



SP432

Low Voltage Adjustable Precision Shunt Regulators

DESCRIPTION

The SP432 is low-voltage three-terminal adjustable voltage references, with specified thermal stability over applicable industrial and commercial temperature ranges. Output voltage can be set to any value between V_{REF} (1.24V) and 20V with two external resistors. These devices have a typical output impedance of 0.25Ω . Active output circuitry provides a very sharp turn-on characteristic, making the SP432 excellent replacements for low-voltage Zener diodes in many applications, including onboard regulation and adjustable power supplies.

APPLICATIONS

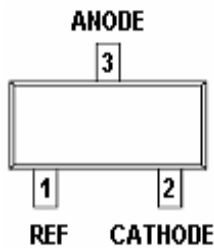
- Battery Power Equipment
- Linear Regulators
- Switch Power Supply
- Cellular Phone
- Digital Cameras
- Computer Disk Drivers
- Instrumentation

FEATURES

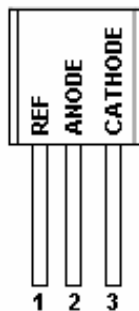
- ◆ Low-Voltage Operation --- Down to 1.24 V
- ◆ Adjustable Output Voltage, $V_o = V_{ref}$ to 20 V
- ◆ Low Operational Cathode Current --- 80uA (Typ)
- ◆ 0.25Ω Typical Output Impedance

PIN CONFIGURATION

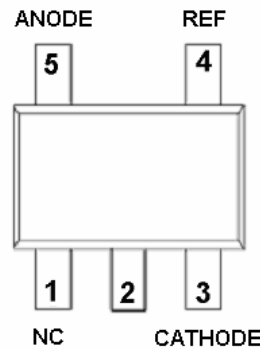
SOT-23



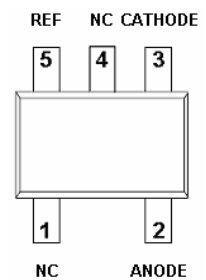
TO-92



SOT-23-5L

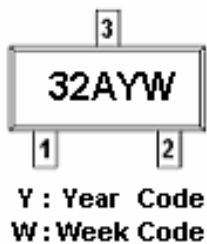


SOT-353 (SC-70)

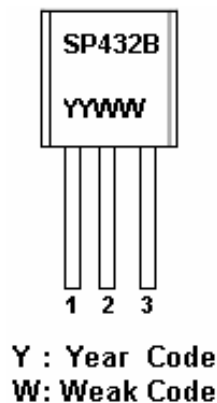


PART MARKING

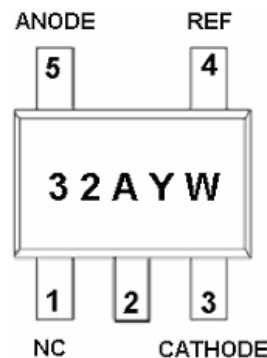
SOT-23



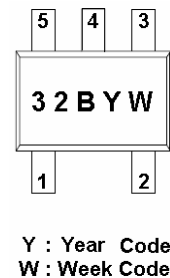
TO-92



SOT-23-5L



SOT-353 (SC-70)

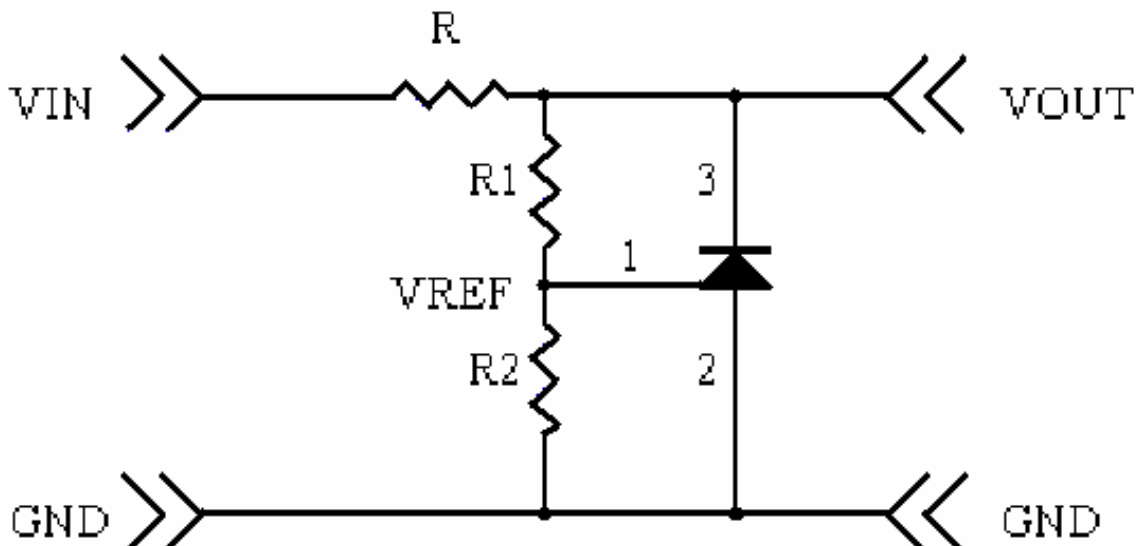




SP432

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TYPICAL APPLICATION CIRCUIT



PIN DESCRIPTION

Pin	Symbol	Description
1	R	REF
2	C	CATHODE
3	A	ANODE

ORDERING INFORMATION

Part Number	Voltage Tolerance	Package	Part Marking
SP432AS23RG	0.5%	SOT-23	32AYW
SP432BS23RG	1.0%	SOT-23	32BYW
SP432AS25RG	0.5%	SOT-23-5L	32AYW
SP432BS25RG	1.0%	SOT-23-5L	32BYW
SP432BT92AG	1.0%	TO-92	SP432B
SP432AS35RG	0.5%	SOT-353	32AYW
SP432BS35RG	1.0%	SOT-353	32BYW

