WESTCODE

Date:- 10 May, 2001

Data Sheet Issue:- 1

Insulated Gate Bi-polar Transistor

Type T1400TA18A

(capsule type)

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{CES}	Collector – emitter voltage (Note 1)	1800	V
V_{GES}	Peak gate – emitter voltage (Note 1)	±20	V

	RATINGS	MAXIMUM LIMITS	UNITS
I_C	DC – Collector current, IGBT (Note 2)	1400	A
I_{CRM}	Repetitive peak collector current, t_p=1ms, IGBT (Note 2)	2800	A
I_F	DC – Forward current, Diode	1400	A
I_{FRM}	Repetitive peak forward current, t_p=1ms, Diode	2800	A
P_{MAX}	Maximum power dissipation, IGBT	6.6	kW
T_j	Operating temperature range (Note 3)	-60 to +150	°C
T_{stg}	Storage temperature range (Note 3)	-60 to +150	°C

Notes: -
1) Unless otherwise indicated T_j = 125ºC
2) T_C = 90°C
3) For operation below –40°C or above 125°C please contact factory

Introduction

This rating report represents the outline specification for an Insulated gate bi-polar transistor (IGBT) housed in a 75mm boss diameter hermetic cold weld capsule.

Characteristics

	PARAMETER	MIN	TYP	MAX	TEST CONDITIONS	UNITS
	IGBT Characteristics					
$V_{CE(sat)}$	Collector – emitter saturation voltage	- -	4.1 5.3	4.3 5.5	I_C = 1400A, V_{GE} = 15V, T_j = 25°C I_C = 1400A, V_{GE} = 15V	V V
V_o r_s	Threshold voltage Slope resistance	- -	- -	2 2.5	Current range 400A – 1400 A	V mΩ
$V_{GE(TH)}$ I_{CES} I_{GES} C_{ies}	Gate threshold voltage Collector – emitter cut-off current Gate leakage current Input capacitance	4 - - -	5.5 - 0.05 150	7 100 ±1 -	V_{CE} = V_{GE}, I_C = 20mA V_{CE} = V_{CES}, V_{GE} = 0V V_{GE} = ±20V V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	V mA mA nF
$t_{d(on)}$ $t_r(I)$ t_{on} $Q_{g(on)}$ E_{on} $t_{d(off)}$ t_f $Q_{g(off)}$ E_{off}	Turn-on delay time Rise time Turn-on time Turn-on gate charge Turn-on energy Turn-off delay time Fall time Turn-off gate charge Turn-off energy	- - - - - - - - -	0.85 0.3 1.85 13 280 1.6 0.75 17.0 525	1.25 - 2.75 - - 2.0 1.0 - -	I_C =1400A, V_{CE} = 0.5V_{CES}, V_{GE} = ±15V, $R_{g(ON)}$=1Ω $R_{g(OFF)}$=5Ω,	µs µs µs µC mJ µs µs µC mJ
	Diode Characteristics.					
V_F	Forward voltage	- -	2 2.1	2.4 2.5	I_F = 1400A, T_j =25°C I_F = 1400A	V V
V_o r_s	Threshold voltage Slope resistance	- -	- -	1.28 0.87	Current range 400A – 1400 A	V mΩ
I_{rm} Q_{ra} t_{rr}	Peak reverse recovery current Recovered charge (50% chord) Reverse recovery time (50% chord)	- - -	300 260 1.4	380 360 1.8	I_F = 1400A, V_{GE} =0V, di/dt = 600A/µs	A µC µs
	Thermal & Mechanical					
$R_{th(j-hs)}$	Thermal impedance junction to sink, IGBT	- - -	- - -	15 25 39	Double side cooled Collector side cooled Emitter side cooled	K/kW K/kW K/kW
$R_{th(j-hs)}$	Thermal impedance junction to sink, Diode	- - -	- - -	35 52 104	Double side cooled Cathode side cooled Anode side cooled	K/kW K/kW K/kW
F W_t	Mounting force Weight	20 -	- 1.2	30 -	(see note 2)	kN kg

Notes:-
1) Unless otherwise indicated T_j=125°C.
2) For other clamping forces, consult factory.

Notes on Ratings and Characteristics

Maximum Ratings

1.0 Collector-emitter voltage

This is measured with a mechanical short circuit connected between gate and emitter. The gate to cathode should not be open-circuit when device is required to support voltage collector to emitter, as the device may be damaged.

2.0 Peak gate-emitter voltage

This is measured with a mechanical short circuit connected between collector and emitter.

3.0 Collector current (IGBT) and Forward current (Diode)

DC condition represents the nominal operating current for the device.

$$I_{C(AV)(T_C)} = \frac{V_0}{2.r_s} + \sqrt{\frac{V_0^{\ 2}}{4.r_s^{\ 2}} + \frac{(T_j - T_c)}{R_{th}.r_s}}$$

4.0 Maximum power

The maximum power dissipation for the IGBT under continuous operating conditions, double side cooled.

Characteristics

5.0 Collector-emitter saturation voltage

The figures given in the characteristics, at the nominal operating current, are supplemented by figures 1 & 2, which give the typical and maximum saturation voltage against collector current. Curves were measured with a forward gate voltage of +15V.

6.0 ABCD Constants

The on-state characteristic I_C vs $V_{CE(SAT)}$, is represented in two ways;

(i) the well established V_0 and r_s tangent used for rating purposes and

(ii) a set of constants A, B, C, D, forming the coefficients of the representative equation for $V_{CE(SAT)}$ in terms of I_C given as:

$$V_{CE(sat)} = A + B \cdot \ln(I_C) + C \cdot I_C + D \cdot \sqrt{I_C}$$

The constants, derived by curve fitting software, are given in this report for both typical & maximum hot characteristics where possible. The resulting values for $V_{CE(SAT)}$ agree with the true device characteristic over a limited current range which is generally that over which the curve is plotted.

	Typical coefficients	Maximum coefficients
A	-0.72348816	-0.52348816
B	0.379996	0.379996
C	1.336454×10^{-3}	1.336454×10^{-3}
D	0.03740789	0.03740789

7.0 Transfer characteristic.

The typical transfer characteristics, at 25 & 125°C, are included in figures 3 & 4 against collector currents of 700A, 1000A and 1400A.

8.0 Leakage currents

These are measured at grade voltage and maximum junction temperature. For I_{CES}, V_{GE} = short circuit. Note: typical values would be much lower.

9.0 Dynamic gate characteristics

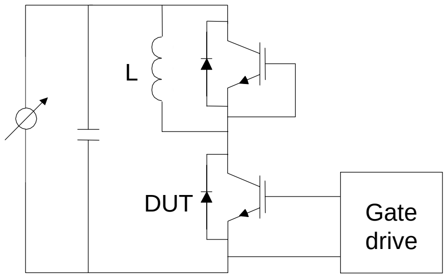
Typical values of gate charge and peak current against series gate resistance, at turn-on and turn-off, are included in figures 5 to 8, device is measured under normal conditions with V_{CE}>20V. Curves are included for gate voltage in the range ±5 to 20V.

10.0 Switching characteristics (IGBT)

Typical and maximum switching times are included in the characteristics table, at the nominal operating current, under inductive load conditions. Figures 9 to 12 give typical switching times against series gate resistance for collector currents of 700 & 1400A, with a gate voltage of ±15V.

11.0 Switching losses (IGBT)

Typical turn-on and turn-off energy against collector current are included in figures 13 to 16. All switching characteristics are measured using the inductive switching circuit outlined in the diagram shown below and a 0.48µF 5.0Ω RC snubber is connected across the test device.



12.0 Reverse bias safe operating area

The curve in figure 17 shows the typical RBSOA. This is defined as the maximum simultaneous collector current and collector emitter voltage that the device can safely switch without breakdown. The maximum collector current is 200% rated at full rated V_{CES}.

13.0 Forward bias safe operating area into short circuit

To prevent damage occurring by short circuits in IGBT circuitry, it is usual to detect this condition and generate an inhibit signal within the gate driver to turn-off the IGBT. The reaction time for the gate detection and storage time of the IGBT must be taken into account. During this period the IGBT must withstand the full short circuit. The IGBT is rated to withstand a short circuit of 10µs. The actual value of the short circuit current is determined by the IGBT characteristics

14.0 Maximum frequency of IGBT

The maximum operating frequency has been calculated as a function of maximum power dissipation, line voltage, total switching losses, conduction losses, $V_{CE(SAT)}$, duty factor and RMS current.

15.0 Diode forward characteristics

The forward voltage in the characteristic table, at the nominal operating current, is supplemented by figures 20 and 21, which give the typical and maximum forward voltage against forward current.

