



# 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  $0.25\Omega$ . 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

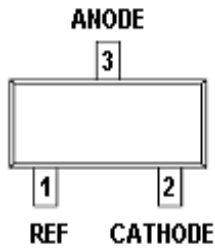
- Battery Power Equipment
- Linear Regulators
- Switch Power Supply
- Cellular Phone
- Digital Cameras
- Computer Disk Drivers
- Instrumentation

### 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)
- ◆  $0.25\Omega$  Typical Output Impedance

### PIN CONFIGURATION

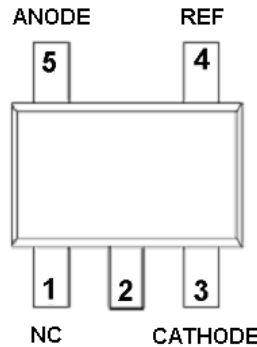
SOT-23



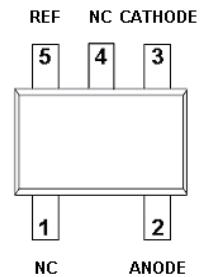
TO-92



SOT-23-5L

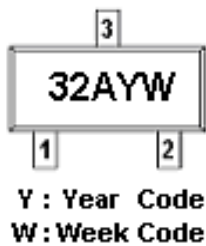


SOT-353 (SC-70)

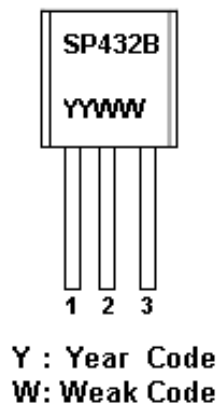


### PART MARKING

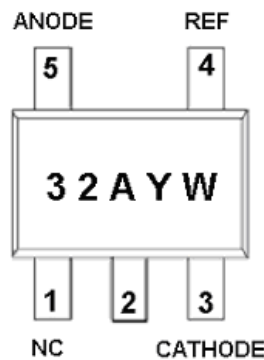
SOT-23



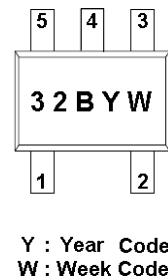
TO-92



SOT-23-5L



SOT-353 (SC-70)

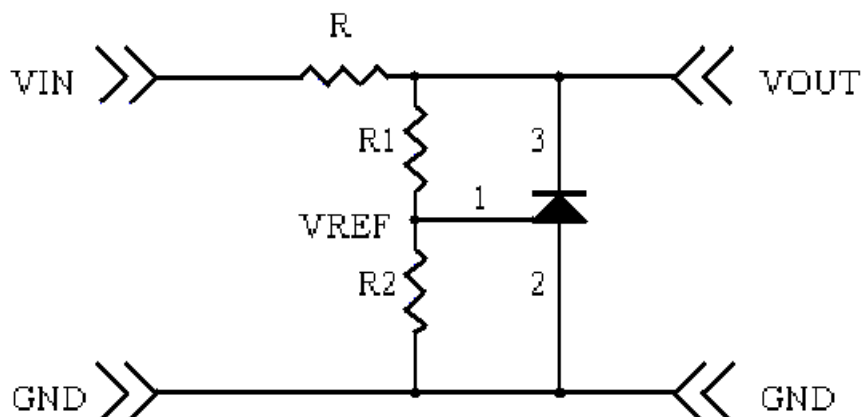




# SP432

## Low Voltage Adjustable Precision Shunt Regulators

### TYPICAL APPLICATION CIRCUIT



### PIN DESCRIPTION

#### SP432AS23RGB/SP432BS23RGB

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

#### SP432AS25RGB/SP432BS25RGB

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

#### SP432AS35RGB/SP432BS35RGB

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

#### SP432BT92AGB

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



# SP432

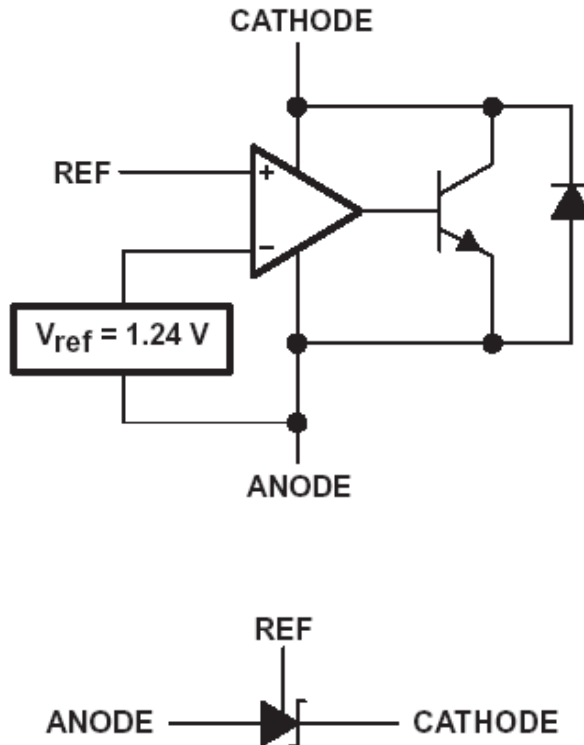
## Low Voltage Adjustable Precision Shunt Regulators

