Soft Recovery Diode
M1494NC160 to M1494NC250

The data sheet on the subsequent pages of this document is a scanned copy of existing data for this product.
(Rating Report 82NR8 Issue 3)

This data reflects the old part number for this product which is: SW16-25CXC924. This part number must **NOT** be used for ordering purposes – please use the ordering particulars detailed below.

Please use the following link to view an up to date outline drawing for this device
Outline W5

Where any information on the product matrix page differs from that in the following data, the product matrix must be considered correct

An electronic data sheet for this product is presently in preparation.

For further information on this product, please contact your local ASM or distributor.

Alternatively, please contact Westcode as detailed below.

Ordering Particulars

M1494	NC	♦♦	**0**
Fixed Type Code	Fixed Outline Code	Voltage code $V_{DRM}/100$ 16-25	Fixed Code
Typical Order Code: M1494NC200, 27.7mm clamp height, 2000V V_{RRM}			

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QUALITY AND EVALUATION LABORATORY

Rating Report No: 82NR8 issue 3

Date: 9th June, 1995

Origin: Q.E.L. PAR94076

Pages: 30

Diode Capsule SM16 - 25CXC924

Written by: M.Short. Checked: M Baker Approved: [signature]

The CXC924 series of fast recovery diodes is based on a diffused 50 mm diameter silicon slice, manufacturing reference FFJFXC, mounted in a cold weld capsule.

This issue supersedes rating report 82NR8 issue 2, dated 15th January, 1987.

Ratings

Voltage Grades	) A blocking voltage derating factor) of 0.13% per deg. Celsius is applicable	: 16 - 25
V_{RSM}	) to this device for T_j below 25°C)	: 1700 - 2600 V
V_{RRM}	) (Note 1 & 2 page 4)	: 1600 - 2500 V

$I_{F(AV)}$: Single phase: 50 Hz, 180° half sinewave;

Double Side Cooled T_{HS} = 55°C, 100°C	: 1495 A, 705 A
Single Side Cooled T_{HS} = 100°C	: 402 A
$I_{F(rms)}$ T_{HS} = 25°C) Double side cooled	: 2984 A
I_F T_{HS} = 25°C) Double side cooled	: 2506 A
I_{FSM} : t = 10ms half sinewave; T_J (initial) = 125°C $V_{RM} = 0.6V_{RRM(MAX)}$	: 19.6 kA
I_{FSM} : t = 10ms half sinewave; T_J (initial) = 125°C $V_{RM} \leq 10V$	: 21.56 kA
I^2t : t = 10ms; T_J (initial) = 125°C; $V_{RM} = 0.6V_{RRM}(MAX)$	: 1.92 x$10^6 A^2s$
I^2t : t = 10ms; T_J (initial) = 125°C; $V_{RM} \leq 10V$	: 2.32 x$10^6 A^2s$
I^2t : t = 3ms; T_J (initial) = 125°C; $V_{RM} \leq 10V$	: 1.72 x$10^6 A^2s$
T_{HS} Operating Range	: -40 To +125 °C
T_{stg} : Non-operating	: -40 To +150 °C

Characteristics (Maximum values unless otherwise stated)

V_o		: 1.15 V
r_s		: 0.265 mΩ
A : $T_J = 25°C$	)	: 6.059922 E-1
B : $T_J = 25°C$	) Valid range 100 A to 8000 A	: 4.837078E-2
C : $T_J = 25°C$	)	: 9.492610E-5
D : $T_J = 25°C$	)	: 1.123040E-2
A : Constant	)	: -5.485326E-2
B : $\ln(i_F)$	) Valid range 100 A to 7000 A	: 1.612135E-1
C : i_F	)	: 2.274044E-4
D : $\sqrt{i_F}$	)	: 2.917716E-4
V_{FM} at I_{FM} = 4500 A		: 2.34 V
$R_{th(J-HS)}$ Double side cooled	) Steady-state d.c. and	: 0.022 K/W
Single side cooled	) 1 ϕ a.c. resistive load	: 0.044 K/W
I_{RRM} : at $V_{RRM(MAX)}$		: 85 mA
V_{fr} : at dI/dt = 1000 A/µs		: 42 V

Reverse recovery at I_{FM} = 1000 A; t_p = 1000 µs
di_R/dt = 60A/µs; V_{RM} = 50 V

Q_{RR} (total area)	: 950 µC
Q_{RA} (50% chord)	: 378 µC
t_{rr} (50% chord)	: 4.9µs
I_{RM}	: 175 A
Mounting Force	: 19 - 26 kN (1900 - 2600 kg.f)
Outline Drawing	: 100A249
JEDEC Outline No.	: D0-200AC

NOTE: All characteristics are at $T_{VJ} = T_{Jmax}$ operating unless stated otherwise.

CONTENTS

Voltage Ratings Table

Voltage Class	V_{RRM} V	V_{RSM} V
16	1,600	1,700
18	1,800	1,900
20	2,000	2,100
22	2,200	2,300
24	2,400	2,500
25	2,500	2,600

1. This Report is applicable to higher or lower voltage grades when supply has been agreed by Sales/Production.

2. A blocking voltage derating factor of 0.13% per deg. Celsius is applicable to this device for T_J below 25°C.

Changes to 82NR8 Issue 2

Page 1.	$I_{F(AV)}$, $I_F$rms, I_F changed.
Page 2.	ABCD coefficients, V_{FR}, Q_{RR}(total area), I_{RM} added. $Rth_{(J\text{-}HS)}$, I_{RRM} changed.
Page 3.	Contents page rewritten.
Page 4.	Notes 1 and 2 added.
Pages 5,6.	Rewritten with addition of page 7.
Pages 8,9,10,11.	Computer modelling section added.
Page 12.	ABCD coefficients added replacing issue 2 page7.
Page 13.	Rth curve replaces issue 2 page 8.
Page 14.	Same as issue 2 page 9.
Page 15.	Forward recovery curve added.
Page 16.	Q_{RA} curves extended to 450A/µs replacing issue 2 page 10.
Page 17.	Q_{RR} curve added.
Page 18	I_{RM} curve added. Replaces issue 2 page 11 's' factor curve.
Page 19.	t_{RR} curve added.
Page 20.	Same as issue 2 page 12.
Pages 21-29.	Replace issue 2 pages 13-21.

INTRODUCTION

This diode series comprises fast recovery capsule devices with all diffused silicon slices. All these diodes have controlled reverse recovery characteristics with good "K" factors, and are particularly suitable for use in free-wheel applications.

NOTES ON THE RATINGS

(a) Square wave ratings

These ratings are given for leading edge linear rates of rise of forward current of 100 and 500 A/µs.

(b) Energy per pulse characteristics

These curves enable rapid estimation of device dissipation to be obtained for conditions not covered by the frequency ratings.

Let: Ep be the Energy per pulse for a given current and pulse width, in joules. Let f be the repetition rate, in Hertz. Let R_{thJ-HS} be the steady state d.c. thermal resistance (junction to heat sink).

Then $W_{AV} = E_P * f$

$$T_{SINK} = T_{J(MAX)} - (E_P * f * R_{thJ-HS})$$

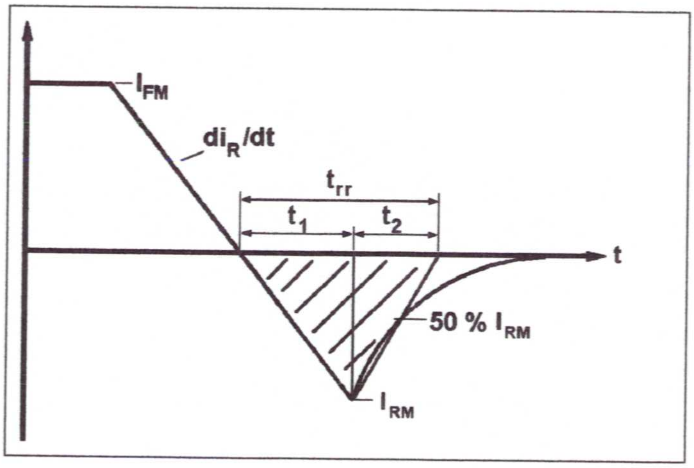
(c) ABCD Constants

These constants (applicable only over current range of V_F characteristic on page 12) are the coefficients of the expression for the forward characteristic given below:

$$V_f = A + B.\ln(i_f) + C.i_f + D.\sqrt{i_f}$$: where i_F = instantaneous forward current.

(d) Reverse recovery ratings

(i) Q_{RA} is based on 50% I_{RM} chord as shown below.



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

$$\text{i.e. } Q_{RR} = \int_{t=0}^{150\mu s} i_{RR}.dt$$

(iii) $$K \ factor = \frac{t1}{t2}$$

Reverse Recovery Loss

The following procedure is recommended for use where it is necessary to include reverse recovery loss.

(a) Determination by measurement

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:

$$T_{SINK(new)} = T_{SINK(original)} - E * (k + f * R_{th(J-HS)})$$

where k = 0.932 (K/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_{thJ-HS} = d.c. thermal resistance (K/W)

The total dissipation is now given by $W_{(tot)} = W_{(original)} + E * f$

(b) Determination without Measurement

In circumstances where it is not possible to measure voltage and current conditions, or for design purposes, the additional losses E in joules may be estimated as follows.

Let E be the value of energy per reverse cycle in joules (curves on p 20).

Let f be the operating frequency in Hz

then $T_{SINK(new)} = T_{SINK(original)} - (E * f * Rth)$

where $T_{SINK(new)}$ is the required maximum heat sink temperature and $T_{SINK(original)}$ is the heat sink temperature given with the frequency ratings.

A suitable R-C snubber network is connected across the diode to restrict the transient reverse voltage waveform to a peak value (V_{RM}) of 0.67 of the maximum grade. If a different grade is being used or V_{RM} is other than 0.67 of Grade, the reverse loss may be approximated by a pro rata adjustment of the maximum value obtained from the curves.

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) a.c. 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 snubber of 0.22μF, 10 ohms connected across diode anode to cathode.

Computer Modelling Parameters

1. Device Dissipation Calculations

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

Where V_o= 1.15V, r_s=0.265 mΩ

$$W_{AV} = \frac{\Delta T}{R_{th}} \qquad \Delta T = t_{JMax} - t_{HS}$$

R_{th} = Supplementary thermal impedance, see table below.

ff = Form factor, see table below.

Supplementary Thermal Impedance						
Conduction Angle	30°	60°	90°	120°	180°	d.c.
Squarewave Double Side Cooled	0.0353	0.0313	0.0288	0.0271	0.0251	0.0220
Squarewave Single Side Cooled	0.0586	0.0542	0.0516	0.0498	0.0478	0.0440
Sinewave Double Side Cooled	0.0313	0.0272	0.0253	0.02414	0.0220	
Sinewave Single Side Cooled	0.0540	0.0496	0.0478	0.0467	0.0440	

Form Factors						
Conduction Angle	30°	60°	90°	120°	180°	d.c.
Squarewave	3.46	2.45	2	1.73	1.41	1
Sinewave	3.98	2.78	2.22	1.88	1.57	

(a) Calculating V_f using ABCD Coefficients

The on-state characteristic I_f vs V_f, on page 10 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, D, forming the co-efficients of the representative equation for V_f in terms of i_f given below:

$$V_f = A + B * \ln(I_f) + C * (I_f) + D * \sqrt{I_f}$$

The constants, derived by curve fitting software, are given in this report for both hot and cold characteristics where possible. 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		25°C Coefficients	
A	-5.485326E-2	A	6.059922E-1
B	1.612135 E-1	B	4.837078E-2
C	2.274044 E-4	C	9.492610E-5
D	2.917716 E-4	D	1.123040E-2

(b) D.C. Thermal Impedance Calculation

$$r_t = \sum_{p=1}^{p=n} r_p \left(1 - e^{-\frac{t}{\tau_p}}\right)$$

Where p = 1 to n, n is the number of terms in the series.

t = Duration of heating pulse in seconds.

r_t = Thermal resistance at time t.

r_p = Amplitude of p_{th} term.

