

Provisional Data

## Extra Fast Recovery Diode

### Type F1600NC120

Development Type No. Fx021NC120

#### Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
$V_{RRM}$	Repetitive peak reverse voltage, (note 1)	1200	V
$V_{RSM}$	Non-repetitive peak reverse voltage, (note 1)	1300	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)}$	Mean forward current, $T_{sink}=55^{\circ}C$ , (note 2)	1326	A
$I_{F(AV)}$	Mean forward current. $T_{sink}=100^{\circ}C$ , (note 2)	605	A
$I_{F(AV)}$	Mean forward current. $T_{sink}=100^{\circ}C$ , (note 3)	337	A
$I_{F(RMS)}$	Nominal RMS forward current, $T_{sink}=25^{\circ}C$ , (note 2)	2673	A
$I_{F(d.c.)}$	D.C. forward current, $T_{sink}=25^{\circ}C$ , (note 4)	2186	A
$I_{FSM}$	Peak non-repetitive surge $t_p=10ms$ , $V_{RM}=0.6V_{RRM}$ , (note 5)	20000	A
$I_{FSM2}$	Peak non-repetitive surge $t_p=10ms$ , $V_{RM}\leq 10V$ , (note 5)	22000	A
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{RM}=0.6V_{RRM}$ , (note 5)	$2.00 \times 10^6$	$A^2s$
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{RM}\leq 10V$ , (note 5)	$2.42 \times 10^6$	$A^2s$
$T_{HS}$	Operating temperature range	-40 to +125	$^{\circ}C$
$T_{stg}$	Storage temperature range	-40 to +150	$^{\circ}C$

Notes:-

- 1) De-rating factor of 0.13% per  $^{\circ}C$  is applicable for  $T_j$  below  $25^{\circ}C$ .
- 2) Double side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 3) Single side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 4) Double side cooled.
- 5) Half-sinewave,  $125^{\circ}C$   $T_j$  initial.

**Characteristics**

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V <sub>FM</sub>	Maximum peak forward voltage	-	-	1.55	I <sub>FM</sub> =1000A	V
		-	-	1.77	I <sub>FM</sub> =1600A	
V <sub>0</sub>	Threshold voltage	-	-	1.32	Over current range 1326 –3978A (Note 2)	V
r <sub>s</sub>	Slope resistance	-	-	0.268		mΩ
V <sub>01</sub>	Threshold voltage	-	-	1.373	Over current range 1600 – 4800A	V
r <sub>s1</sub>	Slope resistance	-	-	0.247		mΩ
V <sub>FRM</sub>	Maximum forward recovery voltage	-	-	20	di/dt = 1000A/μs, 25°C	V
V <sub>FRM</sub>	Maximum forward recovery voltage	-	-	30	di/dt = 1000A/μs	V
I <sub>R RM</sub>	Peak reverse current	-	-	275	Rated V <sub>RRM</sub>	mA
		-	-	50	Rated V <sub>RRM</sub> , T <sub>j</sub> =25°C	
Q <sub>rr</sub>	Recovered charge	-	50	-	I <sub>FM</sub> =1000A, t <sub>p</sub> =1000μs, di/dt=60A/μs, V <sub>r</sub> =50V (Note 3)	μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	20	30		μC
I <sub>rm</sub>	Reverse recovery current	-	35	-		A
t <sub>rr</sub>	Reverse recovery time, 50% Chord	-	1.0	-		μs
Q <sub>rr</sub>	Recovered charge	-	700	-	I <sub>FM</sub> =1600A, t <sub>p</sub> =500μs, di/dt=800A/μs, V <sub>r</sub> =800V	μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	550	-		μC
I <sub>rm</sub>	Reverse recovery current	-	480	-		A
t <sub>rr</sub>	Reverse recovery time, 50% Chord	-	2.3	-		μs
R <sub>th(j-hs)</sub>	Thermal resistance, junction to heatsink	-	-	0.024	Double side cooled	K/W
		-	-	0.048	Single side cooled	
F	Mounting force	19	-	26		kN
W <sub>t</sub>	Weight	-	510	-		g

## Notes:-

- 1) Unless otherwise indicated T<sub>j</sub>=125°C.
- 2) V<sub>0</sub> and r<sub>s</sub> were used to calculate the current ratings illustrated on page one
- 3) Figures 3 to 6 were compiled using these conditions

**Notes on Ratings and Characteristics**

1.0 Voltage Grade Table

Voltage Grade	V <sub>RRM</sub> (V)	V <sub>RSM</sub> (V)	V <sub>R</sub> dc (V)
12	1200	1300	600

2.0 De-rating Factor

A blocking voltage de-rating factor of 0.13% per °C is applicable to this device for T<sub>j</sub> below 25°C.

3.0 ABCD Constants

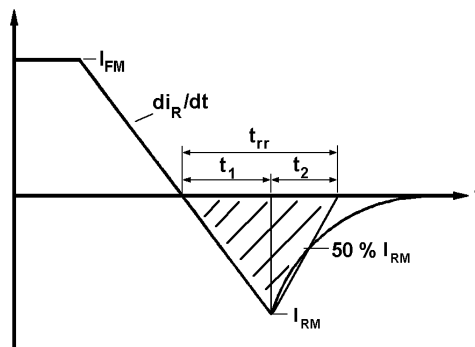
These constants (applicable only over current range of V<sub>F</sub> characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

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

where I<sub>F</sub> = instantaneous forward current.

4.0 Reverse recovery ratings

(i) Q<sub>rr</sub> is based on 50% I<sub>rm</sub> chord as shown in Fig.(a) below.



(ii) Q<sub>rr</sub> is based on a 150µs integration time.

i.e.

