

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

Datasheet - production data

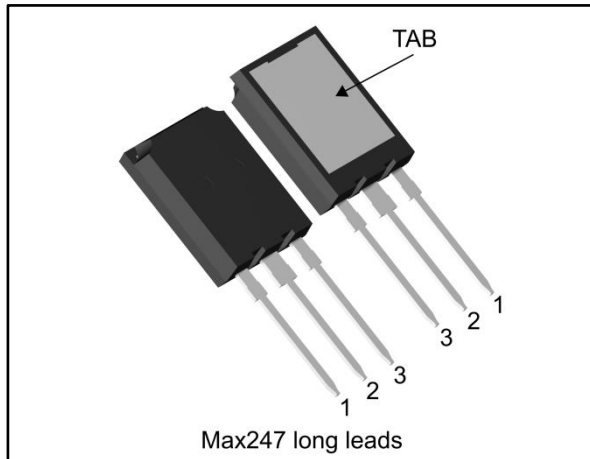
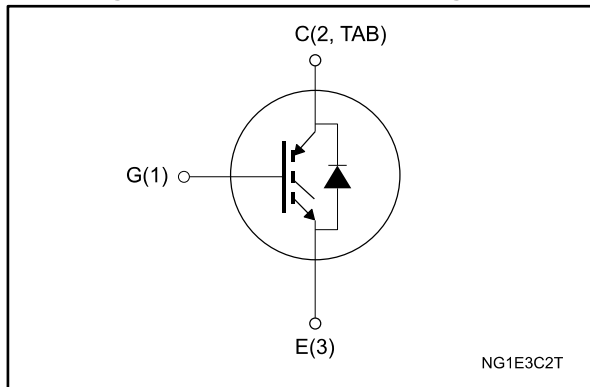


Figure 1: Internal schematic diagram



### Features

- 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 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 low-loss and short-circuit functionality are essential. Furthermore, the positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGYA120M65DF2	G120M65DF2	Max247 long leads	Tube

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# 1 Electrical ratings

**Table 2: 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	$\pm 20$	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 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	

**Notes:**

(1)Current level is limited by bond wires.

(2)Pulse width limited by maximum junction temperature.

**Table 3: 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 4: 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 5: 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	-	
$C_{res}$	Reverse transfer capacitance		-	0.25	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 120\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see <a href="#">Figure 30: "Gate charge test circuit"</a> )	-	420	-	nC
$Q_{ge}$	Gate-emitter charge		-	90	-	
$Q_{gc}$	Gate-collector charge		-	160	-	

Table 6: 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 <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )		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 <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )		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		-	

**Notes:**

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

Table 7: 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 <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	202	-	ns
$Q_{rr}$	Reverse recovery charge		-	2.9	-	$\mu$ C
$I_{rrm}$	Reverse recovery current		-	32.5	-	A
$dl_{rr}/dt$	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 <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	320	-	ns
$Q_{rr}$	Reverse recovery charge		-	11.2	-	$\mu$ C
$I_{rrm}$	Reverse recovery current		-	62	-	A
$dl_{rr}/dt$	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)

