WR431

Adjustable Precision Shunt Regulators

1. General Description

The WR431 is a high precision, highly stable, three-terminal adjustable shunt regulator with reliable thermal stability.

The output voltage of the WR431 can be set to any value between V_{REF} (2.5V) and the corresponding maximum cathode voltage (36V) by two external resistors.

The active output circuitry provides a very sharp turn-on characteristic, making these devices an excellent substitute for Zener diodes in many applications such as on-board regulation, adjustable regulators and switching power supplies.

The low temperature drift and low reference current of the WR431 ensure a highly accurate system. The WR431 precision reference is offered in two voltage tolerances: 0.4% and 0.8%. The IC is available in 5 packages, SOT23, SOT89, SOT23-5, TO92 and SOP8.

The WR431 devices have an operating temperature range of -40°C to 125°C.

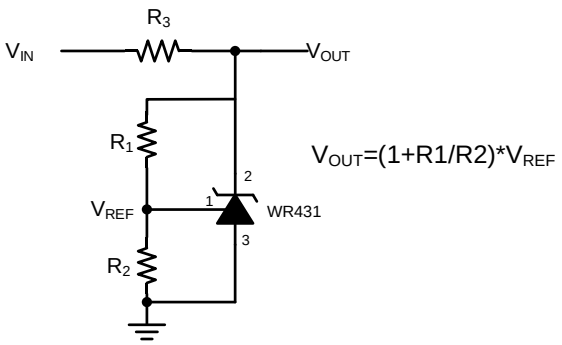
2. Features

- Adjustable output voltage: V_{REF} to 36V
- Low Temperature Drift: 6mV Typical
- Sink Current Capacity from 1mA to 100mA
- Low Output Noise
- Wide Operating Range of -40 to +125°C
- Lead-Free Packages: SOT23, SOT89, SOT23-5, TO-92 and SOP8
- High Stability under Capacitive Load
- Low Equivalent Full-range Temperature Coefficient with 20 PPM/°C Typical

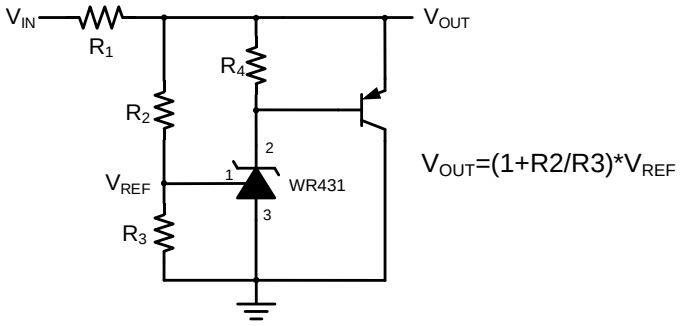
3. Applications

- Precision voltage and current referencing
- Voltage monitoring
- Switching Power Supply
- Comparator with integrated reference
- Zener substitute

