

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

Datasheet - production data

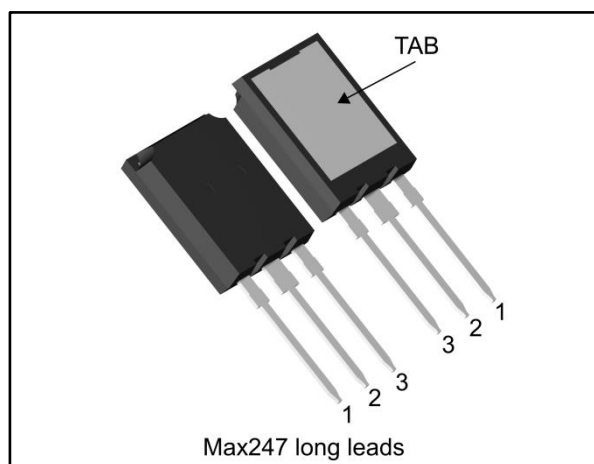
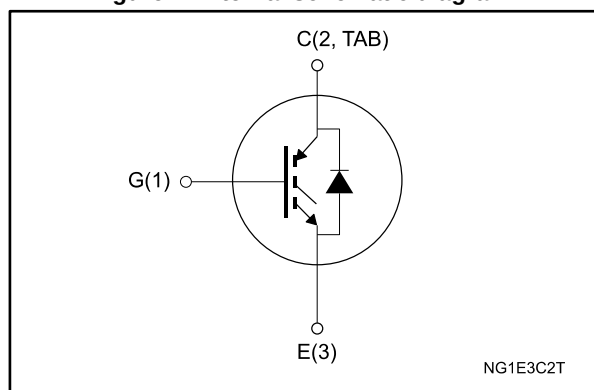


Figure 1: Internal schematic diagram



Features

- 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 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
STGYA120M65DF2AG	G120M65DF2AG	Max247 long leads	Tube

Contents

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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	± 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	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 250	μA

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 Figure 30: "Gate charge test circuit")	-	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 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		-	

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 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
dl_{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
dl_{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 2: Power dissipation vs. case temperature