τ_p = Time Constant of p_{th} term.

D.C. Double Side Cooled				
Term	1	2	3	4
r_p	1.152177E-2	6.032362E-3	2.882934E-3	1.857708E-3
t_p	9.232490E-1	1.483395E-1	2.110802E-2	1.870581E-3

D.C. Single Side Cooled						
Term	1	2	3	4	5	6
r_p	2.60493E-2	6.12466E-3	5.71829E-3	3.44264E-3	1.92072E-3	1.71033E-3
τ_p	5.55958E0	2.63592E0	2.45341E-1	6.75165E-2	1.33211E-2	1.65029E-3

(c) Recovery Parameter Estimation

Maximum recovery parameters may be calculated, using the polynomial expression;

$$y = \sum_{p=0}^{p=n-1} k_p(di_R/dt)^p$$

Where y = recovery parameter,
k_p = coefficient found in the table below,
n = number of terms in the series,
p = term number

Total Recovered Charge, Q_{rr} (Valid di_R/dt range 20 to 450A/μs)

Values of k_p for I_{FM}				
p	500 A	1000 A	2000 A	5000 A
3	5.083269E-5	6.579564E-5	5.972116E-5	5.894028E-5
2	-3.953077E-2	-5.264897E-2	-4.846796E-2	-4.626518E-2
1	9.273132E+0	1.324478E+1	1.356689E+1	1.339473E+1
0	3.79943E+2	3.306376E+2	3.475717E+2	3.501400E+2

Q_{RA} Recovered Charge at 50% chord (Valid di_R/dt range 20 to 450A/μs)

Values of k_p for I_{FM}				
p	500 A	1000 A	2000 A	5000 A
3	2.895264E-5	2.460573E-5	2.500057E-5	2.28597E-5
2	-2.280912E-2	-2.101659E-2	-2.178191E-2	-2.009119E-2
1	5.499176E+0	6.003377E+0	6.637549E+0	6.738425E+0
0	8.090851E+1	8.81422E+1	8.8576177E+1	9.308510E+1

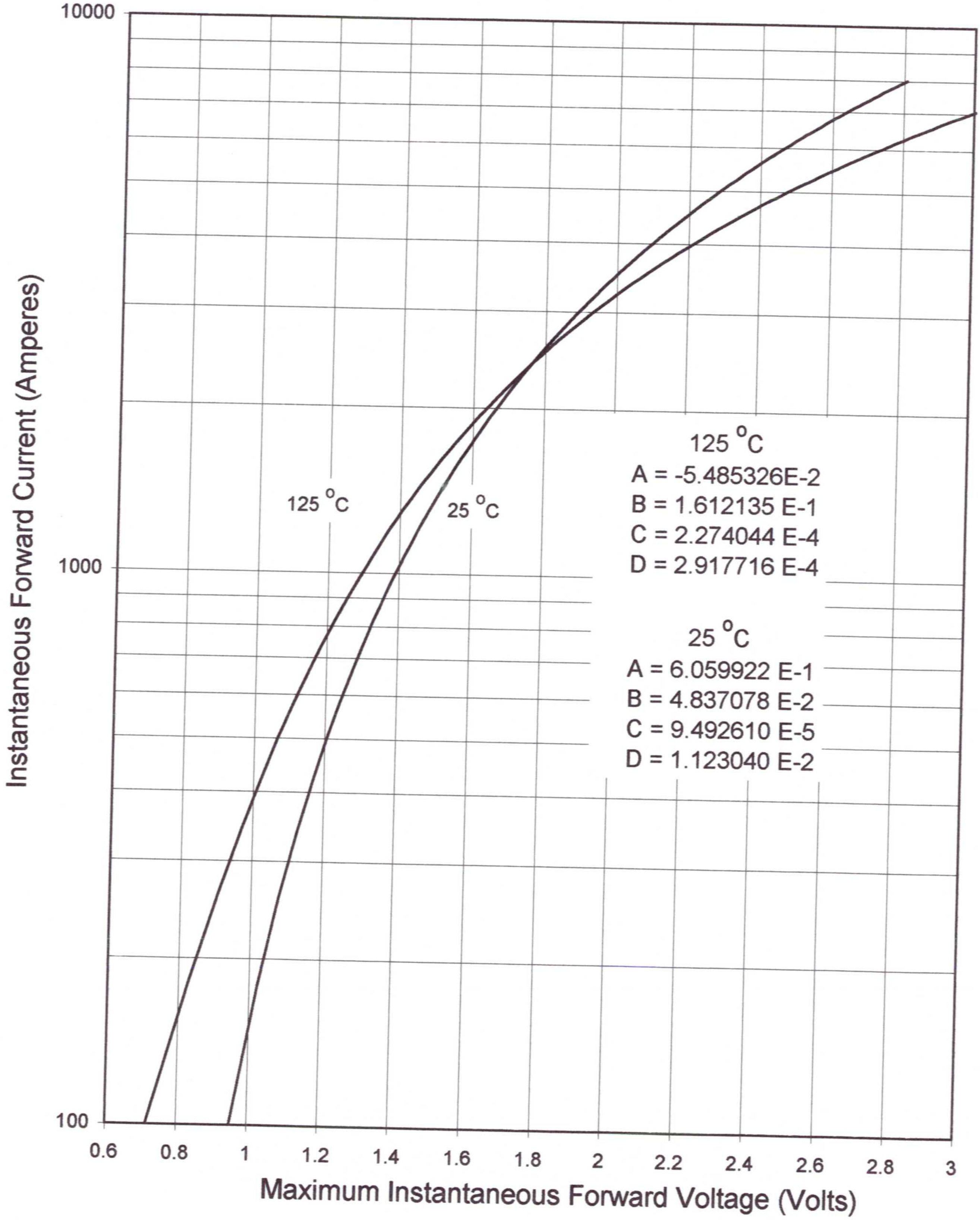
t_{rr} Recovery time (Valid di_R/dt range 30 to 450A/μs)

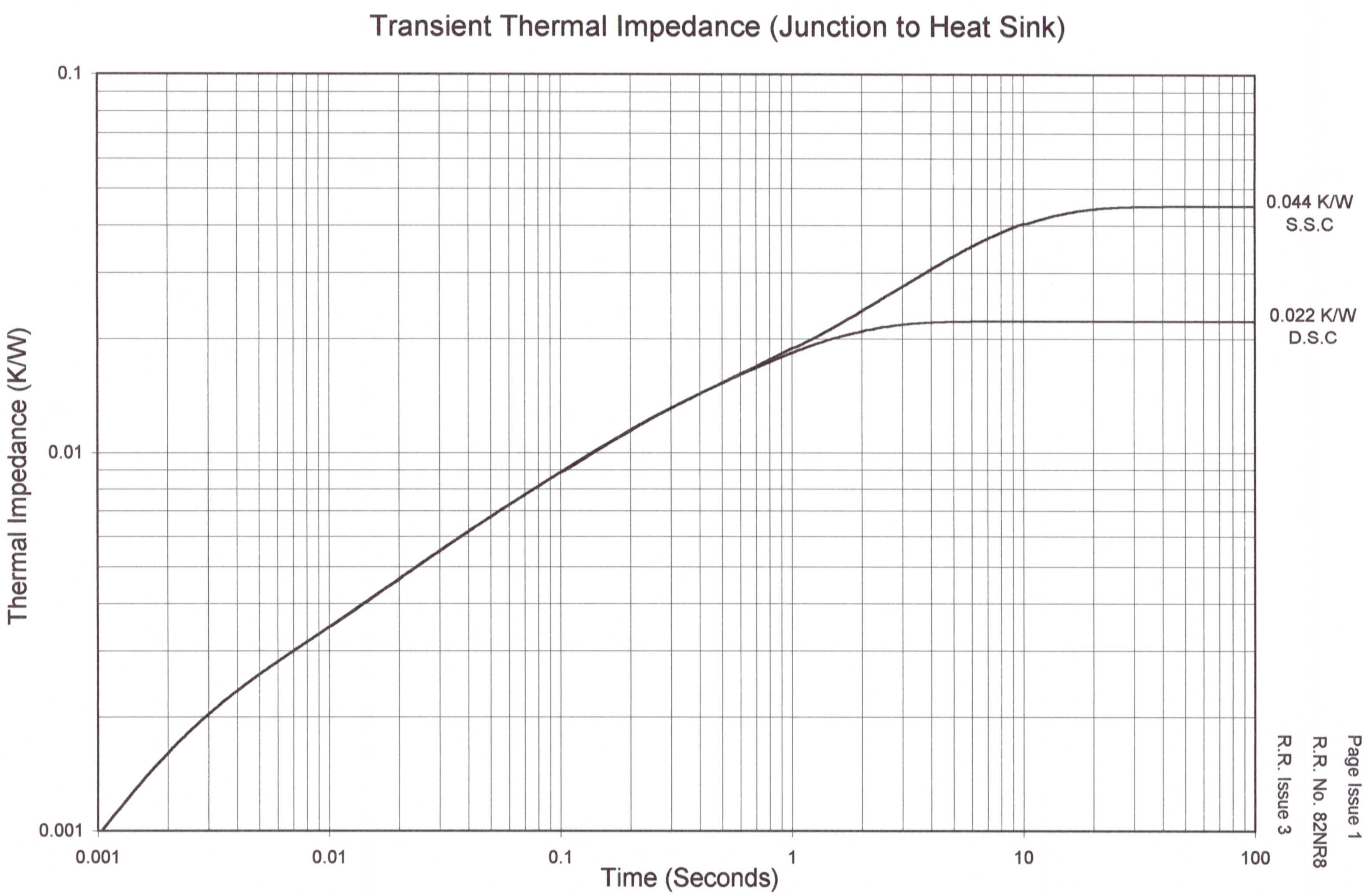
Values of k_p for I_{FM}				
p	500 A	1000 A	2000 A	5000 A
3	-3.218559E-7	-3.837966E-7	-3.503843E-7	-3.630683E-7
2	2.481001E-4	2.935139E-4	2.700988E-4	2.775587E-4
1	-5.696799E-2	-6.633167E-2	-6.210147E-2	-6.269295E-2
0	6.99444E+0	7.936150E+0	8.129416E+0	8.240789E+0

I_{RM} Peak Recovery current (Valid di_R/dt range 40 to 450A/µs)

