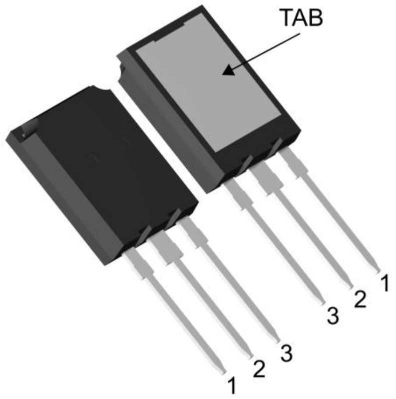
STGYA120M65DF2AG

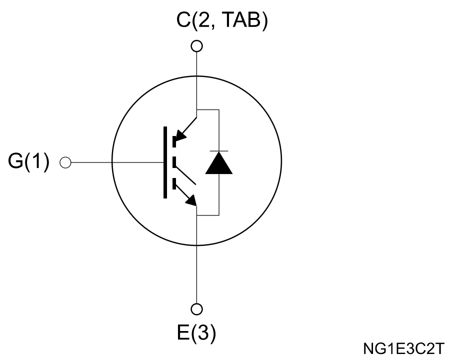
Automotive trench gate field-stop IGBT, M series 650 V, 120 A low loss

Datasheet - production data



Max247 long leads

Figure 1: Internal schematic diagram



Features

- AEC-Q101 qualified
- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.65 V (typ.) @ I_C = 120 A
- Tight parameter distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

Applications

- Motor control
- UPS
- PFC

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

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	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 °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 V, I_C = 2 mA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 120 A		1.65	2.15	V
		V_{GE} = 15 V, I_C = 120 A, T_J = 125 °C		1.95		
		V_{GE} = 15 V, I_C = 120 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 120 A		1.9		V
		I_F = 120 A, T_J = 125 °C		1.7		
		I_F = 120 A, T_J = 175 °C		1.6		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 2 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 V			100	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ± 20 V			± 250	µA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE}= 25 V, f = 1 MHz, V_{GE} = 0 V	-	11	-	nF
C_{oes}	Output capacitance		-	0.61	-	
C_{res}	Reverse transfer capacitance		-	0.25	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 120 A, V_{GE} = 15 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 V, I_C = 120 A, V_{GE} = 15 V, R_G = 4.7 Ω (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/µs
$t_{d(off)}$	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 V, I_C = 120 A, V_{GE} = 15 V, R_G = 4.7 Ω T_J = 175 °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/µs
$t_{d(off)}$	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} ≤ 400 V, V_{GE} = 13 V, T_{Jstart} = 150 °C	10		-	µs
		V_{CC} ≤ 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °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 A, V_R = 400 V, V_{GE} = 15 V (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	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/µs
E_{rr}	Reverse recovery energy		-	500	-	µJ
t_{rr}	Reverse recovery time	I_F = 120 A, V_R = 400 V, V_{GE} = 15 V T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	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/µs
E_{rr}	Reverse recovery energy		-	1710	-	µJ

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

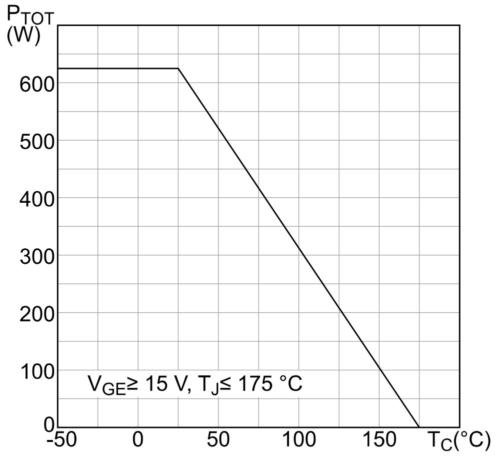


Figure 3: Collector current vs. case temperature

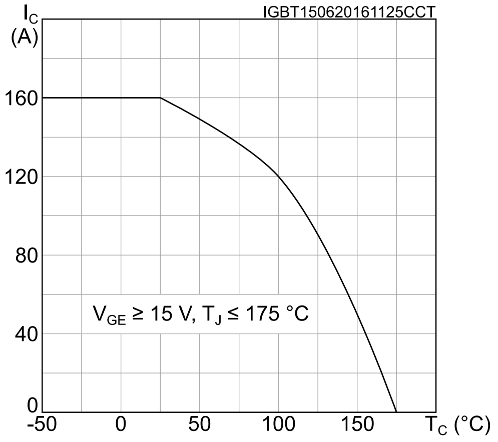


Figure 4: Output characteristics (TJ = 25 °C)