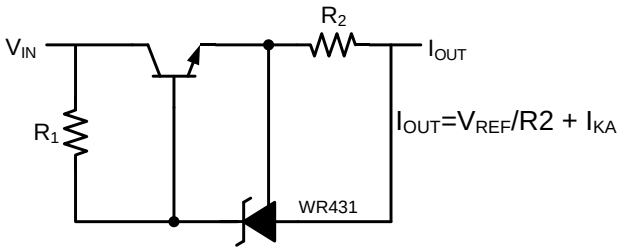
4. Typical Application



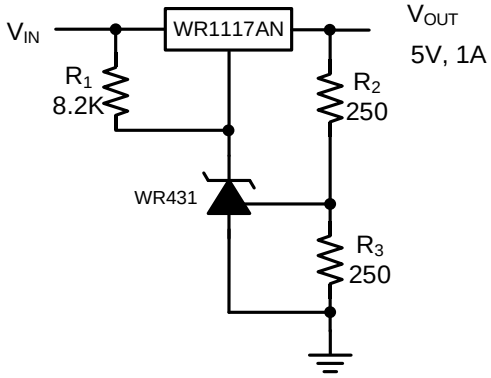
Shunt Regulator



High Current Shunt Regulator



Current Source or Current Limit

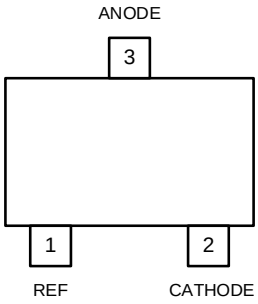


Precision 5V 1A Regulator

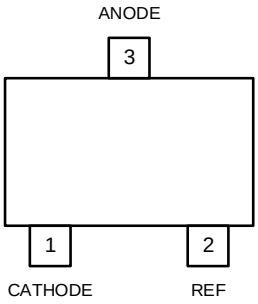
.

5. Pin Configuration

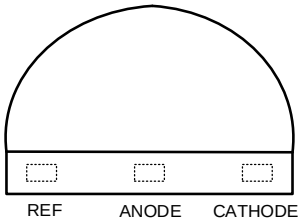
(Top View)



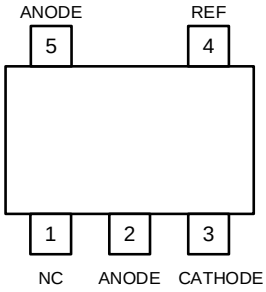
SOT-23(S30)



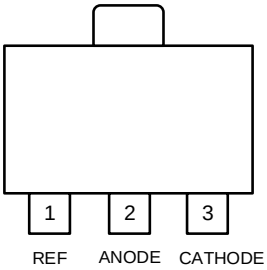
SOT-23(S31)



