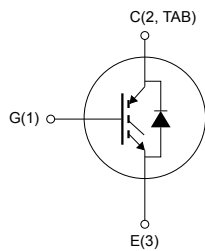
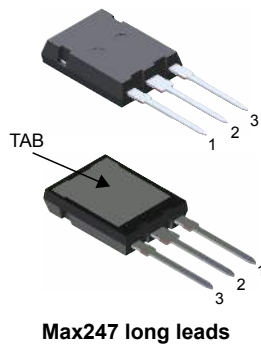


## Trench gate field-stop, 650 V, 120 A, low-loss M series IGBT in a Max247 long leads package



NG1E3C2T



### Features

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

### Applications

- Motor control
- UPS
- PFC
- General purpose inverter

### 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

[STGYA120M65DF2](#)

#### Product summary

<b>Order code</b>	STGYA120M65DF2
<b>Marking</b>	G120M65DF2
<b>Package</b>	Max247 long leads
<b>Packing</b>	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
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	160	A
	Continuous collector current at $T_C = 100\text{ °C}$	120	
$I_{CP}^{(1)}$	Pulsed collector current	360	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current at $T_C = 25\text{ °C}$	160	A
	Continuous forward current at $T_C = 100\text{ °C}$	120	
$I_{FP}^{(1)}$	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	°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	0.24	°C/W
	Thermal resistance, junction-to-case diode	0.6	
$R_{thJA}$	Thermal resistance, junction-to-ambient	50	°C/W

## 2 Electrical characteristics

$T_J = 25\text{ °C}$  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	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$			$\pm 250$	nA

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	11	-	nF
$C_{oes}$	Output capacitance		-	0.61	-	nF
$C_{res}$	Reverse transfer capacitance		-	0.25	-	nF
$Q_g$	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	-	nC
$Q_{gc}$	Gate-collector charge		-	160	-	nC

**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/ $\mu\text{s}$
$t_{d(off)}$	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/ $\mu\text{s}$
$t_{d(off)}$	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	$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 13\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	10		-	$\mu\text{s}$
		$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	6		-	

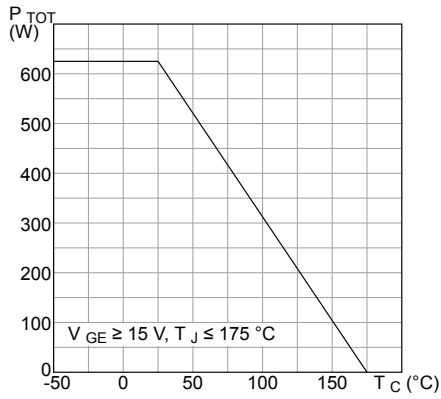
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 6. Diode switching characteristics (inductive load)**

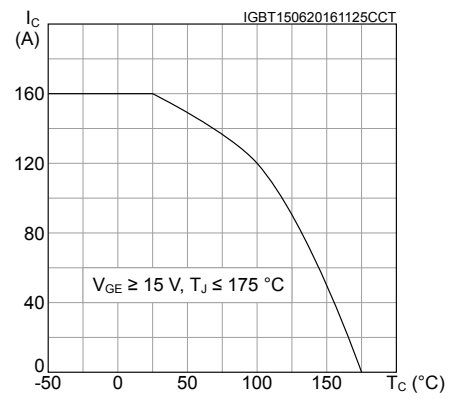
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{rr}$	Reverse recovery time	$I_F = 120\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 29. Test circuit for inductive load switching)	-	202	-	ns	
$Q_{rr}$	Reverse recovery charge			-	2.9	-	$\mu\text{C}$
$I_{rrm}$	Reverse recovery current			-	32.5	-	A
$dI_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$			-	500	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy			-	500	-	$\mu\text{J}$
$t_{rr}$	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	-	$\mu\text{C}$
$I_{rrm}$	Reverse recovery current			-	62	-	A
$dI_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$			-	270	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy			-	1710	-	$\mu\text{J}$

