Fast Recovery Diode Stud
M0336S/RA120 to M0336S/RA140

The data sheet on the subsequent pages of this document is a scanned copy of existing data for this product.
(Rating Report 86NR2 Issue 2)

This data reflects the old part number for this product which is: SM02-14PHN/R170. This part number must **NOT** be used for ordering purposes – please use the ordering particulars detailed below.

The limitations of this data are as follows:
Device no longer available for grades 02 to 10 (200V to 1000V V_{RRM})

Please use the following link to view an up to date outline drawing for this device
Outline W23

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			
M0336	S/RA	♦♦	**0**
Fixed Type Code	Fixed Outline Code SA = Normal polarity RA = Reverse polarity	Voltage Code V_{DRM}/100 12-14	Fixed Code
Typical Order Code: M0336SA120, Normal polarity 3/4" glass and metal stud, 1200V V_{RRM}			

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In the interest of product improvement, Westcode reserves the right to change specifications at any time without prior notice.

Devices with a suffix code (2-letter, 3-letter or letter/digit/letter combination) added to their generic code are not necessarily subject to the conditions and limits contained in this report.

QUALITY EVALUATION LABORATORY

Rating Report: 86NR2 Issue 2

Date: 18th November, 1991

Origin:

Pages: 22

Diode Type SM2-14PHN/R170

Written by: M.W. Dunlop

Checked: MFW

Approved: BJR

The SM2-14PHN/R170 diode series employs a 24 mm silicon slice mounted under spring pressure in a stud base, top hat housing with flexible lead. Rating Report No. 86NR2 is superseded.

Ratings

Voltage Grades	: 2-14
V_{RSM}	: 300-1500V
V_{RRM}	: 200-1400V

$I_F(AV)$; Single phase; 50 Hz, 180°C half sinewave; T_{CASE} = 100°C	: 150A
$I_F(rms)$ max.	: 400A
I_F d.c. max.	: 400A
I_{FSM} : t = 10 ms half sinewave; T_J(initial) = 125°C ; $V_{RM} = 0.6V_{RRM}(MAX)$	: 4500A
I_{FSM} : t = 10 ms half sinewave; T_J(initial) = 125°C ; $V_{RM} \leq 10V$	: 4950A
I^2t : t = 10 ms; T_J (initial) = 125°C ; $V_{RM} = 0.6V_{RRM}(MAX)$	: 101 x $10^3 A^2S$
I^2t : t = 10 ms; T_J(initial) = 125°C ; $V_{RM} \leq 10V$	: 122 x $10^3 A^2S$
I^2t : t = 3 ms; T_J (initial) = 125°C ; $V_{RM} \leq 10V$	: 91 x $10^3 A^2S$
T_C Operating Range	: -40 to 125°C
T_{stg} Non-operating	: -40 to 150°C

Characteristics

(maximum values unless otherwise stated)

V_O; T_J = 125°C	:	1.02V
r_s; T_J = 125°C	:	0.7mohms
V_{FM} ; I_{FM} = 470A T_{VJ} = 125°C	:	1.35V
$R_{th(J-C)}$	:	0.13°C/W
$R_{th(C-HS)}$	:	0.04°C/W
I_{RRM} : T_J = 125°C : V_{RM} = $V_{RRM(Max)}$	:	20mA
Q_{rr} (I_{FM} = 550A ;dI/dt = 40A/uS	:	75uC
t_{rr} (V_{RM} = 50V; T_{VJ} = 125°C	:	3uS
Mounting torque	:	2.5-2.77Kgf.m
Outline drawing	:	100A281
JEDEC Outline No.	:	

CONTENTS

Changes to 86NR2 (Issue 1)

Voltage grade increased from 12 to 14

Voltage Ratings

Voltage Class	V_{RRM} V	V_{RSM} V
2	200	300
4	400	500
6	600	700
8	800	900
10	1000	1100
12	1200	1300
14	1400	1500

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

2.0 Introduction

The diode series comprises fast recovery stud based devices with all diffused silicon slices. All these diodes have controlled reverse recovery characteristics with good "S" factors.

3.0 Notes on the Ratings

(a) Square wave ratings

These ratings are given for leading edge linear rates of rise of forward current of 200 and 100A/uS

(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, and f be the repetition rate

Then $W_{AV} = Ep \times f$

$T_{CASE} = 125 - Ep \times f \times R_{th}$

(c) Housing Loss

The loss caused by coupling between housing and anode current (which gives rise to additional heating at high frequency) has been incorporated into the curves of forward energy loss per pulse.

4.0 Reverse Recovery Loss

On account of the number of circuit variables affecting reverse recovery voltage, no allowance for reverse recovery loss has been made in these ratings. 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 A joules per pulse. A new case temperature can then be evaluated from:

$$T_{CASE}(new) = T_{CASE}(original) - A \left(\frac{r_t \cdot 10^6}{t} + R_{th} \times f\right)$$

where $r_t = 1.77 \times 10^{-4}\sqrt{t}$

t = duration of reverse recovery loss per pulse in microseconds

A = Area under reverse loss waveform per pulse in joules (W.S.)

f = rated frequency at the original case temperature

The total dissipation is now given by

$W_{(TOT)} = W_{(original)} + Axf$

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) The measuring oscilloscope has adequate dynamic range - typically 100 screen heights - to cope with the initial forward current without overload.

(c) Measurement of reverse recovery voltage waveform should be carried out with an appropriate snubber of 0.1uF & 5ohms connected across diode anode to cathode.

(b) Design Method

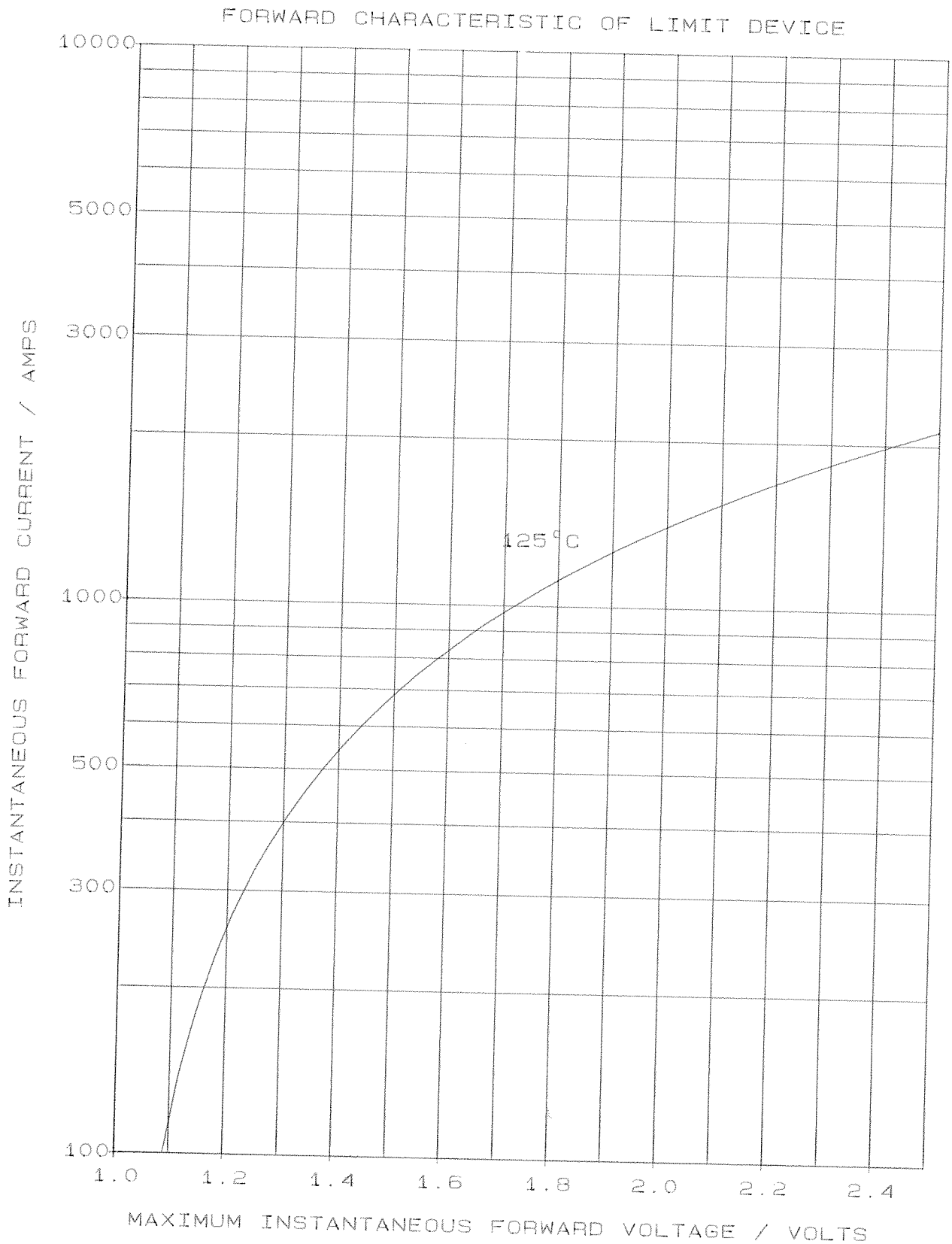
In circumstances where it is not possible to measure voltage and current conditions, or for design purposes, the additional losses may be estimated from curves on page 12.