※ Week Code : A ~ Z (1 ~ 26) ; a ~ z (27 ~ 52)

※ SP432AS23RG : Tape Reel ; Pb – Free

※ SP432BS23RG : Tape Reel ; Pb – Free

※ SP432AS25RG : Tape Reel ; Pb – Free

※ SP432BS25RG : Tape Reel ; Pb – Free

※ SP432BT92AG : Tape Ammo ; Pb-Free

※ SP432AS35RG : Tape Reel ; Pb – Free

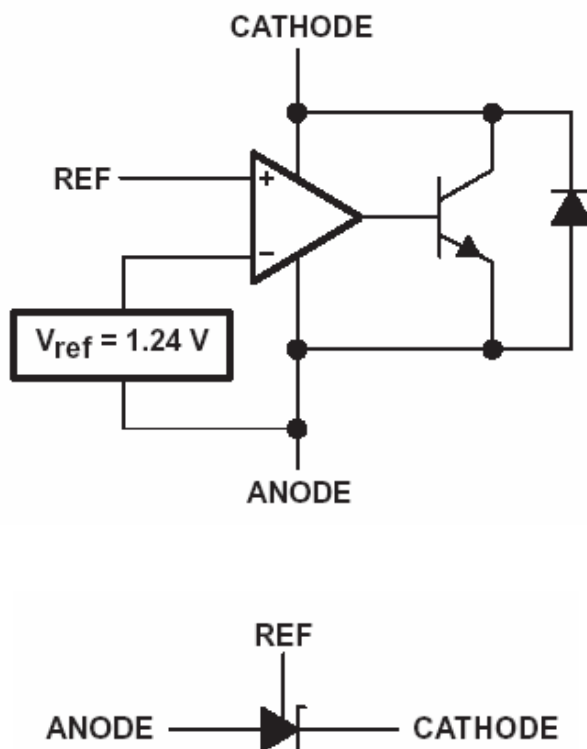
※ SP432BS35RG : Tape Reel ; Pb – Free



SP432

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BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

($T_A=25^{\circ}\text{C}$ Unless otherwise specified)

Parameter	Symbol	Value	Unit	
Cathode Voltage	V_Z	20	V	
Continuous Cathode Current	I_Z	100	mA	
Reference Current	I_{REF}	3	mA	
Operation Junction Temperature Range	T_J	-40 ~ +150	$^{\circ}\text{C}$	
Storage Temperature Range	T_{STG}	-65 ~ +150	$^{\circ}\text{C}$	
Lead Temperature Range (Soldering 10sec.)	T_{SOL}	260	$^{\circ}\text{C}$	
Thermal Resistance	Θ_{JA}	TO-92	140	$^{\circ}\text{C}/\text{W}$
		SOT-23	206	
		SOT-23-5L	206	
		SOT-353	252	

The IC has a protection circuit against static electricity. Do not apply high static electricity or high voltage that exceeds the performance of the protection circuit to the IC.



SP432

Low Voltage Adjustable Precision Shunt Regulators

ELECTRICAL CHARACTERISTICS

($T_A=25^{\circ}\text{C}$, Unless otherwise specified)

SP432AS23RG & SP432AS25RG & SP432AS35RG							
Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Reference Voltage	V_{REF}	$V_Z = V_{REF}$ $I_Z = 10\text{mA}$	$T_A=25^{\circ}\text{C}$	1.234	1.24	1.246	V
			$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$	1.222		1.258	
VREF Temp Deviation	V_{DEV}	$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $V_Z = V_{REF}$, $I_Z = 10\text{mA}$			10	25	mV
Ratio of change in VREF to change in Cathode voltage	$\Delta V_{REF} / \Delta V_Z$	$I_Z = 10\text{mA}$ $\Delta V_Z = 16\text{V} \sim V_{REF}$			-1.0	-2.7	mV / V
Reference Input Current	I_{REF}	$R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$			0.15	0.5	μA
IREF Temp Deviation	$I_{REF(DEV)}$	$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$			0.1	0.4	μA
Off state Cathode Current	$I_{Z(OFF)}$	$V_{REF} = 0\text{V}$	$V_Z = 6\text{V}$		0.5	1.0	μA
			$V_Z = 12\text{V}$				
Dynamic output impedance	R_Z	$f < 1\text{KHZ}$, $V_Z = V_{REF}$ $I_Z = 1\text{mA} \sim 100\text{mA}$			0.25	0.4	Ω
Minimum Operation Current	$I_{Z(MIN)}$	$V_Z = V_{REF}$			30	80	μA

SP432BS23RG & SP432BS25RG & SP432BT92AG & SP432BS35RG							
Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Reference Voltage	V_{REF}	$V_Z = V_{REF}$ $I_Z = 10\text{mA}$	$T_A=25^{\circ}\text{C}$	1.228	1.24	1.252	V
			$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$	1.215		1.265	
VREF Temp Deviation	V_{DEV}	$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $V_Z = V_{REF}$, $I_Z = 10\text{mA}$			10	25	mV
Ratio of change in VREF to change in Cathode voltage	$\Delta V_{REF} / \Delta V_Z$	$I_Z = 10\text{mA}$ $\Delta V_Z = 16\text{V} \sim V_{REF}$			-1.0	-2.7	mV / V
Reference Input Current	I_{REF}	$R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$			0.15	0.5	μA
IREF Temp Deviation	$I_{REF(DEV)}$	$T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$			0.1	0.4	μA
Off state Cathode Current	$I_{Z(OFF)}$	$V_{REF} = 0\text{V}$	$V_Z = 6\text{V}$		0.5	1.0	μA
			$V_Z = 12\text{V}$				
Dynamic output impedance	R_Z	$f < 1\text{KHZ}$, $V_Z = V_{REF}$ $I_Z = 1\text{mA} \sim 100\text{mA}$			0.25	0.4	Ω
Minimum Operation Current	$I_{Z(MIN)}$	$V_Z = V_{REF}$			30	80	μA