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

(iii)

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

### 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:

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

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

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

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

Where  $V_o = 1.32V$ ,  $r_s = 0.268m\Omega$

$ff$  = 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 page 6 is represented in two ways;

- (i) the well established  $V_o$  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	0.374060321
B	0.08526548
C	$6.73844 \times 10^{-5}$
D	0.01643

**Curves**

Figure 1 – Forward characteristics of Limit device

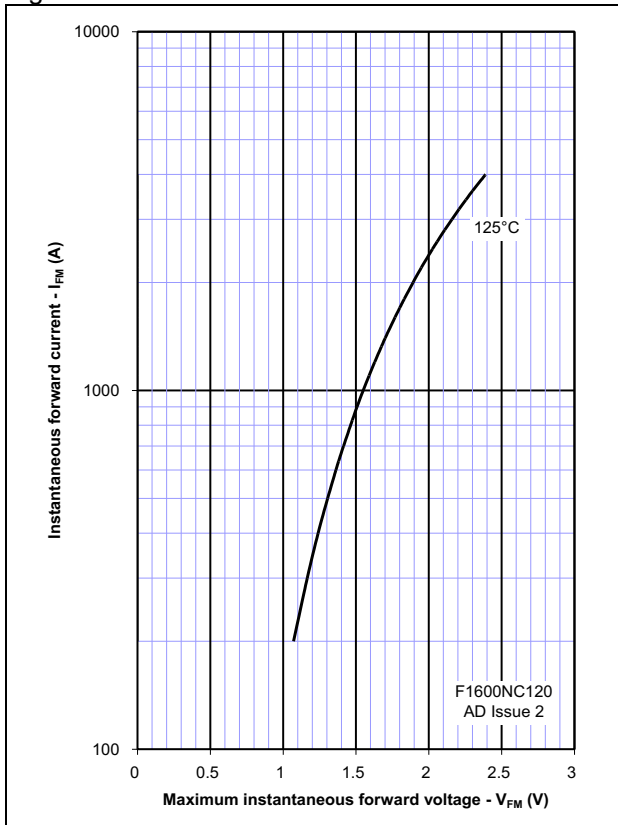


Figure 2 – Maximum forward recovery voltage

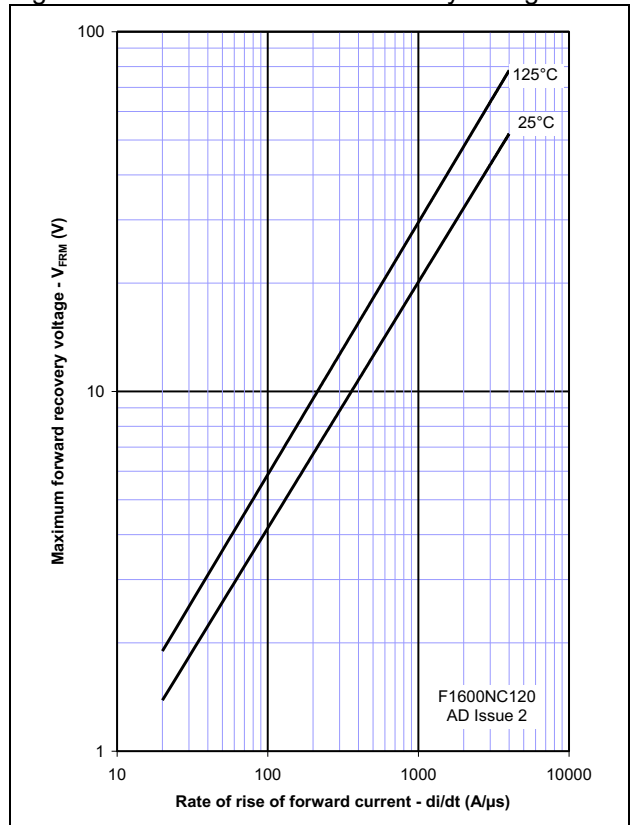


Figure 3 - Recovered charge,  $Q_{rr}$

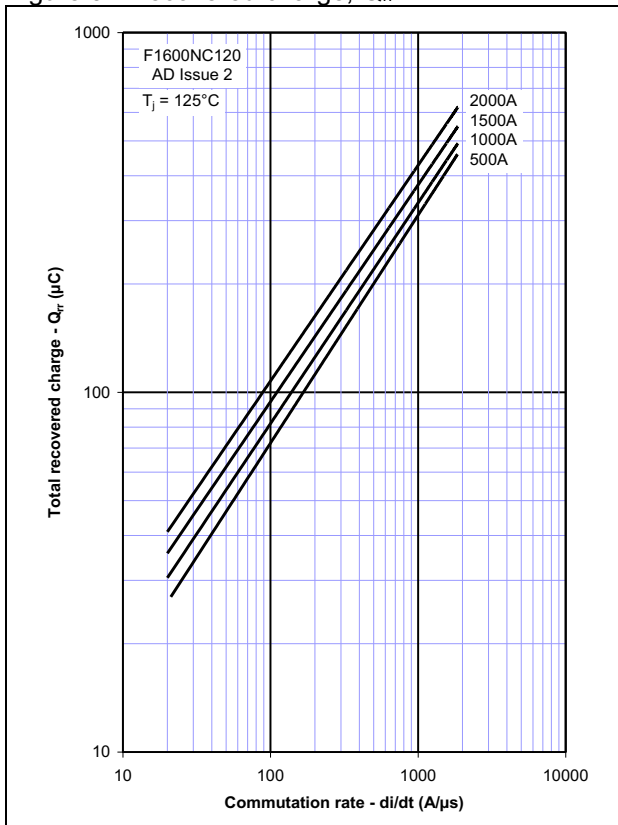


Figure 4 - Recovered charge,  $Q_{ra}$  (50% chord)