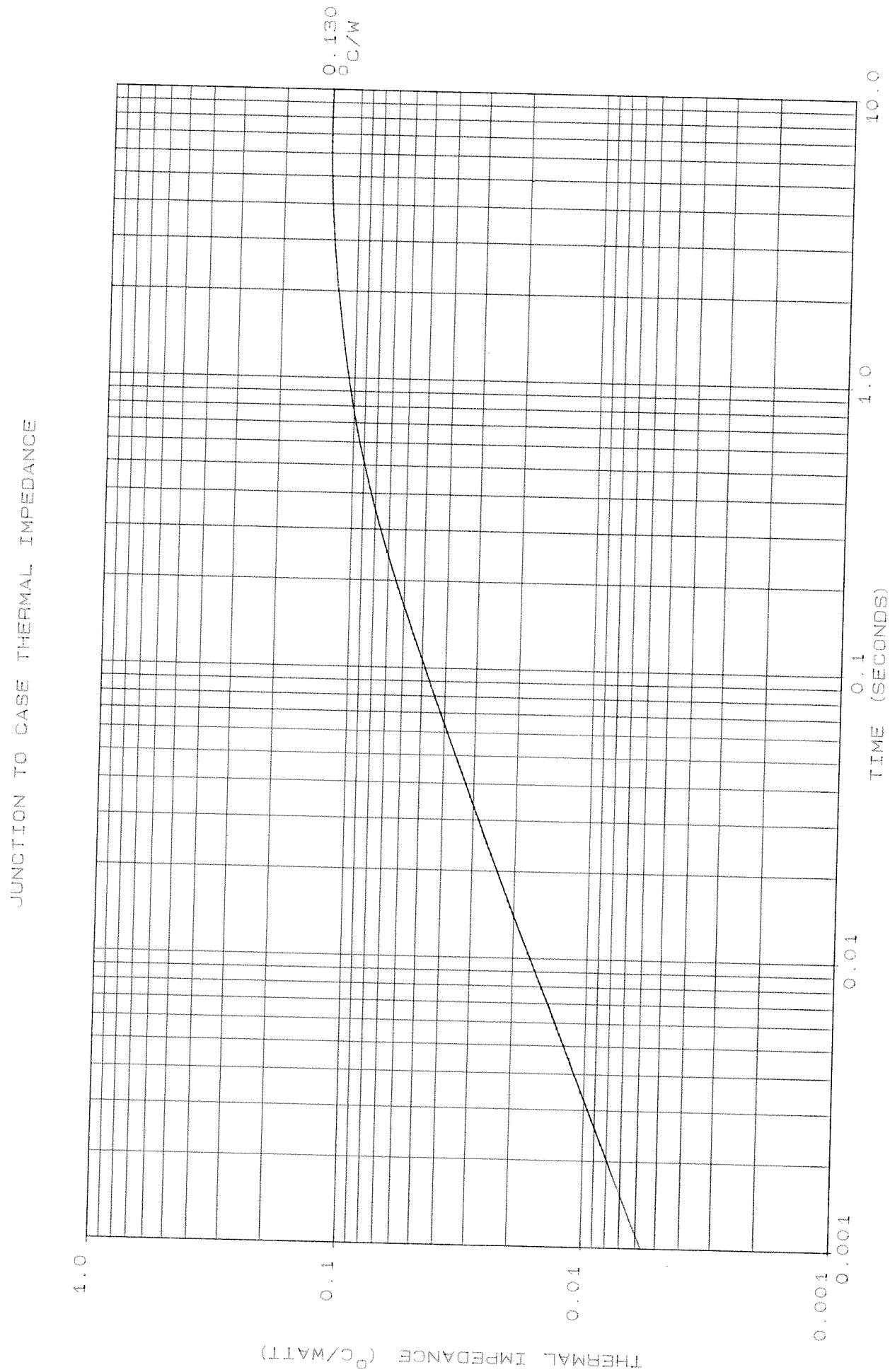
Let E be the value of energy per reverse cycle in joules (curves on page 12).