SP432

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APPLICATION CIRCUIT

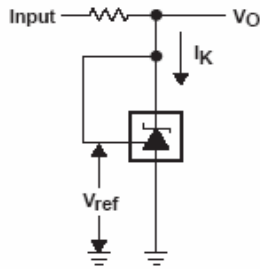


Figure 1. Test Circuit for $V_{KA} = V_{ref}$,
 $V_O = V_{KA} = V_{ref}$

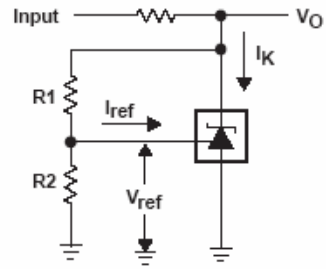


Figure 2. Test Circuit for $V_{KA} > V_{ref}$,
 $V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

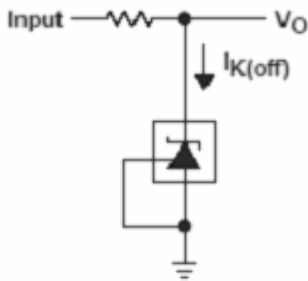


Figure 3. Test Circuit for $I_{K(off)}$

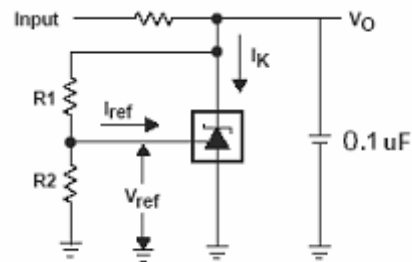


Figure 4. Test Circuit for $V_{KA} > V_{ref}$,
 $V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

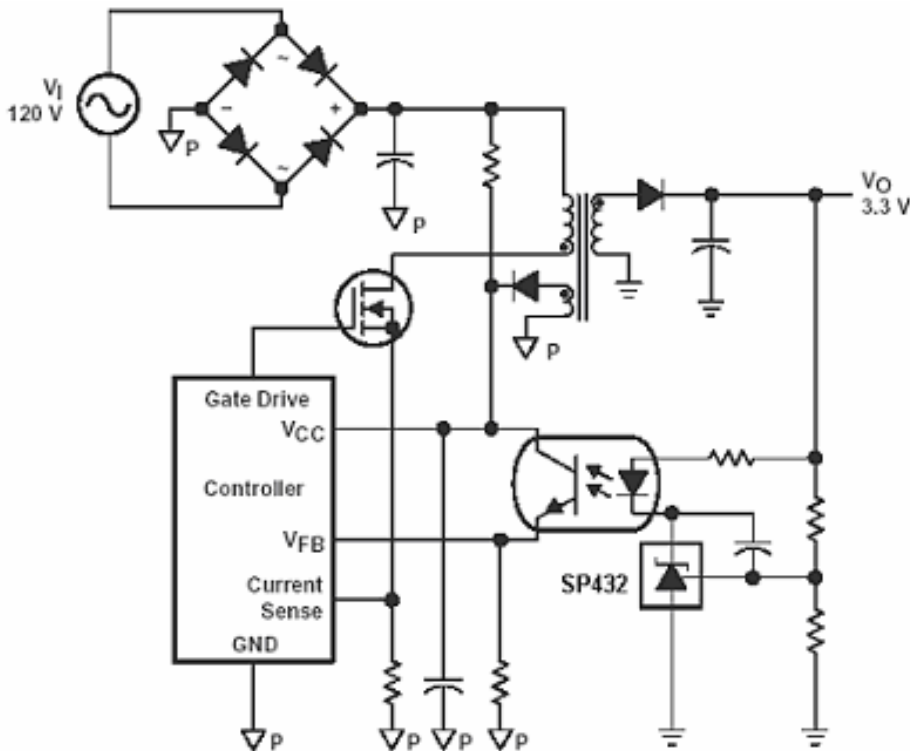


Figure 5. Flyback with isolation using SP432 as voltage reference and error amplifier

