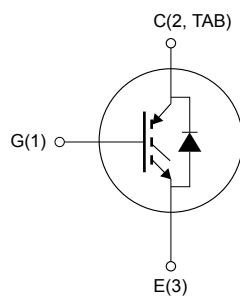
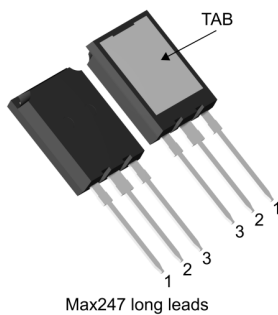


## Automotive-grade trench gate field-stop, 650 V, 120 A, low-loss, M series IGBT in a Max247 long leads package




### Product status link

[STGYA120M65DF2AG](#)

### Product summary

<b>Order code</b>	STGYA120M65DF2AG
<b>Marking</b>	G120M65DF2AG
<b>Package</b>	Max247 long leads
<b>Packing</b>	Tube

## Features

- AEC-Q101 qualified 
- 6  $\mu$ 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.

# 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

$T_C = 25\text{ °C}$  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	$V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$			$\pm 250$	$\mu\text{A}$

**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/ $\mu$ 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/ $\mu$ 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		-	$\mu$ 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.

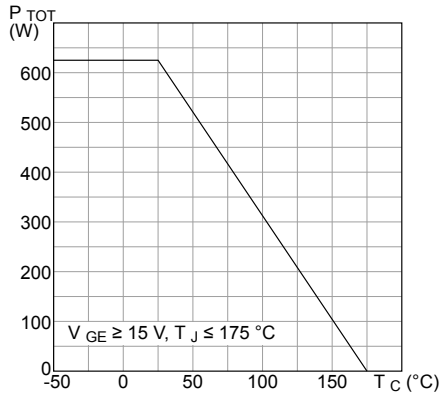
2. Including the tail of the collector current.

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

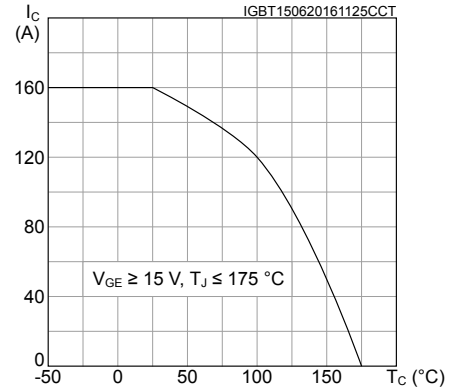
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{rr}$	Reverse recovery time	$I_F = 120\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 29. Test circuit for inductive load switching)	-	202	-	ns	
$Q_{rr}$	Reverse recovery charge			-	2.9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

## 2.1 Electrical characteristics (curves)

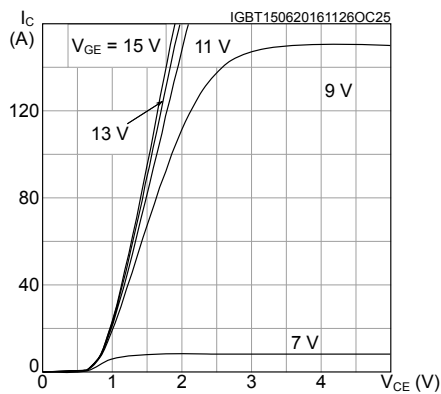
**Figure 1. Power dissipation vs case temperature**



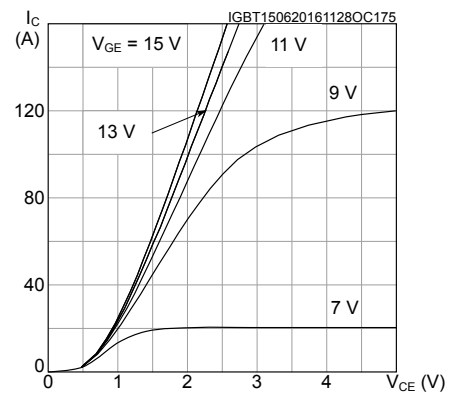
**Figure 2. Collector current vs case temperature**



