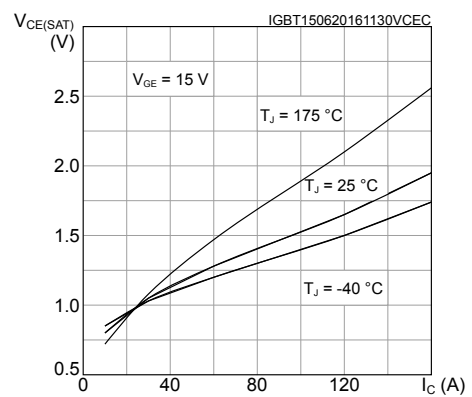


Figure 7. Collector current vs switching frequency

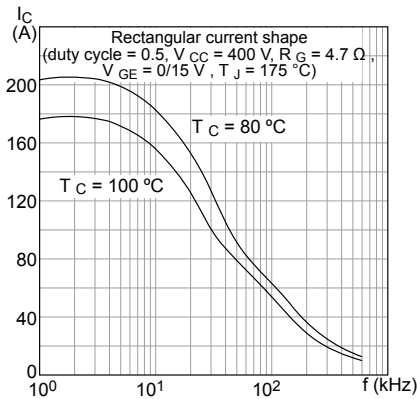


Figure 8. Forward bias safe operating area

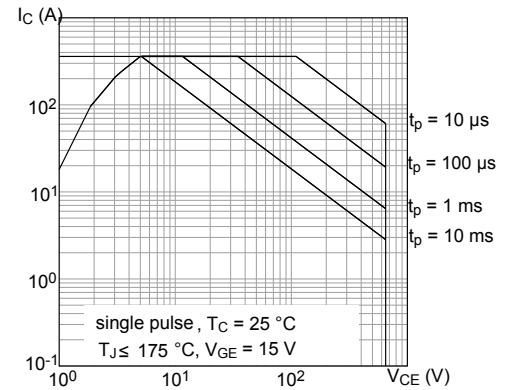


Figure 9. Transfer characteristics

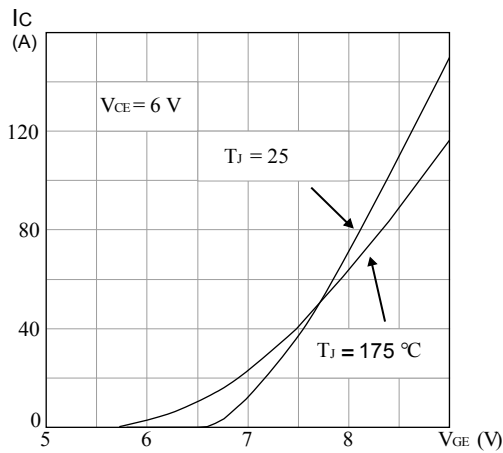


Figure 10. Diode VF vs forward current

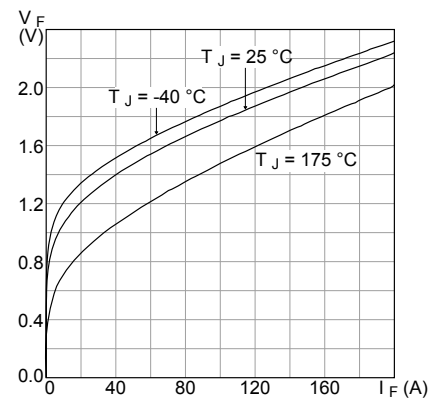


Figure 11. Normalized VGE(th) vs junction temperature

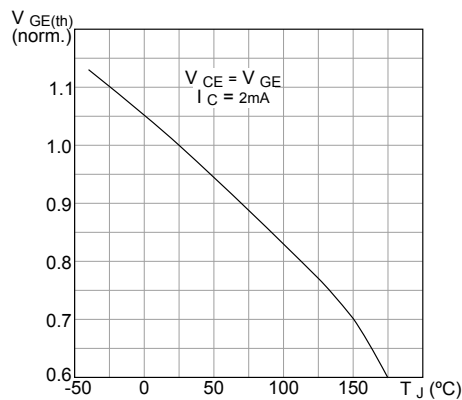


Figure 12. Normalized V(BR)CES vs junction temperature

