Date:-13 October 2018

Data Sheet Issue: A1

Advance Data

High Power Sonic FRD

Type E1500MC33E

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{RRM}	Repetitive peak reverse voltage, (note 1)	3300	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	3400	V
$V_{R(d.c.)}$	Maximum reverse d.c. voltage (note 1)	1800	V

	OTHER RATINGS (note 6)	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Mean forward current, T_{sink}=55°C, (note 2)	1580	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 2)	950	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 3)	610	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 4)	530	A
$I_{F(RMS)}$	Nominal RMS forward current, T_{sink}=25°C, (note 2)	3010	A
$I_{F(d.c.)}$	D.C. forward current, T_{sink}=25°C, (note 5)	2610	A
I_{FSM}	Peak non-repetitive surge t_p=10ms, V_{RM}=60%V_{RRM}, (note 6)	17.33	kA
I_{FSM2}	Peak non-repetitive surge t_p=10ms, $V_{RM}\leq$10V, (note 6)	19.06	kA
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}=60%V_{RRM}, (note 6)	1.5×10^6	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, $V_{RM}\leq$10V, (note 6)	1.82×10^6	A^2s
P_{rr}	Maximum non-repetitive peak reverse recovery power, (note 8)	3.68	MW
$T_{j\ op}$	Operating temperature range	-40 to +140	°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) Anode side cooled, single phase; 50Hz, 180° half-sinewave.
4) Cathode side cooled, single phase; 50Hz, 180° half-sinewave.
5) Double side cooled.
6) Half-sinewave, 140°C T_j initial.
7) Current (I_F) ratings have been calculated using V_{T0} and r_T (see page 2)
8) T_j=T_{jop}, I_F=1000A, di/dt=2000A/µs V_r=1800V and L_s=200nH. Test circuit and sample waveform are shown in diagram 1. IGBT type T1000TC33E used as switch.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V_{FM}	Maximum peak forward voltage	-	1.67	1.90	I_{FM}=1000A	V
		-	-	2.20	I_{FM}=1500A	
		-	-	2.47	I_{FM}=2000A	
V_{T0}	Threshold voltage	-	-	1.509	Current range 1580A - 4740A (Note 2)	V
r_T	Slope resistance	-	-	0.464		mΩ
V_{T01}	Threshold voltage	-	-	1.375	Current range 1000A - 3000A	V
r_{T1}	Slope resistance	-	-	0.525		mΩ
V_{FRM}	Maximum forward recovery voltage	-	-	155	di/dt = 4000A/µs	V
		-	-	128	di/dt = 4000A/µs, T_j=25°C	
I_{RRM}	Peak reverse current	-	-	35	Rated V_{RRM}	mA
		-	-	1	Rated V_{RRM}, T_j=25°C	
Q_{rr}	Recovered charge	-	2040	2250	I_{FM}=1000A, t_p=1ms, di/dt=2000A/µs, V_r=1800V, 50% Chord (note 3)	µC
Q_{ra}	Recovered charge, 50% Chord	-	1280	-		µC
I_{rm}	Reverse recovery current	-	1380	1520		A
t_{rr}	Reverse recovery time, 50% Chord	-	1.85	-		µs
E_{rr}	Reverse recovery energy loss	-	2.25	2.5		J
Q_{rr}	Recovered charge	-	2350	2580	I_{FM}=1500A, t_p=1ms, di/dt=2000A/µs, V_r=1800V, 50% Chord (note 3)	µC
Q_{ra}	Recovered charge, 50% Chord	-	1600	-		µC
I_{rm}	Reverse recovery current	-	1560	1700		A
t_{rr}	Reverse recovery time, 50% Chord	-	2.05	-		µs
E_{rr}	Reverse recovery energy loss	-	2.7	3.0		J
R_{thJK}	Thermal resistance, junction to heatsink	-	-	0.0162	Double side cooled	K/W
		-	-	0.0298	Anode side cooled	
		-	-	0.0354	Cathode side cooled	
F	Mounting force	24	-	32	(Note 4)	kN
W_t	Weight	-	540	-		g

Notes:-
1) Unless otherwise indicated T_j=140°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