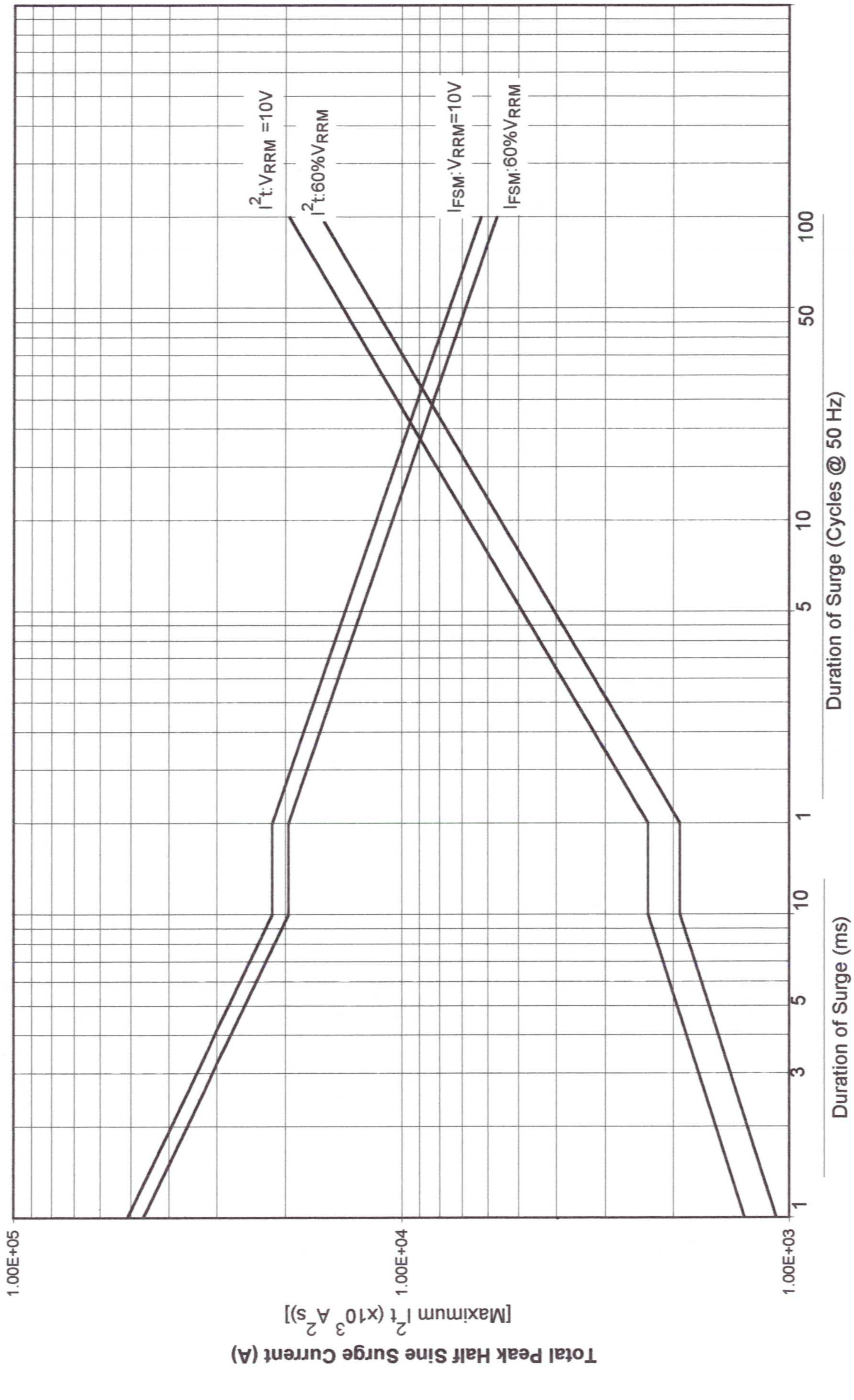
Values of k_p for I_{FM}				
p	500 A	1000 A	2000 A	5000 A
3	3.779148E-6	3.841128E-6	6.218172E-6	2.612124E-6
2	-4.705173E-3	-4.23269E-3	-5.43688E-3	-3.01578E-3
1	2.441796E+0	2.494077E+0	2.74643E+0	2.531726E+0
0	2.961458E+1	3.47634E+1	2.844385E+1	3.338904E+1

Forward Characteristic of Limit Device

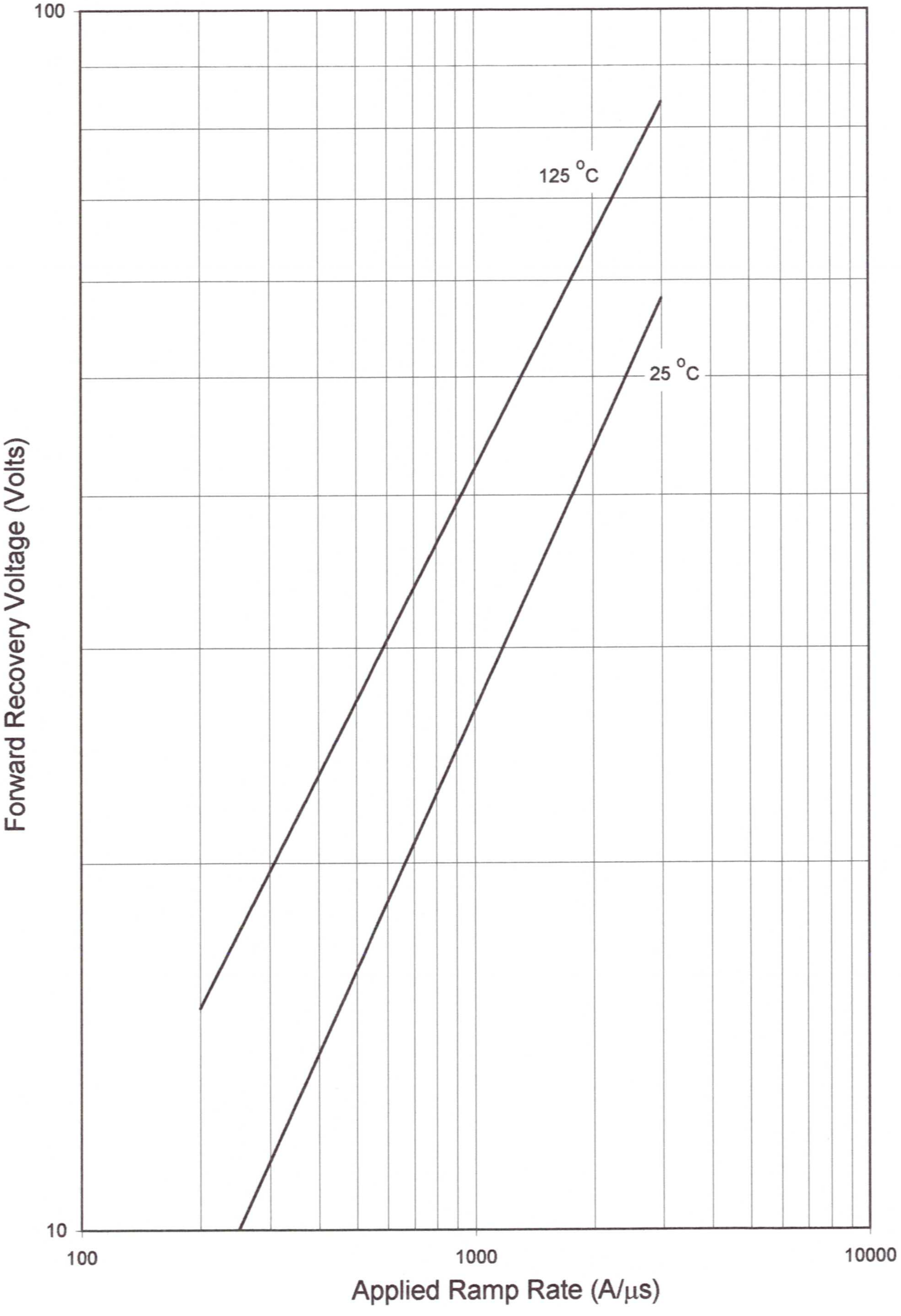



Transient Thermal Impedance (Junction to Heat Sink)
Thermal Impedance (K/W)
0.1
0.01
0.001
0.001
0.01
0.1
1
10
100
Time (Seconds)
0.044 K/W
S.S.C
0.022 K/W
D.S.C

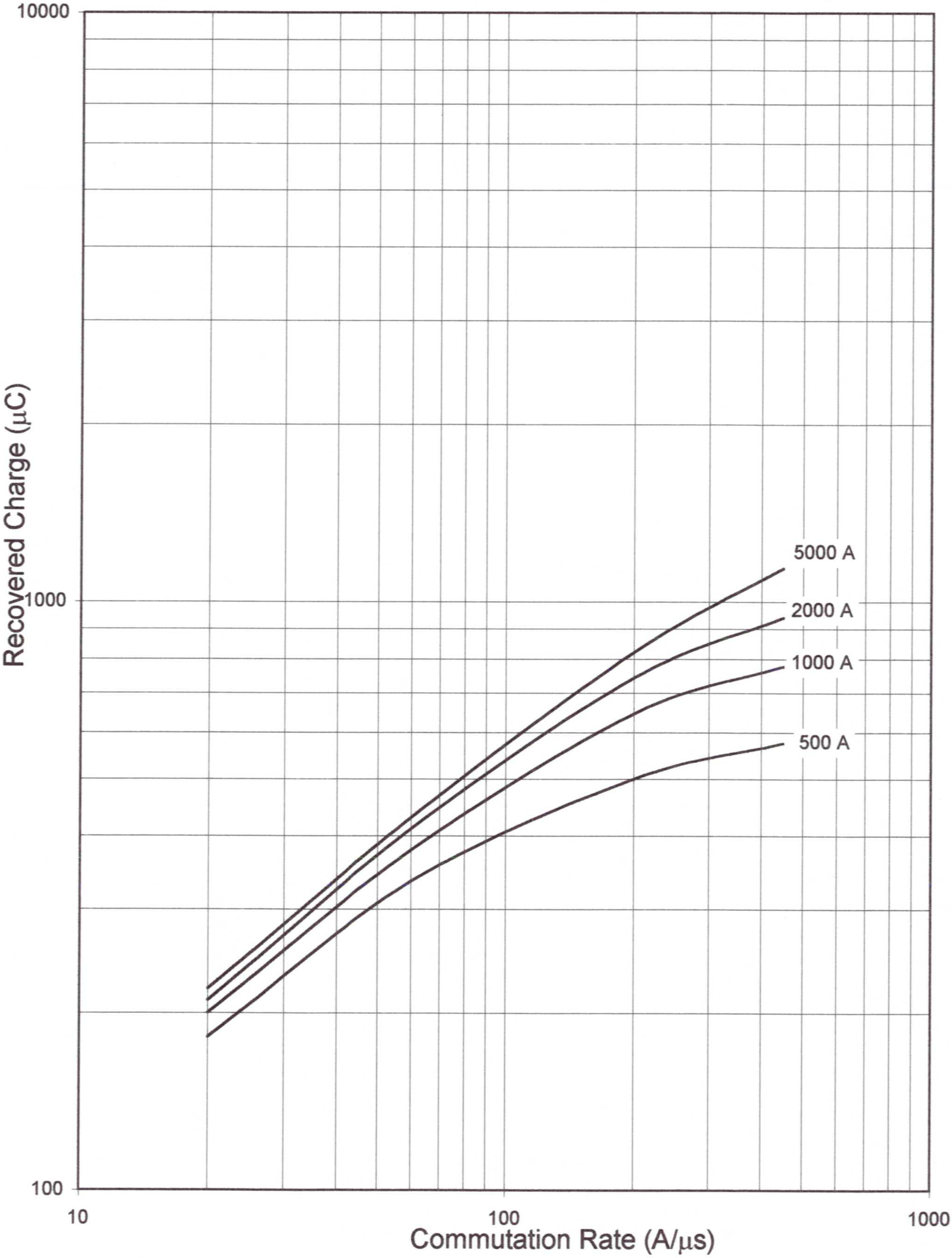
Maximum Non-Repetitive Surge Current @ Initial Junction Temperature 125 °C



