WESTCODE

Date:- 15 Nov, 2001

Data Sheet Issue:- 1

Fast Recovery Diode
Types M0588LC400 to M0588LC450

Absolute Maximum Ratings

	VOLTAGE RATINGS	**MAXIMUM LIMITS**	**UNITS**
V_{RRM}	Repetitive peak reverse voltage, (note 1)	4000-4500	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	4100-4600	V

	OTHER RATINGS (note 6)	**MAXIMUM LIMITS**	**UNITS**
$I_{F(AV)}$	Mean forward current, T_{sink}=55°C, (note 2)	588	A
$I_{F(AV)}$	Mean forward current. T_{sink}=100°C, (note 2)	389	A
$I_{F(AV)}$	Mean forward current. T_{sink}=100°C, (note 3)	237	A
$I_{F(RMS)}$	Nominal RMS forward current, T_{sink}=25°C, (note 2)	1108	A
$I_{F(d.c.)}$	D.C. forward current, T_{sink}=25°C, (note 4)	969	A
I_{FSM}	Peak non-repetitive surge t_p=10ms, V_{RM}=0.6V_{RRM}, (note 5)	3955	A
I_{FSM2}	Peak non-repetitive surge t_p=10ms, $V_{RM}\leq$10V, (note 5)	4350	A
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}=0.6V_{RRM}, (note 5)	78.2×10^3	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, $V_{RM}\leq$10V, (note 5)	94.6×10^3	A^2s
T_{HS}	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.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V_{FM}	Maximum peak forward voltage	-	-	4.8	I_{FM}=1400A	V
V_0	Threshold voltage	-	-	2.32		V
r_S	Slope resistance	-	-	1.77		mΩ
V_{FRM}	Maximum forward recovery voltage	-	-	140	di/dt = 1000A/µs	V
		-	-	85	di/dt = 1000A/µs, T_j=25°C	
I_{RRM}	Peak reverse current	-	-	100	Rated V_{RRM}	mA
Q_{rr}	Reverse Recovery Charge	-	450	-		µC
Q_{ra}	Recovered charge, 50% Chord	-	200	300	I_{FM}=1000A, t_p=1000µs, di/dt=60A/µs,	µC
I_{rm}	Reverse Recovery Current	-	100	-	V_r=50V, 50% Chord.	A
t_{rr}	Reverse recovery time, 50% Chord	-	3.5	-		µs
$R_{th(j-hs)}$	Thermal resistance, junction to heatsink	-	-	0.033	Double side cooled	K/W
		-	-	0.066	Single side cooled	
F	Mounting force	10	-	20		kN
W_t	Weight	-	340	-		g

Notes:-
1) Unless otherwise indicated T_j=150°C.

Introduction

The M0588LC400-450 fast recovery diode range has controlled reverse recovery characteristics.

Devices with a suffix code (2 letter or letter/digit/letter combination) added to their generic code are not necessarily subject to the conditions and limits contained in this report.

Notes on Ratings and Characteristics

1.0 Voltage Grade Table

Voltage Grade	V_{RRM} (V)	V_{RSM} (V)	V_R dc (V)
40	4000	4100	2000
42	4200	4300	2040
44	4400	4500	2080
45	4500	4600	2100

2.0 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.

3.0 ABCD Constants

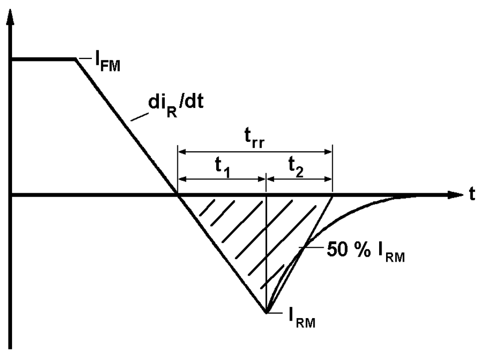
These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

where I_F = instantaneous forward current.

4.0 Reverse recovery ratings

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



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

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

(iii) $$K\ Factor = \frac{t_1}{t_2}$$

5.0 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

6.0 Computer Modelling Parameters

6.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_o + \sqrt{V_o^2 + 4 \cdot ff^2 \cdot r_s \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_s}$$

Where V_o = 2.32 V, r_s = 0.177mΩ
ff = form factor (normally unity for fast diode applications)

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

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

6.2 Calculation of V_F using ABCD Coefficients

The forward characteristic I_F Vs V_F, on Fig. 1 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, 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 hot characteristics. The resulting values for V_F agree with the true device characteristic over a current range, which is limited to that plotted.

