



# Insulated Gate Bi-Polar Transistor Type T1600GB45G

## Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V <sub>CES</sub>	Collector – emitter voltage	4500	V
V <sub>DC link</sub>	Permanent DC voltage for 100 FIT failure rate.	2800	V
V <sub>GES</sub>	Peak gate – emitter voltage	±20	V

	RATINGS	MAXIMUM LIMITS	UNITS
I <sub>C</sub>	DC collector current, IGBT	1600	A
I <sub>CRM</sub>	Repetitive peak collector current, t <sub>p</sub> =1ms, IGBT	3200	A
I <sub>F(DC)</sub>	Continuous DC forward current, Diode	1600	A
I <sub>FRM</sub>	Repetitive peak forward current, t <sub>p</sub> =1ms, Diode	3200	A
I <sub>FSM</sub>	Peak non-repetitive surge t <sub>p</sub> =10ms, V <sub>RM</sub> =60%V <sub>RRM</sub> , Diode (Note 4)	30	kA
I <sub>FSM2</sub>	Peak non-repetitive surge t <sub>p</sub> =10ms, V <sub>RM</sub> ≤10V, Diode (Note 4)	33	kA
P <sub>MAX</sub>	Maximum power dissipation, IGBT (Note 2)	12.8	kW
P <sub>D</sub>	Maximum power dissipation, Diode (Note 2)	8.13	kW
(di/dt) <sub>cr</sub>	Critical diode di/dt (note 3)	3000	A/μs
T <sub>j</sub>	Operating temperature range.	-40 to +125	°C
T <sub>stg</sub>	Storage temperature range.	-40 to +125	°C

### Notes: -

- 1) Unless otherwise indicated T<sub>j</sub> = 125°C.
- 2) T<sub>sink</sub> = 25°C, double side cooled.
- 3) Maximum commutation loop inductance 200nH.
- 4) Half-sinewave, 125°C T<sub>j</sub> initial.

## Characteristics

### IGBT Characteristics

	PARAMETER	MIN	TYP	MAX	TEST CONDITIONS	UNITS
V <sub>CE(sat)</sub>	Collector – emitter saturation voltage	-	2.75	3.2	I <sub>C</sub> = 1600A, V <sub>GE</sub> = 15V, T <sub>j</sub> = 25°C	V
		-	3.50	3.9	I <sub>C</sub> = 1600A, V <sub>GE</sub> = 15V	V
V <sub>T0</sub>	Threshold voltage	-	-	1.79	Current range: 530A – 1600A	V
r <sub>T</sub>	Slope resistance	-	-	1.32		mΩ
V <sub>GE(TH)</sub>	Gate threshold voltage	-	5.1	-	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 170mA	V
I <sub>CES</sub>	Collector – emitter cut-off current	-	45	70	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0V	mA
I <sub>GES</sub>	Gate leakage current	-	-	±20	V <sub>GE</sub> = ±20V	μA
C <sub>ies</sub>	Input capacitance	-	270	-	V <sub>CE</sub> = 25V, V <sub>GE</sub> = 0V, f = 1MHz	nF
t <sub>d(on)</sub>	Turn-on delay time	-	2.2	-	I <sub>C</sub> = 1600A, V <sub>CE</sub> = 2800V, di/dt = 2700A/μs V <sub>GE</sub> = ±15V, L <sub>S</sub> = 200nH R <sub>G(ON)</sub> = 4.3Ω, R <sub>G(OFF)</sub> = 12Ω, C <sub>GE</sub> = 133nF Integral diode used as freewheel diode (Note 3 & 4)	μs
t <sub>r(V)</sub>	Rise time	-	4.4	-		μs
Q <sub>g(on)</sub>	Turn-on gate charge	-	9	-		μC
E <sub>on</sub>	Turn-on energy	-	12	-		J
t <sub>d(off)</sub>	Turn-off delay time	-	4.8	-		μs
t <sub>f(l)</sub>	Fall time	-	2.6	-		μs
Q <sub>g(off)</sub>	Turn-off gate charge	-	10	-		μC
E <sub>off</sub>	Turn-off energy	-	8.7	-		J
I <sub>SC</sub>	Short circuit current	-	5000	-		V <sub>GE</sub> = +15V, V <sub>CC</sub> = 2800V, V <sub>CEmax</sub> ≤ V <sub>CES</sub> , t <sub>p</sub> ≤ 10μs

### Diode Characteristics

	PARAMETER	MIN	TYP	MAX	TEST CONDITIONS	UNITS
V <sub>F</sub>	Forward voltage	-	3.3	3.6	I <sub>F</sub> = 1600A, T <sub>j</sub> = 25°C	V
		-	3.45	3.8	I <sub>F</sub> = 1600A	V
V <sub>T0</sub>	Threshold voltage	-	-	2.14	Current range 530A - 1600A	V
r <sub>T</sub>	Slope resistance	-	-	1.04		mΩ
I <sub>rm</sub>	Peak reverse recovery current	-	1270	-	I <sub>F</sub> = 1600A, V <sub>r</sub> = 2800V, V <sub>GE</sub> = -15V, di/dt = 2700A/μs	A
Q <sub>rr</sub>	Recovered charge	-	1960	-		μC
t <sub>rr</sub>	Reverse recovery time, 50% chord	-	1.75	-		μs
E <sub>r</sub>	Reverse recovery energy	-	2.03	-		J