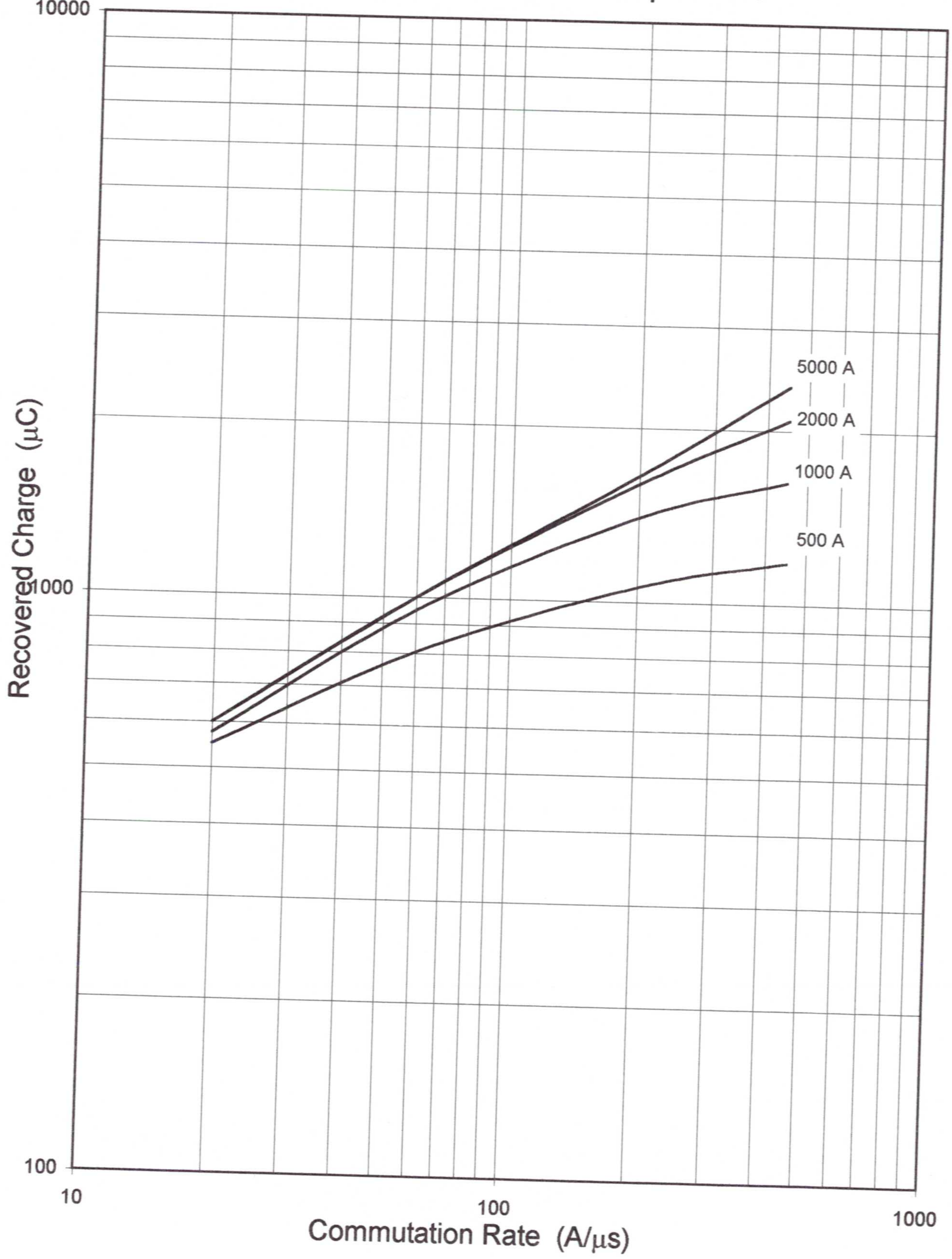
Forward Recovery Voltage (Maximum Peak)



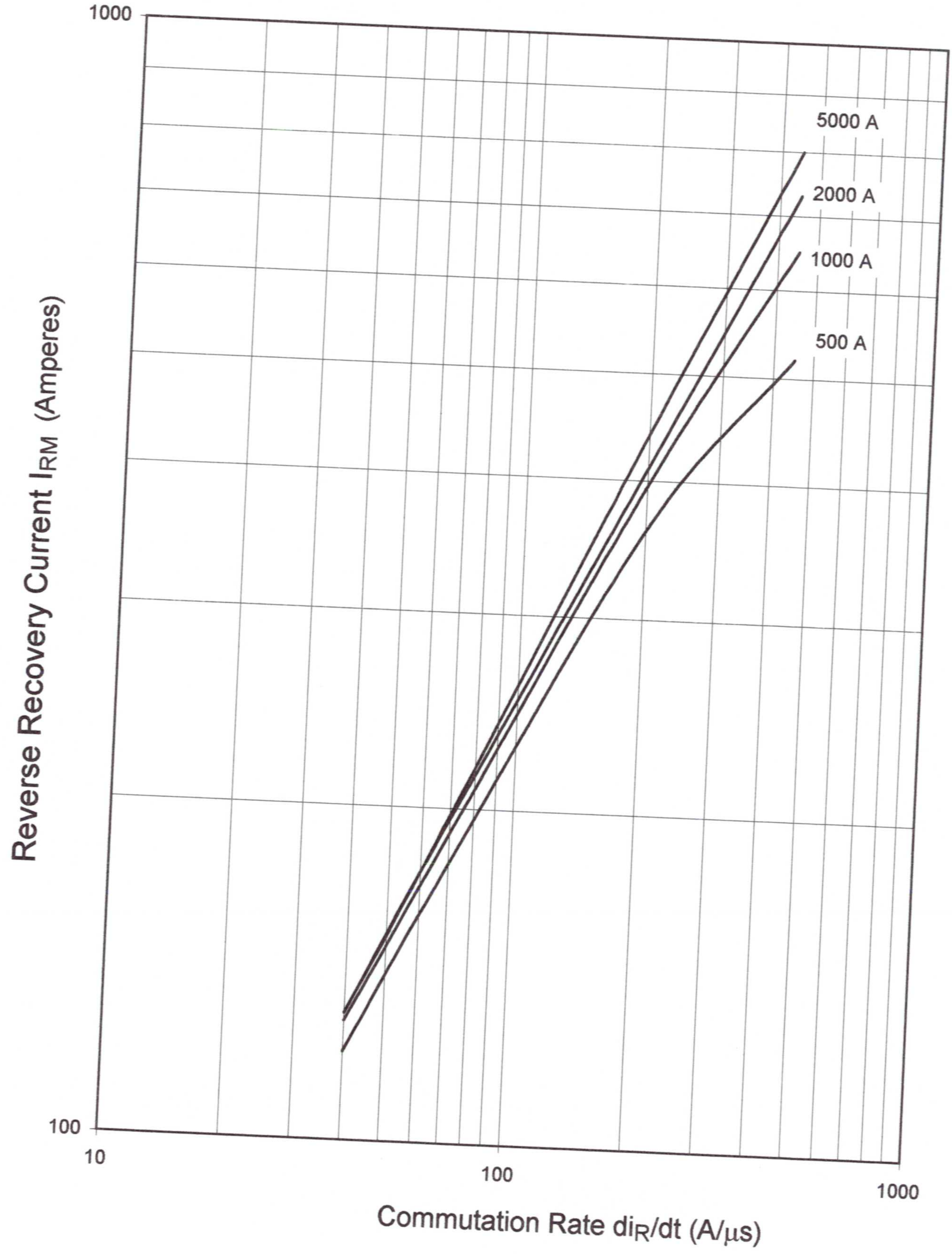
Maximum Recovered Charge Qra 50 % Chord @125 °C Junction Temperature



