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TEL:805-498-2111 FAX:805-498-3804 WEB:http://www.semtech.com

## DESCRIPTION

The SC431 is a three terminal adjustable shunt regulator with thermal stability guaranteed over temperature. The output voltage can be adjusted to any value from 2.5V ($V_{REF}$) to 36V with two external resistors. The SC431 has a typical dynamic output impedance of 0.25Ω. Active output circuitry provides a very sharp turn on characteristic, making the SC431 an excellent replacement for zener diodes.

The SC431 shunt regulator is available in three voltage tolerances (0.5%, 1.0% and 2.0%) and three package options (SOT-23-3, SO-8 and TO-92). The three voltage tolerances allow the designer the opportunity to select the proper cost/tolerance for their application.

## FEATURES

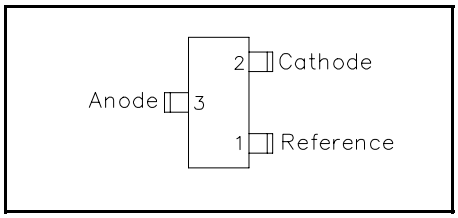
- Wide operating current range 100µA to 150mA
- Low dynamic output impedance 0.25 Ω typ.
- Trimmed bandgap design ± 0.5%
- Alternate for TL431, LM431 & AS431

## APPLICATIONS

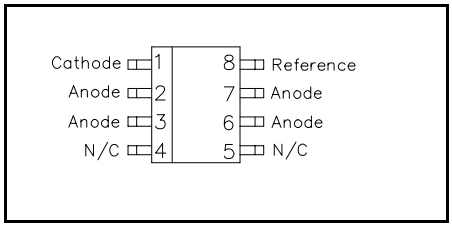
- Linear Regulators
- Adjustable Supplies
- Switching Power Supplies
- Battery Operated Computers
- Instrumentation
- Computer Disk Drives