15.1 ABCD Coefficients

The forward characteristic I_F vs. V_F is represented in two ways:

(i) the well established V_o and r_s tangent used for rating purposes and;

(ii) a set of constants A, B, C, D, forming the coefficients of the representative equation for V_F in terms of I_F given as:

$$V_F = A + B \cdot \ln(I_F) + C \cdot I_F + D \cdot \sqrt{I_F}$$

The constants, derived by curve fitting software, are given in this report for both typical & maximum hot characteristics where possible. The resulting values for V_F agree with the true device characteristic over a limited current range which is generally that over which the curve is plotted.

	Typical coefficients	Maximum coefficients
A	0.25867154	0.65867154
B	0.02979237	0.02979237
C	2.453228×10^{-4}	2.453228×10^{-4}
D	0.03426433	0.03426433

16.0 Diode recovery characteristics

The figures given in the characteristic table are supplemented by curves 22 to 25. Curves are included for maximum and typical recovered charge plus typical peak recovery current and recovery time against commutation rate. All curves are given at the nominal operating current of 1400A.

17.0 Thermal and mechanical characteristics

Double and single side transient thermal impedance characteristics are included in figures 26 & 27 for the IGBT & Diode respectively.

18.0 Handling Precautions

Precautions against electrostatic failure.
IGBT semiconductors are electrostatic-sensitive devices and require special handling techniques in accordance with British Standard BS EN 100015-1 1992.

