Date: - 18th Dec 2018

Data Sheet Issue: - 2

Soft Recovery Diode

Type M0859LC140 to M0859LC180

(Old Type No.: SM02-16CXC220)

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{RRM}	Repetitive peak reverse voltage, (note 1)	1400-1800	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	1500-1900	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Maximum average forward current, T_{sink}=55°C, (note 2)	859	A
$I_{F(AV)M}$	Maximum average forward current. T_{sink}=85°C, (note 2)	562	A
$I_{F(AV)M}$	Maximum average forward. T_{sink}=85°C, (note 3)	319	A
$I_{F(RMS)}$	Nominal RMS forward current, T_{sink}=25°C, (note 2)	1742	A
$I_{f(d.c.)}$	D.C. forward current, T_{sink}=25°C, (note 4)	1404	A
I_{FSM}	Peak non-repetitive surge t_p=10ms, V_{RM}=60%V_{RRM}, (note 5)	10	kA
I_{FSM2}	Peak non-repetitive surge t_p=10ms, $V_{RM} \leq$10V, (note 5)	11	kA
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}=60%V_{RRM}, (note 5)	500×10^3	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, $V_{RM} \leq$10V, (note 5)	605×10^3	A^2s
$T_{j\ op}$	Operating temperature range	-40 to +125	°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, 125°C T_j initial.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V_{FM}	Maximum peak forward voltage	-	-	1.55	I_{FM}=1200A	V
		-	-	1.7	I_{FM}=1750A	
V_{T0}	Threshold voltage	-	-	1.17		V
r_T	Slope resistance	-	-	0.32		mΩ
V_{FRM}	Maximum forward recovery voltage	-	-	20	di/dt = 1000A/µs, T_j=25°C	V
		-	-	30	di/dt = 1000A/µs	
I_{RRM}	Peak reverse current	-	-	50	Rated V_{RRM}	mA
Q_{rr}	Recovered charge	-	280	-	I_{FM}=800A, t_p=500µs, di/dt=50A/µs, V_r=50V, 50% Chord.	µC
Q_{ra}	Recovered charge, 50% Chord	-	110	140		µC
I_{rm}	Reverse recovery current	-	75	-		A
t_{rr}	Reverse recovery time, 50% Chord	-	3	-		µs
R_{thJK}	Thermal resistance, junction to heatsink	-	-	0.044	Double side cooled	K/W
		-	-	0.088	Single side cooled	
F	Mounting force	10	-	20		kN
W_t	Weight	-	340	-		g

Notes:-
1) Unless otherwise indicated T_j=125°C.

Notes on Ratings and Characteristics

1.0 Voltage Grade Table

Voltage Grade	V_{RRM} (V)	V_{RSM} (V)	V_R dc (V)
14	1400	1500	930
16	1600	1700	1040
18	1800	1900	1200

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

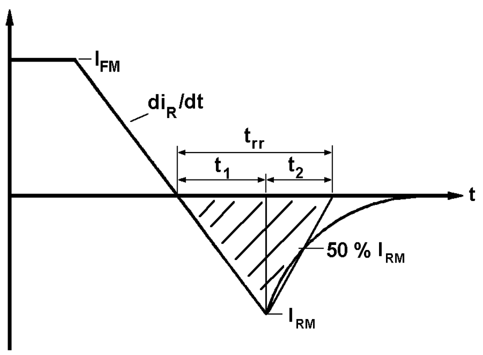
These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

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:

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

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.
$R_{th(JK)}$ = 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 Snubber Components

When selecting snubber components, care must be taken not to use excessively large values of snubber capacitor or excessively small values of snubber resistor. Such excessive component values may lead to device damage due to the large resultant values of snubber discharge current. If required, please consult the factory for assistance.

7.0 Computer Modelling Parameters

7.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_0 + \sqrt{V_0 + 4 \cdot ff^2 \cdot r_s \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_s}$$

Where V_{T0} = 1.17V, r_T = 0.32mΩ
ff = form factor (normally unity for fast diode applications)

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

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

7.2 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		125°C Coefficients	
A	0.9692108214	A	0.5014768256
B	0.0334639000	B	0.1050145000
C	8.17008×10^{-5}	C	1.371460×10^{-4}
D	9.5403280×10^{-3}	D	4.0237590×10^{-3}

8.0 Frequency Ratings

The curves illustrated in figures 8 to 16 are for guidance only and are superseded by the maximum ratings shown on page 1.

9.0 Square wave ratings

These ratings are given for load component rate of rise of forward current of 100 and 500 A/µs.

10.0 Duty cycle lines

The 100% duty cycle is represented on all the ratings by a straight line. Other duties can be included as parallel to the first.