### ORDERING INFORMATION

Part Number	Voltage Tolerance	Package	Part Marking
SP432AS23RGB	0.5%	SOT-23	32AYW
SP432BS23RGB	1.0%	SOT-23	32BYW
SP432AS25RGB	0.5%	SOT-23-5L	32AYW
SP432BS25RGB	1.0%	SOT-23-5L	32BYW
SP432BT92AGB	1.0%	TO-92	SP432B
SP432AS35RGB	0.5%	SOT-353	32AYW
SP432BS35RGB	1.0%	SOT-353	32BYW

- ※ SP432AS23RGB : Tape Reel ; Pb – Free; Halogen – Free
- ※ SP432BS23RGB : Tape Reel ; Pb – Free; Halogen – Free
- ※ SP432AS25RGB : Tape Reel ; Pb – Free; Halogen – Free
- ※ SP432BS25RGB : Tape Reel ; Pb – Free; Halogen – Free
- ※ SP432BT92AGB : Tape Ammo ; Pb-Free; Halogen – Free
- ※ SP432AS35RGB : Tape Reel ; Pb – Free; Halogen – Free
- ※ SP432BS35RGB : Tape Reel ; Pb – Free; Halogen – Free

### BLOCK DIAGRAM





# SP432

## Low Voltage Adjustable Precision Shunt Regulators

### ABSOLUTE MAXIMUM RATINGS

(TA=25°C Unless otherwise specified)

Parameter	Symbol	Value	Unit
Cathode Voltage	VZ	20	V
Continuous Cathode Current	IZ	100	mA
Reference Current	IREF	3	mA
Operation Junction Temperature Range	TJ	-40 ~ +150	°C
Storage Temperature Range	TSTG	-65 ~ +150	°C
Lead Temperature Range (Soldering 10sec.)	TSOL	260	°C
Thermal Resistance	ΘJA	TO-92	140
		SOT-23	206
		SOT-23-5L	206
		SOT-353	252
			°C/W

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.

### ELECTRICAL CHARACTERISTICS

(TA=25°C , Unless otherwise specified)

SP432AS23RG & SP432AS25RG & SP432AS35RG							
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Reference Voltage	VREF	VZ = VREF IZ = 10mA	TA=25°C	1.234	1.24	1.246	V
			TA=-40°C ~ +80°C	1.222		1.258	
VREF Temp Deviation	VDEV	TA=-40°C ~ +80°C VZ = VREF , IZ = 10mA		10	25	mV	
Ratio of change in VREF to change in Cathode voltage	ΔVREF / ΔVZ	IZ = 10mA ΔVZ = 16V ~ VREF		-1.0	-2.7	mV / V	
Reference Input Current	IREF	R1=10KΩ , R2 = ∞ , IZ = 10mA		0.15	0.5	uA	
IREF Temp Deviation	IREF(DEV)	TA=-40°C ~ +80°C R1=10KΩ , R2 = ∞ , IZ = 10mA		0.1	0.4	uA	
Off state Cathode Current	IZ(OFF)	VREF = 0V	VZ = 6V		0.5	1.0	uA
			VZ = 12V				
Dynamic output impedance	RZ	f < 1KHZ , VZ = VREF IZ = 1mA ~ 100mA		0.25	0.4	Ω	
Minimum Operation Current	IZ(MIN)	VZ = VREF		30	80	uA	



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## Low Voltage Adjustable Precision Shunt Regulators

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

### APPLICATION CIRCUIT

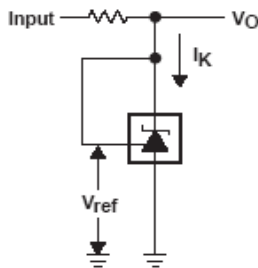


Figure 1. Test Circuit for  $V_{KA} = V_{ref}$ ,  
 $V_O = V_{KA} = V_{ref}$

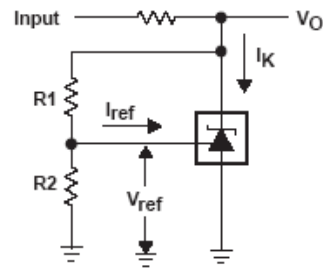


Figure 2. Test Circuit for  $V_{KA} > V_{ref}$ ,  
 $V_O = V_{KA} = V_{ref} \times (1 + R_1/R_2) + I_{ref} \times R_1$

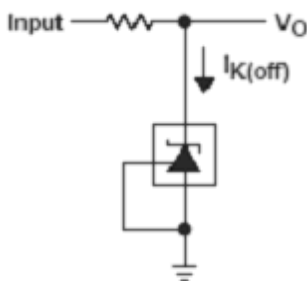


Figure 3. Test Circuit for  $I_{K(off)}$

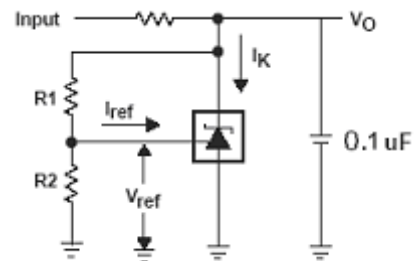


Figure 4. Test Circuit for  $V_{KA} > V_{ref}$ ,  
 $V_O = V_{KA} = V_{ref} \times (1 + R_1/R_2) + I_{ref} \times R_1$



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## Low Voltage Adjustable Precision Shunt Regulators

