WESTCODE

An IXYS Company

Date:- 17 May, 2010

Data Sheet Issue:- 1

Advance Data

High Power Sonic FRD

Type E2400TC45C

Absolute Maximum Ratings

	VOLTAGE RATINGS	**MAXIMUM LIMITS**	**UNITS**
V_{RRM}	Repetitive peak reverse voltage, (note 1)	4500	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	4800	V
$V_{R(d.c.)}$	Maximum reverse d.c. voltage (note 1)	3000	V

	OTHER RATINGS (note 6)	**MAXIMUM LIMITS**	**UNITS**
$I_{F(AV)M}$	Mean forward current, T_{sink}=55°C, (note 2)	2233	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 2)	1480	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 3)	918	A
$I_{F(RMS)}$	Nominal RMS forward current, T_{sink}=25°C, (note 2)	4150	A
$I_{F(d.c.)}$	D.C. forward current, T_{sink}=25°C, (note 4)	3688	A
I_{FSM}	Peak non-repetitive surge t_p=10ms, V_{RM}=60%V_{RRM}, (note 5)	25.6	kA
I_{FSM2}	Peak non-repetitive surge t_p=10ms, $V_{RM}\leq$10V, (note 5)	28.2	kA
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}=60%V_{RRM}, (note 5)	3.29×10^6	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, $V_{RM}\leq$10V, (note 5)	3.98×10^6	A^2s
P_{rr}	Maximum peak reverse recovery power, (note 7)	6	MW
$T_{j\ op}$	Operating temperature range	-40 to +150	°C
T_{stg}	Storage temperature range	-40 to +150	°C

Notes:-
1) De-rating factor of 0.13% per °C is applicable for T_j below 25°C.
2) Double side cooled, single phase; 50Hz, 180° half-sinewave.
3) Single side cooled, single phase; 50Hz, 180° half-sinewave.
4) Double side cooled.
5) Half-sinewave, 150°C T_j initial.
6) Current (I_F) ratings have been calculated using V_{T0} and r_T (see page 2)
7) T_j=T_{jop}, I_F=2400A, di/dt=3000A/µs V_r=3000V and L_s=200nH. Test circuit and sample waveform are shown in diagram 1. IGBT type T2400GB45E used as switch.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V_{FM}	Maximum peak forward voltage	-	3.30	3.50	I_{FM}=2400A	V
		-	-	5.01	I_{FM}=4800A	
V_{T0}	Threshold voltage	-	-	2.06	Current range 2233A- 6699A (Note 2)	V
r_T	Slope resistance	-	-	0.59		mΩ
V_{T01}	Threshold voltage	-	-	2.12	Current range 2400A-7200A	V
r_{T1}	Slope resistance	-	-	0.57		mΩ
V_{FRM}	Maximum forward recovery voltage	-	-	140	di/dt = 2000A/µs	V
		-	-	75	di/dt = 2000A/µs, T_j=25°C	
I_{RRM}	Peak reverse current	-	-	100	Rated V_{RRM}	mA
		-	-	15	Rated V_{RRM}, T_j=25°C	
Q_{rr}	Recovered charge	-	3700	4000	I_{FM}=2400A, t_p=1ms, di/dt=3000A/µs, V_r=3000V, 50% and L_s=200nH. IGBT type T2400GB45E used as switch. (note 3)	µC
Q_{ra}	Recovered charge, 50% Chord	-	1550	-		µC
I_{rm}	Reverse recovery current	-	2050	2250		A
t_{rr}	Reverse recovery time, 50% Chord	-	1.5	-		µs
R_{thJK}	Thermal resistance, junction to heatsink	-	-	0.008	Double side cooled	K/W
		-	-	0.016	Single side cooled	
F	Mounting force	60	-	75	(Note 4)	kN
W_t	Weight	-	1.23	-		kg

Notes:-
1) Unless otherwise indicated T_j=150°C.
2) V_{T0} and r_T were used to calculate the current ratings illustrated on page one.
3) Figures 3-7 were compiled using these conditions. Test circuit and sample waveform are shown in diagram 1.
4) For clamp forces outside these limits, please consult factory.

Additional information on Ratings and Characteristics

1.0 De-rating Factor

A blocking voltage de-rating factor of 0.13% per °C is applicable to this device for T_j below 25°C.

2.0 ABCD Constants

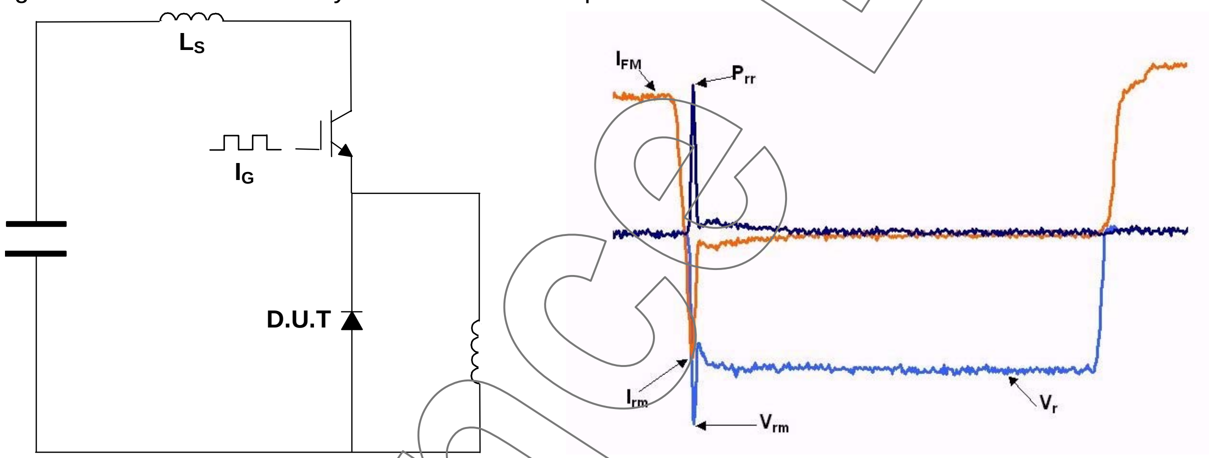
These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

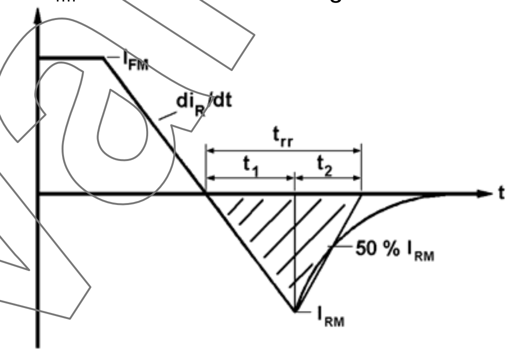
where I_F = instantaneous forward current.