## 2.1 Electrical characteristics (curves)

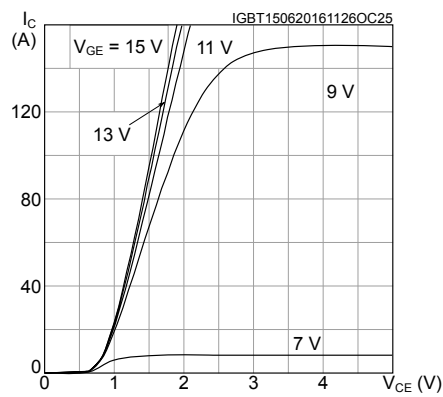
**Figure 1. Total power dissipation vs temperature**



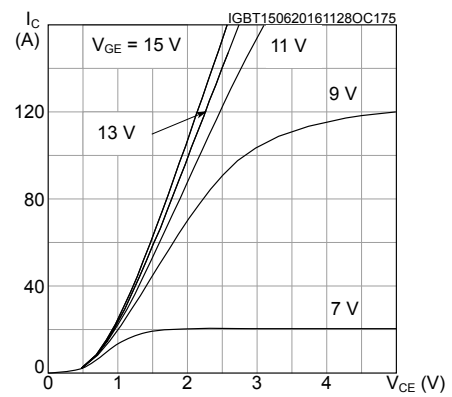
**Figure 2. Collector current vs temperature**



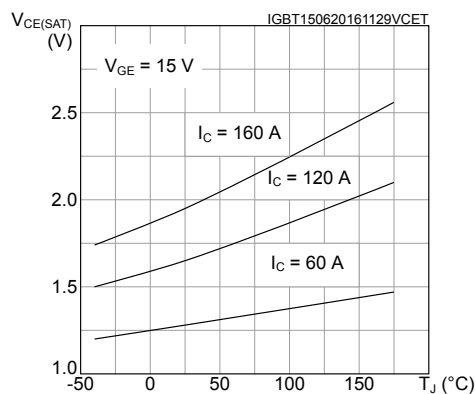
**Figure 3. Typical output characteristics (T<sub>J</sub> = 25 °C)**



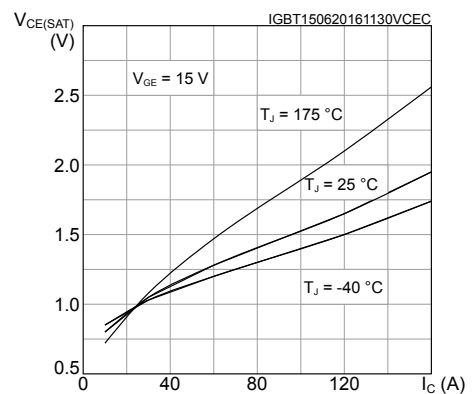
**Figure 4. Typical output characteristics (T<sub>J</sub> = 175 °C)**



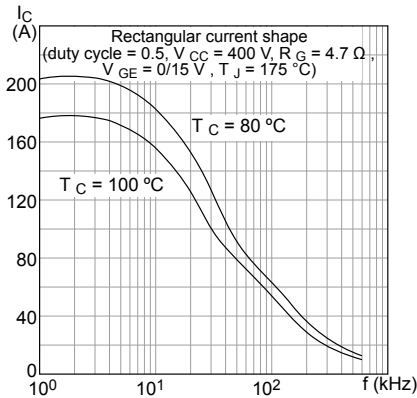
**Figure 5. Typical V<sub>CE(sat)</sub> vs temperature**



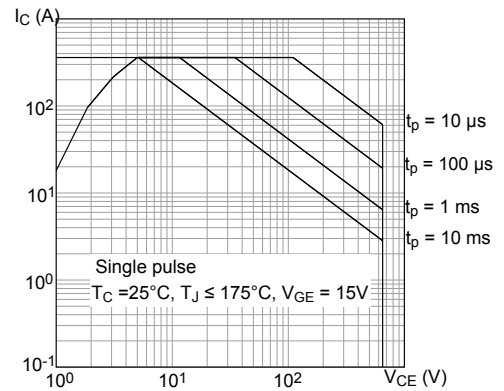
**Figure 6. Typical V<sub>CE(sat)</sub> vs collector current**