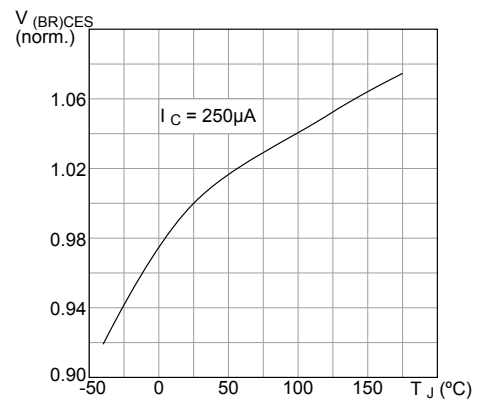


Figure 13. Capacitance variations

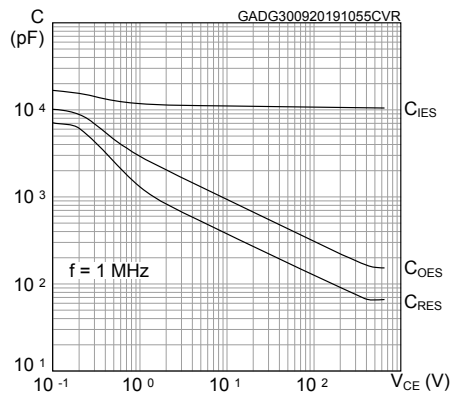


Figure 14. Gate charge vs gate-emitter voltage

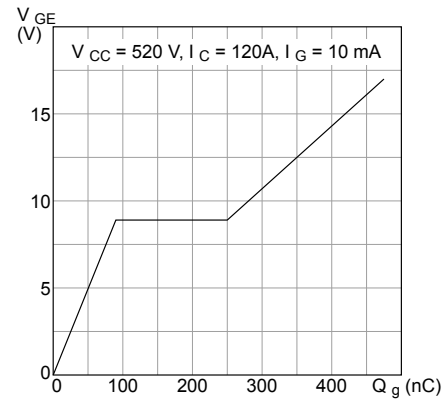


Figure 15. Switching energy vs collector current

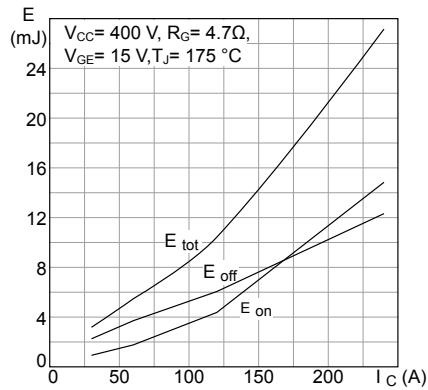


Figure 16. Switching energy vs gate resistance

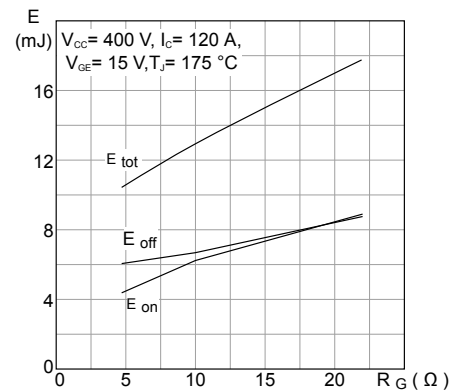


Figure 17. Switching energy vs temperature

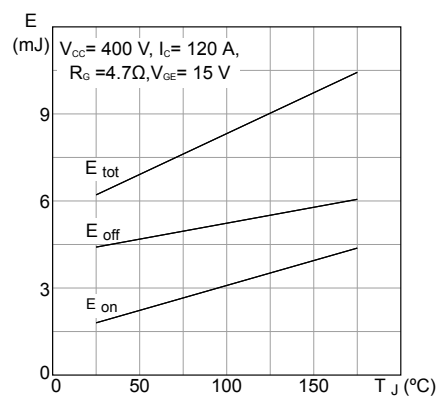