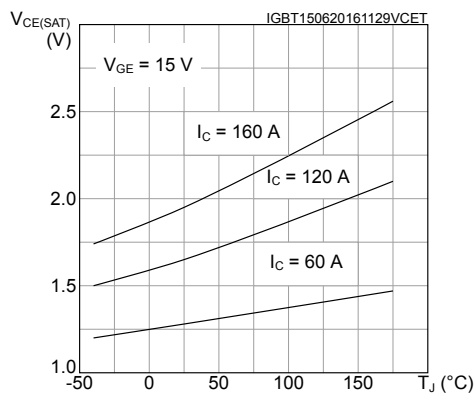
**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**



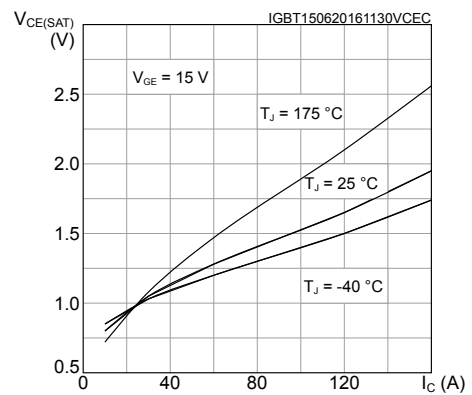
**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**



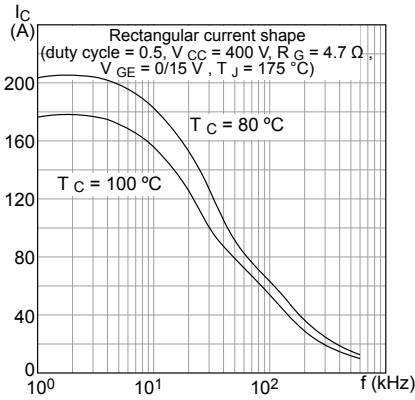
**Figure 5. V<sub>CE(sat)</sub> vs junction temperature**



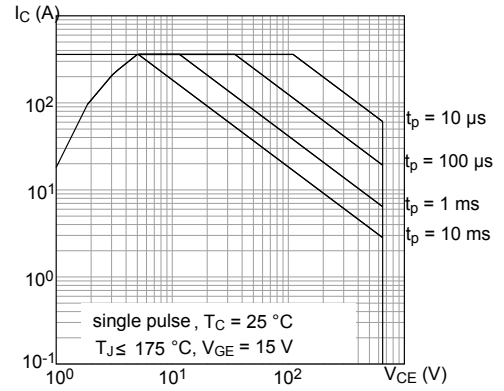
**Figure 6. V<sub>CE(sat)</sub> vs collector current**



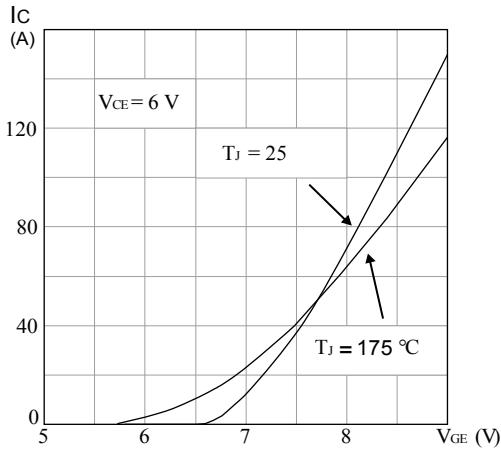
**Figure 7. Collector current vs switching frequency**



