

Date: - 20 Oct 2014

Data Sheet Issue:- 2

Soft Recovery Diode Type M1494NC180 to M1494NC250

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{RRM}	Repetitive peak reverse voltage, (note 1)	1800-2500	V
V _{RSM}	Non-repetitive peak reverse voltage, (note 1)	1900-2600	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
I _{F(av)M}	Maximum average forward current, T _{sink} =55°C, (note 2)	1494	Α
I _{F(av)M}	Maximum average forward current. T _{sink} =100°C, (note 2)	705	Α
I _{F(av)M}	Maximum average forward. T _{sink} =100°C, (note 3)	402	А
I _{F(RMS)}	Nominal RMS forward current, T _{sink} =25°C, (note 2)	2982	Α
I _{F(d.c.)}	D.C. forward current, T _{sink} =25°C, (note 4)	2506	А
I _{FSM}	Peak non-repetitive surge t _p =10ms, V _{RM} =60%V _{RRM} , (note 5)	19.6	kA
I _{FSM2}	Peak non-repetitive surge t _p =10ms, V _{RM} ≤10V, (note 5)	21.5	kA
l ² t	I ² t capacity for fusing t _p =10ms, V _{RM} =60%V _{RRM} , (note 5)	1.92 × 10 ⁶	A ² s
l ² t	I²t capacity for fusing t _P =10ms, V _{RM} ≤10V, (note 5)	2.31×10^{6}	A ² s
Тјор	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_i initial.



Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS	
V _{FM}	Maximum peak forward voltage	-	-	1.85	I _{FM} =3000A	V	
VEM	VFM INIAMITIUITI PEAK TOTWATU VOITAGE	-	-	2.34	I _{FM} =4500A	V	
V _{T0}	Threshold voltage	-	-	1.150		V	
r⊤	Slope resistance	-	-	0.265		mΩ	
\/	V _{FRM} Maximum forward recovery voltage	-	-	45	di/dt = 1000A/µs	V	
VFRM		-	-	28	di/dt = 1000A/µs, T _j = 25°C	V	
I _{RRM}	Peak reverse current	-	-	85	Rated V _{RRM}	mA	
Qrr	Recovered charge	-	815	-		μC	
Qra	Recovered charge, 50% Chord	-	275	380	$I_{FM}=1000A$, $t_p=1000\mu s$, $di/dt=60A/\mu s$,	μC	
I _{rm}	Reverse recovery current	-	140	-	V _r =50V, 50% Chord.	Α	
t _{rr}	Reverse recovery time, 50% Chord	-	3.9	-		μs	
R_{thJK}	Thermal registance, junction to heateigh	-	-	0.022	Double side cooled	K/W	
' `thJK	Thermal resistance, junction to heatsink	-	-	0.044	Single side cooled	rv/vv	
F	Mounting force	19	-	26	Note 2	kN	
Wt	Weight	-	510	-		g	

Notes:-

- Unless otherwise indicated T_j=125°C.
 For other clamp forces, please consult factory.



Notes on Ratings and Characteristics

1.0 Voltage Grade Table

Voltage Grade	V _{RRM}	V _{RSM}	V _R dc
	(V)	(V)	(V)
18	1800	1900	1150
20	2000	2100	1250
22	2200	2300	1350
24	2400	2500	1450
25	2500	2600	1500

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

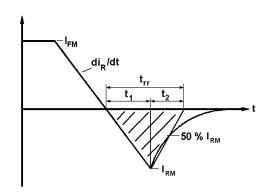
These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

where I_F = instantaneous forward current.

4.0 Reverse recovery ratings

(i) Qra is based on 50% Irm chord as shown in Fig.(a) below.



