

## PHASE CONTROL THYRISTORS

### Stud Version

### Features

- High current and high surge ratings
- $dv/dt = 1000V/\mu s$  option
- Ceramic housing
- Threaded studs UNF 1/2 - 20UNF2A
- Types up to 1200V  $V_{RRM}/V_{DRM}$
- $di/dt = 300A/\mu s$

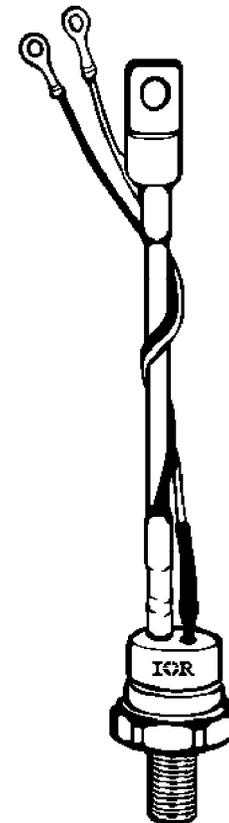
110A

### Typical Applications

- DC motor controls
- Controlled DC power supplies
- AC controllers

### Major Ratings and Characteristics

Parameters	111RKI	Units
$I_{T(AV)}$	110	A
@ $T_C$	90	°C
$I_{T(RMS)}$	172	A
$I_{TSM}$ @ 50Hz	2080	A
@ 60Hz	2180	A
$I^2t$ @ 50Hz	21.7	KA <sup>2</sup> s
@ 60Hz	19.8	KA <sup>2</sup> s
$V_{DRM}/V_{RRM}$	400 to 1200	V
$t_q$ typical	110	$\mu s$
$T_J$	- 40 to 140	°C



case style  
TO-209AC (TO-94)

**ELECTRICAL SPECIFICATIONS**

## Voltage Ratings

Type number	Voltage Code	$V_{DRM}/V_{RRM}$ , max. repetitive peak and off-state voltage V	$V_{RSM}$ , maximum non-repetitive peak voltage V	$I_{DRM}/I_{RRM}$ max. @ $T_J = T_J$ max. mA
111RKI	40	400	500	20
	80	800	900	
	120	1200	1300	

## On-state Conduction

Parameter	111RKI	Units	Conditions	
$I_{T(AV)}$ Max. average on-state current @ Case temperature	110	A	180° conduction, half sine wave	
	90	°C		
$I_{T(RMS)}$ Max. RMS on-state current	172	A	DC @ 83°C case temperature	
$I_{TSM}$ Max. peak, one-cycle non-repetitive surge current	2080		t = 10ms	No voltage reappplied
	2180		t = 8.3ms	reappplied
	1750		t = 10ms	100% $V_{RRM}$
	1830		t = 8.3ms	reappplied
$I^2t$ Maximum $I^2t$ for fusing	21.7	$KA^2s$	t = 10ms	No voltage reappplied
	19.8		t = 8.3ms	reappplied
	15.3		t = 10ms	100% $V_{RRM}$
	14.0		t = 8.3ms	reappplied
$I^2\sqrt{t}$ Maximum $I^2\sqrt{t}$ for fusing	217	$KA^2\sqrt{s}$	t = 0.1 to 10ms, no voltage reappplied	
$V_{T(TO)1}$ Low level value of threshold voltage	0.82	V	$(16.7\% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J = T_J$ max.	
$V_{T(TO)2}$ High level value of threshold voltage	1.02		$(I > \pi \times I_{T(AV)})$ , $T_J = T_J$ max.	
$r_{t1}$ Low level value of on-state slope resistance	2.16	mΩ	$(16.7\% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J = T_J$ max.	
$r_{t2}$ High level value of on-state slope resistance	1.70		$(I > \pi \times I_{T(AV)})$ , $T_J = T_J$ max.	
$V_{TM}$ Max. on-state voltage	1.57	V	$I_{pk} = 350A$ , $T_J = T_J$ max., $t_p = 10ms$ sine pulse	
$I_H$ Maximum holding current	150	mA	$T_J = 25^\circ C$ , anode supply 6V resistive load	
$I_L$ Typical latching current	400			