Figure 18. Switching energy vs collector emitter voltage

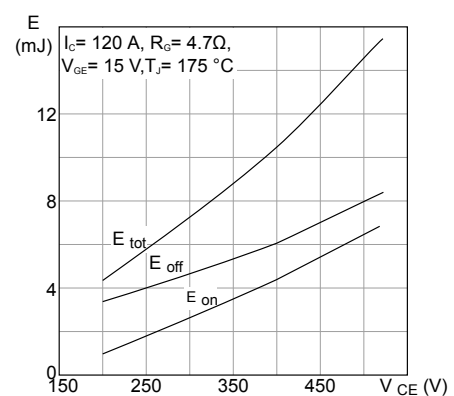


Figure 19. Short circuit time and current vs V_{GE}

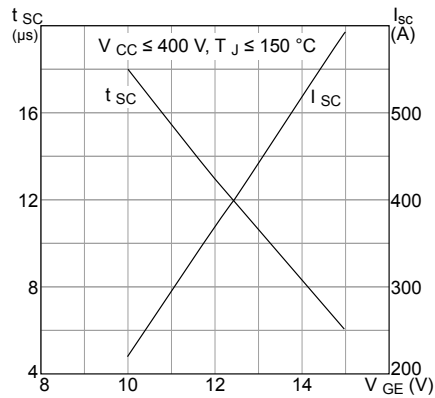


Figure 20. Switching times vs collector current

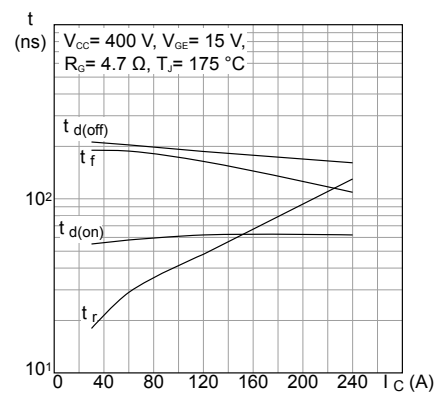


Figure 21. Switching times vs gate resistance

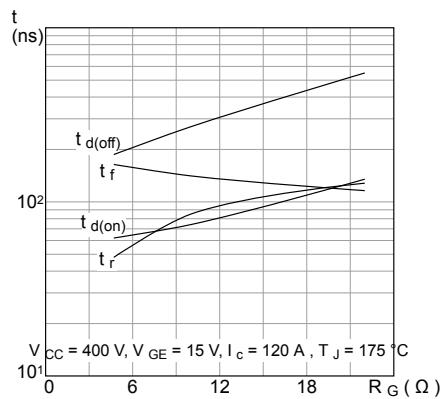


Figure 22. Reverse recovery current vs diode current slope

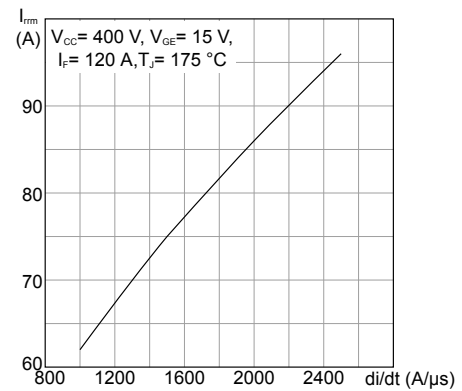


Figure 23. Reverse recovery time vs diode current slope