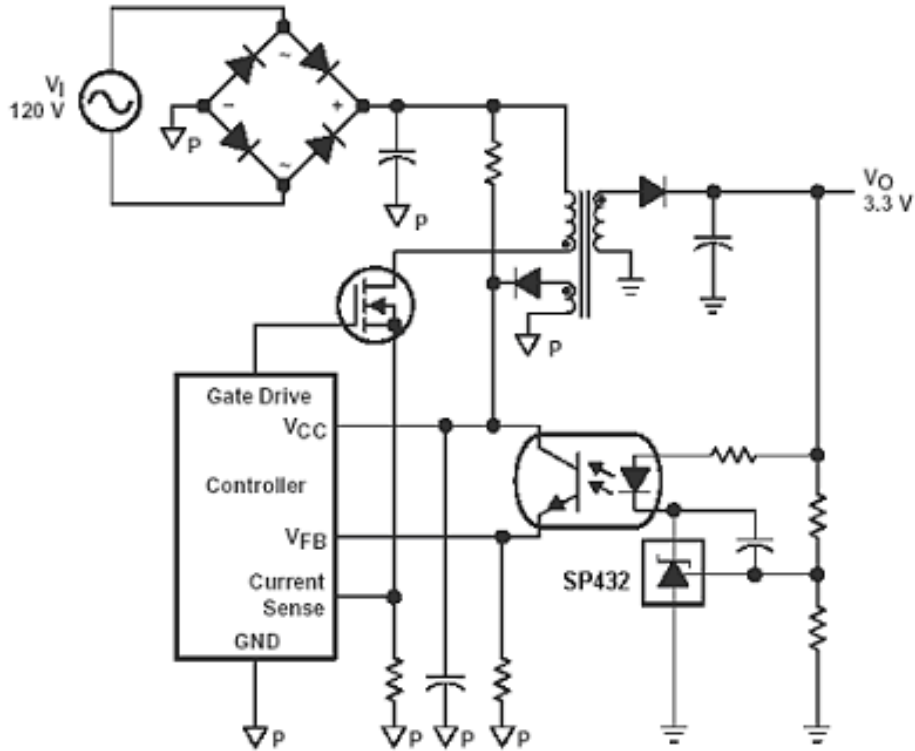


Figure 5. Flyback with isolation using SP432 as voltage reference and error amplifier

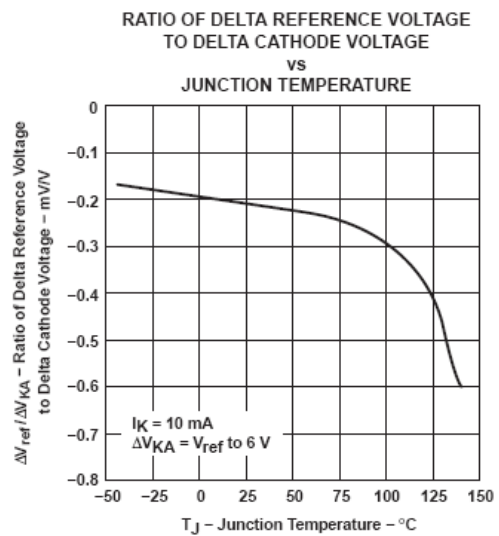
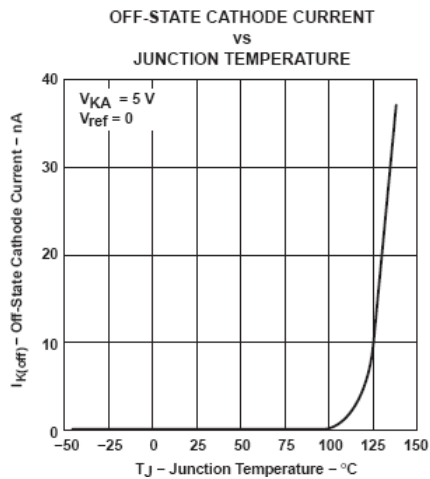
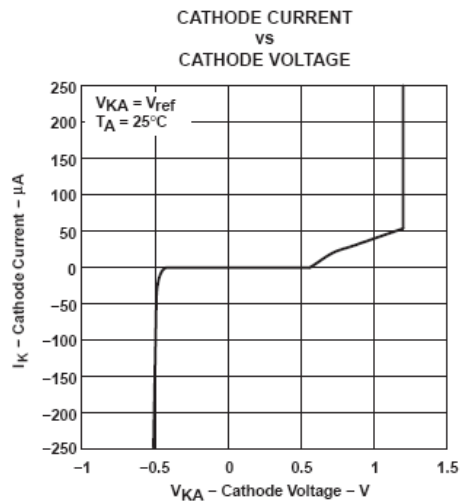
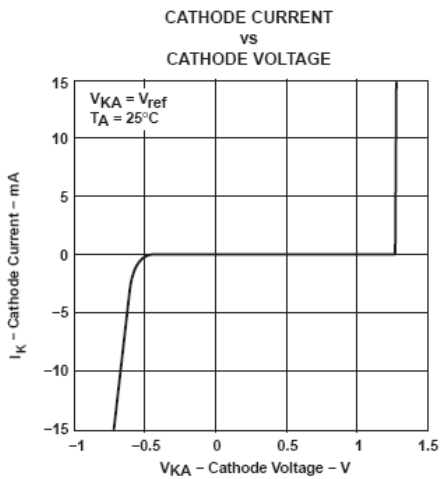
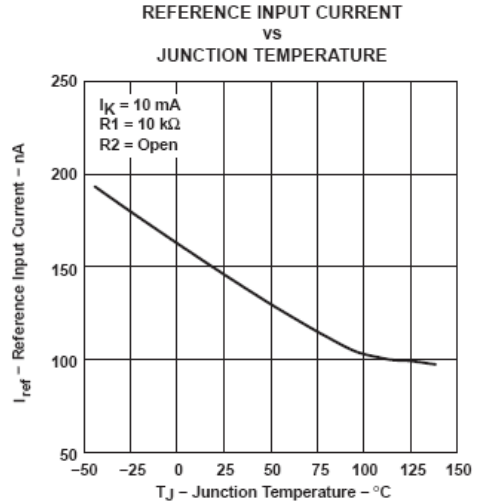
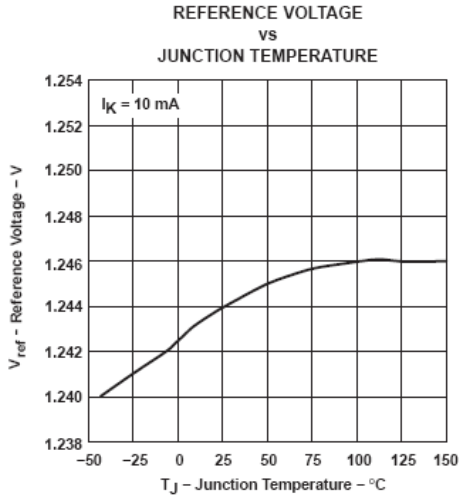
※ To improve the stability of output voltage, Figure 4, a 0.1uf capacitor is recommended between cathode to anode