## Switching

Parameter	111RKI	Units	Conditions
$di/dt$ Max. non-repetitive rate of rise of turned-on current	300	A/ $\mu s$	Gate drive 20V, 20Ω, $t_r \leq 1\mu s$ $T_J = T_J$ max, anode voltage $\leq 80\% V_{DRM}$
$t_d$ Typical delay time	1	$\mu s$	Gate current 1A, $di_g/dt = 1A/\mu s$ $V_d = 0.67\% V_{DRM}$ , $T_J = 25^\circ C$
$t_q$ Typical turn-off time	110		$I_{TM} = 50A$ , $T_J = T_J$ max., $di/dt = -5A/\mu s$ , $V_R = 50V$ $dv/dt = 20V/\mu s$ , Gate 0V 25Ω

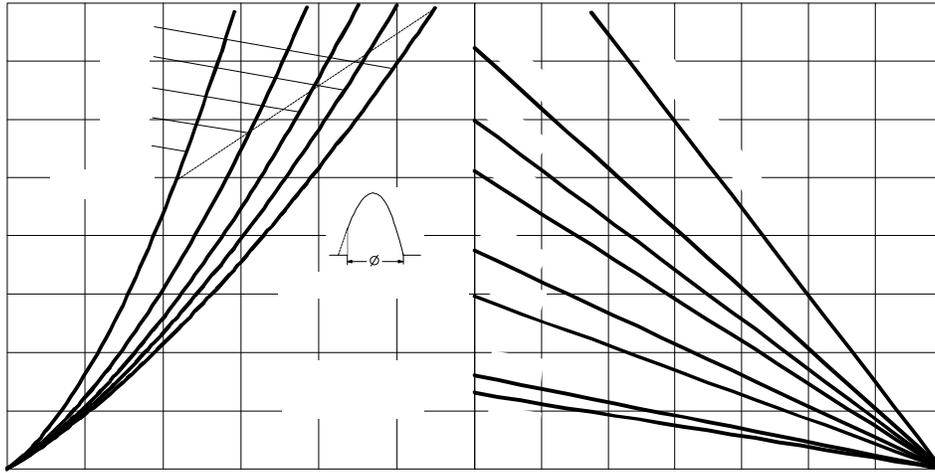