125°C Coefficients	
A	2.164756168
B	-0.3369446
C	3.54133×10^{-4}
D	0.1224153

Curves

Figure 1 – Forward characteristics of Limit device

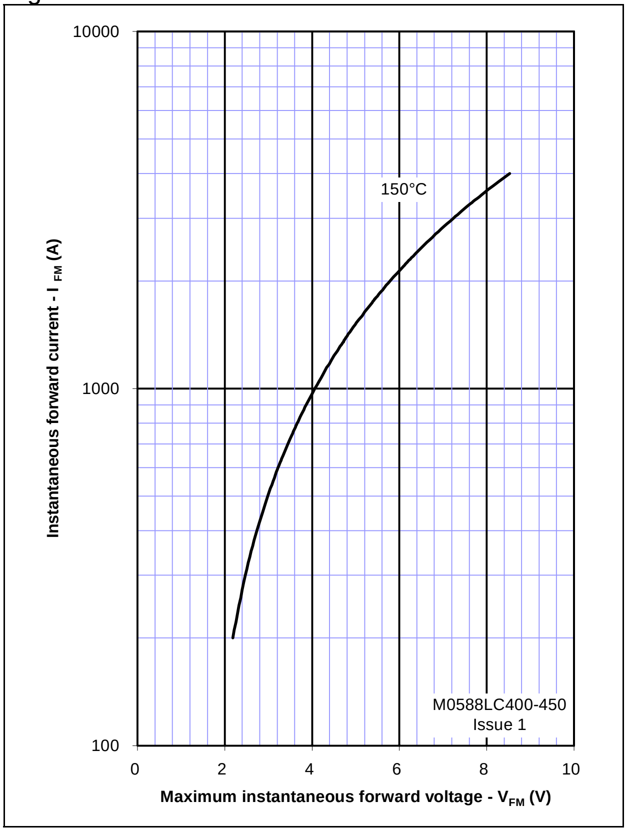


Figure 2 – Maximum forward recovery voltage

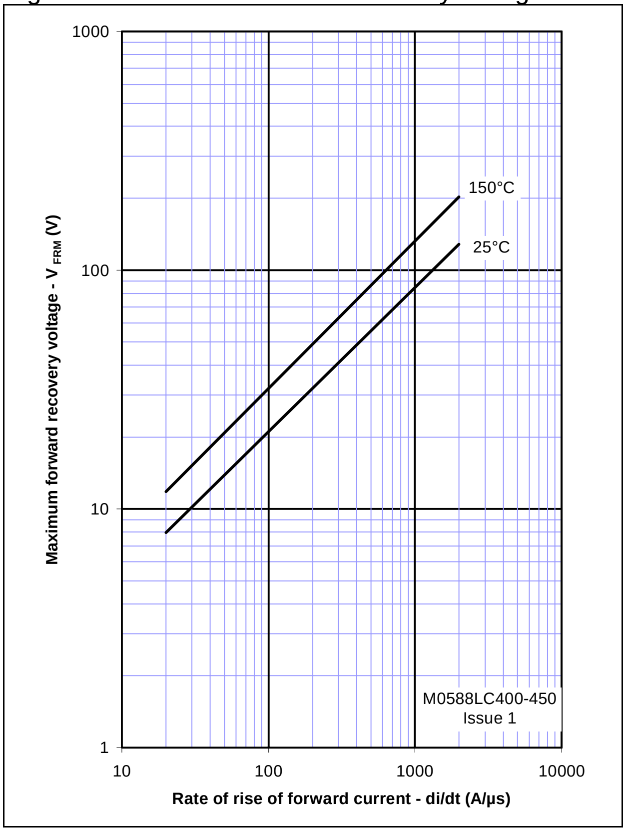


Figure 3 - Recovered charge, Q_{rr}

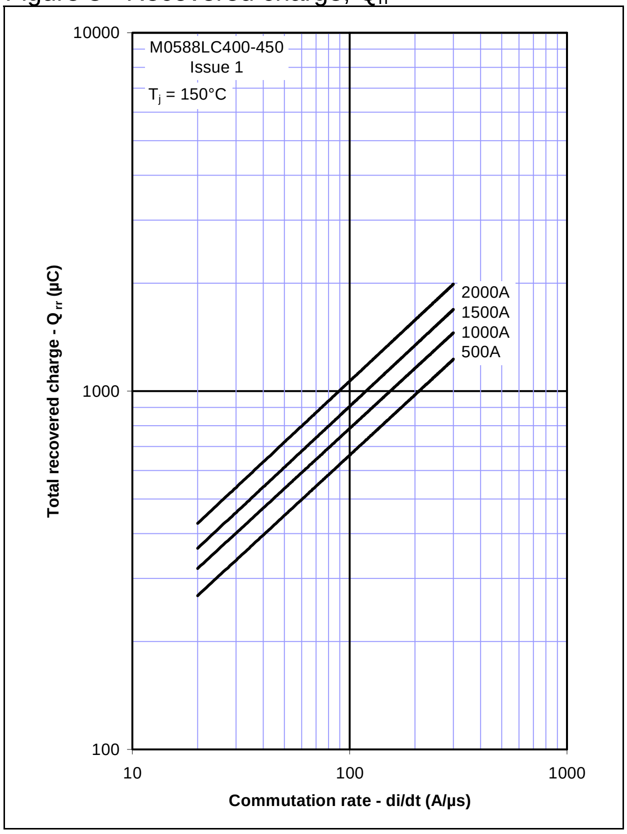


Figure 4 - Recovered charge, Q_{ra} (50% chord)