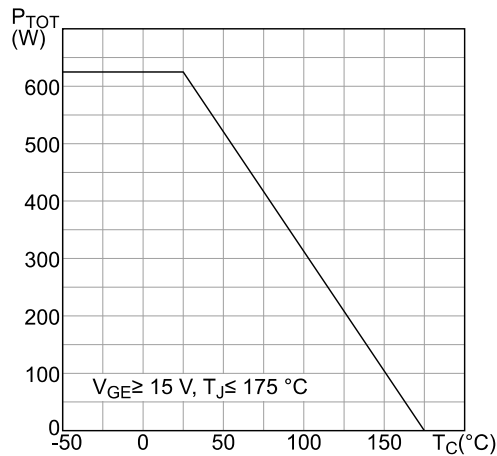


Figure 3: Collector current vs. case temperature

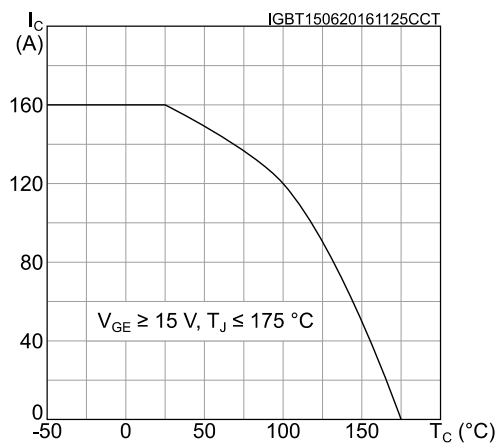
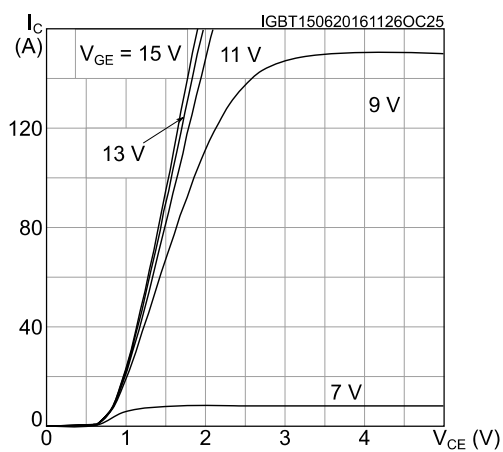
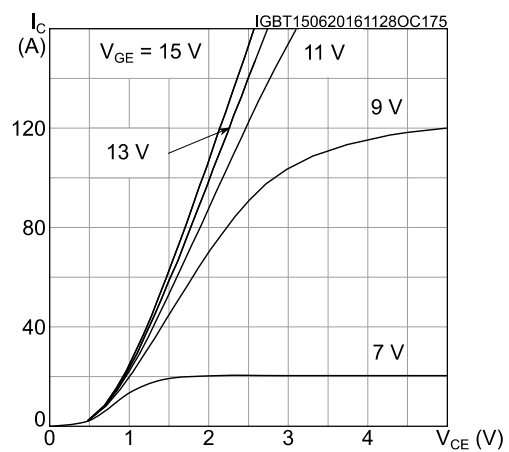
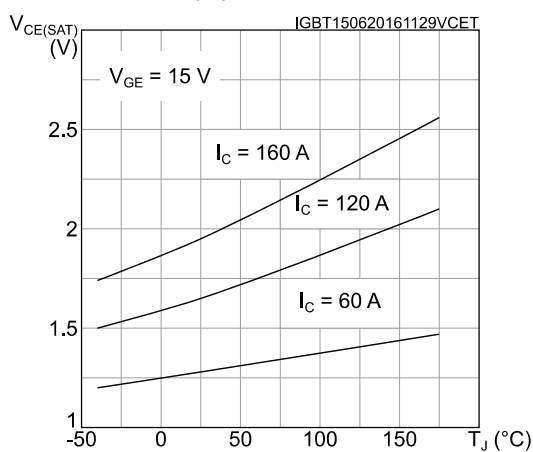
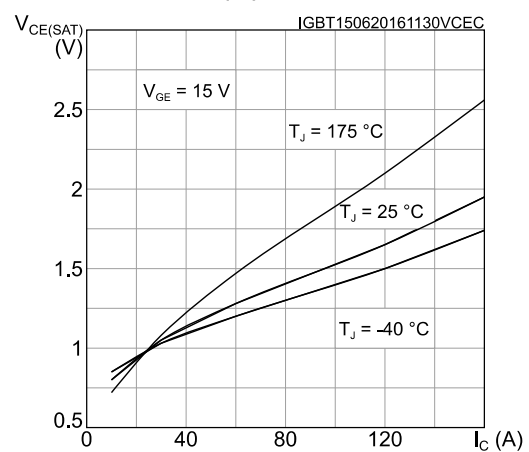
Figure 4: Output characteristics ($T_J = 25$ °C)Figure 5: Output characteristics ($T_J = 175$ °C)Figure 6: $V_{CE(sat)}$ vs. junction temperatureFigure 7: $V_{CE(sat)}$ vs. collector current

