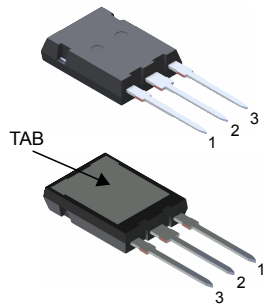
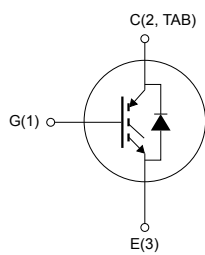


Automotive-grade trench gate field-stop, 650 V, 120 A, low-loss, M series IGBT in a Max247 long leads package



Max247 long leads



NG1E3C2T



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

- 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.

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
	Transient gate-emitter voltage ($t_p \leq 10\text{ }\mu\text{s}$, $D < 0.01$)	± 30	
$I_F^{(1)}$	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. Limited by bonding wires.

2. Pulse width limited by maximum junction temperature.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case IGBT	0.24	°C/W
R_{thJC}	Thermal resistance, junction-to-case diode	0.6	
R_{thJA}	Thermal resistance, junction-to-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	$V_{CC} = 520\text{ V}$, $I_C = 120\text{ A}$,	-	420	-	nC
Q_{ge}	Gate-emitter charge	$V_{GE} = 0\text{ to }15\text{ V}$	-	90	-	
Q_{gc}	Gate-collector charge	(see Figure 29. Gate charge test circuit)	-	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 28. 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 28. 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 28. 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/ μ s
E_{rr}	Reverse recovery energy		-	500	-	μJ
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 28. 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/ μ s
E_{rr}	Reverse recovery energy		-	1710	-	μJ

2.1 Electrical characteristics (curves)

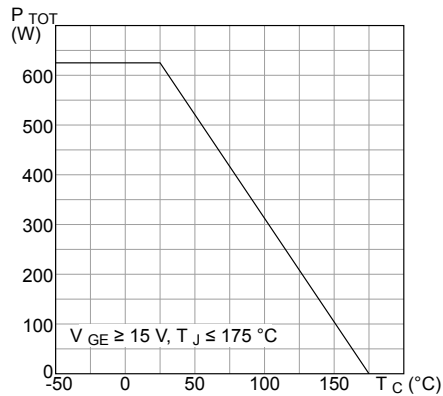
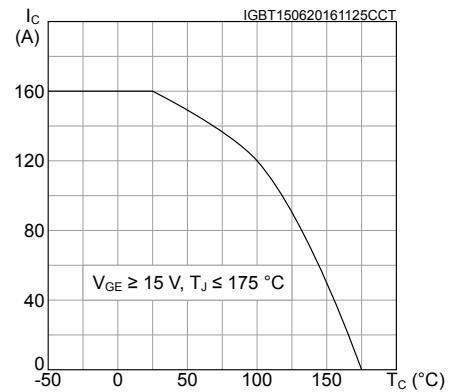
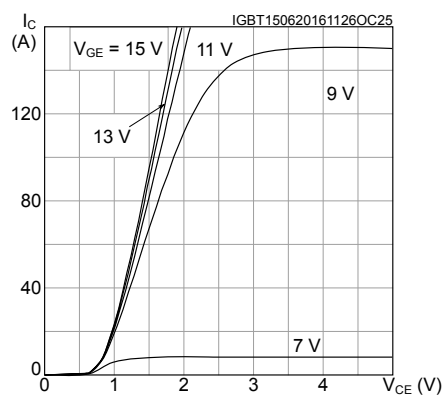
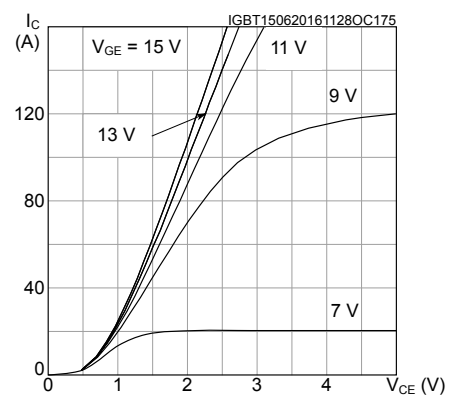
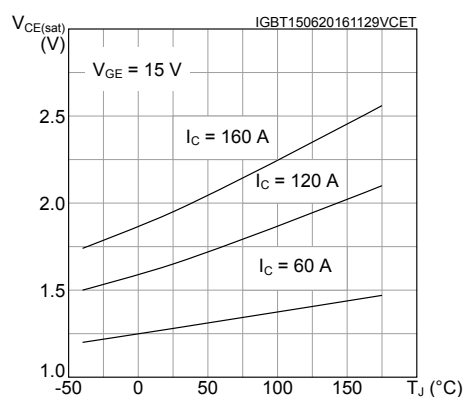
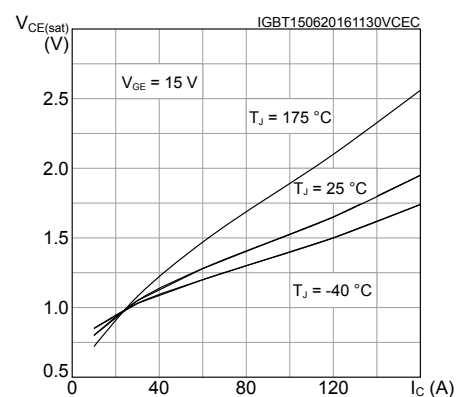
Figure 1. Power dissipation vs case temperature