3.0 Reverse recovery ratings

Diagram 1 – Reverse Recovery test circuit and sample waveform



(i) Q_{ra} is based on 50% I_{rm} chord as shown in Figure below.



(ii) Q_{rr} is based on a 150µs integration time.

i.e.

$$Q_{rr} = \int_0^{150\mu s} i_{rr}.dt$$

(iii)

$$K\ Factor = \frac{t_1}{t_2}$$

4.0 Reverse Recovery Loss

The following procedure is recommended for use where it is necessary to include reverse recovery loss.

From waveforms of recovery current obtained from a high frequency shunt (see Note 1) and reverse voltage present during recovery, an instantaneous reverse recovery loss waveform must be constructed. Let the area under this waveform be E joules per pulse. A new sink temperature can then be evaluated from:

$$T_{SINK} = T_{J(MAX)} - E \cdot \left[k + f \cdot R_{th(J-Hs)}\right]$$

Where k = 0.2314 (°C/W)/s

E = Area under reverse loss waveform per pulse in joules (W.s.)
f = Rated frequency in Hz at the original sink temperature.
$R_{th(J-Hs)}$ = d.c. thermal resistance (°C/W)

The total dissipation is now given by:

$$W_{(tot)} = W_{(original)} + E \cdot f$$

NOTE 1 - Reverse Recovery Loss by Measurement

This device has a low reverse recovered charge and peak reverse recovery current. When measuring the charge, care must be taken to ensure that:

(a) AC coupled devices such as current transformers are not affected by prior passage of high amplitude forward current.

(b) A suitable, polarised, clipping circuit must be connected to the input of the measuring oscilloscope to avoid overloading the internal amplifiers by the relatively high amplitude forward current signal.

(c) Measurement of reverse recovery waveform should be carried out with an appropriate critically damped snubber, connected across diode anode to cathode. The formula used for the calculation of this snubber is shown below:

$$R^2 = 4 \cdot \frac{V_r}{C_s \cdot {di}/{dt}}$$

Where: V_r = Commutating source voltage
C_S = Snubber capacitance
R = Snubber resistance

5.0 Computer Modelling Parameters

5.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_{T0} + \sqrt{{V_{T0}}^2 + 4 \cdot ff^2 \cdot r_T \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_T}$$

Where V_{T0} = 2.06V, r_T = 0.59mΩ

ff = form factor (normally unity for fast diode applications)

$$W_{AV} = \frac{\Delta T}{R_{th}}$$

$$\Delta T = T_{j(MAX)} - T_K$$

5.2 Calculation of V_F using ABCD Coefficients

The forward characteristic I_F Vs V_F, on page 6 is represented in two ways;

(i) the well established V_{T0} and r_T tangent used for rating purposes and

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

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

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

	25°C Coefficients	150°C Coefficients
A	0.397706	0.809905
B	0.116449	-8.40312×10^{-2}
C	1.46027×10^{-4}	1.32145×10^{-4}
D	3.88009×10^{-2}	6.17880×10^{-2}