### Thermal Characteristics

	PARAMETER	MIN	TYP	MAX	TEST CONDITIONS	UNITS
R <sub>thJK</sub>	Thermal resistance junction to sink, IGBT	-	-	7.8	Double side cooled	K/kW
		-	-	12.8	Collector side cooled	K/kW
		-	-	20.3	Emitter side cooled	K/kW
R <sub>thJK</sub>	Thermal resistance junction to sink, Diode	-	-	12.3	Double side cooled	K/kW
		-	-	19.5	Cathode side cooled	K/kW
		-	-	35.7	Anode side cooled	K/kW
F	Mounting force	50	-	70	Note 2	kN
W <sub>t</sub>	Weight	-	2	-		kg

Notes:-

- 1) Unless otherwise indicated T<sub>j</sub> = 125°C.
- 2) Consult application note 2008AN01 for detailed mounting requirements
- 3) C<sub>GE</sub> is additional gate – emitter capacitance added to output of gate drive
- 4) Figures 4 to 10 are obtained using integral diode as freewheeling diode

**Curves**

Figure 1 – Typical collector-emitter saturation voltage characteristics

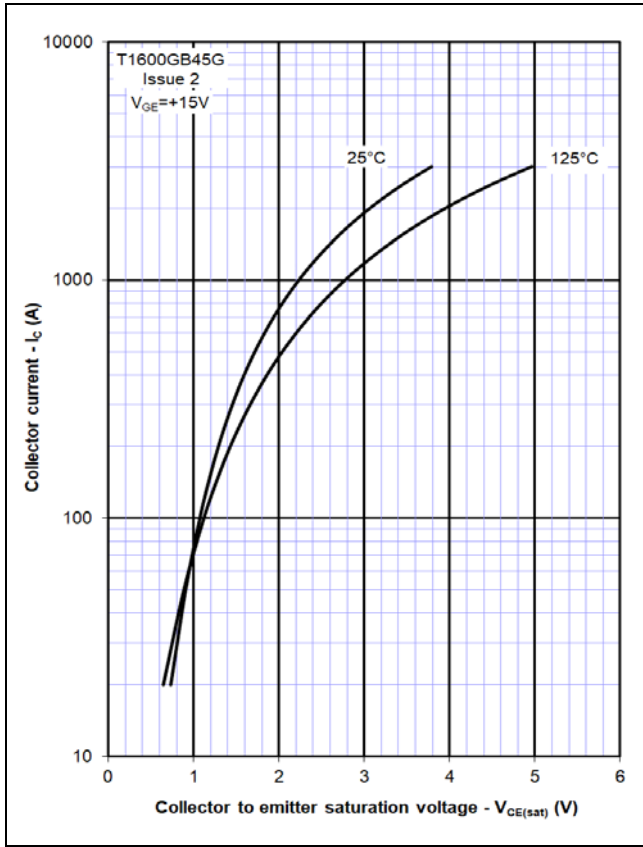


Figure 2 – Typical output characteristic

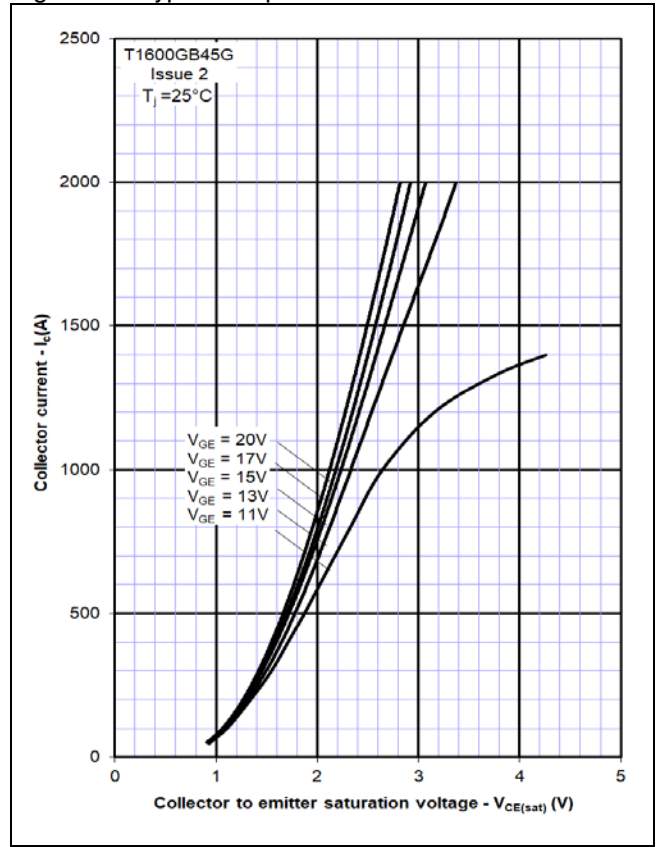


Figure 3 – Typical output characteristic

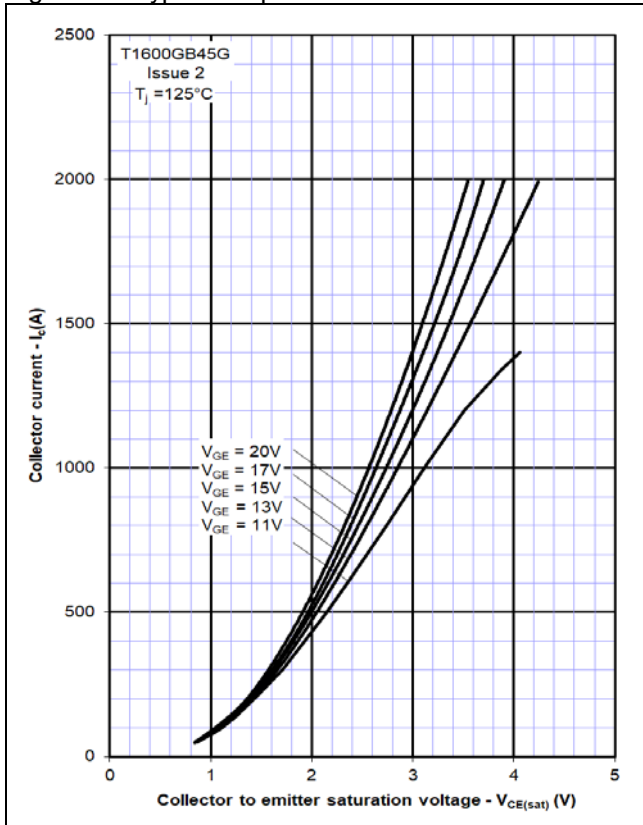


Figure 4 – Typical turn-on delay time vs gate resistance