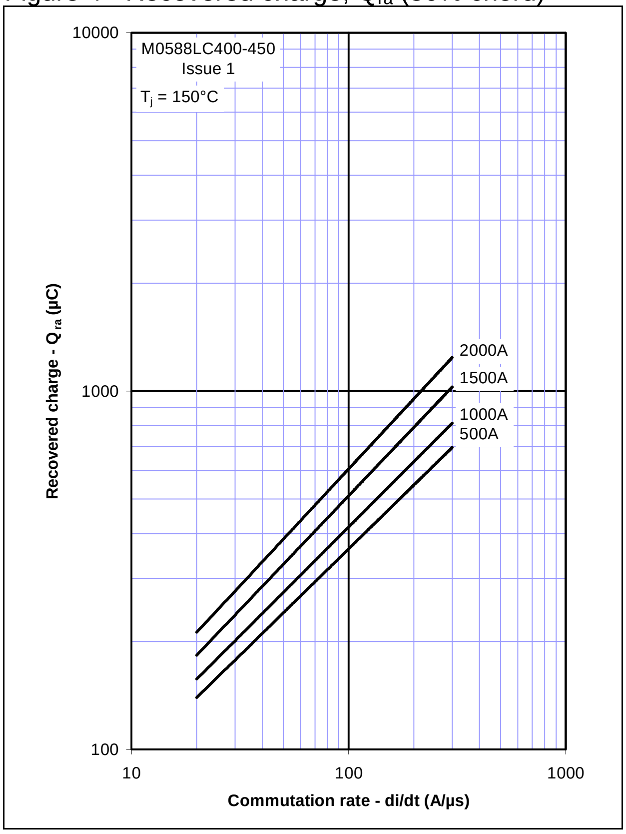


Figure 5 - Maximum reverse current, I_{rm}

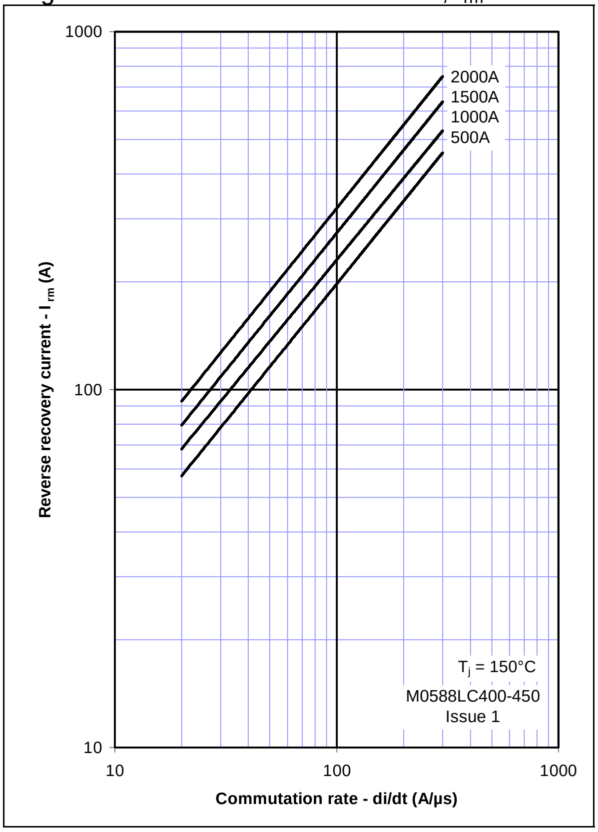


Figure 6 - Maximum recovery time, t_{rr} (50% chord)