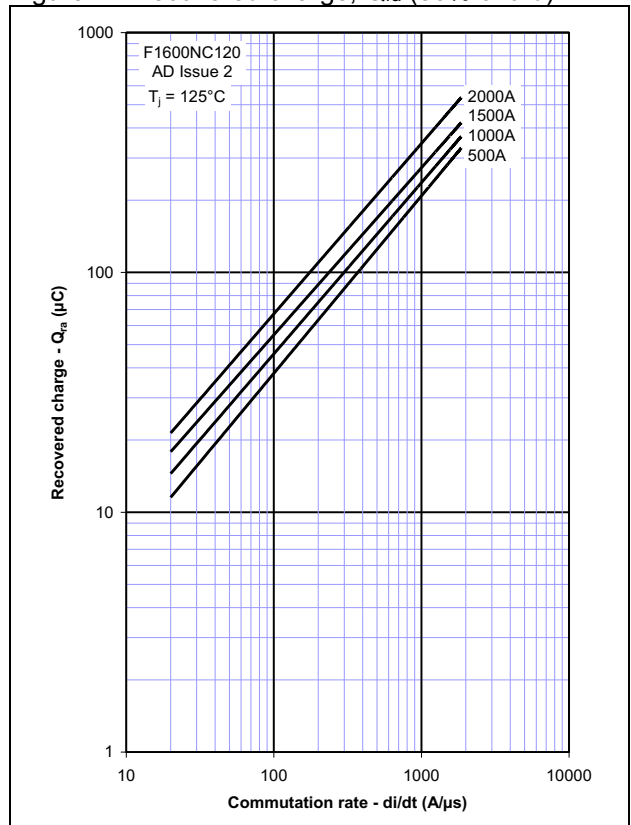


Figure 5 - Maximum reverse current,  $I_{rm}$

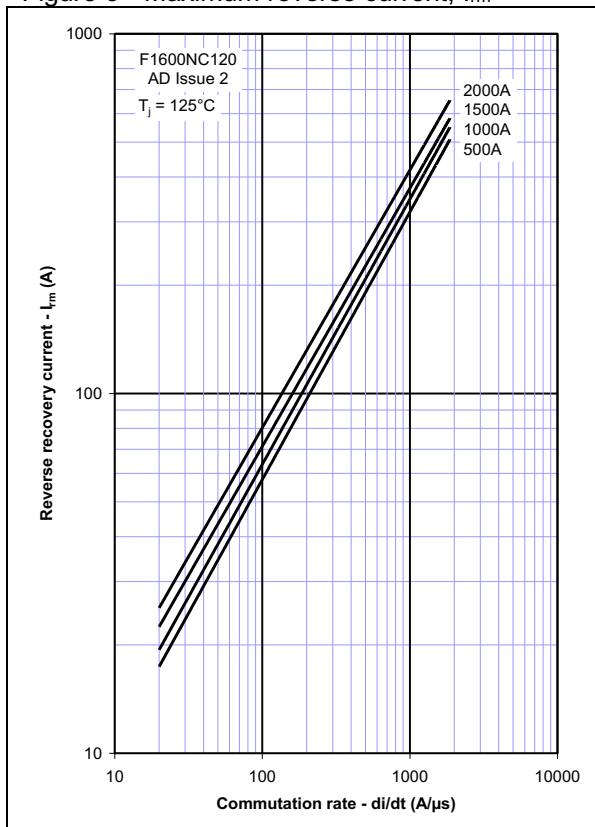


Figure 6 - Maximum recovery time,  $t_{rr}$  (50% chord)