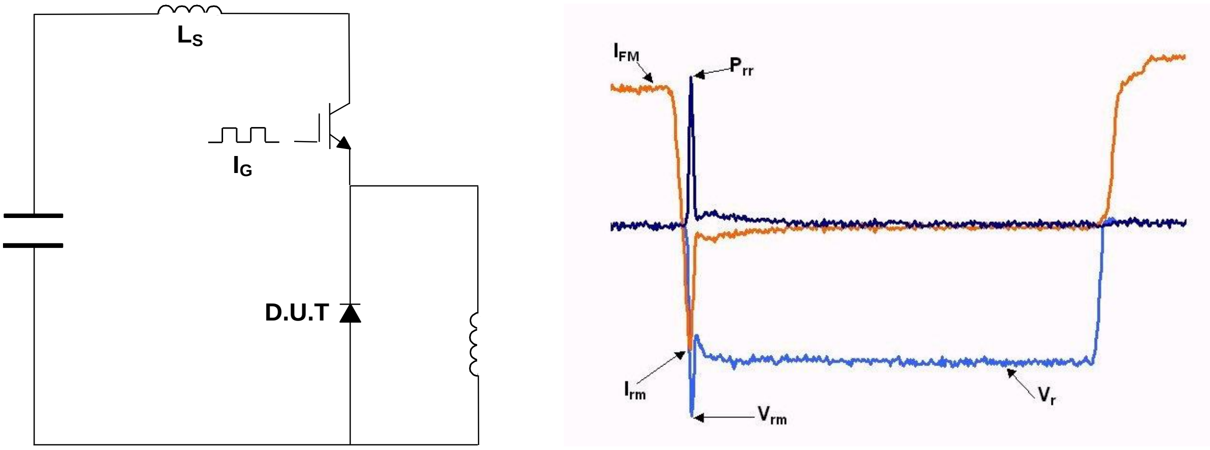
These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

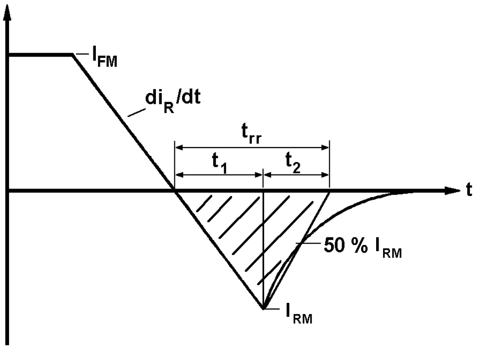
where I_F = instantaneous forward current.

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} =1.509V, r_T =0.464mΩ

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	140°C Coefficients
A	0.6843399	0.4478687
B	0.1075824	0.08783481
C	2.612481×10^{-4}	2.643642×10^{-4}
D	5.124698×10^{-3}	18.37166×10^{-3}