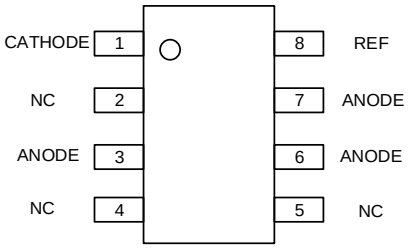
TO-92



SOT23-5



SOT89-3

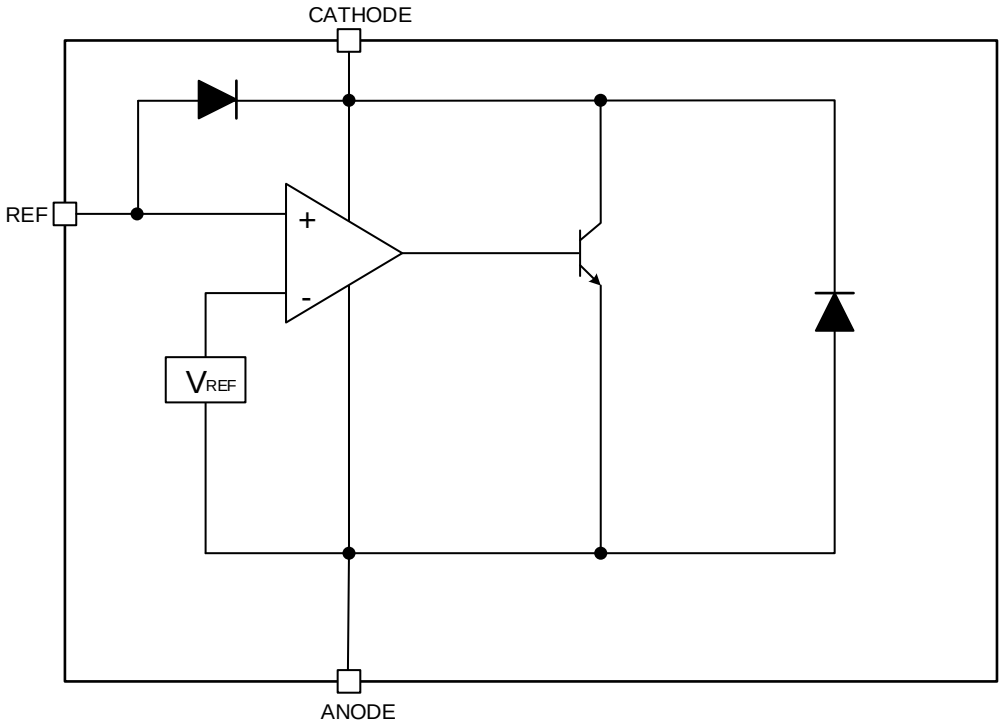


SOP8

6. Pin Description

PIN NUMBER						PIN NAME	I/O	PIN FUNCTIONS
SOT-23 (S30)	SOT-23 (S31)	TO-92	SOT23-5	SOT89-3	SOP8			
1	2	1	4	1	8	REF	I	Threshold relative to common anode
2	1	3	3	3	1	CATHODE	I/O	Shunt Current/Voltage input
3	3	2	2/5	2	3,6,7	ANODE	O	Common pin, normally connected to ground

7. Functional Block Diagram



8. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)[1]

SYMBOL	PARAMETER		RATING	UNIT
V_{KA}	Cathode Voltage		40	V
I_{KA}	Cathode Current Range (Continuous)		-100 to 150	mA
I_{REF}	Reference Input Current Range		10	
P_D[2]	Power Dissipation $P_{D(MAX)}$@T_A =25°C	SOT23	595	mW
		SOT89	2272	
		TO-92	862	
		SOT23-5	595	
θ_{JA} [3]	Junction-to-ambient thermal resistance	SOT23	210	°C/W
		SOT89	55	
		TO-92	145	
		SOT23-5	210	
θ_{JC}	Junction-to-case (top) thermal resistance	SOT23	80	
		SOT89	12	
		TO-92	58	
		SOT23-5	135	
T_J	Junction Temperature		+150	°C
T_{STG}	Storage Temperature Range		-65 to +150	
ESD	ESD (Human Body Model)		2000	V

NOTE1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE2: Power dissipation is calculate by $P_{D(MAX)} = (T_J - T_A) / R_{\theta JA}$.

NOTE3: Measured on 2cm x 2cm 2-layer FR4 PCB board, 1 oz copper, no via holes on GND copper.

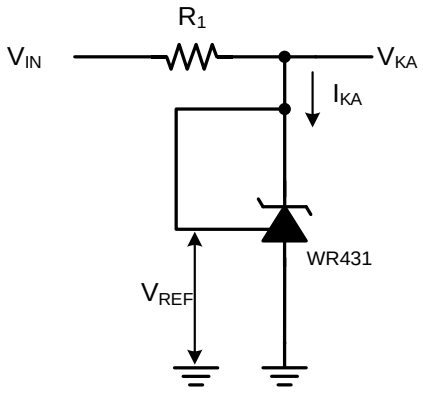
9. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{KA}	Cathode Voltage	V_{REF}	36	V
I_{KA}	Cathode Current	1.0	100	mA
T_A	Operating Ambient Temperature Range	-40	+125	°C

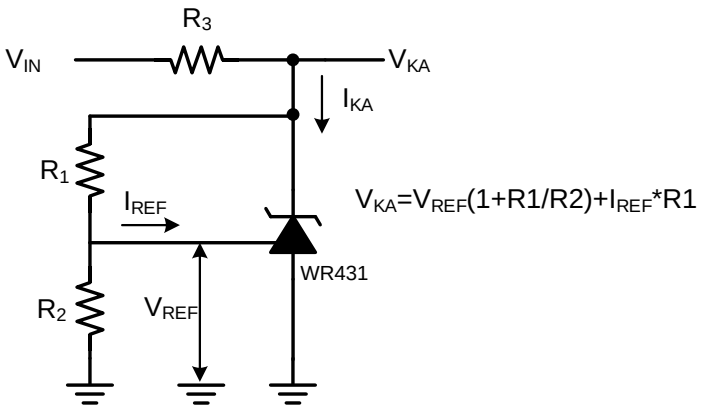
10. Electrical Characteristics

(T_A=25°C, unless otherwise noted)