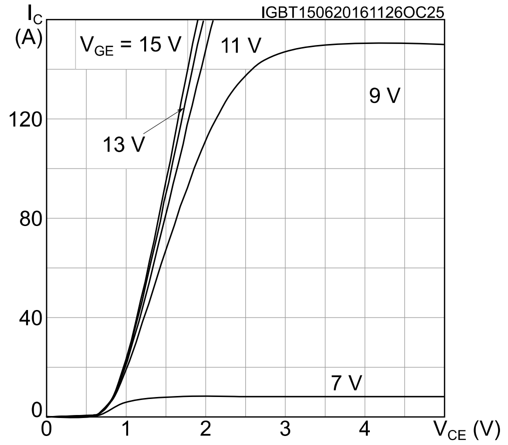


Figure 5: Output characteristics (TJ = 175 °C)

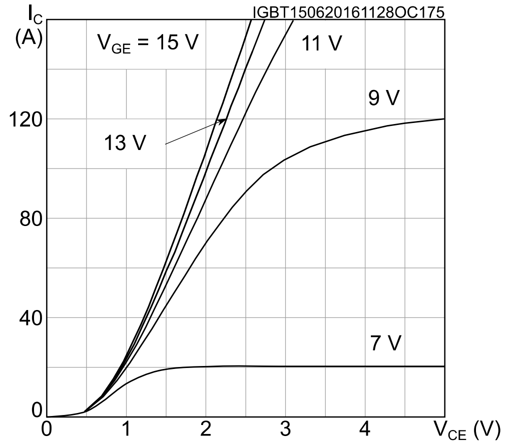


Figure 6: VCE(sat) vs. junction temperature

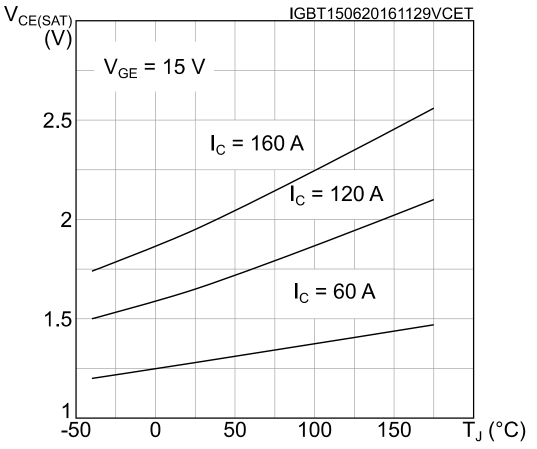


Figure 7: VCE(sat) vs. collector current

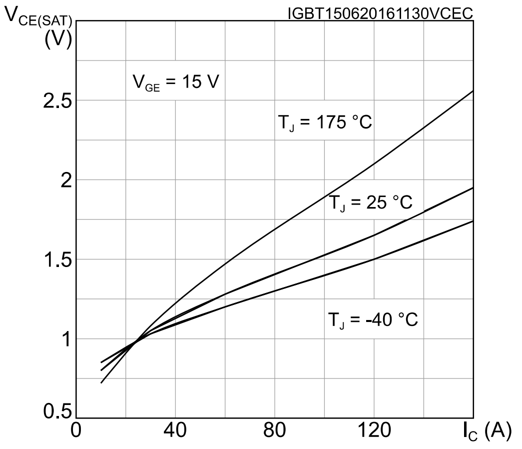


Figure 8: Collector current vs. switching frequency

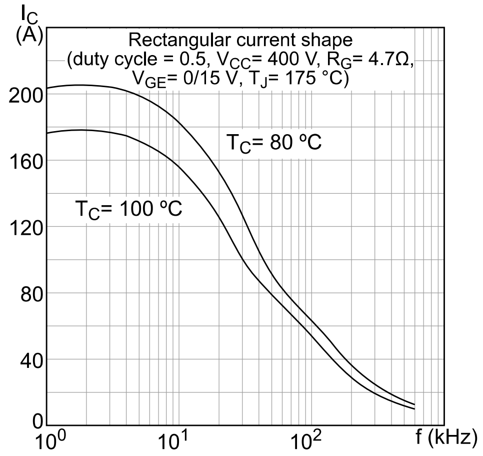


Figure 9: Forward bias safe operating area