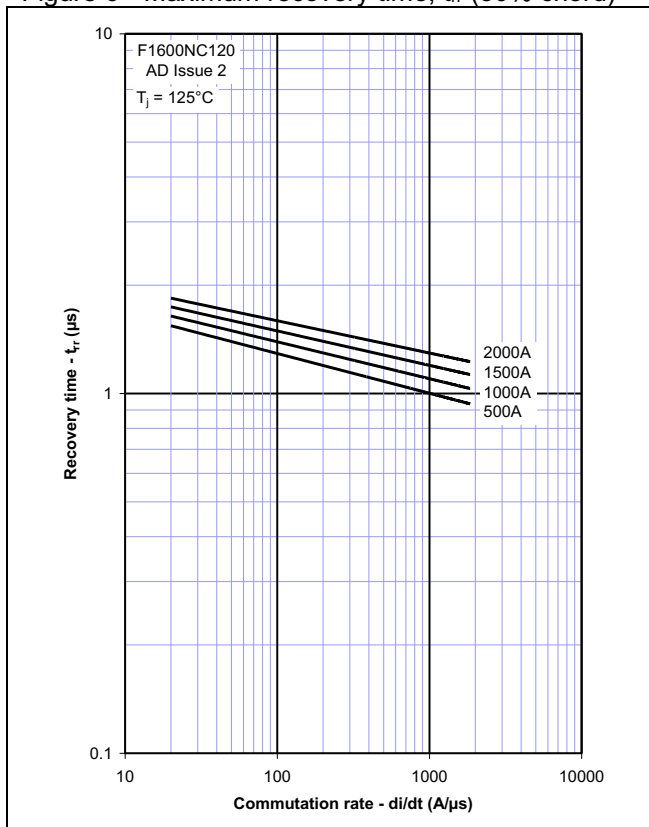


Figure 7 - Reverse recovery energy per pulse

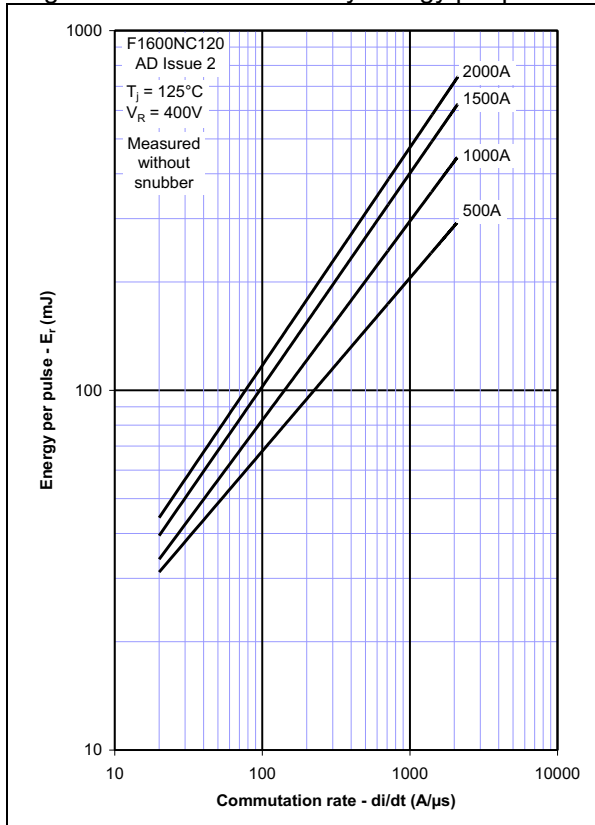


Figure 8 - Sine wave energy per pulse

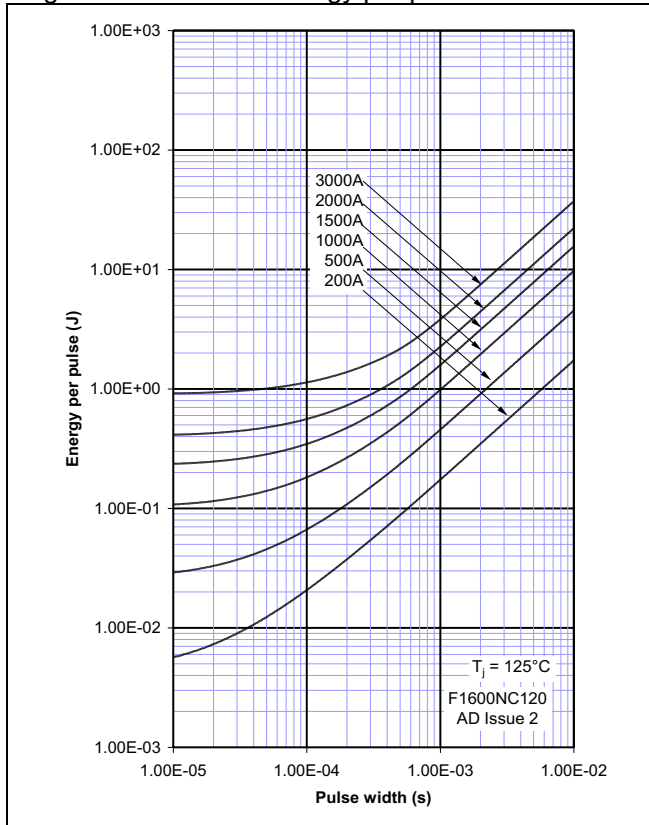


Figure 9 - Sine wave frequency vs. pulse width