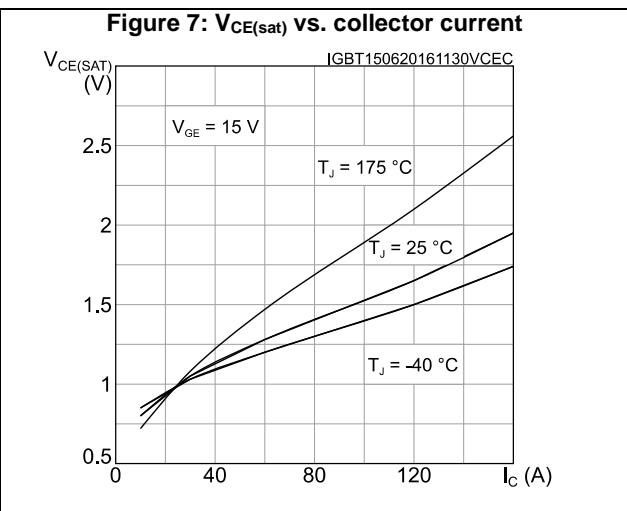
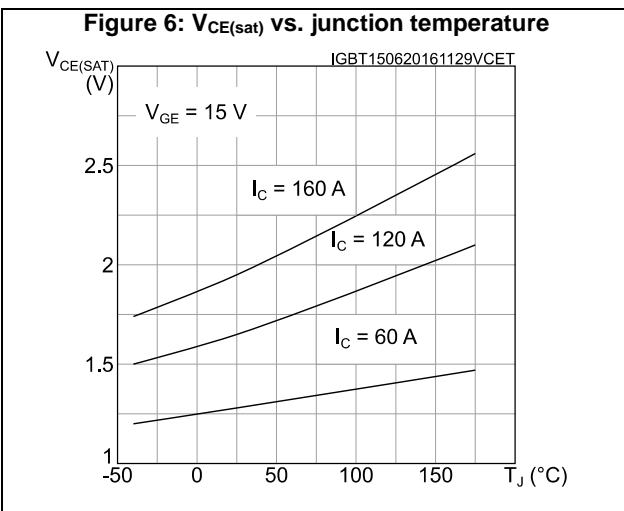
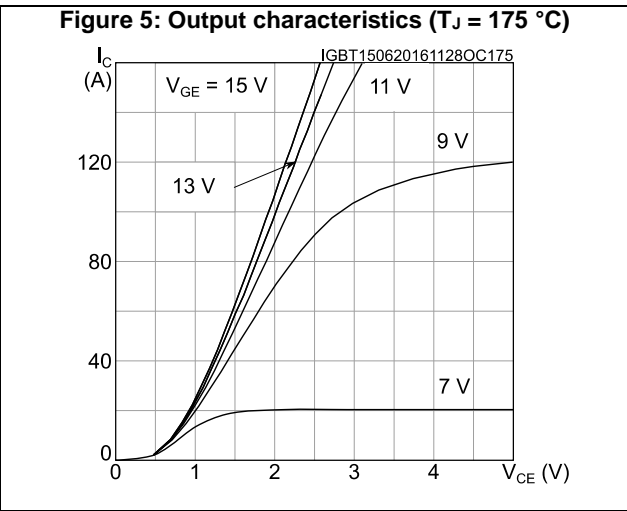
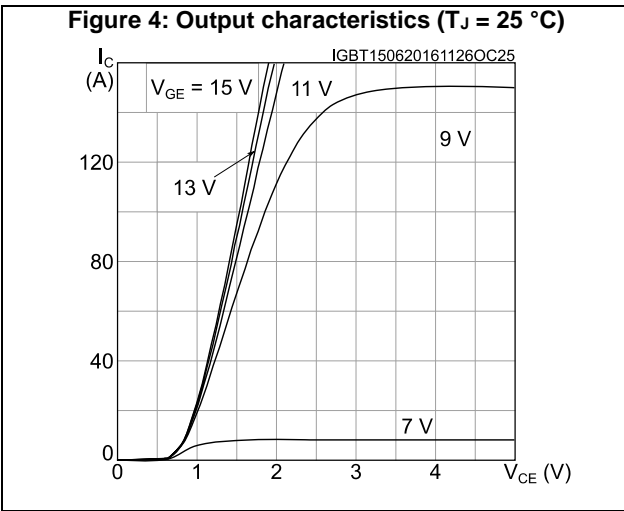
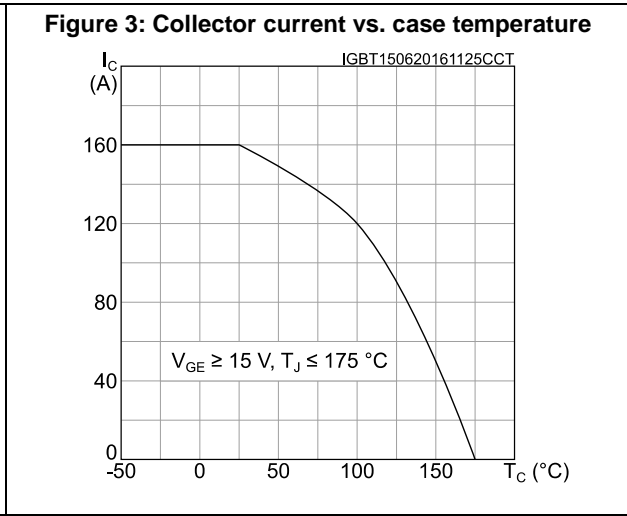
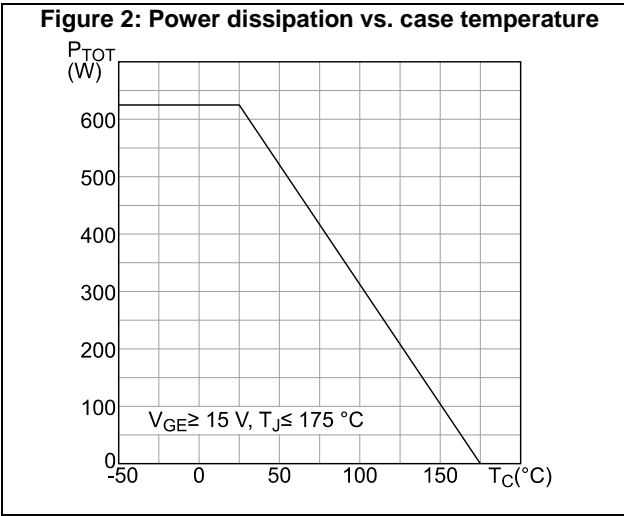