Curves

Figure 1 – Forward characteristics of limit device

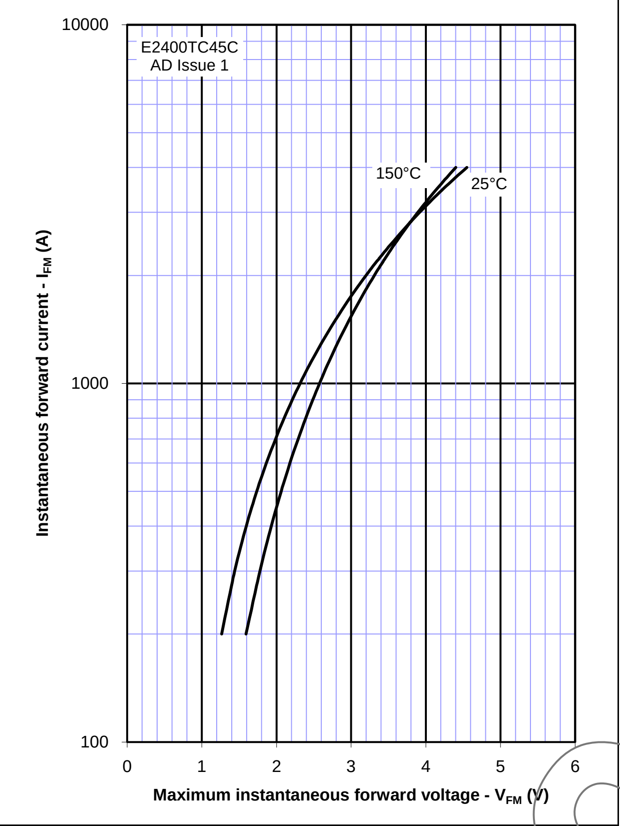


Figure 2 – Maximum forward recovery voltage

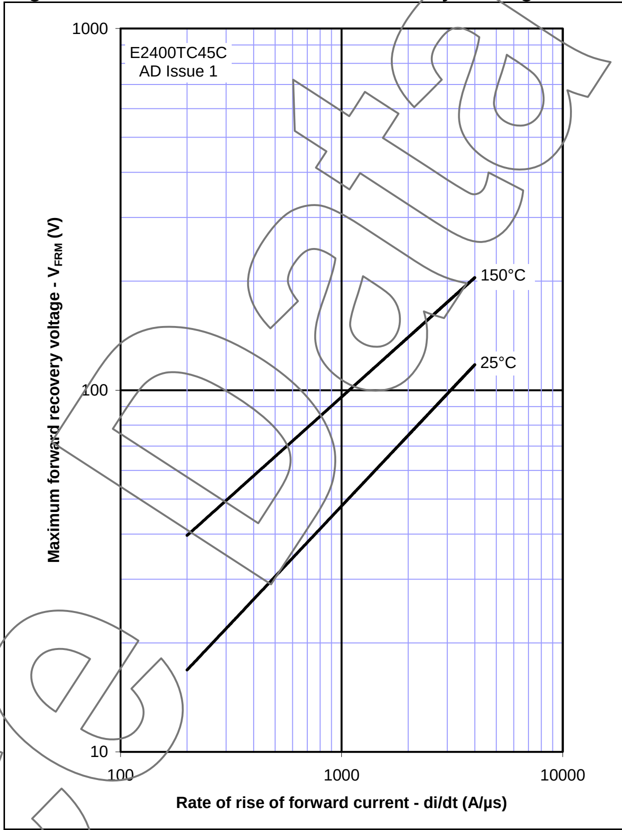


Figure 3 - Recovered charge, Q_{rr}

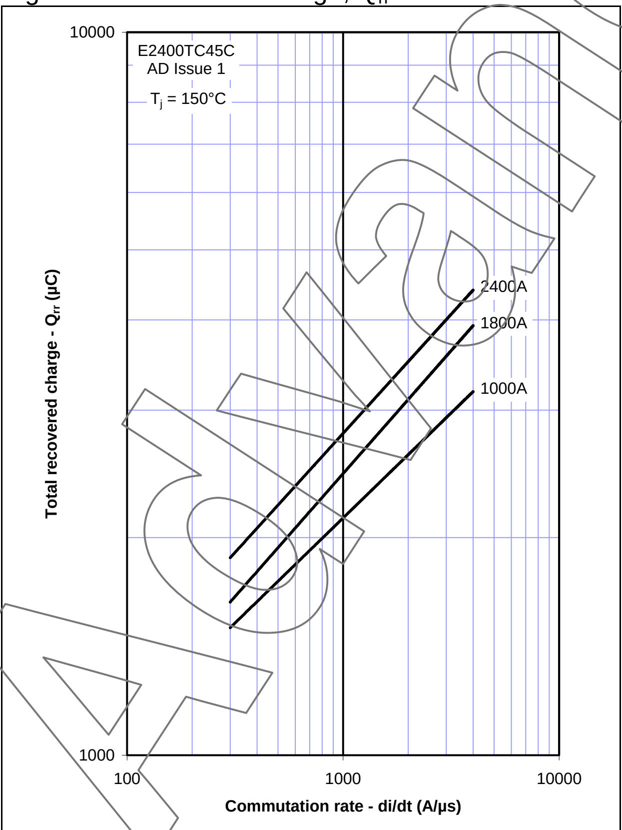


Figure 4 – Recovered charge, Q_{ra} (50% chord)

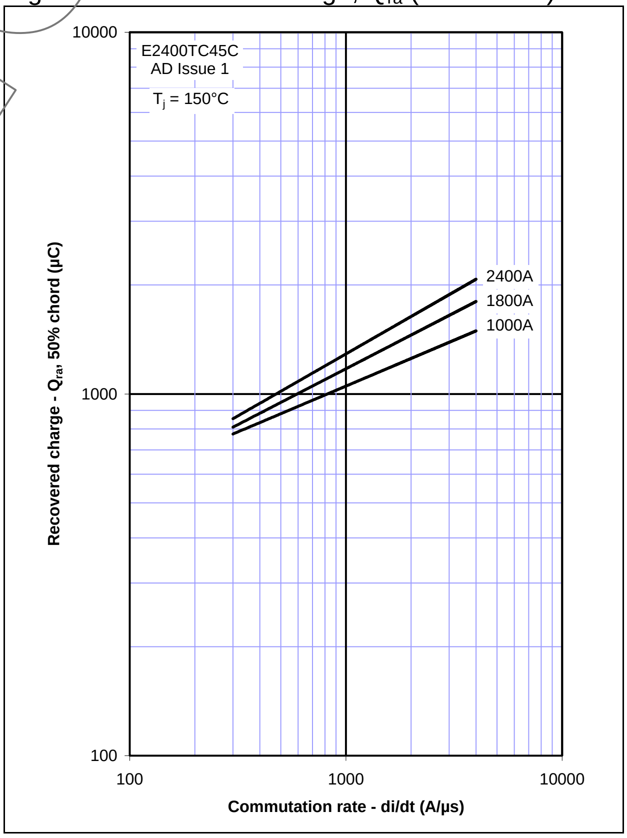


Figure 5 - Maximum reverse current, I_{rm}

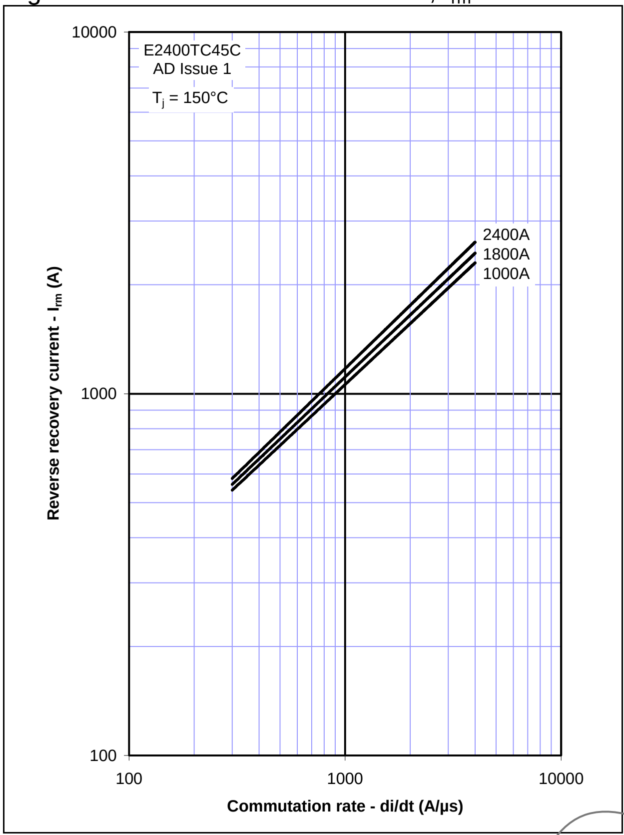


Figure 6 – Maximum recovery time, t_{rr} (50% chord)