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

l.e.
$$Q_{rr}=\int\limits_{0}^{150\mu s}i_{rr}.dt$$
 (iii) $K\ Factor=rac{t_{1}}{t_{2}}$

(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:

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

Where $k = 0.2314 \, (^{\circ}\text{C/W})/\text{s}$

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:

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

Where: V_r = Commutating source voltage

Cs = 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

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

Where $V_{T0} = 1.15 \text{V}$, $r_T = 0.265 \text{m}\Omega$

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

$$W_{AV} = \frac{\Delta T}{R_{th}}$$
$$\Delta T = T_{i(MAX)} - T_{K}$$

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 hot 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
Α	0.6059922	-0.0548532
В	0.0483707	0.1612135
С	9.492610×10 ⁻⁵	2.274044×10 ⁻⁴
D	0.0112304	2.917716×10 ⁻⁴

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

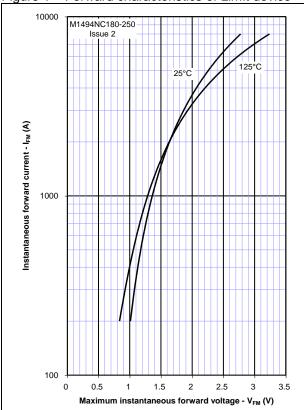


Figure 2 - Maximum forward recovery voltage

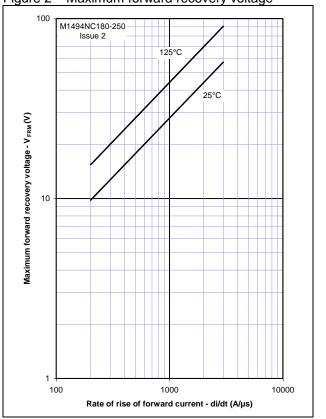


Figure 3 - Recovered charge, Qrr

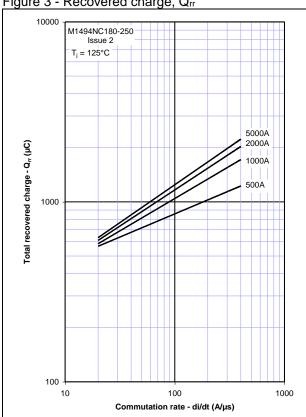
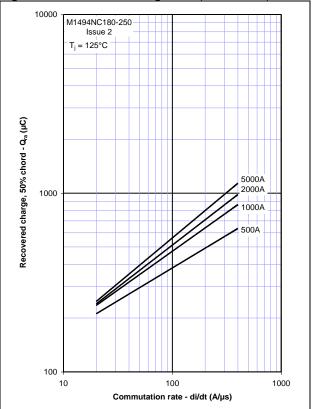
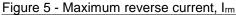


Figure 4 - Recovered charge, Qra (50% chord)







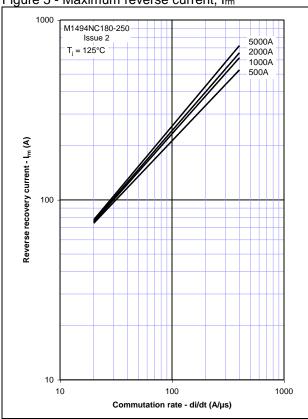
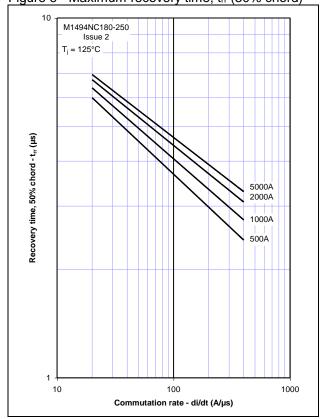


Figure 6 - Maximum recovery time, trr (50% chord)