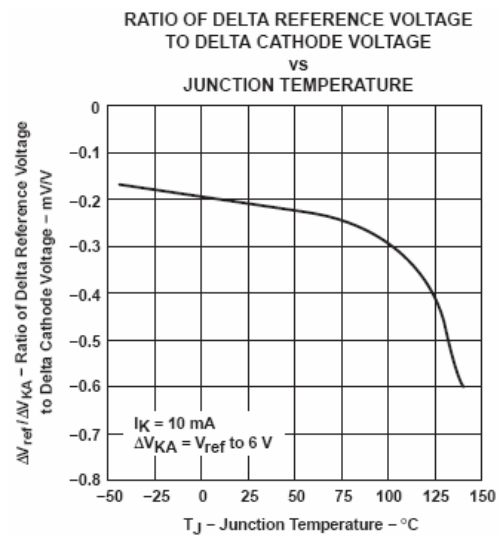
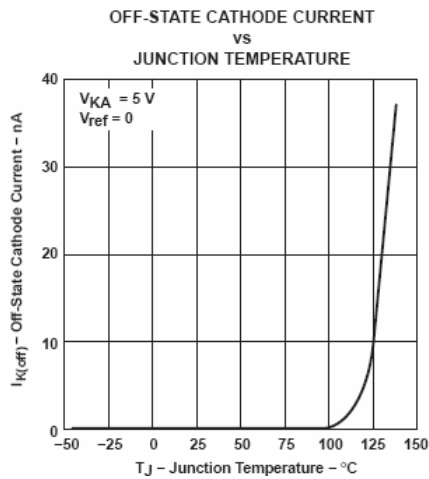
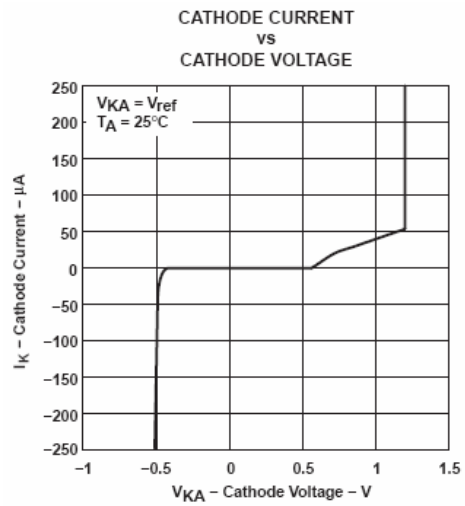
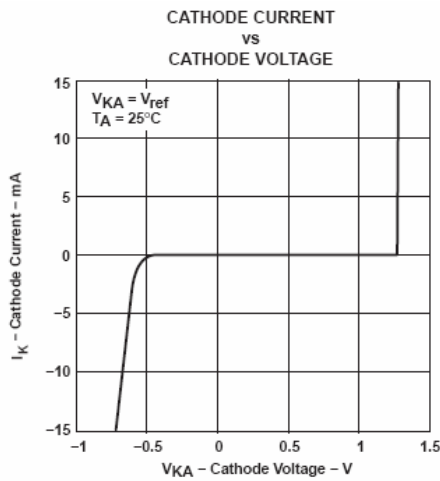
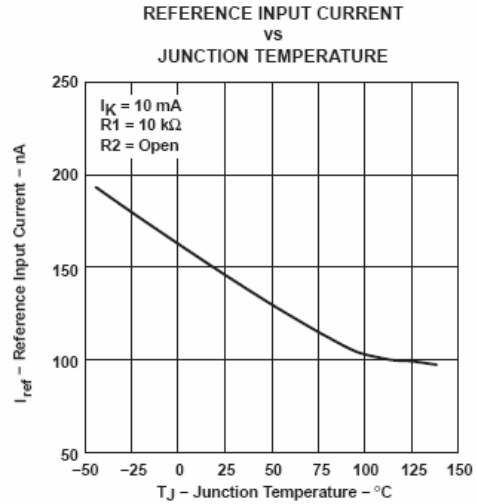
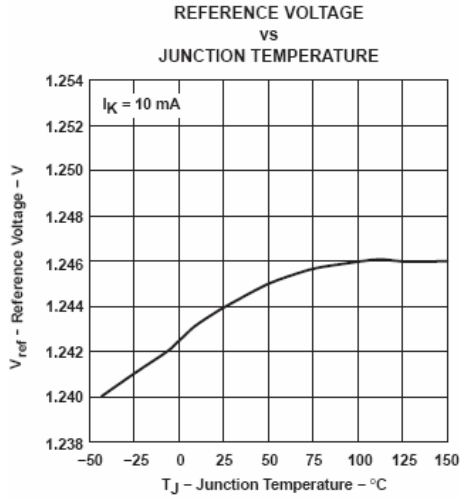
※ To improve the stability of output voltage, Figure 4, a 0.1uF capacitor is recommended between cathode to anode