Maximum Total Recovered Charge Qrr @ 125 °C Junction Temperature

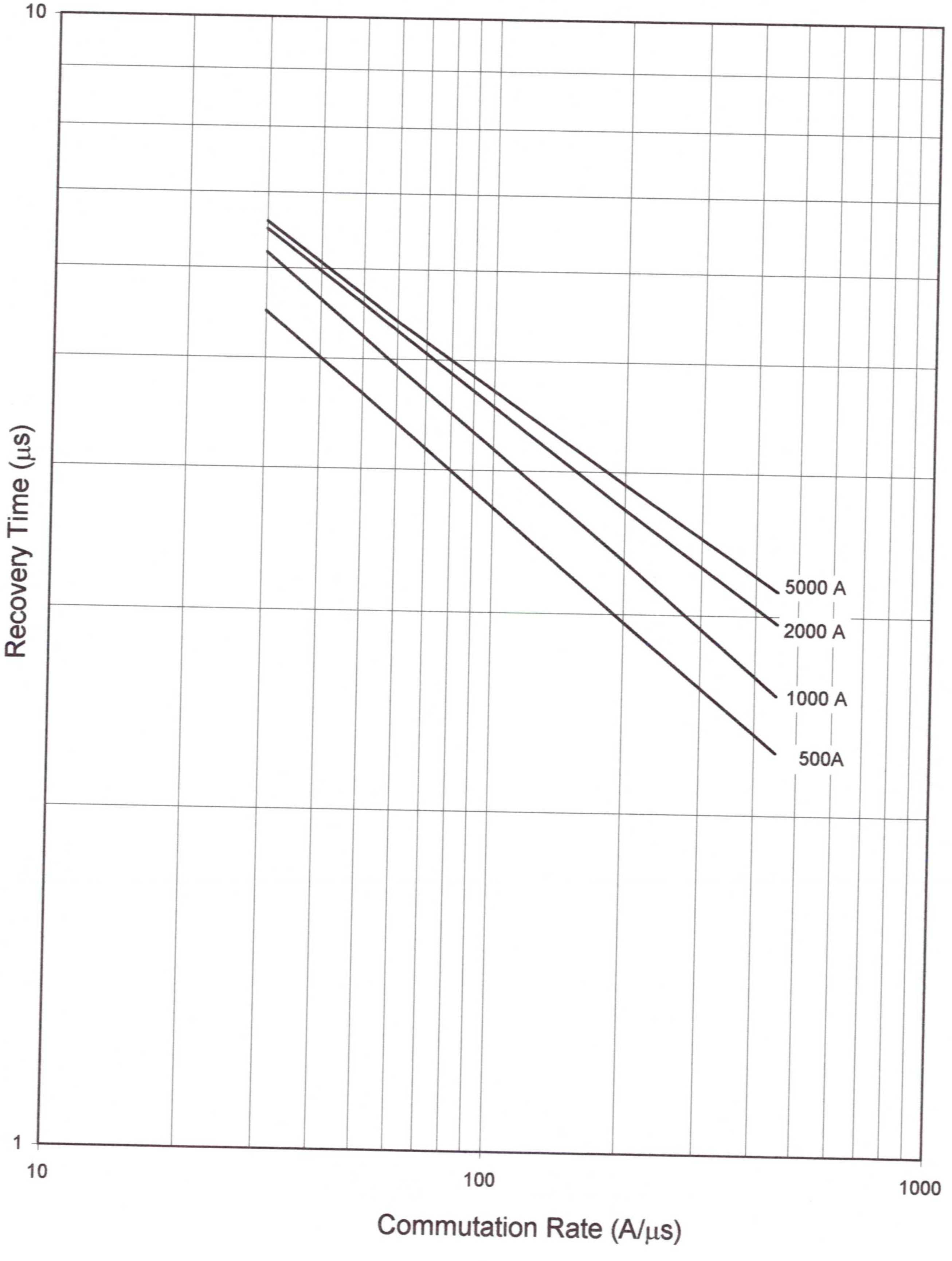


Maximum Peak Recovered Current I_{RM} @ 125 °C Junction Temperature



Maximum Recovery Time t_{rr}

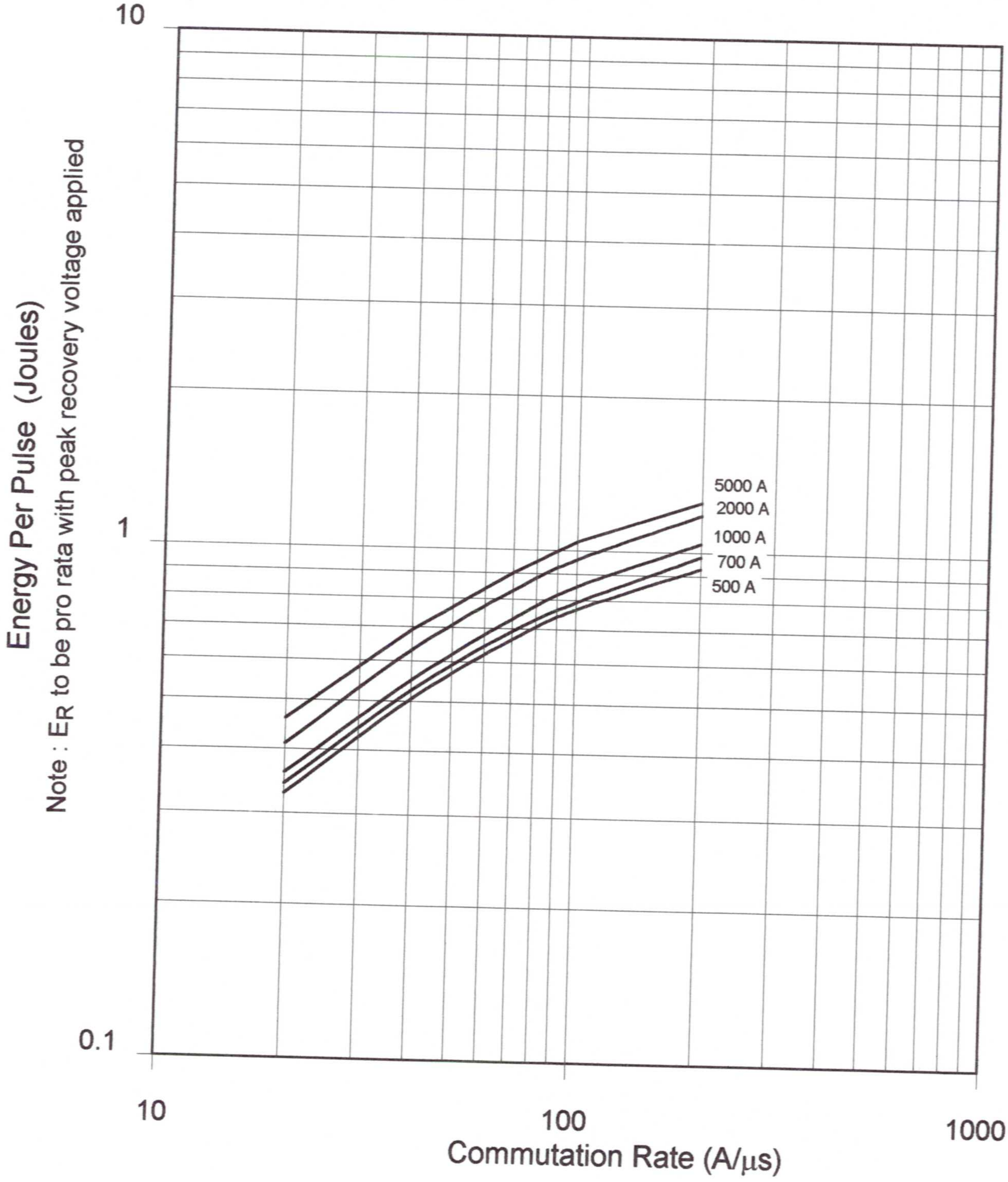
@125 °C Junction Temperature, 50% Chord



Maximum Reverse recovered Energy Loss Per Pulse E_R

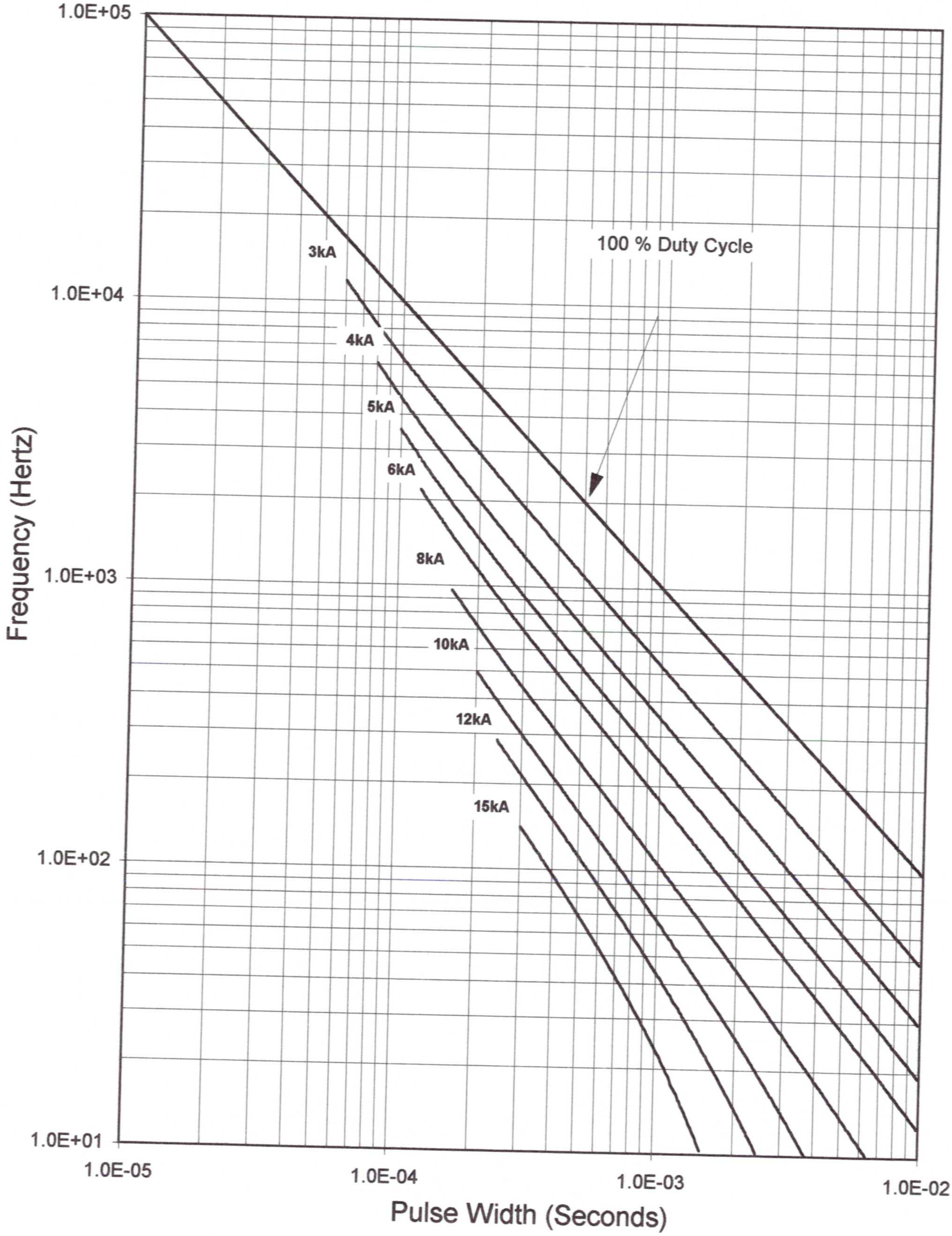
@ 125 °C Junction Temperature

Snubber 0.22 μF & 10 Ω. V_{RM} =0.67 Voltage Grade



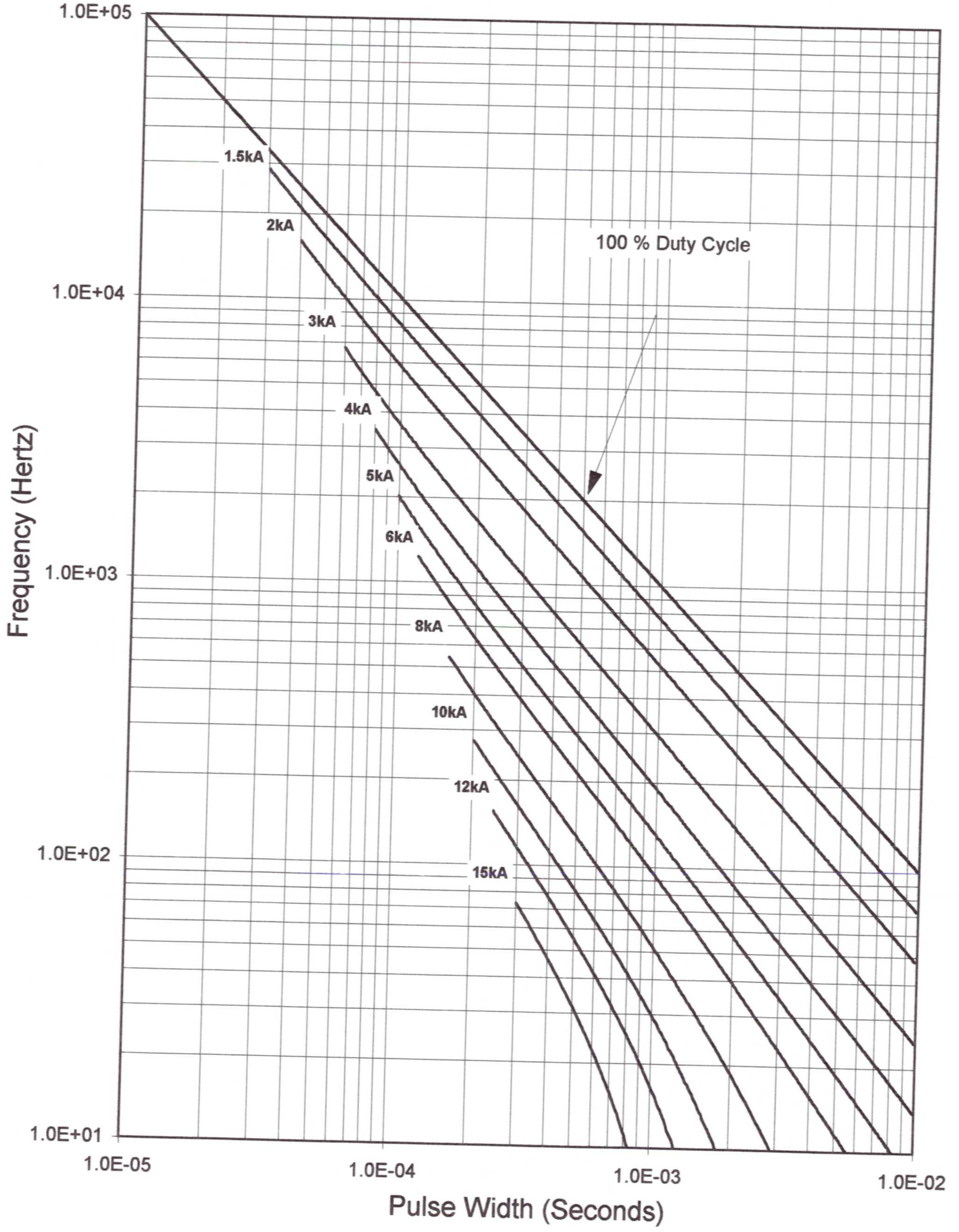
Frequency vs Pulse Width

Heat Sink Temperature 55°C, di/dt 100 A/μs



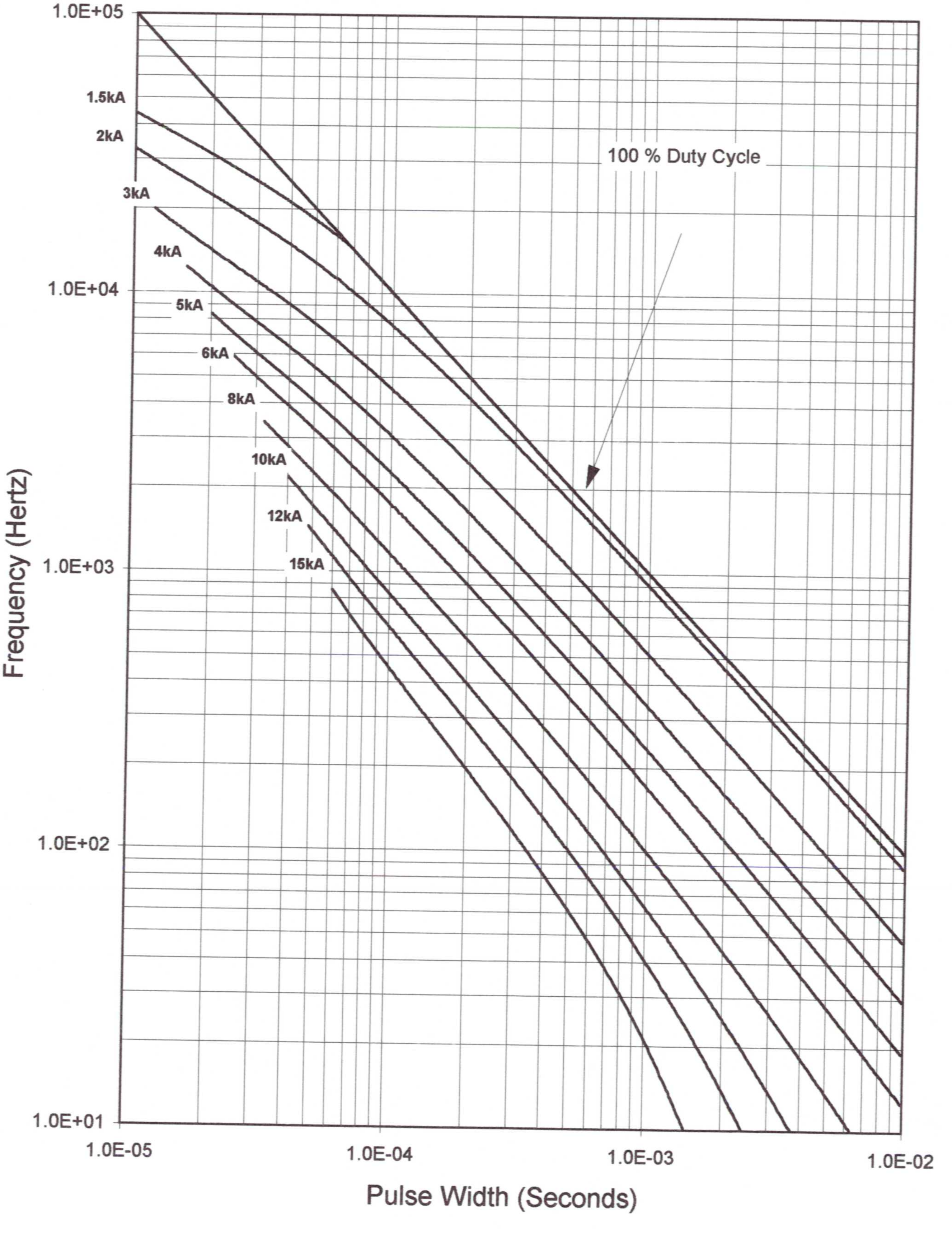
Frequency vs Pulse Width