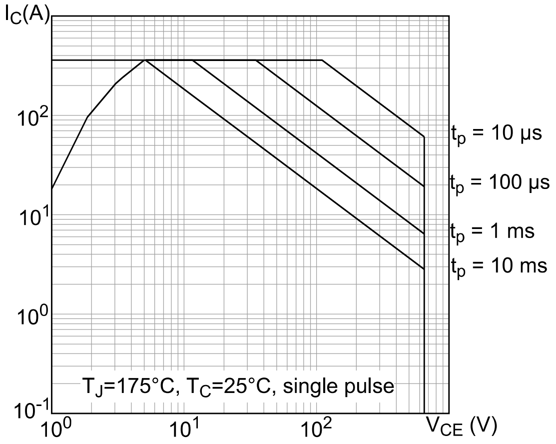


Figure 10: Transfer characteristics

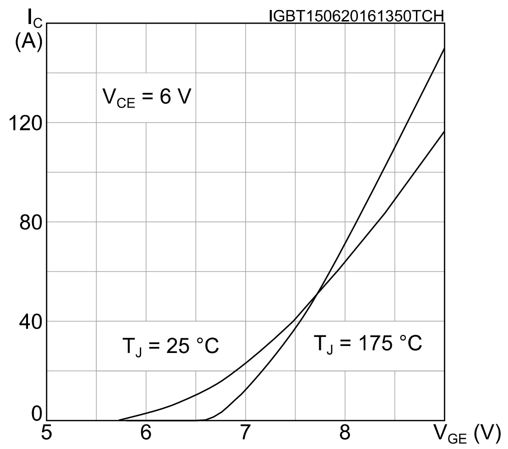


Figure 11: Diode VF vs. forward current

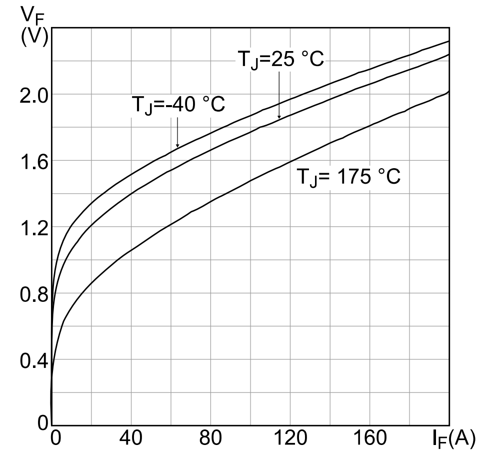


Figure 12: Normalized VGE(th) vs. junction temperature

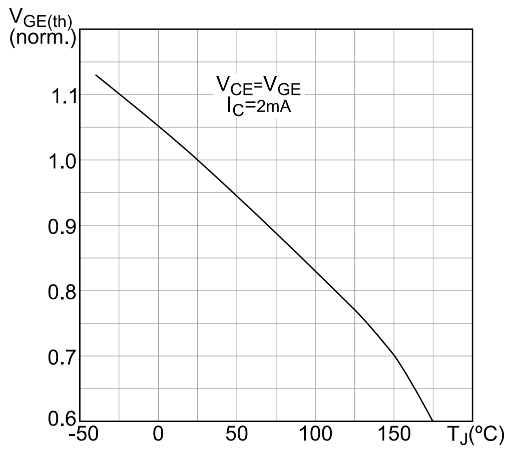


Figure 13: Normalized V(BR)CES vs. junction temperature

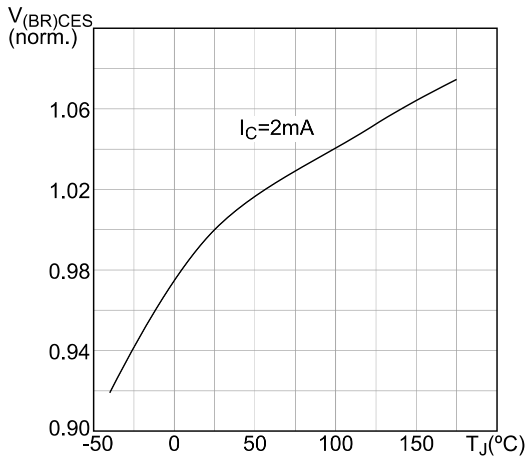


Figure 14: Capacitance variations