SP432

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PERFORMANCE CHARACTERISTICS



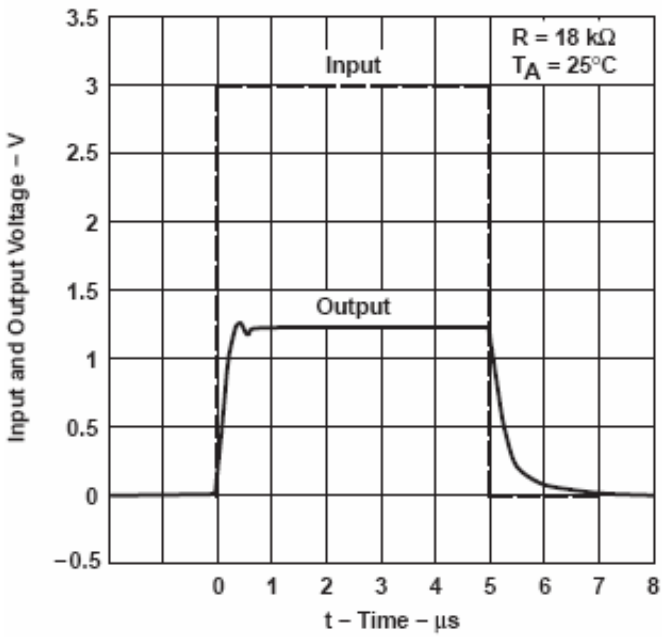


SP432

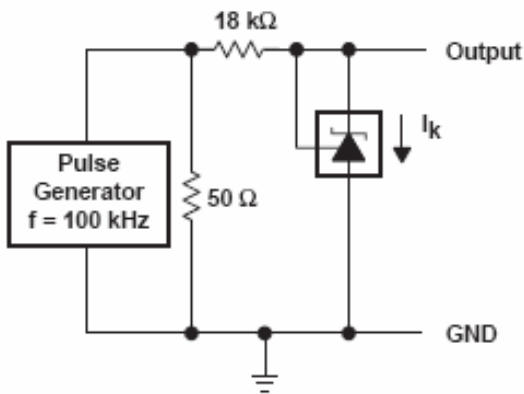
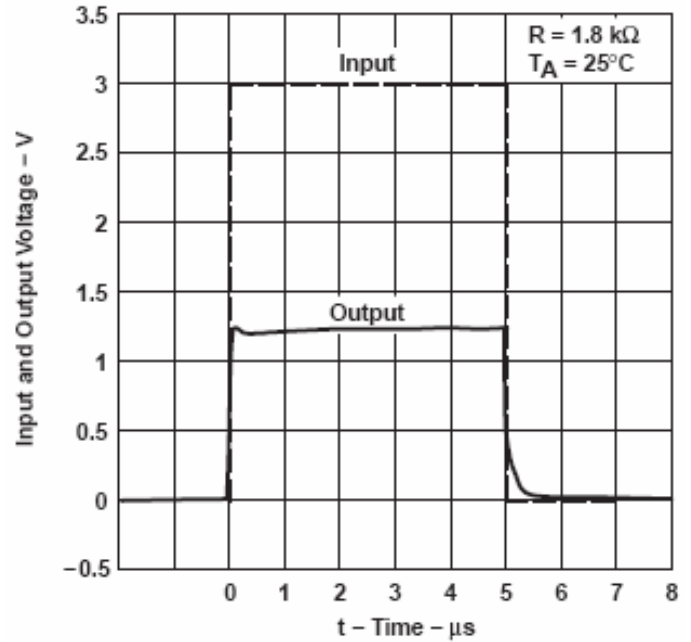
Low Voltage Adjustable Precision Shunt Regulators

PERFORMANCE CHARACTERISTICS

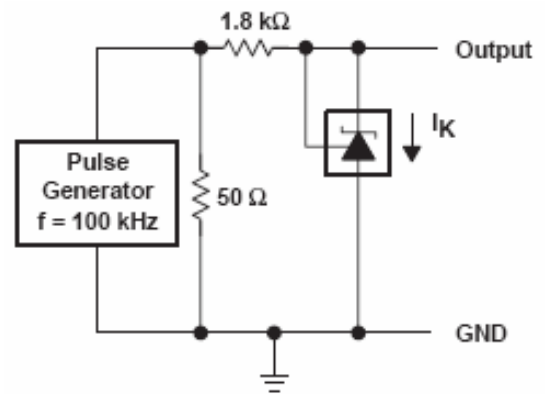
PULSE RESPONSE



PULSE RESPONSE



TEST CIRCUIT FOR PULSE RESPONSE



TEST CIRCUIT FOR PULSE RESPONSE

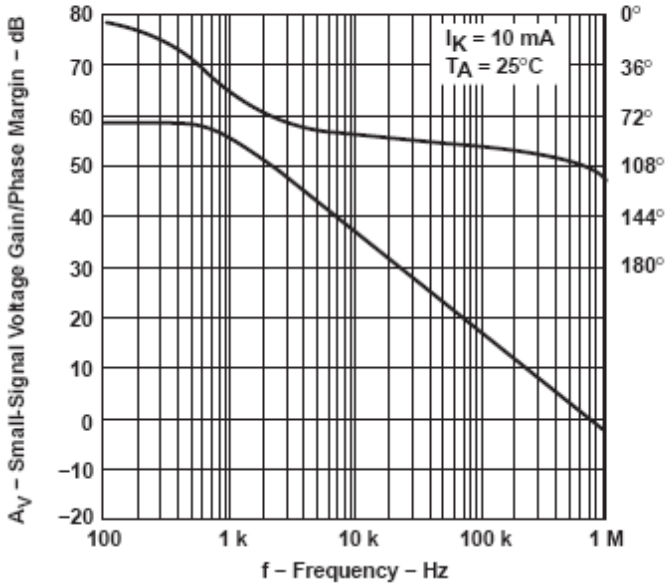


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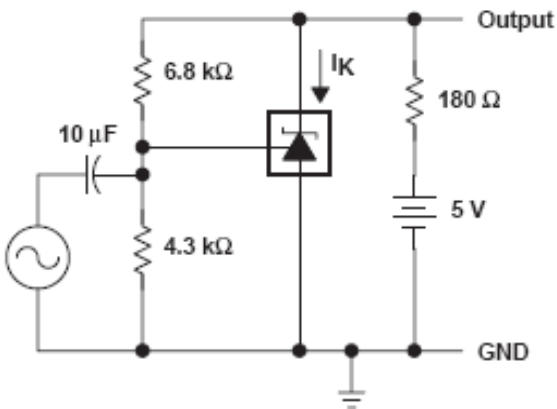
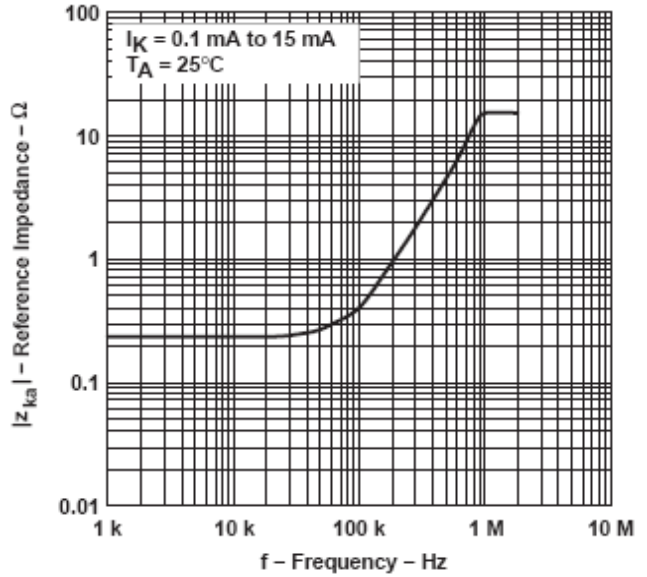
Low Voltage Adjustable Precision Shunt Regulators