Curves

Figure 1 – Forward characteristics of Limit device

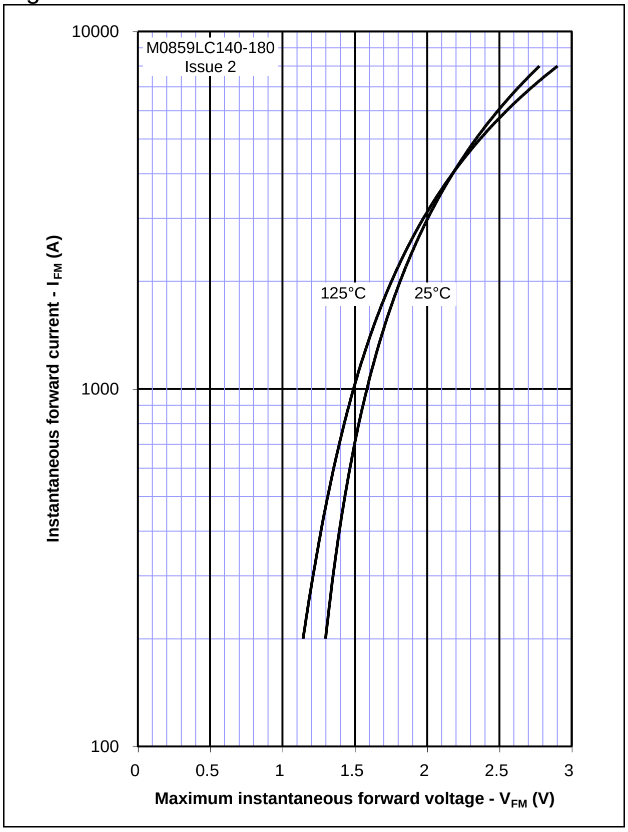


Figure 2 – Maximum forward recovery voltage

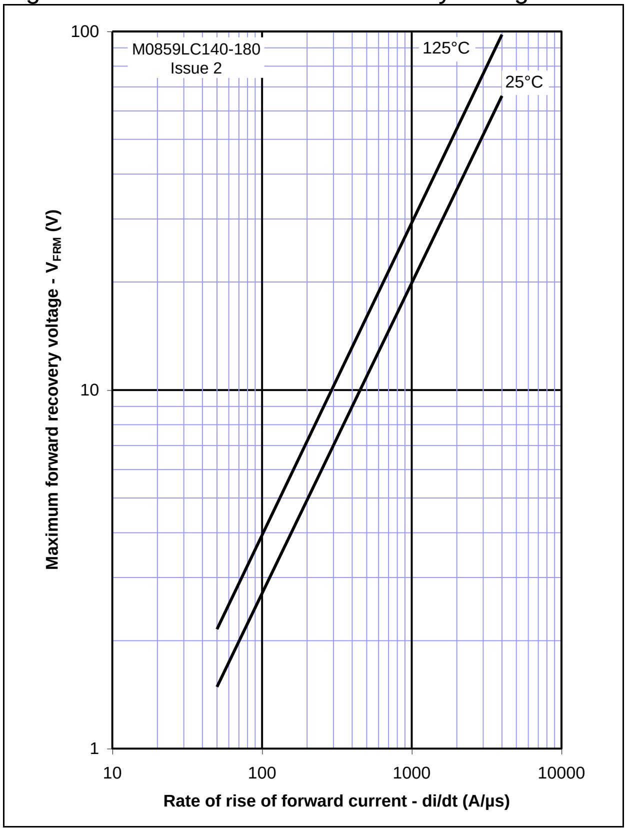


Figure 3 - Recovered charge, Q_{rr}

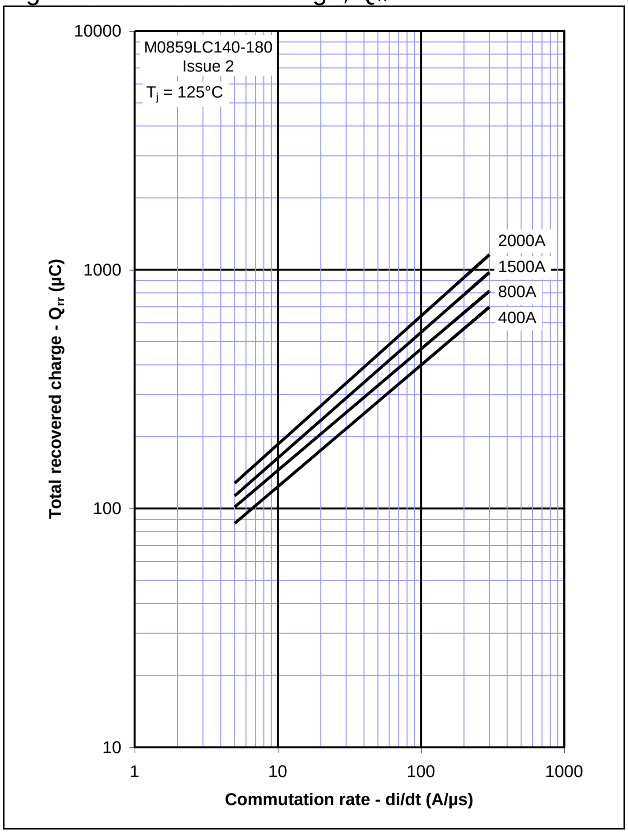


Figure 4 - Recovered charge, Q_{ra} (50% chord)

