

# DISCRETE POWER DIODES and THYRISTORS

## DATA BOOK

Bulletin I25171/B

International
IOR Rectifier

# ST333S SERIES

**INVERTER GRADE THYRISTORS** **Stud Version**

330A

## Features

- All diffused design
- Center amplifying gate
- Guaranteed high dv/dt
- Guaranteed high di/dt
- High surge current capability
- Low thermal impedance
- High speed performance

## Typical Applications

- Inverters
- Choppers
- Induction heating
- All types of force-commutated converters

case style
TO-209AE (TO-118)

## Major Ratings and Characteristics

| Parameters | | ST333S | Units |
|---|---|---|---|
| $I_{T(AV)}$ | | 330 | A |
| | @ $T_C$ | 75 | °C |
| $I_{T(RMS)}$ | | 518 | A |
| $I_{TSM}$ | @ 50Hz | 11000 | A |
| | @ 60Hz | 11520 | A |
| $I^2t$ | @ 50Hz | 605 | $KA^2s$ |
| | @ 60Hz | 550 | $KA^2s$ |
| $V_{DRM}/V_{RRM}$ | | 400 to 800 | V |
| $t_q$ range | | 10 to 30 | µs |
| $T_J$ | | - 40 to 125 | °C |

## ELECTRICAL SPECIFICATIONS

### Voltage Ratings

| Type number | Voltage Code | $V_{DRM}/V_{RRM}$, maximum repetitive peak voltage V | $V_{RSM}$, maximum non-repetitive peak voltage V | $I_{DRM}/I_{RRM}$ max. @ $T_J = T_J$ max. mA |
|---|---|---|---|---|
| ST333S | 04 | 400 | 500 | 50 |
| | 08 | 800 | 900 | |

### Current Carrying Capability

| Frequency | 180°el $I_{TM}$ | | 180°el $I_{TM}$ | | 100µs $I_{TM}$ | | Units |
|---|---|---|---|---|---|---|---|
| 50Hz | 840 | 600 | 1280 | 1040 | 5430 | 4350 | A |
| 400Hz | 650 | 450 | 1280 | 910 | 2150 | 1560 | |
| 1000Hz | 430 | 230 | 1090 | 730 | 1080 | 720 | |
| 2500Hz | 140 | 60 | 490 | 250 | 400 | 190 | |
| Recovery voltage Vr | 50 | 50 | 50 | 50 | 50 | 50 | V |
| Voltage before turn-on Vd | $V_{DRM}$ | | $V_{DRM}$ | | $V_{DRM}$ | | |
| Rise of on-state current di/dt | 50 | 50 | - | - | - | - | A/µs |
| Case temperature | 50 | 75 | 50 | 75 | 50 | 75 | °C |
| Equivalent values for RC circuit | 10Ω / 0.47µF | | 10Ω / 0.47µF | | 10Ω / 0.47µF | | |

### On-state Conduction

| Parameter | | ST333S | Units | Conditions | | |
|---|---|---|---|---|---|---|
| $I_{T(AV)}$ | Max. average on-state current | 330 | A | 180° conduction, half sine wave | | |
| | @ Case temperature | 75 | °C | | | |
| $I_{T(RMS)}$ | Max. RMS on-state current | 518 | A | DC @ 63°C case temperature | | |
| $I_{TSM}$ | Max. peak, one half cycle, non-repetitive surge current | 11000 | A | t = 10ms | No voltage reapplied | Sinusoidal half wave, Initial $T_J = T_J$ max |
| | | 11520 | | t = 8.3ms | | |
| | | 9250 | | t = 10ms | 100% $V_{RRM}$ reapplied | |
| | | 9700 | | t = 8.3ms | | |
| $I^2t$ | Maximum $I^2t$ for fusing | 605 | $KA^2s$ | t = 10ms | No voltage reapplied | |
| | | 550 | | t = 8.3ms | | |
| | | 430 | | t = 10ms | 100% $V_{RRM}$ reapplied | |
| | | 390 | | t = 8.3ms | | |
| $I^2\sqrt{t}$ | Maximum $I^2\sqrt{t}$ for fusing | 6050 | $KA^2\sqrt{s}$ | t = 0.1 to 10ms, no voltage reapplied | | |