Figure 8: Collector current vs. switching frequency

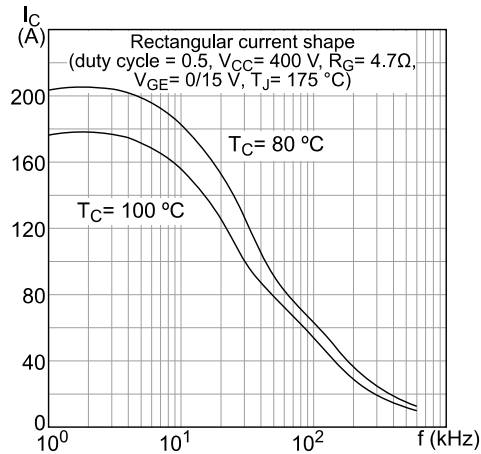


Figure 9: Forward bias safe operating area

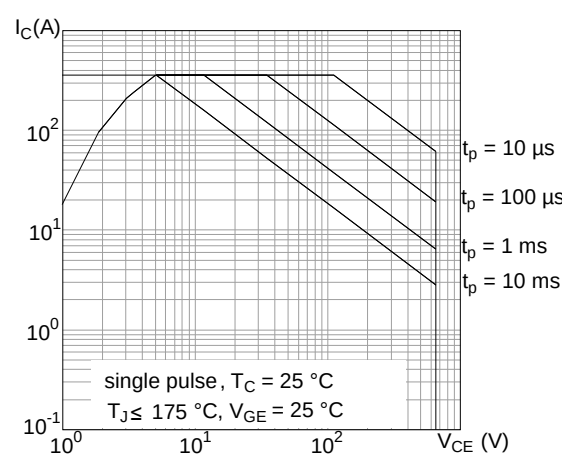


Figure 10: Transfer characteristics

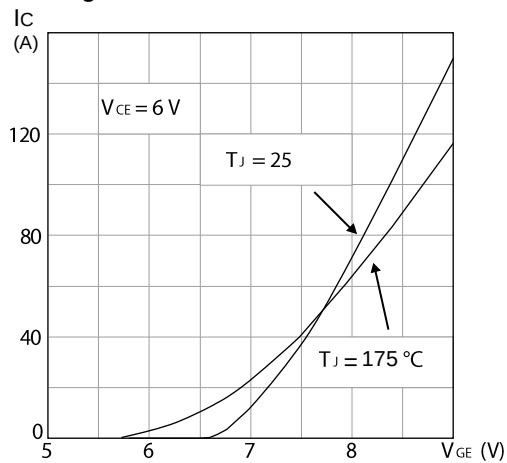
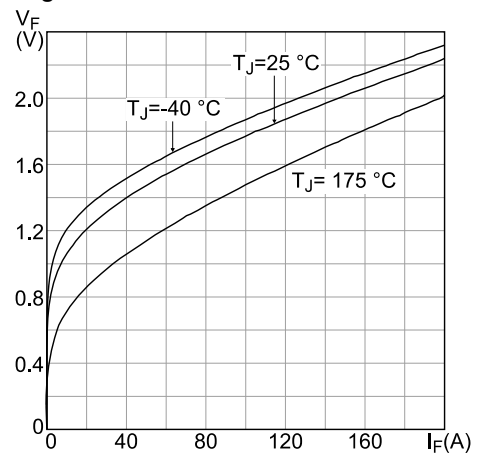
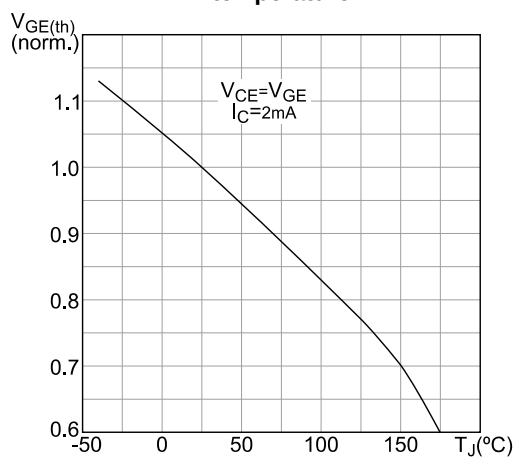
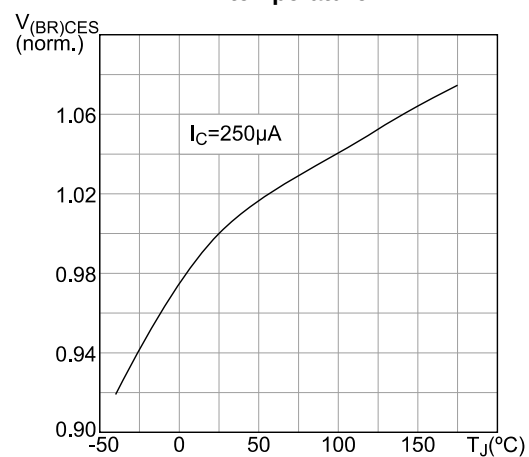
Figure 11: Diode V_F vs. forward currentFigure 12: Normalized $V_{GE(th)}$ vs. junction temperatureFigure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