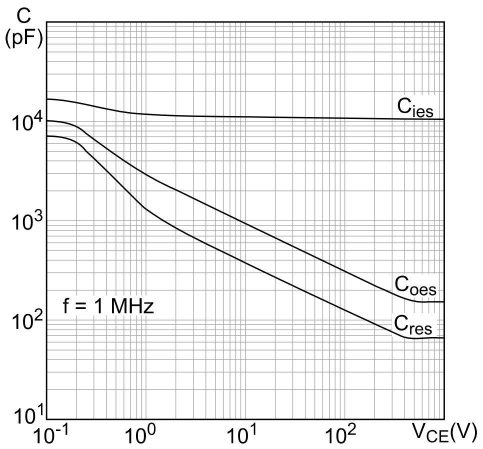


Figure 15: Gate charge vs. gate-emitter voltage

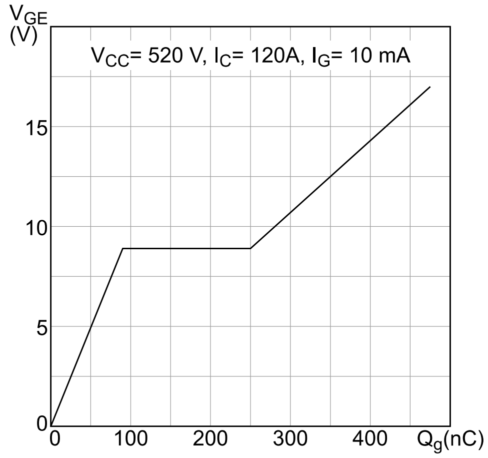


Figure 16: Switching energy vs. collector current

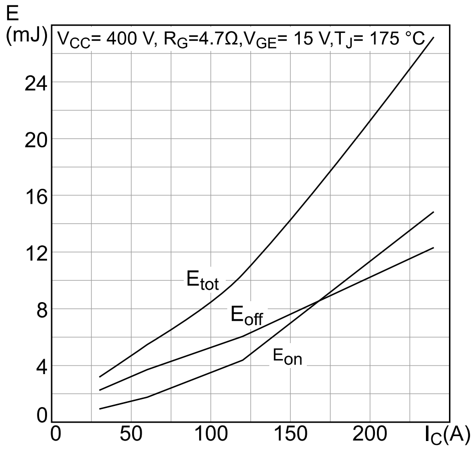


Figure 17: Switching energy vs. gate resistance

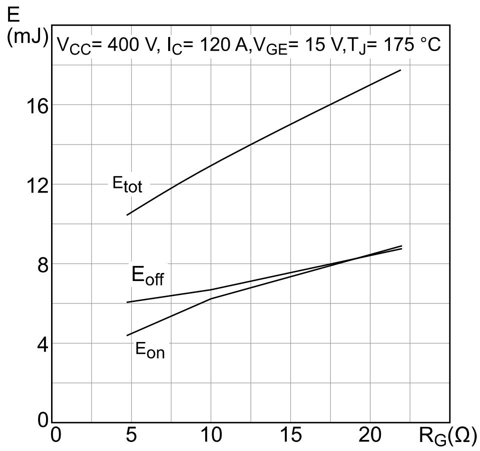


Figure 18: Switching energy vs. temperature

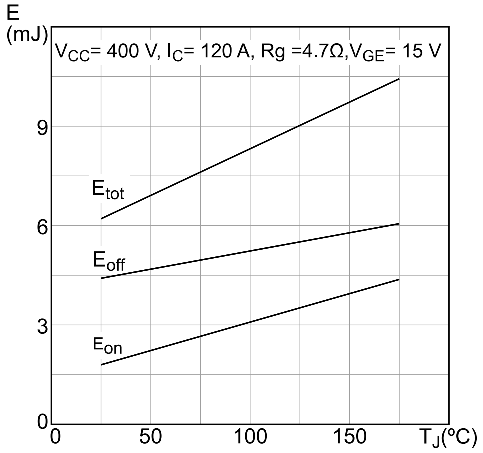


Figure 19: Switching energy vs. collector emitter voltage