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## Low Voltage Adjustable Precision Shunt Regulators

### PERFORMANCE CHARACTERISTICS



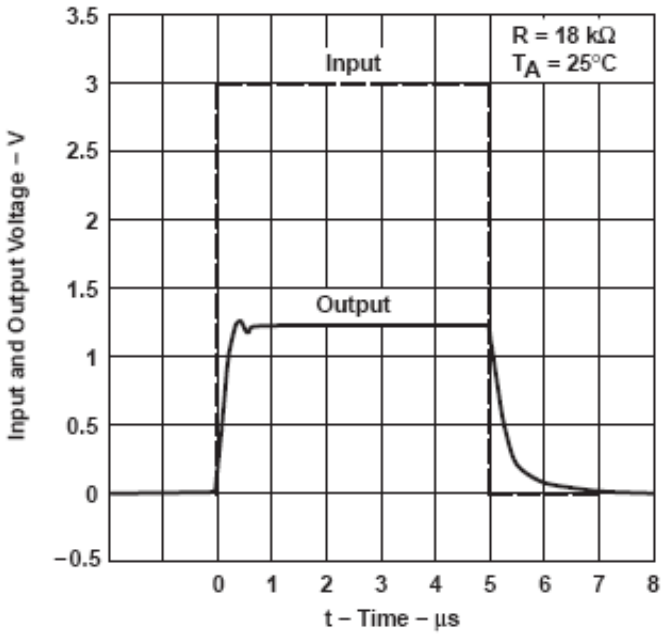


# SP432

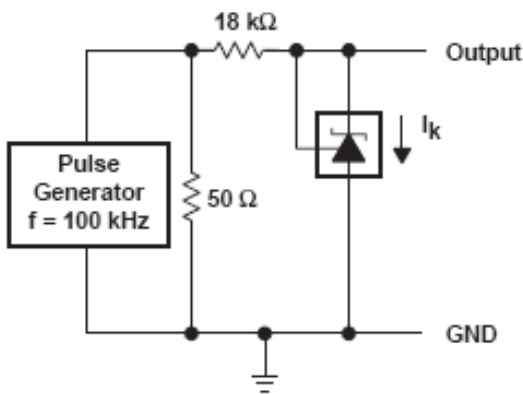
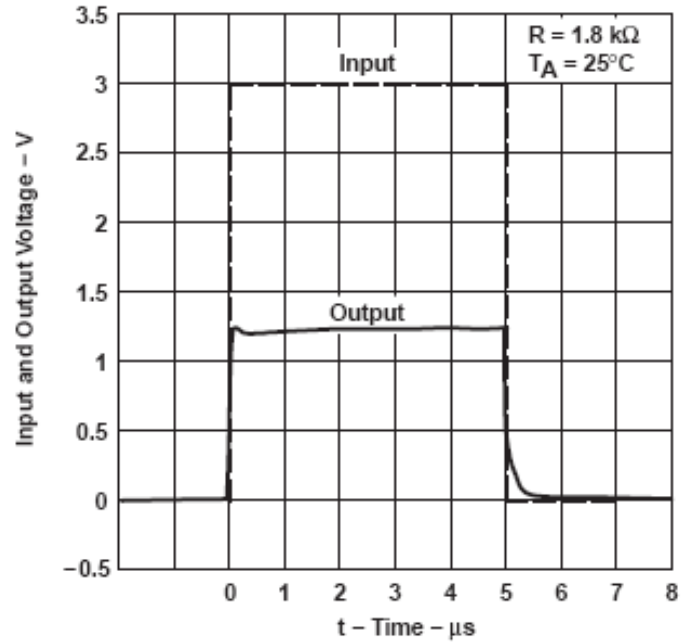
## Low Voltage Adjustable Precision Shunt Regulators

