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March 2015

# KA431S / KA431SA / KA431SL Programmable Shunt Regulator

## Features

- Programmable Output Voltage to 36 V
- Low Dynamic Output Impedance 0.2  $\Omega$  (Typical)
- Sink Current Capability: 1.0 to 100 mA
- Equivalent Full-Range Temperature Coefficient of 50 ppm/ $^{\circ}\text{C}$  (Typical)
- Temperature Compensated for Operation Over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response

## Description

The KA431S / KA431SA / KA431SL are three-terminal adjustable regulator series with a guaranteed thermal stability over the operating temperature range. The output voltage can be set to any value between  $V_{REF}$  (approximately 2.5 V) and 36 V with two external resistors. These devices have a typical dynamic output impedance of 0.2  $\Omega$ . Active output circuitry provides a sharp turn-on characteristic, making these devices excellent replacement for zener diodes in many applications.

### SOT-23F



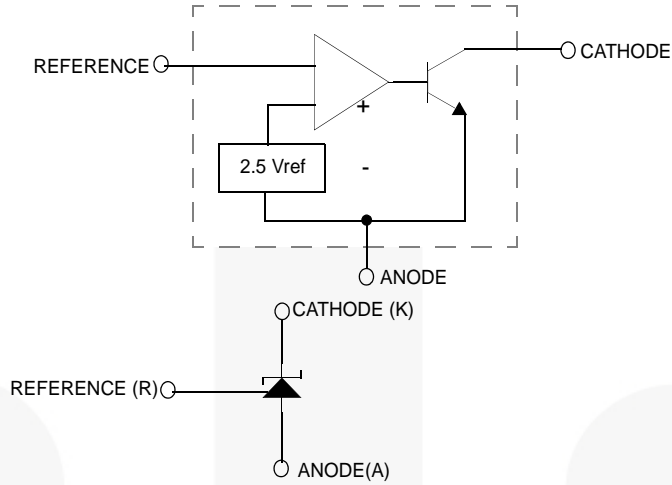
MF- 1.Cathode 2. Ref 3. Anode  
MF2- 1. Ref 2. Cathode 3. Anode

## Ordering Information

Part Number	Operating Temperature Range	Output Voltage Tolerance	Top Mark	Package	Packing Method
KA431SMFTF	-25 to +85 $^{\circ}\text{C}$	2%	43A	SOT-23F 3L	Tape and Reel
KA431SMF2TF			43D		
KA431SAMFTF		1%	43B		
KA431SAMF2TF			43E		
KA431SLMFTF		0.5%	43C		
KA431SLMF2TF			43F		

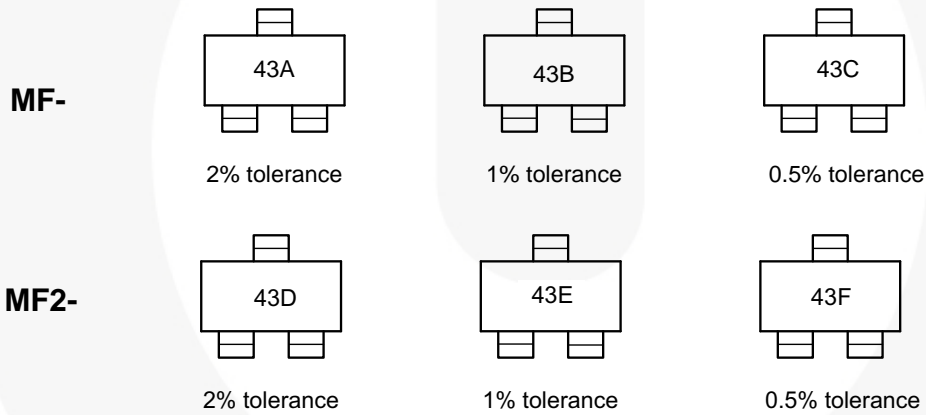
KA431S / KA431SA / KA431SL — Programmable Shunt Regulator