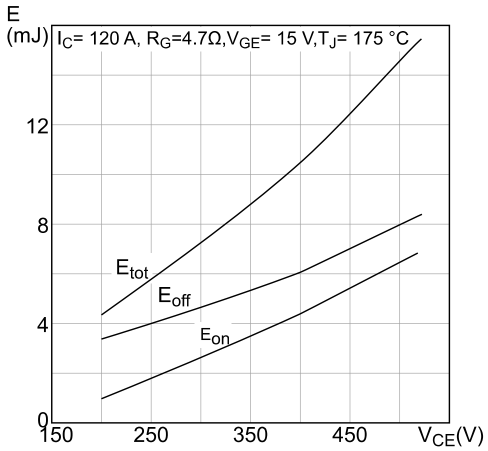


Figure 20: Short circuit time and current vs. VGE

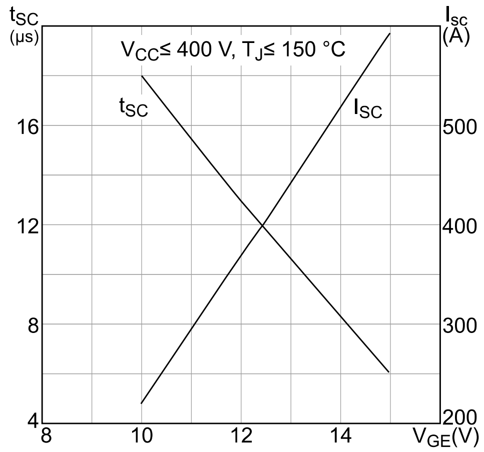


Figure 21: Switching times vs. collector current

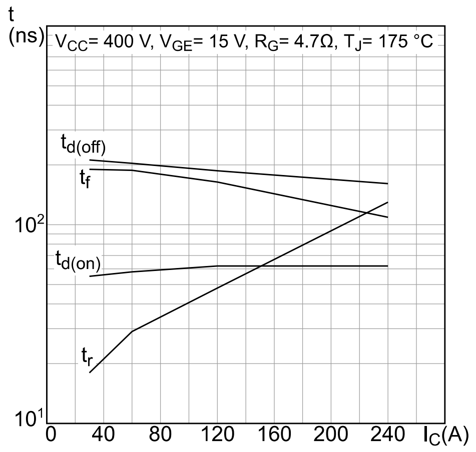


Figure 22: Switching times vs. gate resistance

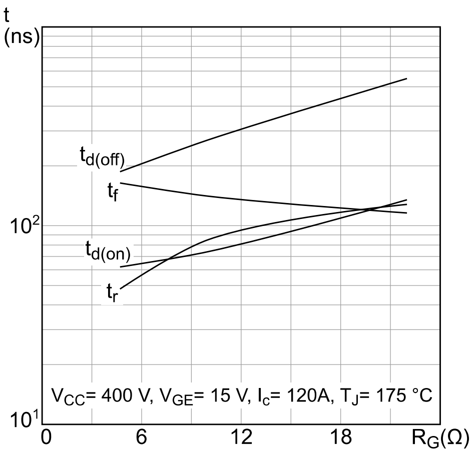


Figure 23: Reverse recovery current vs. diode current slope

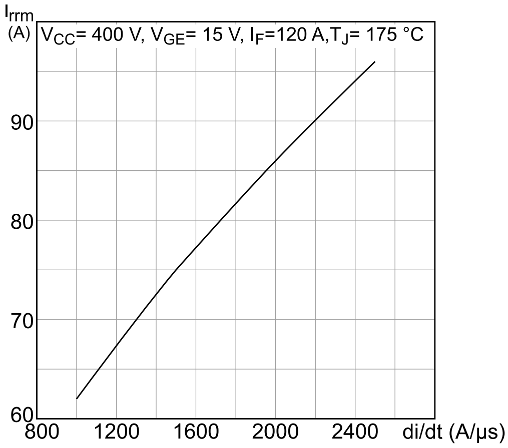