Heat Sink Temperature 85°C, di/dt 100 A/μs



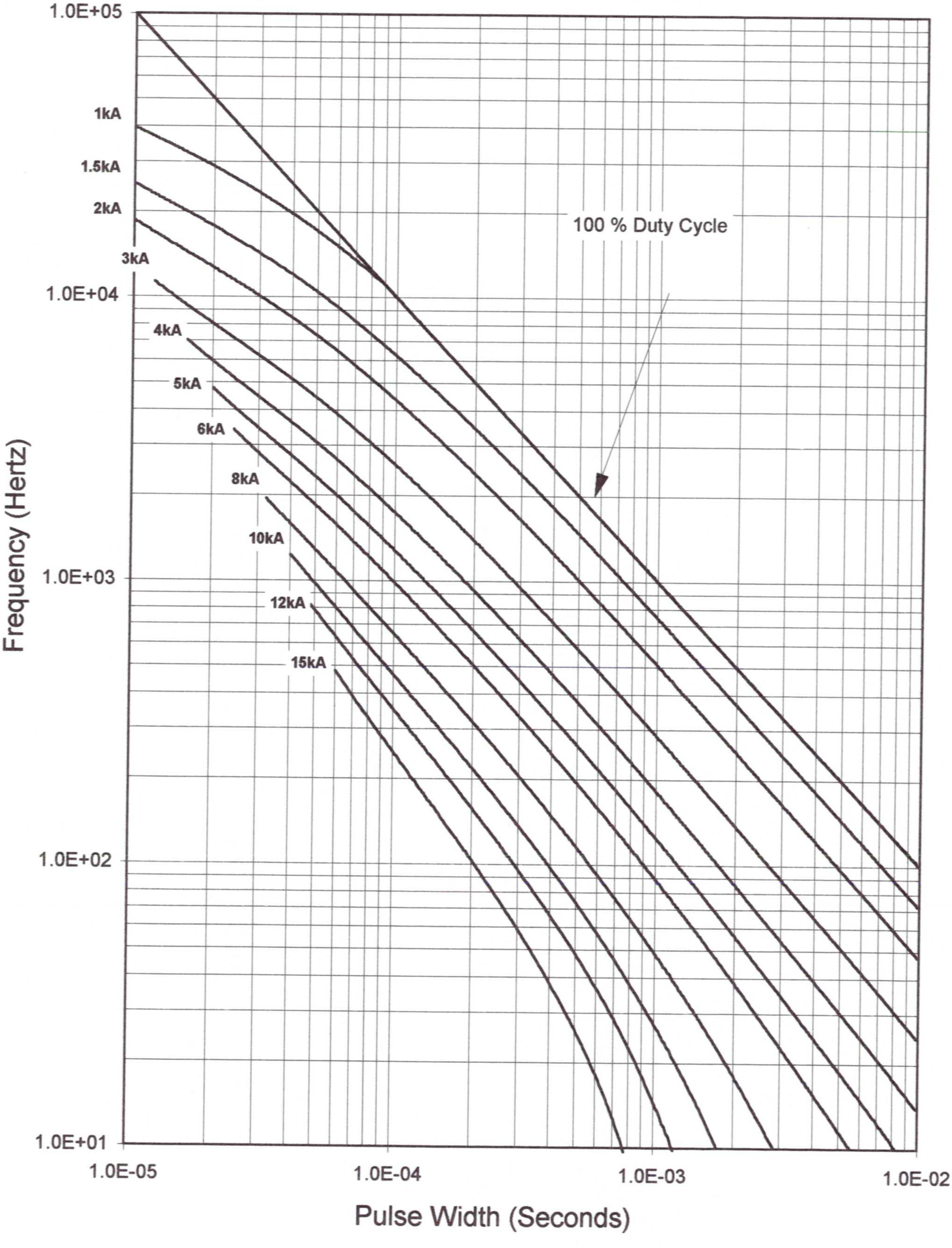
Frequency vs Pulse Width

Heat Sink Temperature 55°C, di/dt 500 A/μs



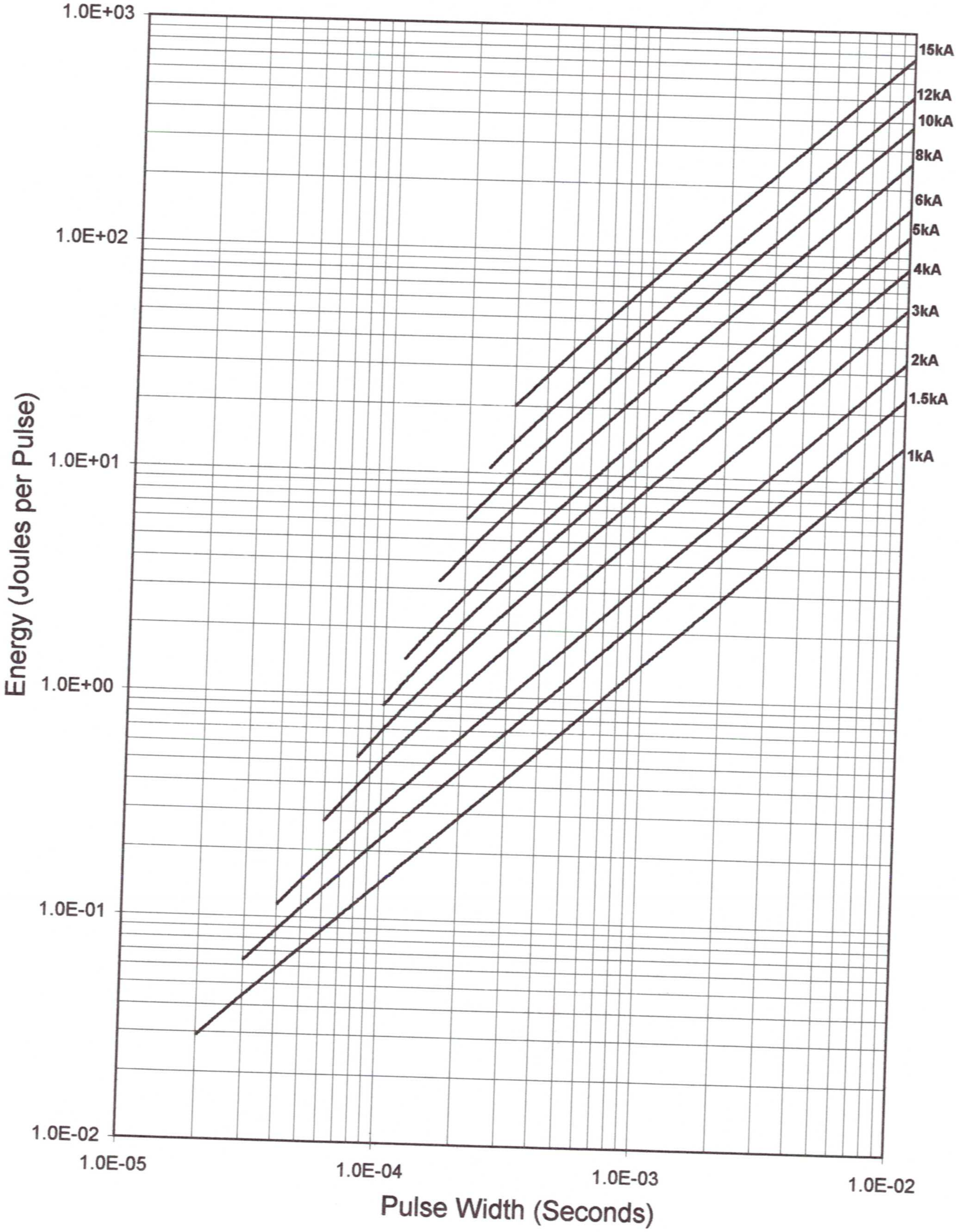
Frequency vs Pulse Width

Heat Sink Temperature 85°C, di/dt 500 A/μs



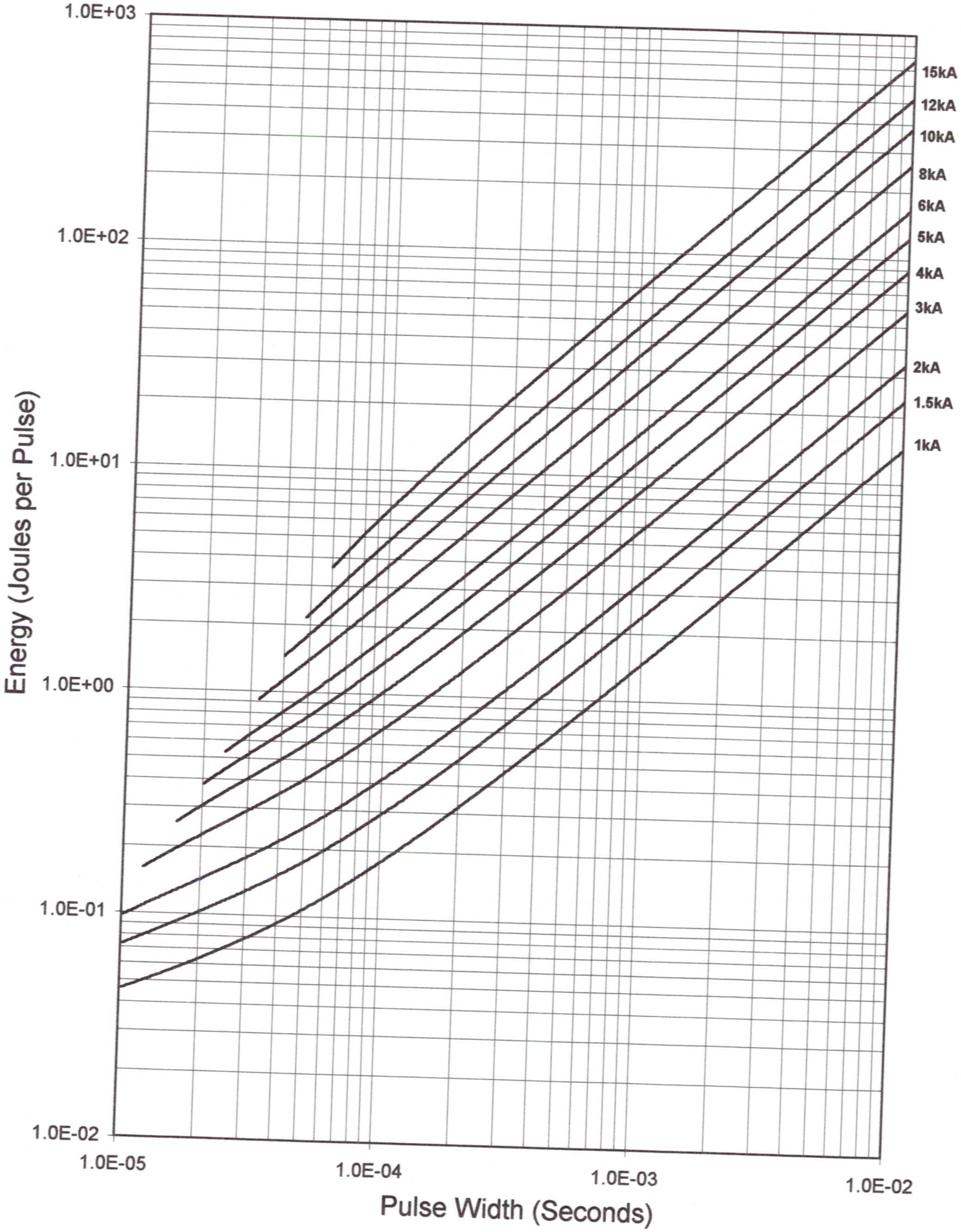
Energy vs Pulse Width

Junction Temperature 125 °C, di/dt 100 A/µs



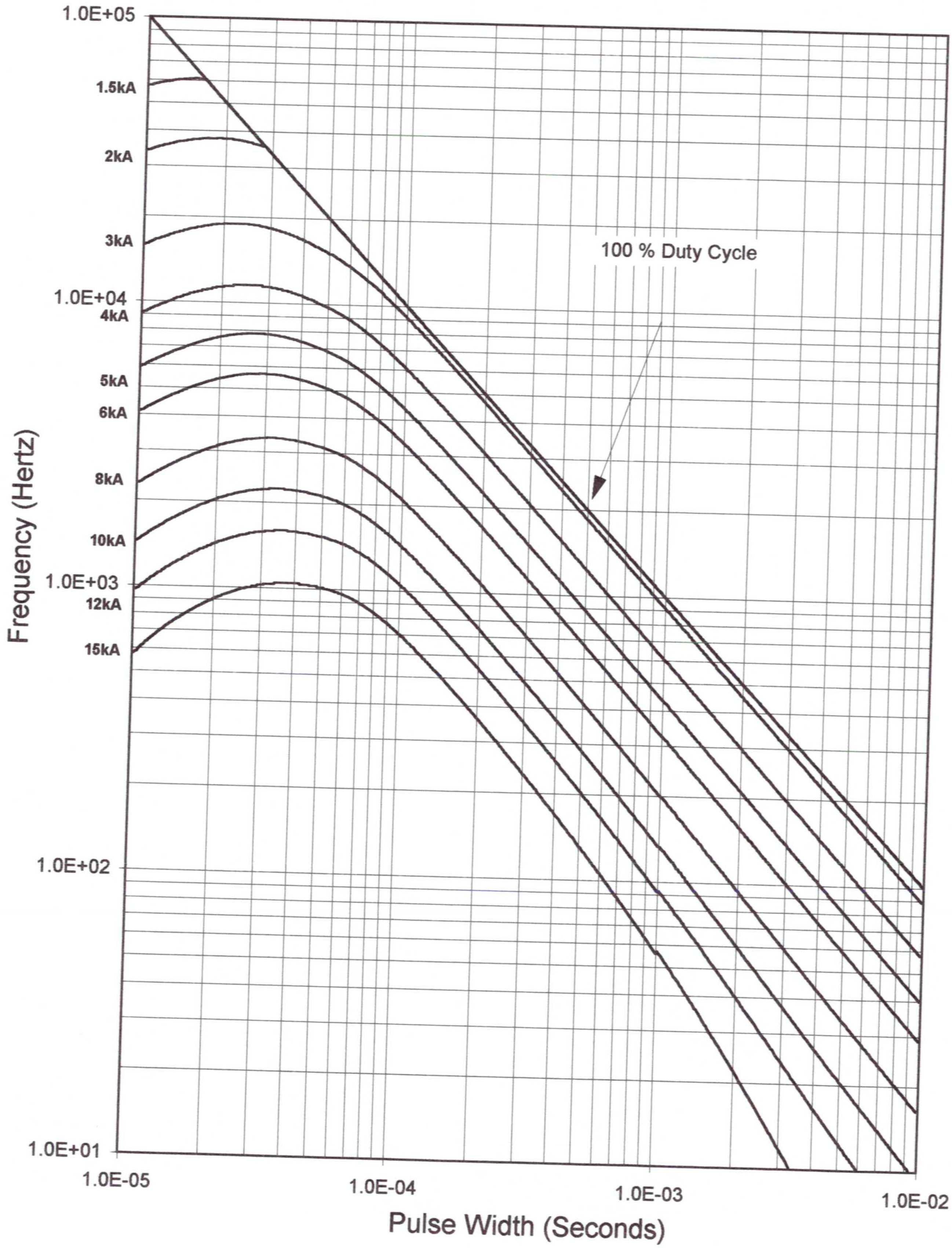
Energy vs Pulse Width

Junction Temperature 125 °C, di/dt 500 A/μs



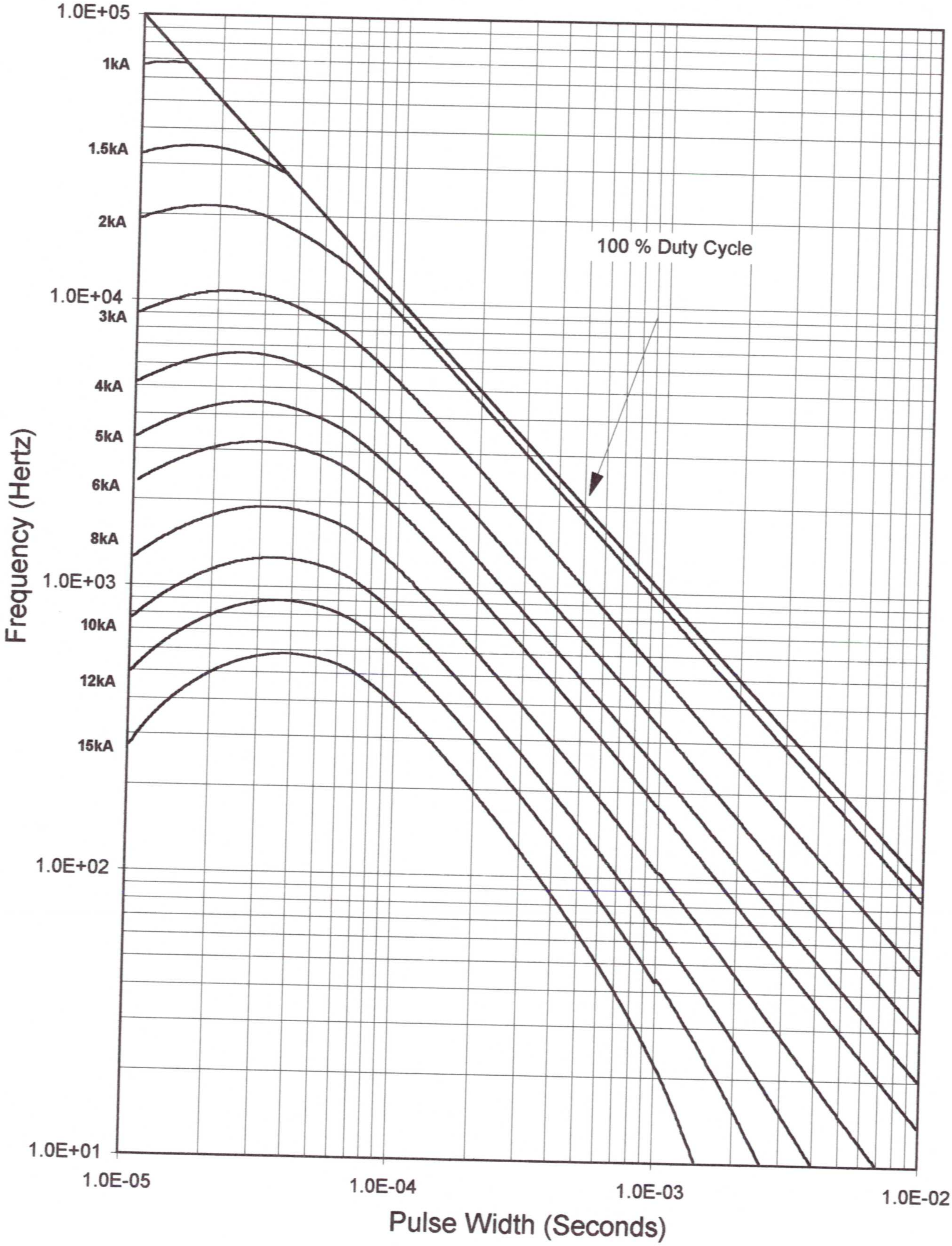
Frequency vs Pulse Width

Heat Sink Temperature 55^{o}C, Sine Wave



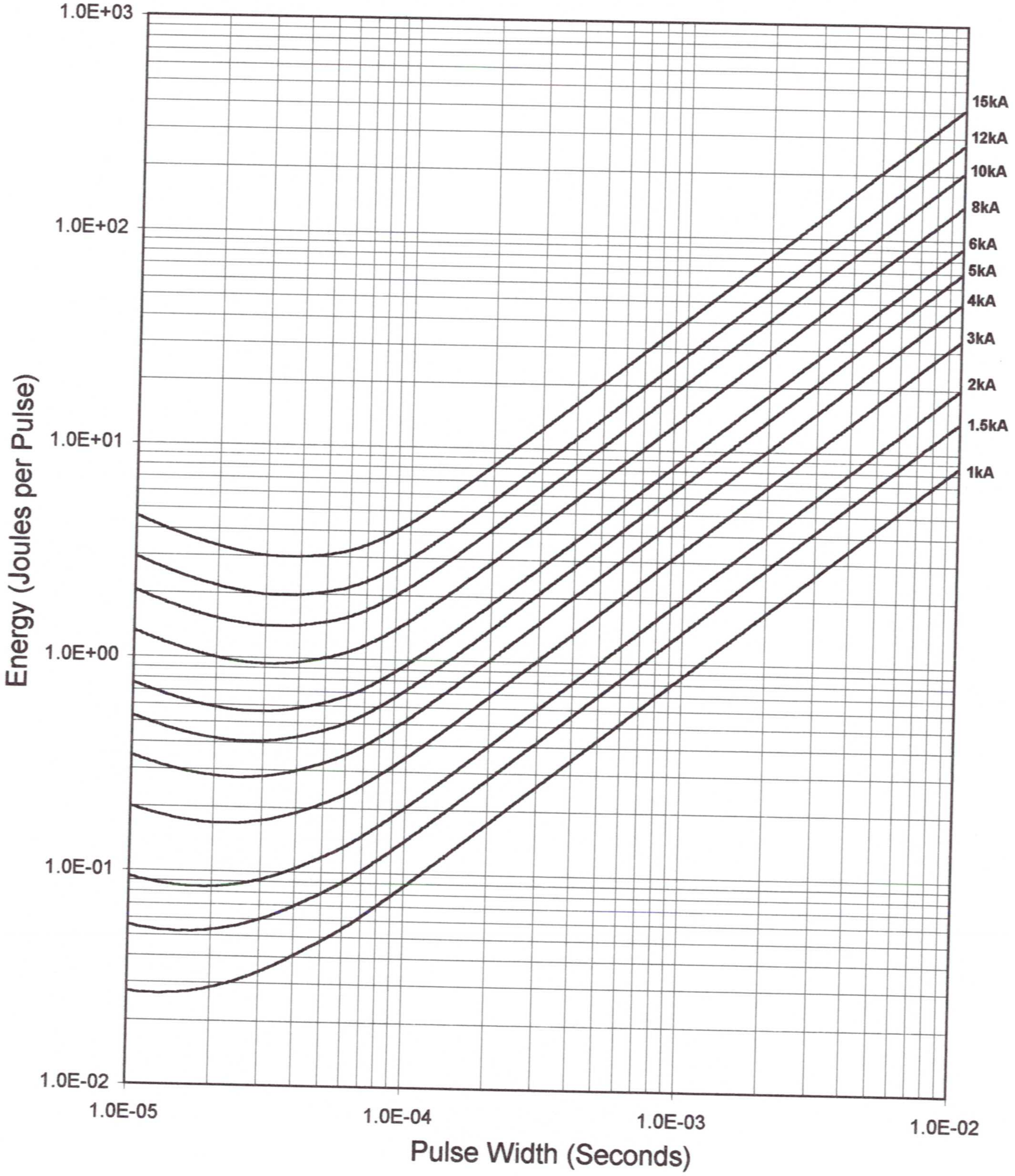