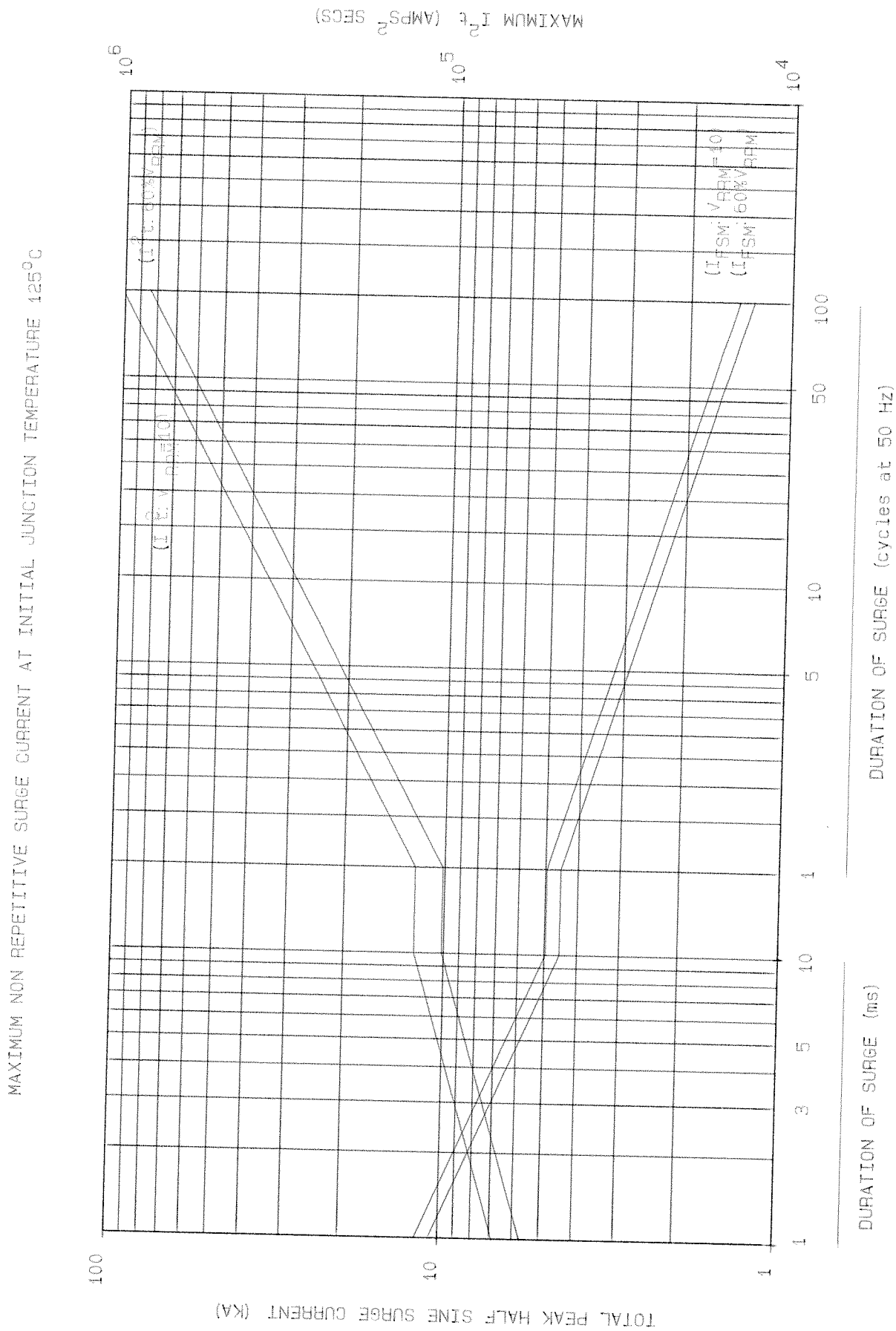
Let f be the operating frequency in Hz

Then T_{CASE} new = T_{CASE} original - $ER_{th} \times f$

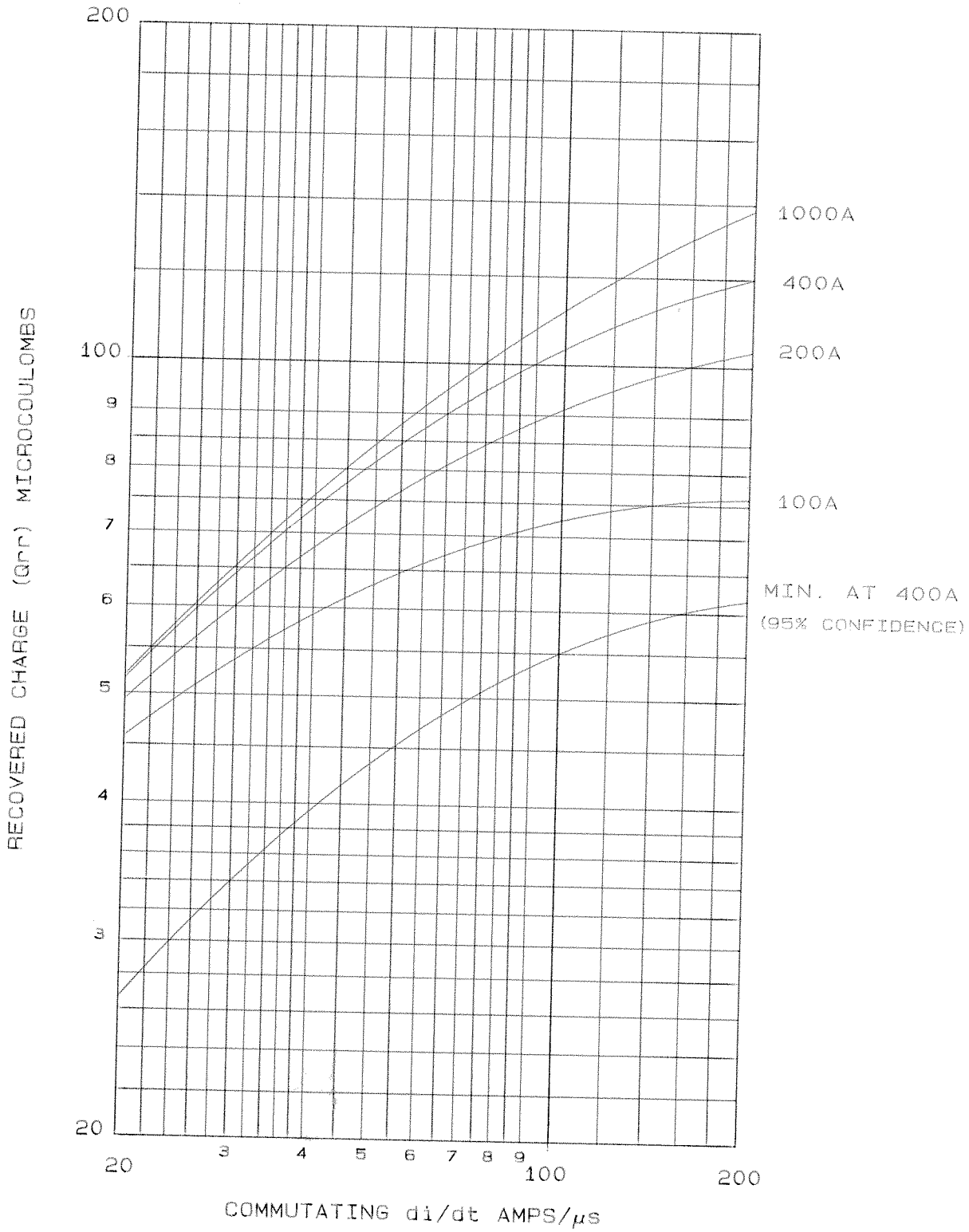
Where T_{CASE} new is the required maximum case temperature and T_{CASE} original is the case temperature given with the frequency ratings.

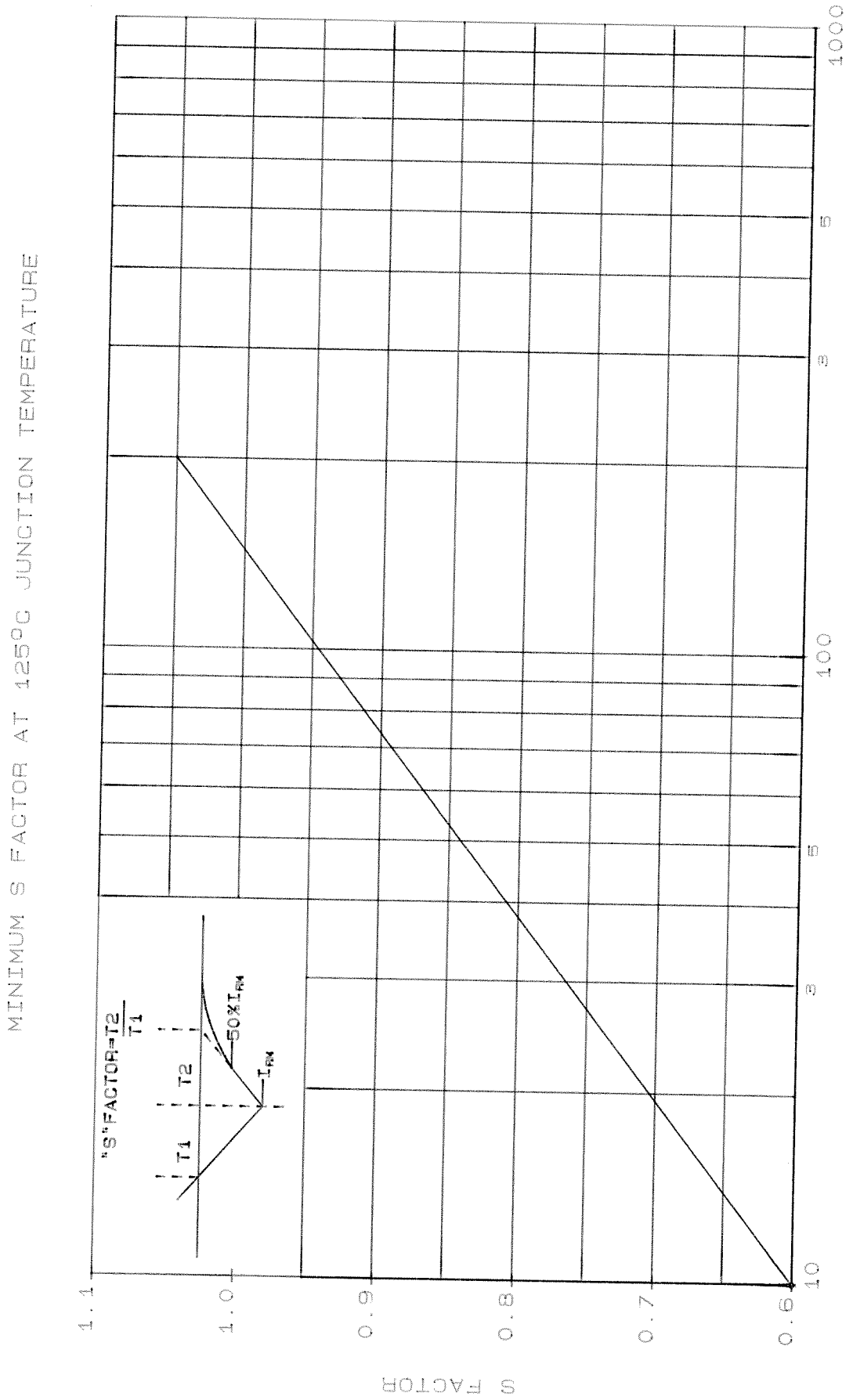

FORWARD CHARACTERISTIC OF LIMIT DEVICE
10000
5000
3000
1000
500
300
100
INSTANTANEOUS FORWARD CURRENT / AMPS
125°C
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
MAXIMUM INSTANTANEOUS FORWARD VOLTAGE / VOLTS