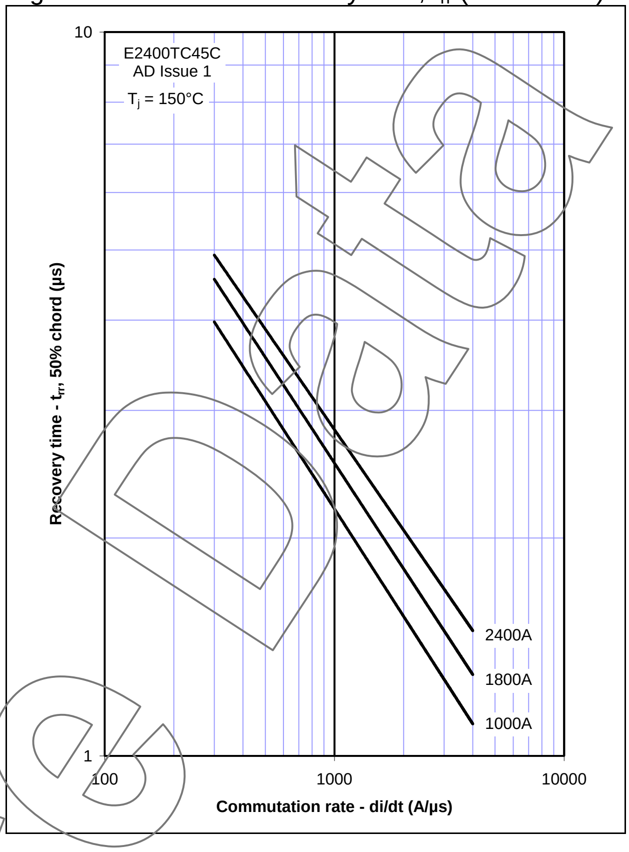


Figure 7 – Reverse recovery energy per pulse

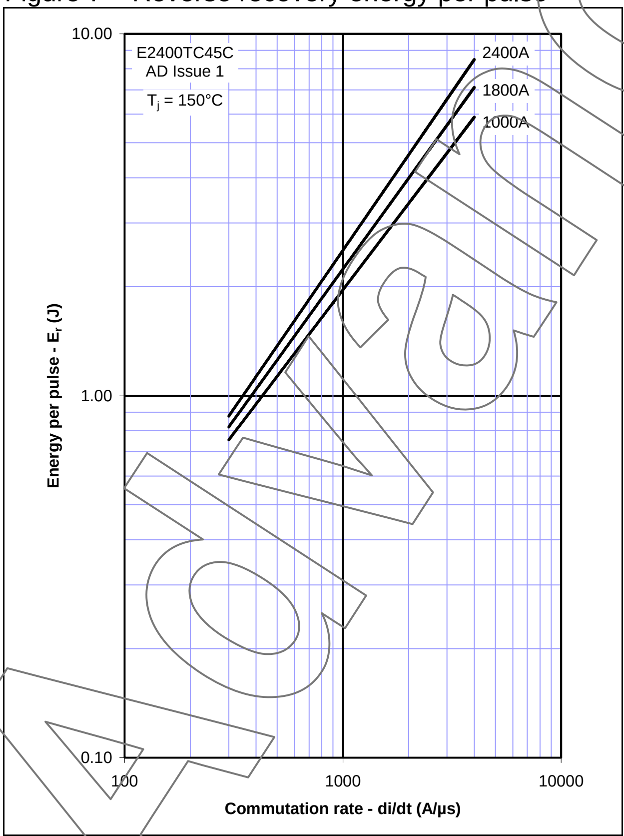


Figure 8 – Sine wave energy per pulse

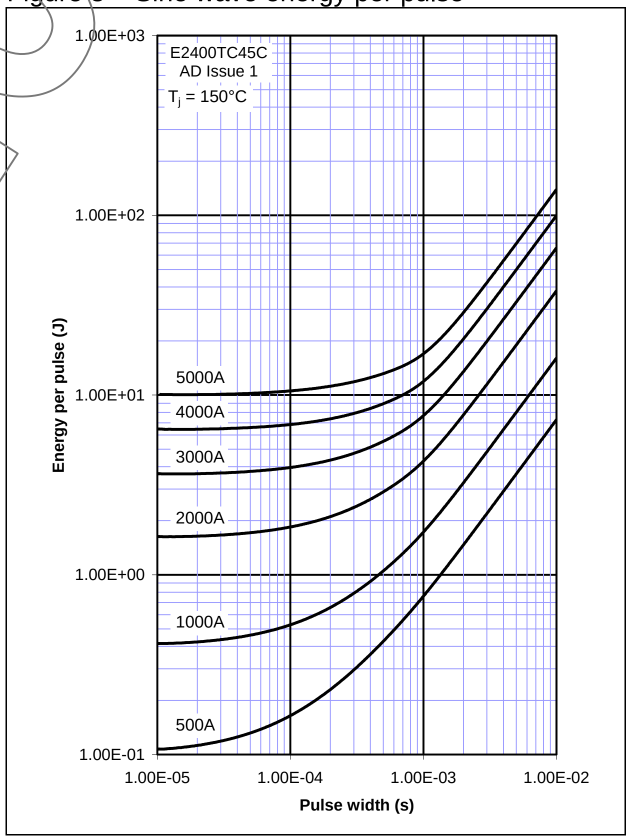


Figure 9 - Sine wave frequency vs. pulse width

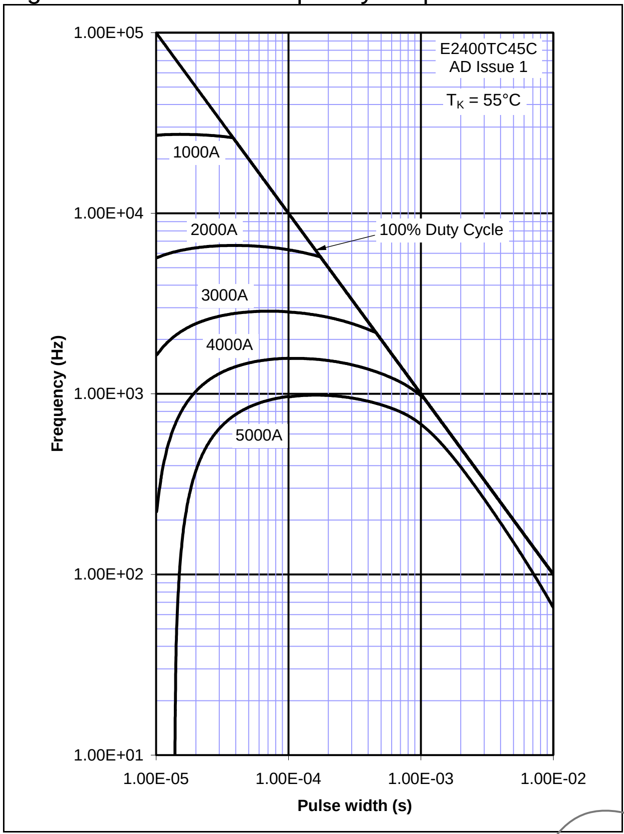


Figure 10 – Sine wave frequency vs. pulse width

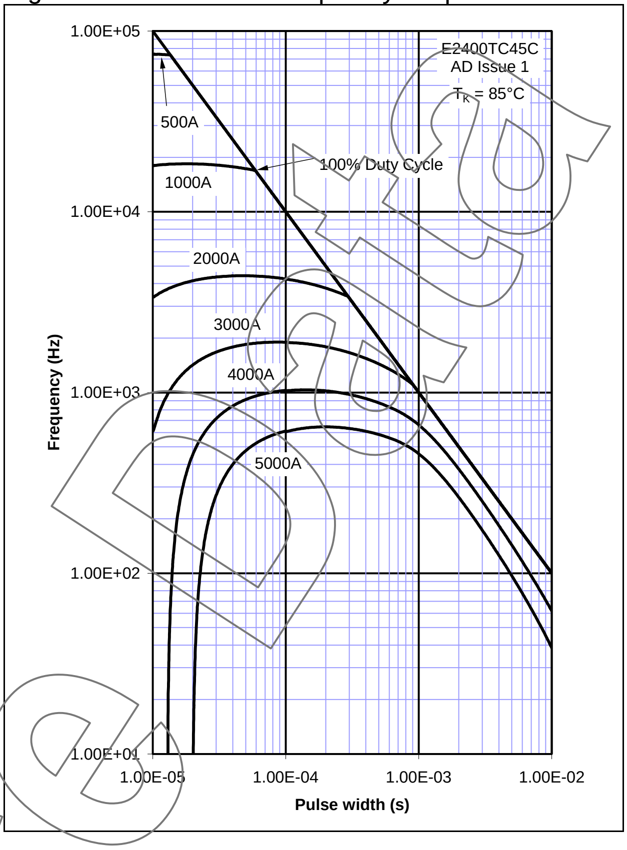