Figure 8: Collector current vs. switching frequency

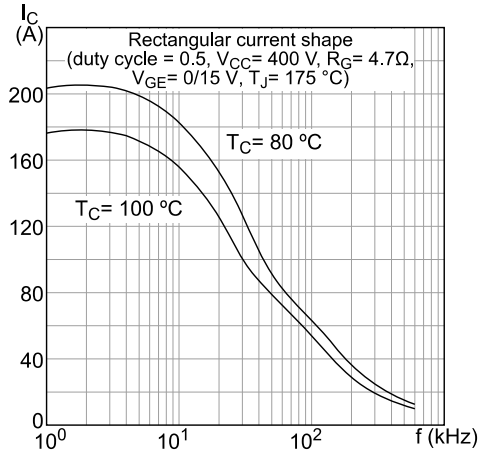


Figure 9: Forward bias safe operating area

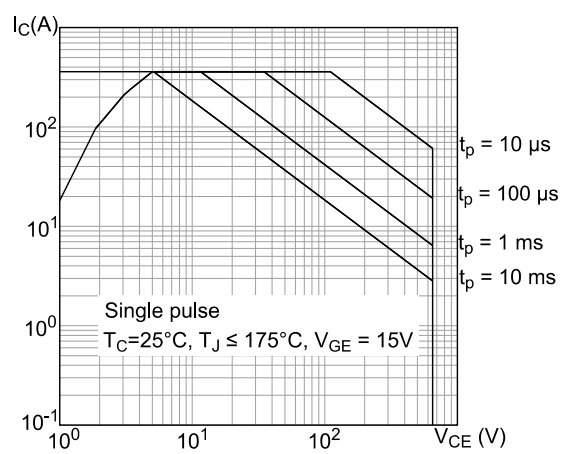


Figure 10: Transfer characteristics

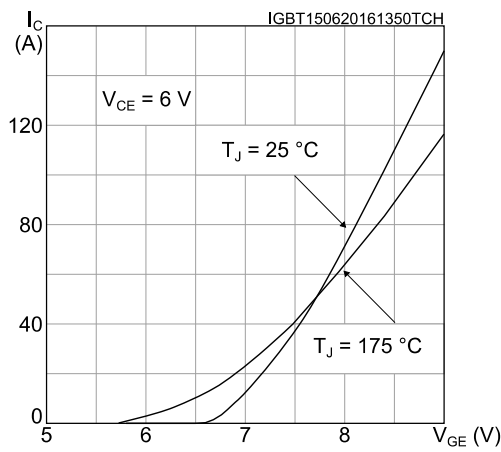


Figure 11: Diode VF vs. forward current

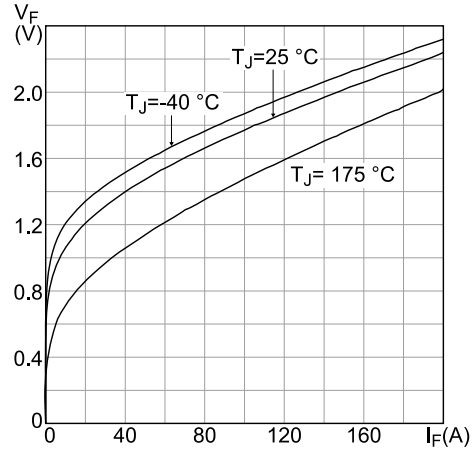