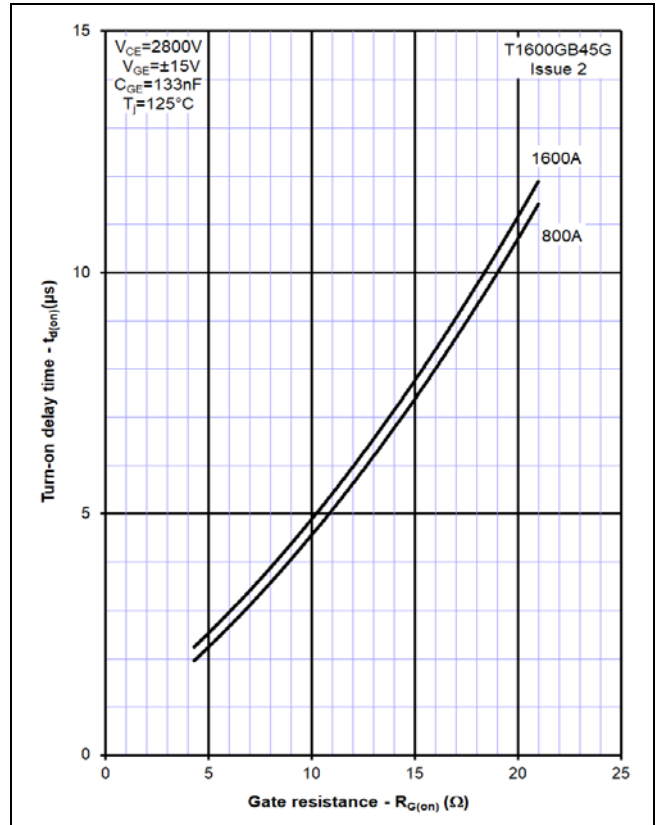


Figure 5 – Typical turn-off delay time vs. gate resistance

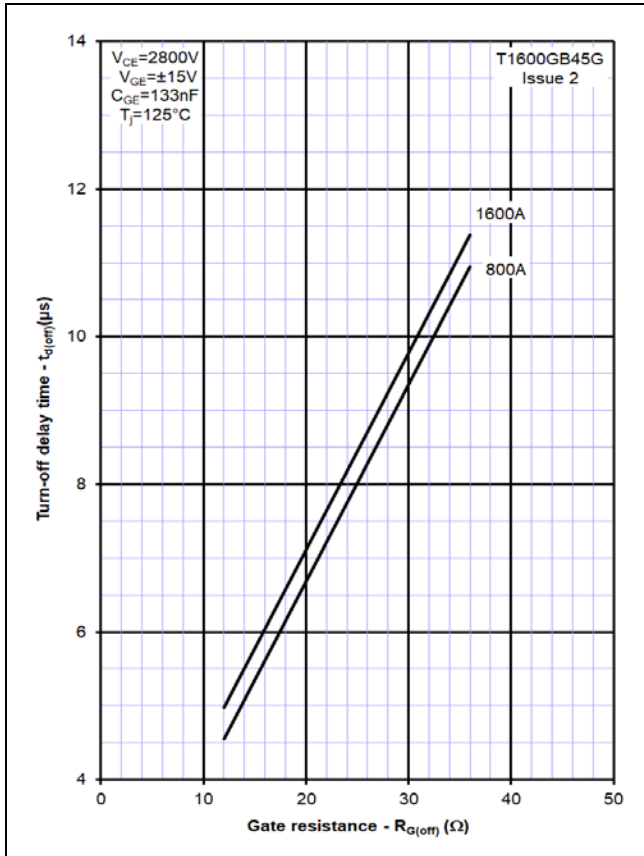


Figure 6 – Typical turn-on energy vs. collector current

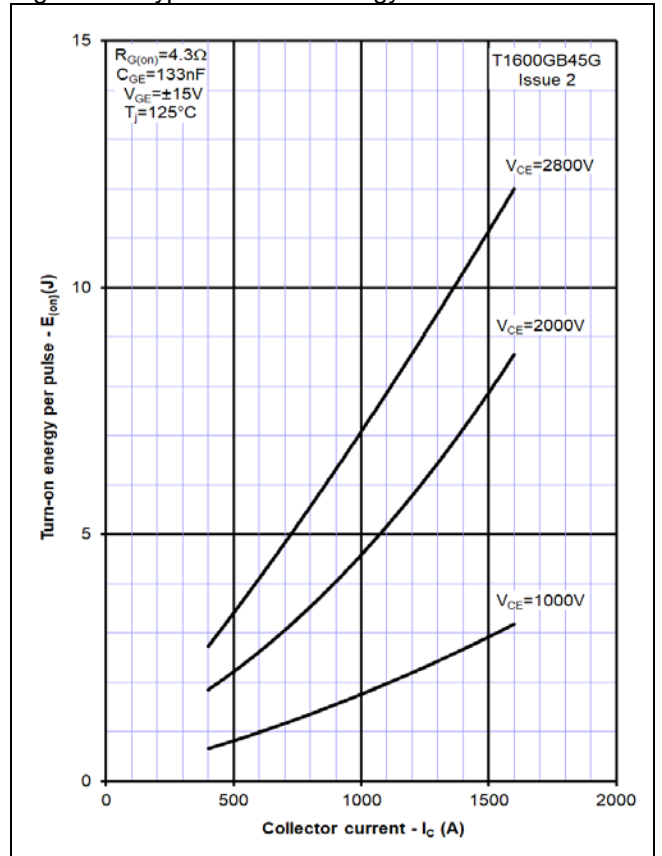


Figure 7 – Typical turn-on energy vs. di/dt

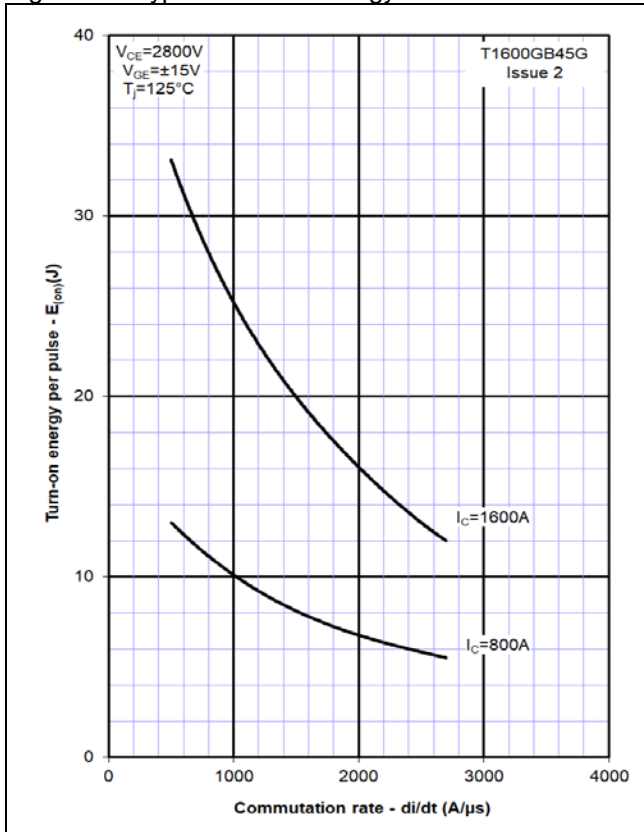


Figure 8 – Typical turn-off energy vs. collector current

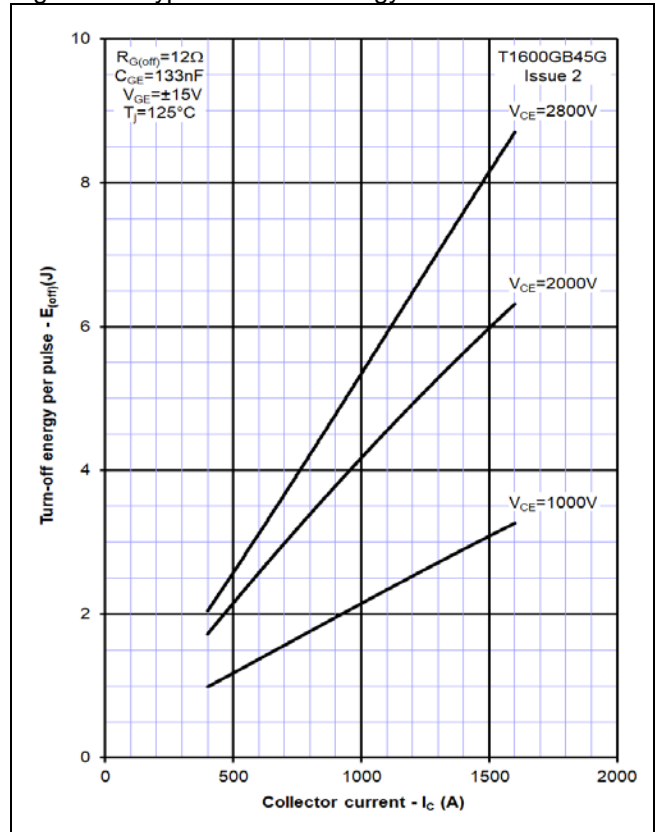


Figure 9 – Turn-off energy vs voltage

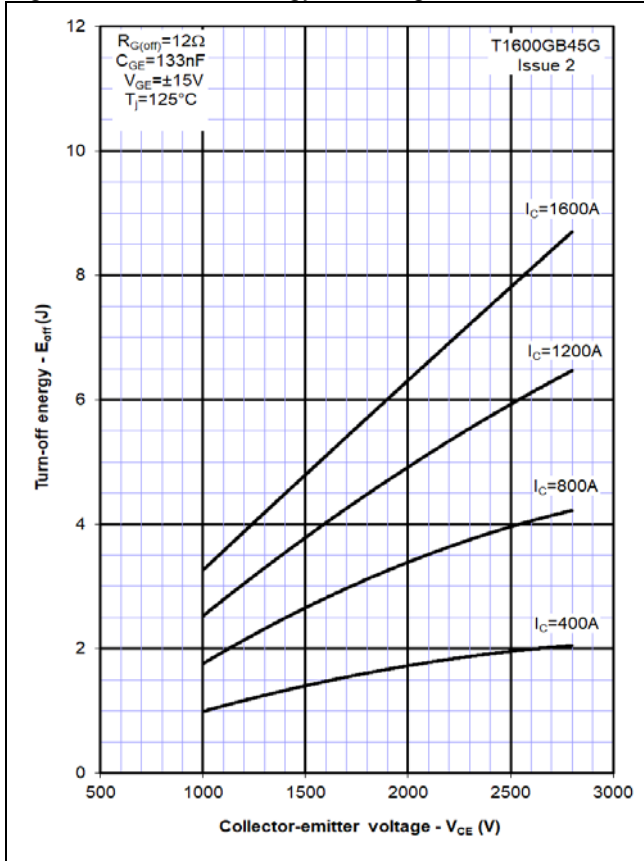


Figure 10 – Safe operating area (IGBT)