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


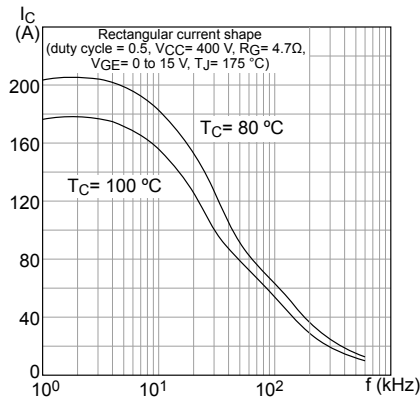
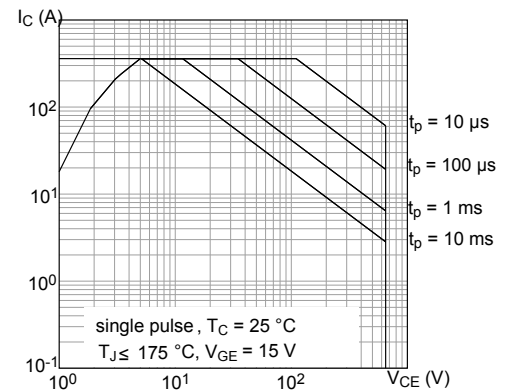
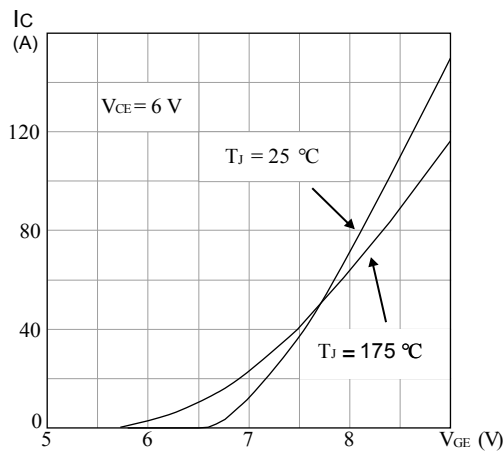
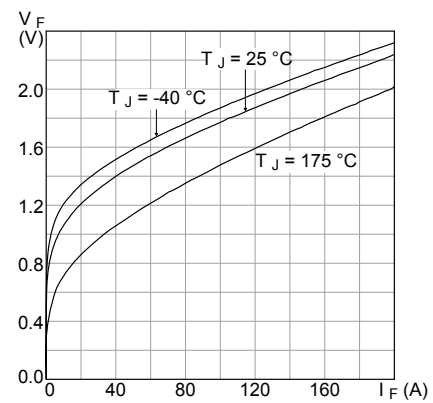
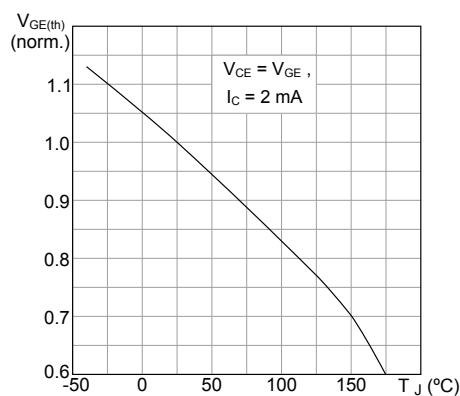
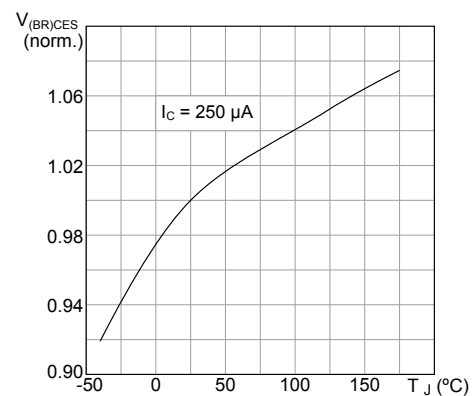
Figure 7. Collector current vs switching frequency