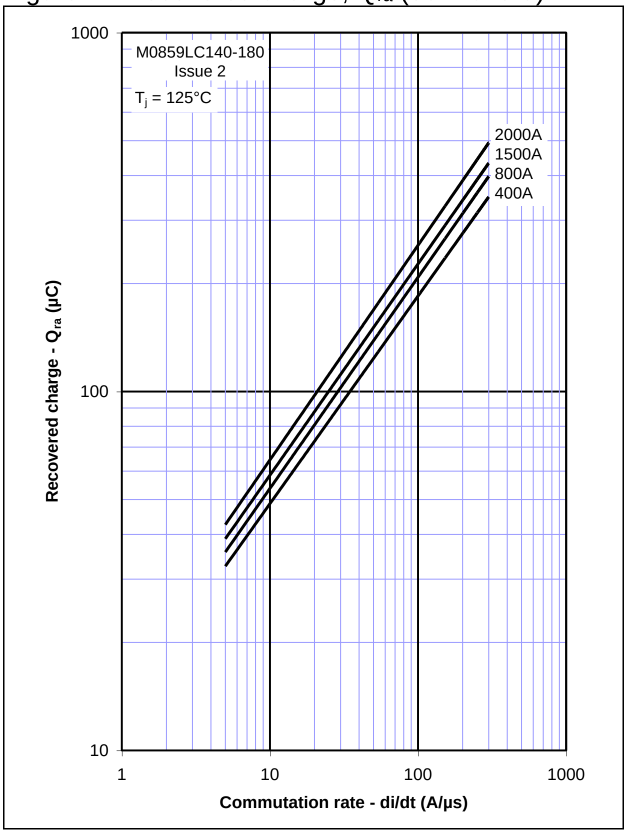


Figure 5 - Maximum reverse current, I_{rm}

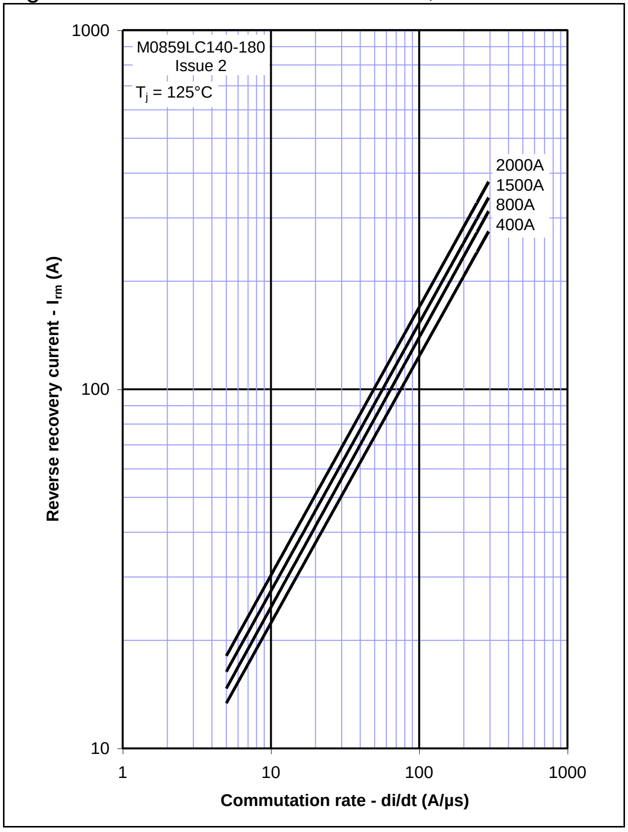


Figure 6 - Maximum recovery time, t_{rr} (50% chord)