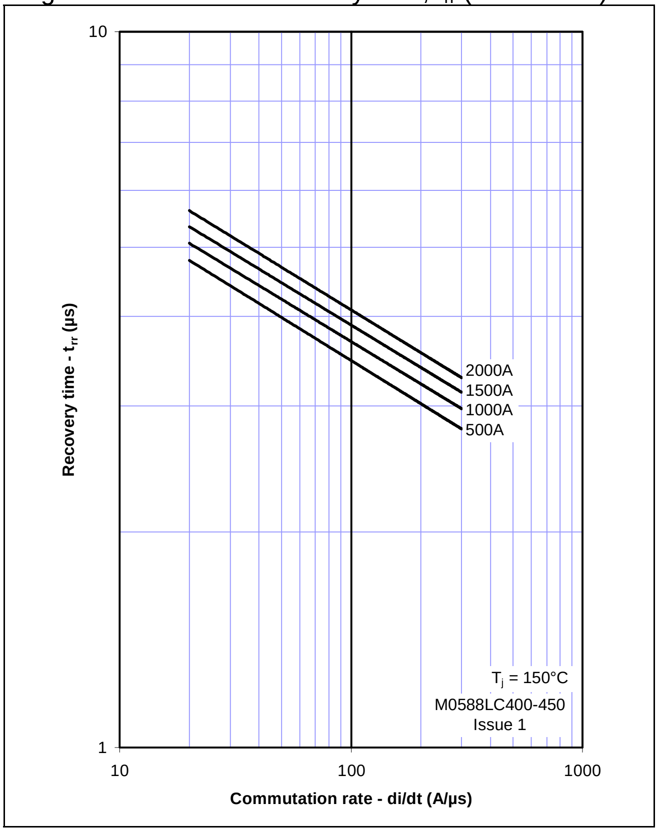


Figure 7 – Reverse recovery energy per pulse

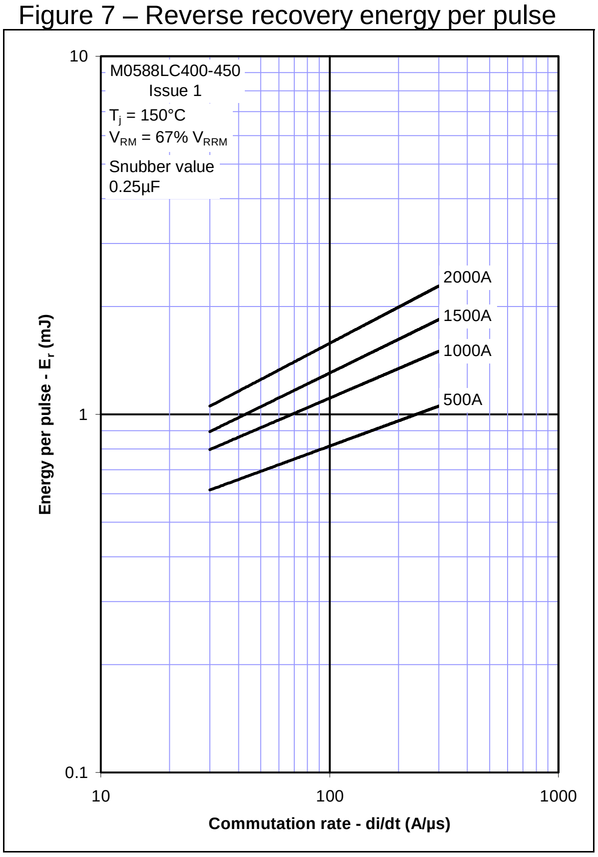


Figure 8 - Sine wave energy per pulse

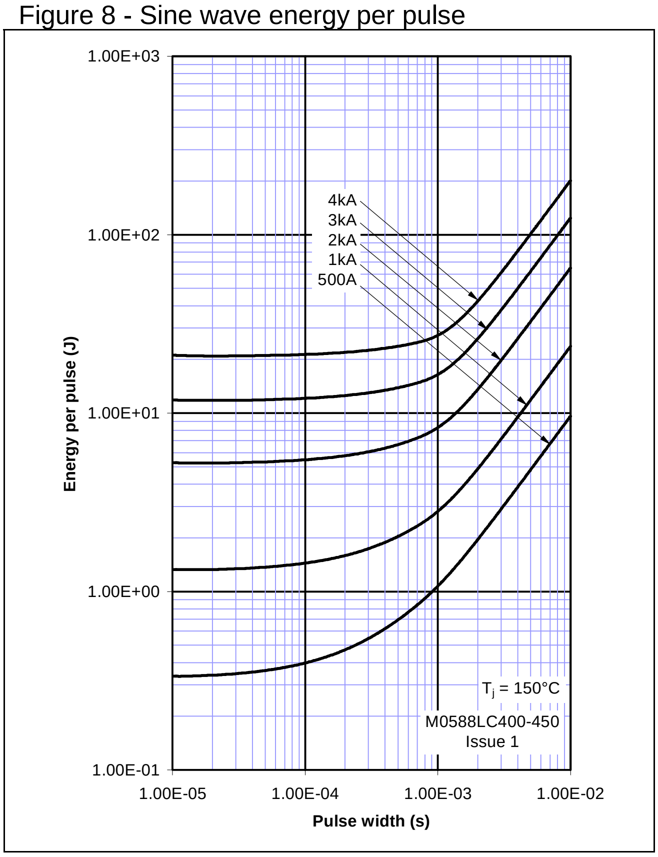


Figure 9 - Sine wave frequency vs. pulse width

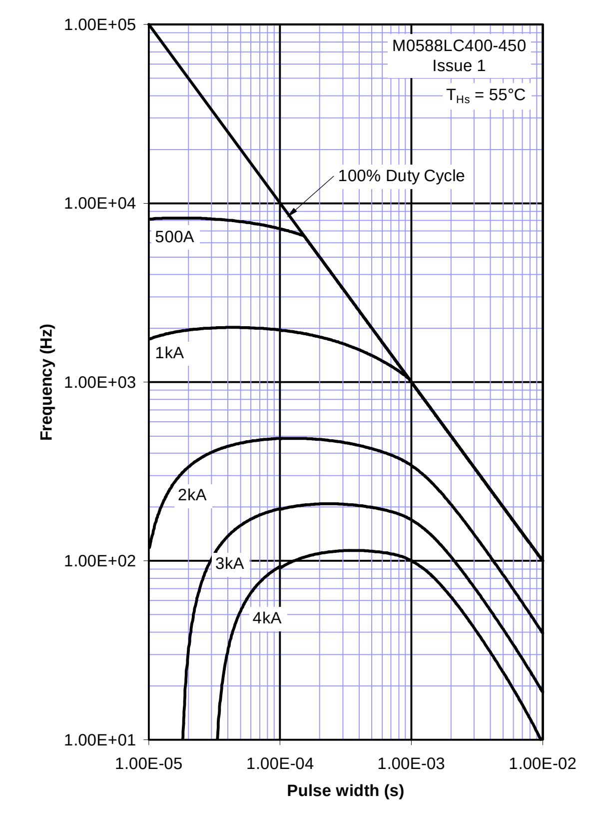