Figure 8. Forward bias safe operating area

Figure 9. Transfer characteristics

Figure 10. Diode VF vs forward current

Figure 11. Normalized VGE(th) vs junction temperature

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


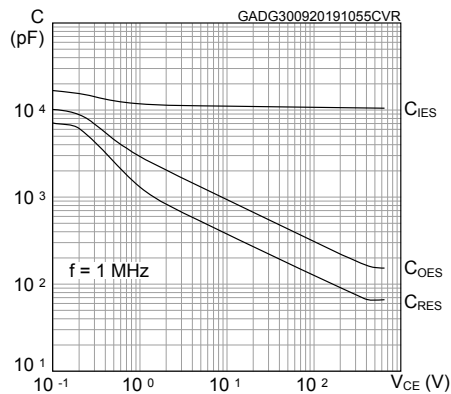
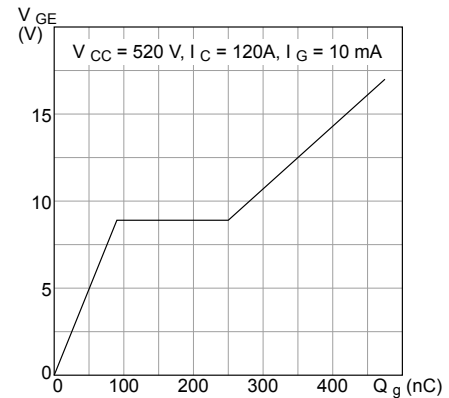
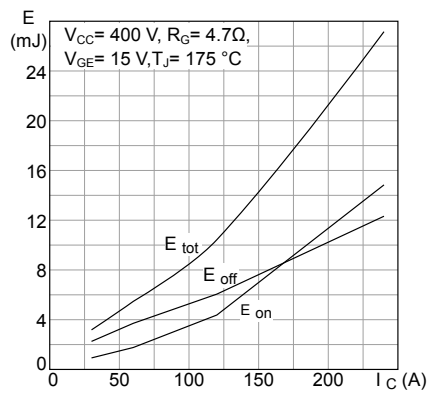
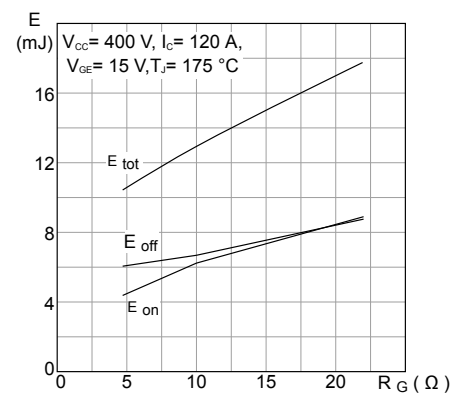
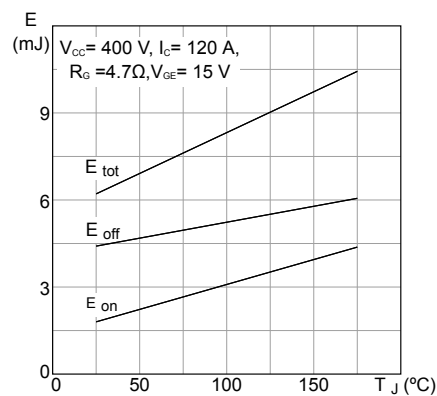
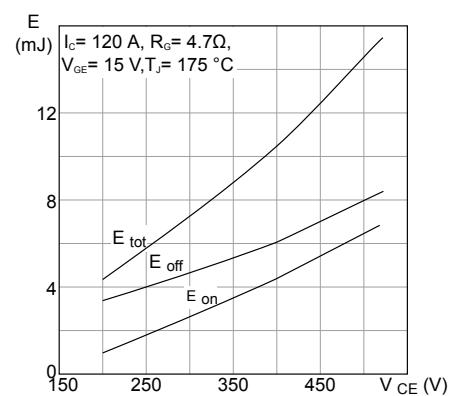
Figure 13. Capacitance variations