PERFORMANCE CHARACTERISTICS

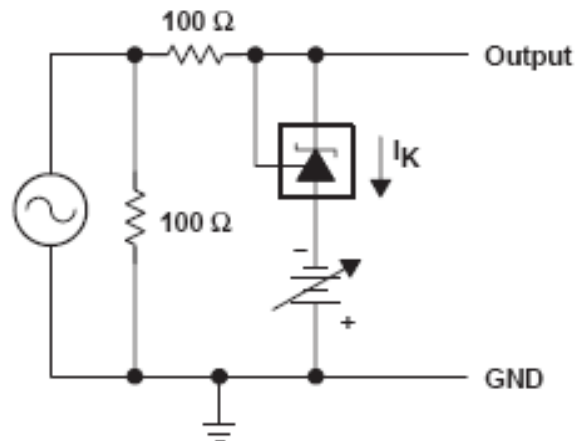
SMALL-SIGNAL VOLTAGE GAIN/PHASE MARGIN
VS
FREQUENCY



REFERENCE IMPEDANCE
VS
FREQUENCY



TEST CIRCUIT FOR VOLTAGE GAIN
AND PHASE MARGIN



TEST CIRCUIT FOR REFERENCE IMPEDANCE

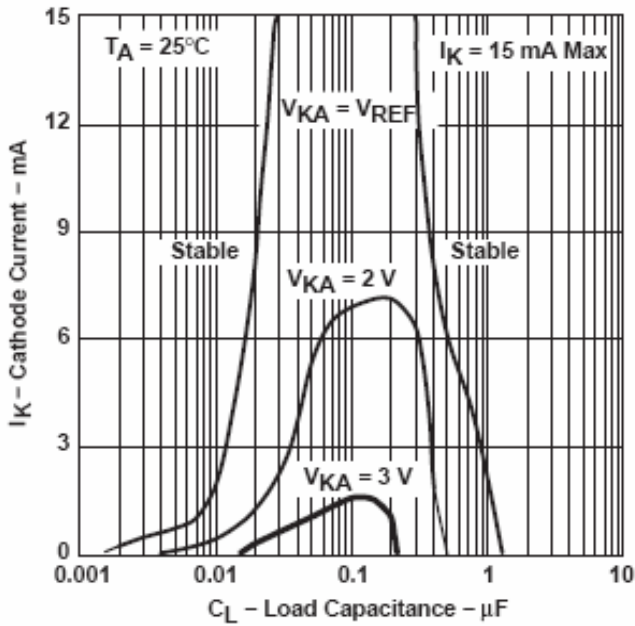


SP432

Low Voltage Adjustable Precision Shunt Regulators

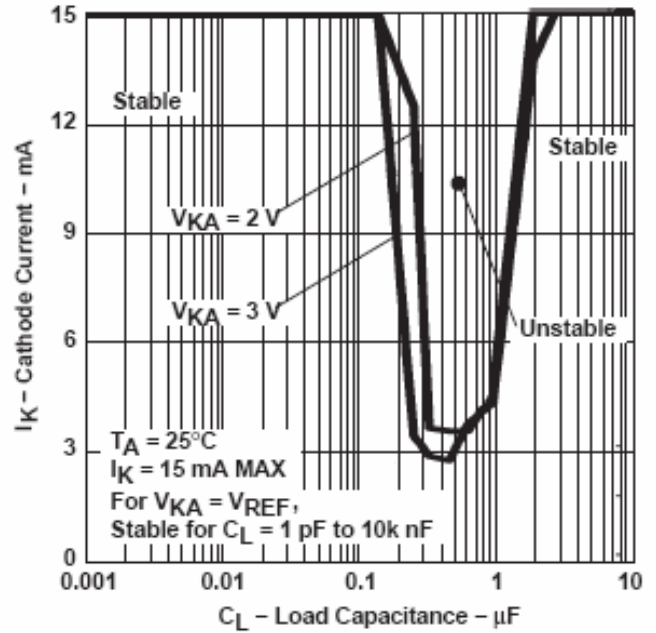
PERFORMANCE CHARACTERISTICS

STABILITY BOUNDARY CONDITION

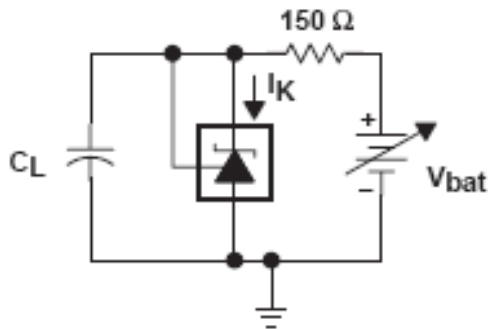


(For 1.0%)

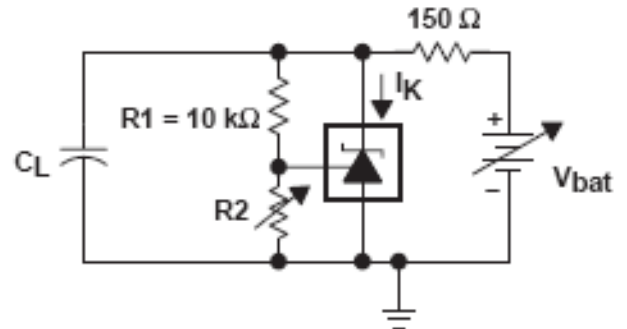
STABILITY BOUNDARY CONDITION†



(For 0.5%)