Figure 12: Normalized VGE(th) vs. junction temperature

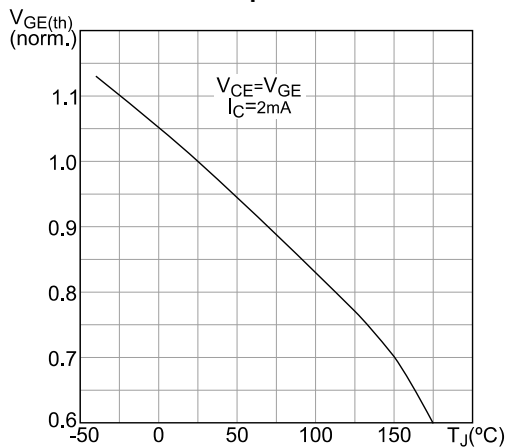
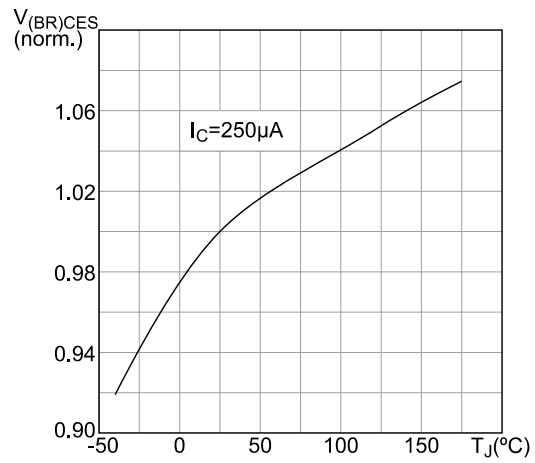
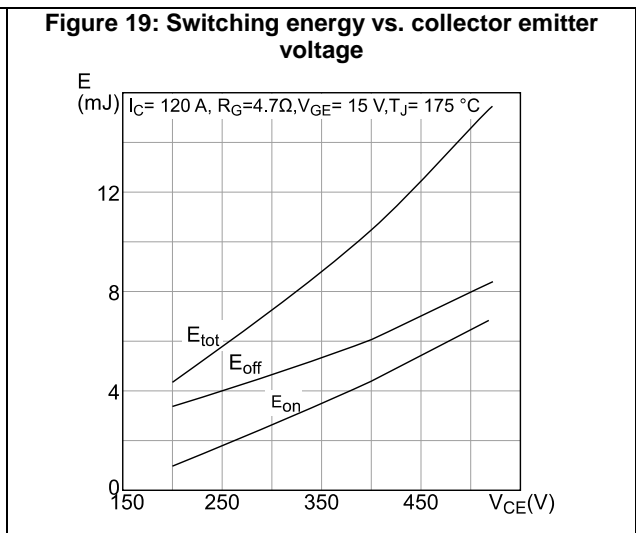
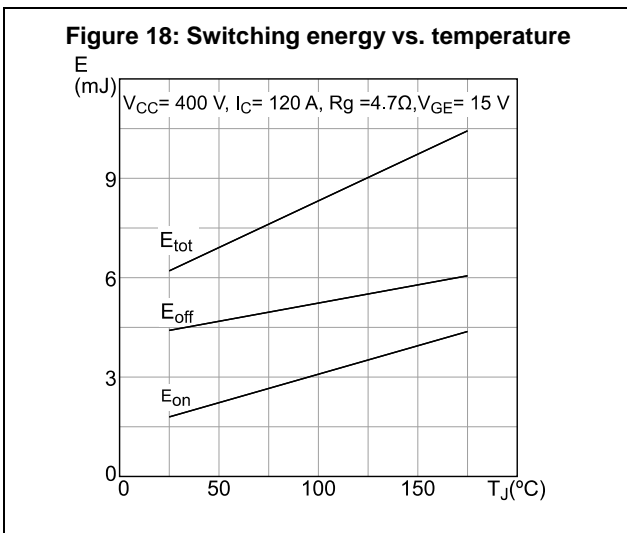
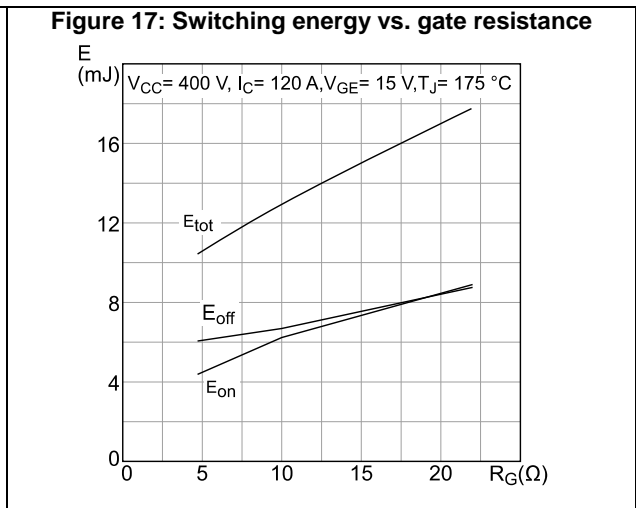
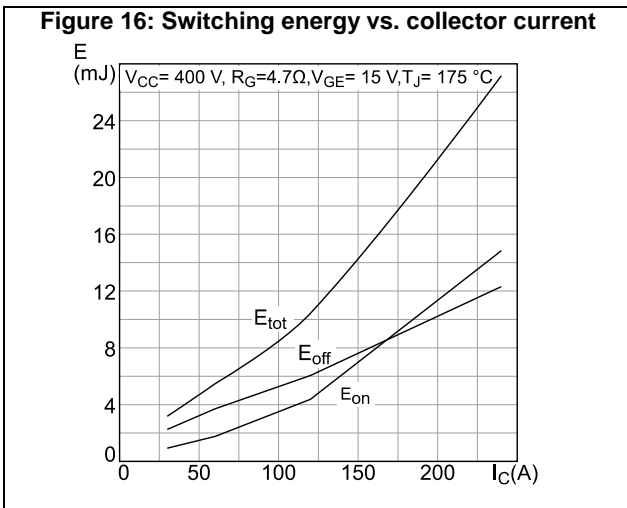
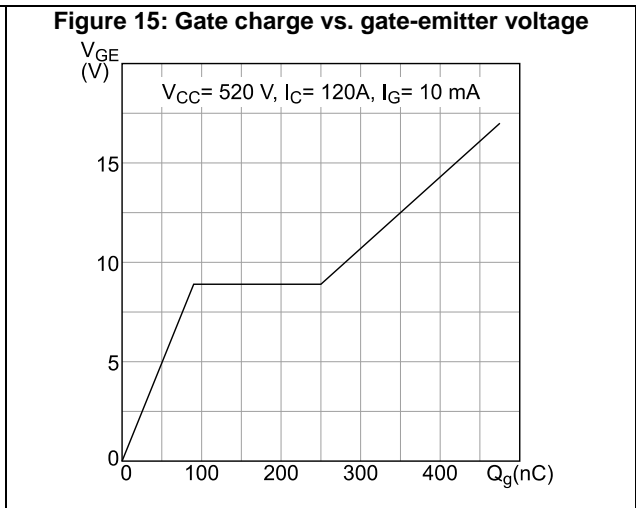
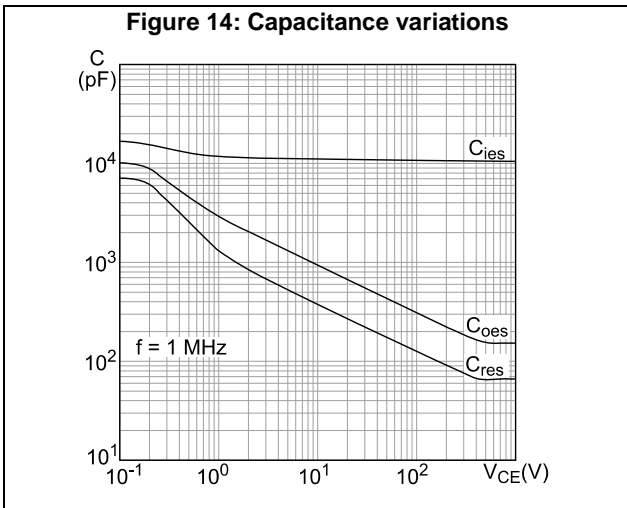