Curves

Figure 1 – Typical collector-emitter saturation voltage characteristics

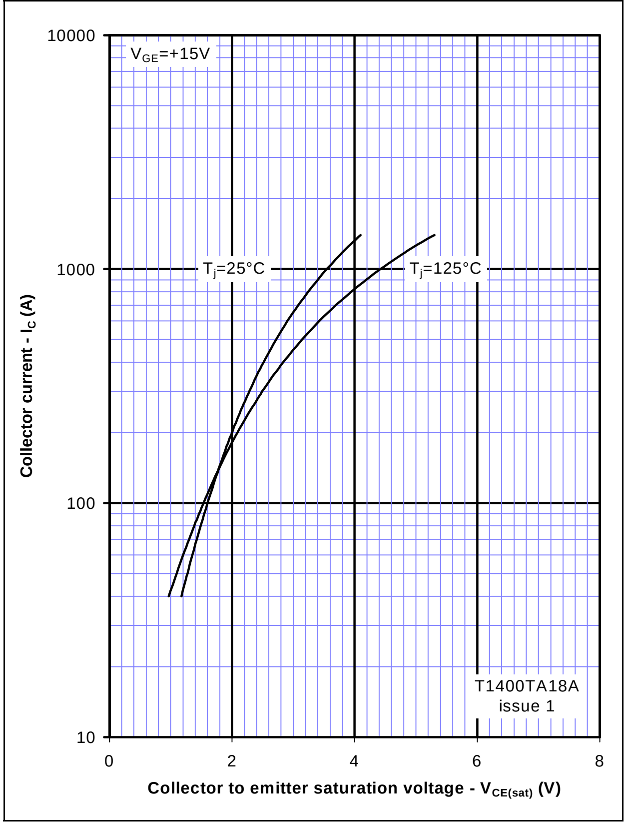


Figure 2 – Maximum collector-emitter saturation voltage characteristics

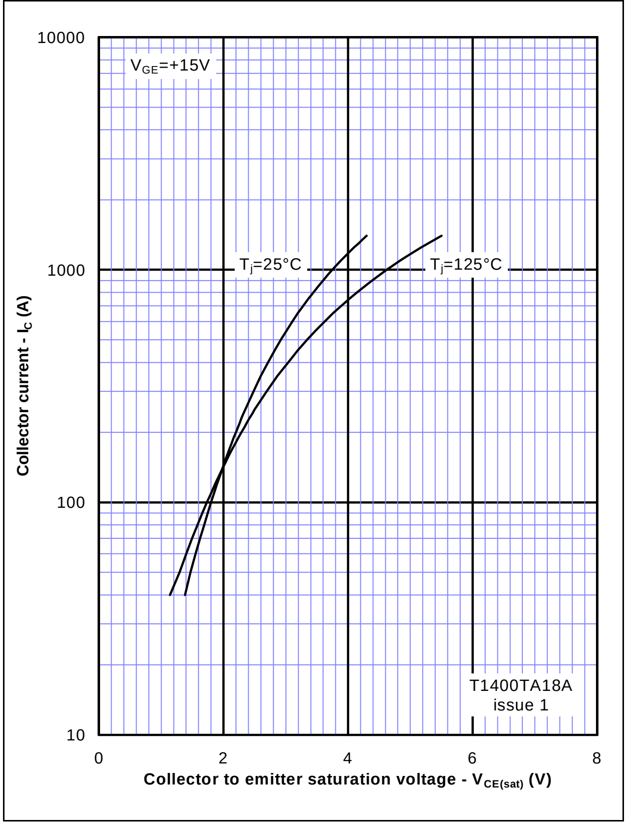


Figure 3 – Typical transfer characteristic at 25°C

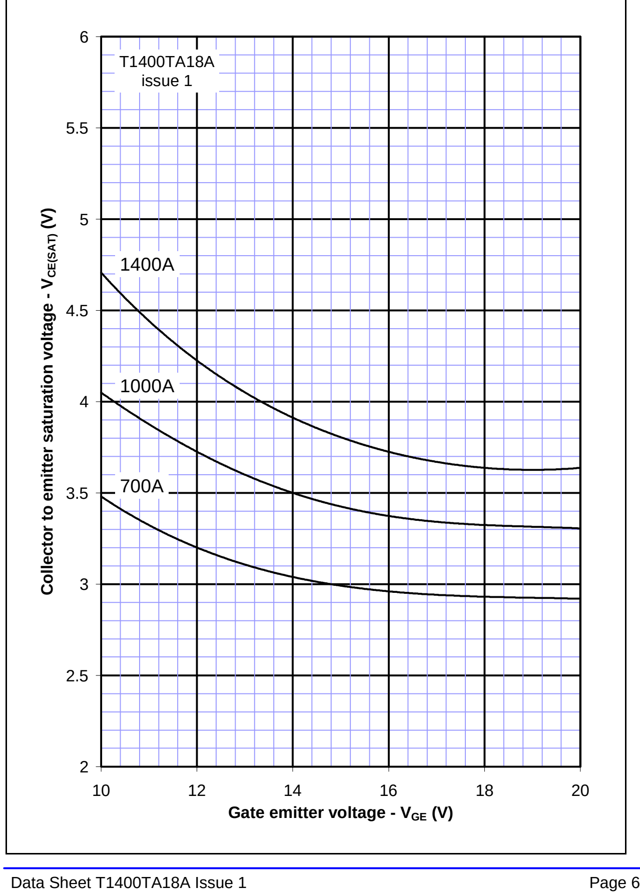


Figure 4 – Typical transfer characteristic at 125°C

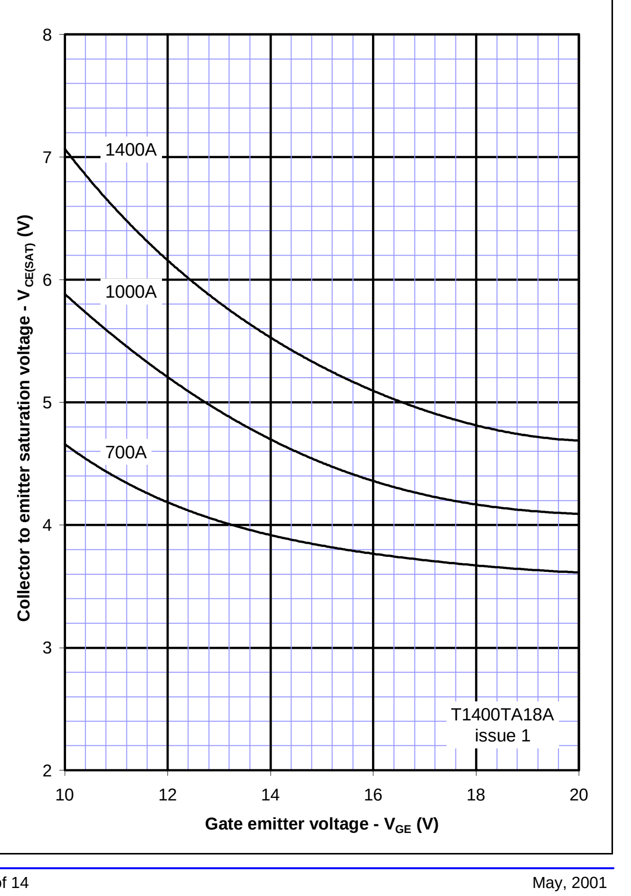


Figure 5 – Typical peak turn-on gate current

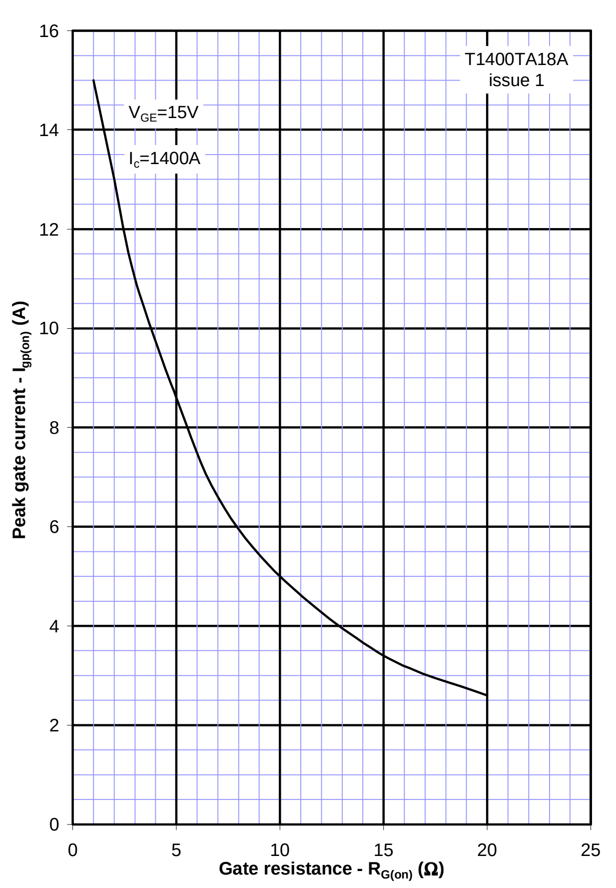