## PIN CONFIGURATIONS

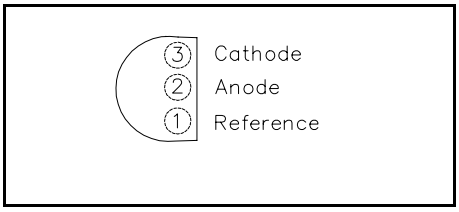
**SOT-23 -3 Lead (Top View)**



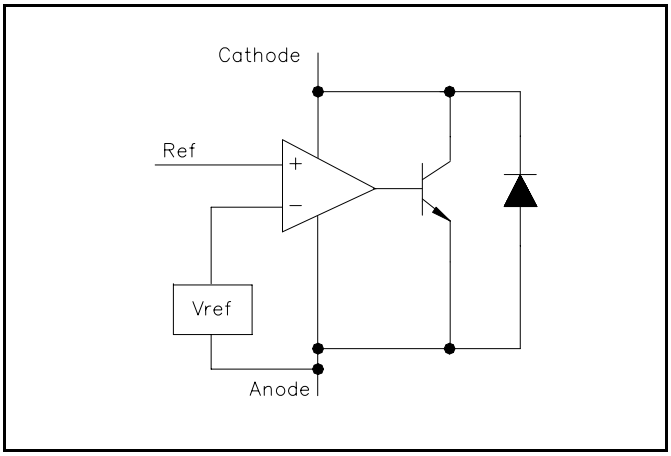

**SOIC 8 Lead (Top View)**



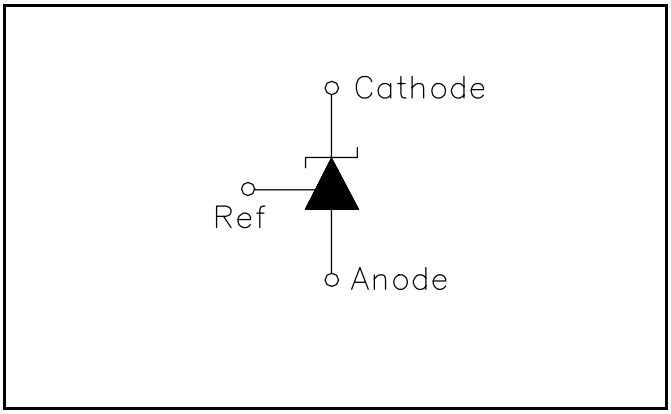

**TO-92 (Top View)**




## BLOCK DIAGRAM




## SYMBOL DIAGRAM





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## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Maximum | Units |
|---|---|---|---|
| Cathode Voltage | $V_Z$ | 37 | V |
| Continous Cathode Current | $I_Z$ | 150 | mA |
| Reference Input Current | $I_{REF}$ | 10 | mA |
| Operating Junction Temperature Range | $T_J$ | -40 to +150 | °C |
| Storage Temperature Range | $T_{STG}$ | -65 to +150 | °C |
| Thermal Resistance<br>TO-92<br>SO-8<br>SOT-23 | $\theta_{JA}$ | <br>160<br>175<br>410 | °C/W |
| Power Dissipation at $T_A$ = 25°C<br>TO-92<br>SO-8<br>SOT-23 | $P_D$ | <br>0.78<br>0.71<br>0.30 | W |
| Lead Temperature (Soldering) 10 seconds | $T_{LEAD}$ | 260 | °C |

## ORDERING INFORMATION

| PACKAGE | TOLERANCE | | | |
|---|---|---|---|---|
| | **0.5%** | **1.0%** | **2.0%** | **T/R Quantity** |
| SO-8 (1) | SC431CS - .5 | SC431CS - 1 | SC431CS - 2 | 2.5K |
| SOT-23 (1) | SC431CSK - .5 | SC431CSK - 1 | SC431CSK - 2 | 3K |
| TO-92 (1)(2) | SC431CZ - .5 | SC431CZ - 1 | SC431CZ - 2 | TR=3K, TA=2K |

Notes:
(1) Add suffix 'TR' for Tape & Reel.
(2) Add suffix 'TA' for Tape Ammo.




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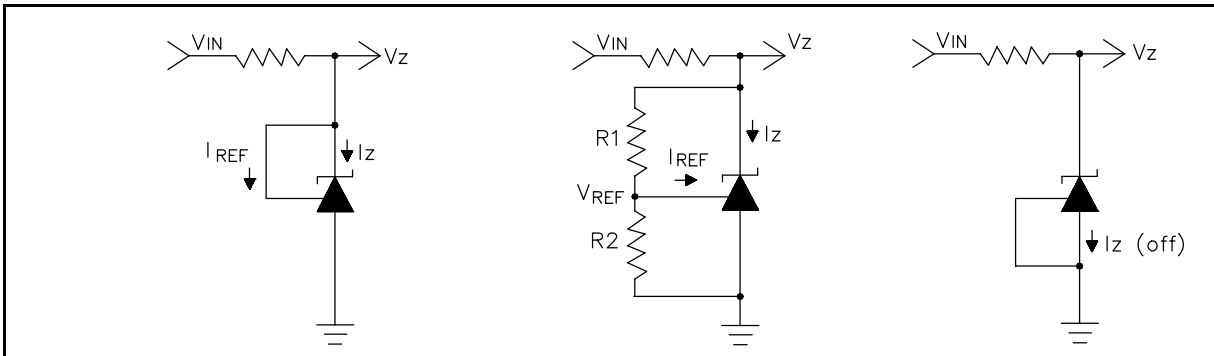
## ELECTRICAL CHARACTERISTICS

Unless specified, $T_A$ = 25°C

| | | | SC431 0.5% | | | SC431 1% | | | SC431 2% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Condition** | **MIN** | **TYP** | **MAX** | **MIN** | **TYP** | **MAX** | **MIN** | **TYP** | **MAX** | **UNITS** |
| Reference Voltage | $V_{REF}$ | $V_Z = V_{REF}$, $I_Z$ = 10mA, $T_A$ = 25°C (test circuit 1) | 2.482 | 2.495 | 2.507 | 2.470 | 2.495 | 2.520 | 2.445 | 2.495 | 2.545 | V |
| $V_{REF}$ Temp Deviation | $V_{DEV}$ | $T_A$ = -40 to +85°C, $V_Z = V_{REF}$, $I_Z$ = 10mA (test circuit 1) | | 8 | 17 | | 8 | 25 | | 15 | 30 | mV |
| Ratio of Change in $V_{REF}$ to Change in Cathode Voltage | $\frac{\Delta V_{REF}}{\Delta V_Z}$ | $I_Z$ = 10mA, $\Delta V_Z$ = 10V to $V_{REF}$ | | -0.5 | -2.7 | | -0.5 | -2.7 | | -0.5 | -2.7 | mV/V |
| | | $I_Z$ = 10mA, $\Delta V_Z$ = 36V to 10V | | -1.0 | -2.0 | | -1.0 | -2.0 | | -1.0 | -2.0 | |
| Reference Input Current | $I_{REF}$ | R1 = 10kΩ, R2 = ∞, $I_Z$ = 10mA (test circuit 2) | | 0.5 | 4 | | 0.5 | 4 | | 0.5 | 4 | µA |
| $I_{REF}$ Temp Deviation | $I_{REF(DEV)}$ | $T_A$ = -40 to +85°C, R1 = 10kΩ, R2 = ∞, $I_Z$ =10mA (test circuit 2) | | 0.4 | 1.2 | | 0.4 | 1.2 | | 0.4 | 1.2 | µA |
| Off State Cathode Current | $I_{Z\ (off)}$ | $V_{REF}$ = 0V, $V_Z$ = 36V (test circuit 3) | | 0.04 | 0.5 | | 0.04 | 0.5 | | 0.04 | 0.5 | µA |
| Dynamic Output Impedance | $r_Z$ | f < 1kHz, $V_Z = V_{REF}$, $I_Z$ = 100uA to 100mA (test circuit 1) | | 0.25 | 0.5 | | 0.25 | 0.5 | | 0.25 | 0.5 | Ω |
| Minimum Operating Current | $I_{Z\ (min)}$ | $V_Z = V_{REF}$ (test circuit 1) | | | 100 | | | 100 | | | 100 | µA |