Figure 13: Normalized V(BR)CES vs. junction temperature







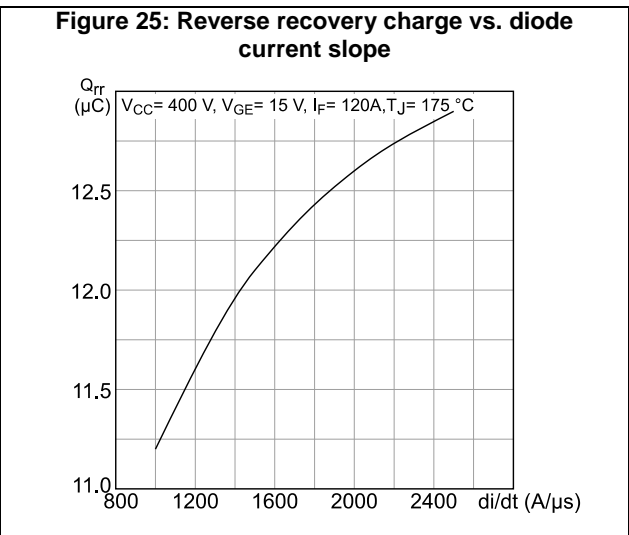
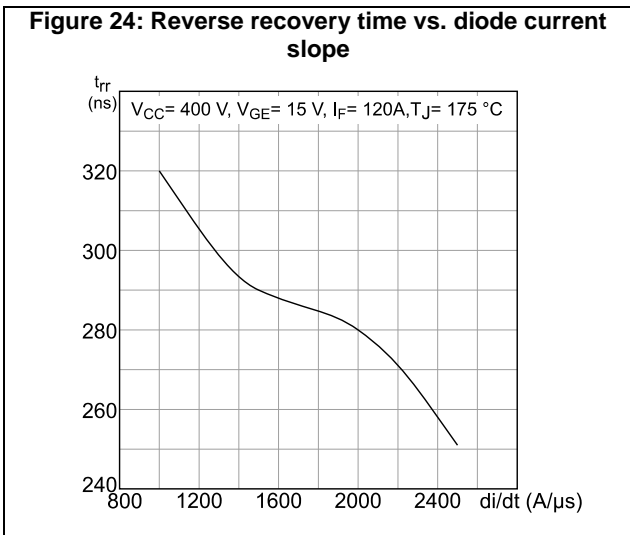
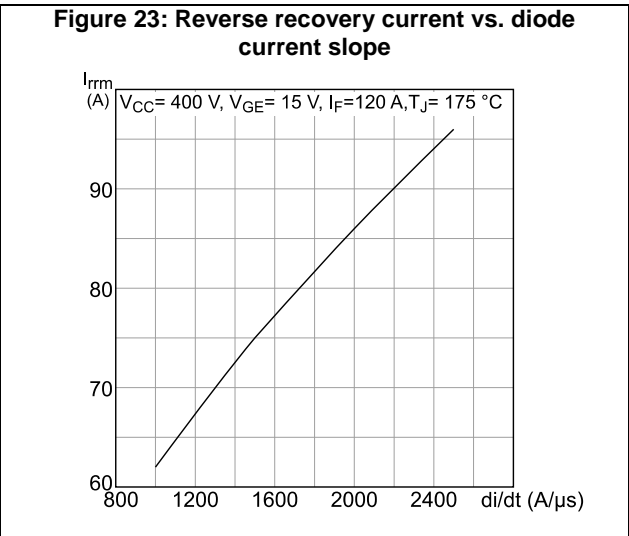
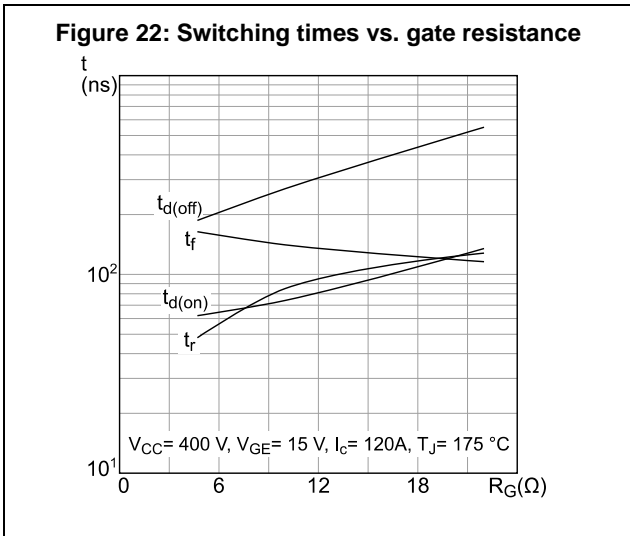