**Block Diagram**



**Figure 1. Block Diagram**

**Marking Information**



**Figure 2. Top Mark (per package)**



## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Value	Unit
$V_{KA}$	Cathode Voltage	37	V
$I_{KA}$	Cathode Current Range (Continuous)	-100 ~ +150	mA
$I_{REF}$	Reference Input Current Range	-0.05 ~ +10	mA
$R_{\theta JA}$	Thermal Resistance Junction-Air <sup>(1,2)</sup> MF Suffix Package	350	$^\circ\text{C}/\text{W}$
$P_D$	Power Dissipation <sup>(3,4)</sup> MF Suffix Package	350	mW
$T_J$	Junction Temperature	150	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature Range	-25 ~ +85	$^\circ\text{C}$
$T_{STG}$	Storage Temperature Range	-65 ~ +150	$^\circ\text{C}$

### Notes:

- Thermal resistance test board  
Size: 1.6mm x 76.2mm x 114.3mm (1S0P)  
JEDEC Standard: JESD51-3, JESD51-7.
- Assume no ambient airflow.
- $T_{JMAX} = 150^\circ\text{C}$ ; Ratings apply to ambient temperature at  $25^\circ\text{C}$ .
- Power dissipation calculation:  $P_D = (T_J - T_A) / R_{\theta JA}$ .

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
$V_{KA}$	Cathode Voltage	$V_{REF}$	36	V
$I_{KA}$	Cathode Current	1	100	mA

**Electrical Characteristics<sup>(5)</sup>**Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Conditions	KA431S			KA431SA			KA431SL			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
$V_{REF}$	Reference Input Voltage	$V_{KA} = V_{REF}$ , $I_{KA} = 10\text{ mA}$	2.450	2.500	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V	
$\Delta V_{REF}/\Delta T$	Deviation of Reference Input Voltage Over-Temperature	$V_{KA} = V_{REF}$ , $I_{KA} = 10\text{ mA}$ , $T_{MIN} \leq T_A \leq T_{MAX}$		4.5	17.0		4.5	17.0		4.5	17.0	mV	
$\Delta V_{REF}/\Delta V_{KA}$	Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$I_{KA} = 10\text{ mA}$	$\Delta V_{KA} = 10\text{ V} - V_{REF}$		-1.0	-2.7		-1.0	-2.7		-1.0	-2.7	mV/V
			$\Delta V_{KA} = 36\text{ V} - 10\text{ V}$		-0.5	-2.0		-0.5	-2.0		-0.5	-2.0	
$I_{REF}$	Reference Input Current	$I_{KA} = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$		1.5	4.0		1.5	4.0		1.5	4.0	$\mu\text{A}$	
$\Delta I_{REF}/\Delta T$	Deviation of Reference Input Current Over Full Temperature Range	$I_{KA} = 10\text{ mA}$ , $R1 = 10\text{ k}\Omega$ , $R2 = \infty$ , $T_A = \text{Full Range}$		0.4	1.2		0.4	1.2		0.4	1.2	$\mu\text{A}$	
$I_{KA(MIN)}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{REF}$		0.45	1.00		0.45	1.00		0.45	1.00	mA	
$I_{KA(OFF)}$	Off - Stage Cathode Current	$V_{KA} = 36\text{ V}$ , $V_{REF} = 0$		0.05	1.00		0.05	1.00		0.05	1.00	$\mu\text{A}$	
$Z_{KA}$	Dynamic Impedance	$V_{KA} = V_{REF}$ , $I_{KA} = 1\text{ to }100\text{ mA}$ , $f \geq 1.0\text{ kHz}$		0.15	0.50		0.15	0.50		0.15	0.50	$\Omega$	