Figure 10 - Sine wave frequency vs. pulse width

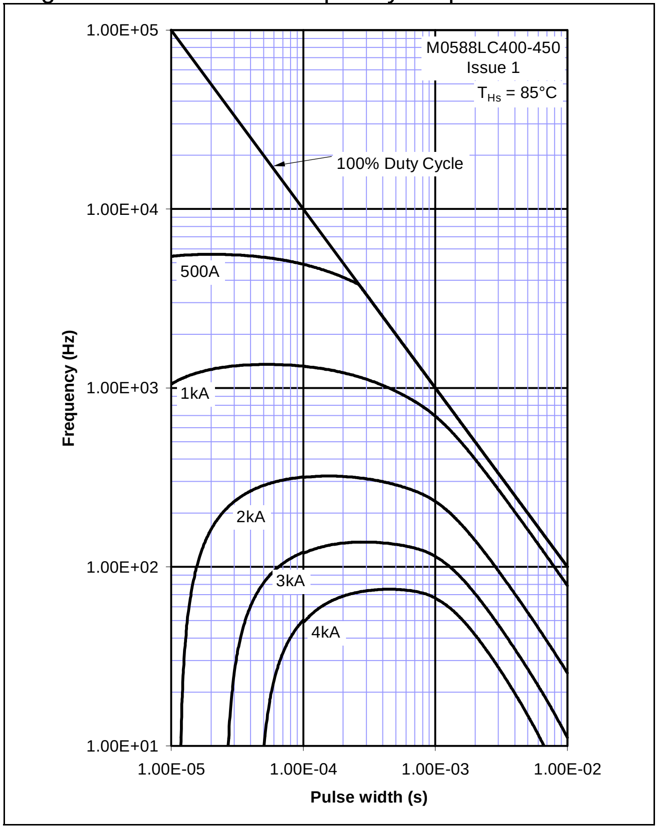


Figure 11 - Square wave frequency vs pulse width

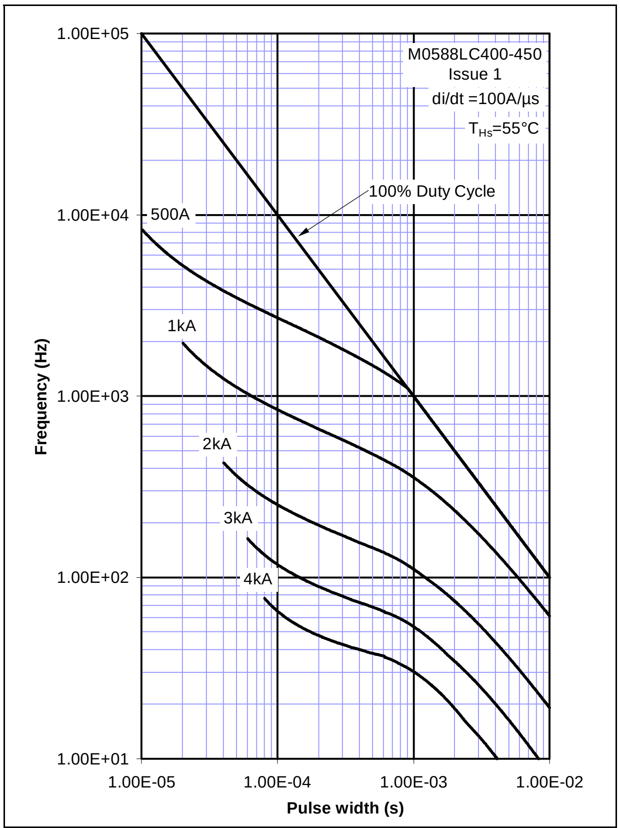


Figure 12 - Square wave frequency vs pulse width

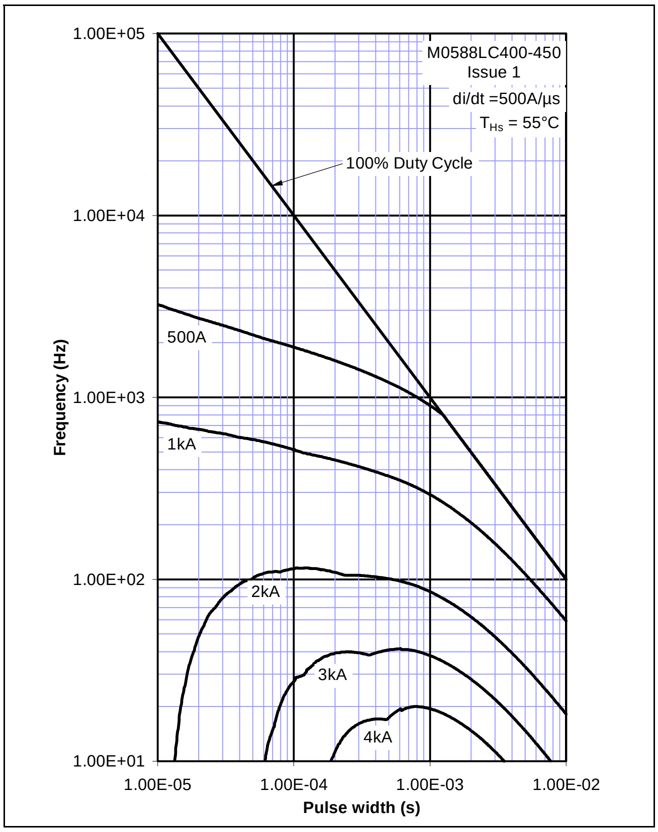