Frequency vs Pulse Width

Heat Sink Temperature 85°C, Sine Wave



Energy vs Pulse Width

Junction Temperature 125 °C, Sine Wave



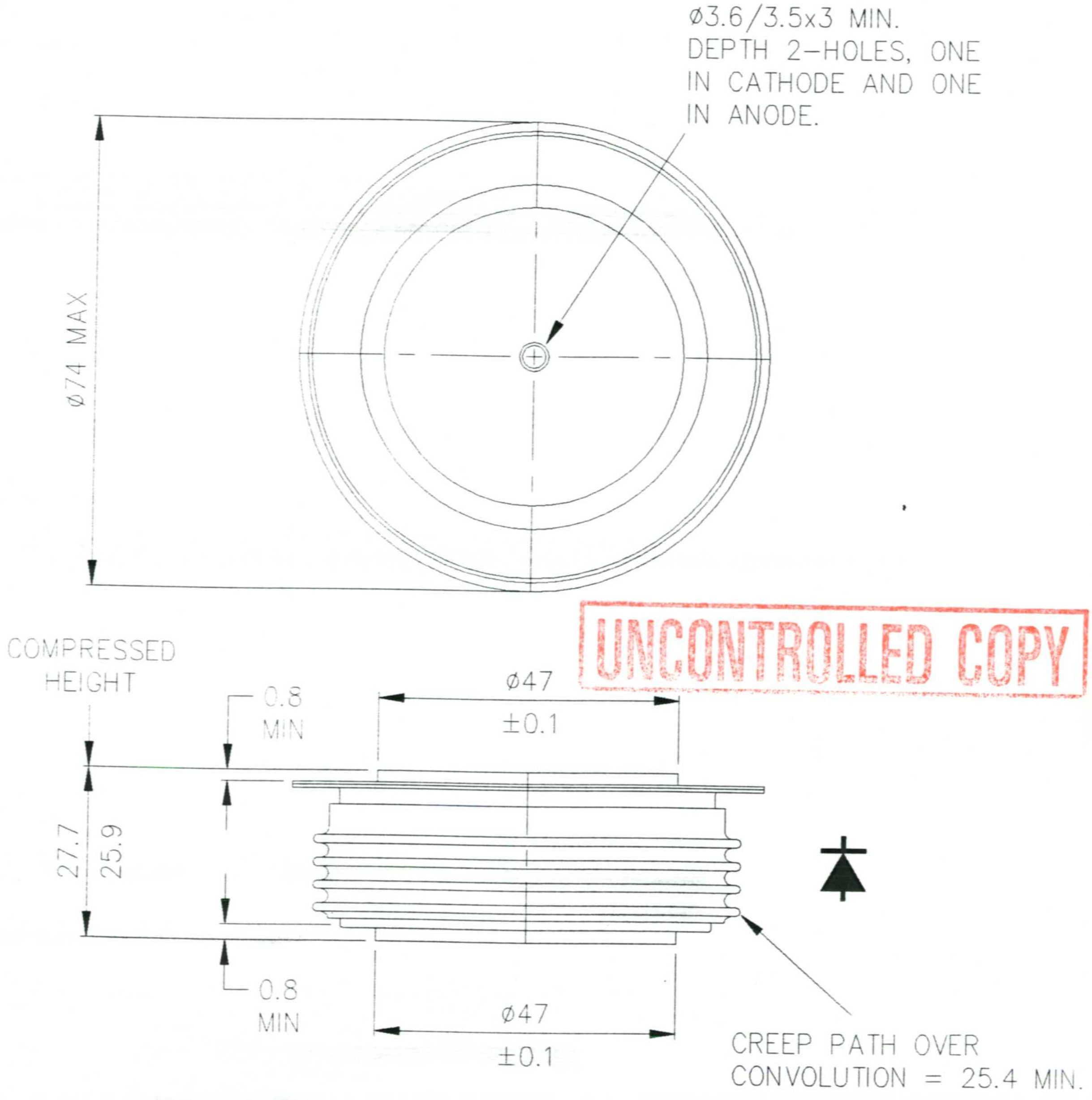
ACAD REF: 100A249

INTERNATIONAL OUTLINE No. DO-200AC
G.A. DWG No. 159B100H350-H359
WEIGHT. 480 GRAMS
FINISH. NICKEL PLATE

DEVICE MOUNTING: CLAMPING FORCE TO BE APPLIED ON CENTRE LINE OF LOCATION HOLES AND BE EVENLY DISTRIBUTED OVER AREA OF CONTACT. FLAT TOL. ON SURFACES TO WHICH DEVICE IS CLAMPED TO BE 0.04 WIDE. CLAMPING FORCE = 1900-2600kgf. (19-26kN).

TYPE NUMBER

CXC334	CXC680	CXC950
CXC500	CXC815	CXC990
CXC504	CXC818	CXC1170
CXC574	CXC820	CXC11C
CXC604	CXC824	CXC12C
CXC614	CXC915	CXC14C
CXC620	CXC930	CXC19C
CXC624	CXC924	



ISS	REVISIONS
4	11-09-90 REDRAWN ON CAD HDN
5A	TYPE No.'s CXC504, 574, 604 & 614 ADDED. M1944 21.7.92.
6D	30.6.93. M2266. TYPE's CXC334 & CXC344 ADDED. HN
7D	26.8.93. M2313. CXC19C ADDED. HN.
8D	2.12.93. M2439. CXC915 ADDED. HN.
9D	10.1.94. M2408. CXC344 DELETED. CLAMPING FORCE IN kN ADDED. HN
10 D	22.8.94. M2664. CXC12C ADDED. HN.
11 D	1.12.94 M2748 CXC818 ADDED. RFCB.
12 D	2.2.95. M2771. CXC1170 ADDED. HN.

THIRD ANGLE PROJECTION.
DWG. COMPLIES WITH BS 308.
DIMNS. IN MILLIMETRES.
DWG No. 100A249

SCALE 1/1 DRAWN HDN DIST. A

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