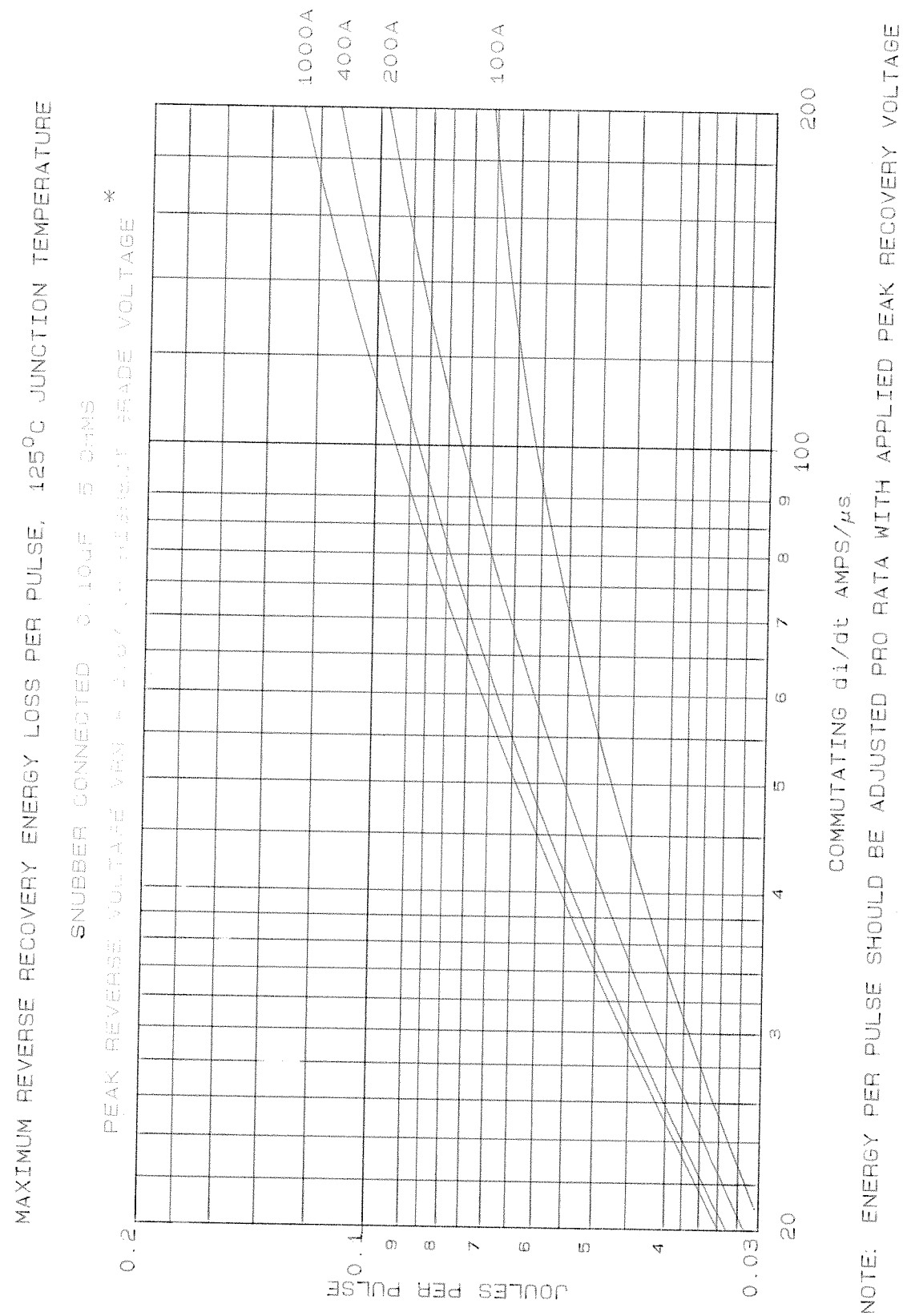

JUNCTION TO CASE THERMAL IMPEDANCE
0.130 °C/W
THERMAL IMPEDANCE (°C/WATT)
1.0
0.1
0.01
0.001
0.001
0.01
0.1
1.0
10.0
TIME (SECONDS)

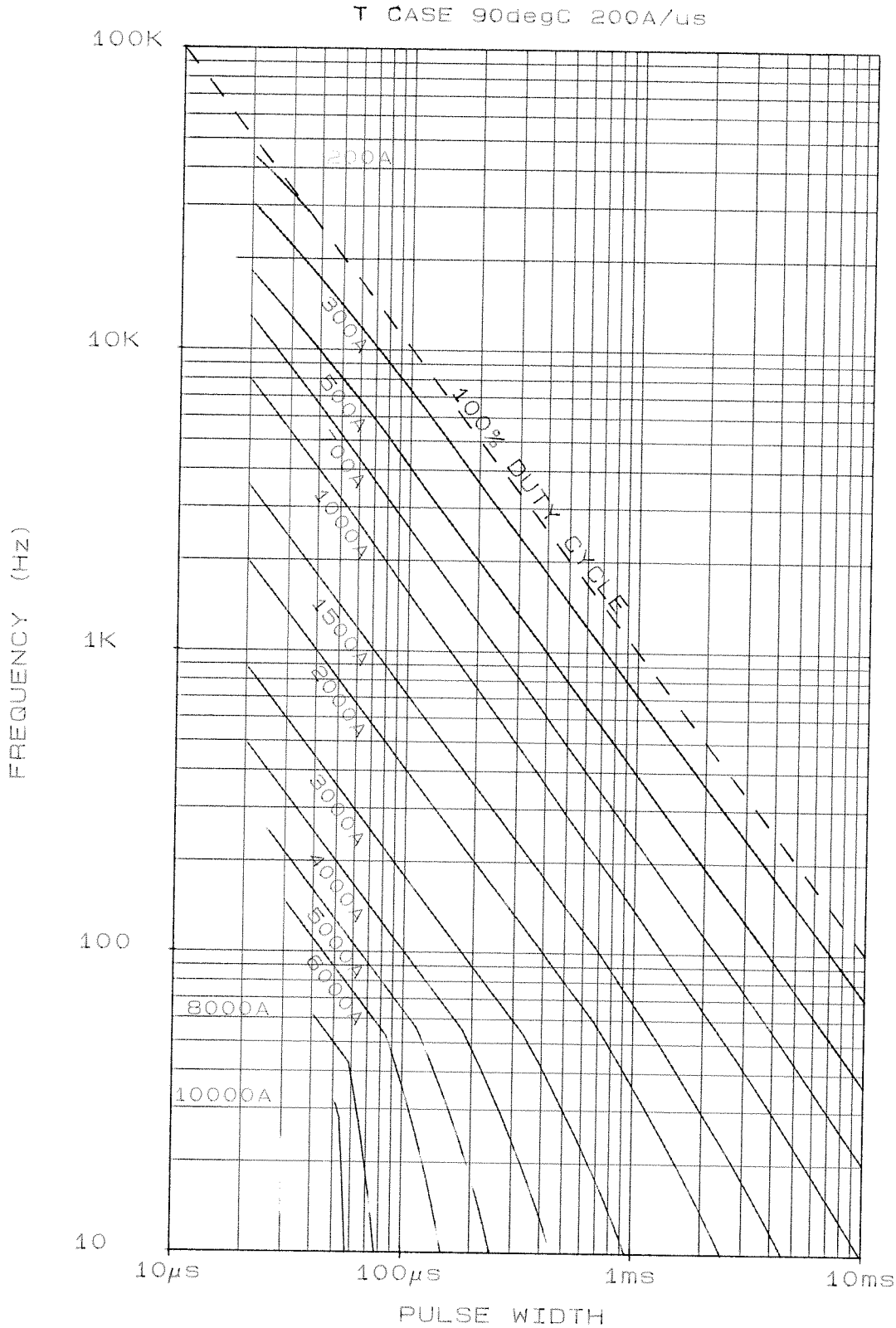

MAXIMUM NON REPETITIVE SURGE CURRENT AT INITIAL JUNCTION TEMPERATURE 125°C
MAXIMUM I²t (AMPS² SECS)
10⁶
10⁵
10⁴
(I.T. 60% PEAK)
(I.T. 100% PEAK)
(IFSM) VRM = 10
(IFSM) 60% VRRM
100
50
10
5
1
10
5
3
1
DURATION OF SURGE (cycles at 50 Hz)
DURATION OF SURGE (ms)
100
10
1
TOTAL PEAK HALF SINE SURGE CURRENT (KA)