Curves

Figure 1 – Forward characteristics of limit device

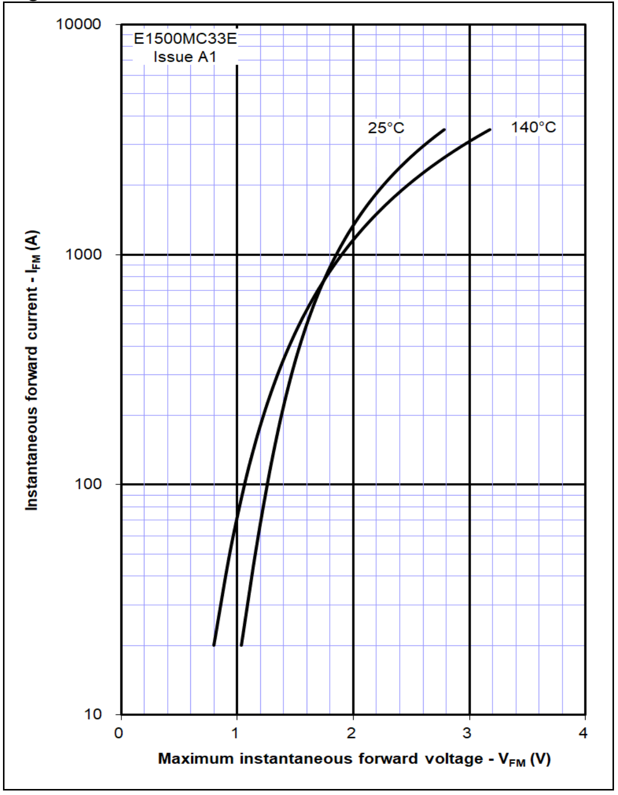


Figure 2 – Maximum forward recovery voltage

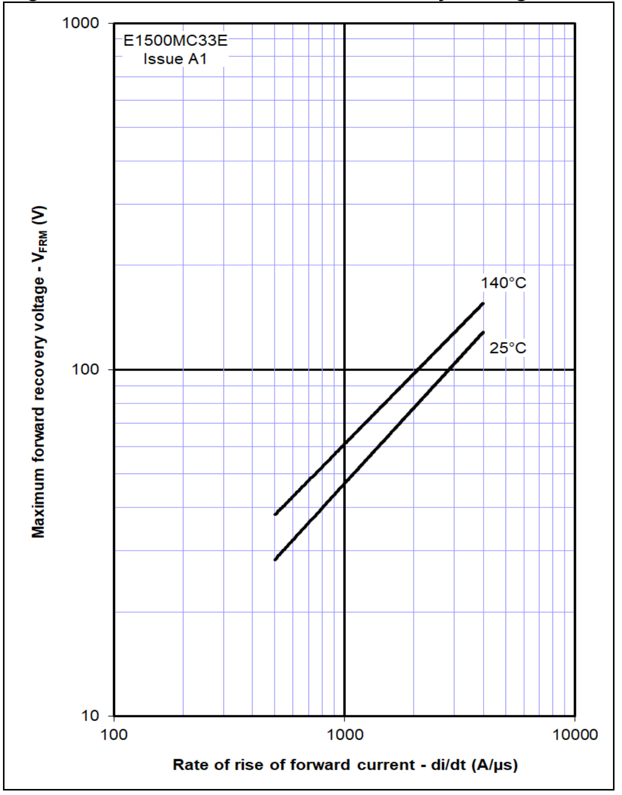


Figure 3 – Maximum recovered charge, Q_{rr}

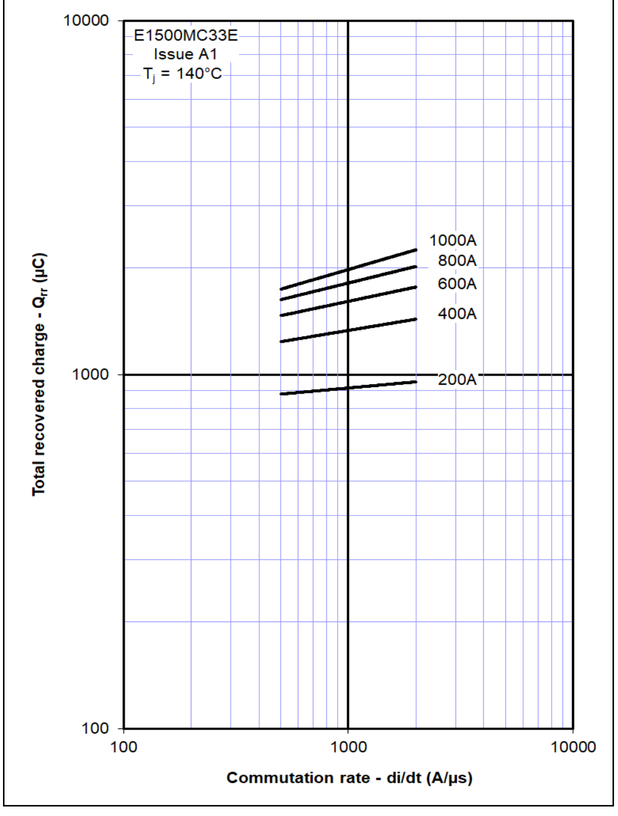


Figure 4 – Maximum recovery charge, Q_{ra} (50% chord)