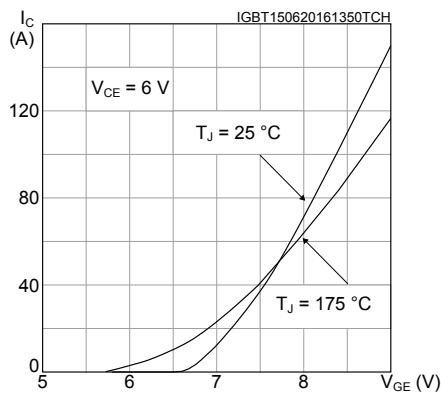
**Figure 7. Collector current vs switching frequency**



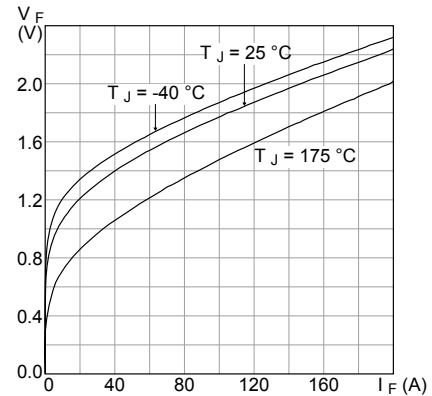
**Figure 8. Forward bias safe operating area**



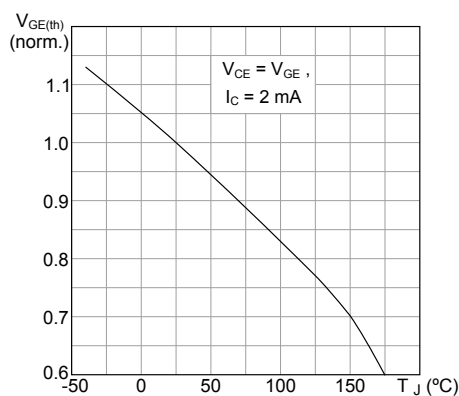
**Figure 9. Typical transfer characteristics**



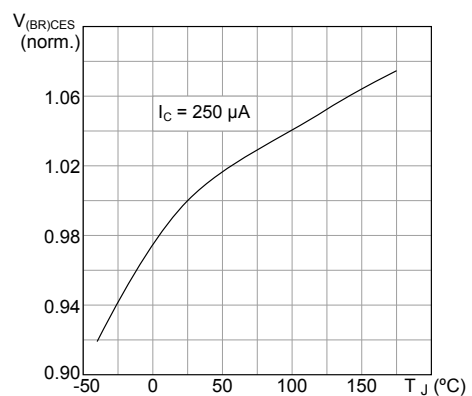
**Figure 10. Typical diode Vf vs forward current**



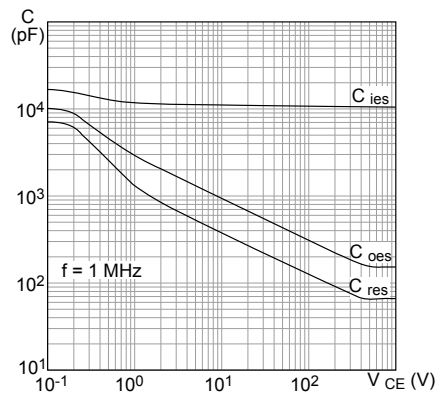
**Figure 11. Normalized VGE(th) vs temperature**



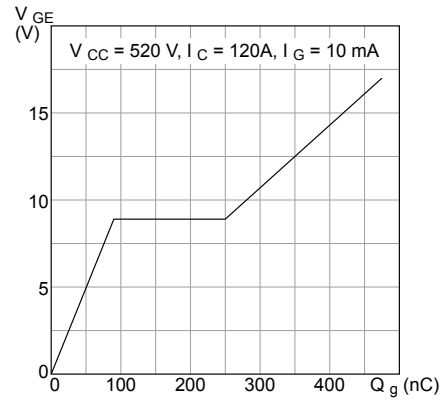
**Figure 12. Normalized V(BR)CES vs temperature**



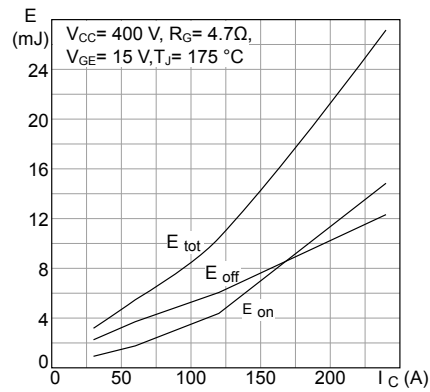
**Figure 13. Typical capacitance characteristics**