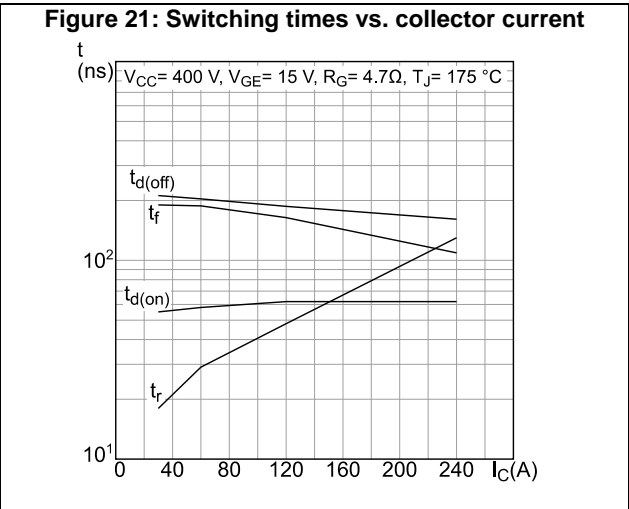
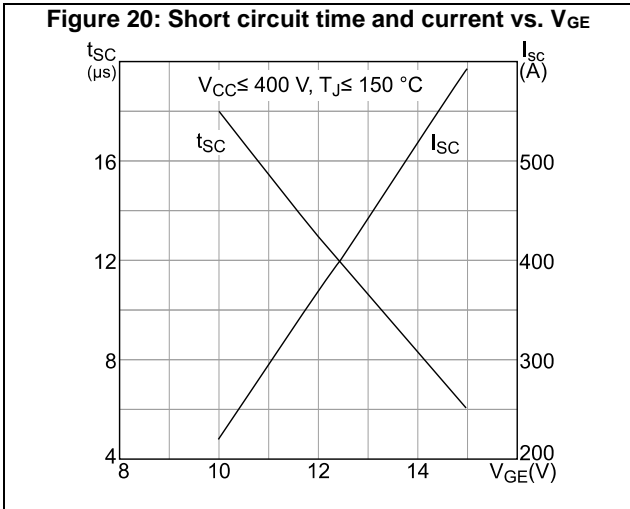
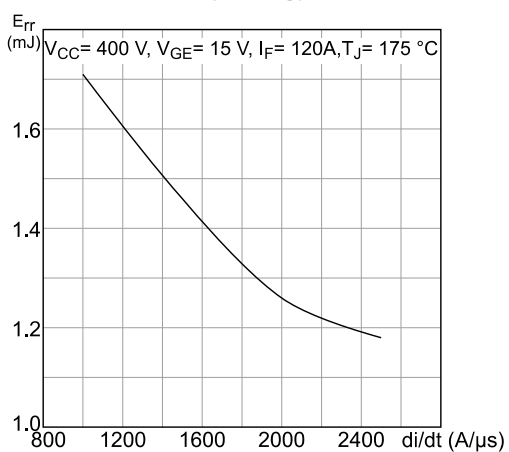
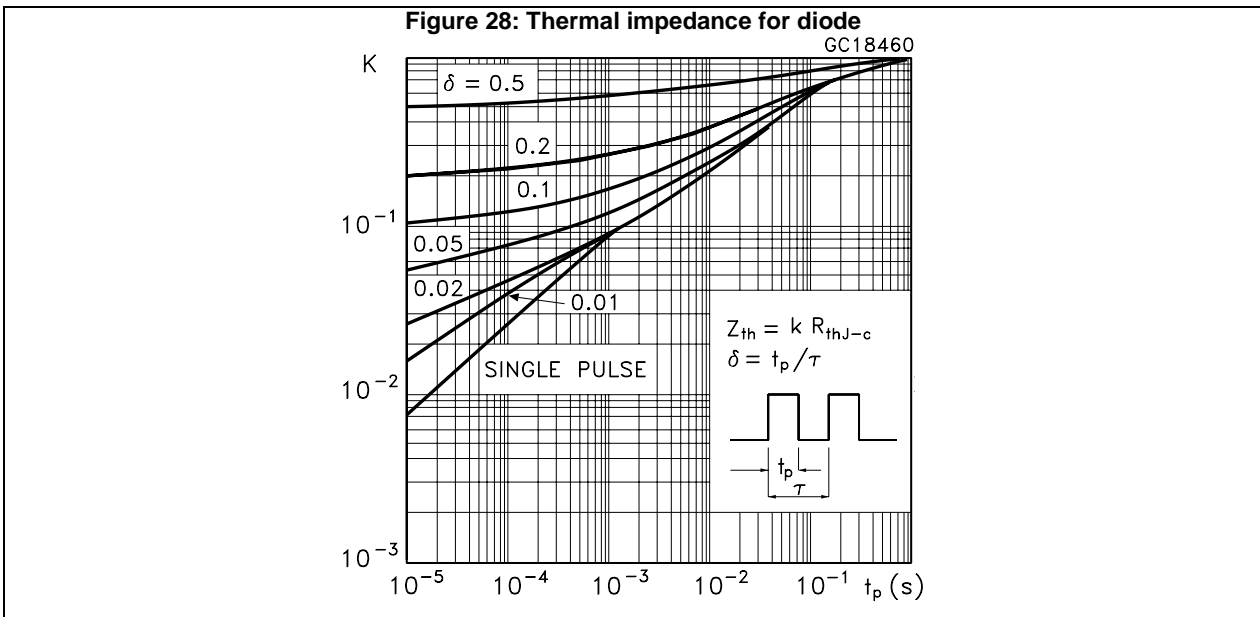
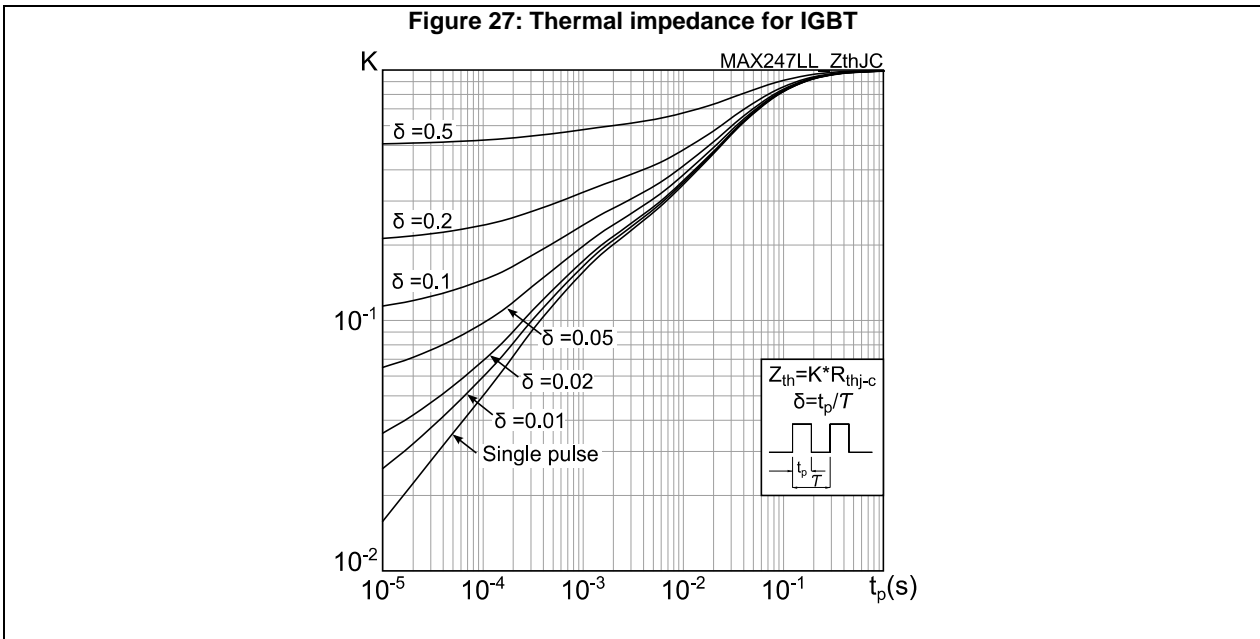