## TEST CIRCUITS




**Test Circuit 1: $V_Z = V_{REF}$**

**Test Circuit 2: $V_Z > V_{REF}$**

**Test Circuit 3: Off State Current**

## RECOMMENDED OPERATING CONDITIONS

| | Min | Max | Symbol |
|---|---|---|---|
| Cathode Voltage, $V_Z$ | $V_{REF}$ | 36 | V |
| Cathode Current, $I_Z$ | 0.1 | 150 | mA |

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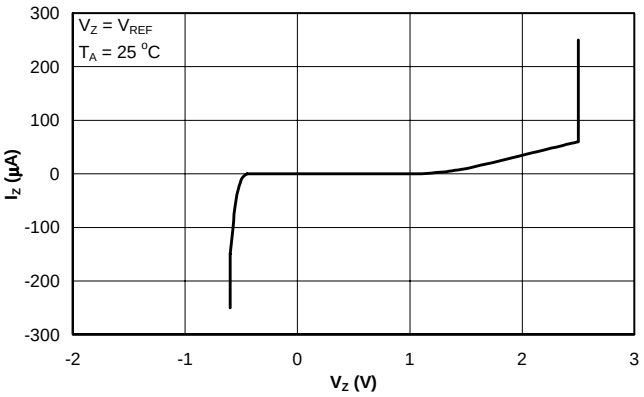
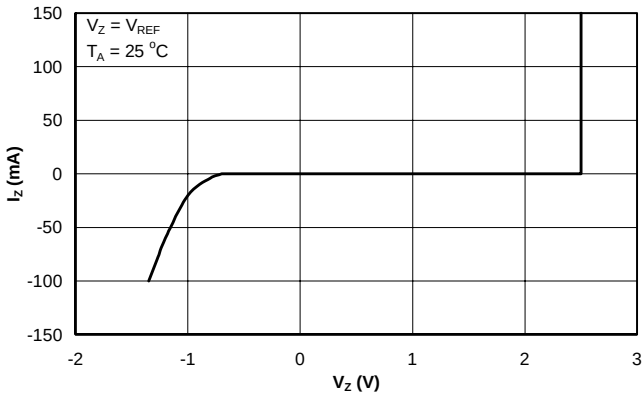
## TYPICAL CHARACTERISTICS