Figure 6 – Typical turn-on gate charge

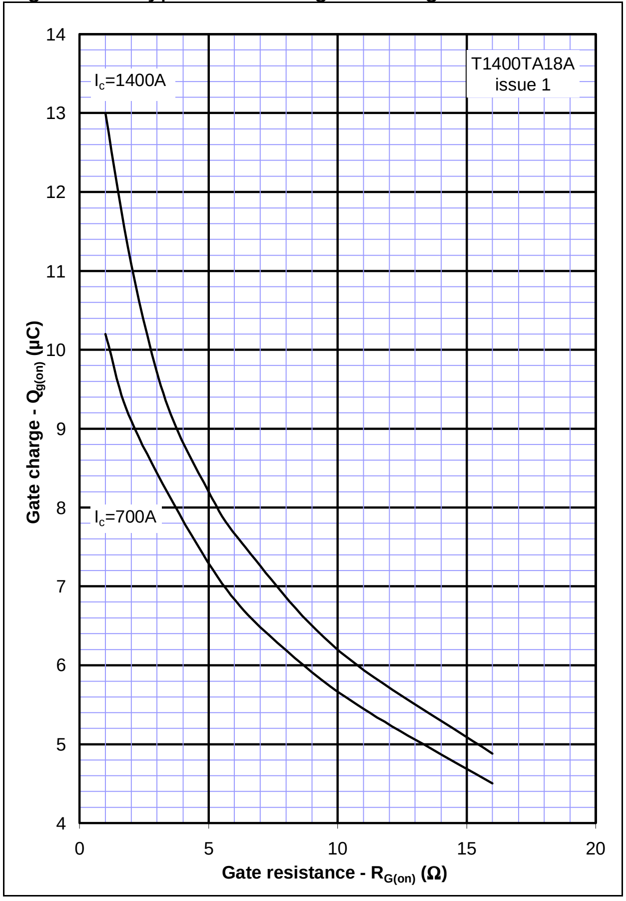


Figure 7 – Typical peak turn-off gate current

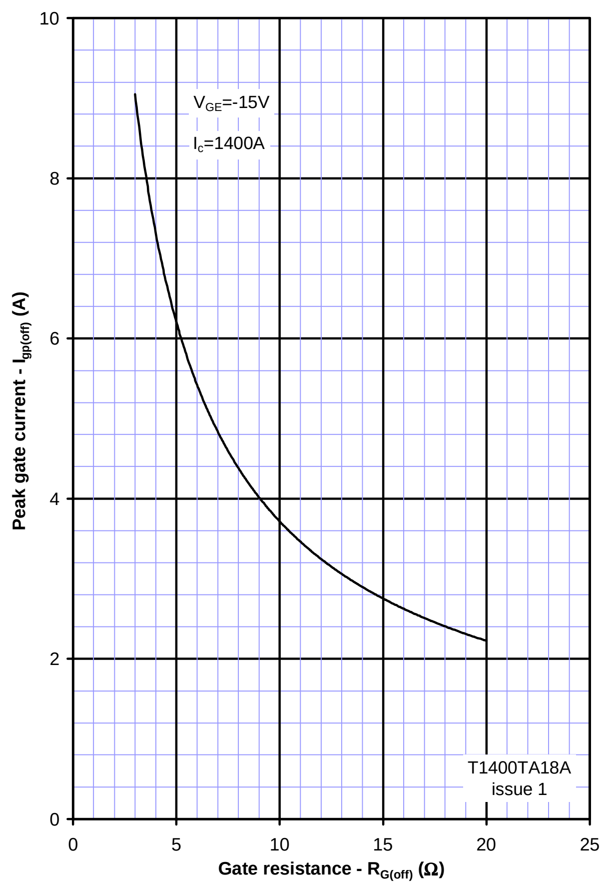


Figure 8 – Typical turn-off gate charge

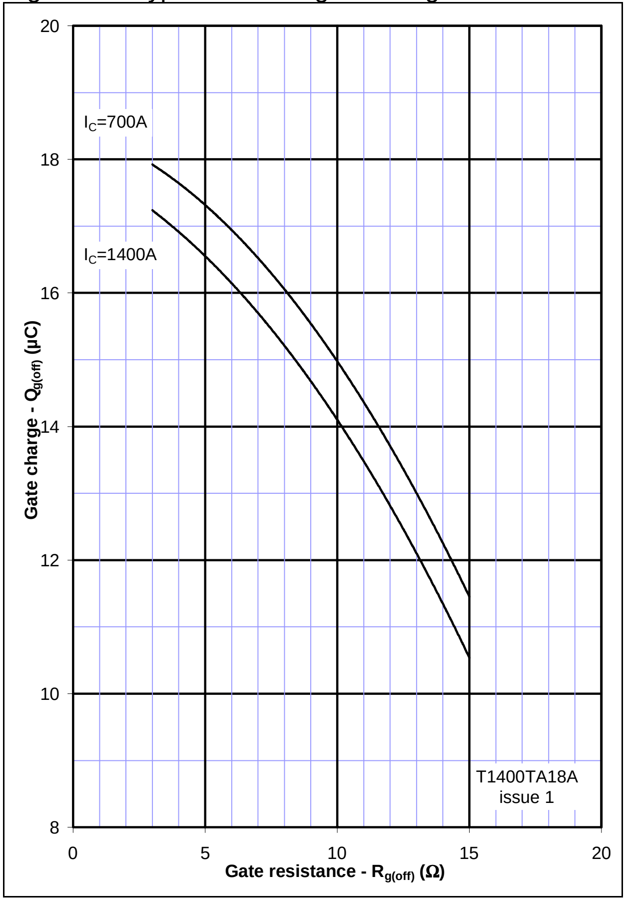


Figure 9 – Typical turn-on delay time vs gate resistance

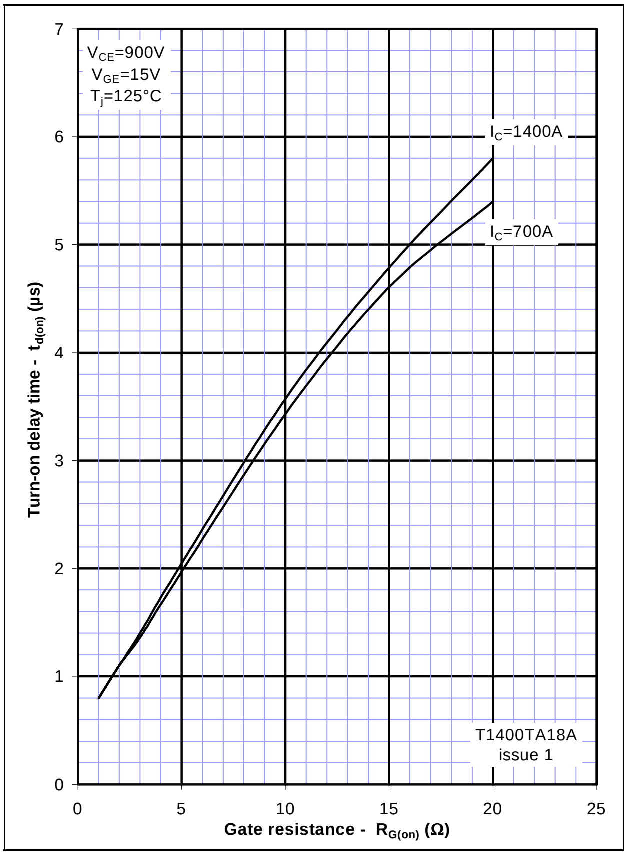


Figure 10 – Typical rise time vs gate resistance

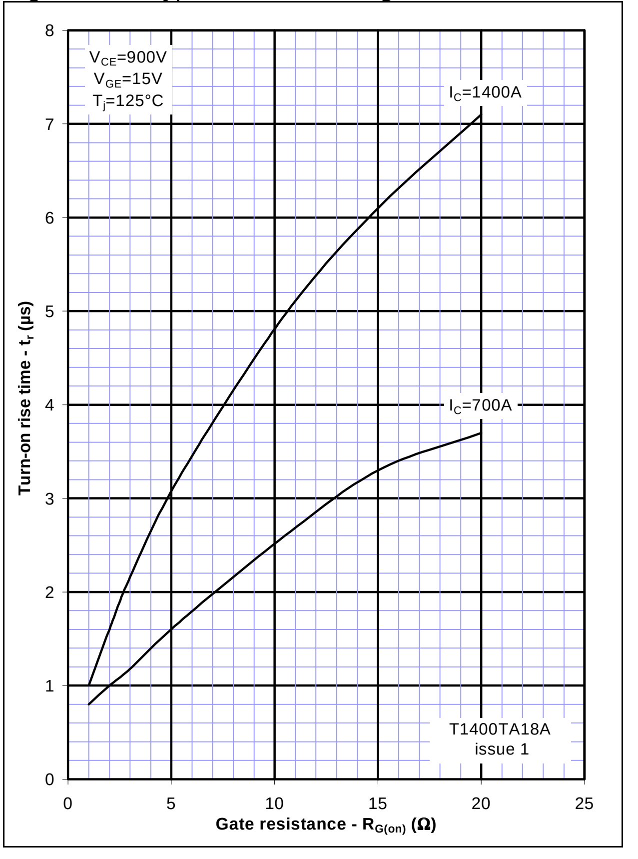


Figure 11 – Typical turn-off delay time vs gate resistance

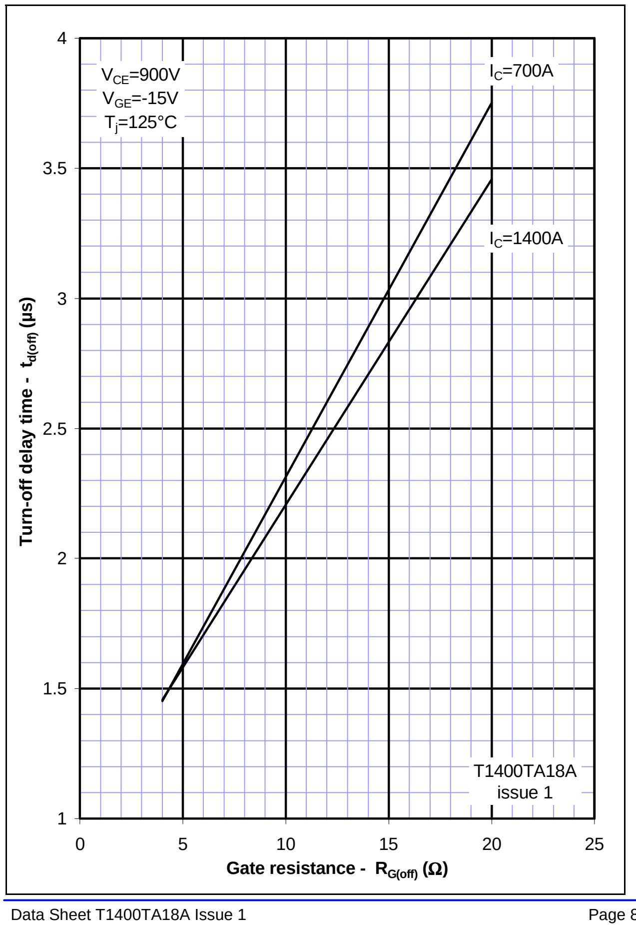