**Note:**5.  $T_{MIN} = -25^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$

## Test Circuits

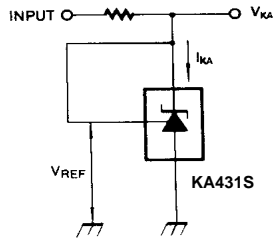


Figure 3. Test Circuit for  $V_{KA} = V_{REF}$

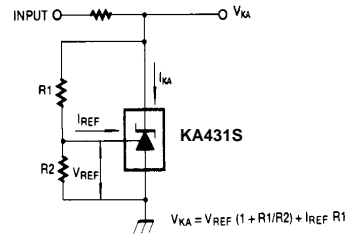


Figure 4. Test Circuit for  $V_{KA} \geq V_{REF}$

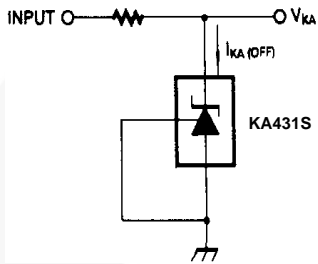


Figure 5. Test Circuit for  $I_{KA(OFF)}$

## Typical Applications

$$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{ref}$$

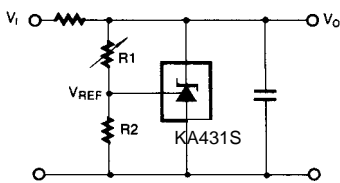


Figure 6. Shunt Regulator

$$V_O = V_{ref} \left(1 + \frac{R_1}{R_2}\right)$$

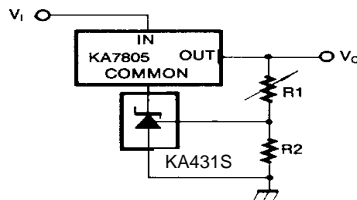


Figure 7. Output Control for Three-Terminal Fixed Regulator

$$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{ref}$$

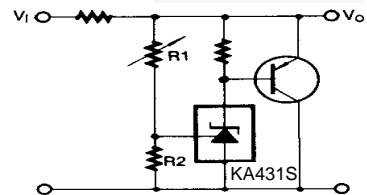


Figure 8. High Current Shunt Regulator