Figure 14: Capacitance variations

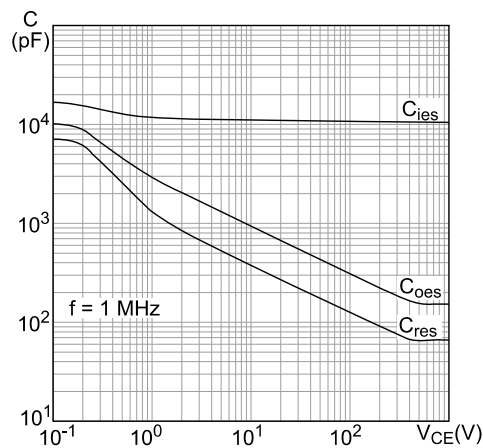


Figure 15: Gate charge vs. gate-emitter voltage

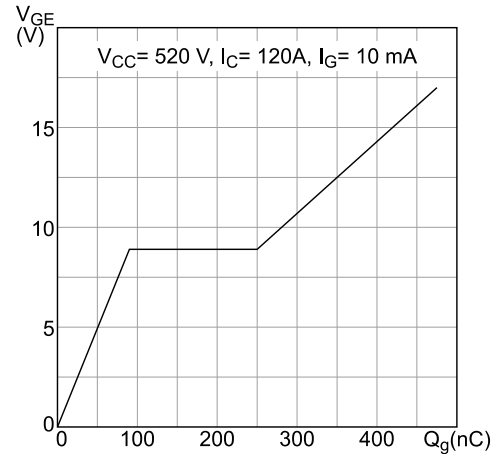


Figure 16: Switching energy vs. collector current

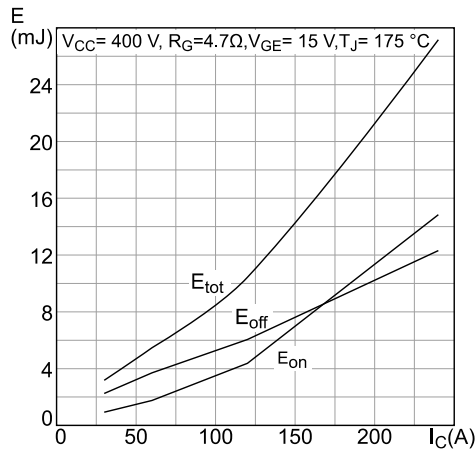


Figure 17: Switching energy vs. gate resistance

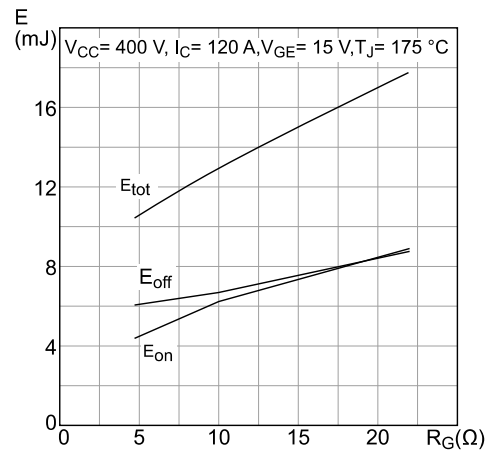


Figure 18: Switching energy vs. temperature

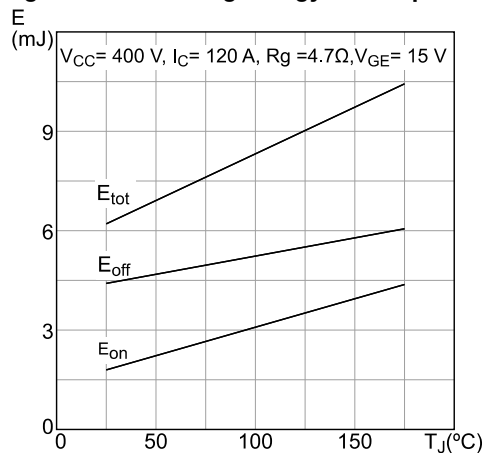


Figure 19: Switching energy vs. collector emitter voltage

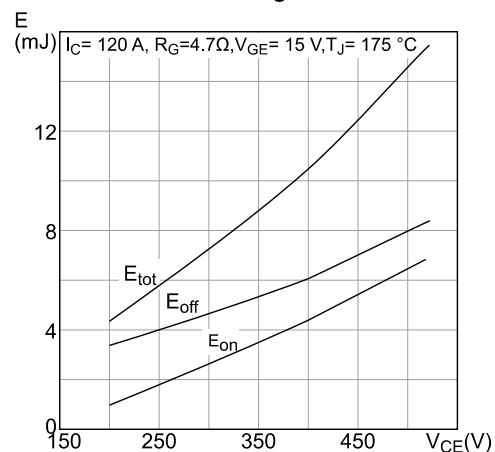


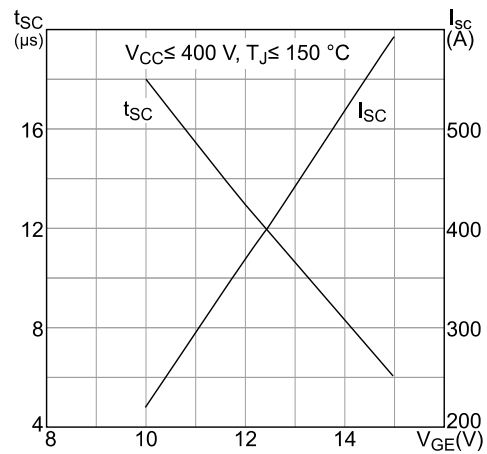
Figure 20: Short circuit time and current vs. V_{GE} 