Figure 12 – Typical fall time vs gate resistance

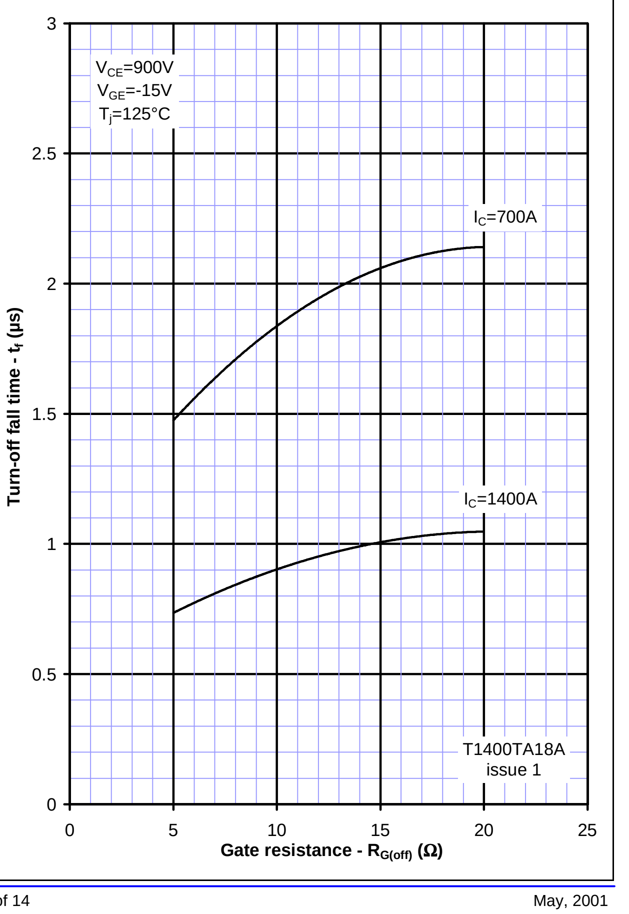


Figure 13 – Typical turn-on energy vs. collector current

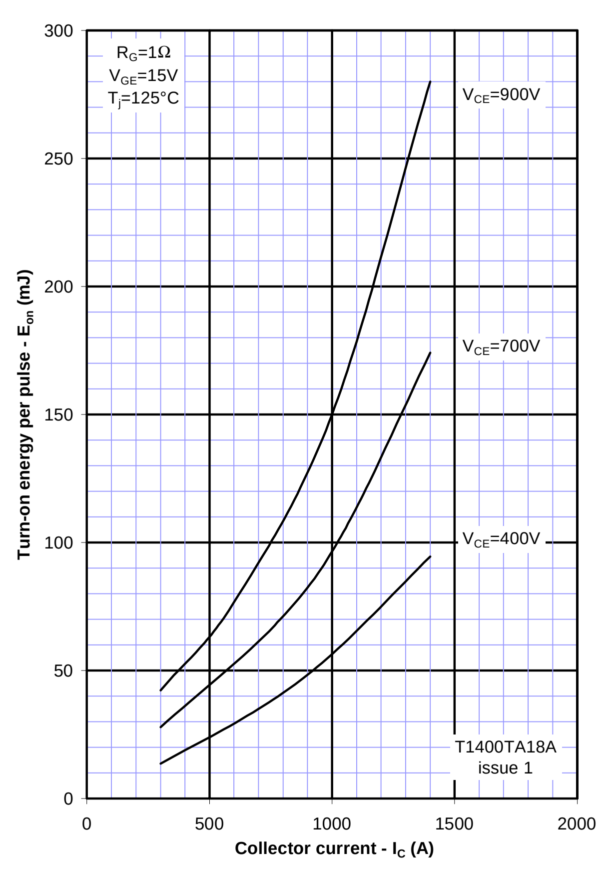


Figure 14 – Typical turn-on energy vs. gate resistance

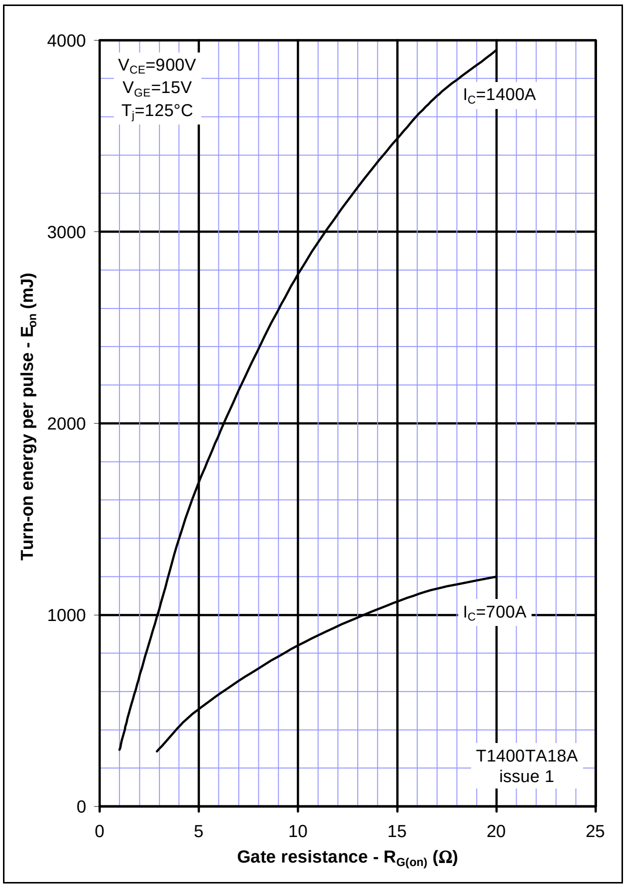


Figure 15 – Typical turn-off energy vs. collector current

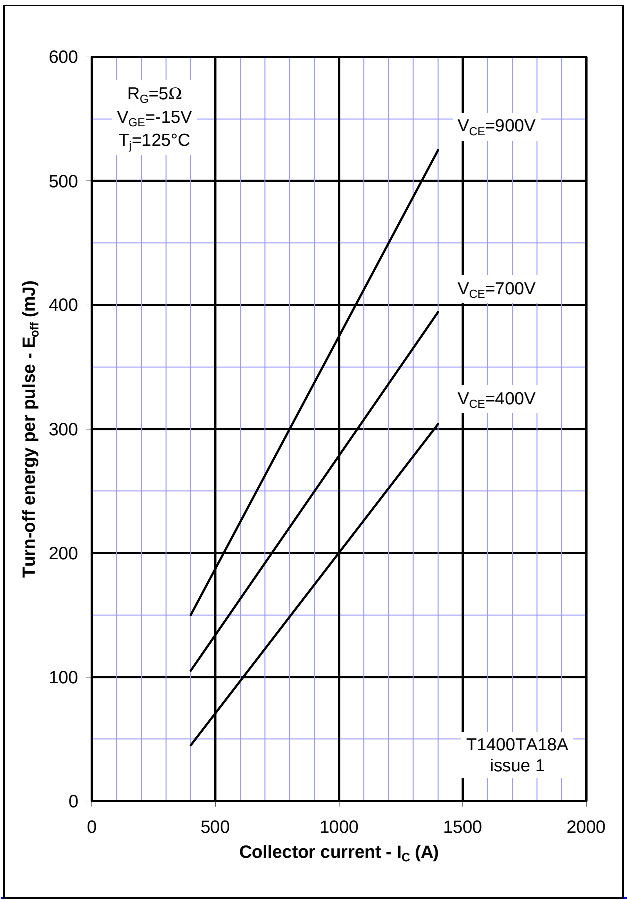


Figure 16 – Typical turn-off energy vs. gate resistance

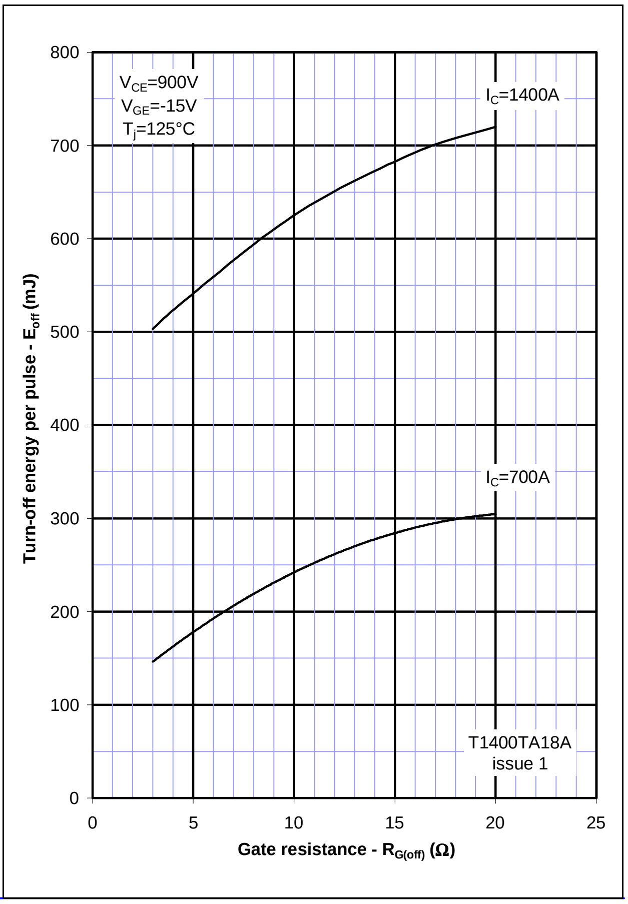


Figure 17 – RBSOA