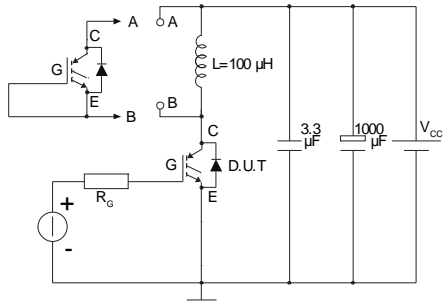
Figure 26: Reverse recovery energy vs. diode current slope





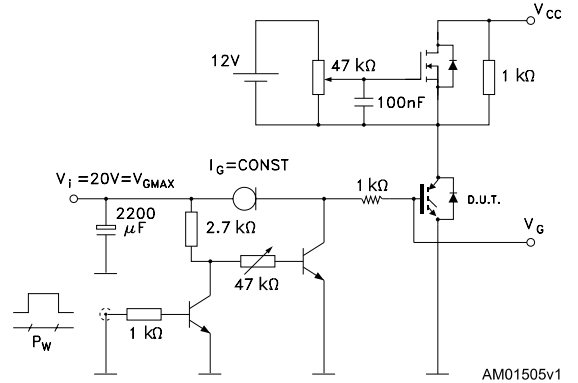
### 3 Test circuits

**Figure 29: Test circuit for inductive load switching**



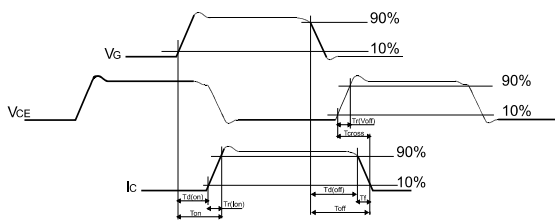
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**Figure 30: Gate charge test circuit**