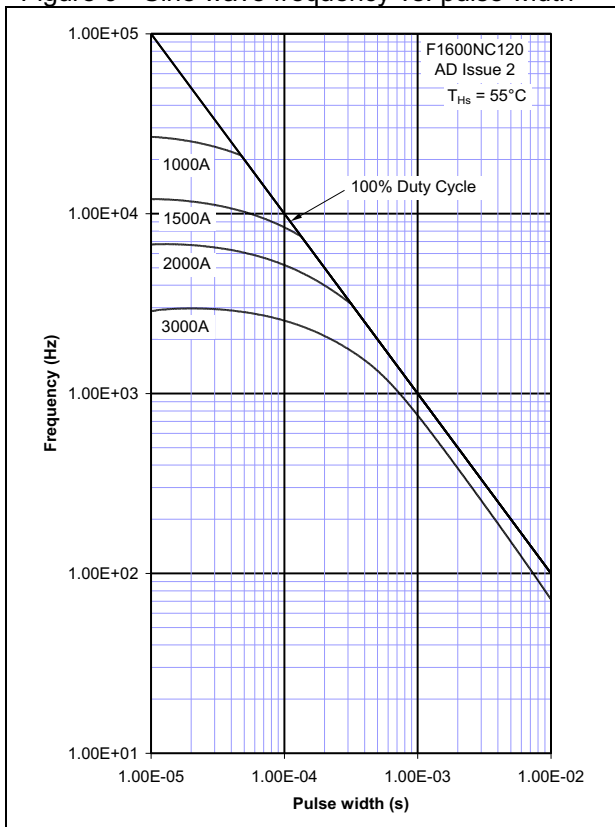


Figure 10 - Sine wave frequency vs. pulse width

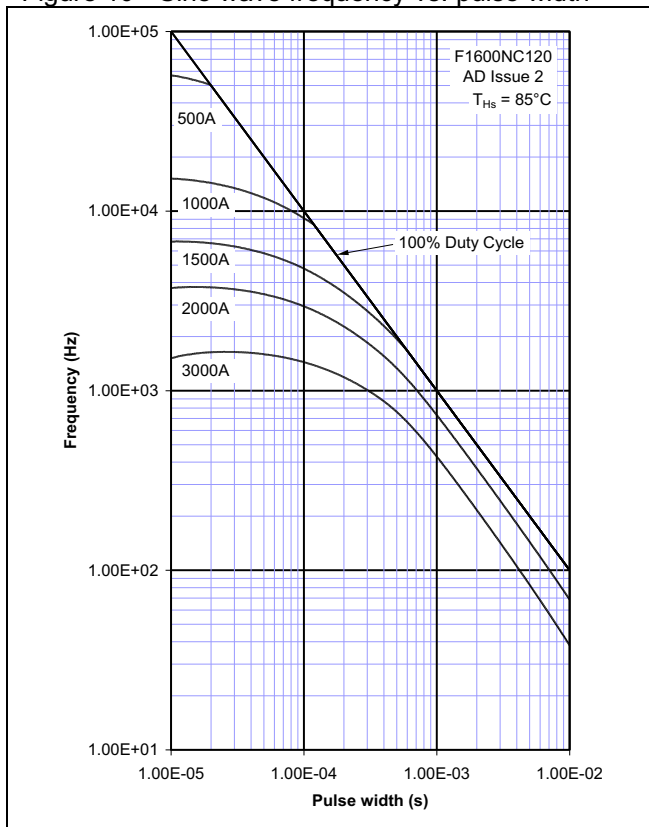


Figure 11 - Square wave energy per pulse

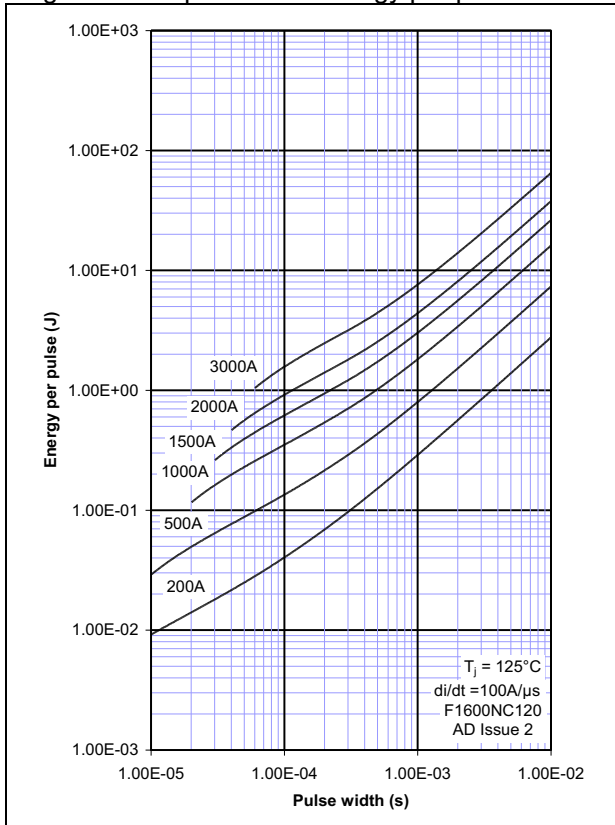


Figure 12 - Square wave energy per pulse