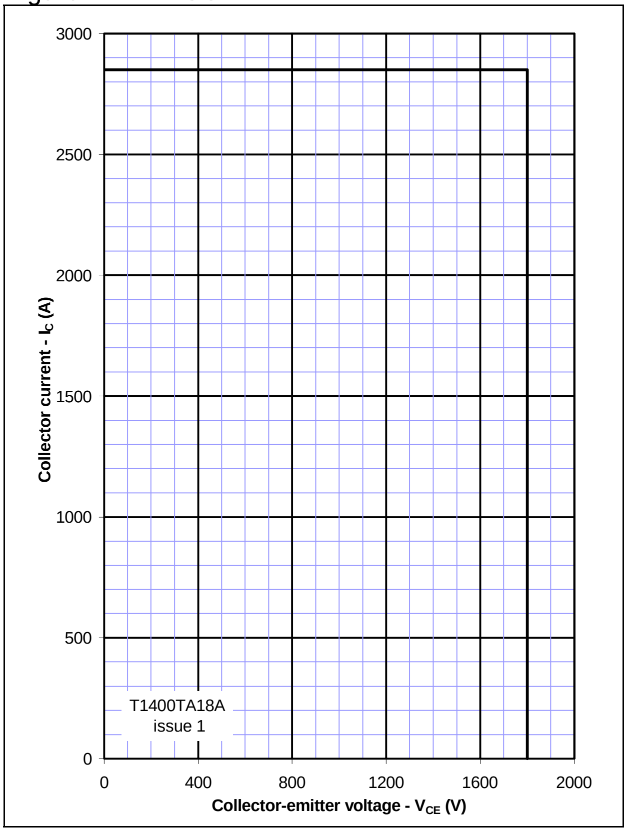


Figure 18 – FBSOA into short circuit

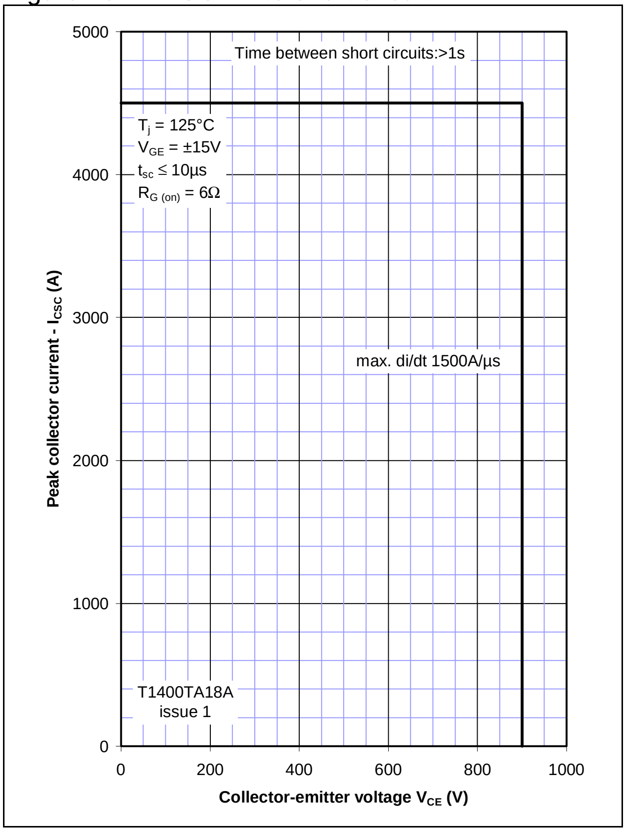


Figure 19 – Maximum operating frequency

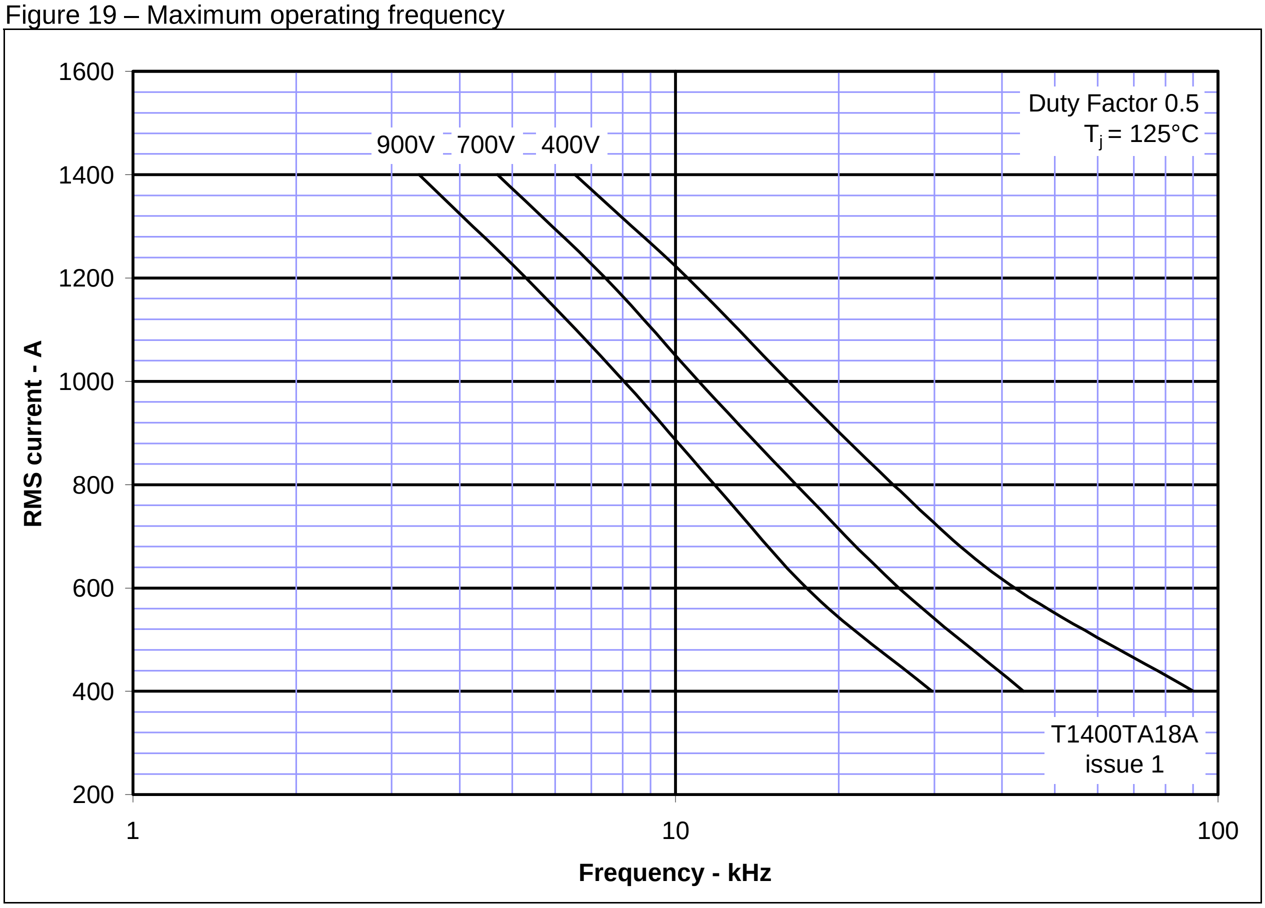


Figure 20 – Typical diode forward characteristic

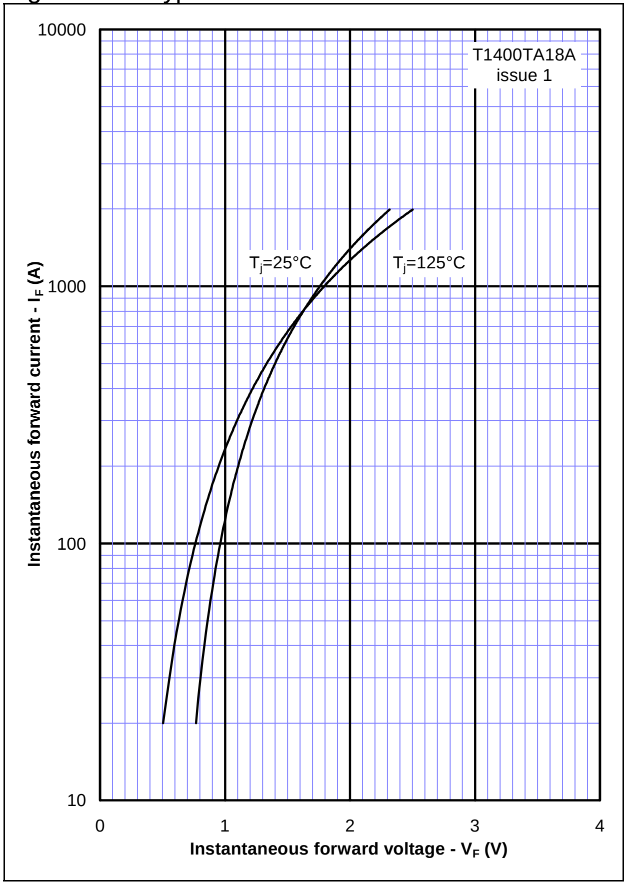


Figure 21 – Maximum diode forward characteristic

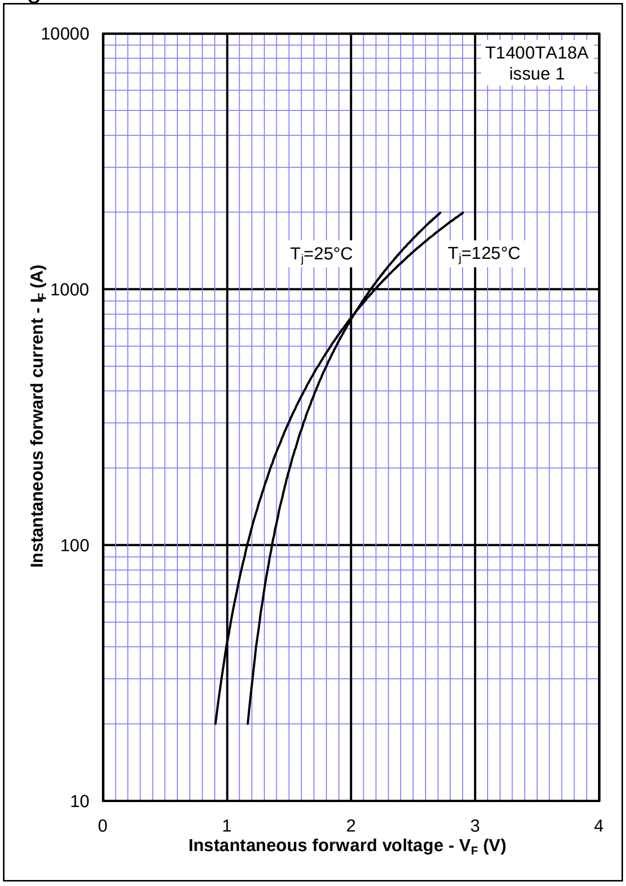


Figure 22 – Typical recovered charge (50% chord)

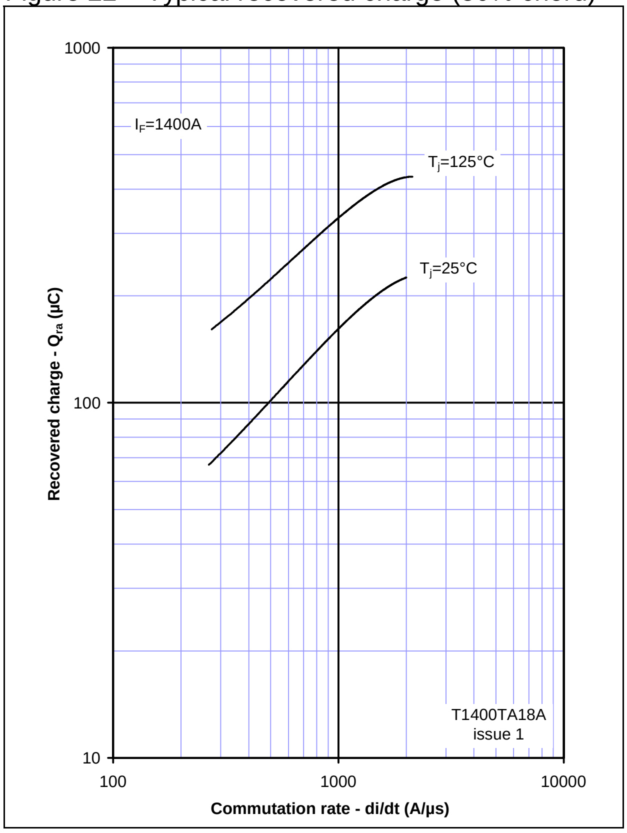


Figure 23 – Maximum recovered charge (50% chord)