Figure 21: Switching times vs. collector current

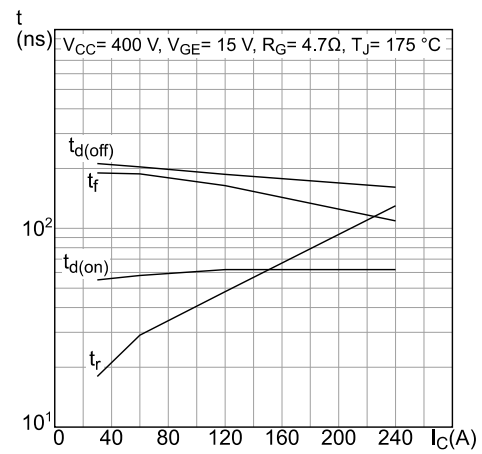


Figure 22: Switching times vs. gate resistance

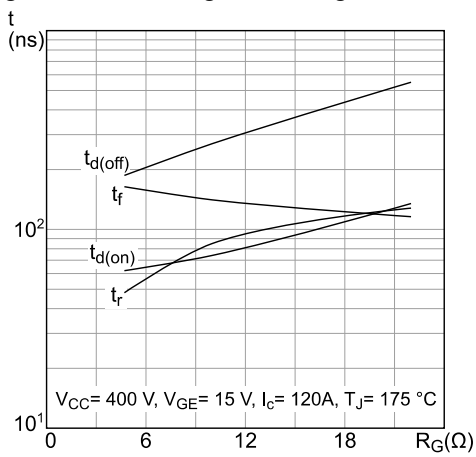


Figure 23: Reverse recovery current vs. diode current slope

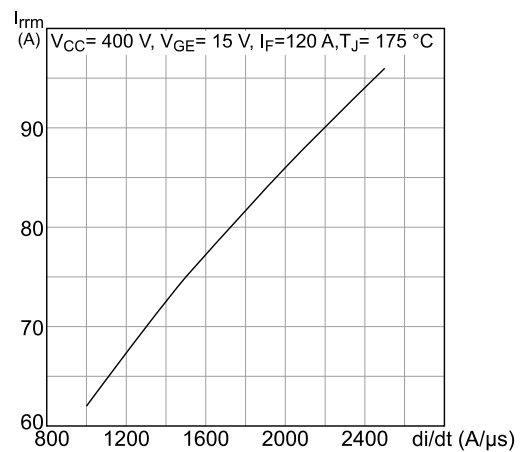


Figure 24: Reverse recovery time vs. diode current slope

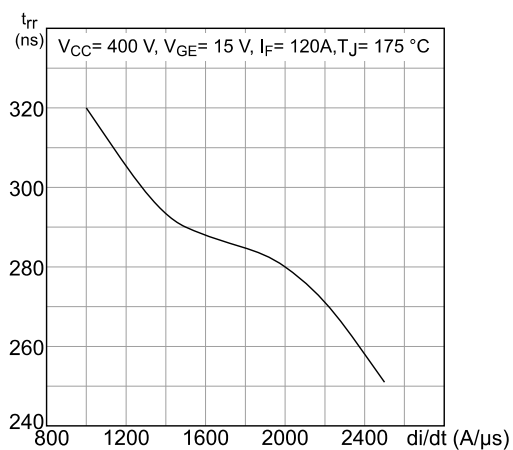