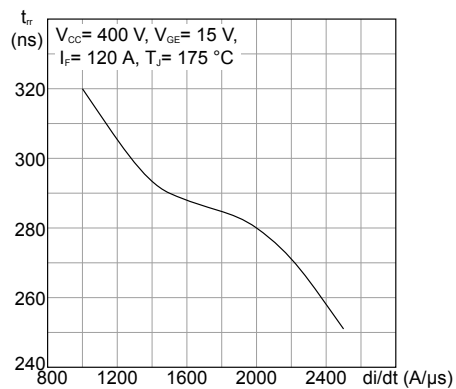


Figure 24. Reverse recovery charge vs diode current slope

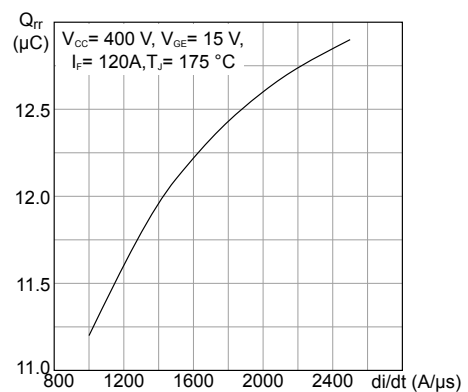


Figure 25. Reverse recovery energy vs diode current slope

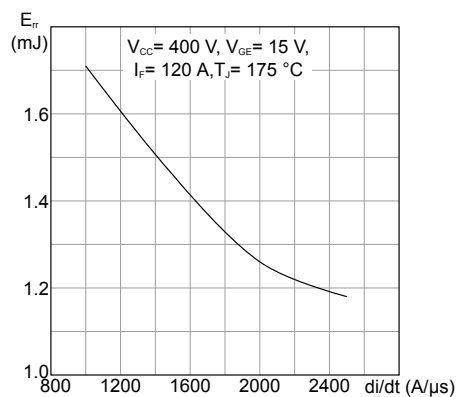


Figure 26. Thermal impedance for IGBT

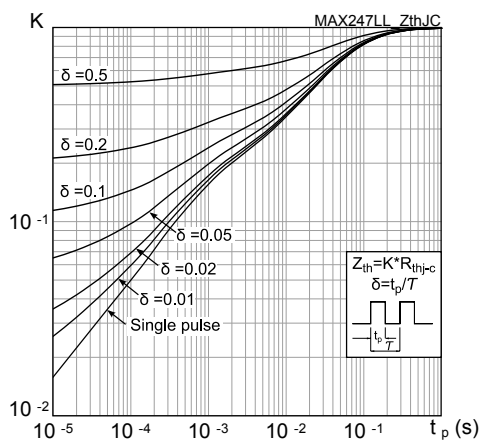
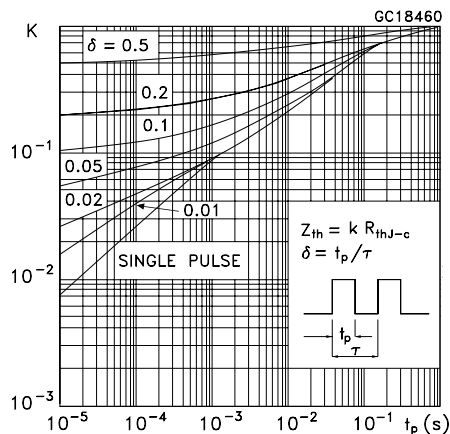
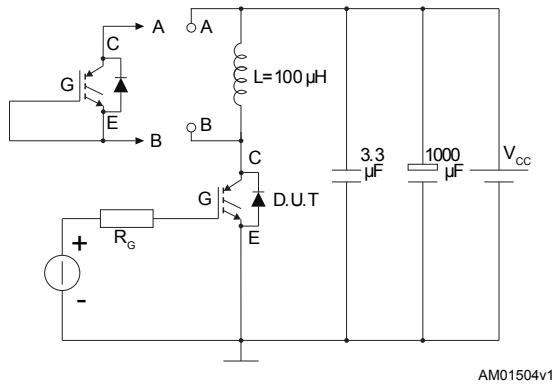
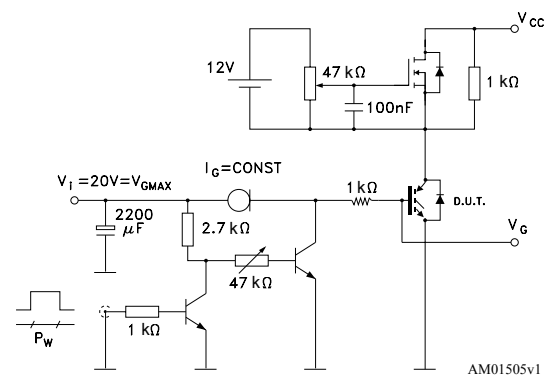
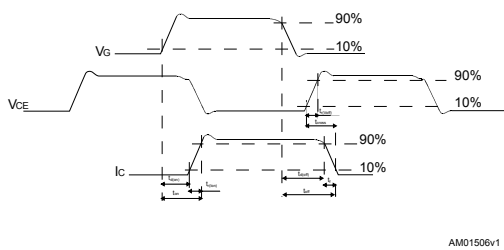
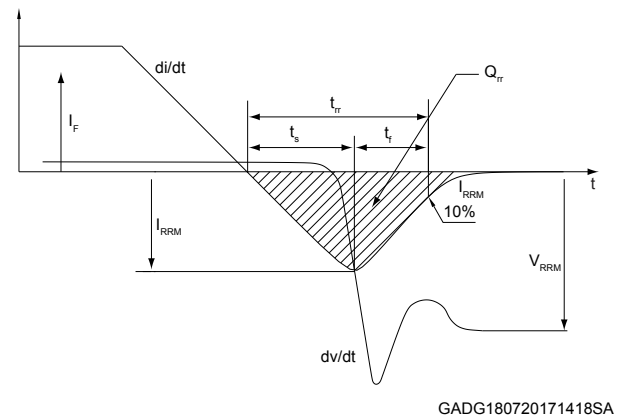