Fig. 3 - On-state Power Loss Characteristics

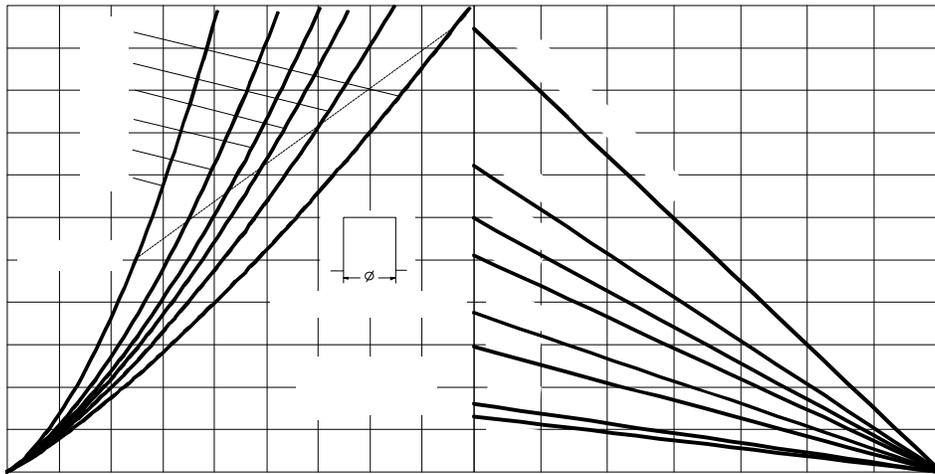


Fig. 4 - On-state Power Loss Characteristics

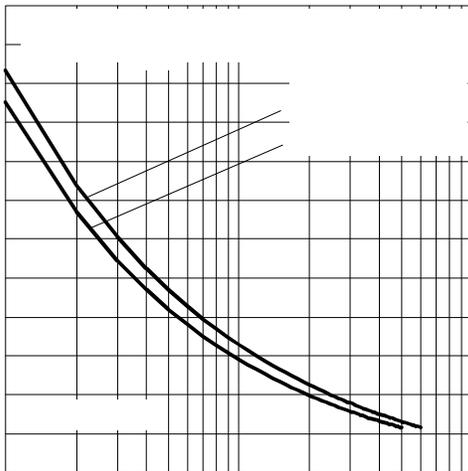


Fig. 5 - Maximum Non-Repetitive Surge Current

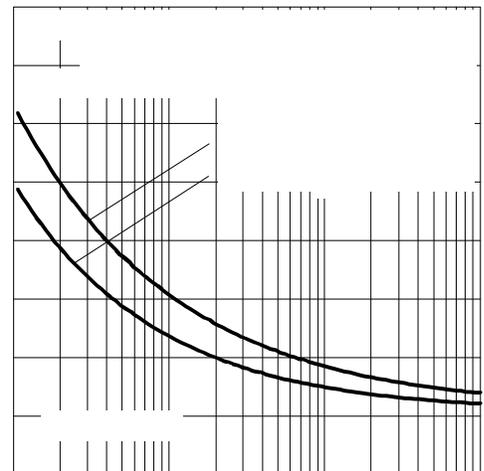


Fig. 6 - Maximum Non-Repetitive Surge Current

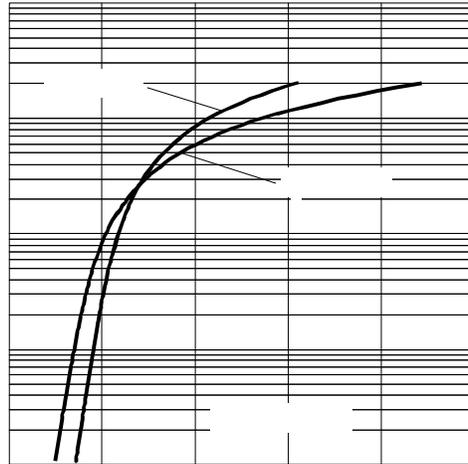


Fig. 7 - On-state Voltage Drop Characteristics

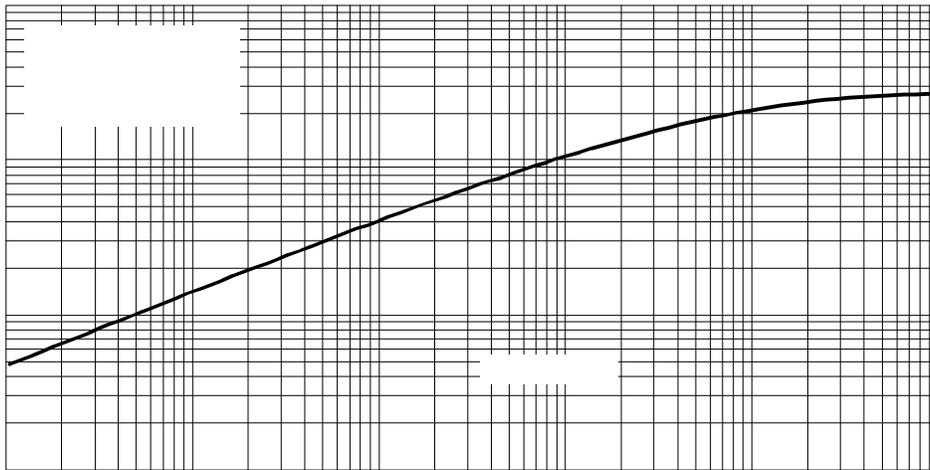
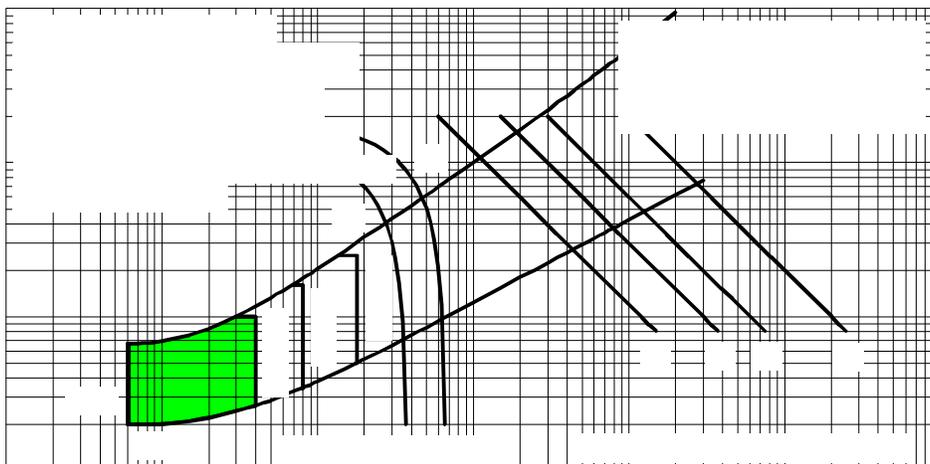
Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic

Fig. 9 - Gate Characteristics

## Blocking

Parameter	111RKI	Units	Conditions
$dv/dt$ Maximum critical rate of rise of off-state voltage	500	V/ $\mu$ s	$T_J = T_J$ max. linear to 80% rated $V_{DRM}$
$I_{RRM}$ $I_{DRM}$ Max. peak reverse and off-state leakage current	20	mA	$T_J = T_J$ max, rated $V_{DRM}/V_{RRM}$ applied

## Triggering

Parameter	111RKI	Units	Conditions
$P_{GM}$ Maximum peak gate power	12	W	$T_J = T_J$ max, $t_p \leq 5$ ms
$P_{G(AV)}$ Maximum average gate power	3.0		$T_J = T_J$ max, $f = 50$ Hz, $d\% = 50$
$I_{GM}$ Max. peak positive gate current	3.0	A	$T_J = T_J$ max, $t_p \leq 5$ ms
$+V_{GM}$ Maximum peak positive gate voltage	20	V	$T_J = T_J$ max, $t_p \leq 5$ ms
$-V_{GM}$ Maximum peak negative gate voltage	10		
$I_{GT}$ DC gate current required to trigger	TYP.	MAX.	$T_J = -40^\circ\text{C}$ $T_J = 25^\circ\text{C}$ $T_J = 140^\circ\text{C}$
	180	-	
	80	100	
$V_{GT}$ DC gate voltage required to trigger	2.5	-	$T_J = -40^\circ\text{C}$ $T_J = 25^\circ\text{C}$ $T_J = 140^\circ\text{C}$
	1.6	2	
	1	-	
$I_{GD}$ DC gate current not to trigger	6.0	mA	$T_J = T_J$ max Max. gate current/ voltage not to trigger is the max. value which will not trigger any unit with rated $V_{DRM}$ anode-to-cathode applied
$V_{GD}$ DC gate voltage not to trigger	0.25	V	

Max. required gate trigger/ current/ voltage are the lowest value which will trigger all units 12V anode-to-cathode applied

## Thermal and Mechanical Specification

Parameter	111RKI	Units	Conditions
$T_J$ Max. operating temperature range	-40 to 140	$^\circ\text{C}$	
$T_{stg}$ Max. storage temperature range	-40 to 150		
$R_{thJC}$ Max. thermal resistance, junction to case	0.27	K/W	DC operation
$R_{thCS}$ Max. thermal resistance, case to heatsink	0.1		Mounting surface, smooth, flat and greased
T Mounting torque, $\pm 10\%$	15.5	Nm (lbf-in)	Non lubricated threads
	(137)		Lubricated threads
	14 (120)		
wt Approximate weight	130	g	
Case style	TO - 209AC (TO-94)		See Outline Table

# 111RKI Series

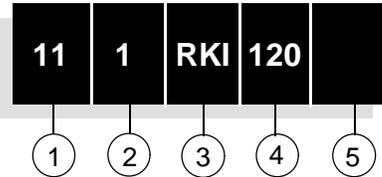
## $\Delta R_{thJC}$ Conduction

(The following table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC)

Conduction angle	Sinusoidal conduction	Rectangular conduction	Units	Conditions
180°	0.043	0.031	K/W	$T_J = T_{J \text{ max.}}$
120°	0.052	0.053		
90°	0.066	0.071		
60°	0.096	0.101		
30°	0.167	0.169		