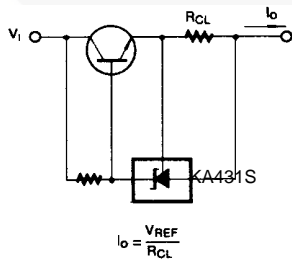


Figure 9. Current Limit or Current Source

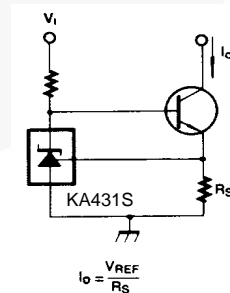


Figure 10. Constant-Current Sink

## Typical Performance Characteristics

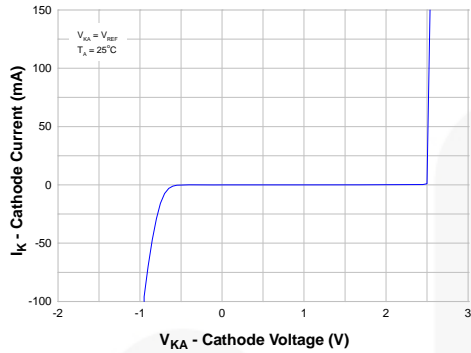


Figure 11. Cathode Current vs. Cathode Voltage

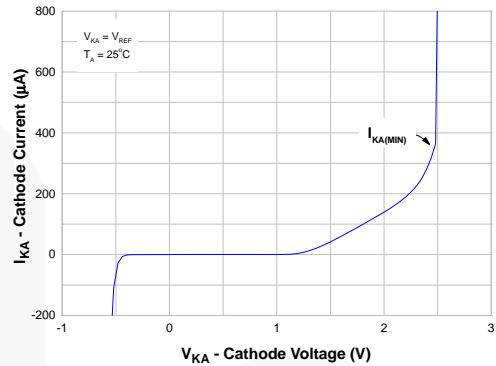


Figure 12. Cathode Current vs. Cathode Voltage

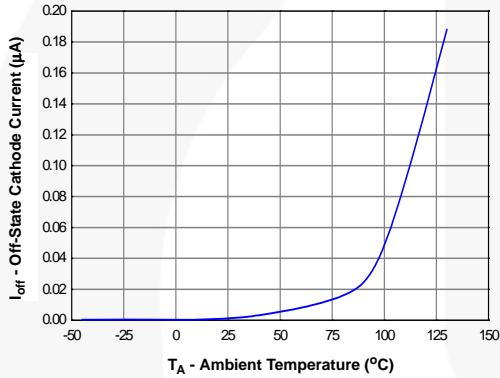


Figure 13. OFF-State Cathode Current vs. Ambient Temperature

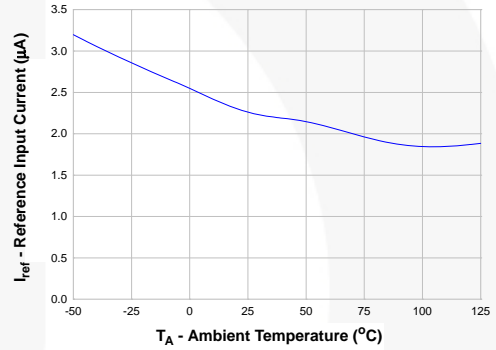


Figure 14. Reference Input Current vs. Ambient Temperature

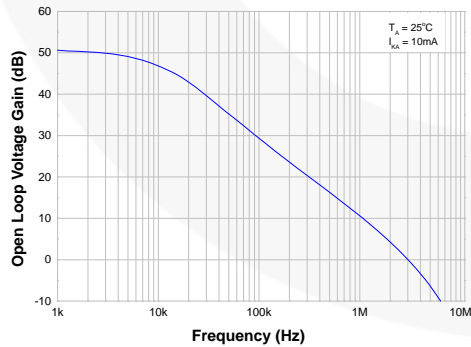


Figure 15. Frequency vs. Small Signal Voltage Amplification

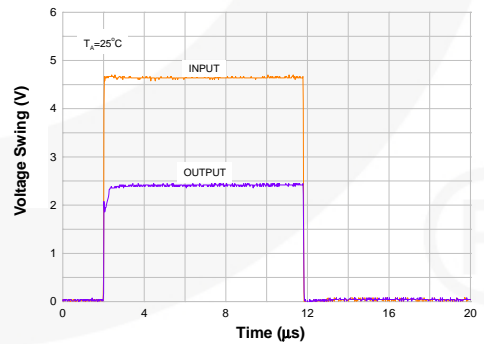


Figure 16. Pulse Response

Typical Performance Characteristics (Continued)