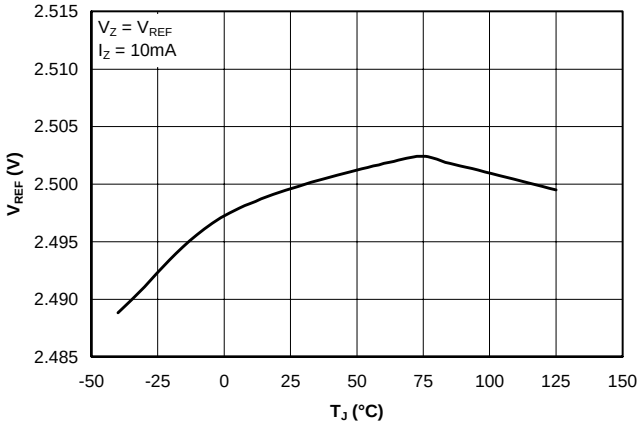
### Cathode Current vs. Cathode Voltage



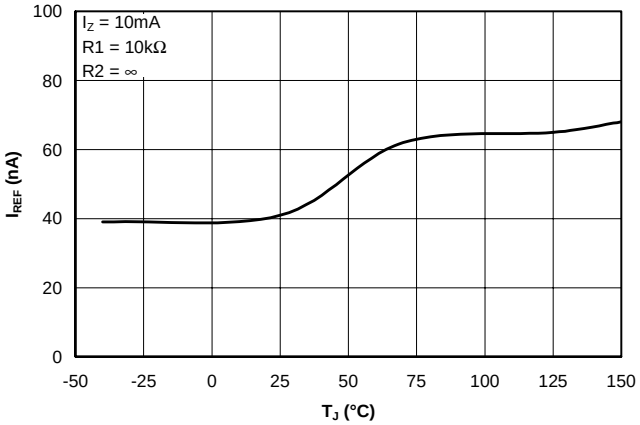

### Cathode Current vs. Cathode Voltage



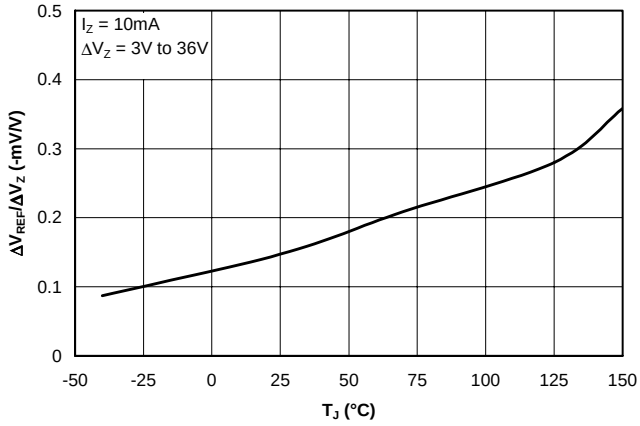

### Reference Voltage vs. Junction Temperature



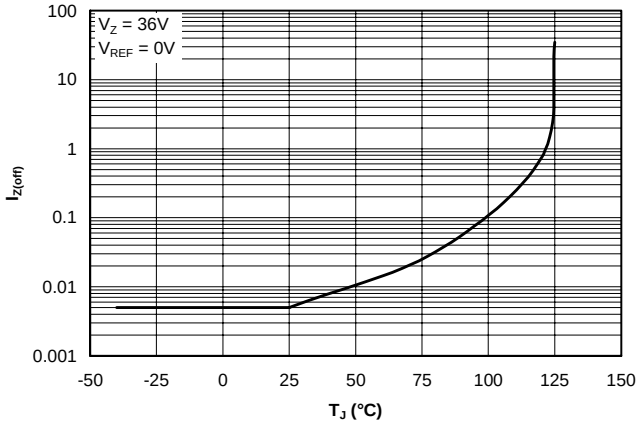

### Reference Input Current vs. Junction Temperature




### Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Junction Temperature




### Off-State Cathode Current vs. Junction Temperature



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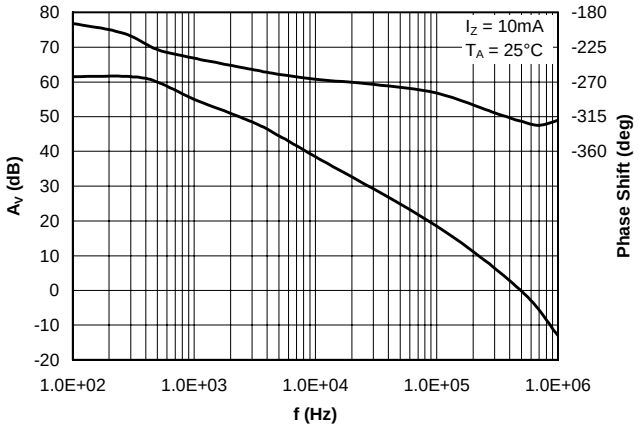
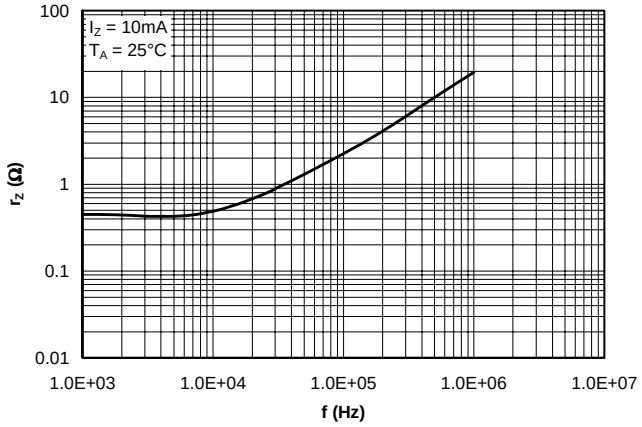
## TYPICAL CHARACTERISTICS (Cont.)