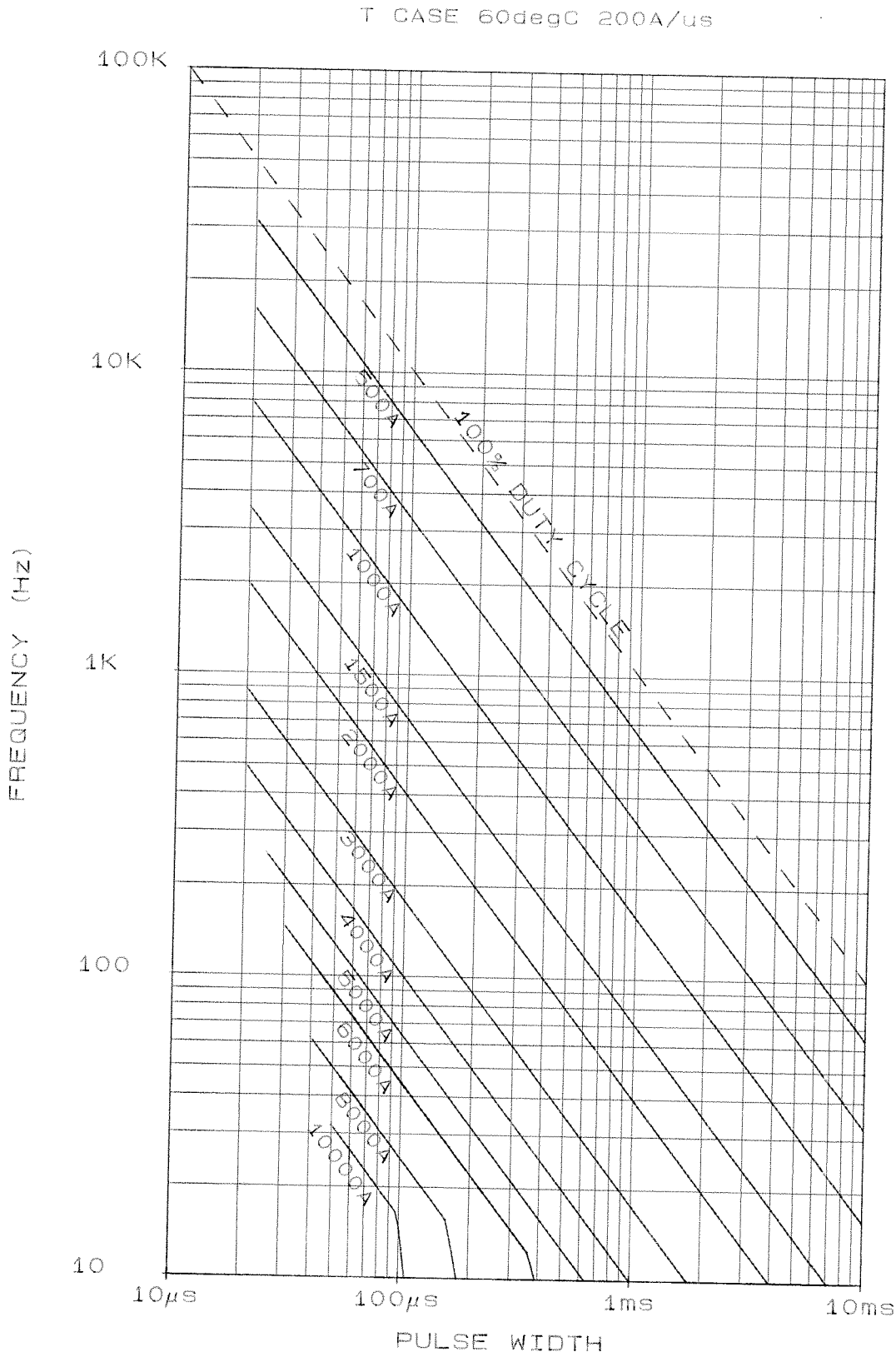
MAXIMUM RECOVERED CHARGE AT 125°C JUNCTION TEMPERATURE



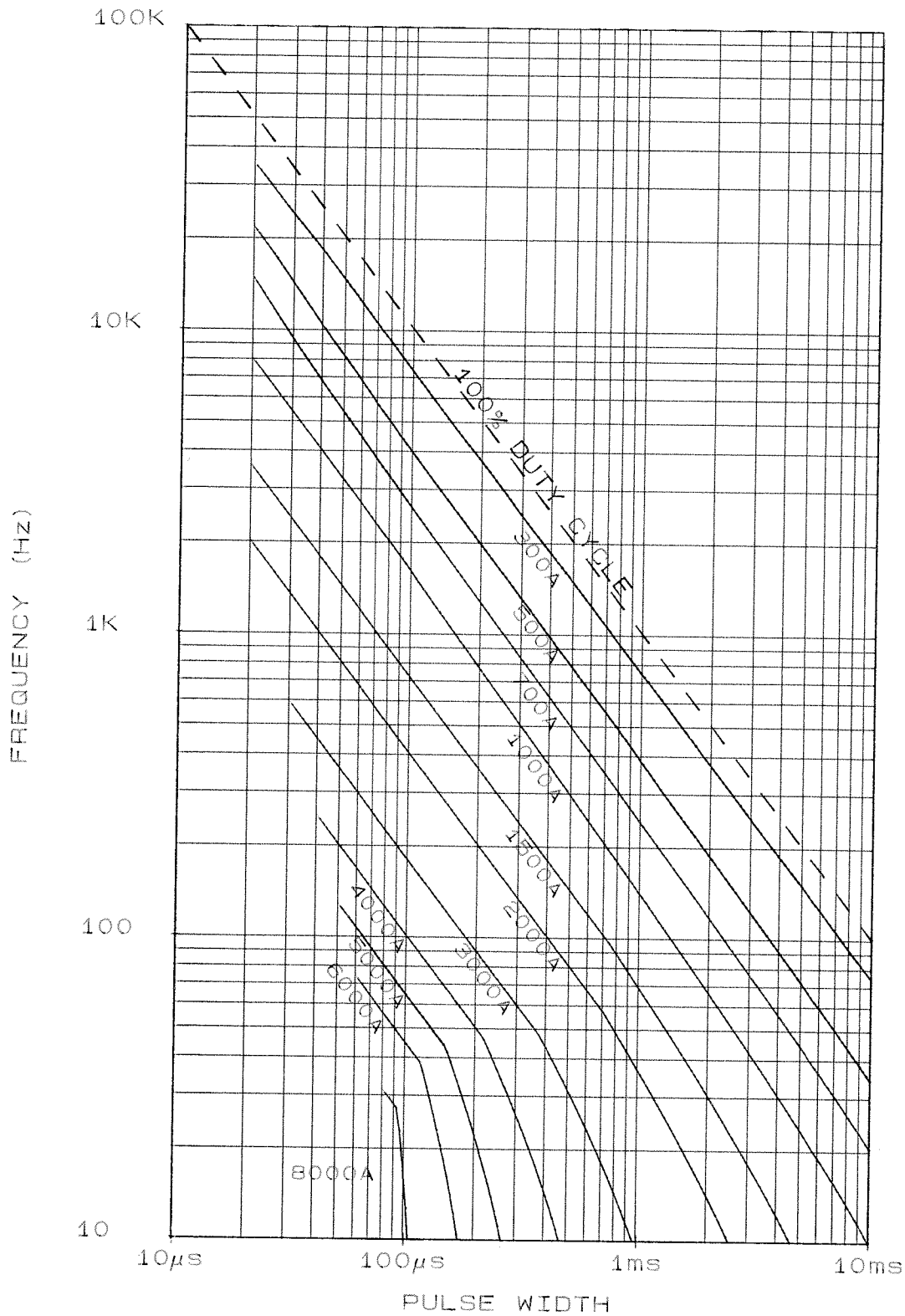

MINIMUM S FACTOR AT 125°C JUNCTION TEMPERATURE
S FACTOR
1.1
1.0
0.9
0.8
0.7
0.6
RECOVERED CHARGE μC
10
30
100
300
1000
500
"S" FACTOR = T2/T1
T1
T2
50%IRM
IRM

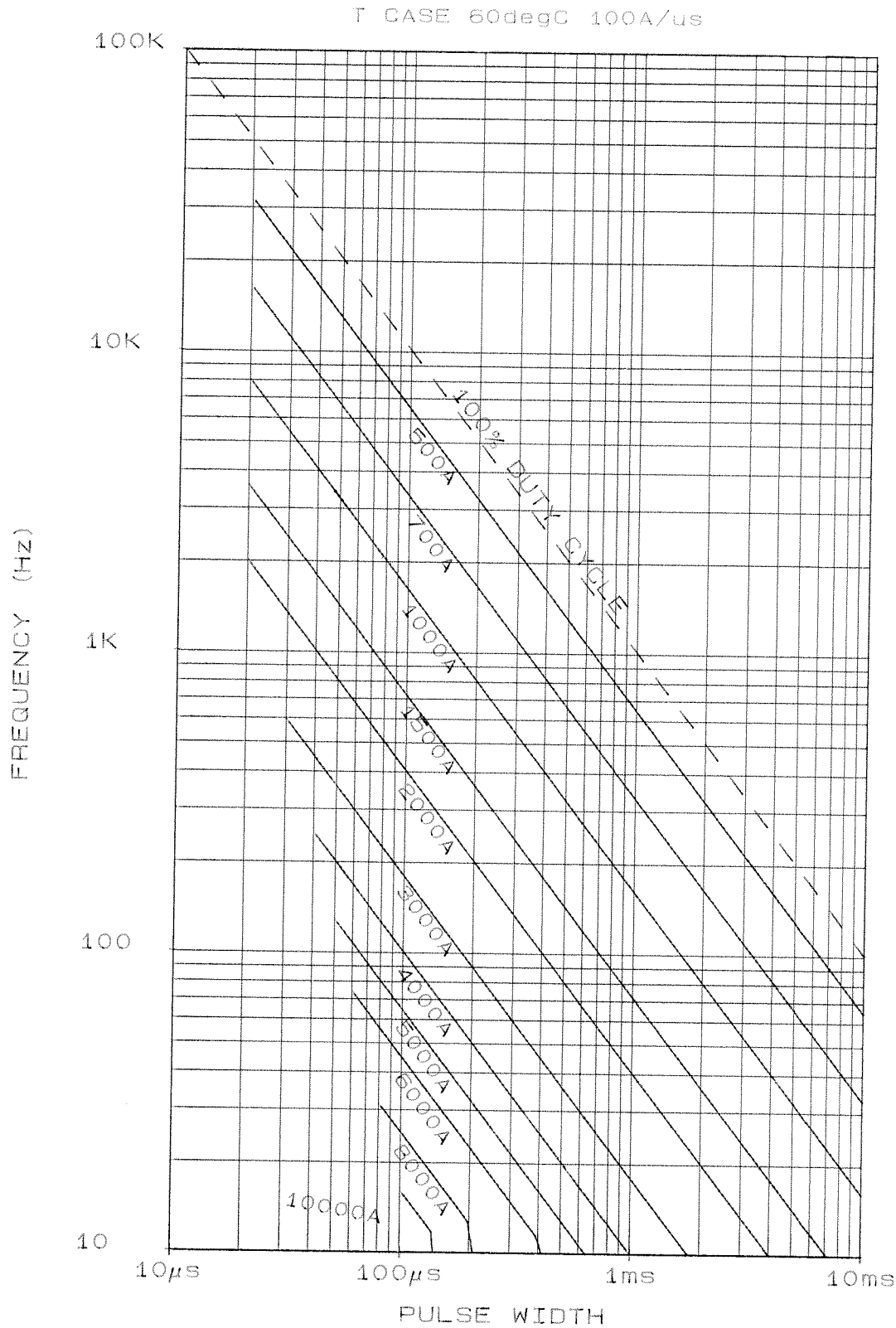

MAXIMUM REVERSE RECOVERY ENERGY LOSS PER PULSE, 125°C JUNCTION TEMPERATURE
SNUBBER CONNECTED 0.1μF 5 OHMS
PEAK REVERSE VOLTAGE VRM = 1.0 x RATED REPETITIVE PEAK REVERSE VOLTAGE *
1000A
400A
200A
100A
JOULES PER PULSE
0.2
0.1
0.03
20
100
200
COMMUTATING di/dt AMPS/μs
* NOTE: ENERGY PER PULSE SHOULD BE ADJUSTED PRO RATA WITH APPLIED PEAK RECOVERY VOLTAGE