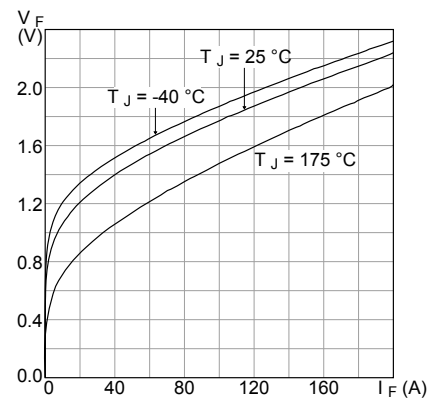
**Figure 8. Forward bias safe operating area**



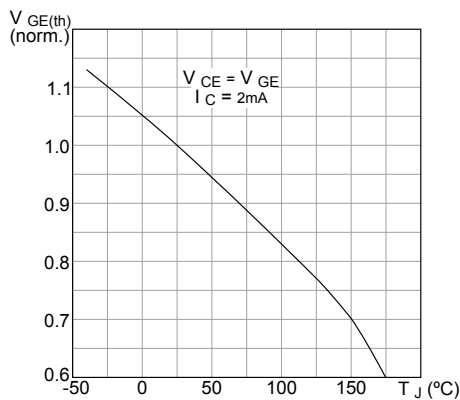
**Figure 9. Transfer characteristics**



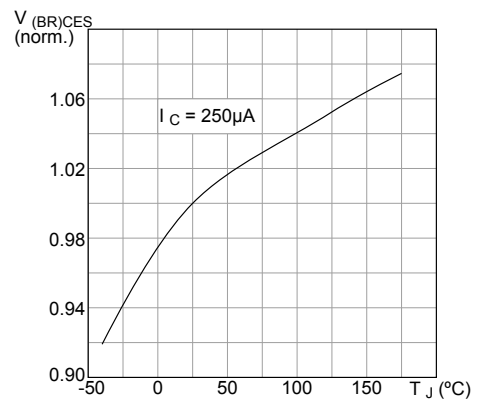
**Figure 10. Diode VF vs forward current**



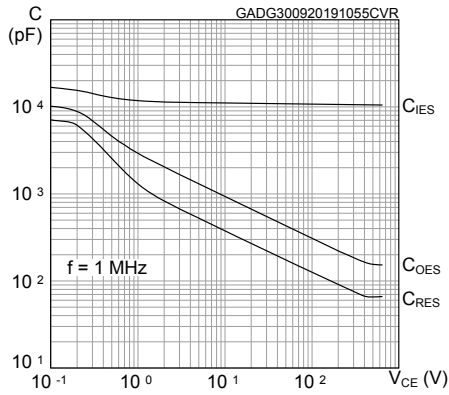
**Figure 11. Normalized VGE(th) vs junction temperature**



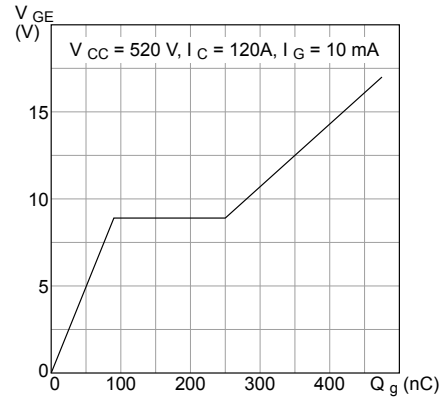
**Figure 12. Normalized V(BR)CES vs junction temperature**



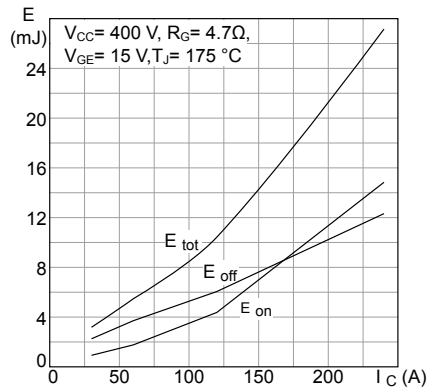
**Figure 13. Capacitance variations**



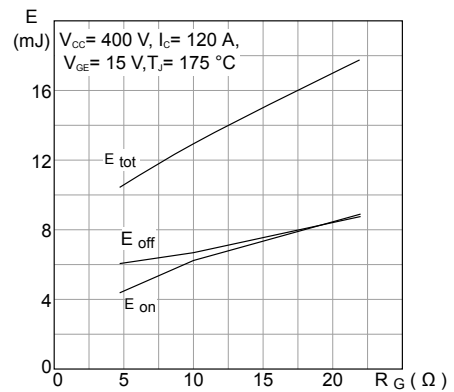
**Figure 14. Gate charge vs gate-emitter voltage**