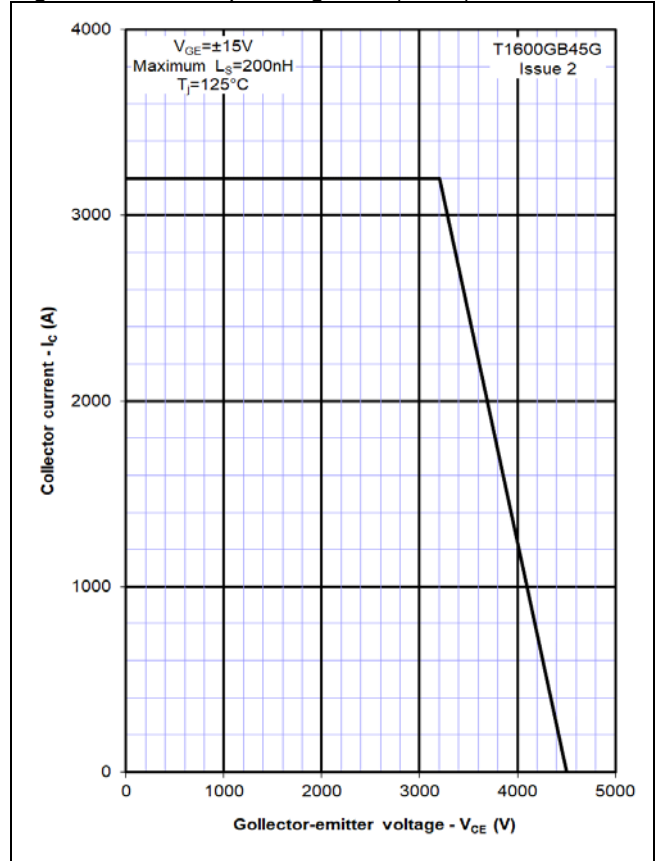


Figure 11 – Typical diode forward characteristics

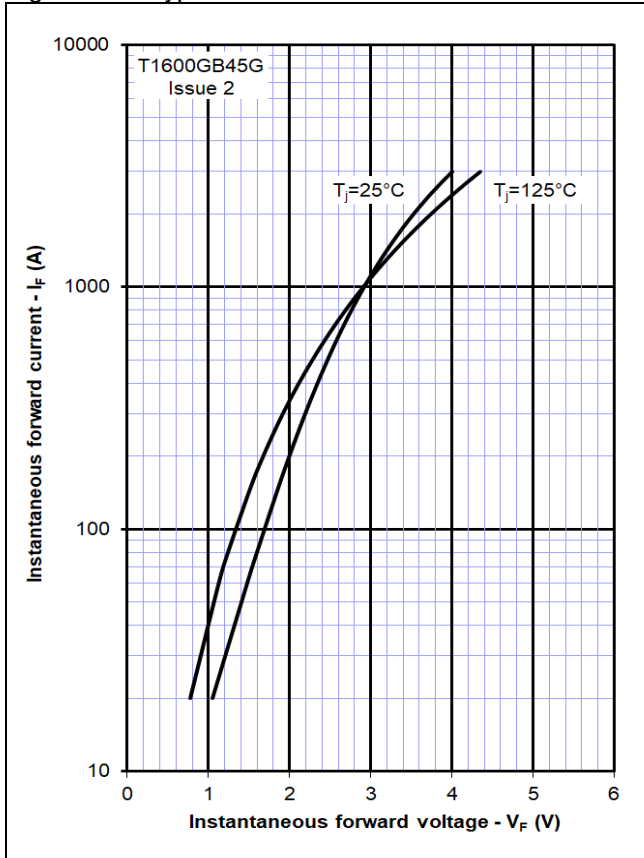


Figure 12 – Typical recovered charge

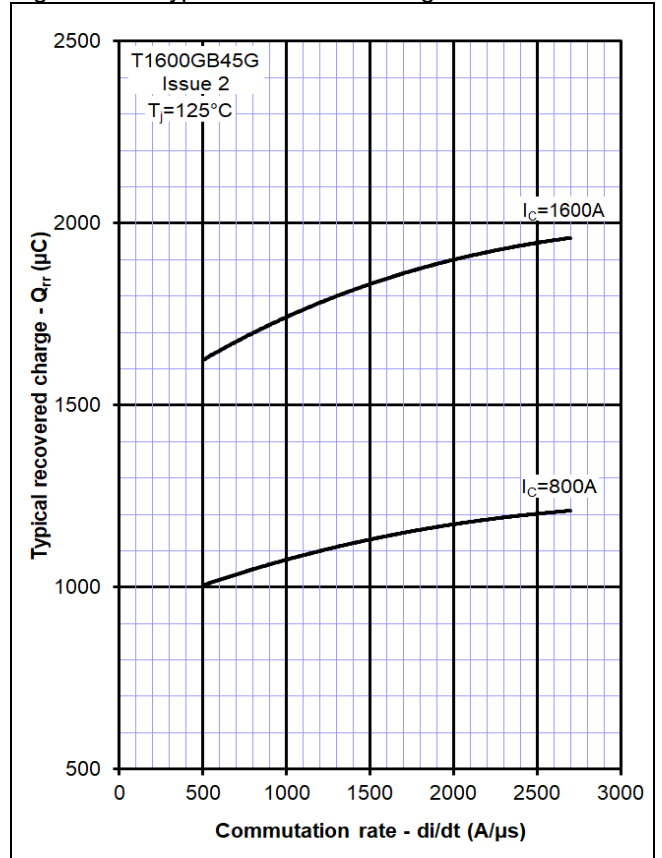


Figure 13 – Typical reverse recovery current