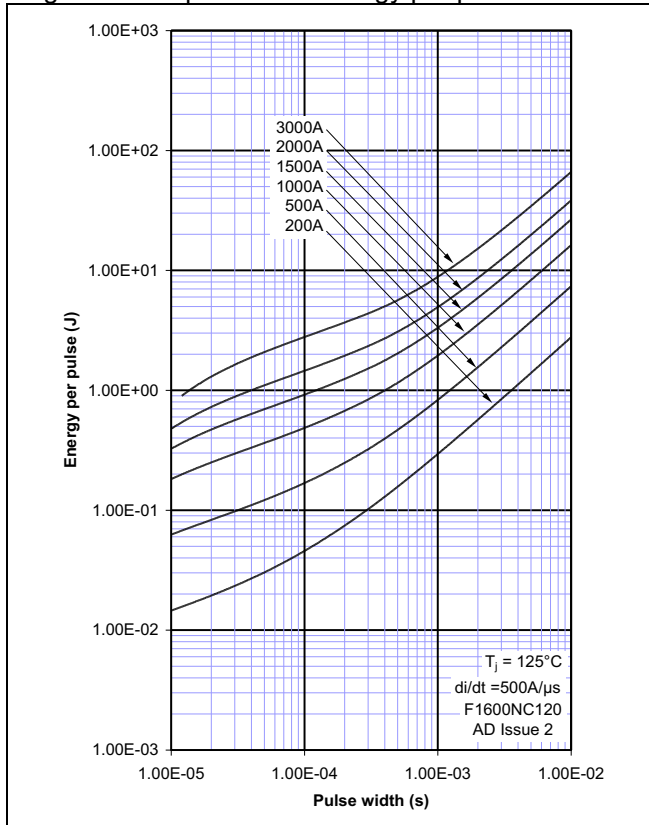




Figure 13 - Square wave frequency vs. pulse width

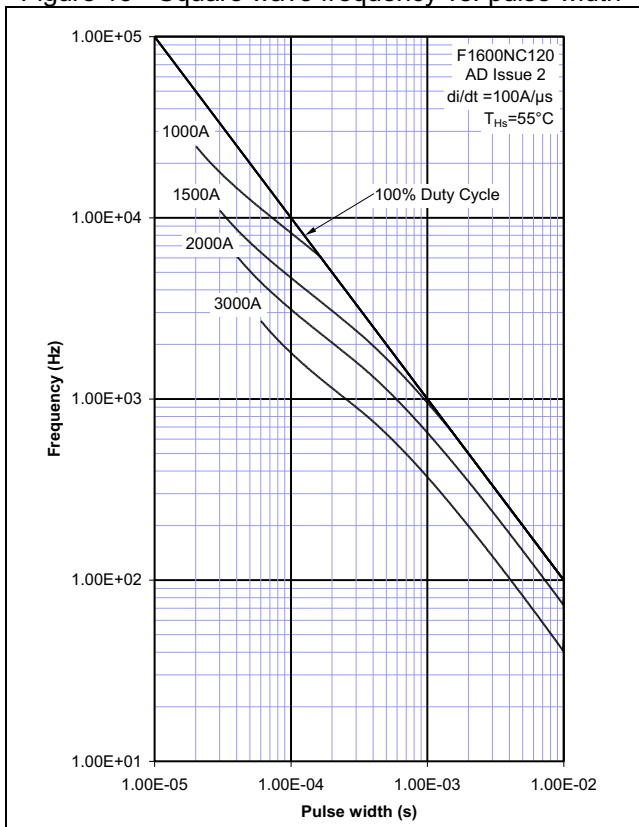


Figure 14 - Square wave frequency vs. pulse width

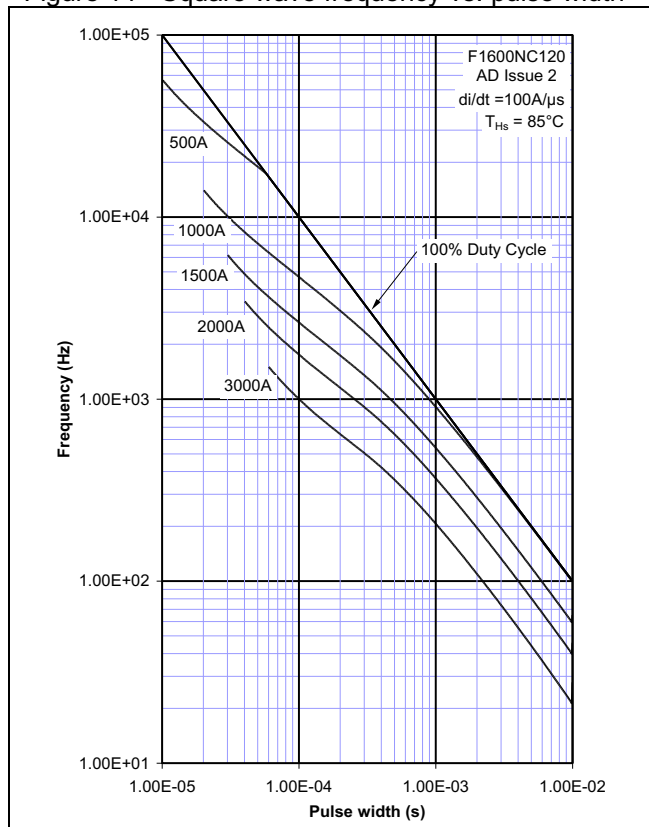


Figure 15 - Square wave frequency vs. pulse width