Figure 24: Reverse recovery time vs. diode current slope

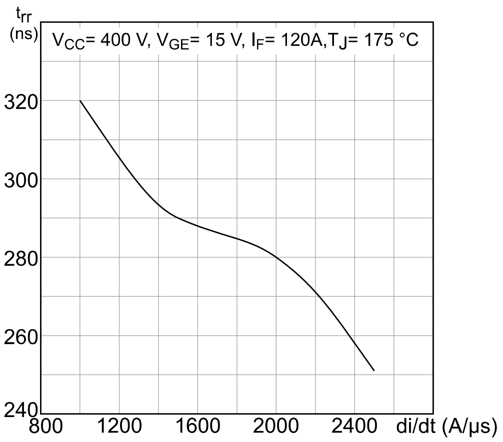


Figure 25: Reverse recovery charge vs. diode current slope

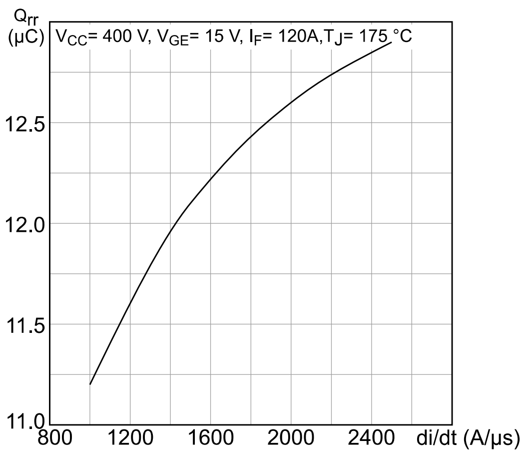


Figure 26: Reverse recovery energy vs. diode current slope

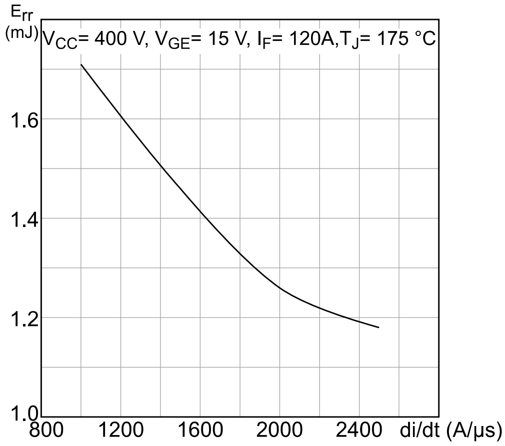


Figure 27: Thermal impedance for IGBT

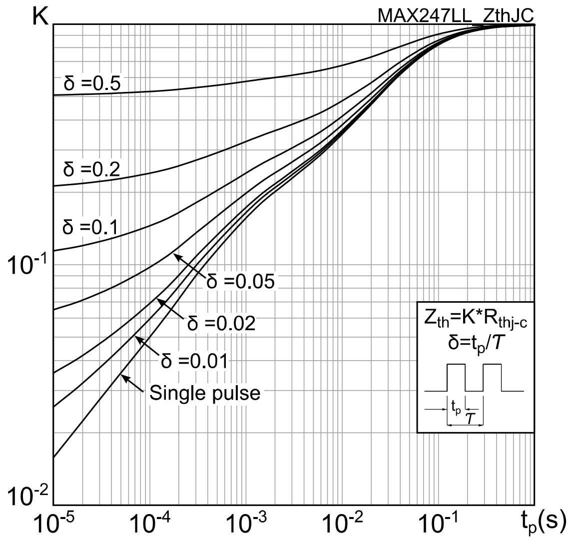
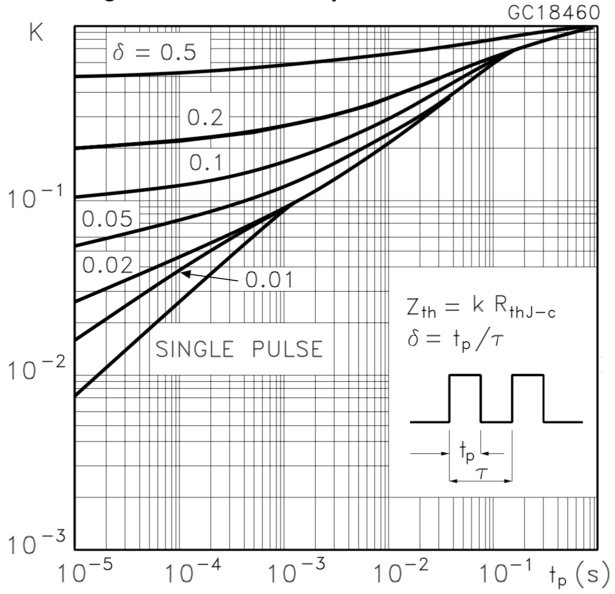