### PERFORMANCE CHARACTERISTICS

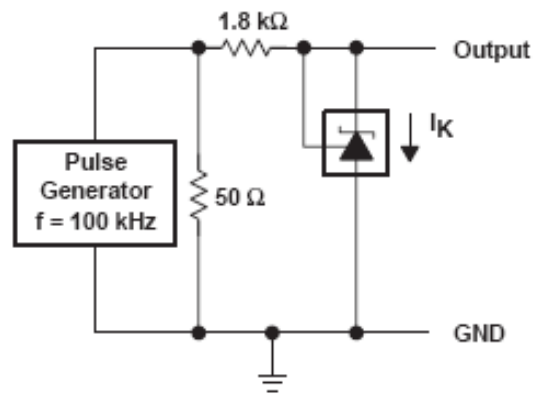
PULSE RESPONSE



PULSE RESPONSE



TEST CIRCUIT FOR PULSE RESPONSE



TEST CIRCUIT FOR PULSE RESPONSE



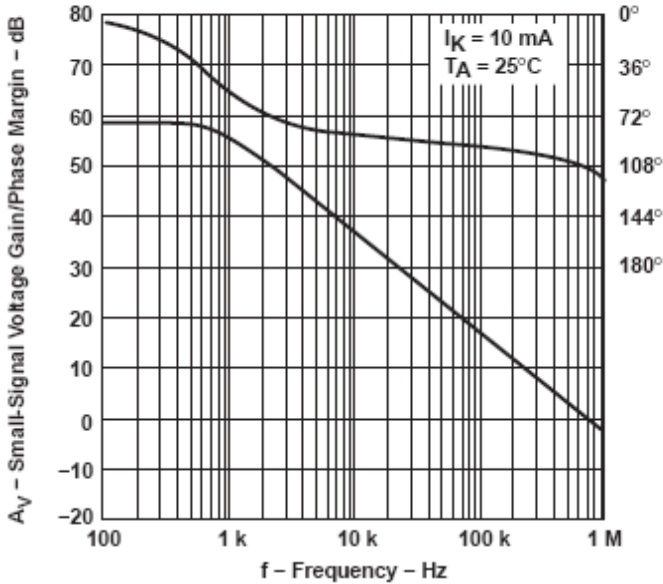


# SP432

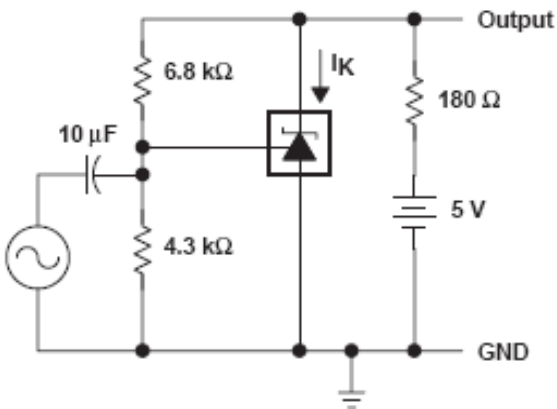
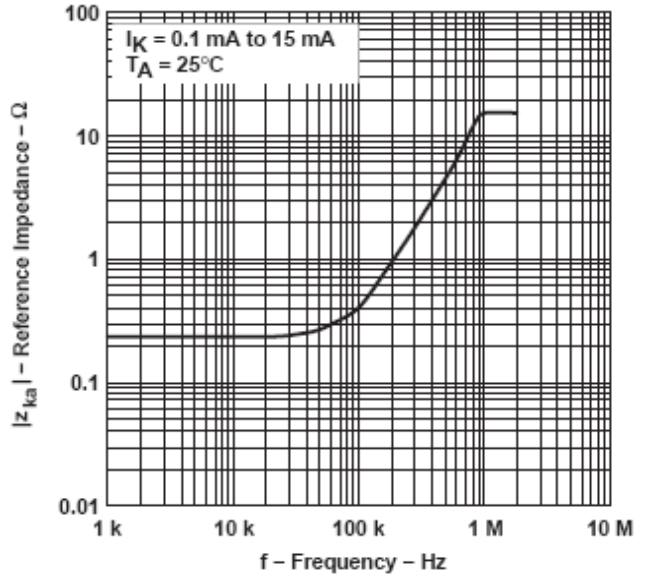
## Low Voltage Adjustable Precision Shunt Regulators