Figure 25: Reverse recovery charge vs. diode current slope

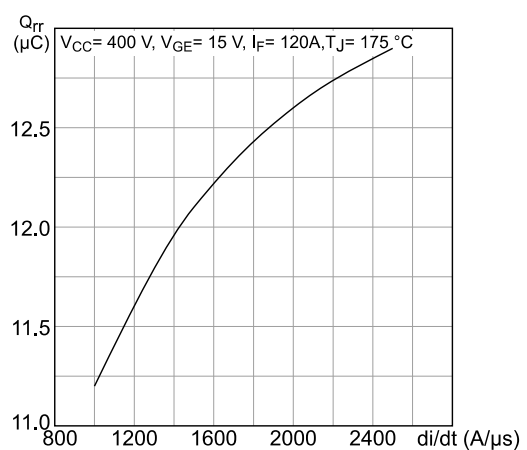


Figure 26: Reverse recovery energy vs. diode current slope

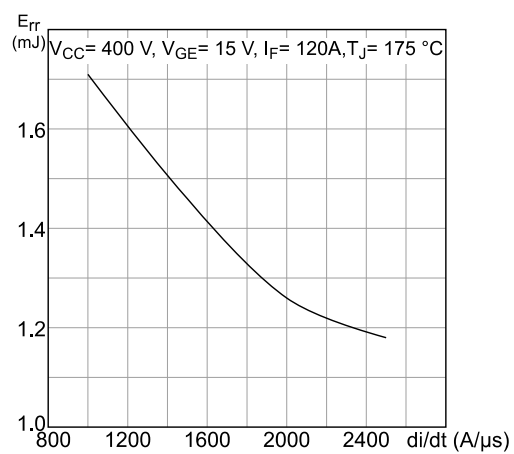


Figure 27: Thermal impedance for IGBT

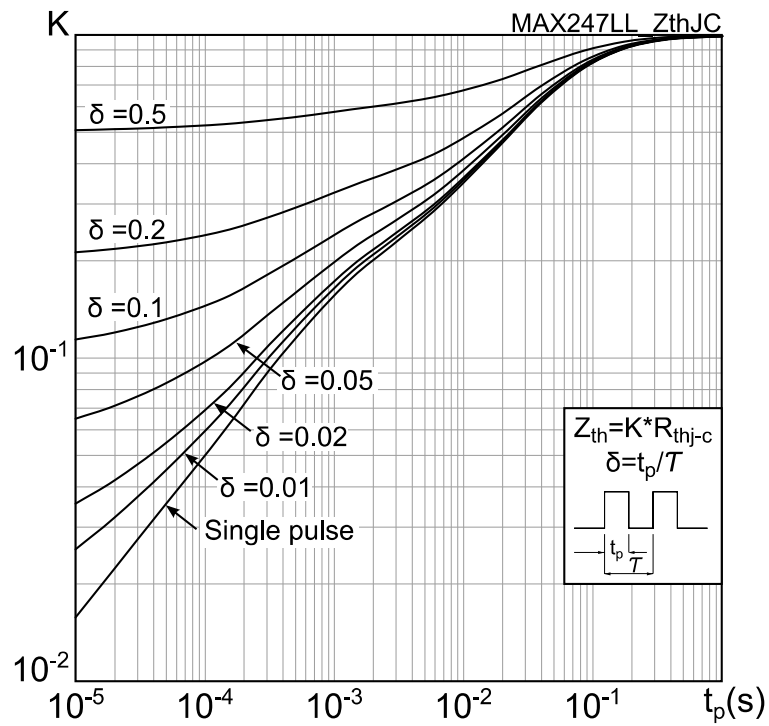
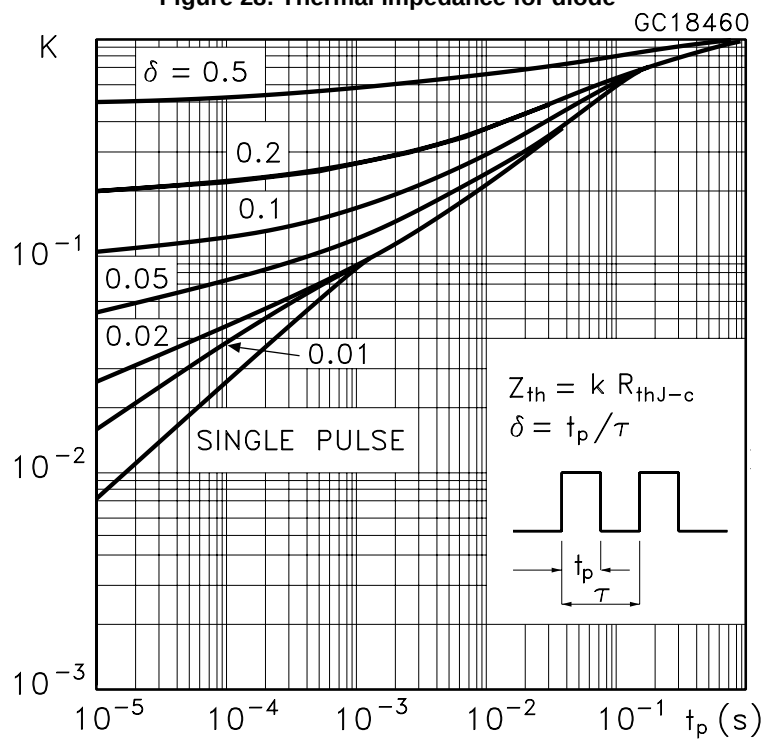
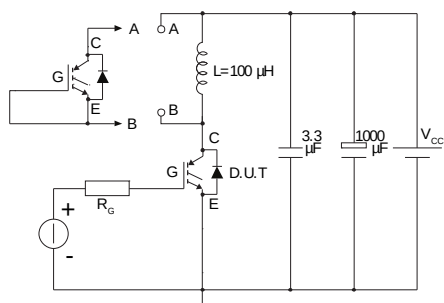