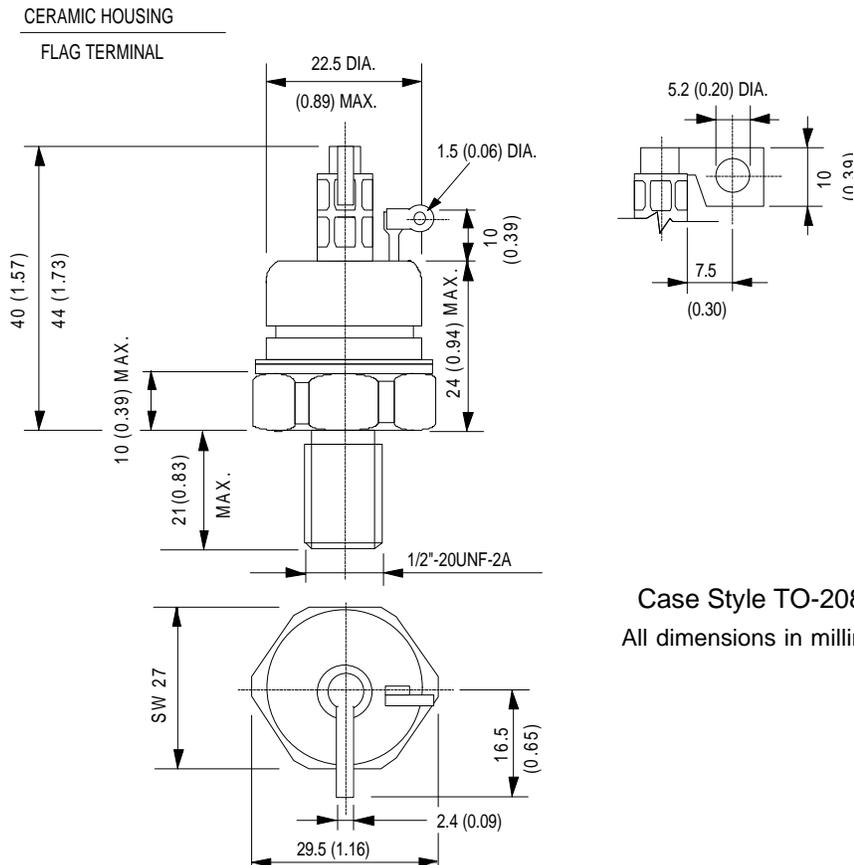
## Ordering Information Table

### Device Code



- 1** -  $I_{T(AV)}$  rated average output current (rounded/10)
- 2** - 0 = Eyelet terminals (Gate and Auxiliary Cathode Leads)  
1 = Fast - on terminals (Gate and Auxiliary Cathode Leads)  
2 = Flag terminals (For Cathode and Gate Terminals)
- 3** - Thyristor
- 4** - Voltage code: Code x 10 =  $V_{RRM}$  (See Voltage Rating Table)
- 5** - Critical dv/dt: None = 500V/ $\mu$ sec  
S90 = 1000V/ $\mu$ sec

## Outline Table



Case Style TO-208AD (TO-83)  
All dimensions in millimeters (inches)