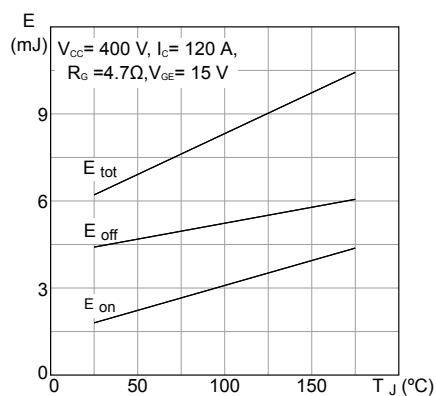
**Figure 15. Switching energy vs collector current**



**Figure 16. Switching energy vs gate resistance**



**Figure 17. Switching energy vs temperature**



**Figure 18. Switching energy vs collector emitter voltage**

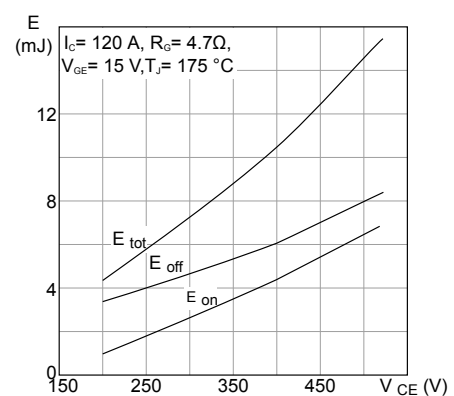


Figure 19. Short circuit time and current vs  $V_{GE}$

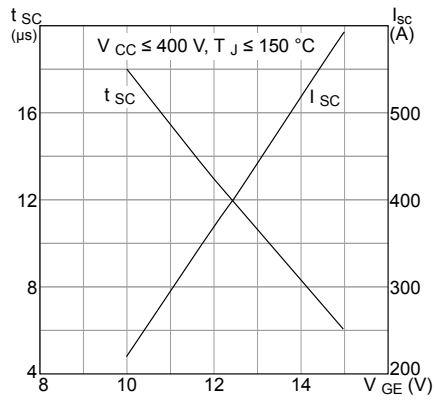


Figure 20. Switching times vs collector current

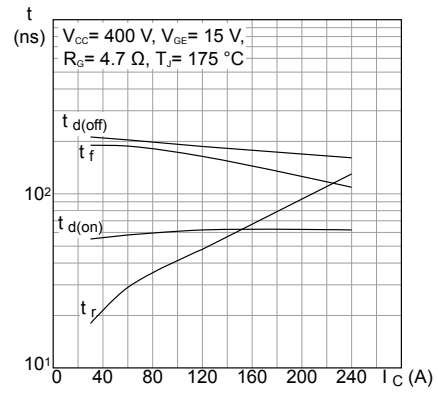


Figure 21. Switching times vs gate resistance