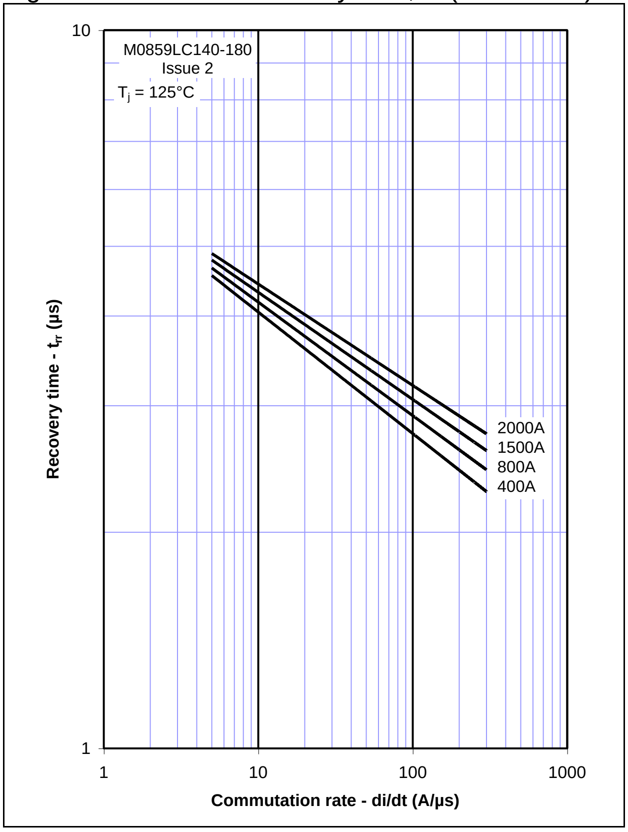


Figure 7 – Reverse recovery energy per pulse

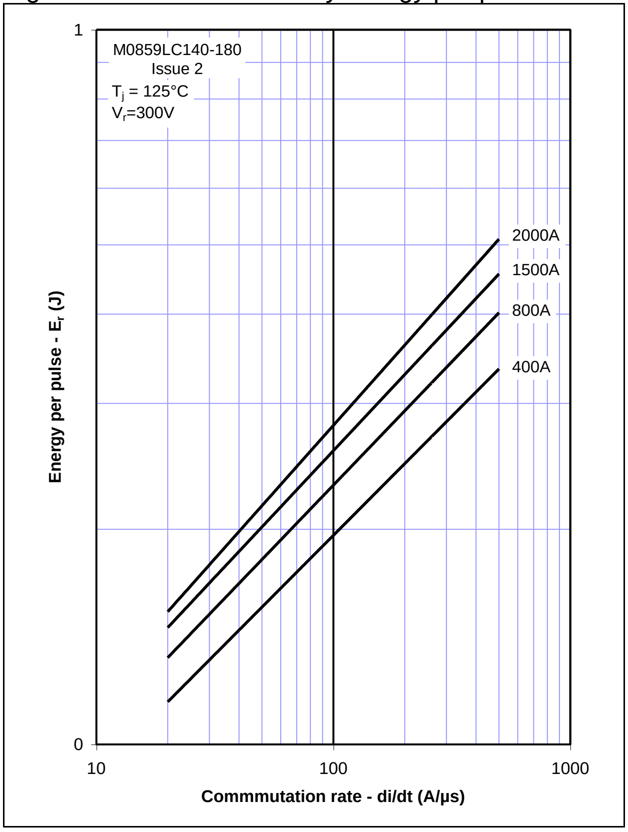


Figure 8 - Sine wave energy per pulse

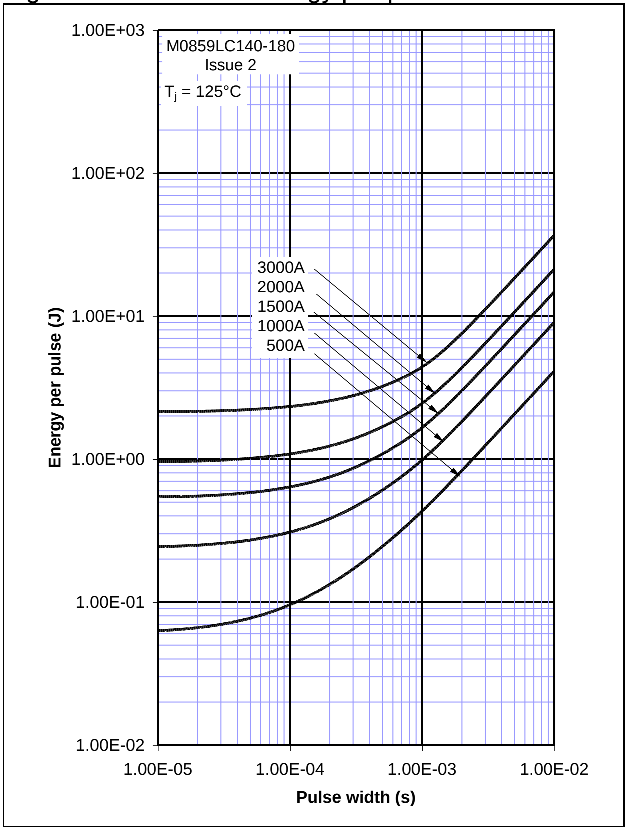


Figure 9 - Sine wave frequency vs. pulse width

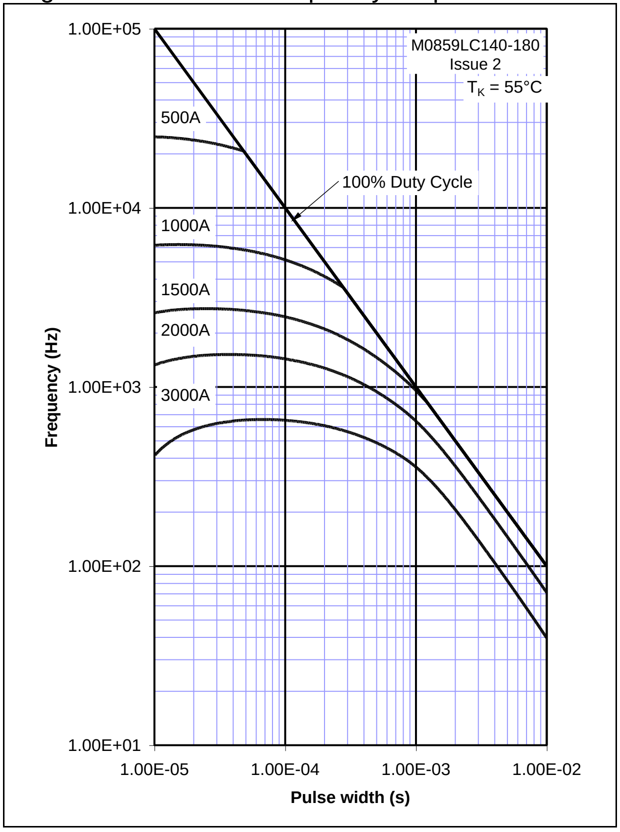