Figure 11 - Square wave energy per pulse

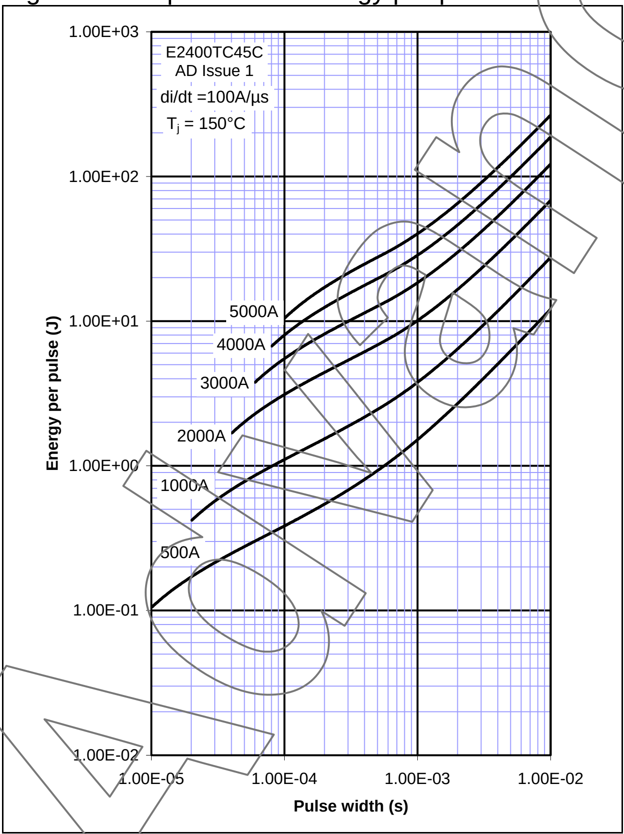


Figure 12 – Square wave energy per pulse

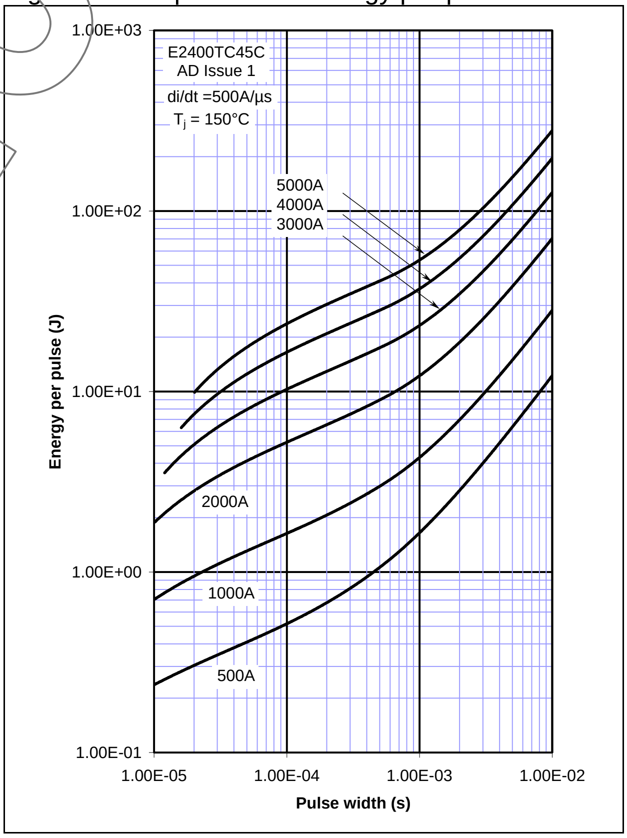


Figure 13 - Square wave frequency vs pulse width

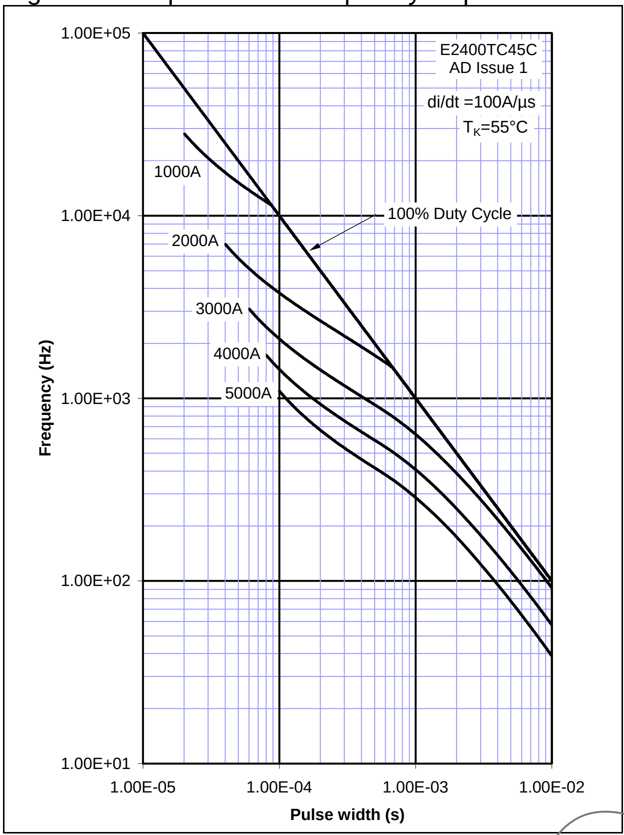


Figure 14 – Square wave frequency vs pulse width

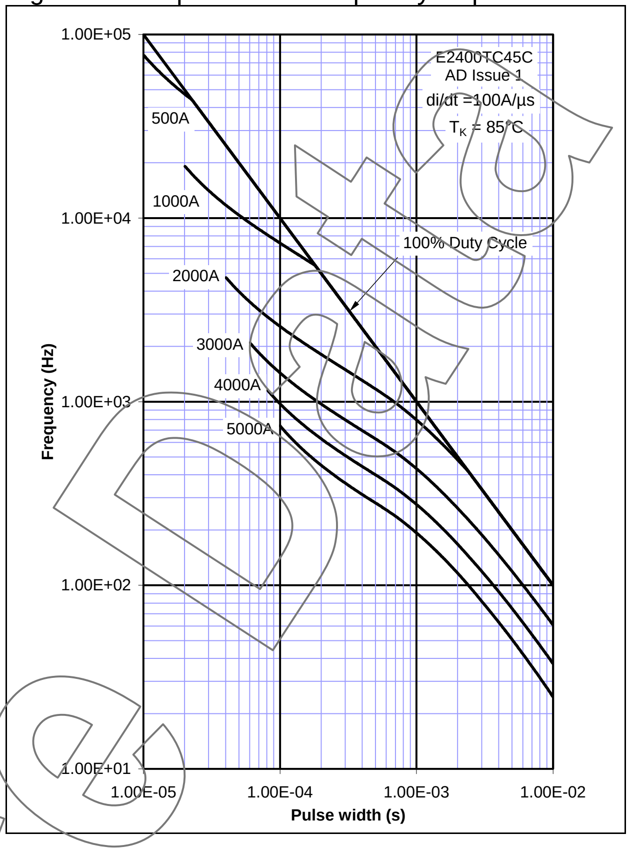


Figure 15 - Square wave frequency vs pulse width