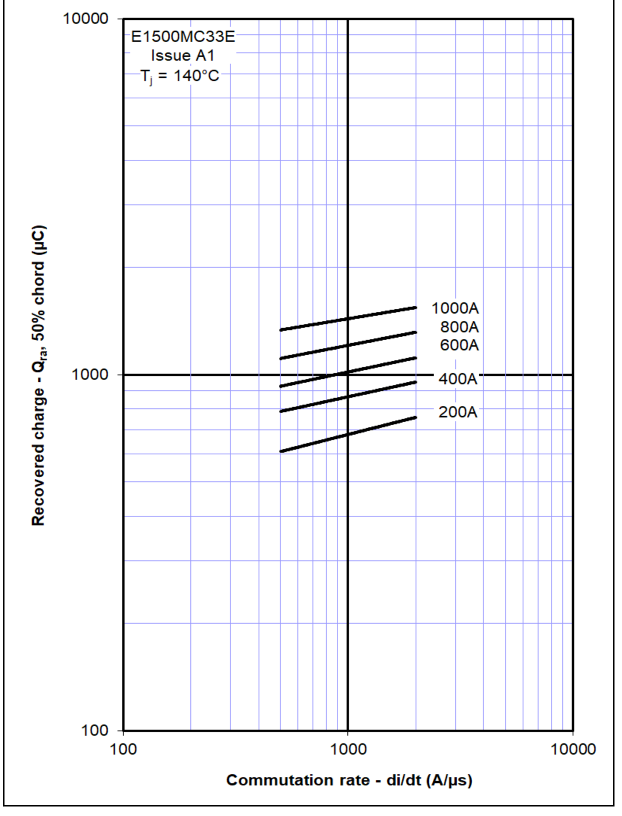


Figure 5 - Maximum reverse current, I_{rm}

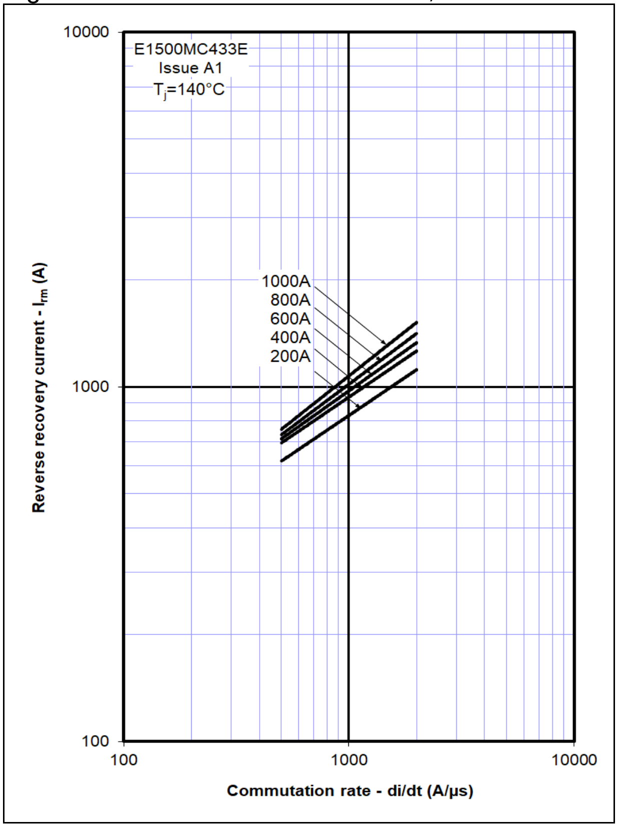


Figure 6 – Maximum recovery time, t_{rr} (50% chord)