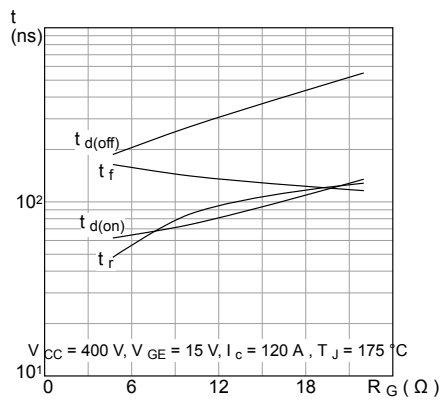


Figure 22. Reverse recovery current vs diode current slope

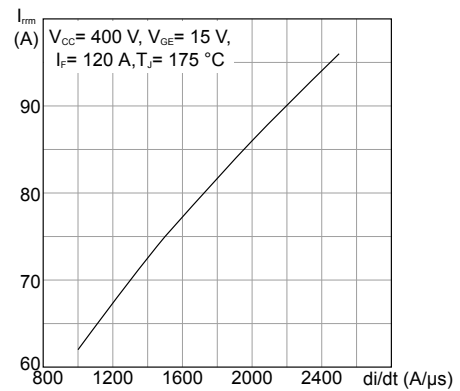


Figure 23. Reverse recovery time vs diode current slope

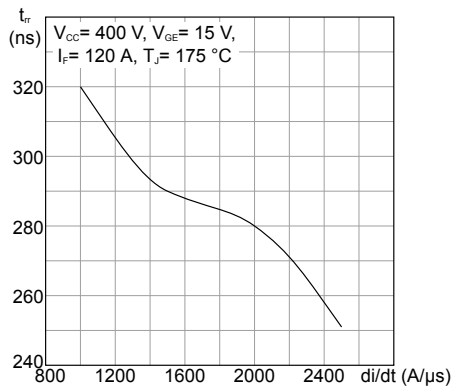


Figure 24. Reverse recovery charge vs diode current slope

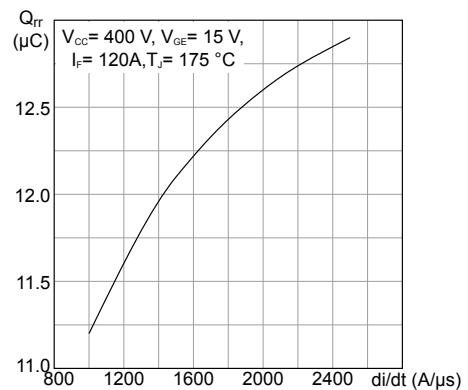


Figure 25. Reverse recovery energy vs diode current slope

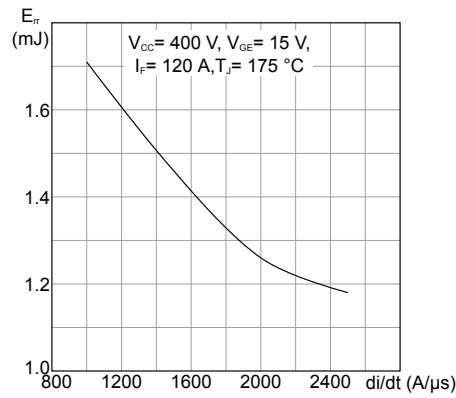


Figure 26. Thermal impedance for IGBT

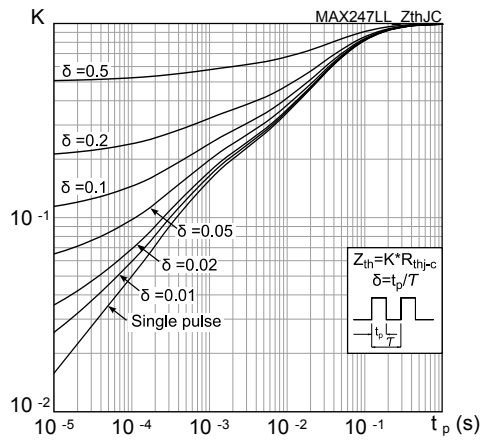
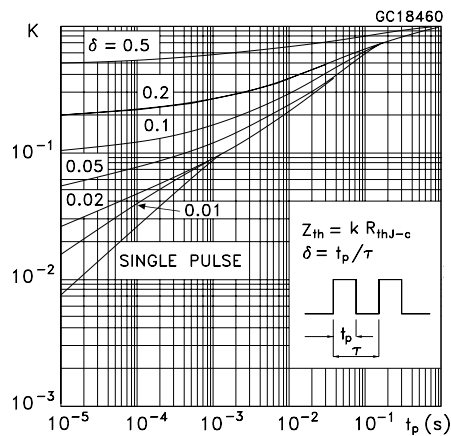