### PERFORMANCE CHARACTERISTICS

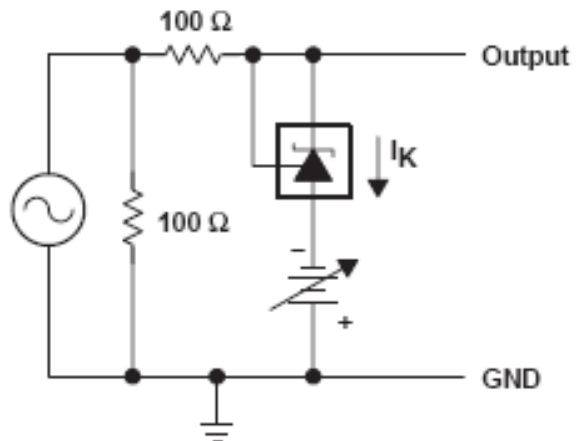
SMALL-SIGNAL VOLTAGE GAIN/PHASE MARGIN  
VS  
FREQUENCY



REFERENCE IMPEDANCE  
VS  
FREQUENCY



TEST CIRCUIT FOR VOLTAGE GAIN  
AND PHASE MARGIN



TEST CIRCUIT FOR REFERENCE IMPEDANCE

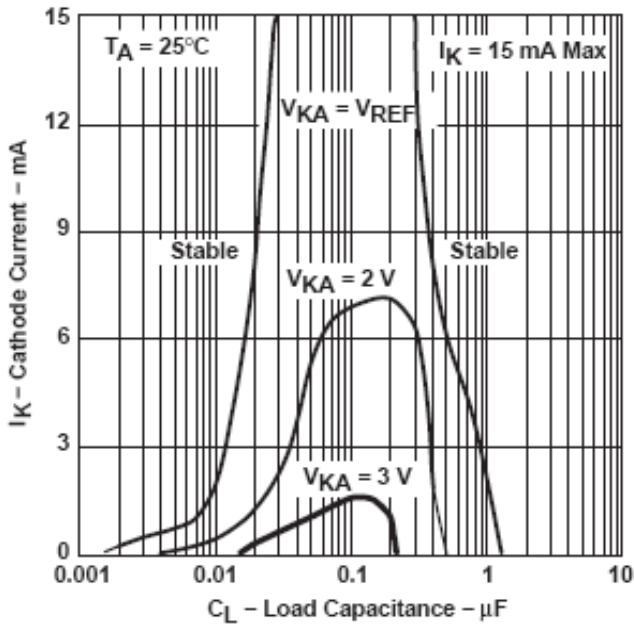


# SP432

## Low Voltage Adjustable Precision Shunt Regulators

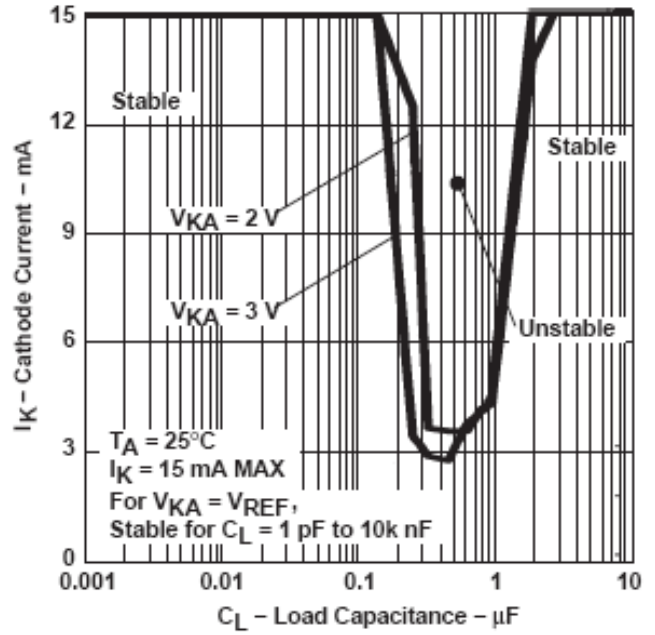
### PERFORMANCE CHARACTERISTICS

STABILITY BOUNDARY CONDITION

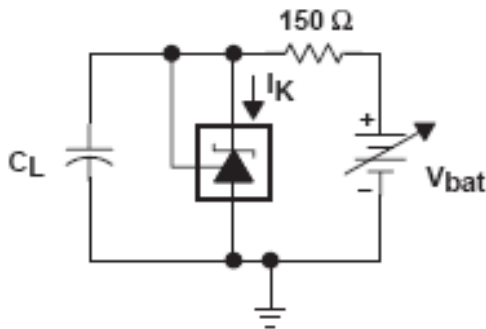


(For 1.0%)

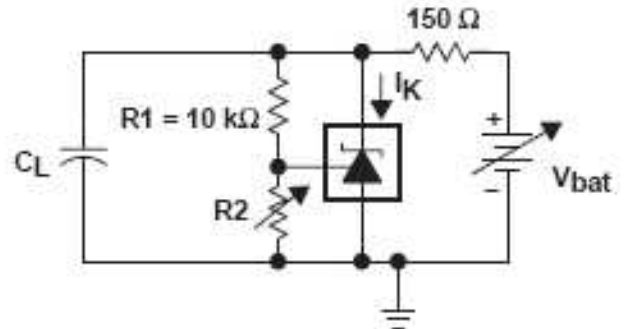
STABILITY BOUNDARY CONDITION†



( For 0.5% )