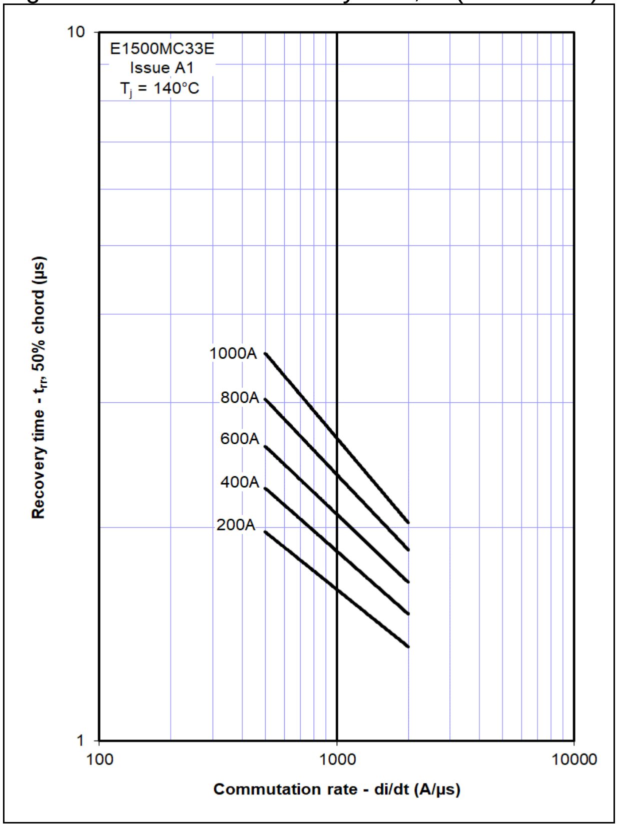


Figure 7 – Typical reverse recovery energy per pulse

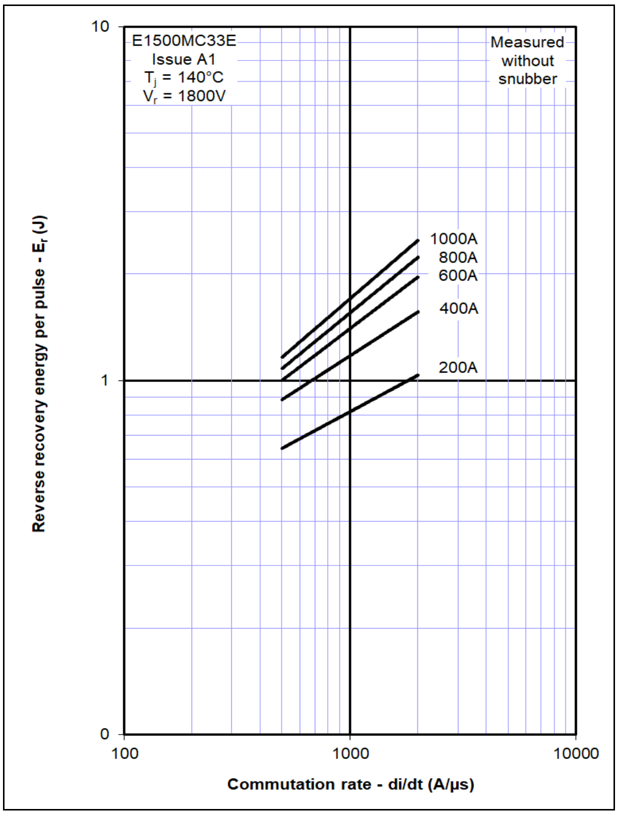


Figure 8 – Safe operating area

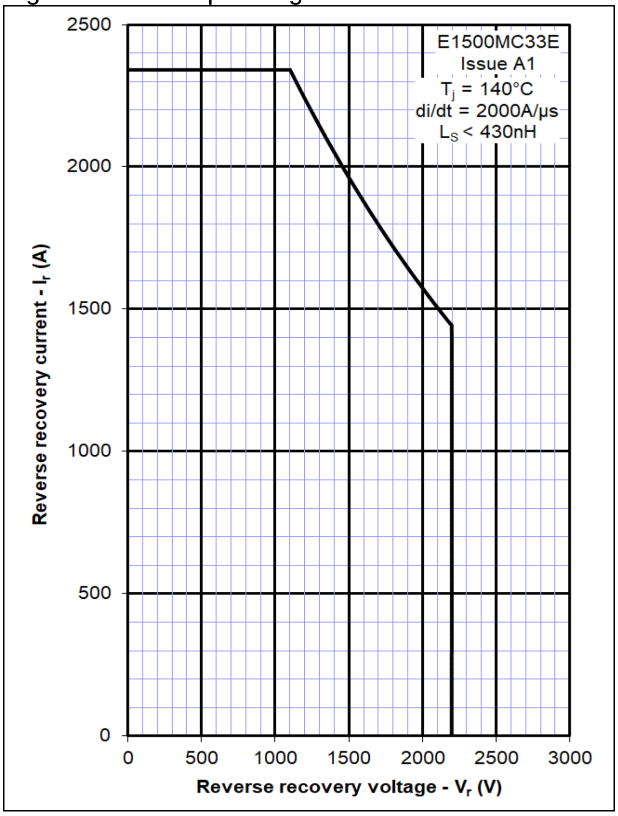


Figure 9 – Transient thermal impedance