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


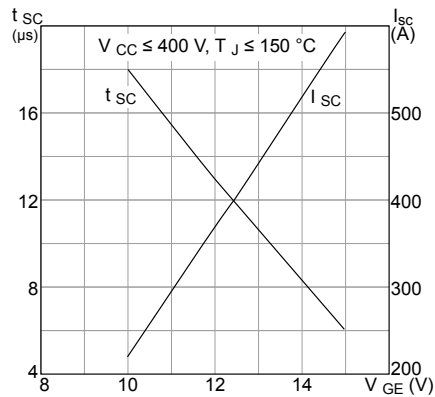
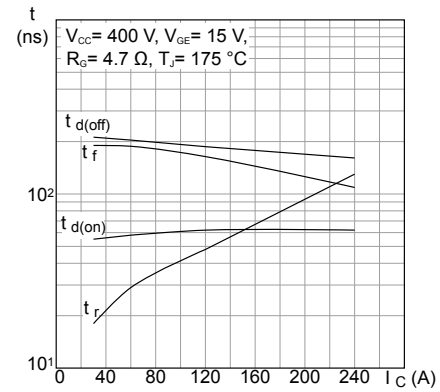
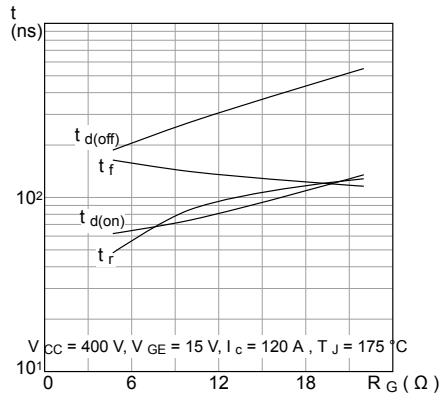
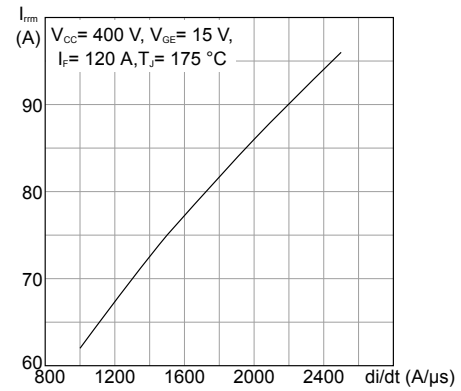
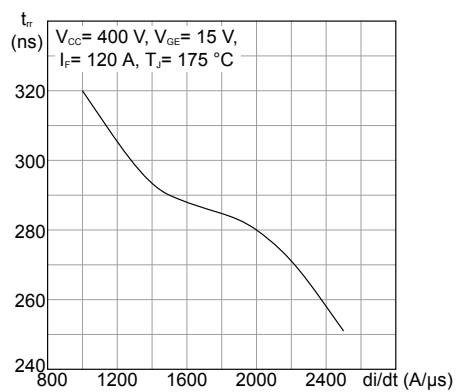
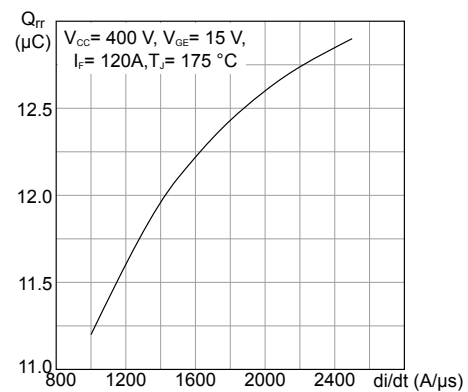
Figure 19. Short circuit time and current vs V_{GE}