TEST CIRCUIT FOR $V_{KA} = V_{REF}$



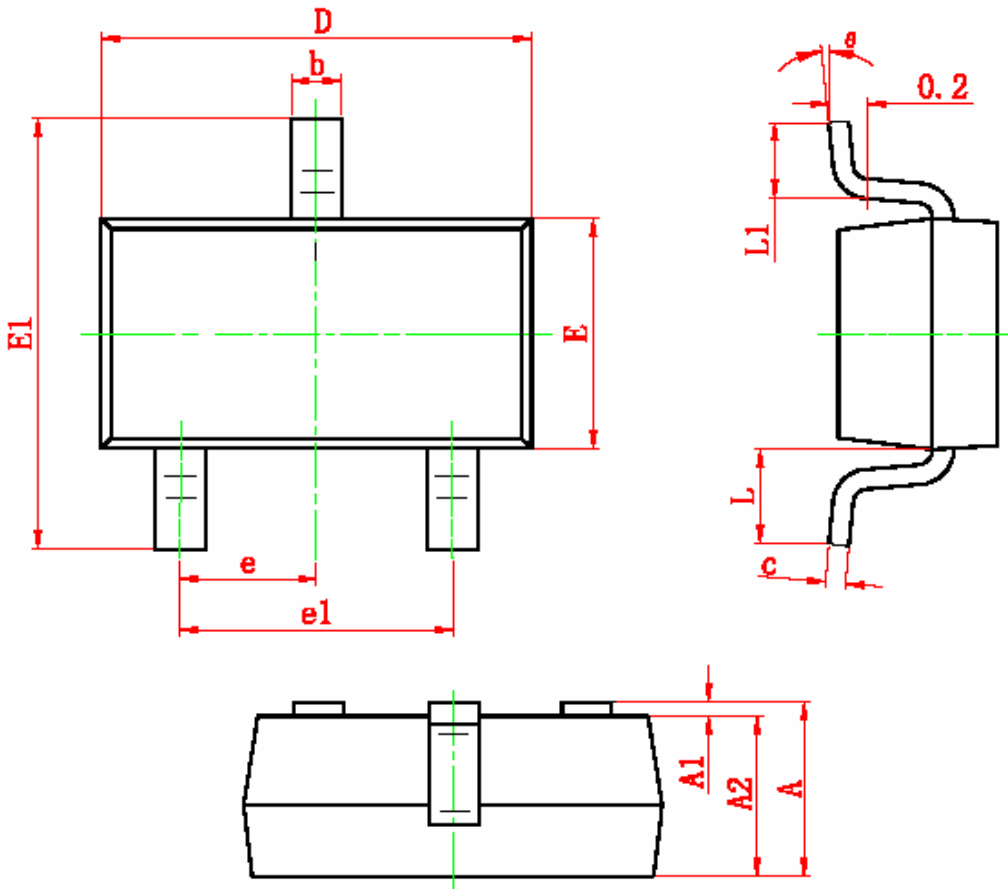
TEST CIRCUIT FOR $V_{KA} = 2 \text{ V}, 3 \text{ V}$



SP432

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SOT-23 PACKAGE OUTLINE



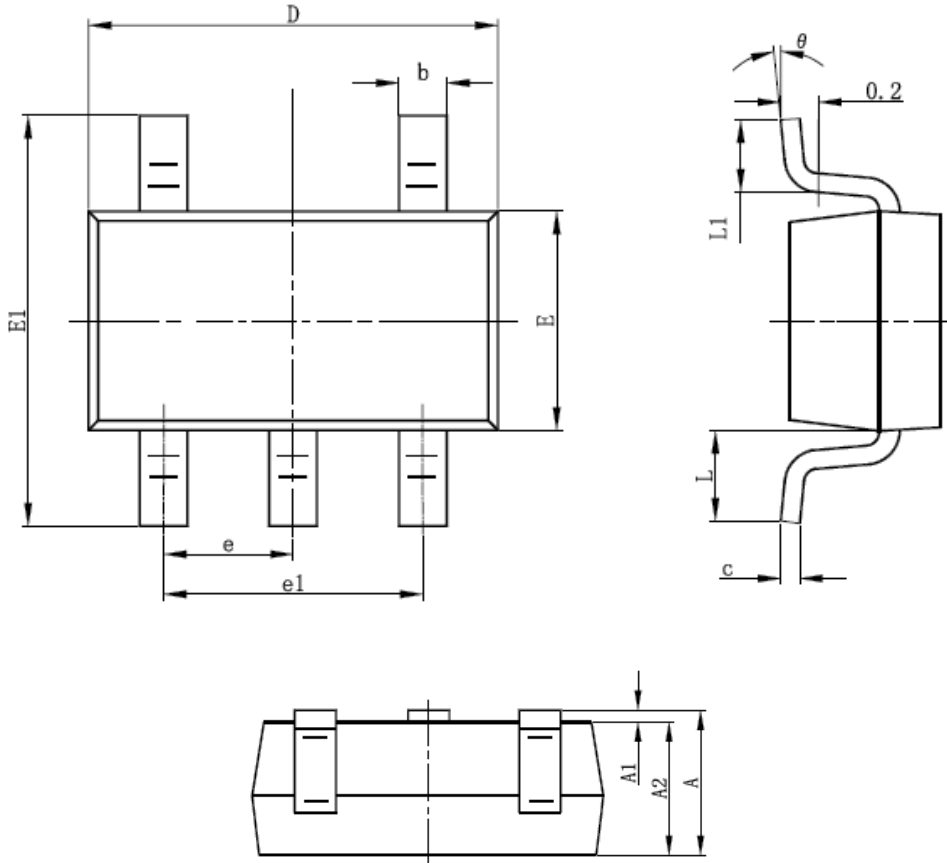
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.200	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.100	0.035	0.039
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e	0.950 TYP		0.037 TYP	
e1	1.800	2.000	0.071	0.079
L	0.550 REF		0.022 REF	
L1	0.300	0.500	0.012	0.020
θ	0°	8°	0°	6°