Figure 13 - Square wave frequency vs pulse width

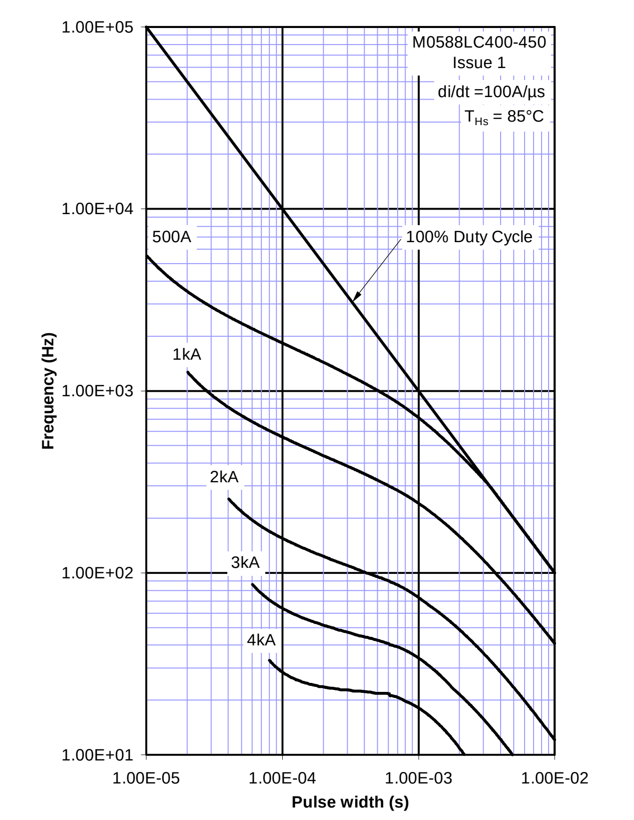


Figure 14 - Square wave frequency vs pulse width

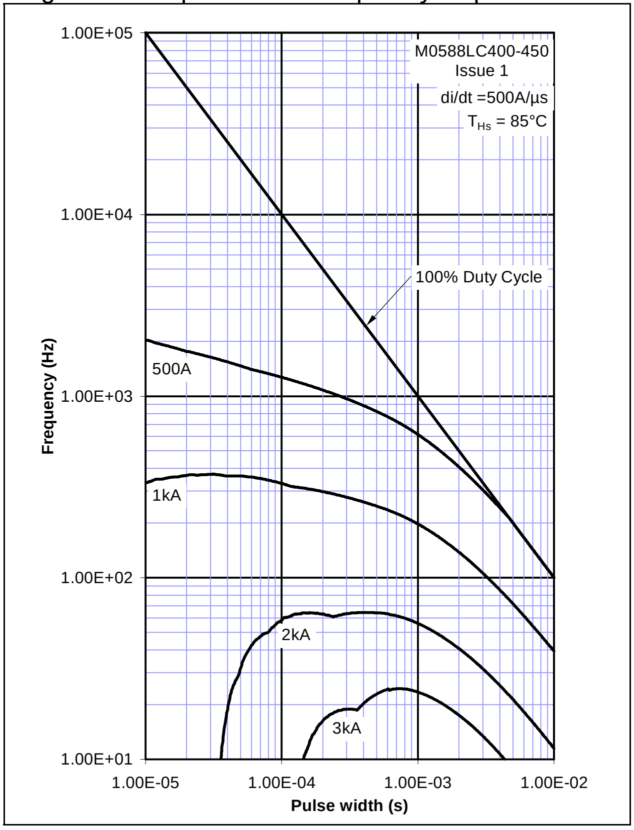


Figure 15 - Square wave energy per pulse

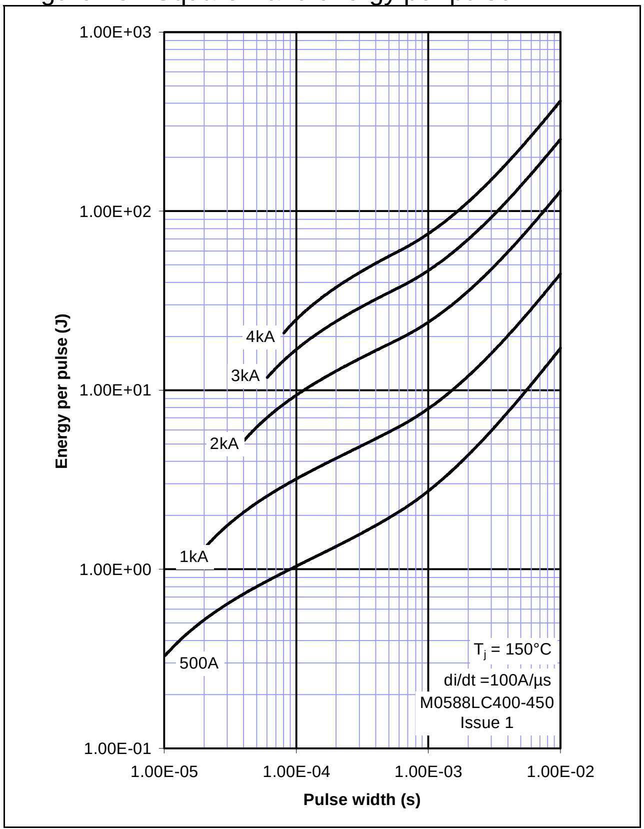


Figure 16 - Square wave energy per pulse