Figure 28: Thermal impedance for diode



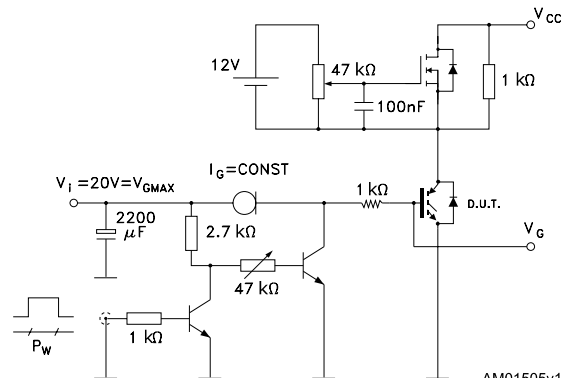
3 Test circuits

Figure 29: Test circuit for inductive load switching



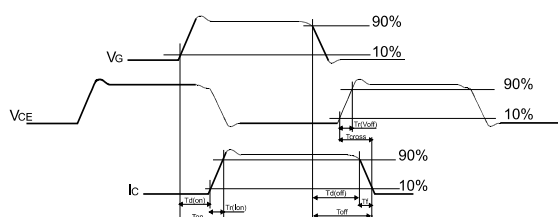
AM01504v1

Figure 30: Gate charge test circuit



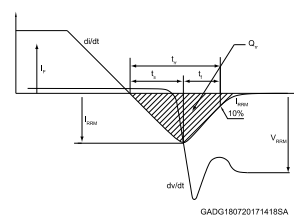
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Figure 31: Switching waveform