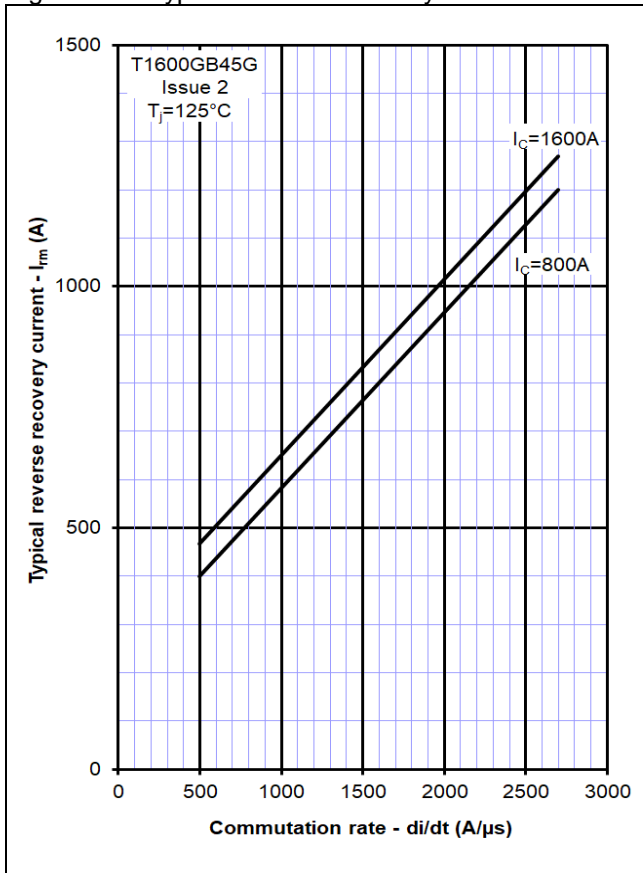


Figure 14 – Typical reverse recovery time

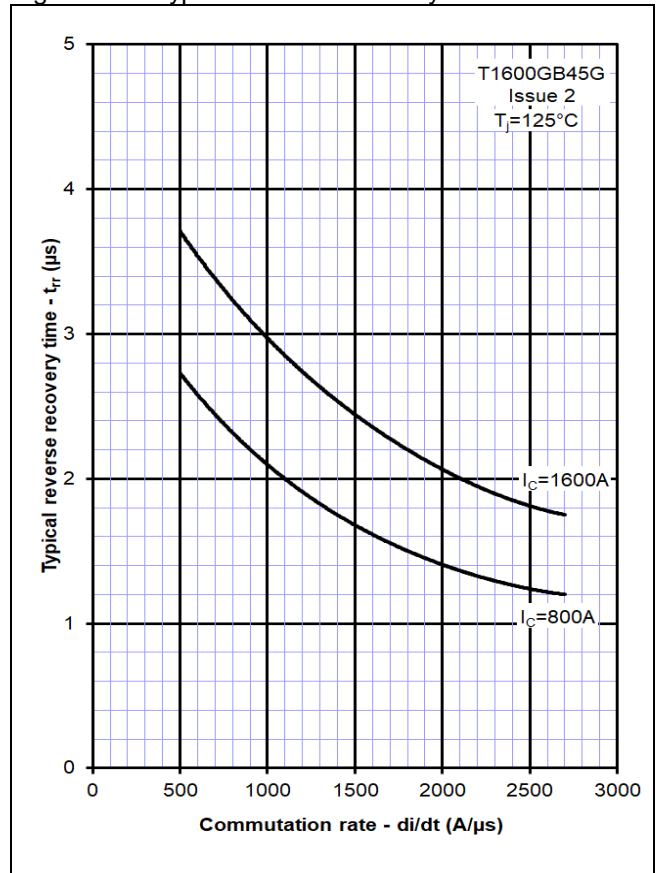


Figure 15 – Typical reverse recovery energy

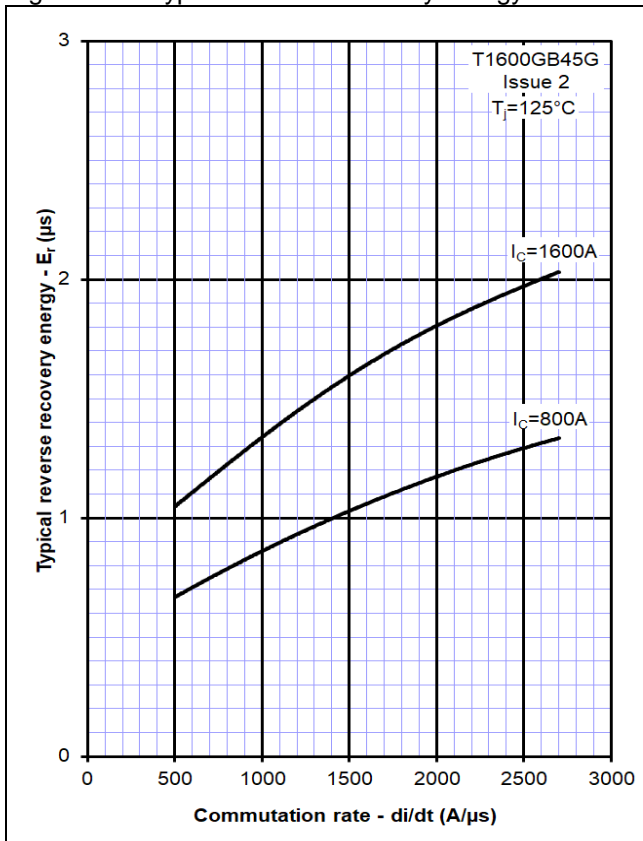


Figure 16 – Safe operating area (Diode)