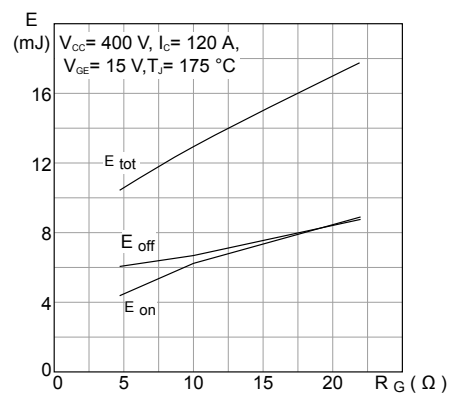
**Figure 14. Typical gate charge characteristics**



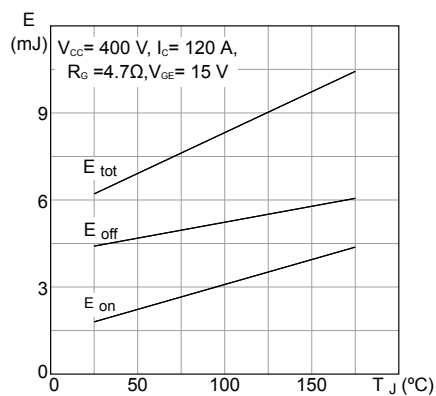
**Figure 15. Typical switching energy vs collector current**



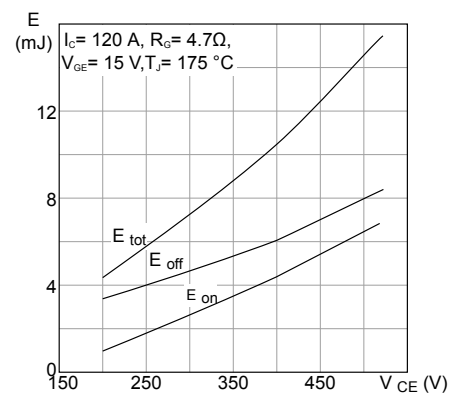
**Figure 16. Typical switching energy vs R\_G**



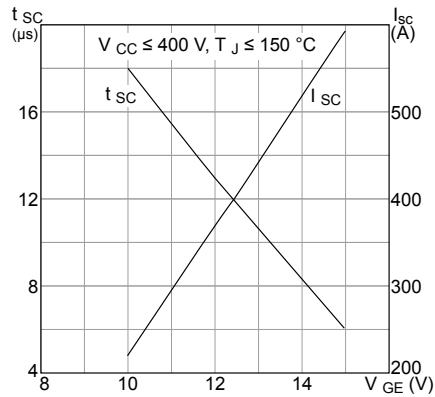
**Figure 17. Typical switching energy vs temperature**



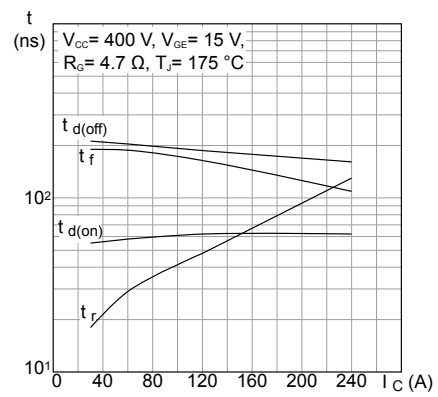
**Figure 18. Typical switching energy vs collector emitter voltage**



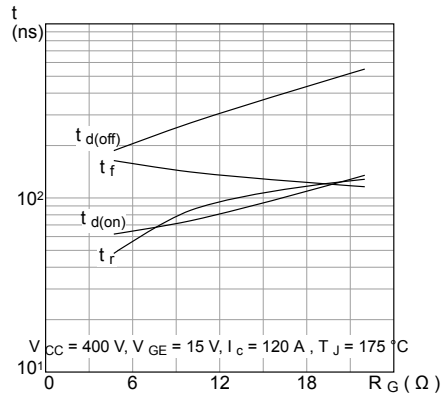
**Figure 19. Short circuit time and current vs.  $V_{GE}$**