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

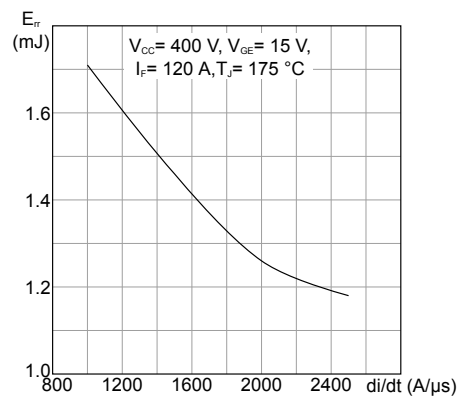


Figure 26. IGBT normalized transient thermal impedance

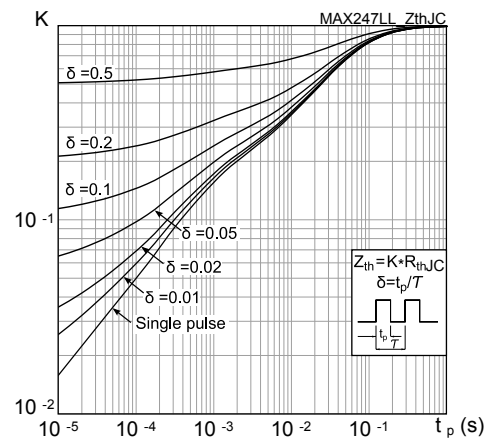
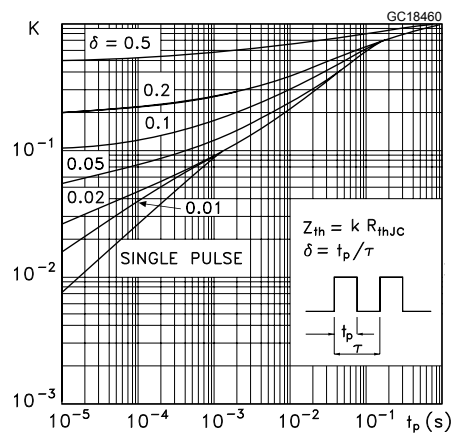
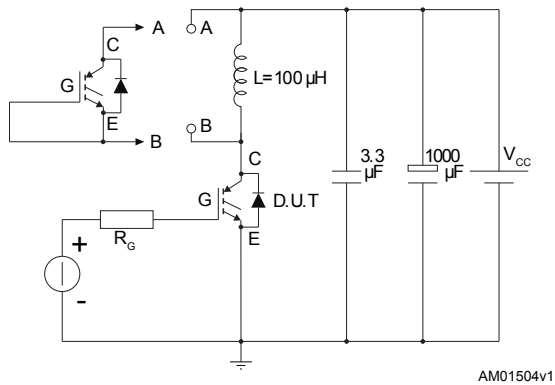
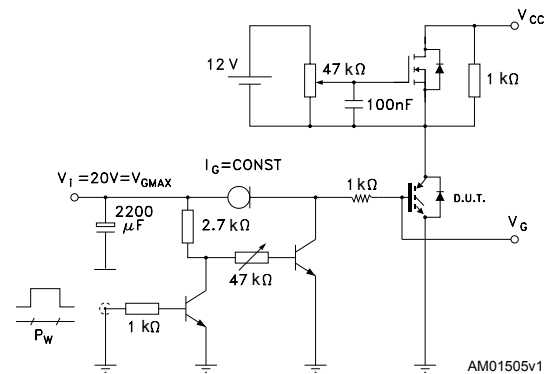
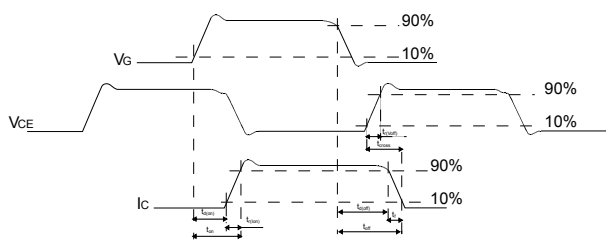


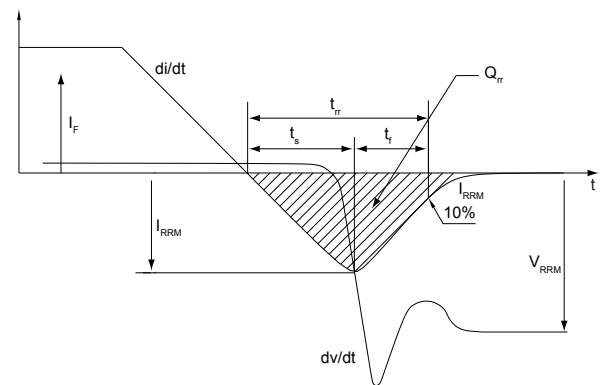
Figure 27. Diode normalized transient thermal impedance