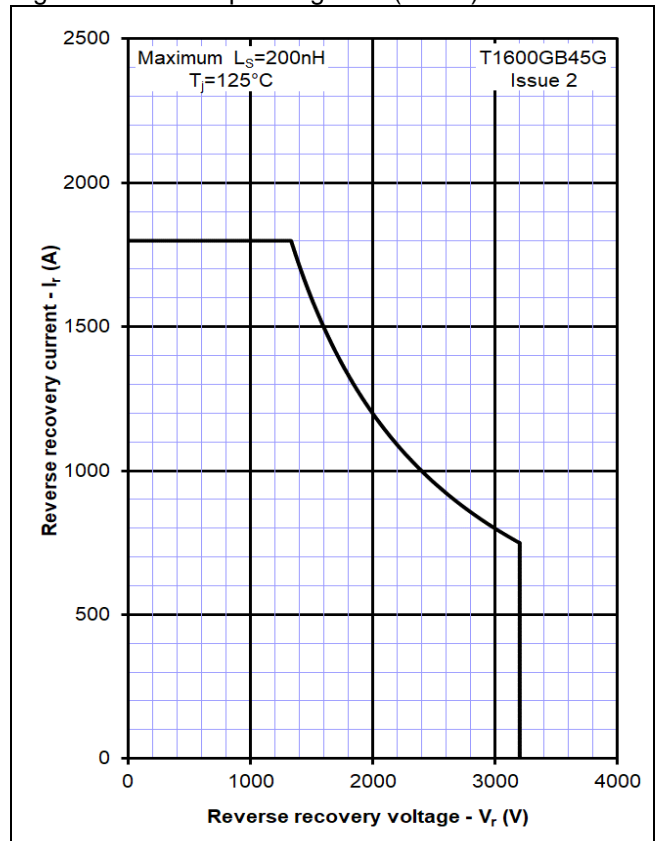


Figure 17 – Transient thermal impedance (IGBT)