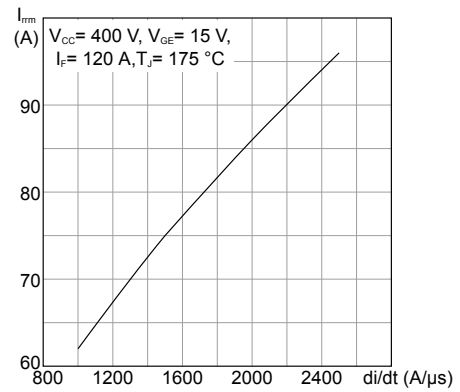
**Figure 20. Typical switching times vs collector current**



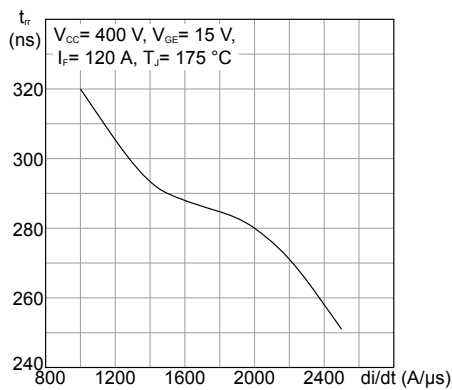
**Figure 21. Typical switching times vs gate resistance**