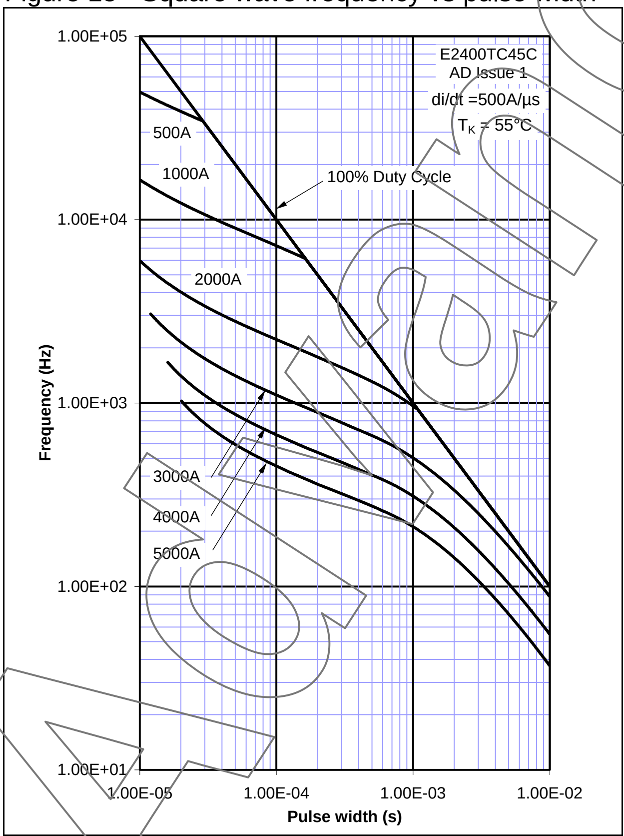


Figure 16 – Square wave frequency vs pulse width

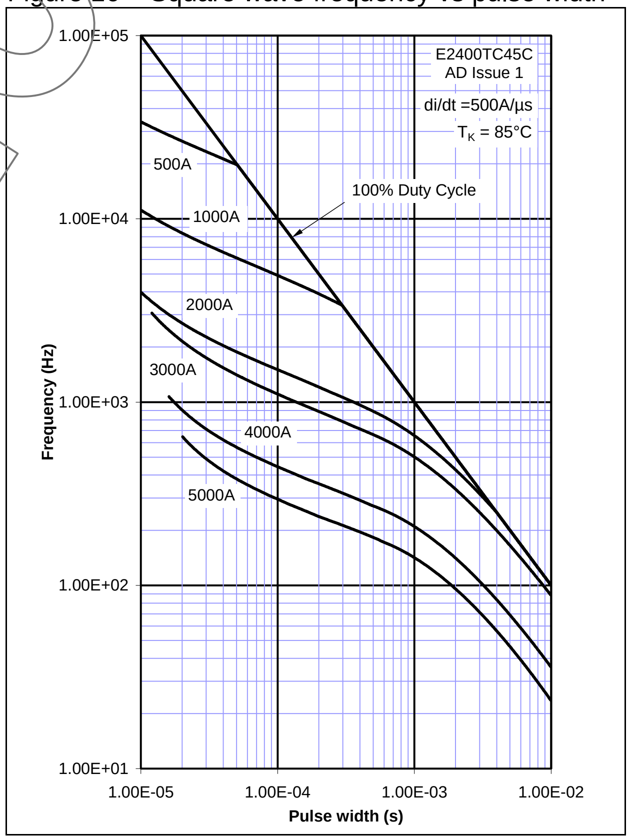


Figure 17 – Safe operating area

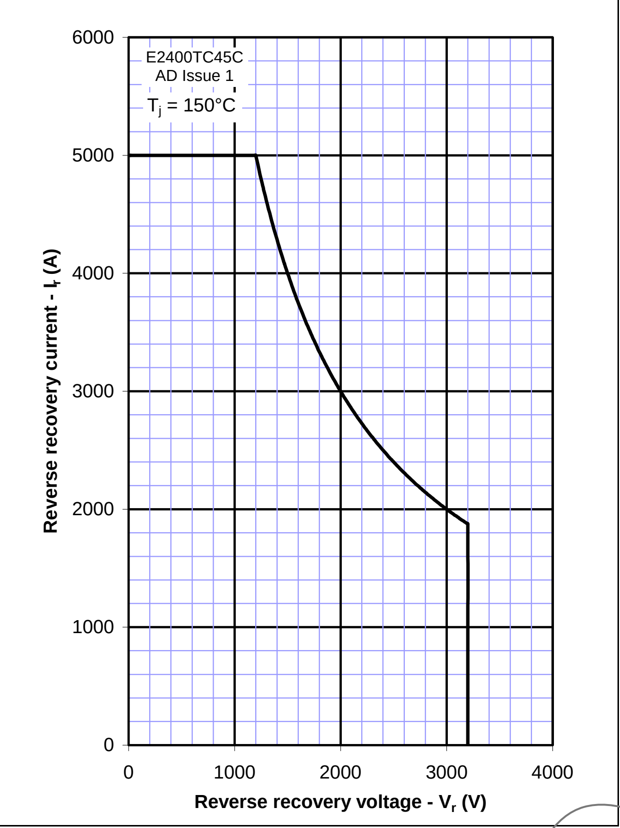


Figure 18 – Transient thermal impedance

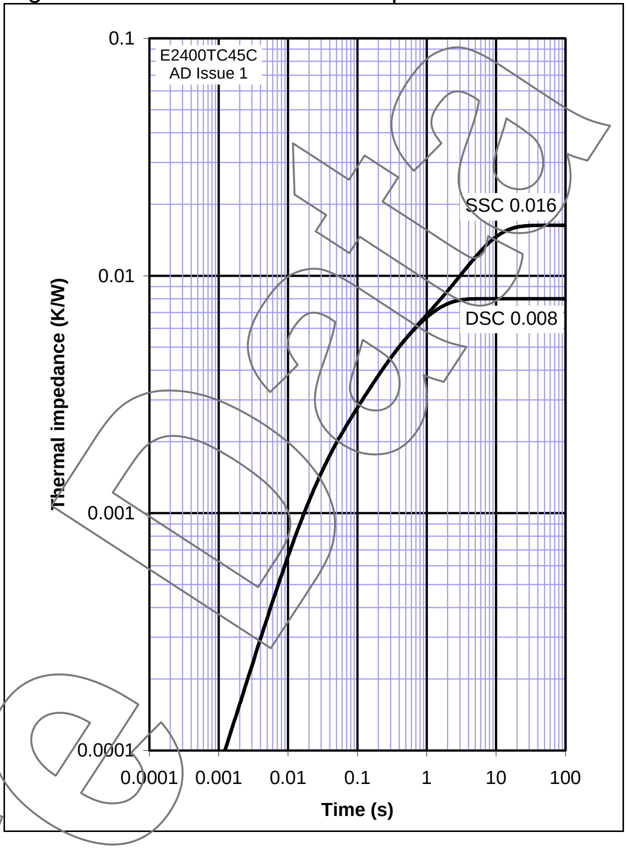
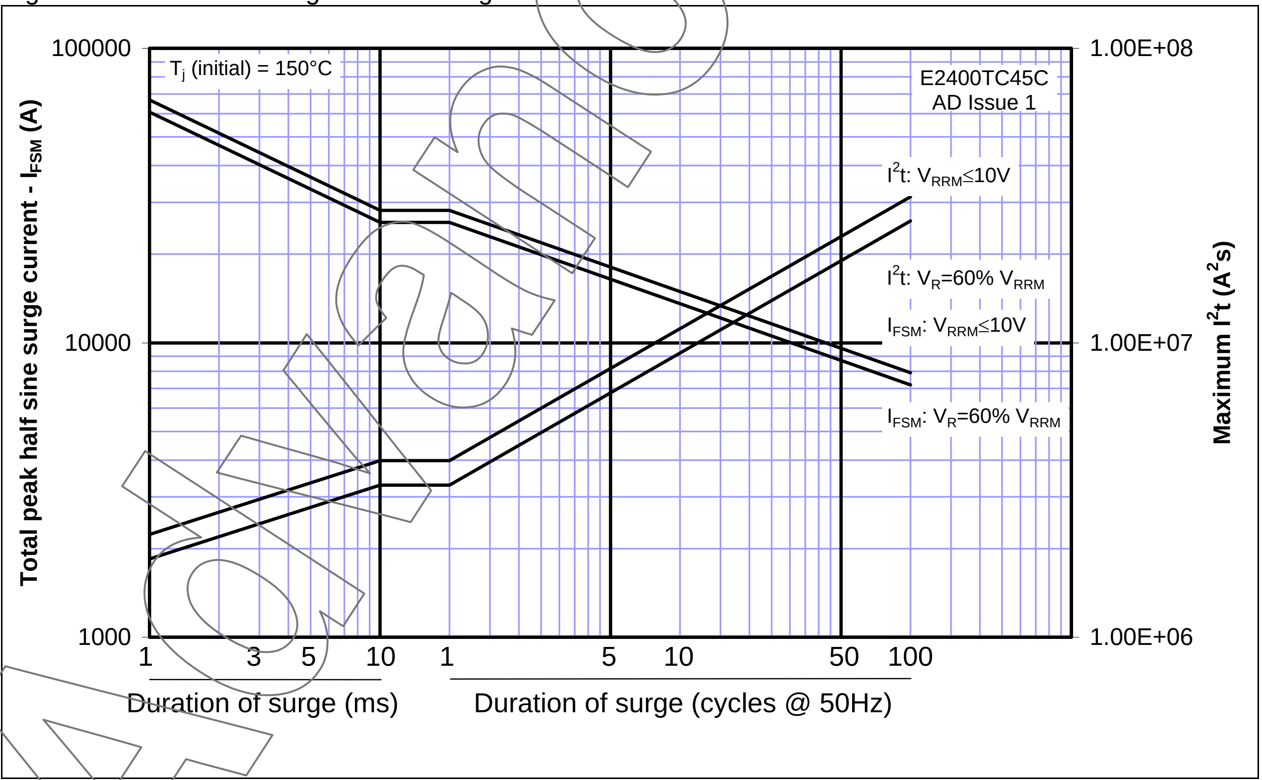
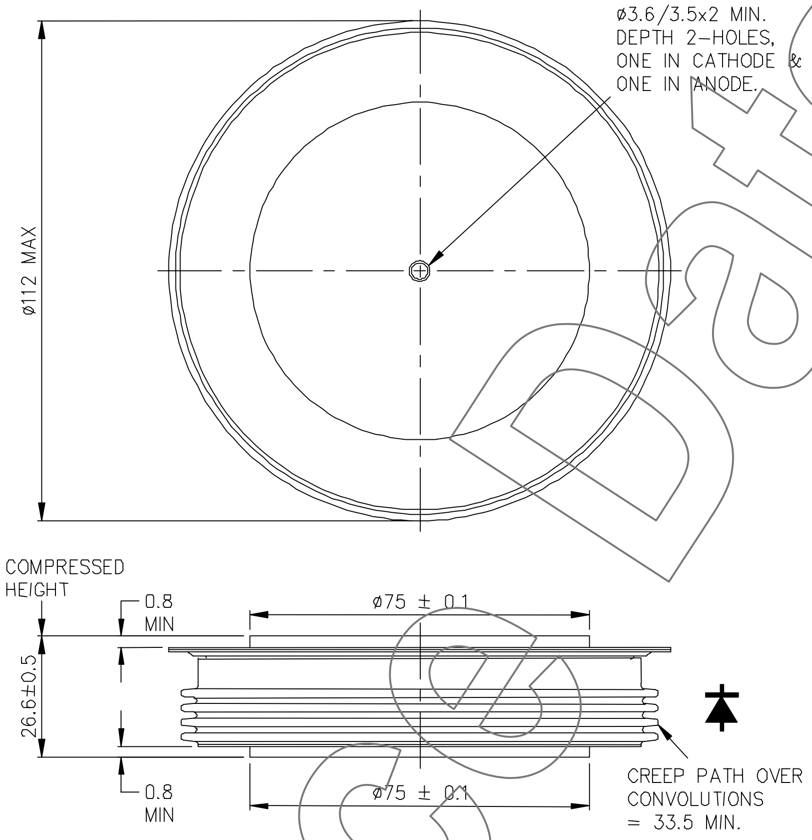


Figure 19 – Maximum surge and I^2t ratings



Outline Drawing & Ordering Information



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ORDERING INFORMATION	(Please quote 10 digit code as below)		
E2400	**TC**	**45**	**C**
Fixed Type Code	Fixed outline code	Fixed voltage code V_{RRM}/100 45	Fixed code, product series
Order code: E2400TC45C – 4500V V_{RRM}, 26mm clamp height capsule.			

IXYS Semiconductor GmbH
Edisonstraße 15,
D-68623 Lampertheim
Tel: +49 6206 503-0
Fax: +49 6206 503-627
E-mail: marcom@ixys.de

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

WESTCODE
An IXYS Company

www.westcode.com

www.ixys.com

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

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.comT

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