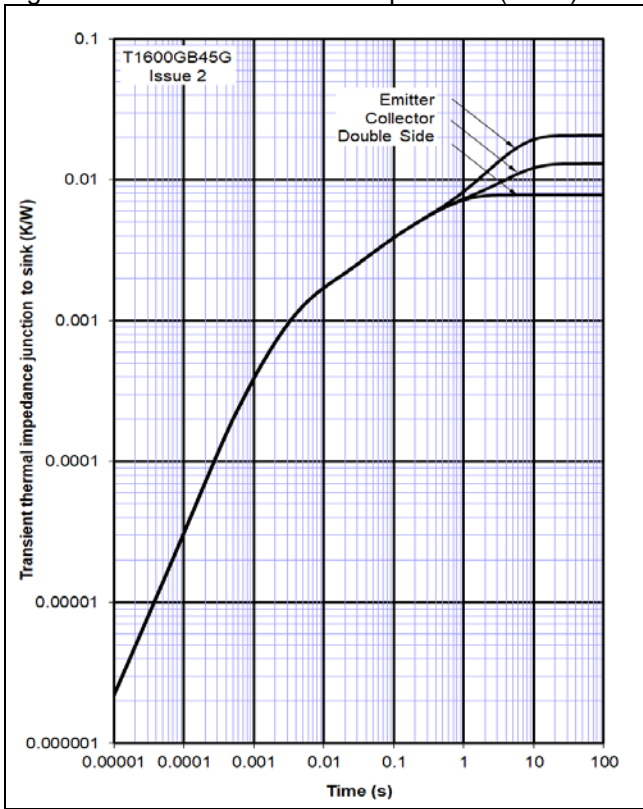
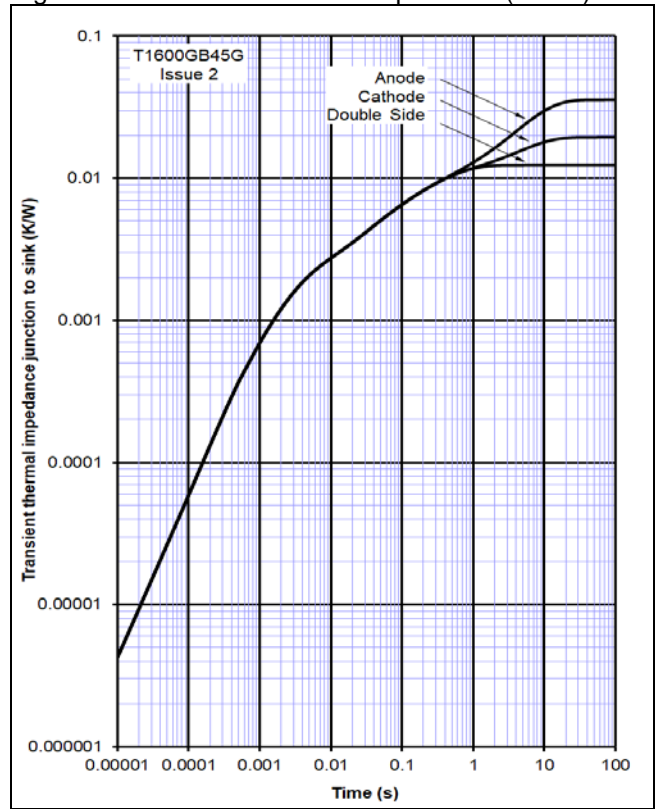
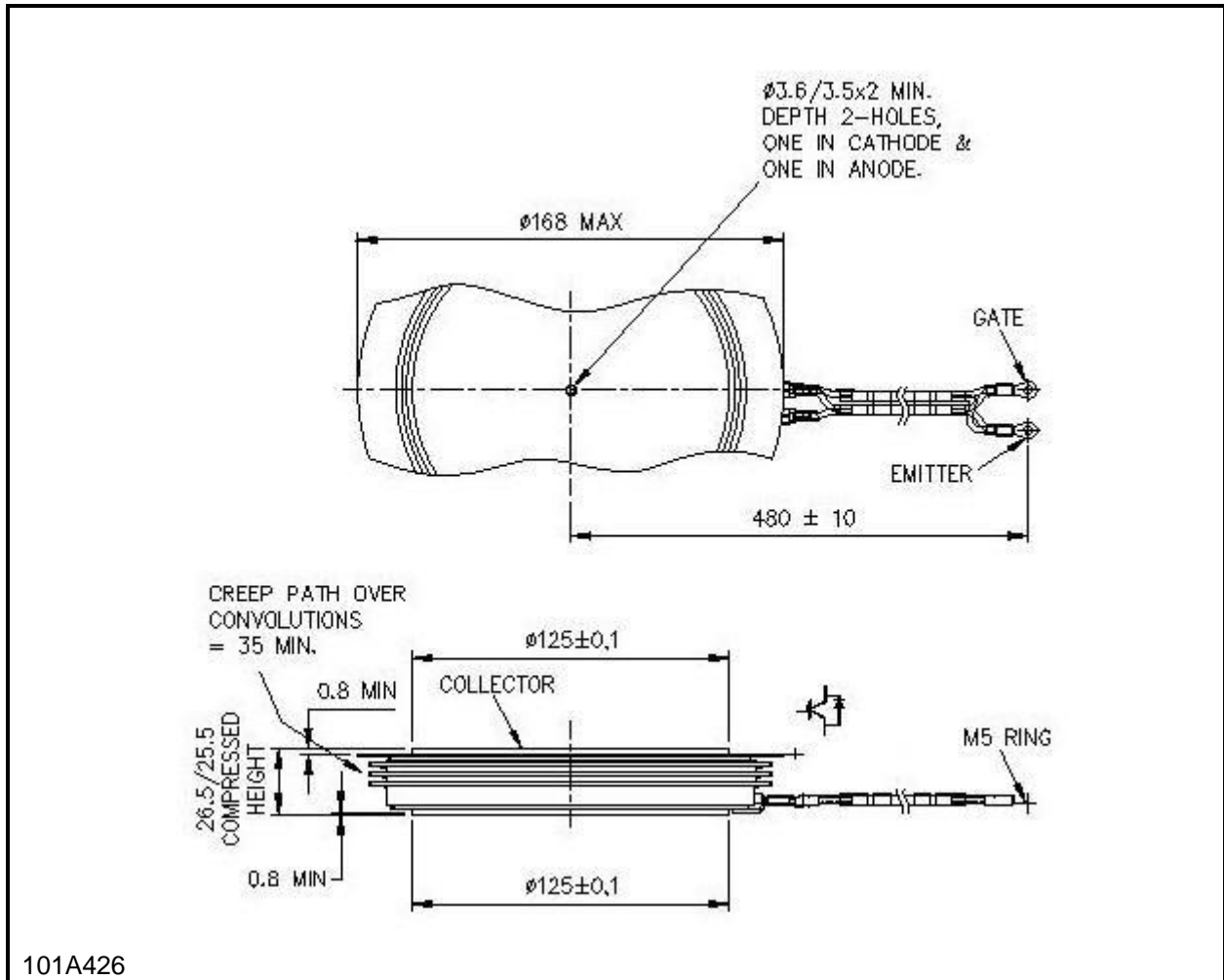


Figure 18 – Transient thermal impedance (Diode)



## Outline Drawing & Ordering Information



### ORDERING INFORMATION

(Please quote 10 digit code as below)

T1600	GB	45	G
Fixed type Code	Fixed Outline Code	Voltage Grade $V_{CES}/100$ 45	Fixed format code

 Typical order code: T1600GB45G ( $V_{CES} = 4500V$ )

**IXYS Semiconductor GmbH**  
 Edisonstraße 15  
 D-68623 Lampertheim  
 Tel: +49 6206 503-0  
 Fax: +49 6206 503-627  
 E-mail: [marcom@ixys.de](mailto:marcom@ixys.de)



**IXYS**  
 A Littelfuse Technology

**IXYS UK Westcode Ltd**  
 Langley Park Way, Langley Park,  
 Chippenham, Wiltshire, SN15 1GE.  
 Tel: +44 (0)1249 444524  
 E-mail: [sales@ixysuk.com](mailto:sales@ixysuk.com)

**IXYS Corporation**  
 1590 Buckeye Drive  
 Milpitas CA 95035-7418  
 Tel: +1 (408) 457 9000  
 Fax: +1 (408) 496 0670  
 E-mail: [sales@ixys.net](mailto:sales@ixys.net)

[www.littelfuse.com](http://www.littelfuse.com)

[www.ixysuk.com](http://www.ixysuk.com)

[www.ixys.net](http://www.ixys.net)

**IXYS Long Beach**  
 IXYS Long Beach, Inc  
 2500 Mira Mar Ave, Long Beach  
 CA 90815  
 Tel: +1 (562) 296 6584  
 Fax: +1 (562) 296 6585  
 E-mail: [service@ixyslongbeach.com](mailto:service@ixyslongbeach.com)

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