**Figure 22. Typical reverse recovery current vs diode current slope**



**Figure 23. Typical reverse recovery time vs. diode current slope**



**Figure 24. Typical reverse recovery charge vs diode current slope**

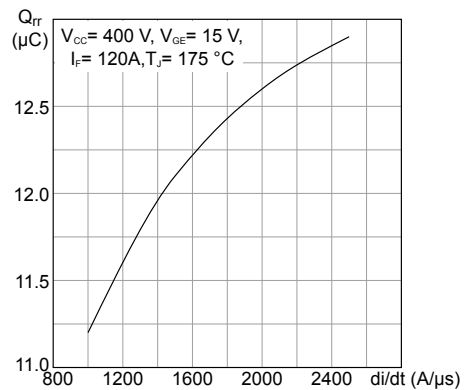




Figure 25. Typical reverse recovery energy vs diode current slope

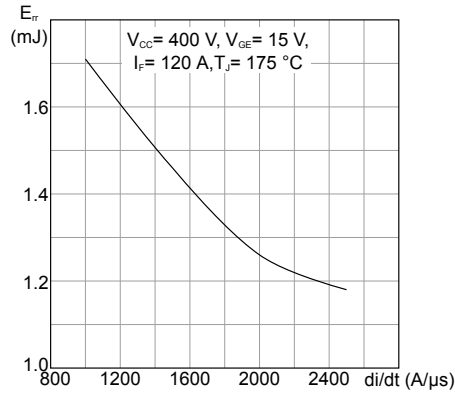


Figure 26. Normalized transient thermal impedance for IGBT

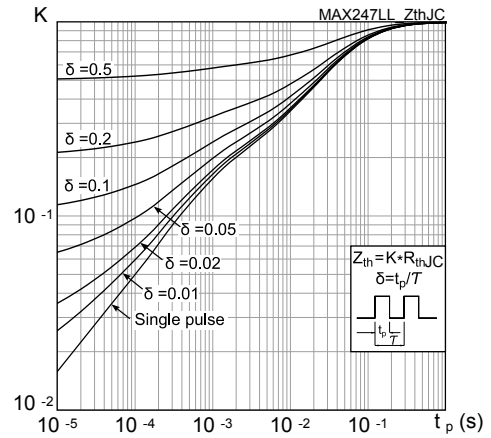
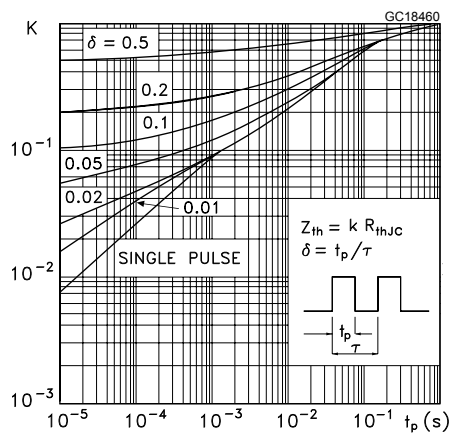
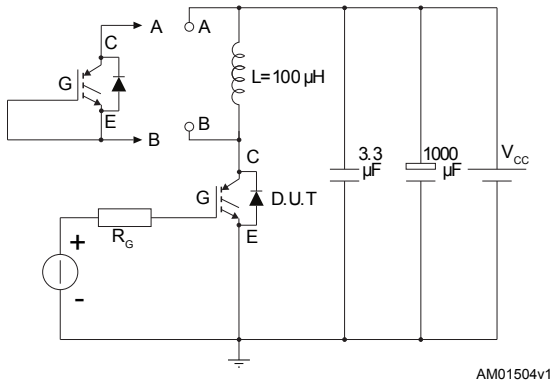
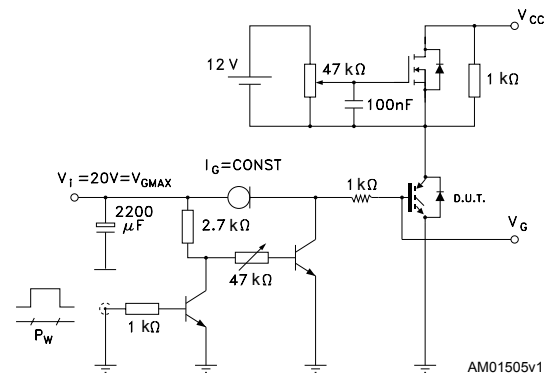
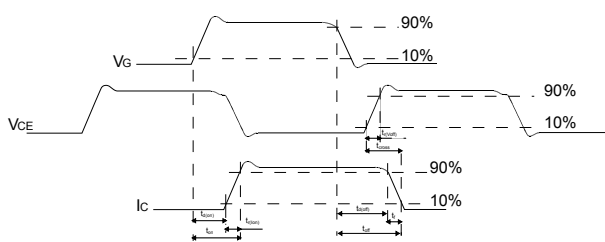
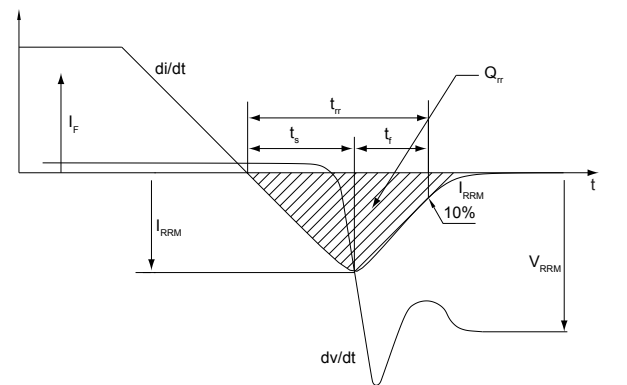