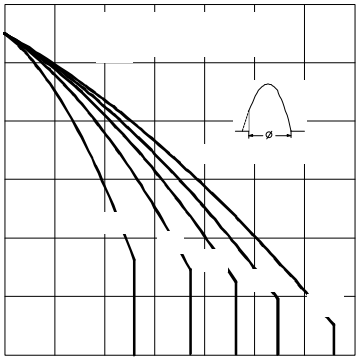


Fig. 1 - Current Ratings Characteristics

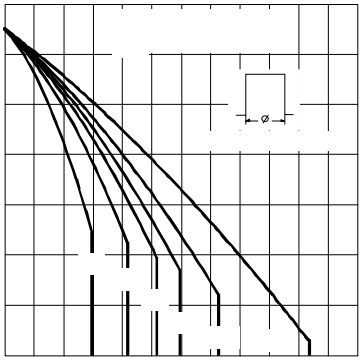


Fig. 2 - Current Ratings Characteristics

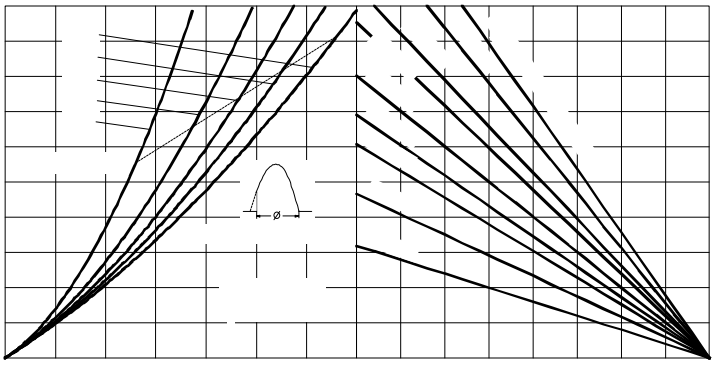


Fig. 3 - On-state Power Loss Characteristics



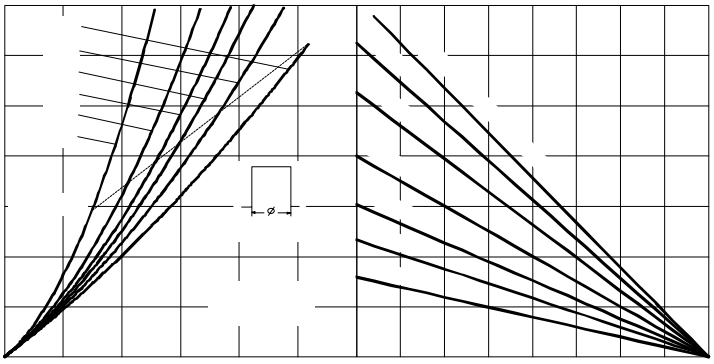


Fig. 4 - On-state Power Loss Characteristics

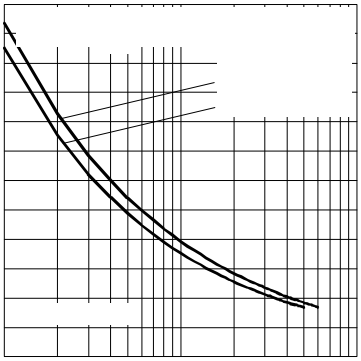


Fig. 5 - Maximum Non-repetitive Surge Current

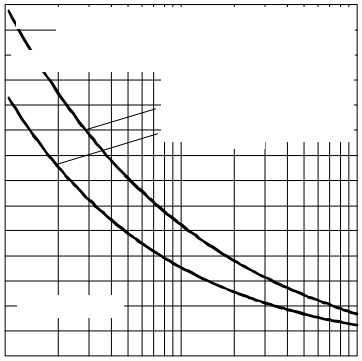


Fig. 6 - Maximum Non-repetitive Surge Current

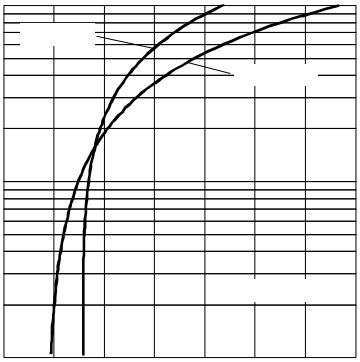


Fig. 7 - On-state Voltage Drop Characteristics

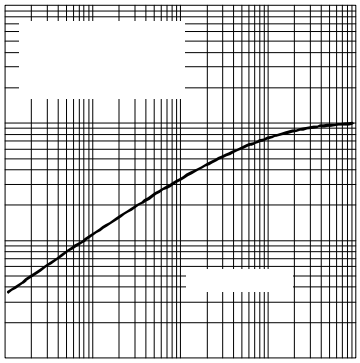


Fig. 8 - Thermal Impedance $Z_{thJC}$ Characteristic