SP432

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SOT-23-5L PACKAGE OUTLINE



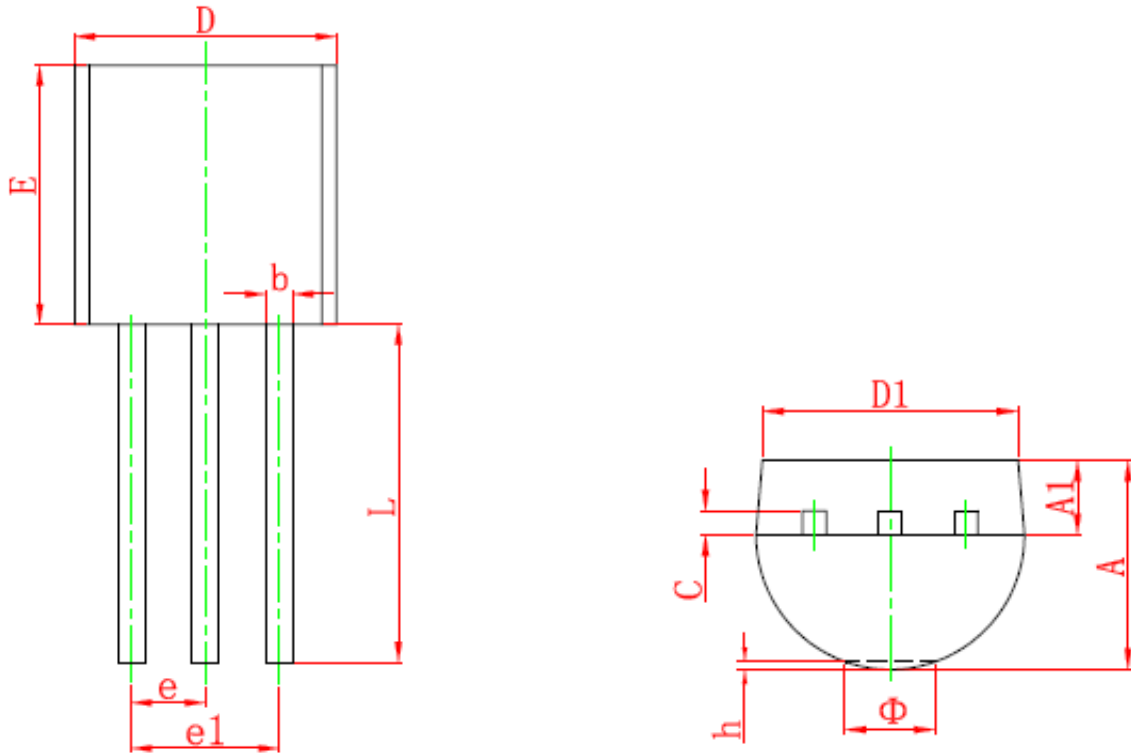
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



SP432

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TO-92 PACKAGE OUTLINE



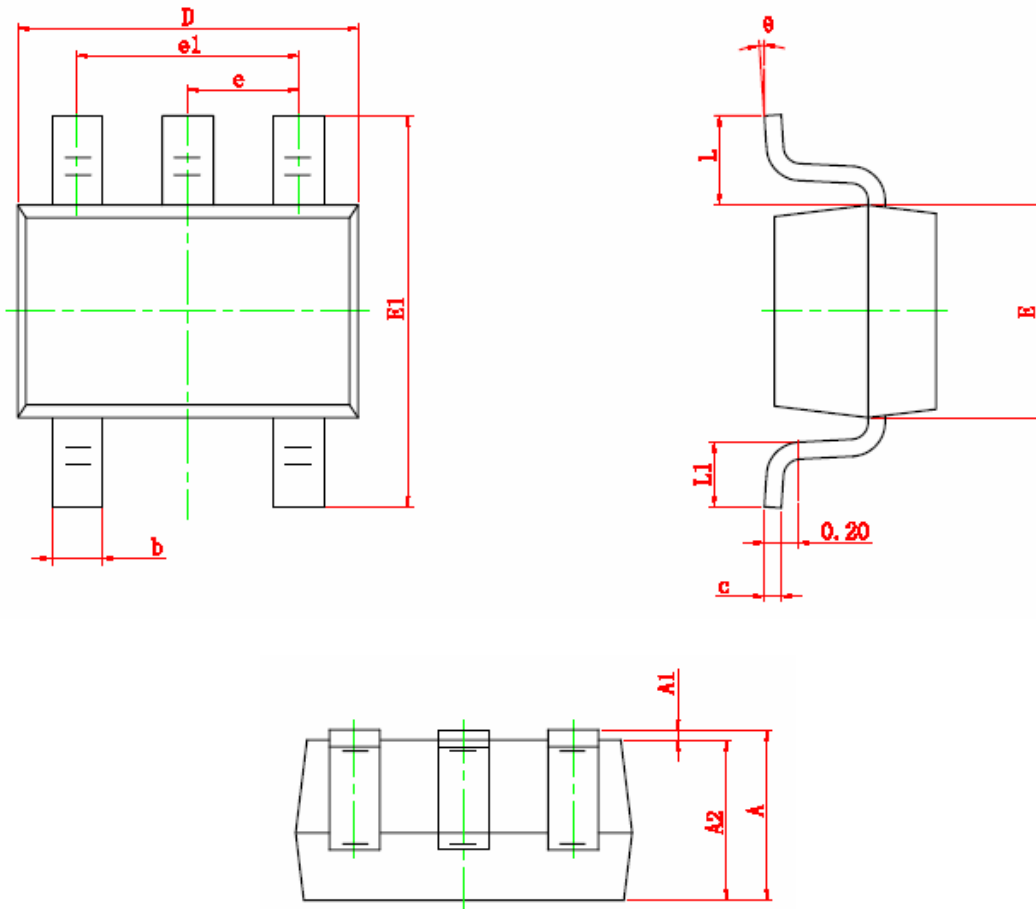
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.400	4.700	0.173	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.571
Φ		1.600		0.063
h	0.000	0.380	0.000	0.015



SP432

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SOT-353 PACKAGE OUTLINE



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650 TYP		0.026 TYP	
e1	1.200	1.400	0.047	0.055
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°