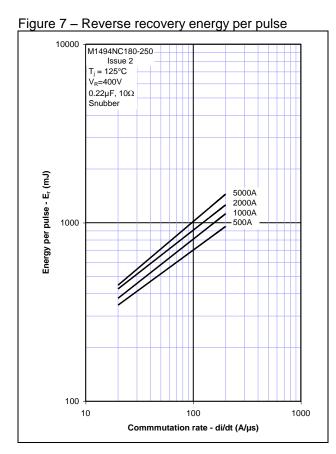


Figure 8 - Sine wave energy per pulse

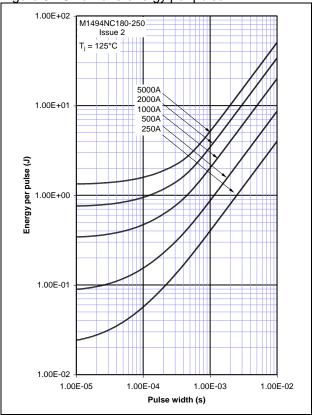




Figure 9 - Sine wave frequency vs. pulse width

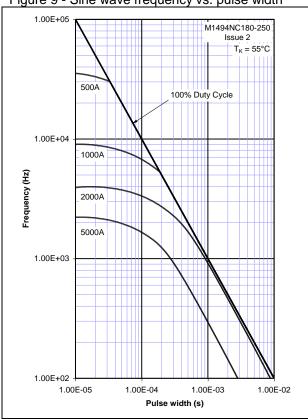
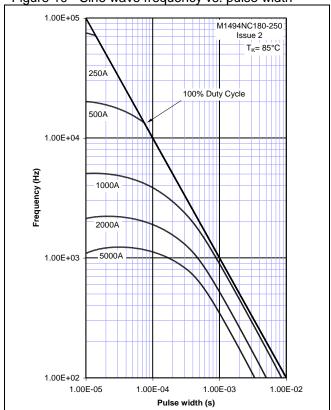


Figure 10 - Sine wave frequency vs. pulse width



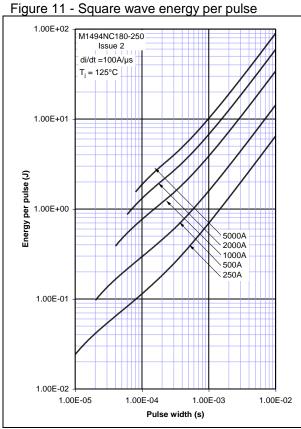


Figure 12 - Square wave energy per pulse

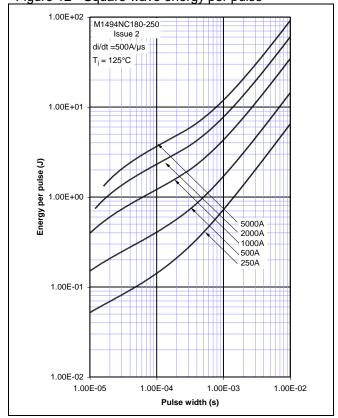




Figure 13 - Square wave frequency vs. pulse width

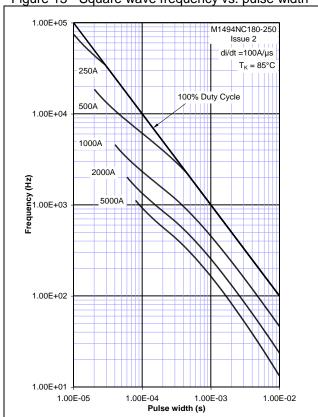
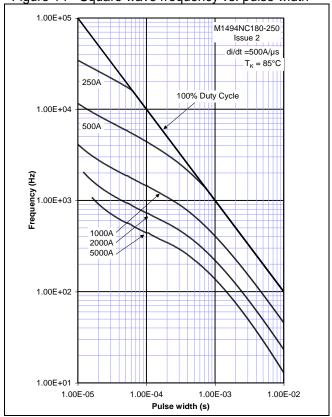


Figure 14 - Square wave frequency vs. pulse width



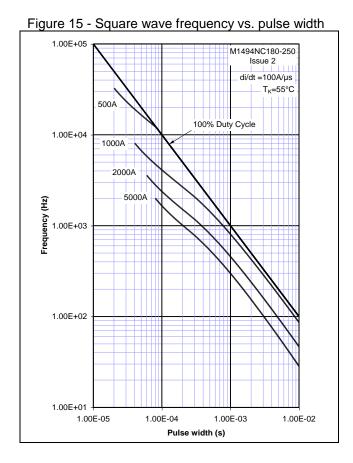
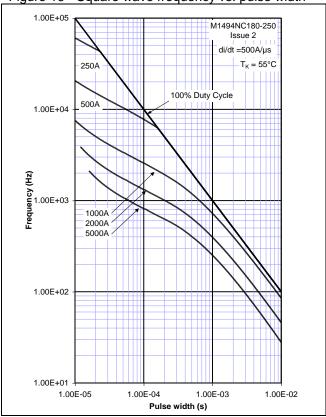
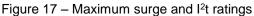