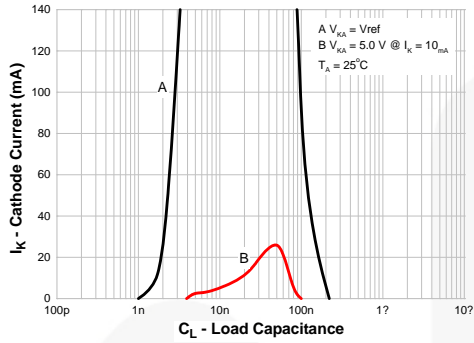


Figure 17. Stability Boundary Conditions

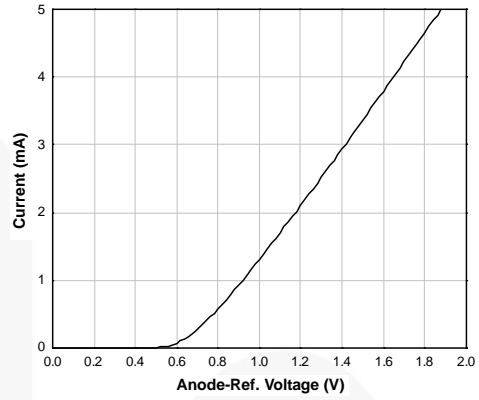


Figure 18. Anode-Reference Diode Curve

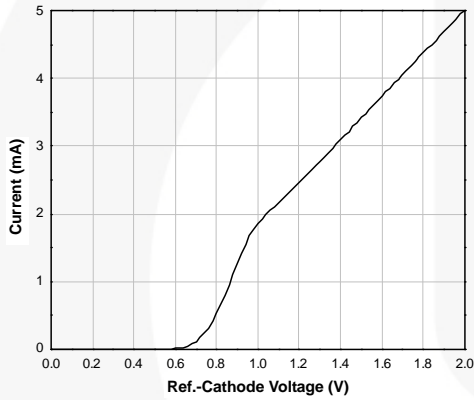


Figure 19. Reference-Cathode Diode Curve

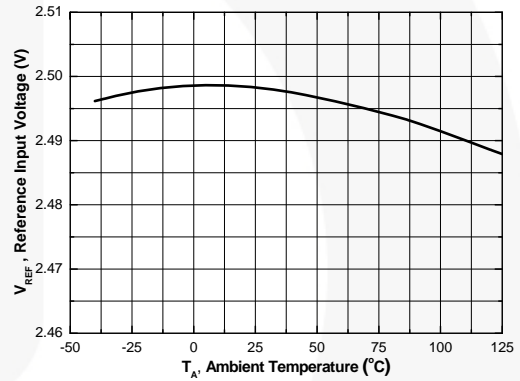


Figure 20. Reference Input Voltage vs. Ambient Temperature



Physical Dimensions

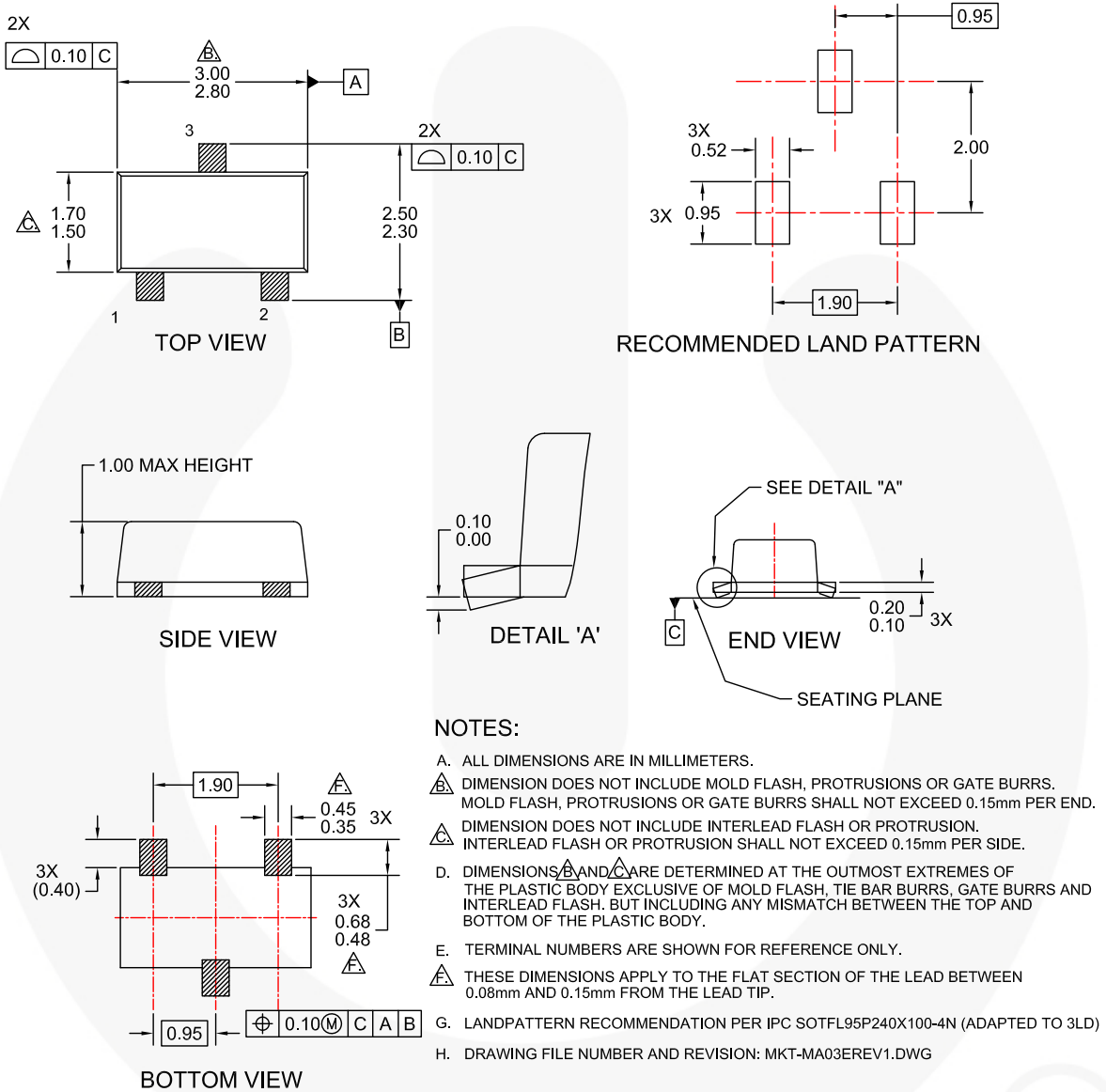



Figure 21. 3-LEAD, SOT23, FLAT LEAD, LOW PROFILE





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