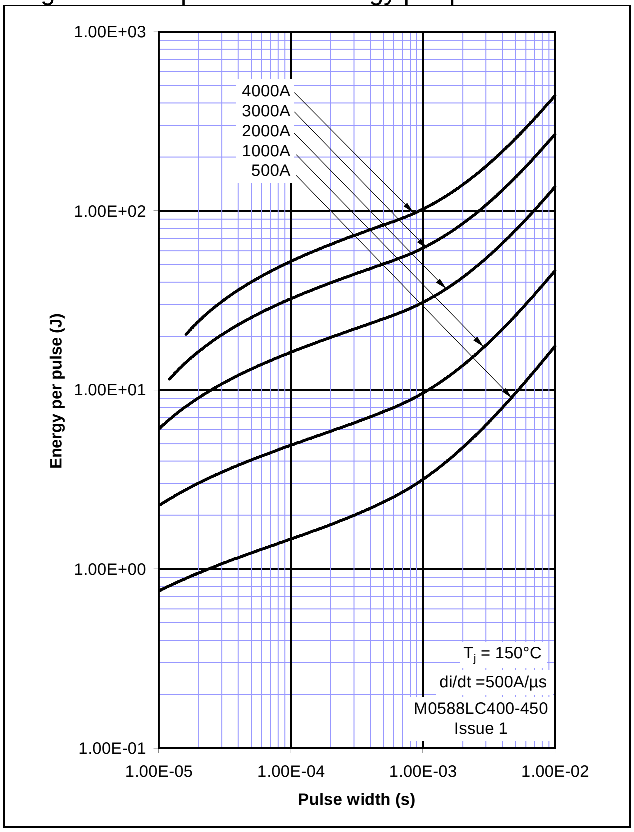


Figure 17 – Maximum surge and I^2t ratings

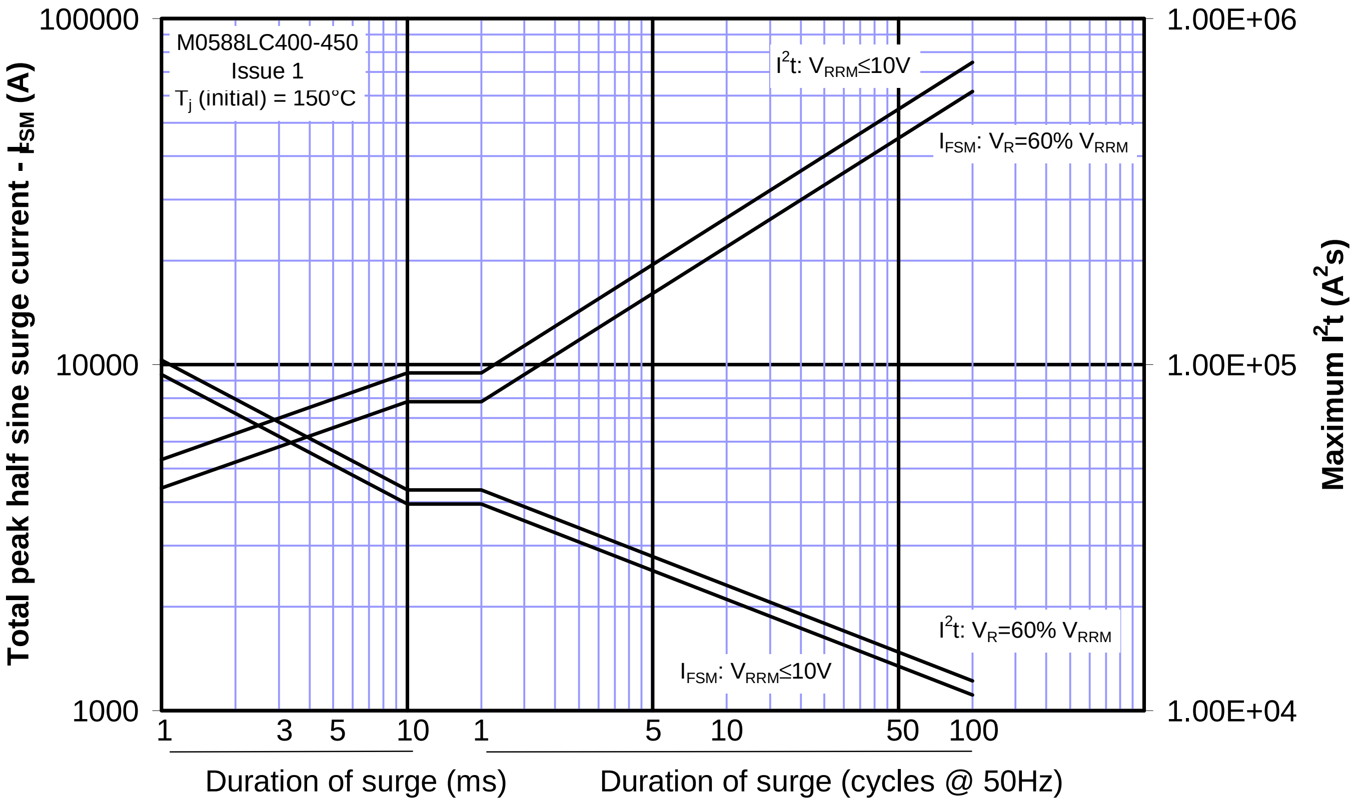
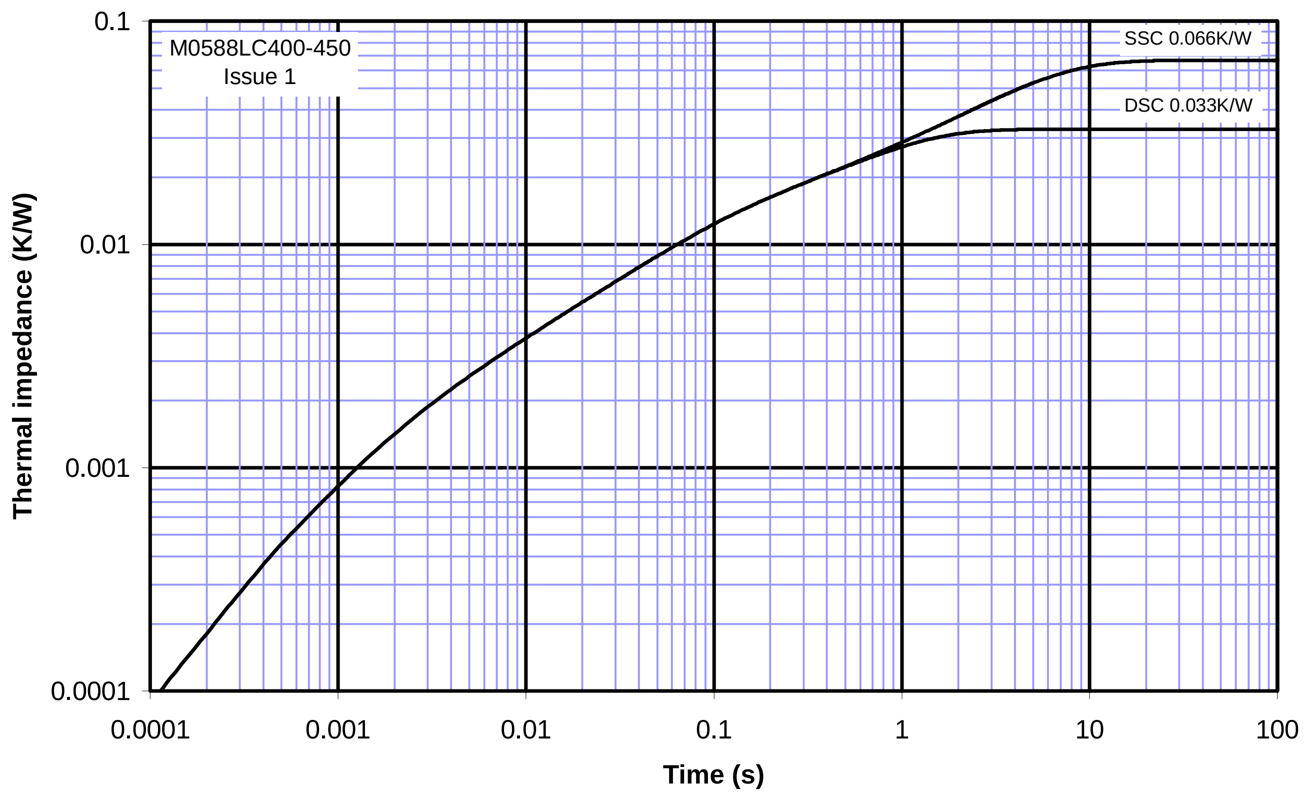
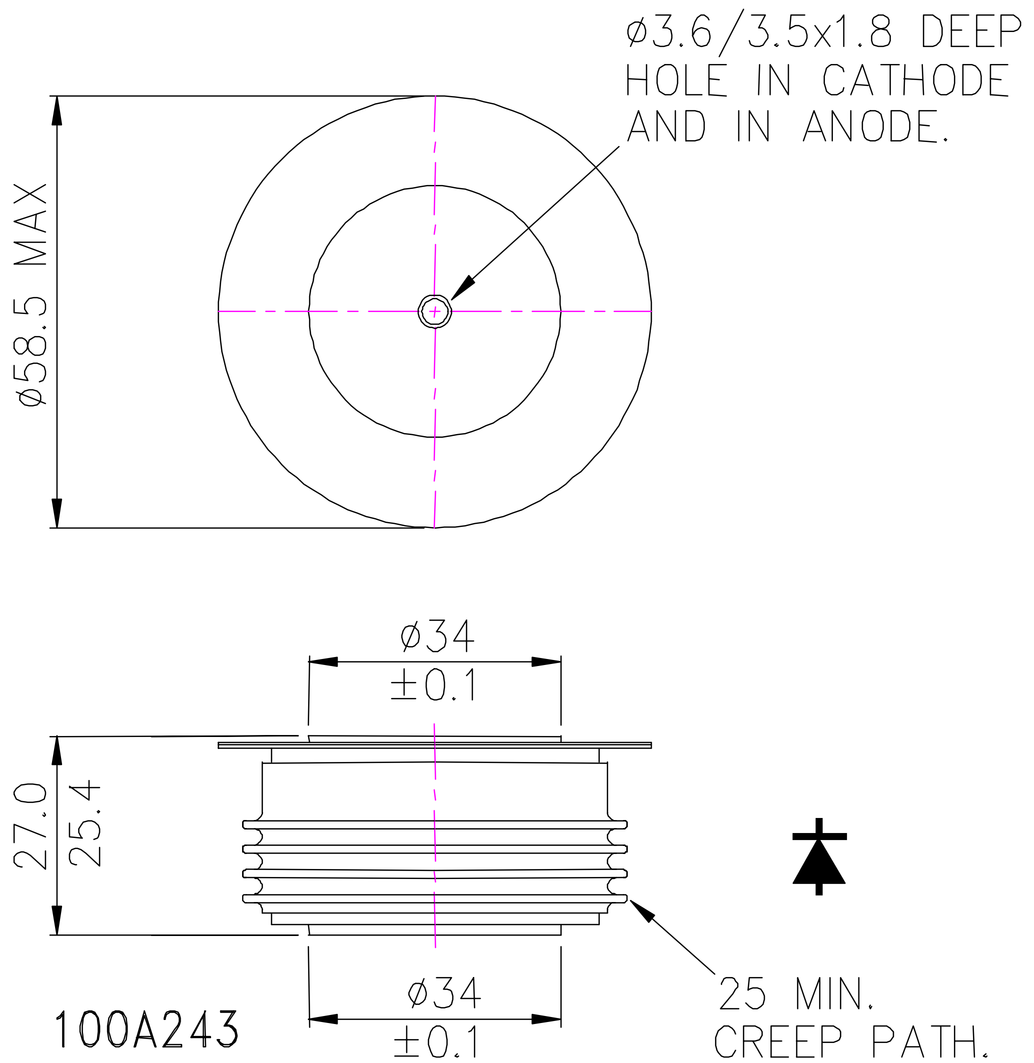


Figure 18 – Transient thermal impedance



Outline Drawing & Ordering Information



ORDERING INFORMATION		(Please quote 10 digit code as below)		
M	**0588**	**LC**	**♦♦**	**0**
Fixed Type Code	Fixed Type code	Fixed outline code	Voltage code 40-45	Fixed code

Typical order code: M0588LC420 – 4200V V_{RRM}, 27mm clamp height capsule.

WESTCODE

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