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

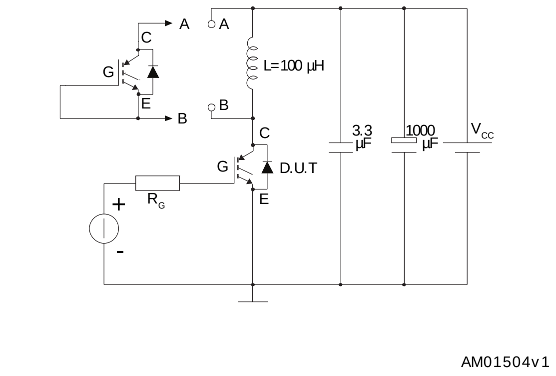


Figure 30: Gate charge test circuit

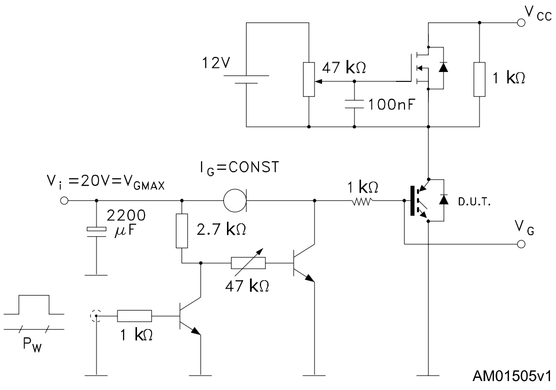


Figure 31: Switching waveform

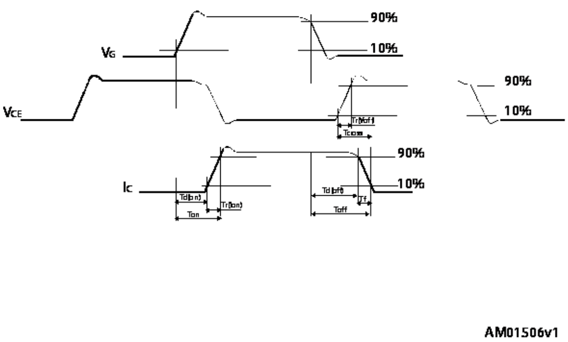
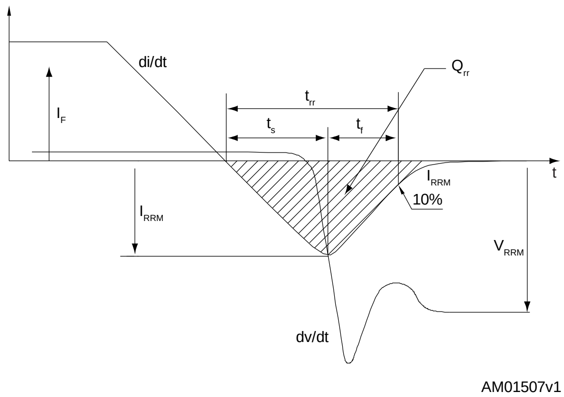


Figure 32: Diode reverse recovery waveform



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***. ECOPACK® is an ST trademark.