AM01506v1

Figure 32: Diode reverse recovery waveform



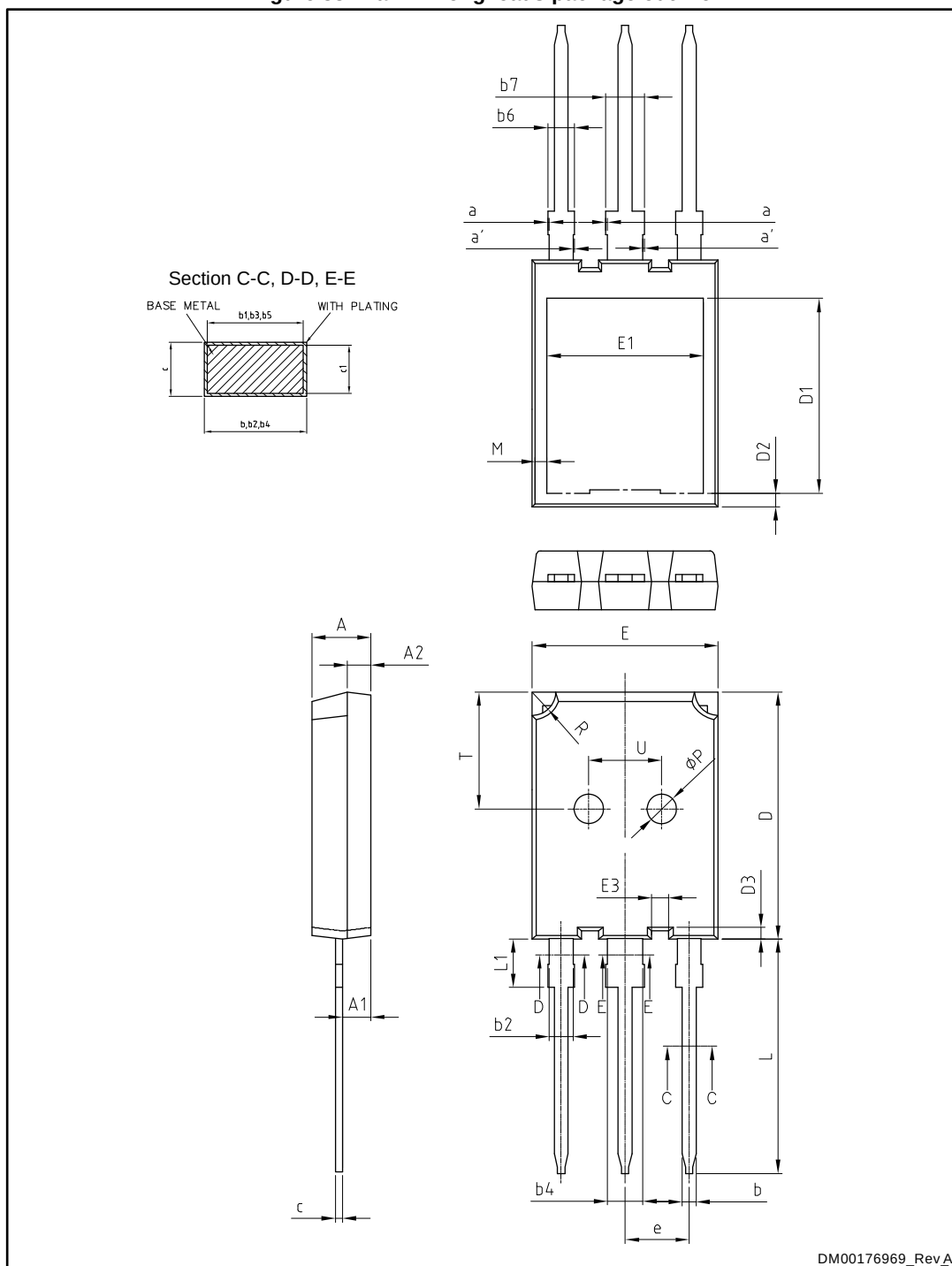
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4 Package information

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**. ECOPACK® is an ST trademark.

4.1 Max247 long leads package information

Figure 33: Max247 long leads package outline



DM00176969_Rev A

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
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 Table 4: "Static characteristics" Minor text changes.

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