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



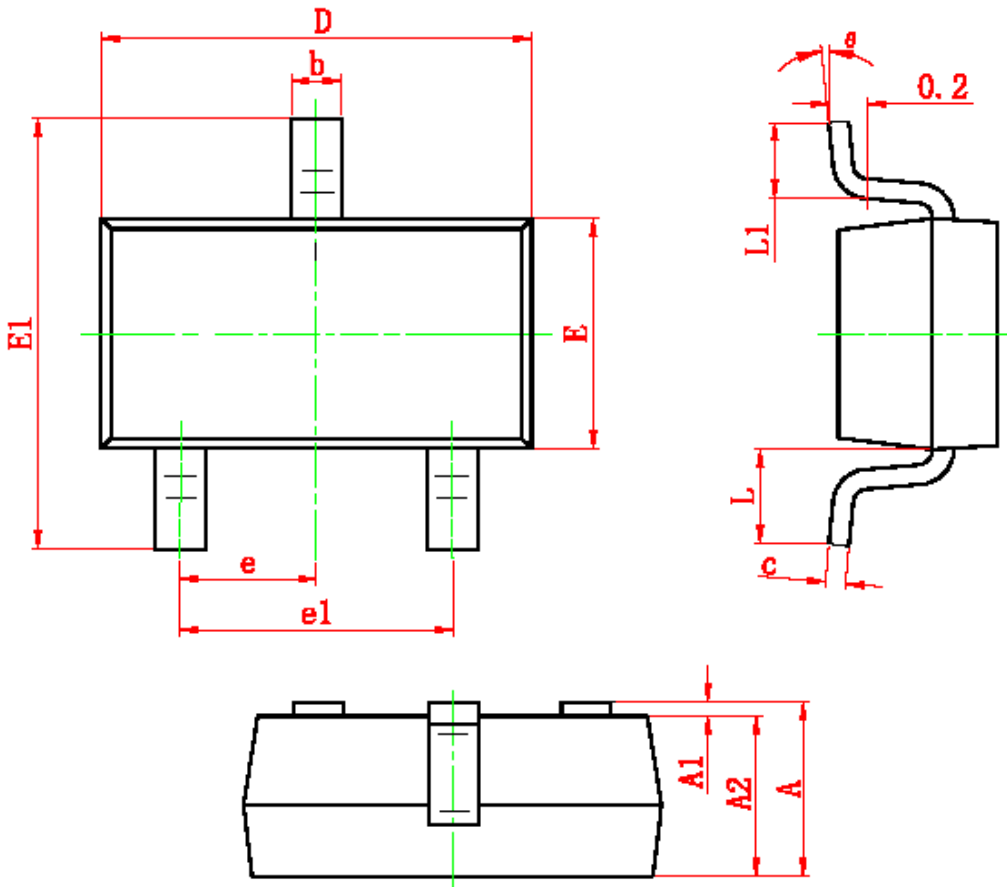
TEST CIRCUIT FOR  $V_{KA} = 2V, 3V$



# SP432

## Low Voltage Adjustable Precision Shunt Regulators

### SOT-23 PACKAGE OUTLINE



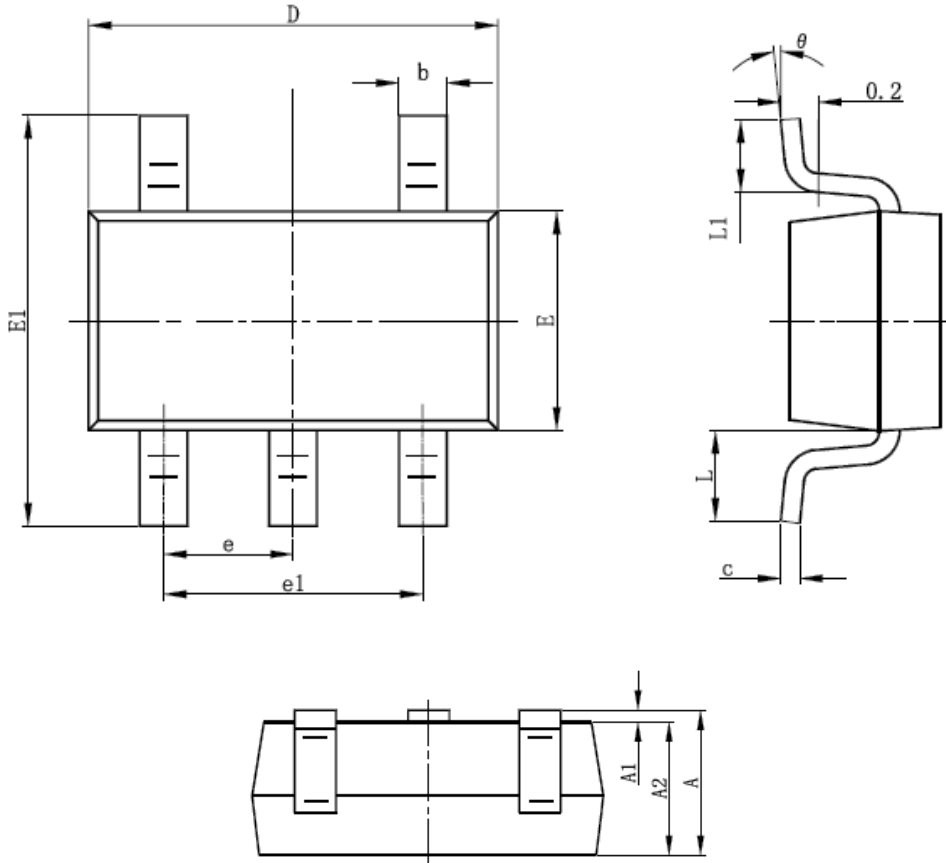
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.200	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.100	0.035	0.039
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e	0.950 TYP		0.037 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
$\theta$	0°	8°	0°	6°