4.1 Max247 long leads package information

Figure 33: Max247 long leads package outline

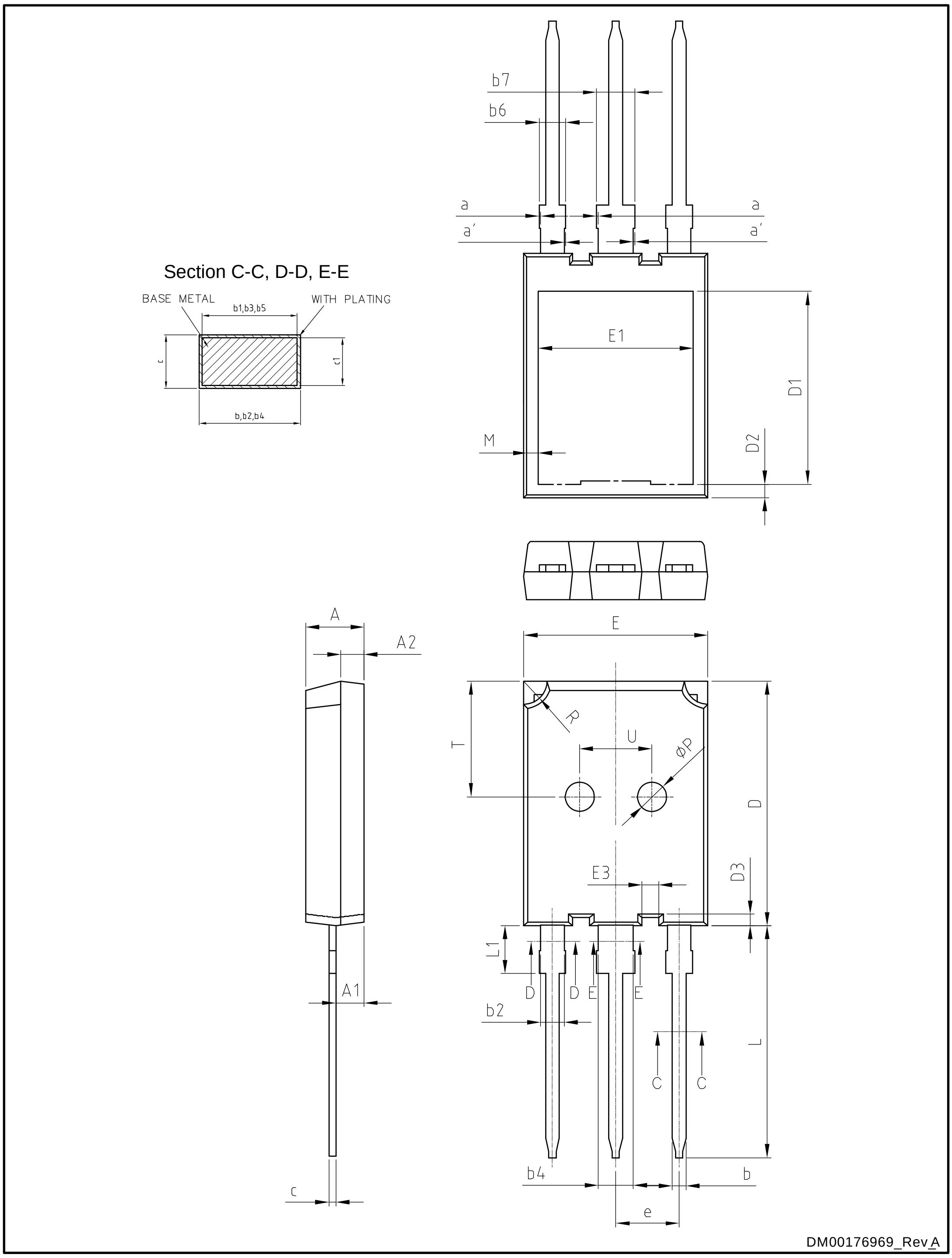


Table 8: Max247 long leads package mechanical data

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
12-Aug-2016	1	First release.
12-Dec-2016	2	Document status promoted from preliminary to production data. Minor text changes.