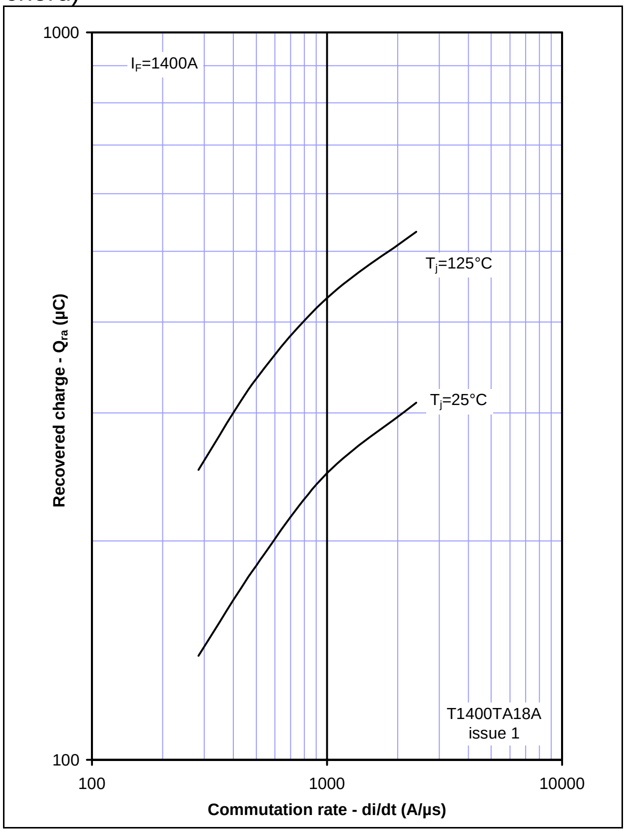


Figure 24 – Typical reverse recovery current

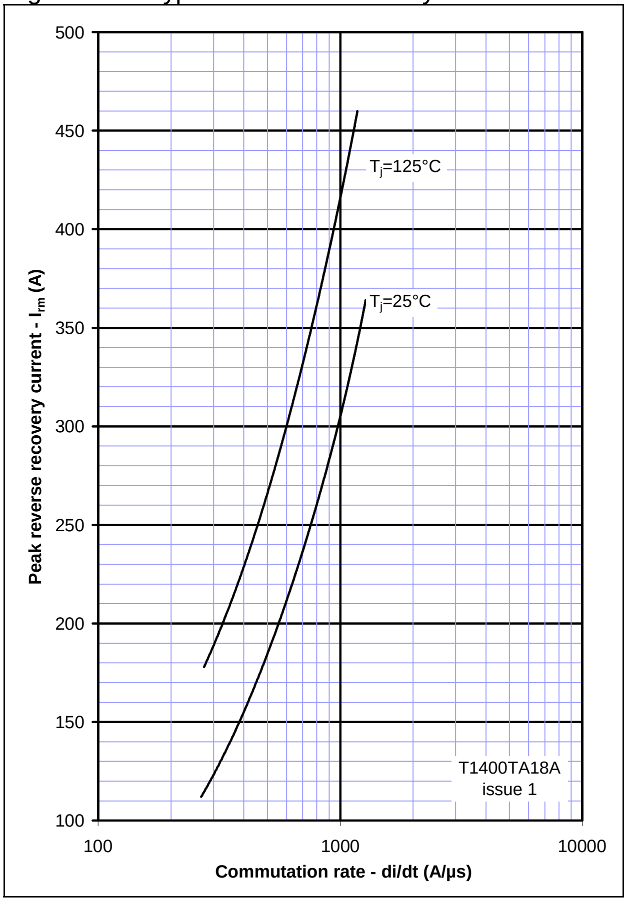


Figure 25 – Typical reverse recovery time

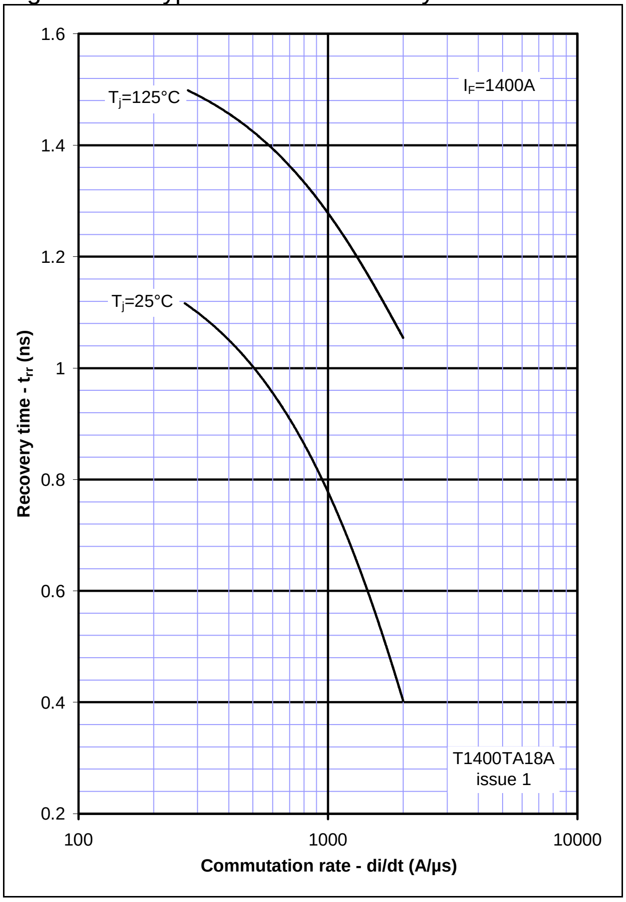


Figure 26 – Transient thermal impedance (IGBT)