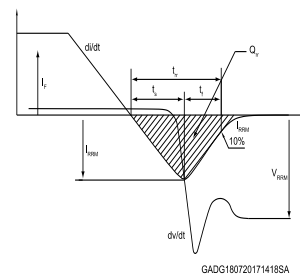
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**Figure 31: Switching waveform**



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**Figure 32: Diode reverse recovery waveform**



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## 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 33: Max247 long leads package outline

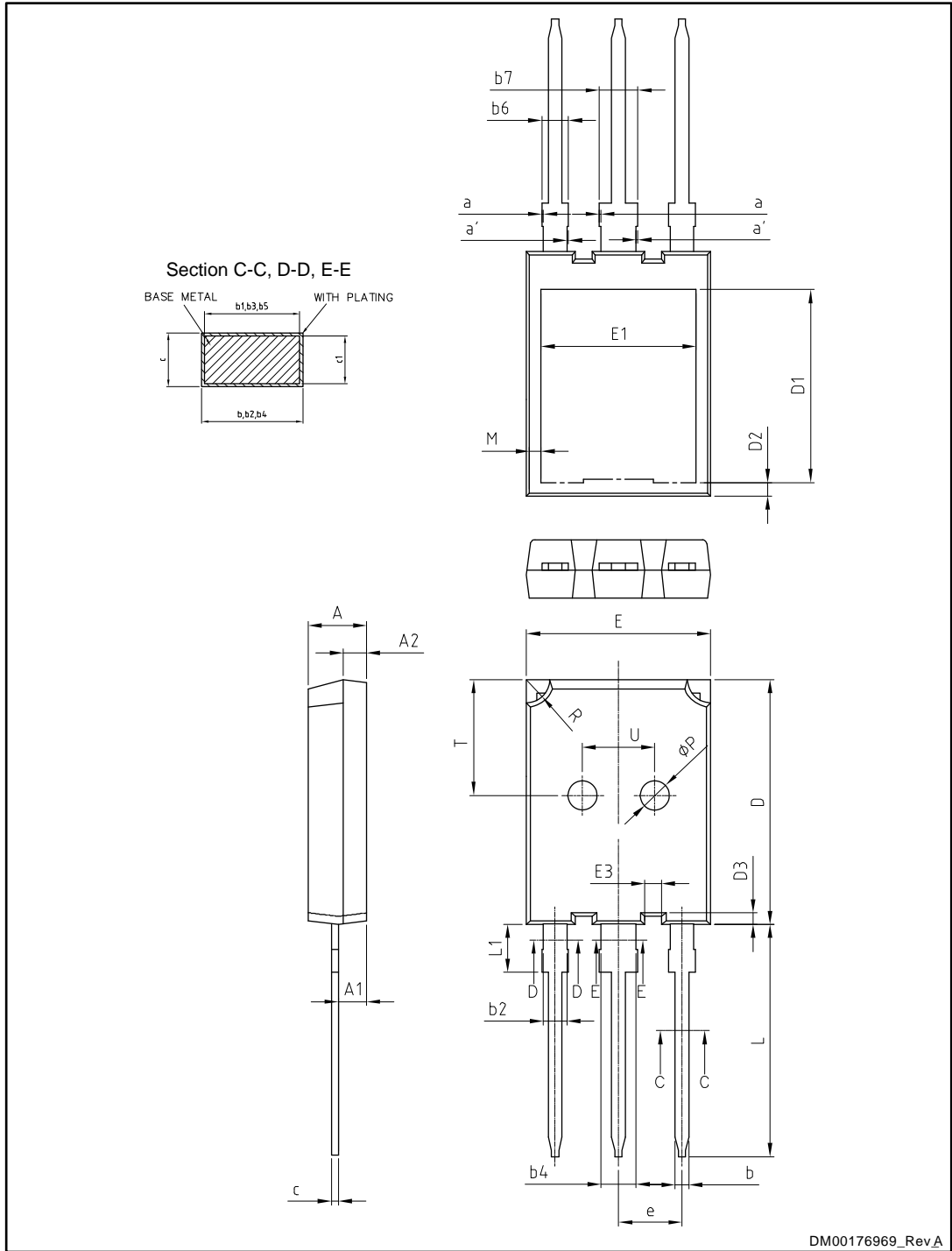


Table 8: Max247 long leads package mechanical data

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

## 5 Revision history

**Table 9: 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 <i>Table 7: "Diode switching characteristics (inductive load)"</i> and <i>Figure 25: Reverse recovery charge vs. diode current slope</i> . Minor text changes.
13-Sep-2017	5	Updated title, features and application in cover page. Updated <i>Figure 13: "Normalized <math>V(BR)_{CES}</math> vs. junction temperature"</i> . Minor text changes.