Figure 10 - Sine wave frequency vs. pulse width

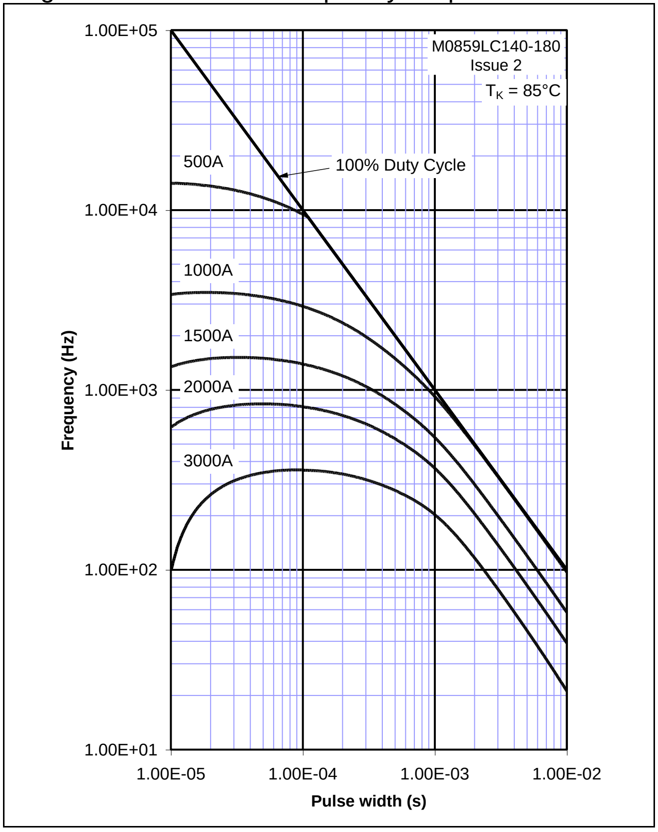


Figure 11 - Square wave energy per pulse

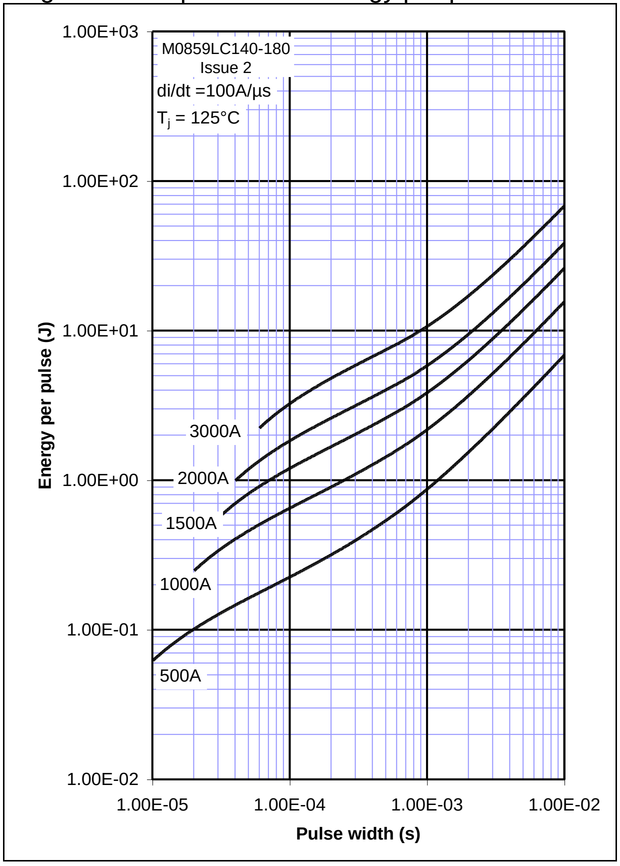


Figure 12 - Square wave energy per pulse

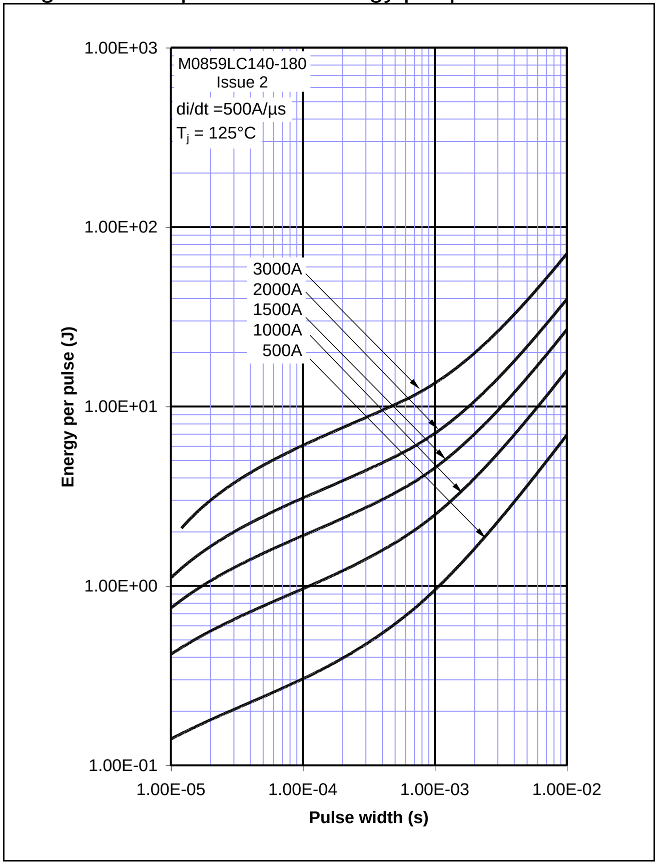


Figure 13 - Square wave frequency vs. pulse width