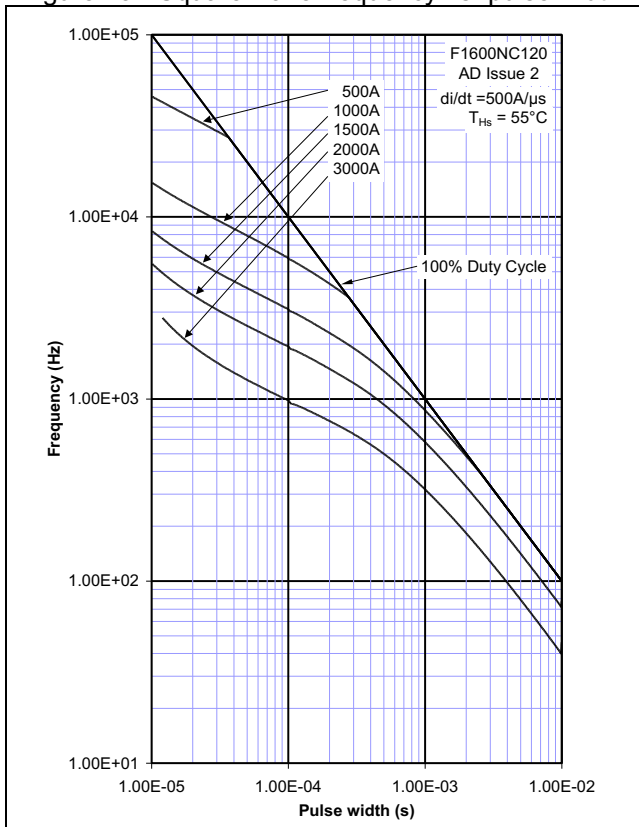


Figure 16 - Square wave frequency vs. pulse width

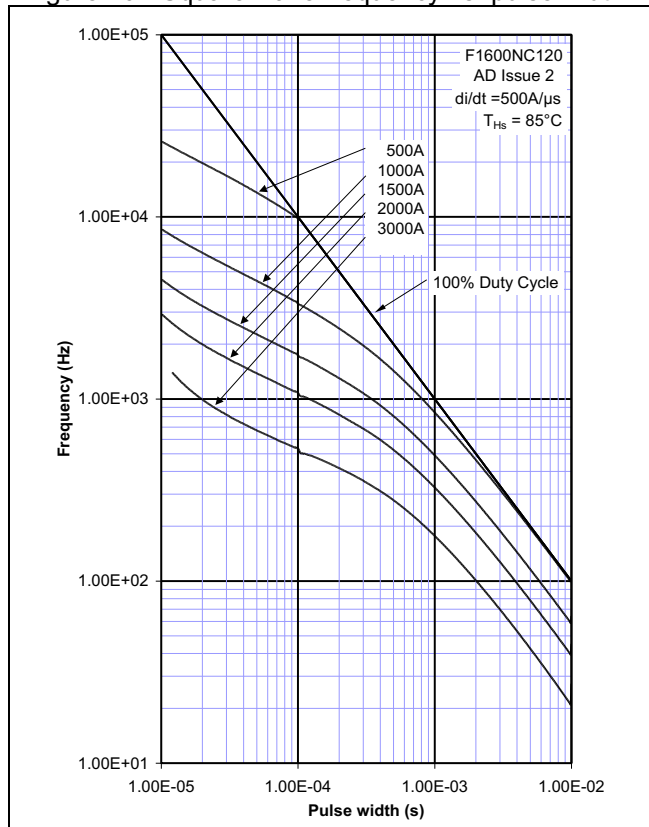


Figure 17 – Maximum surge and I<sup>2</sup>t ratings

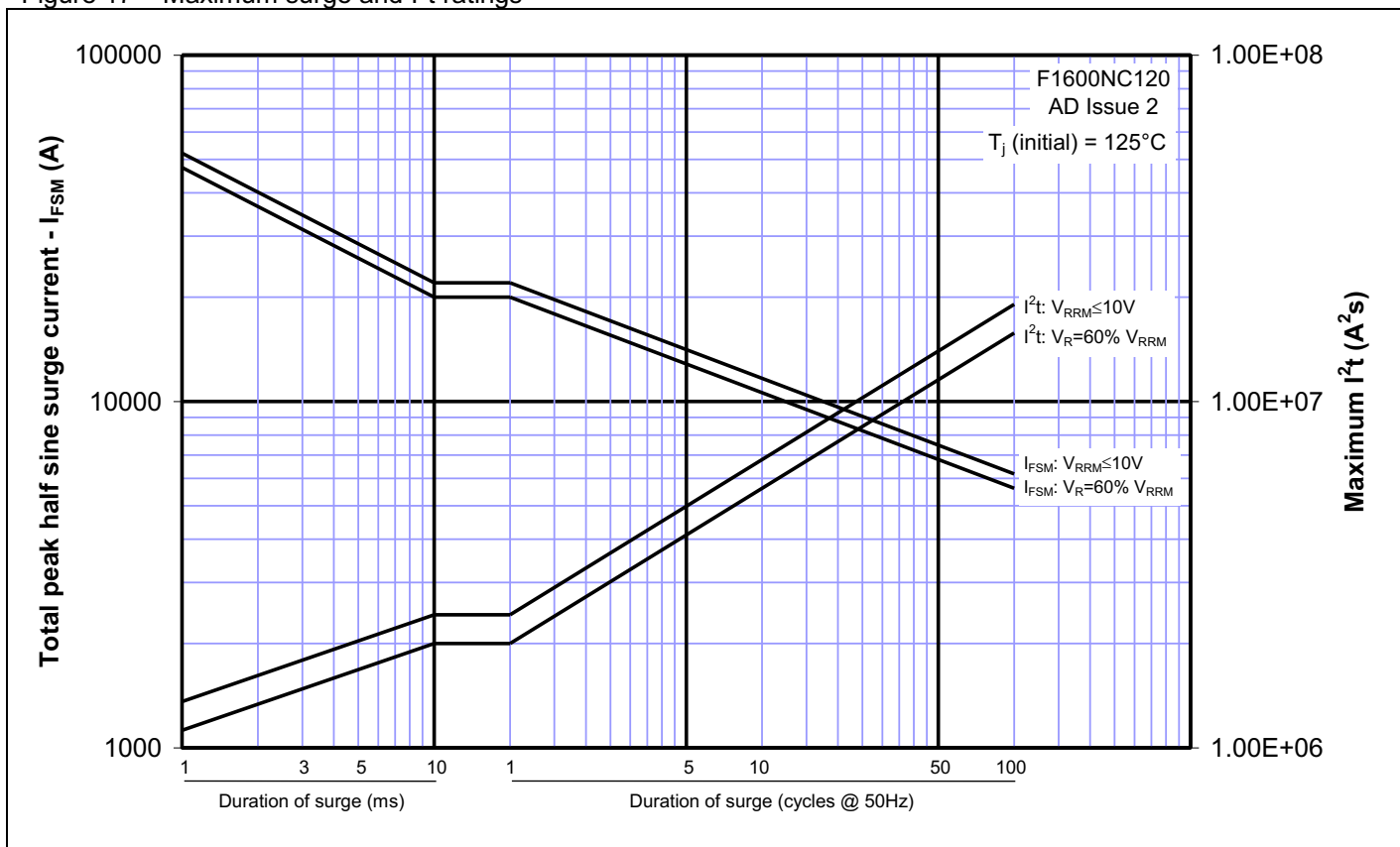
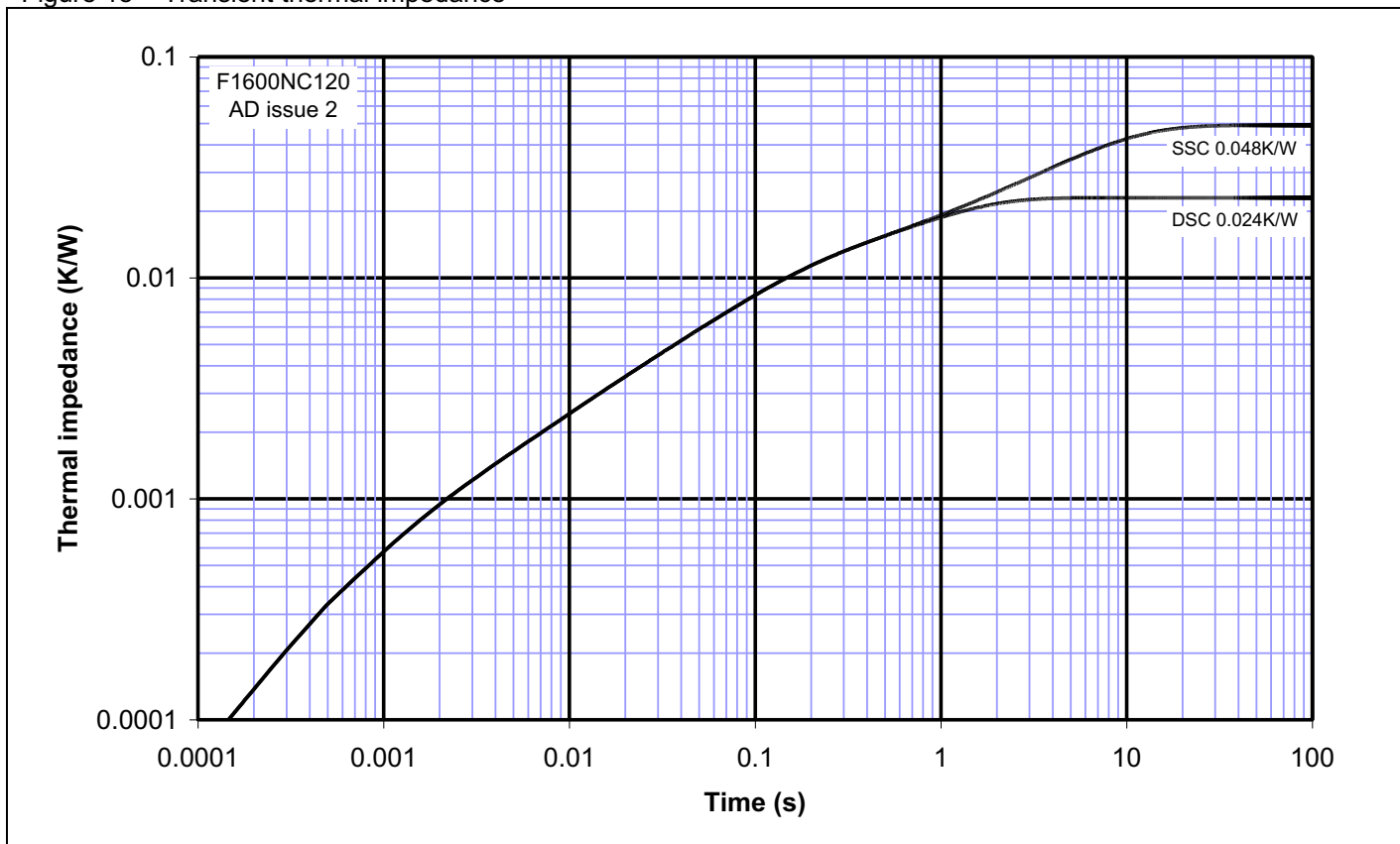