T CASE 90degC 200A/us
100K
10K
1K
100
10
FREQUENCY (Hz)
200A
300A
500A
700A
1000A
1500A
2000A
3000A
4000A
5000A
6000A
8000A
10000A
100% DUTY CYCLE
10µs
100µs
1ms
10ms
PULSE WIDTH

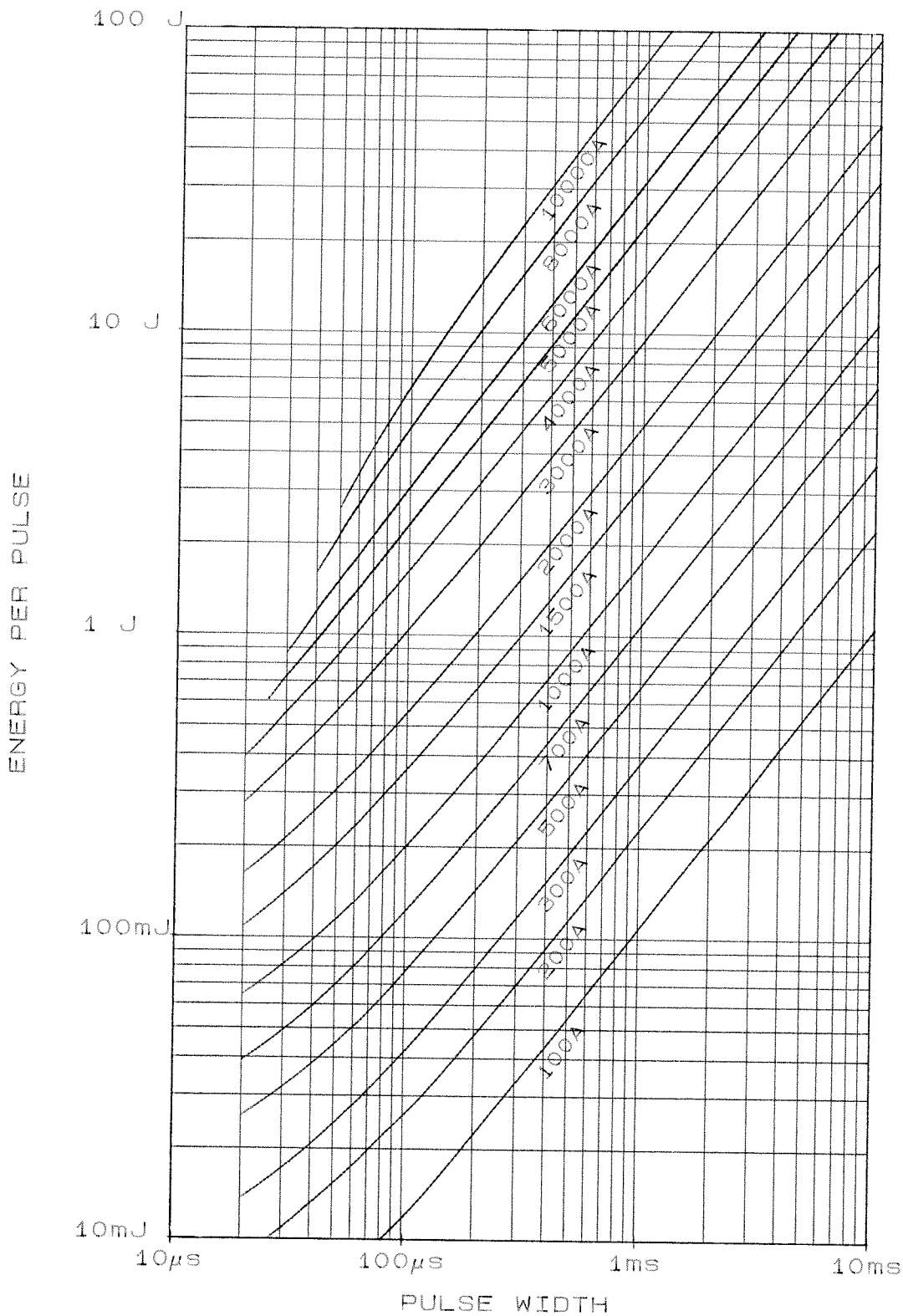

T CASE 60degC 200A/us
100K
10K
1K
100
10
FREQUENCY (Hz)
500A
100% DUTY CYCLE
1000A
1000A
1500A
2000A
3000A
4000A
5000A
6000A
8000A
10000A
10µs
100µs
1ms
10ms
PULSE WIDTH