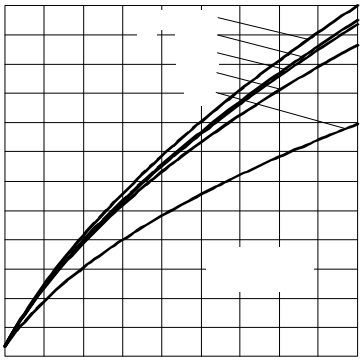


Fig. 9 - Reverse Recovered Charge Characteristics

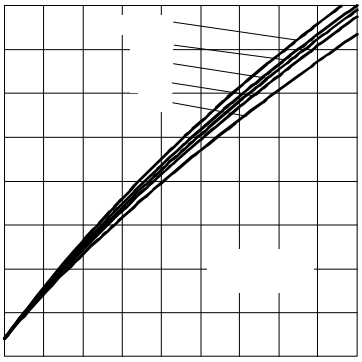


Fig. 10 - Reverse Recovery Current Characteristics

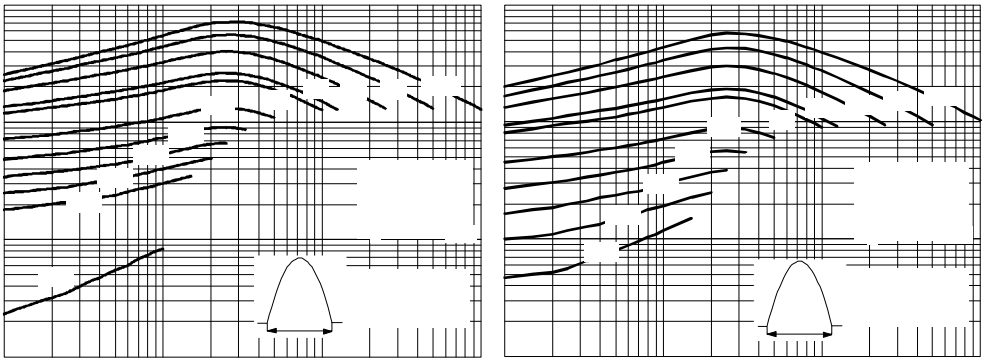


Fig. 11 - Frequency Characteristics

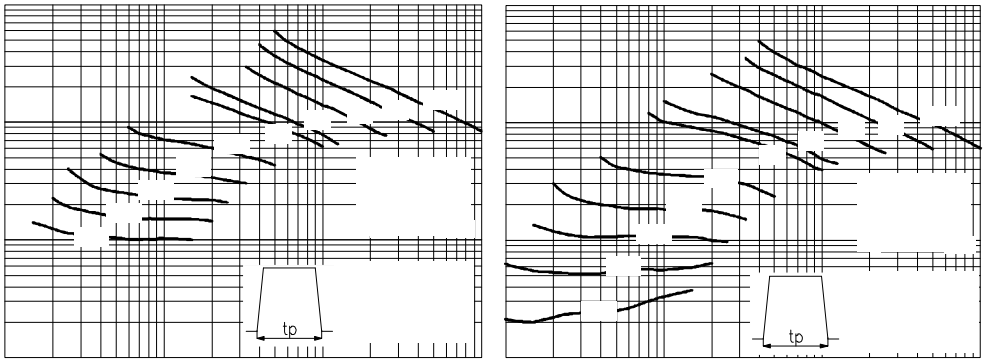





Fig. 12 - Frequency Characteristics

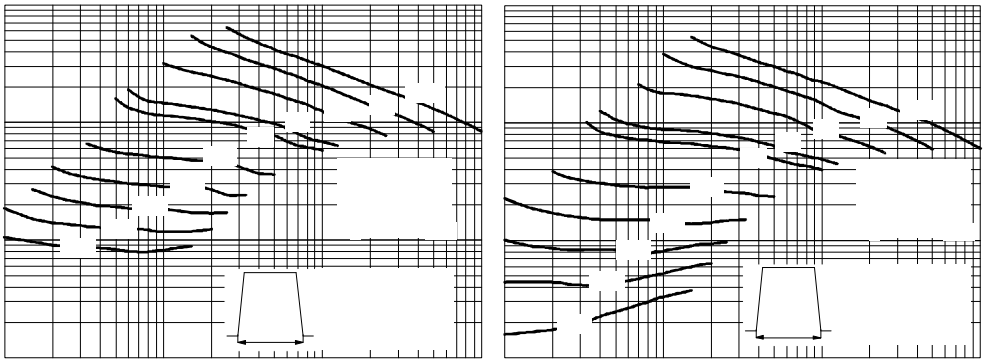


Fig. 13 - Frequency Characteristics

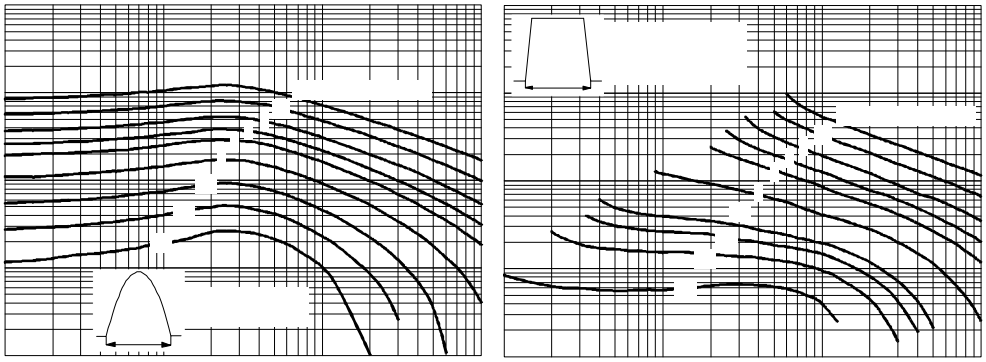


Fig. 14 - Maximum On-state Energy Power Loss Characteristics

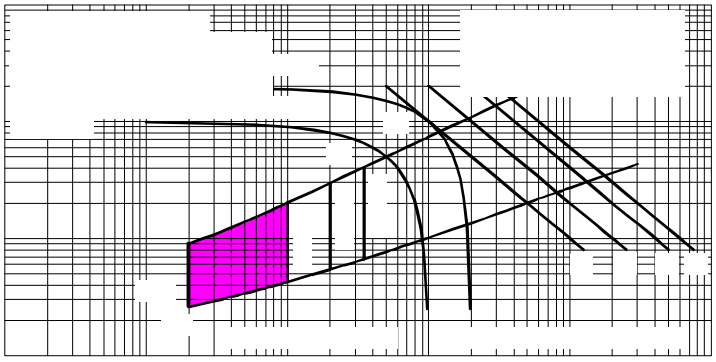




Fig. 15 - Gate Characteristics

## On-state Conduction

| Parameter | | ST333S | Units | Conditions |
|---|---|---|---|---|
| $V_{TM}$ | Max. peak on-state voltage | 1.51 | V | $I_{TM}$= 1040A, $T_J = T_J$ max, $t_p$ = 10ms sine wave pulse |
| $V_{T(TO)1}$ | Low level value of threshold voltage | 0.91 | | (16.7% x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ max. |
| $V_{T(TO)2}$ | High level value of threshold voltage | 0.92 | | (I > π x $I_{T(AV)}$), $T_J = T_J$ max. |
| $r_{t1}$ | Low level value of forward slope resistance | 0.58 | mΩ | (16.7% x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ max. |
| $r_{t2}$ | High level value of forward slope resistance | 0.58 | | (I > π x $I_{T(AV)}$), $T_J = T_J$ max. |
| $I_H$ | Maximum holding current | 600 | mA | $T_J$ = 25°C, $I_T$ > 30A |
| $I_L$ | Typical latching current | 1000 | | $T_J$ = 25°C, $V_A$= 12V, Ra = 6Ω, $I_G$= 1A |