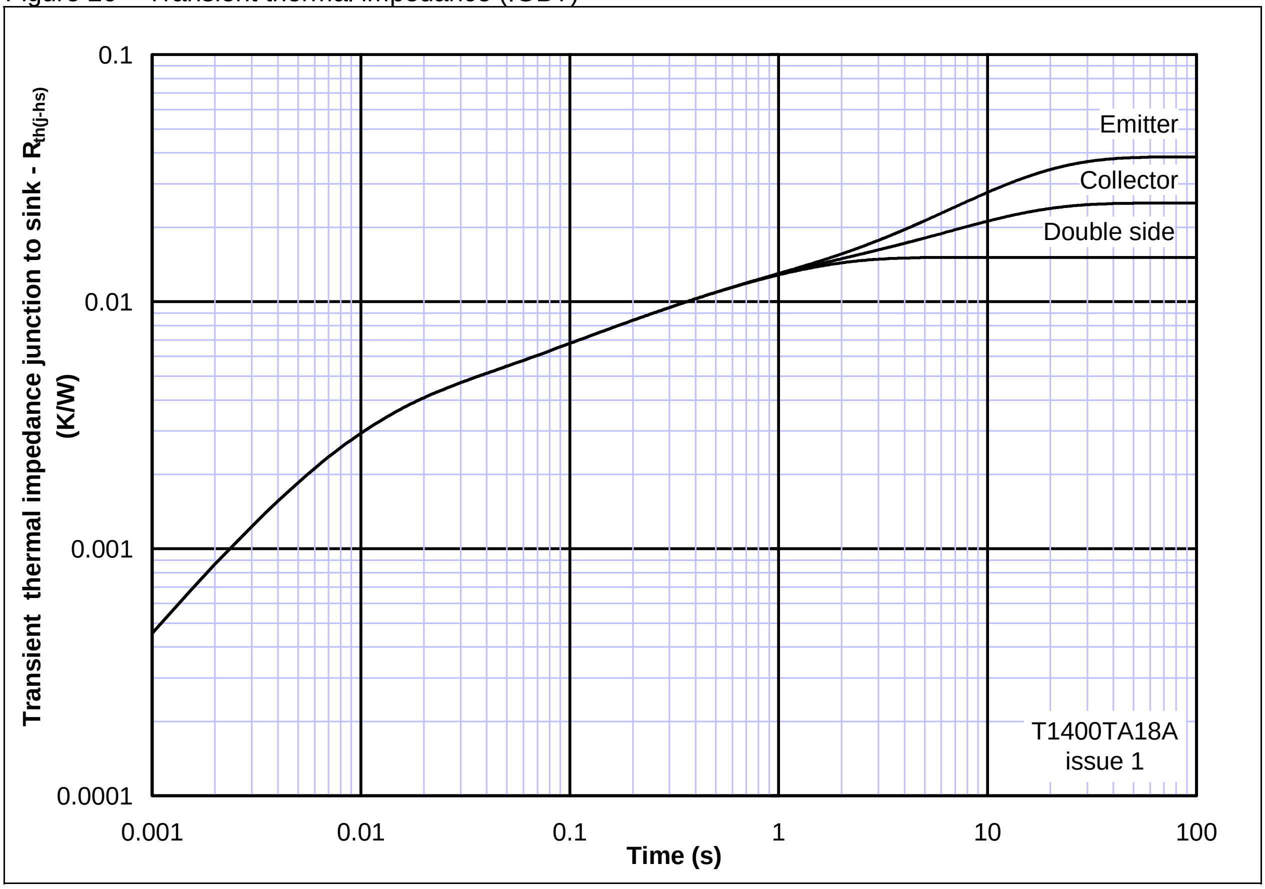
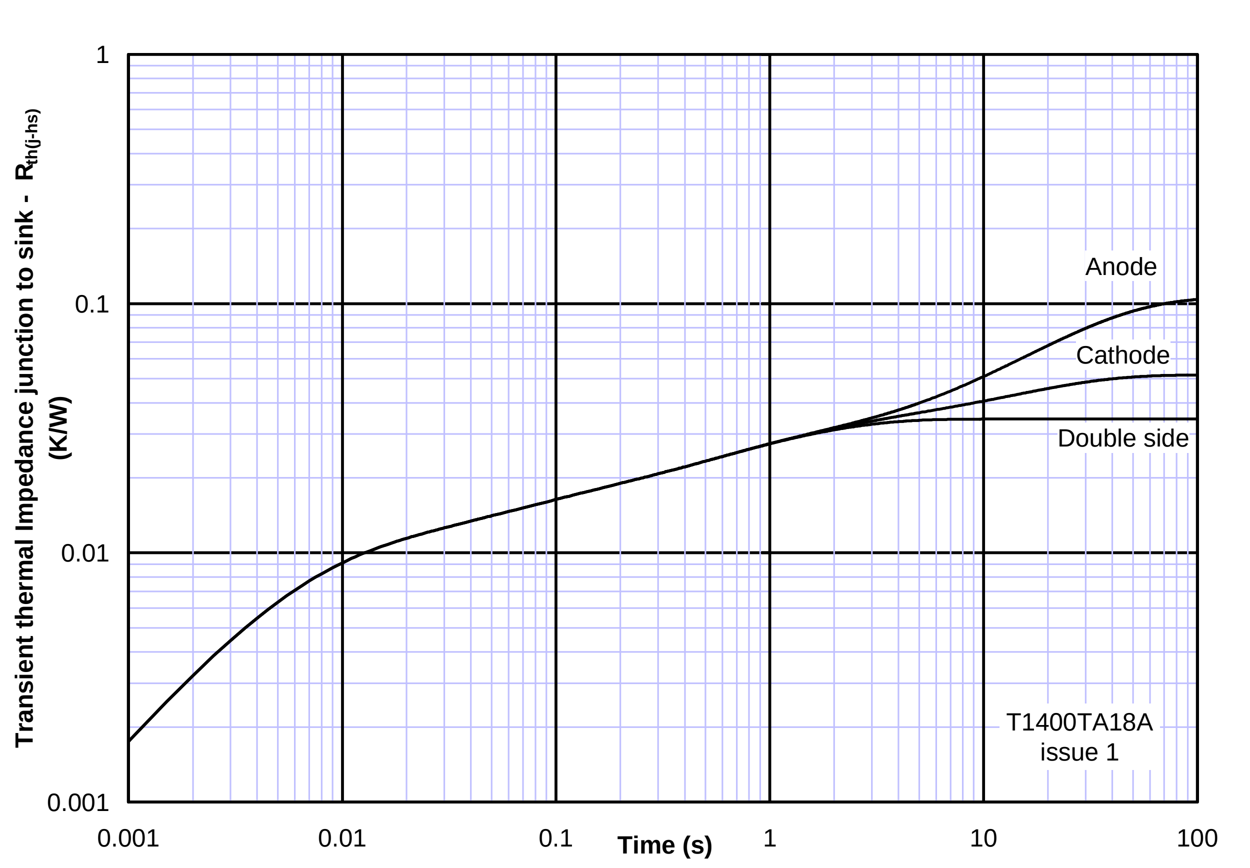
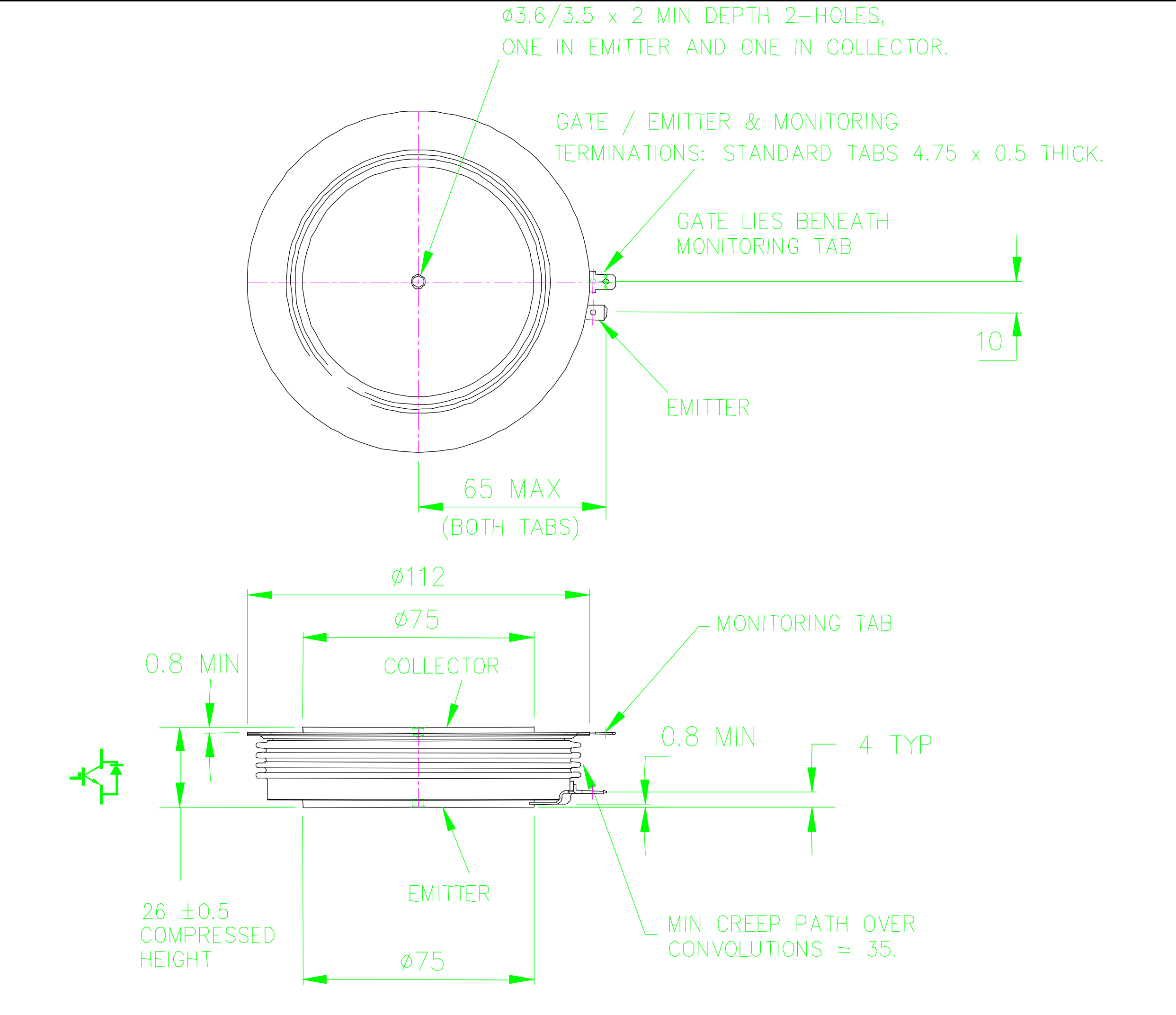


Figure 27 – Transient thermal impedance (Diode)



Outline Drawing & Ordering Information



ORDERING INFORMATION	(Please quote 10 digit code as below)		
T1400	**TA**	**18**	**A**
Fixed type code	Fixed Outline Code	Voltage Grade 1800V	Standard Product

Typical order code: T1400TA18A (V_{CES} = 1800V)

WESTCODE

UK: Westcode Semiconductors Ltd.
P.O. Box 57, Chippenham, Wiltshire, England. SN15 1JL.
Tel: +44 (0) 1249 444524 Fax: +44 (0) 1249 659448
E-Mail: WSL.sales@westcode.com

USA: Westcode Semiconductors Inc.
3270 Cherry Avenue, Long Beach, California 90807
Tel: 562 595 6971 Fax: 562 595 8182
E-Mail: WSI.sales@westcode.com

Internet: http://www.westcode.com