T CASE 90degC 100A/us

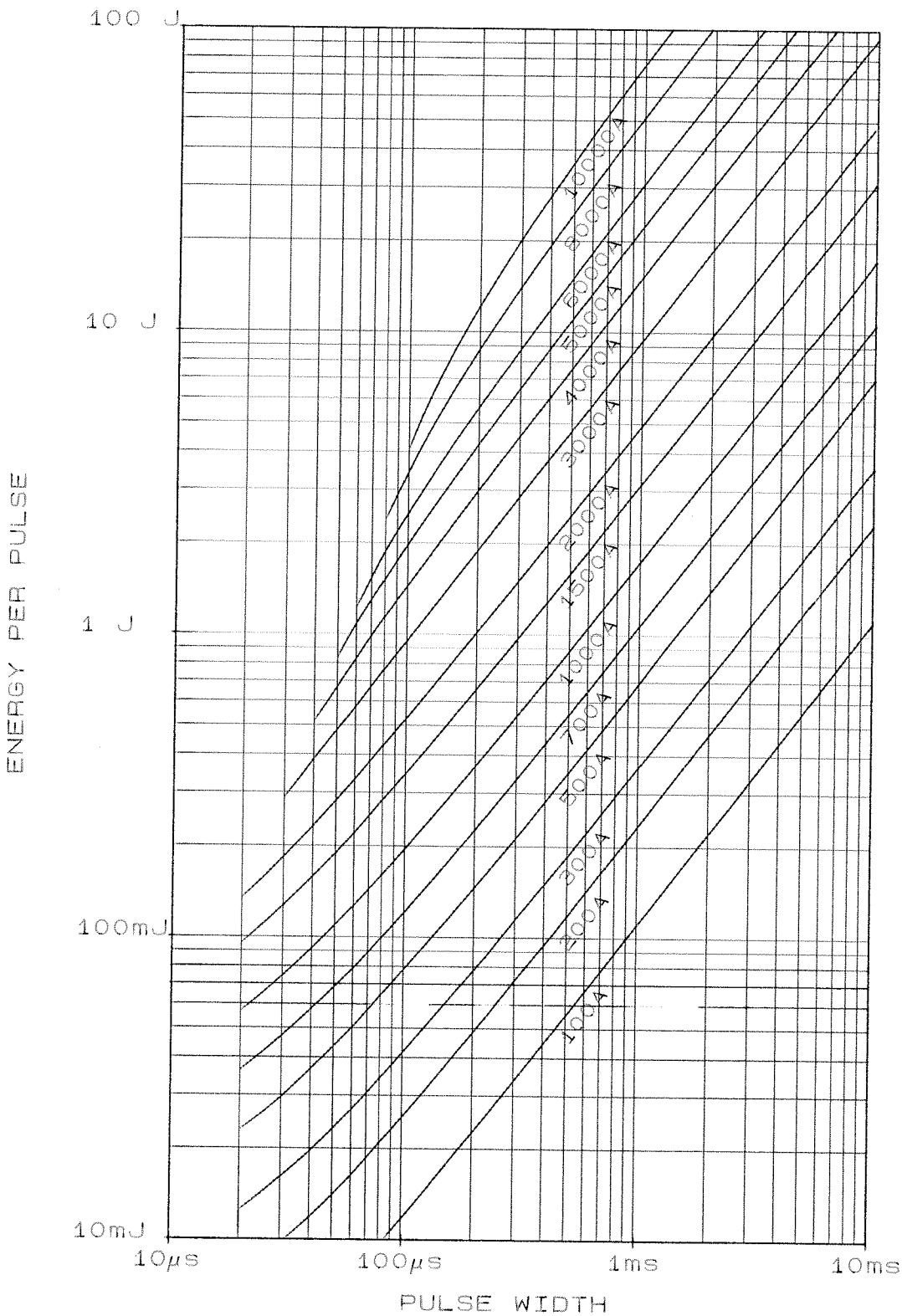


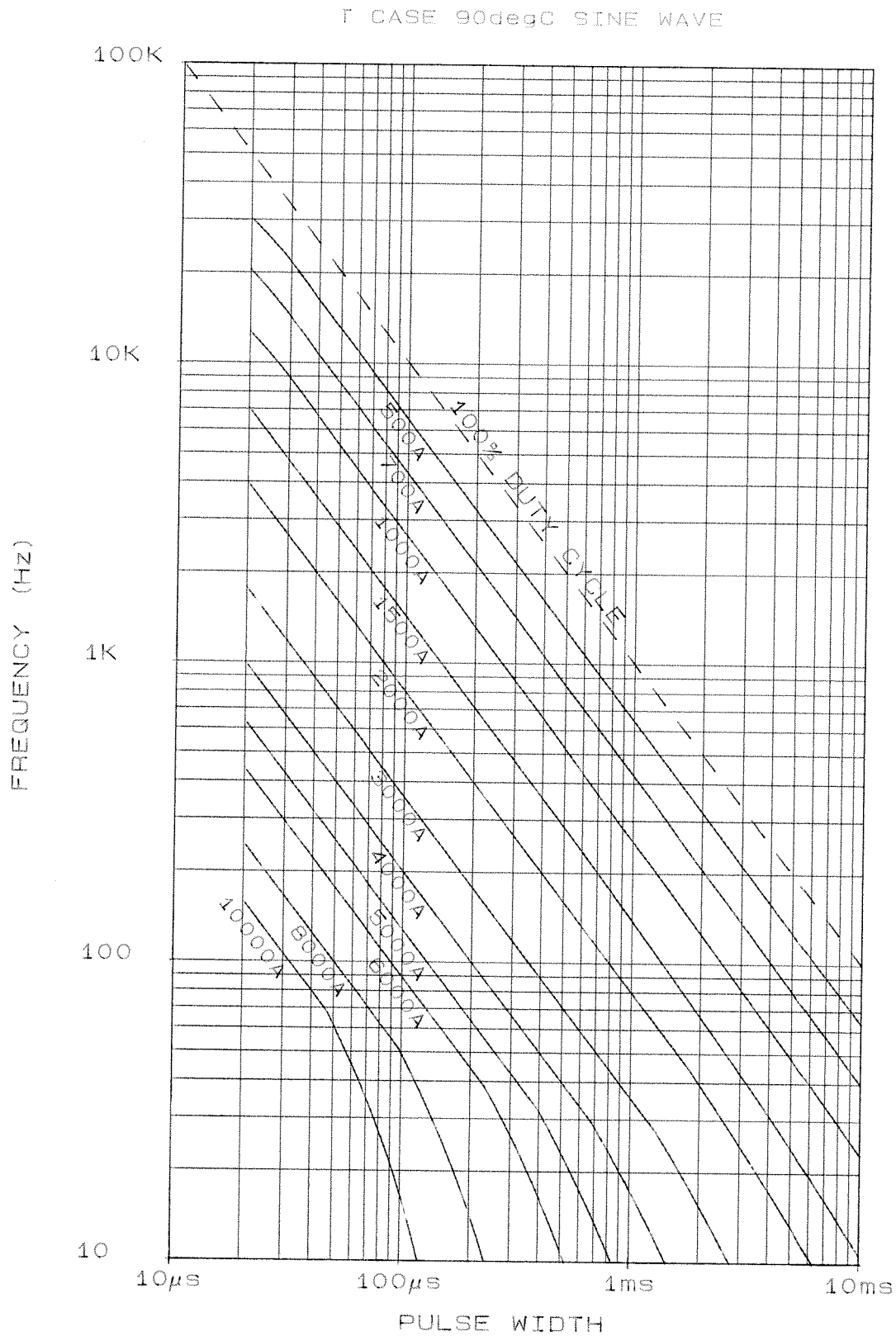

T CASE 60degC 100A/us
100K
10K
1K
100
10
FREQUENCY (Hz)
100% DUTY CYCLE
500A
700A
1000A
1500A
2000A
3000A
4000A
5000A
6000A
8000A
10000A
10μs
100μs
1ms
10ms
PULSE WIDTH