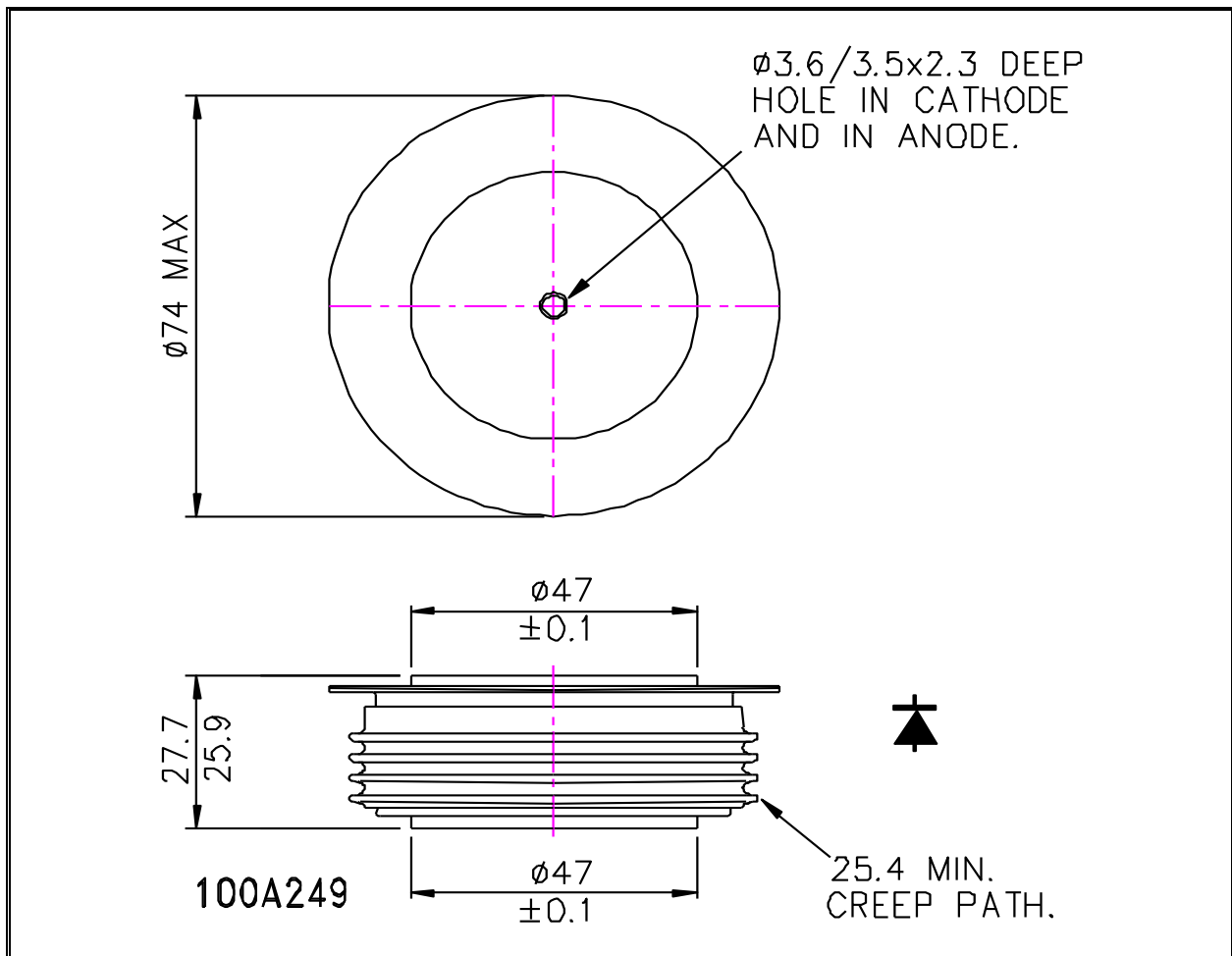


Figure 18 – Transient thermal impedance



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Order code: F1600NC120 – 1200V  $V_{RRM}$ , 26.6mm clamp height capsule.

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