## Switching

| Parameter | | ST333S | | Units | Conditions |
|---|---|---|---|---|---|
| di/dt | Max. non-repetitive rate of rise of turned-on current | 1000 | | A/µs | $T_J = T_J$ max, $V_{DRM}$ = rated $V_{DRM}$<br>$I_{TM}$ = 2 x di/dt |
| $t_d$ | Typical delay time | 1.0 | | µs | $T_J$= 25°C, $V_{DM}$ = rated $V_{DRM}$, $I_{TM}$ = 50A DC, $t_p$= 1µs<br>Resistive load, Gate pulse: 10V, 5Ω source |
| | | Min | Max | | |
| $t_q$ | Max. turn-off time | 10 | 30 | | $T_J = T_J$ max, $I_{TM}$ = 550A, commutating di/dt = 40A/µs<br>$V_R$ = 50V, $t_p$ = 500µs, dv/dt: see table in device code |

## Blocking

| Parameter | | ST333S | Units | Conditions |
|---|---|---|---|---|
| dv/dt | Maximum critical rate of rise of off-state voltage | 500 | V/µs | $T_J = T_J$ max. linear to 80% $V_{DRM}$, higher value available on request |
| $I_{RRM}$<br>$I_{DRM}$ | Max. peak reverse and off-state leakage current | 50 | mA | $T_J = T_J$ max, rated $V_{DRM}/V_{RRM}$ applied |



## Triggering

| Parameter | | ST333S | Units | Conditions |
|---|---|---|---|---|
| $P_{GM}$ | Maximum peak gate power | 60 | W | $T_J = T_J$ max, f = 50Hz, d% = 50 |
| $P_{G(AV)}$ | Maximum average gate power | 10 | | |
| $I_{GM}$ | Max. peak positive gate current | 10 | A | $T_J = T_J$ max, $t_p \leq$ 5ms |
| $+V_{GM}$ | Maximum peak positive gate voltage | 20 | V | $T_J = T_J$ max, $t_p \leq$ 5ms |
| $-V_{GM}$ | Maximum peak negative gate voltage | 5 | | |
| $I_{GT}$ | Max. DC gate current required to trigger | 200 | mA | $T_J$ = 25°C, $V_A$ = 12V, Ra = 6Ω |
| $V_{GT}$ | Max. DC gate voltage required to trigger | 3 | V | |
| $I_{GD}$ | Max. DC gate current not to trigger | 20 | mA | $T_J = T_J$ max, rated $V_{DRM}$ applied |
| $V_{GD}$ | Max. DC gate voltage not to trigger | 0.25 | V | |

## ST333S Series

### Thermal and Mechanical Specifications

| | Parameter | ST333S | Units | Conditions |
|---|---|---|---|---|
| $T_J$ | Max. junction operating temperature range | -40 to 125 | °C | |
| $T_{stg}$ | Max. storage temperature range | -40 to 150 | | |
| $R_{thJC}$ | Max. thermal resistance, junction to case | 0.10 | K/W | DC operation |
| $R_{thCS}$ | Max. thermal resistance, case to heatsink | 0.03 | | Mounting surface, smooth, flat and greased |
| T | Mounting torque, ± 10% | 48.5 (425) | Nm (lbf-in) | Non lubricated threads |
| wt | Approximate weight | 535 | g | |
| | Case style | TO-209AE (TO-118) | | See Outline Table |

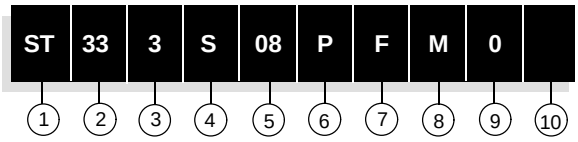
### $\Delta R_{thJC}$ Conduction

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

| Conduction angle | Sinusoidal conduction | Rectangular conduction | Units | Conditions |
|---|---|---|---|---|
| 180° | 0.011 | 0.008 | K/W | $T_J = T_J$ max. |
| 120° | 0.013 | 0.014 | | |
| 90° | 0.017 | 0.018 | | |
| 60° | 0.025 | 0.026 | | |
| 30° | 0.041 | 0.042 | | |

### Ordering Information Table

**Device Code**






**1** - Thyristor
**2** - Essential part number
**3** - 3 = Fast turn off
**4** - S = Compression bonding Stud
**5** - Voltage code: Code x 100 = $V_{RRM}$ (See Voltage Ratings table)
**6** - P = Stud base 3/4" 16UNF-2A
M = Stud base metric threads M24 x 1.5
**7** - Reapplied dv/dt code (for $t_q$ test condition)
**8** - $t_q$ code
**9** - 0 = Eyelet terminals (Gate and Aux. Cathode Leads)
1 = Fast-on terminals (Gate and Aux. Cathode Leads)
3 = Threaded top terminal 3/8" 24UNF-2A
**10** - Critical dv/dt:
None = 500V/µsec (Standard value)
L = 1000V/µsec (Special selection)