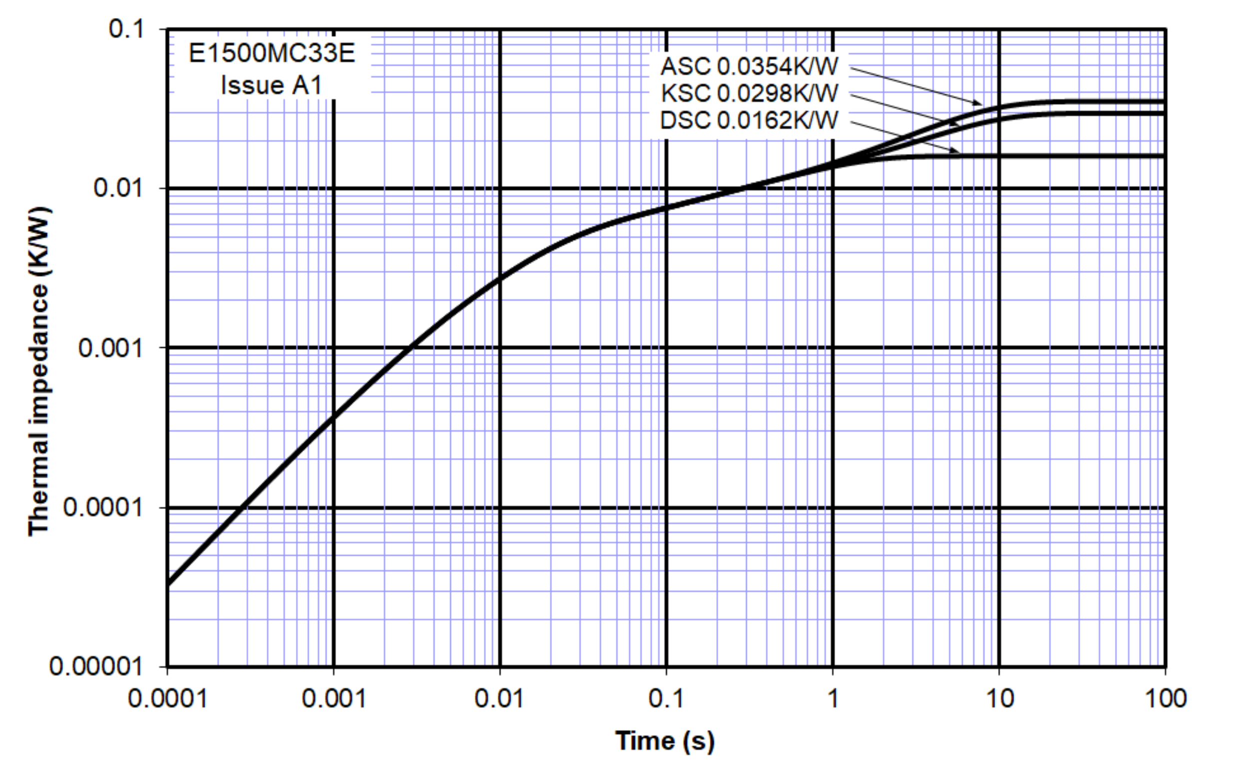
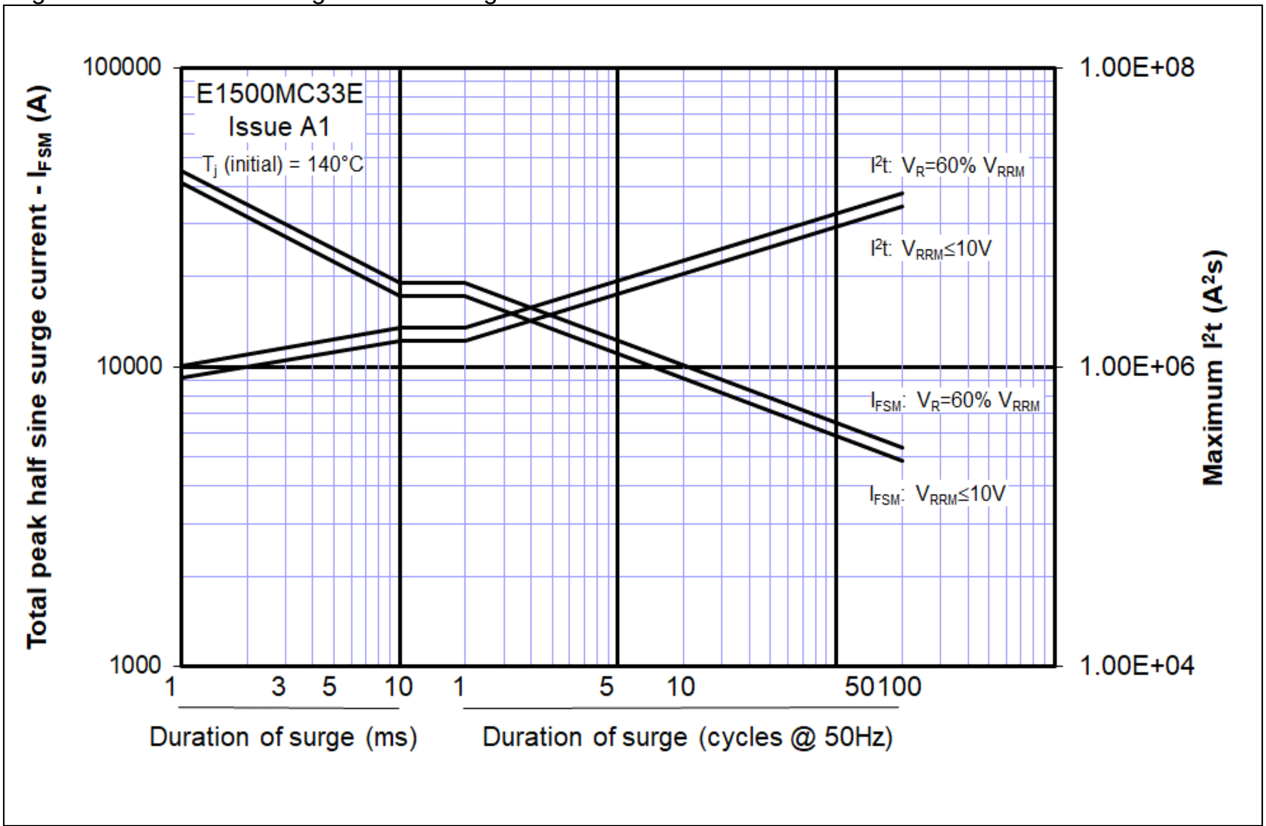
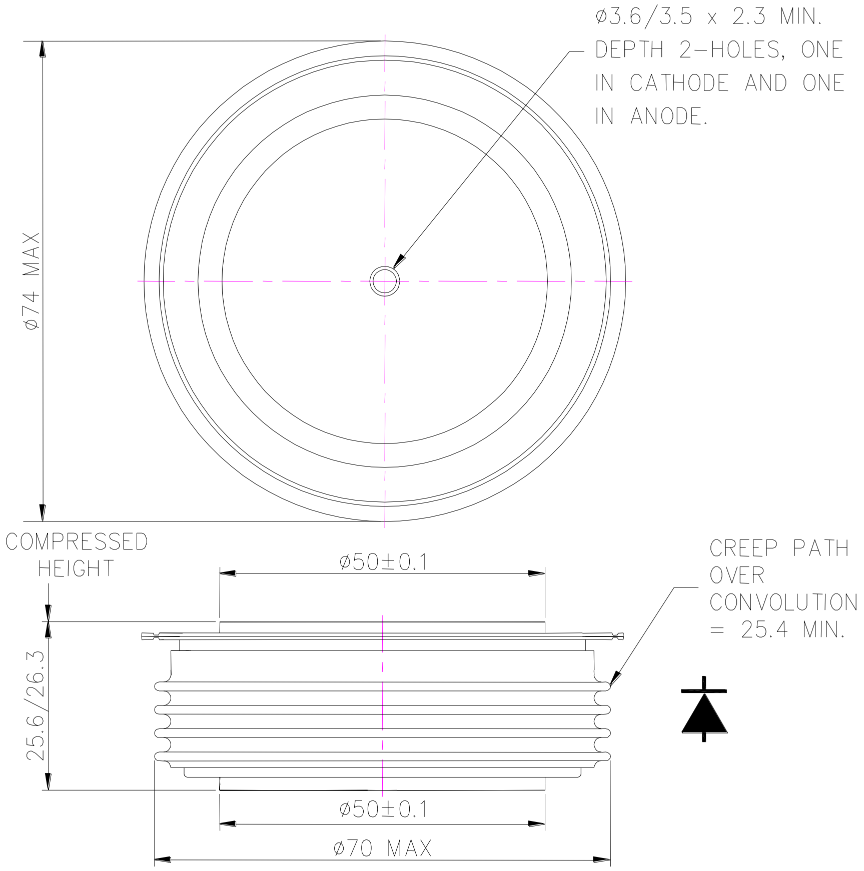


Figure 10 – Maximum surge and I^2t ratings



Outline Drawing & Ordering Information



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ORDERING INFORMATION (Please quote 10 digit code as below)

E1500	MC	33	E
Fixed Type Code	Fixed outline code	Fixed voltage code $V_{RRM}/100$ 33	Fixed code, product series

Order code: E1500MC33E – 3300V V_{RRM}, 26mm clamp height capsule.

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