3 Test circuits

Figure 28. Test circuit for inductive load switching

Figure 29. Gate charge test circuit

Figure 30. Switching waveform


AM01506v1

Figure 31. Diode reverse recovery waveform


GADG180720171418SA

4 Package information

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

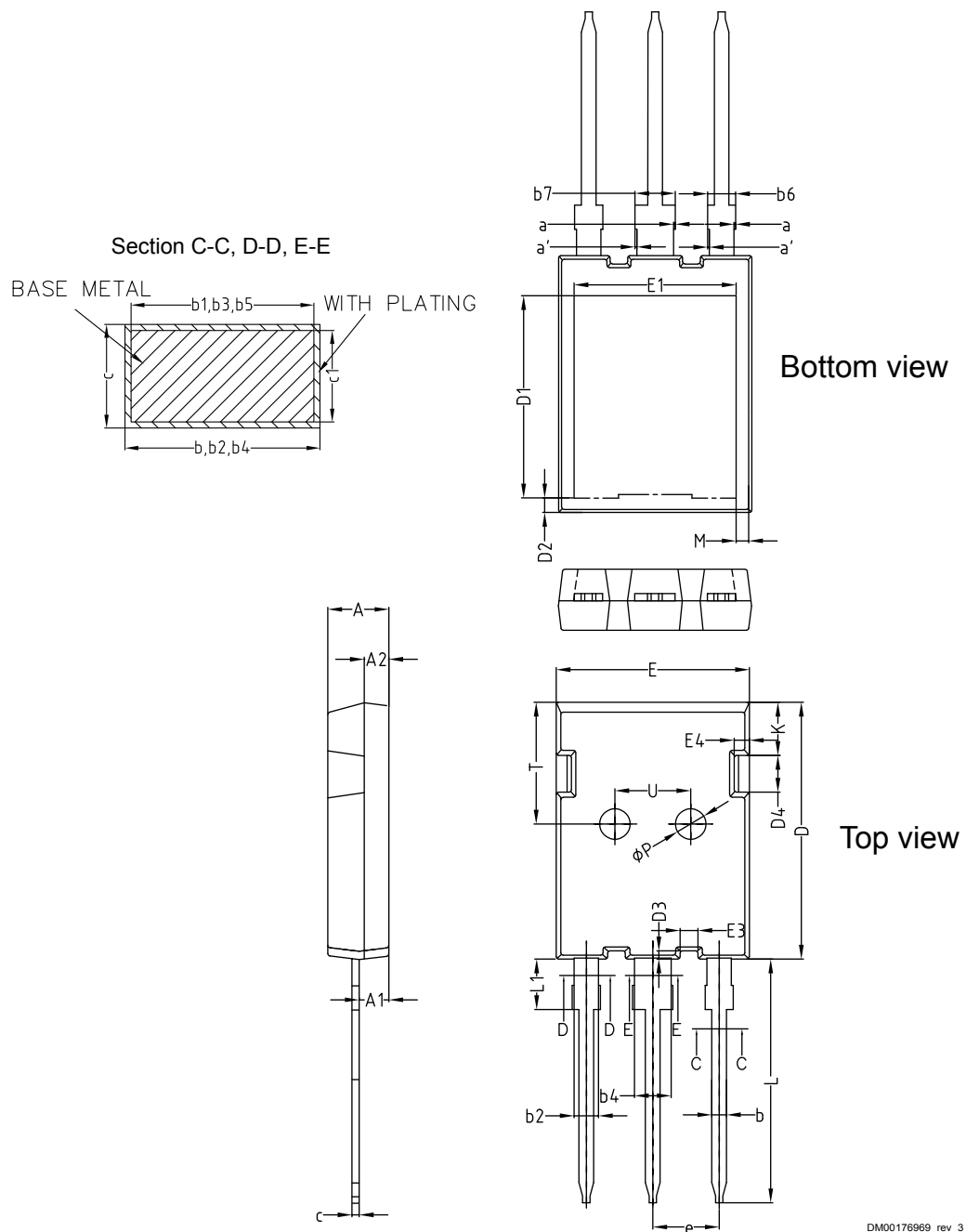


Table 7. Max247 long leads package mechanical data

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 <i>Table 4: "Static characteristics"</i> . Minor text changes.
08-Oct-2019	4	Updated <i>Table 4. Dynamic characteristics</i> . Updated <i>Figure 9. Forward bias safe operating area</i> and <i>Figure 14. Capacitance variations</i> . Minor text changes
16-Nov-2022	5	Updated Section 4.1: Max247 long leads package information . Minor text changes.
06-Mar-2025	6	Minor text changes in Table 1. Absolute maximum ratings and Table 2. Thermal data .

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