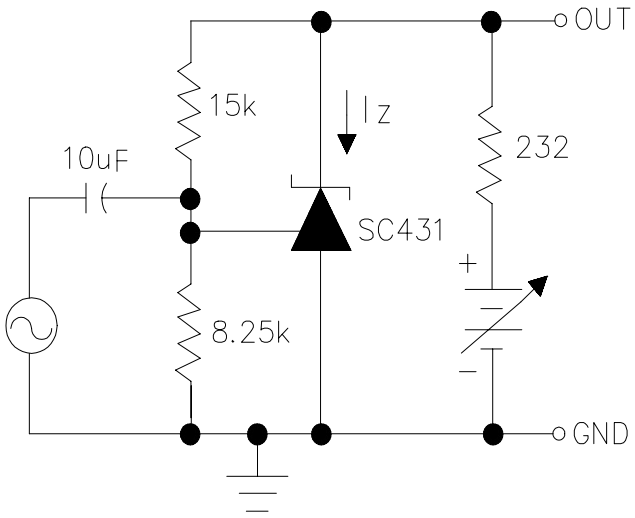
**Small-Signal Gain and Phase Shift vs. Frequency**



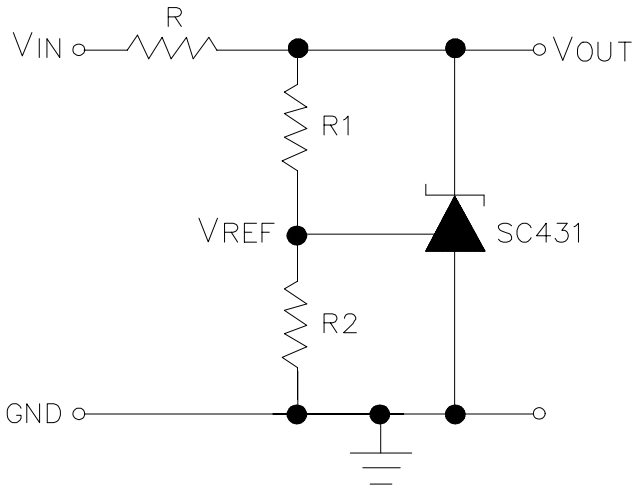

**Reference Impedance vs. Frequency**




**Test Circuit For Small-Signal Gain and Phase Shift**




## APPLICATION CIRCUIT




**Notes for Application Circuit:**

1) Set $V_{OUT}$ according to the following equation:

$$V_{OUT} = V_{REF}\left(1+\frac{R1}{R2}\right)+I_{REF}\ R1$$

2) Choose the value for R as follows:

- The maximum limit for R should be such that the cathode current, $I_Z$, is greater than the minimum operating current (100µA) at $V_{IN(min)}$.
- The minimum limit for R should be such that $I_Z$ does not exceed 150mA under all load conditions, and the instantaneous turn-on value for $I_Z$ does not exceed 200mA. Both of the following conditions must be met:

$$R_{min} \geq \frac{V_{IN(max)}}{200\,mA}$$ (to limit instantaneous turn-on $I_Z$)

$$R_{min} \geq \frac{V_{IN(max)} - V_{OUT}}{I_{OUT(min)} + 150\,mA}$$ (to limit $I_Z$ under normal operating conditions)