Figure 16 - Square wave frequency vs. pulse width







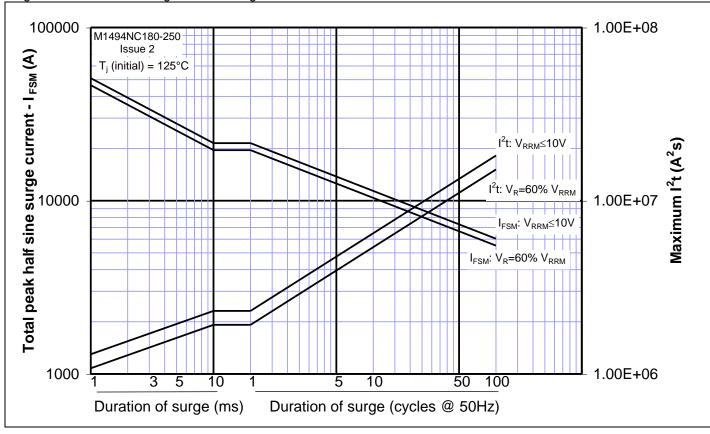
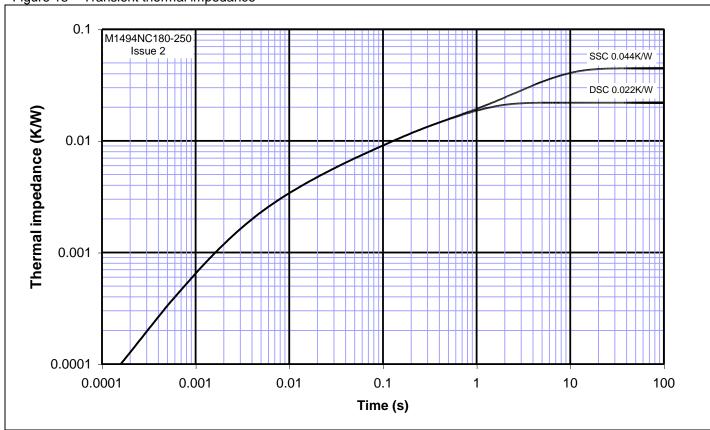
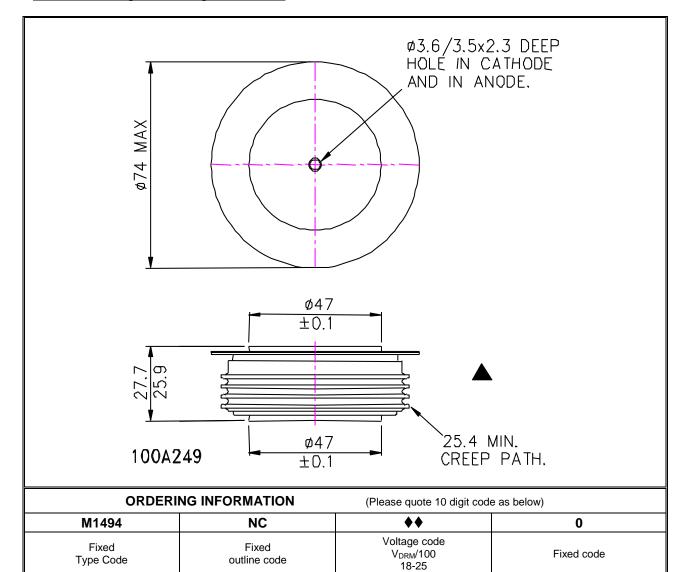


Figure 18 - Transient thermal impedance





Outline Drawing & Ordering Information



Order code: M1494NC180 - 1800V V_{RRM}, 27.7mm clamp height capsule.

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