Figure 27. Thermal impedance for diode



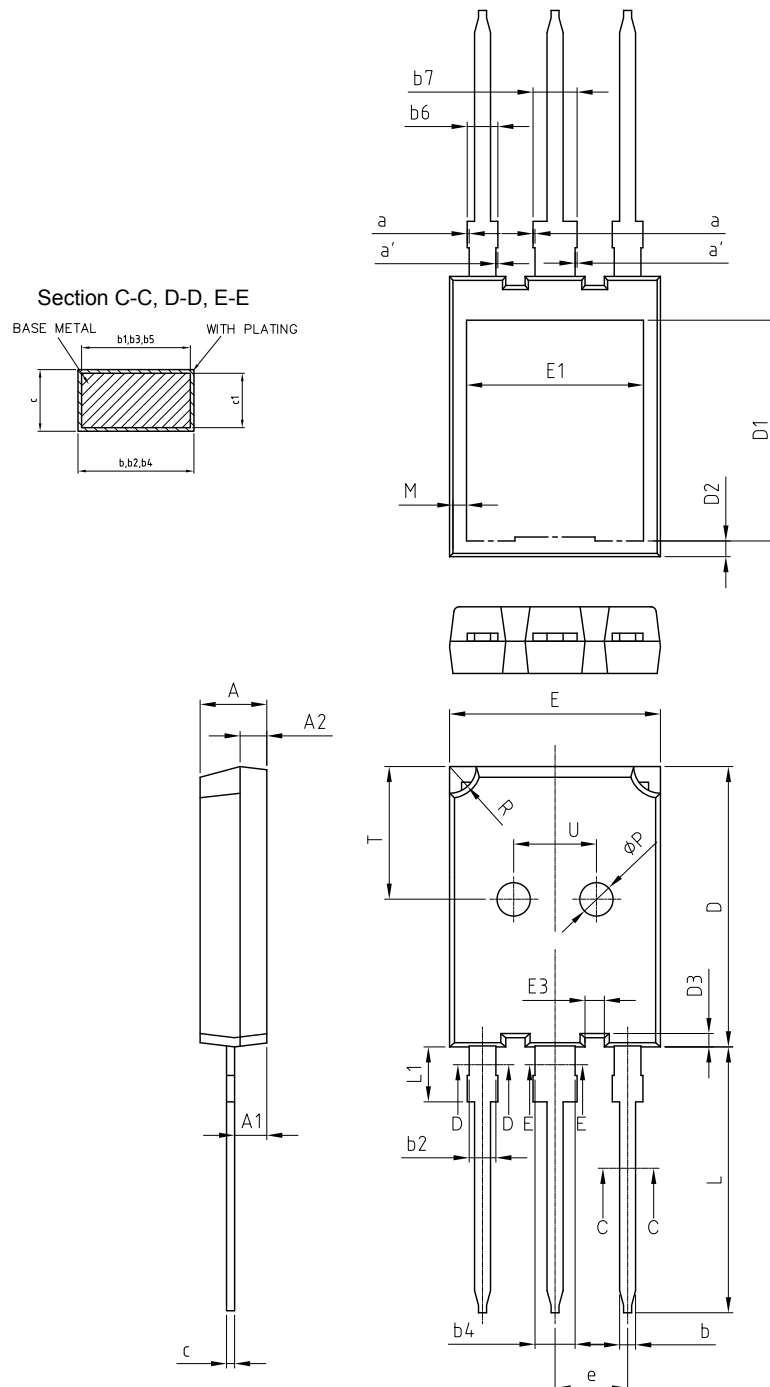


## 4 Package information

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\_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 <a href="#">Table 4. Dynamic characteristics</a> . Updated <a href="#">Figure 9. Forward bias safe operating area</a> and <a href="#">Figure 14. Capacitance variations</a> . Minor text changes

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