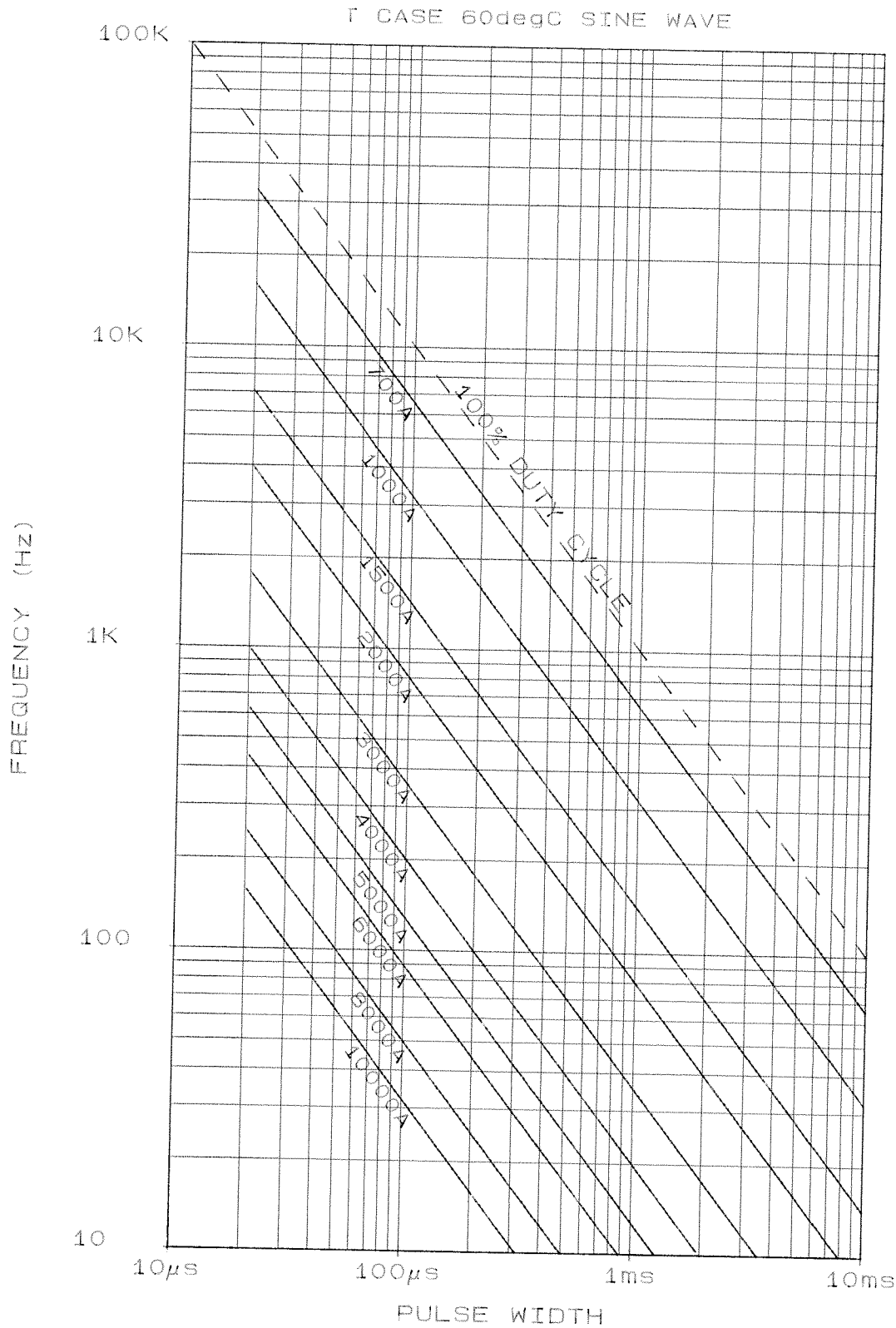
Tj 125°C. 200A/μs

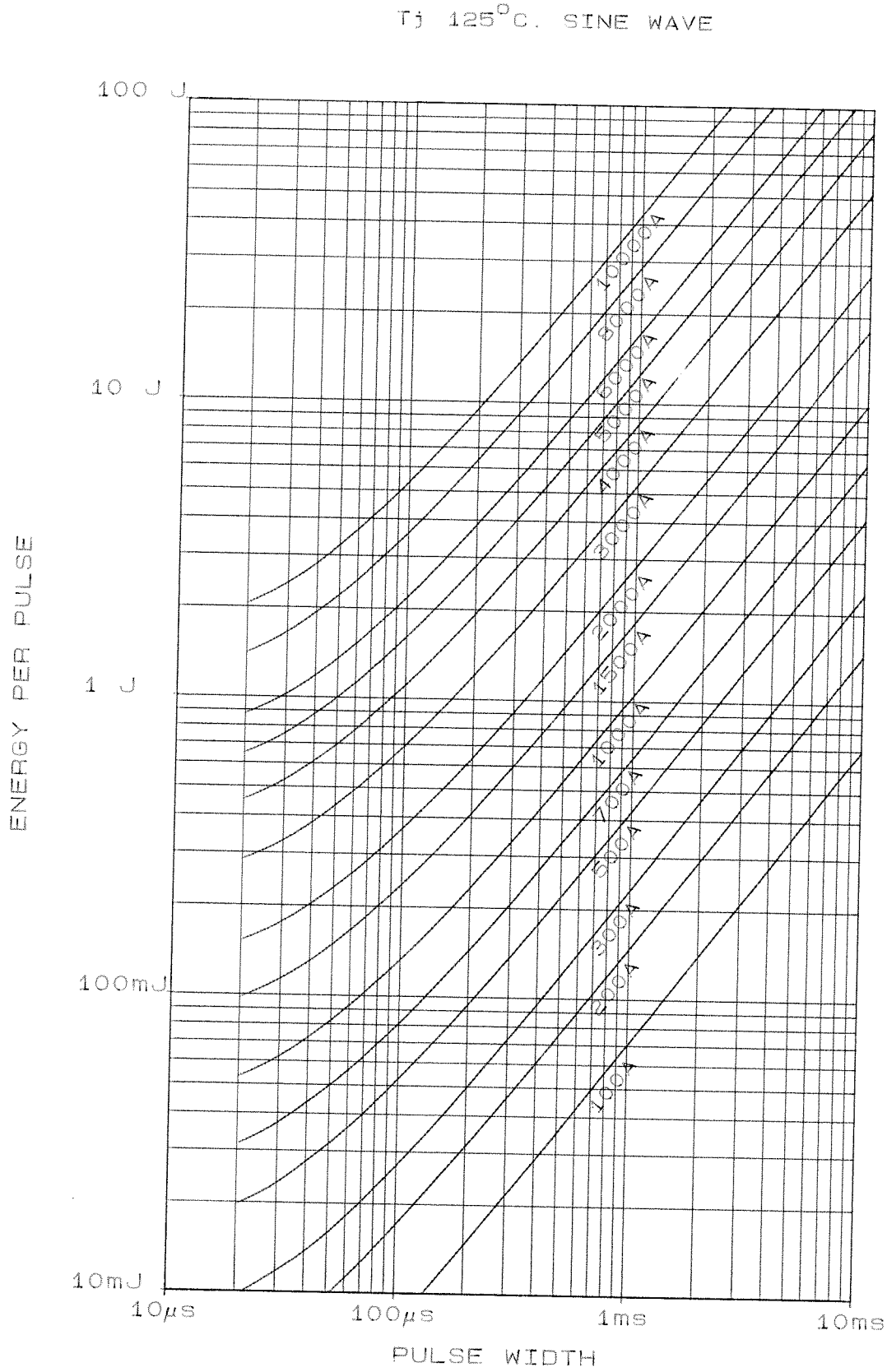


Tj 125°C. 100A/μs




T CASE 90degC SINE WAVE
100K
10K
1K
100
10
FREQUENCY (Hz)
100% DUTY CYCLE
500A
700A
1000A
1500A
2000A
3000A
4000A
5000A
6000A
8000A
10000A
10μs
100μs
1ms
10ms
PULSE WIDTH


T CASE 60degC SINE WAVE
100K
10K
1K
100
10
FREQUENCY (Hz)
100A
100% DUTY CYCLE
1000A
1500A
2000A
3000A
4000A
5000A
6000A
8000A
10000A
10μs
100μs
1ms
10ms
PULSE WIDTH


Tj 125°C. SINE WAVE
100 J
10 J
1 J
100mJ
10mJ
ENERGY PER PULSE
10000A
8000A
6000A
5000A
4000A
3000A
2000A
1500A
1000A
700A
500A
300A
200A
100A
10μs
100μs
1ms
10ms
PULSE WIDTH

SCALE	1/1
DRN	
CHKD	
APPD	
S	A
S	NI

INTERNATIONAL OUTLINE No.

WEIGHT. 250 GRAMS.

FINISH. BRIGHT NICKEL PLATE. 22

DEVICE MARKING INCLUDES MONOGRAM, TYPE No., SPEC. No. AND POLARITY SYMBOL.

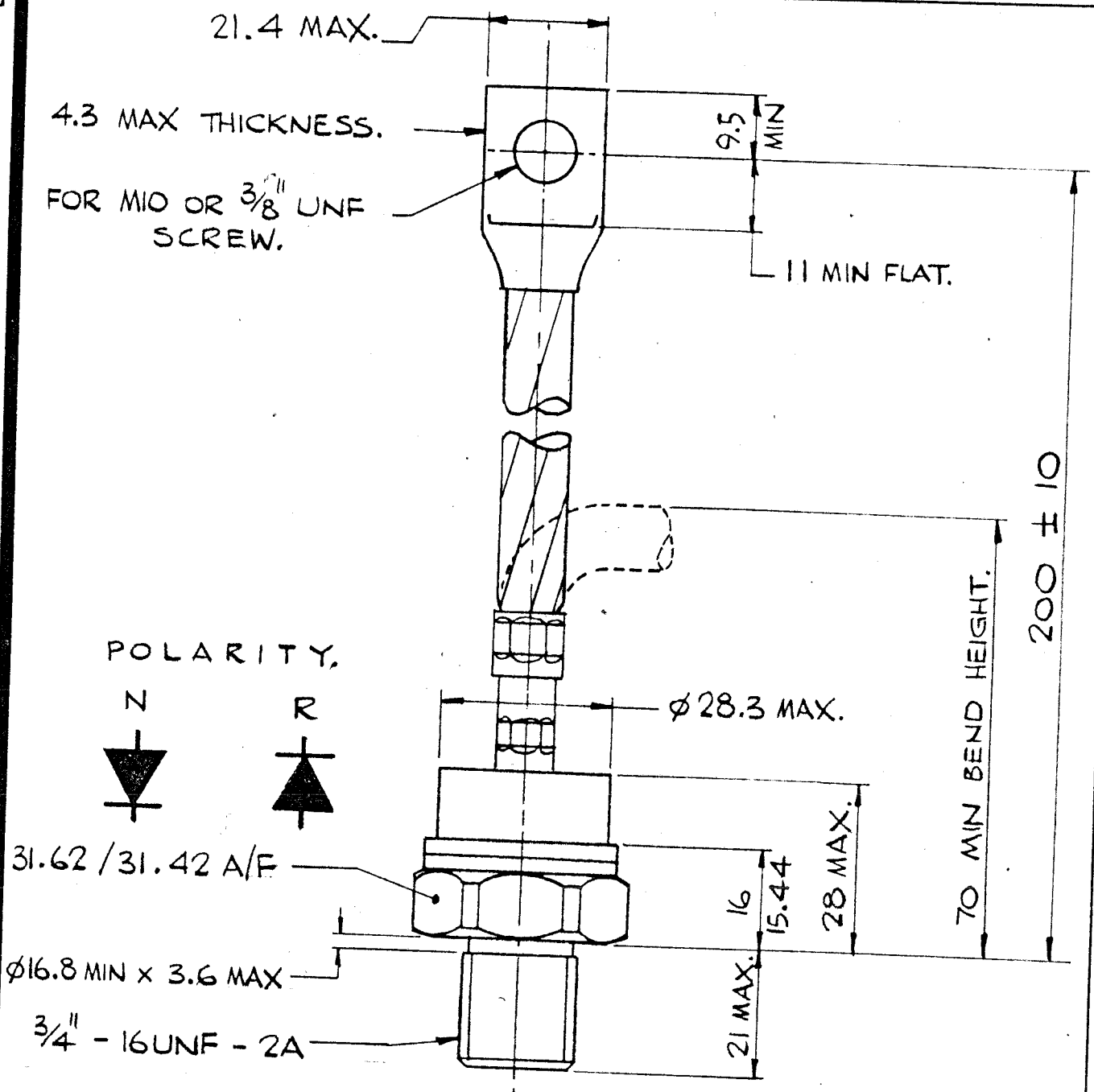
DEVICE MOUNTING:

MOUNTING TORQUE TO BE 27 - 24.5 Nm (2.77 - 2.5 kgf m). THREAD MUST NOT BE LUBRICATED.

DIODE TYPE NUMBER

PHN/R170, 300, 400

G.A. DRG. No. 102A216H05



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WESTCODE ® SEMICONDUCTORS

THIRD ANGLE PROJECTION

DIMNS. IN MILLIMETRES

DRG. No. 100A281

ISS	REVISIONS
1	11.9.78
4	12.12.79 M806 REDRAWN. DRG Nº WAS 100A257
5	27.11.84 M1218 FIN WAS ET