# SP432

## Low Voltage Adjustable Precision Shunt Regulators

### SOT-23-5L PACKAGE OUTLINE



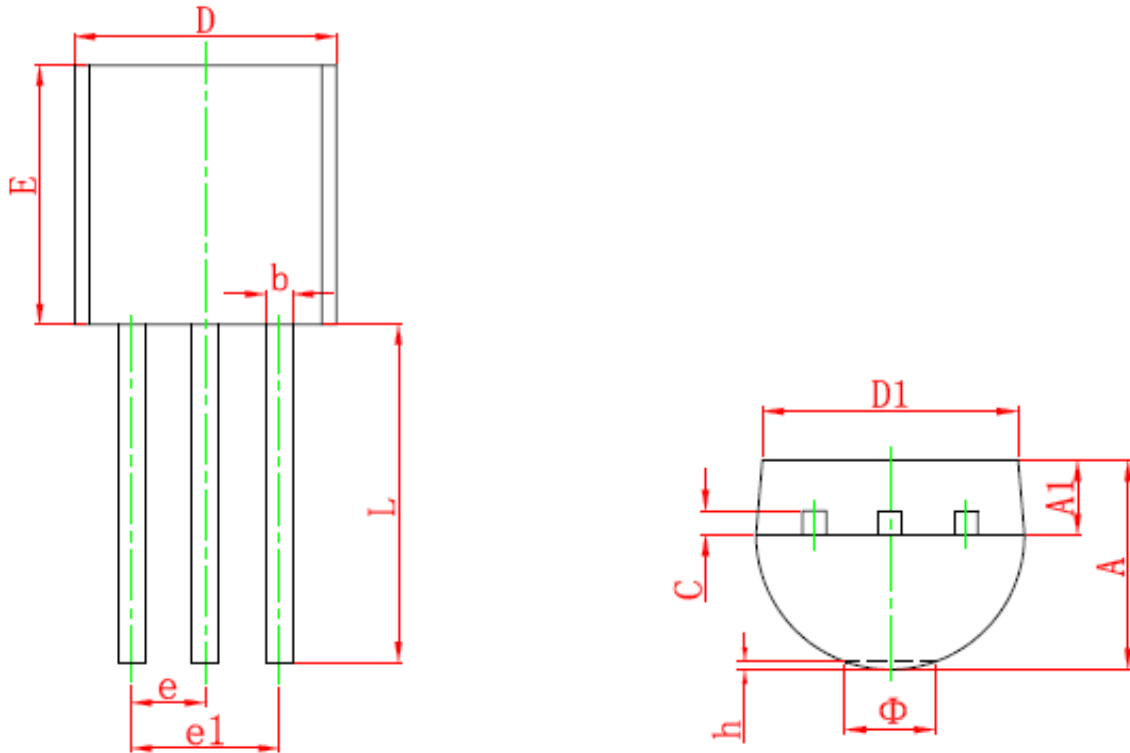
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
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

## Low Voltage Adjustable Precision Shunt Regulators

### TO-92 PACKAGE OUTLINE



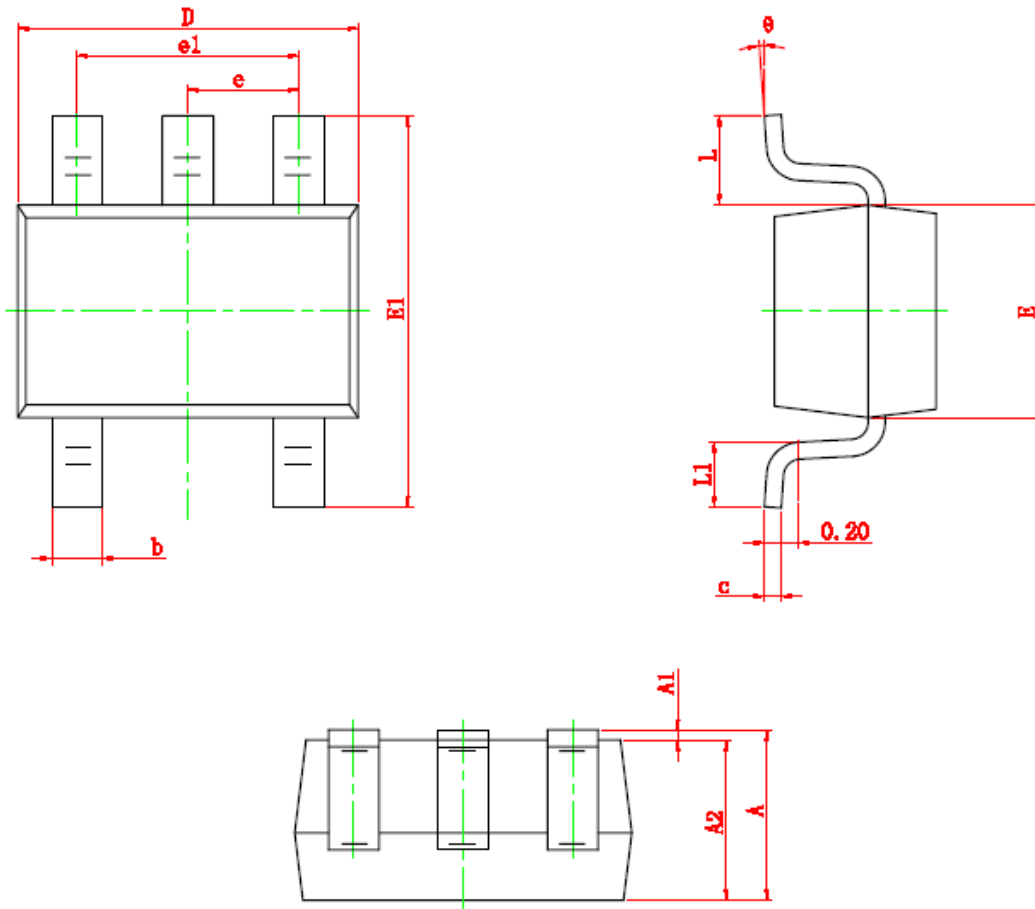
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.400	4.700	0.173	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.100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



# SP432

## Low Voltage Adjustable Precision Shunt Regulators

### 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°



# SP432

## Low Voltage Adjustable Precision Shunt Regulators

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