Figure 27. Thermal impedance for diode



3 Test circuits

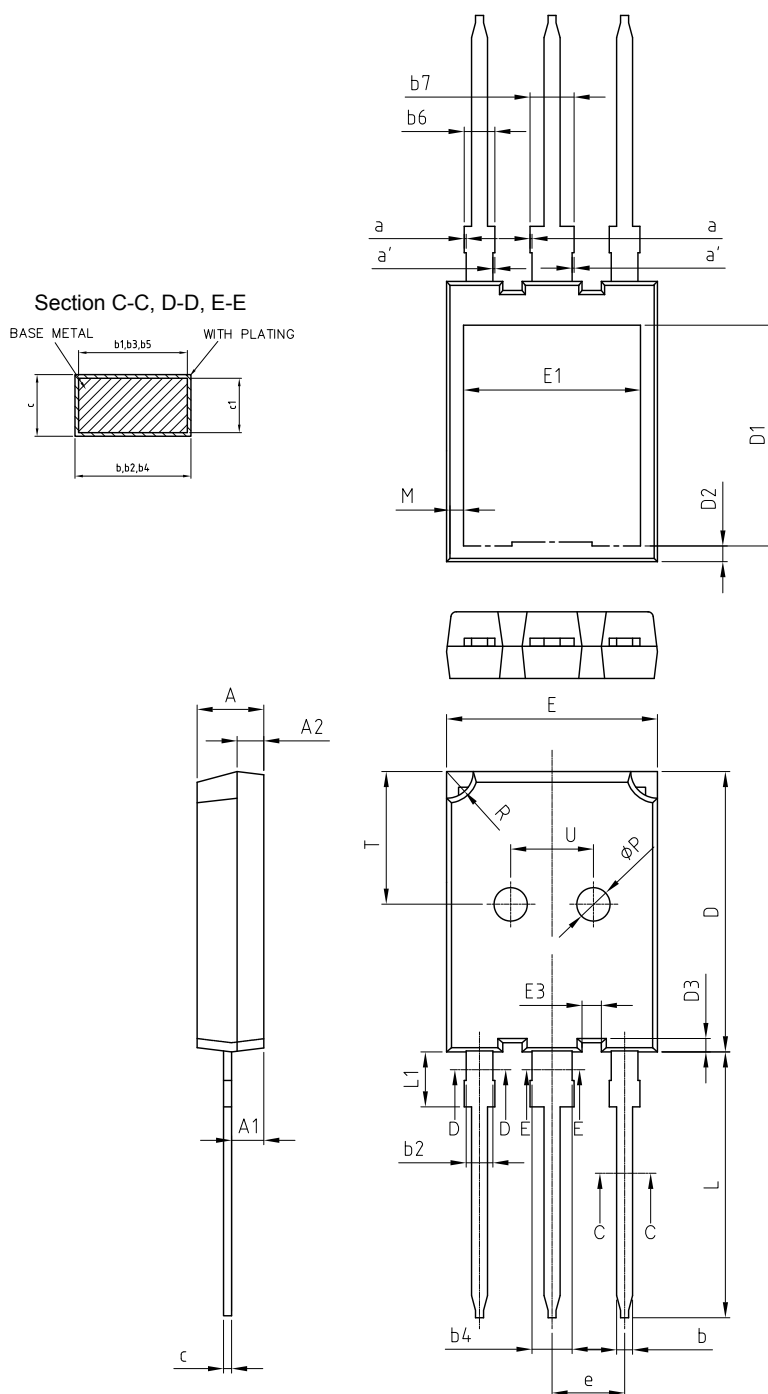
Figure 28. Test circuit for inductive load switching

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



DM00176969_rev_1

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	0.75	1.00	1.25
E	15.70	15.80	15.90
E1	13.10	13.26	13.50
E3	1.35	1.45	1.55
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
M	0.70		1.30
P	2.40	2.50	2.60
R	1.90	2.00	2.10
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 <i>Table 4: "Static characteristics"</i> . 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

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