Figure 27. Normalized transient thermal impedance for diode



### 3 Test circuits

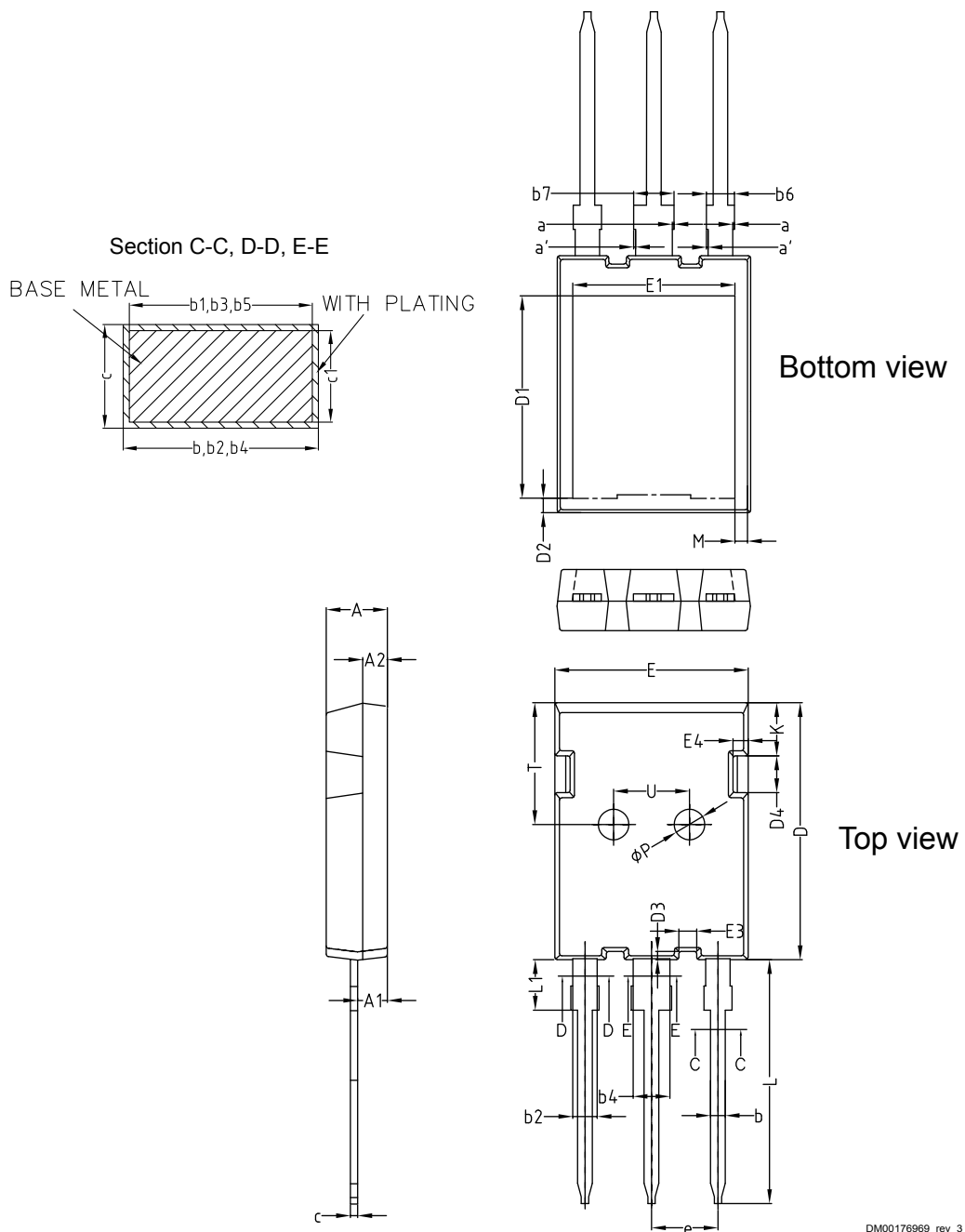
**Figure 28. Test circuit for inductive load switching**

**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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 Max247 long leads package information

Figure 32. Max247 long leads package outline



DM00176969\_rev\_3

**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
06-Apr-2016	1	First release.
10-May-2016	2	Document status promoted to production data. Added Section 2.1: "Electrical characteristics (curves)"
15-Jun-2016	3	Updated Figure 1: "Internal schematic diagram" and Table 2: "Absolute maximum ratings". Updated Section 2.1: "Electrical characteristics (curves)". Minor text changes.
12-Aug-2016	4	Updated Table 7: "Diode switching characteristics (inductive load)" and Figure 25: "Reverse recovery charge vs. diode current slope". Minor text changes.
13-Sep-2017	5	Updated title, features and application in cover page. Updated Figure 13: "Normalized $V(BR)_{CES}$ vs. junction temperature". Minor text changes.
07-Feb-2023	6	Updated Section 4.1 Max247 long leads package information. Minor text changes.

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## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>2</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>3</b>
<b>2.1</b>	<b>Electrical characteristics (curves)</b> .....	<b>5</b>
<b>3</b>	<b>Test circuits</b> .....	<b>10</b>
<b>4</b>	<b>Package information</b> .....	<b>11</b>
<b>4.1</b>	<b>Max247 long leads package information</b> .....	<b>11</b>
	<b>Revision history</b> .....	<b>13</b>

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