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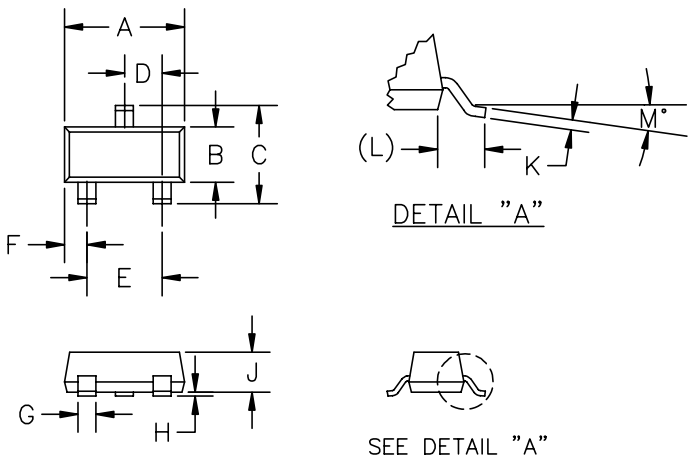
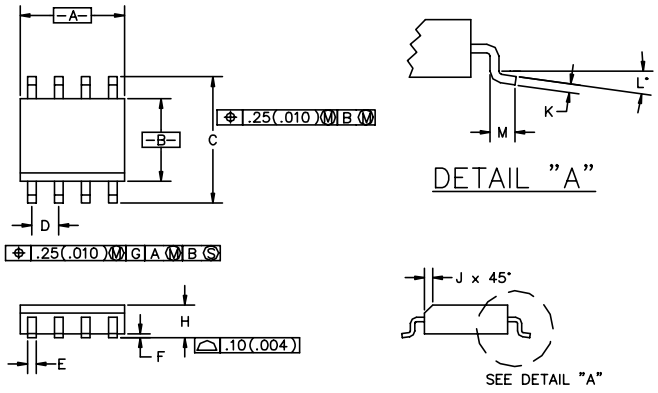
## OUTLINE DRAWING SOT-23



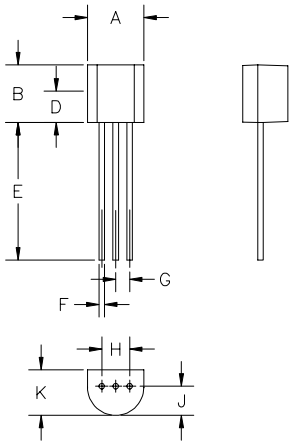

| DIMENSIONS [1] | | | | | |
|---|---|---|---|---|---|
| DIM | INCHES | | MM | | NOTE |
| | MIN | MAX | MIN | MAX | |
| A | .110 | .120 | 2.80 | 3.04 | — |
| B | .047 | .055 | 1.20 | 1.40 | — |
| C | .083 | .104 | 2.10 | 2.64 | — |
| D | .035 | .040 | 0.89 | 1.03 | — |
| E | .070 | .080 | 1.78 | 2.05 | — |
| F | .018 | .024 | .45 | .60 | — |
| G | .015 | .020 | .37 | .51 | — |
| H | .0005 | .004 | .013 | 0.10 | — |
| J | .034 | .040 | .877 | 1.02 | — |
| K | .003 | .007 | .085 | .180 | — |
| L | — | .027 | — | 0.69 | REF |
| M | 0 | 8° | 0 | 8° | — |

## OUTLINE DRAWING SO-8




| DIMENSIONS | | | | | |
|---|---|---|---|---|---|
| DIM | INCHES | | MM | | NOTE |
| | MIN | MAX | MIN | MAX | |
| A | .188 | .197 | 4.80 | 5.00 | |
| B | .149 | .158 | 3.80 | 4.00 | |
| C | .228 | .244 | 5.80 | 6.20 | |
| D | .050 BSC | | 1.27 BSC | | |
| E | .013 | .020 | 0.33 | 0.51 | |
| F | .004 | .010 | 0.10 | 0.25 | |
| H | .053 | .069 | 1.35 | 1.75 | |
| J | .011 | .019 | 0.28 | 0.48 | |
| K | .007 | .010 | .19 | .25 | |
| L | 0° | 8° | 0° | 8° | |
| M | .016 | .050 | 0.40 | 1.27 | |

## OUTLINE DRAWING TO-92




| DIMENSIONS | | | | | |
|---|---|---|---|---|---|
| DIM | INCHES | | MM | | NOTE |
| | MIN | MAX | MIN | MAX | |
| A | .175 | .205 | 4.445 | 5.207 | — |
| B | .170 | .210 | 4.318 | 5.334 | — |
| E | .500 | .610 | 12.7 | 15.5 | — |
| F | .016 | .021 | .407 | .533 | — |
| G | .045 | .055 | 1.143 | 1.397 | — |
| H | .095 | .105 | 2.413 | 2.667 | — |
| J | .080 | .105 | 2.032 | 2.667 | — |
| K | .125 | .165 | 3.175 | 4.191 | — |