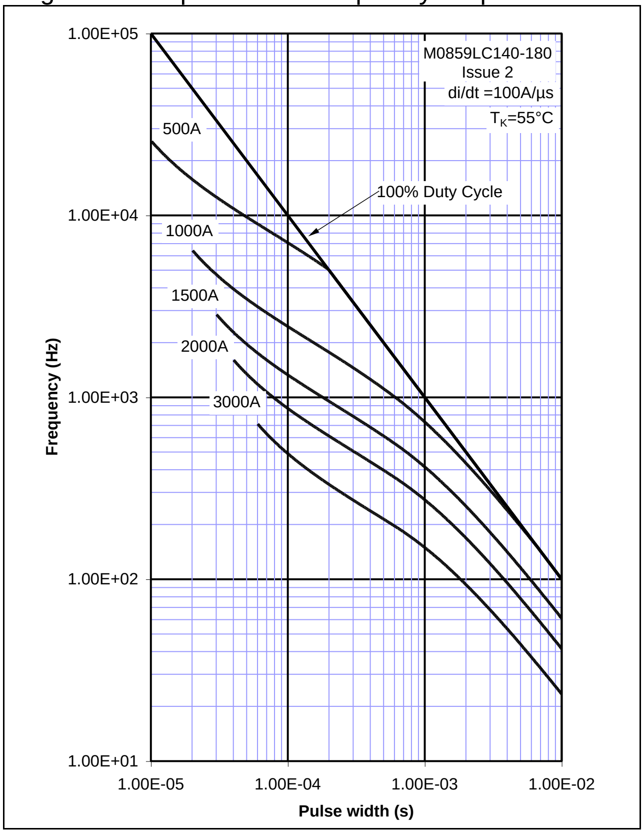


Figure 14 - Square wave frequency vs. pulse width

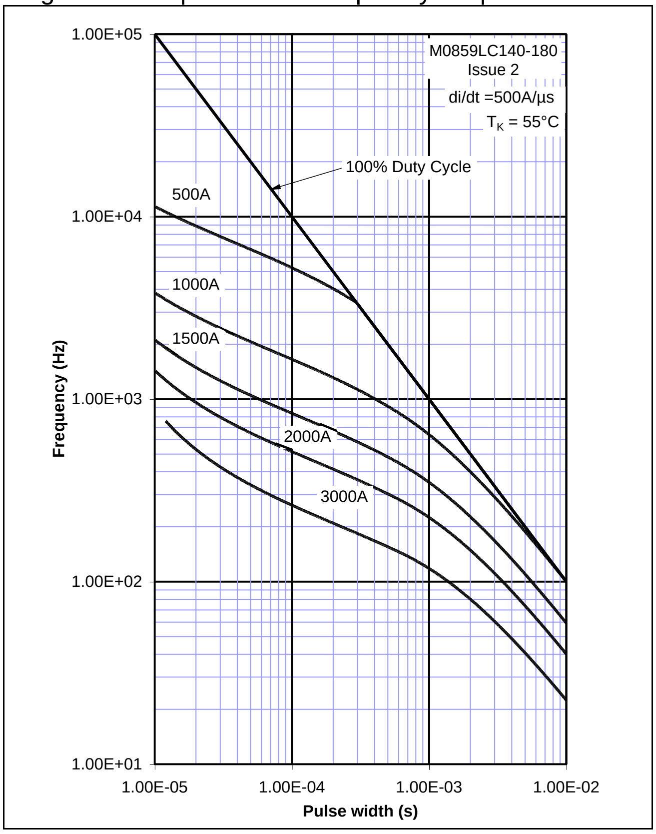


Figure 15 - Square wave frequency vs. pulse width

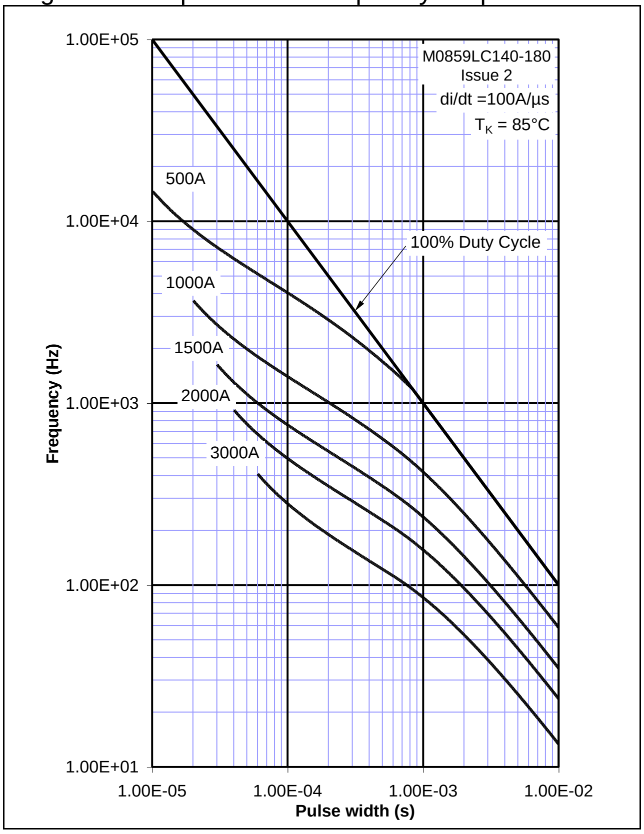


Figure 16 - Square wave frequency vs. pulse width

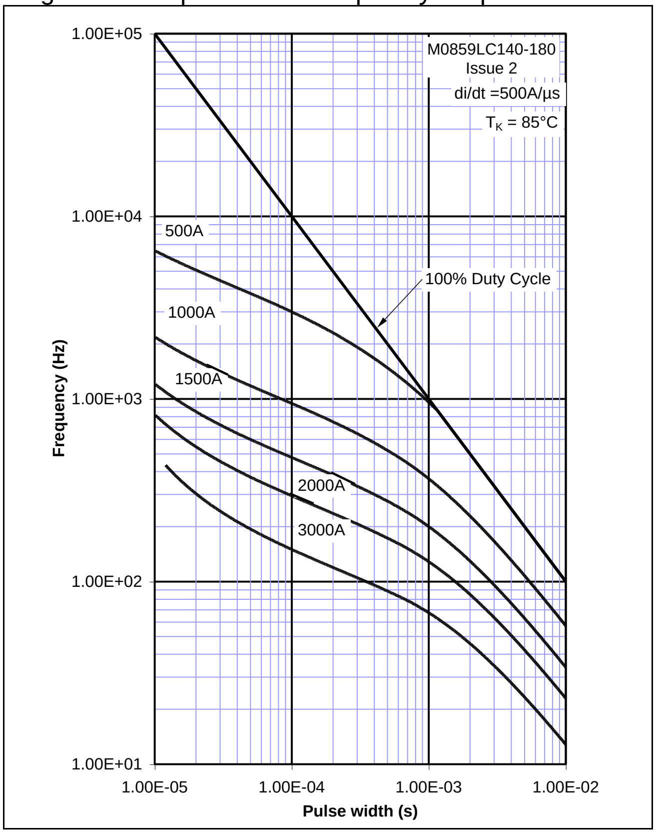