Outline Table

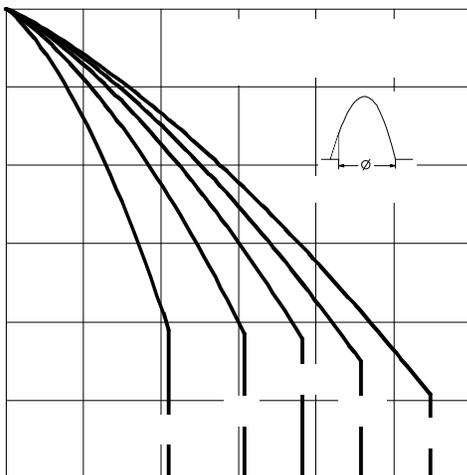
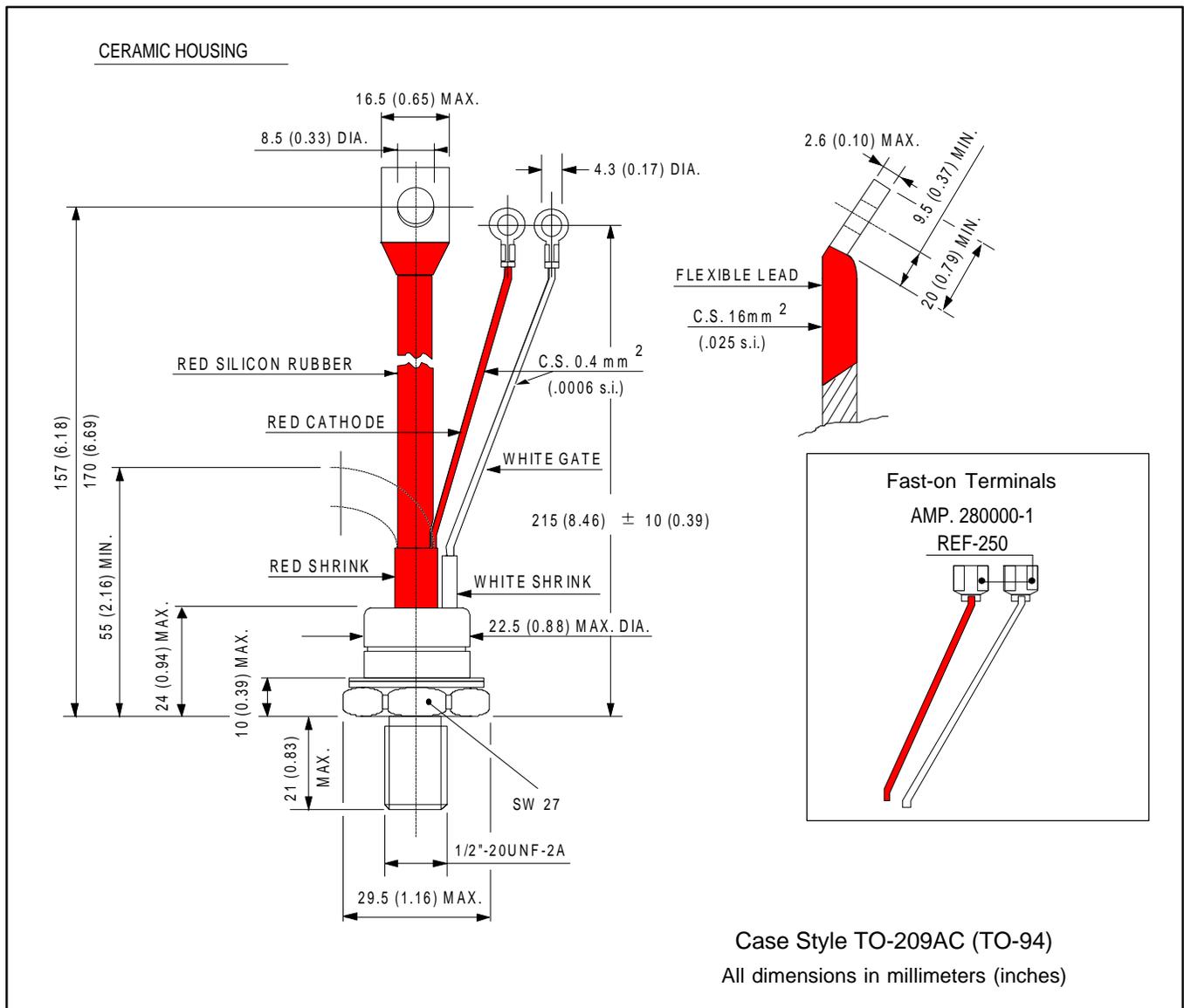


Fig. 1 - Current Ratings Characteristics

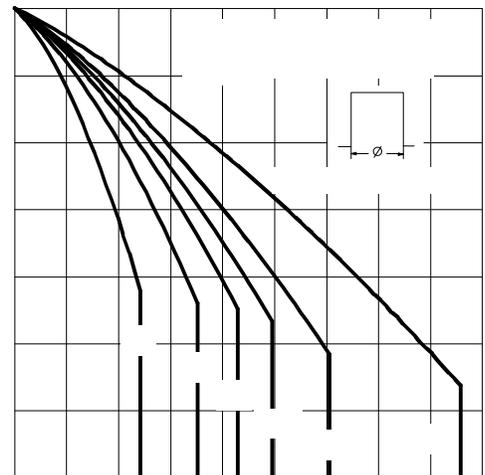


Fig. 2 - Current Ratings Characteristics