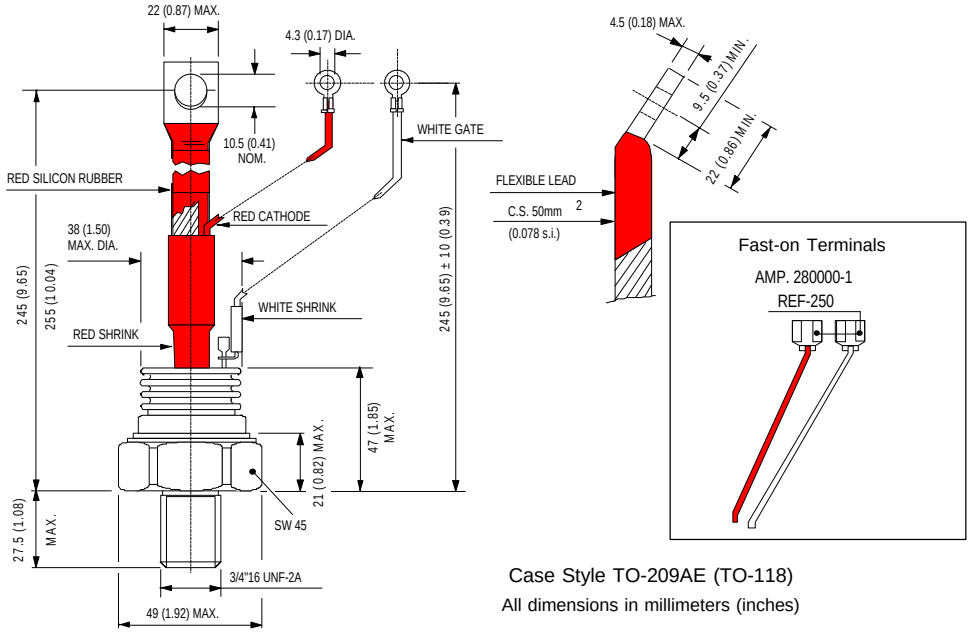
**dv/dt - $t_q$ combinations available**

| $t_q$(µs) \ dv/dt (V/µs) | 20 | 50 | 100 | **200** | 400 |
|---|---|---|---|---|---|
| 10 | CN | DN | EN | -- | -- |
| 12 | CM | DM | EM | **FM *** | -- |
| 15 | CL | DL | EL | **FL *** | HL |
| 18 | CP | DP | EP | FP | HP |
| 20 | CK | DK | EK | FK | HK |
| 25 | -- | -- | -- | FJ | HJ |
| 30 | -- | -- | -- | -- | HH |

***Standard part number.**
All other types available only on request.

## Outline Table

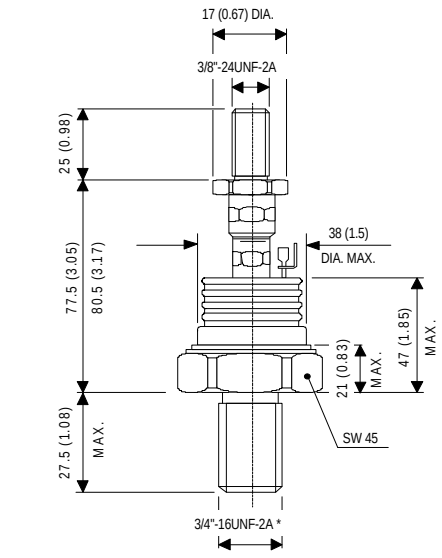
CERAMIC HOUSING




Case Style TO-209AE (TO-118)
All dimensions in millimeters (inches)

* FOR METRIC DEVICE: M24 X 1.5 - LENGHT SCREW 21 (0.83) MAX.

CERAMIC HOUSING




Case Style TO-209AE (TO-118)
with top thread terminal 3/8"
All dimensions in millimeters (inches)

* FOR METRIC DEVICE: M24 x 1.5 - LENGHT SCREW 21 (0.83) MAX.