Figure 17 – Maximum surge and I^2t ratings

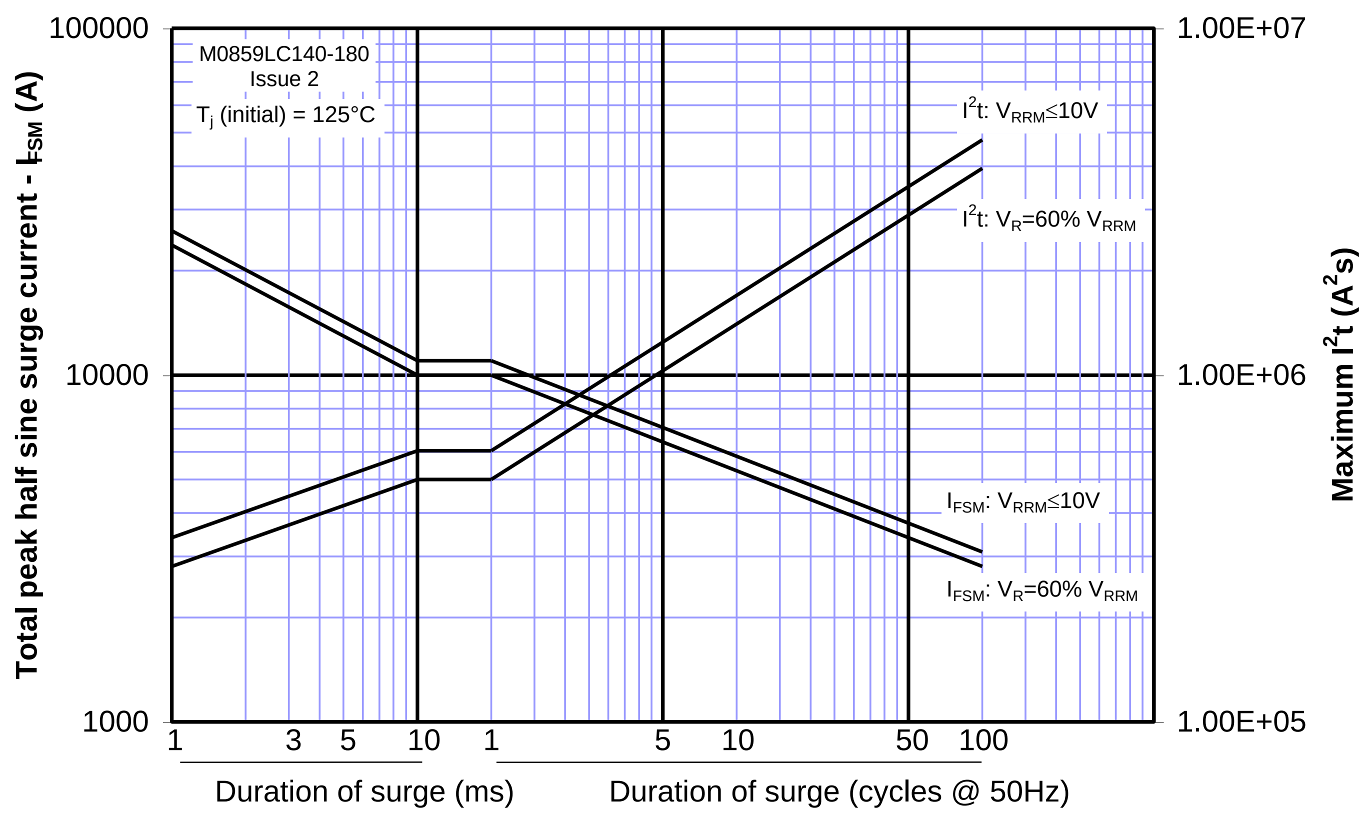
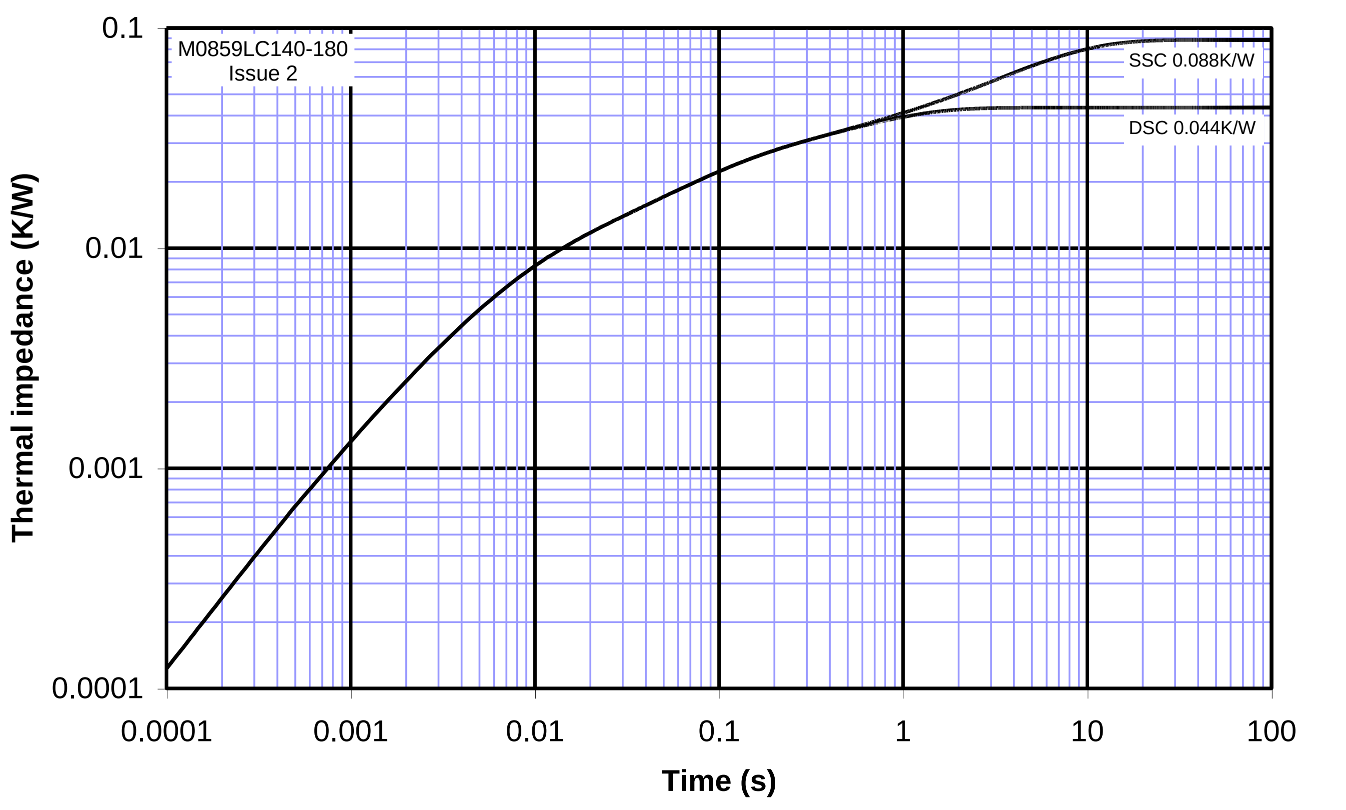
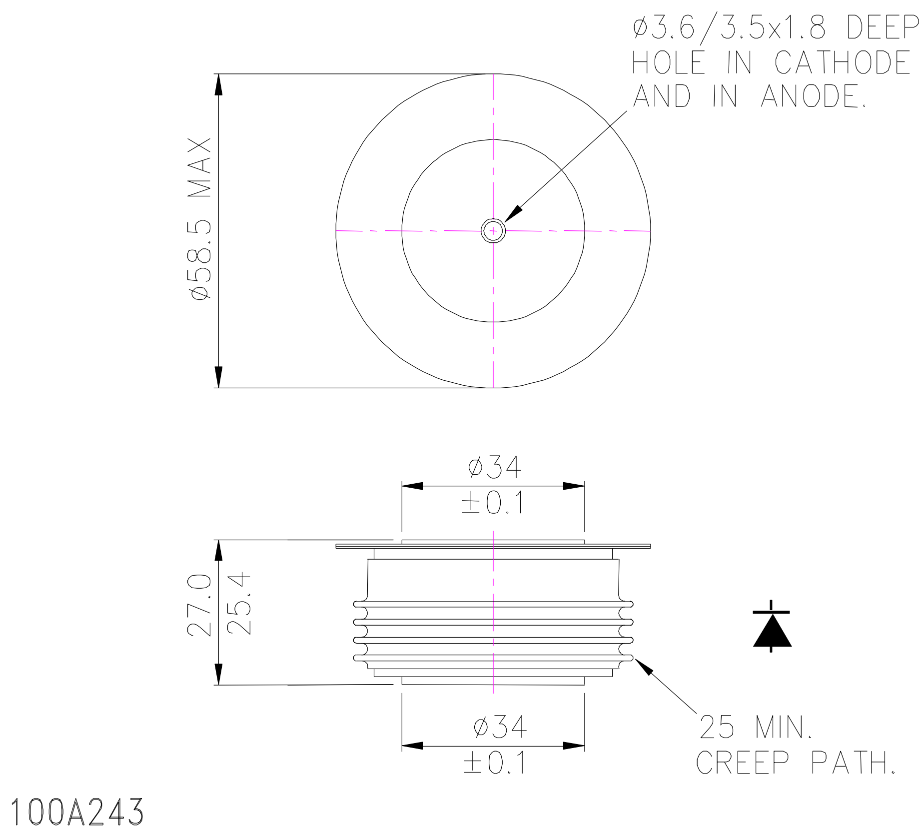


Figure 18 – Transient thermal impedance



Outline Drawing & Ordering Information



ORDERING INFORMATION		(Please quote 10-digit code as below)	
M0859	**LC**	♦♦	**0**
Fixed Type Code	Fixed outline code	Voltage code V_{DRM}/100 14-18	Fixed code

Order code: M0859LC180 – 1800V V_{RRM}, 27.0mm 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

www.littelfuse.com

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

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