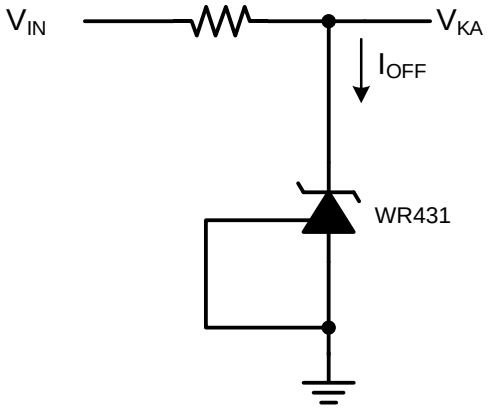
SYMBOL	PARAMETER		CONDITIONS		TEST CIRCUIT	MIN	TYP.	MAX	UNIT
V_{REF}	Reference Voltage	0.4%	V_{KA} = V_{REF}, I_{KA} = 10mA		Test Circuit1	2.49	2.50	2.51	V
		0.8%				2.48	2.50	2.52	
ΔV_{REF}	Deviation of Reference Voltage		V_{KA}=V_{REF}, I_{KA} = 10mA	0 to +70°C	Test Circuit1	-	6	14	mV
				-40 to +85°C		-	7	16	
				-40 to +125°C		-	9	20	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change in Reference Voltage to the Change in Cathode Voltage		I_{KA} = 10mA	ΔV_{KA}=10V to V_{REF}	Test Circuit2	-	-1.0	-2.7	mV/V
				ΔV_{KA}=36V to 10V		-	-0.5	-2.0	
I_{REF}	Reference Current		I_{KA} = 10mA, R1 = 10kΩ, R2 =∞		Test Circuit2	-	1.0	4	μA
ΔI_{REF}	Deviation of Reference Current Over Full Temperature Range		I_{KA} = 10mA, R1 = 10kΩ R2 = ∞, T_A = -40 to +125°C		Test Circuit2	-	0.4	1.2	μA
I_{KA}(Min)	Minimum Cathode Current for Regulation		V_{KA} = V_{REF}		Test Circuit1	-	0.4	0.7	mA
I_{KA}(Off)	Off-state Cathode Current		V_{KA}=36V, V_{REF}=0		Test Circuit3	-	0.04	1.0	μA
Z_{KA}	Dynamic Impedance		V_{KA}= V_{REF}, I_{KA} = 1 to 100mA, F≤1.0kHz		Test Circuit1	-	0.15	0.5	Ω



Test Circuit 1 for V_{KA} = V_{REF}



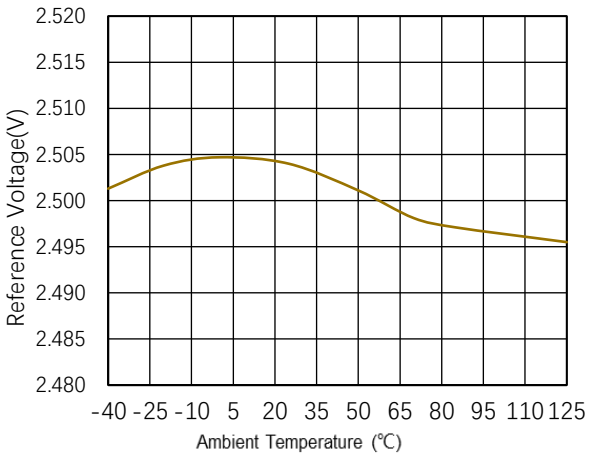
Test Circuit 2 for $V_{KA} > V_{REF}$



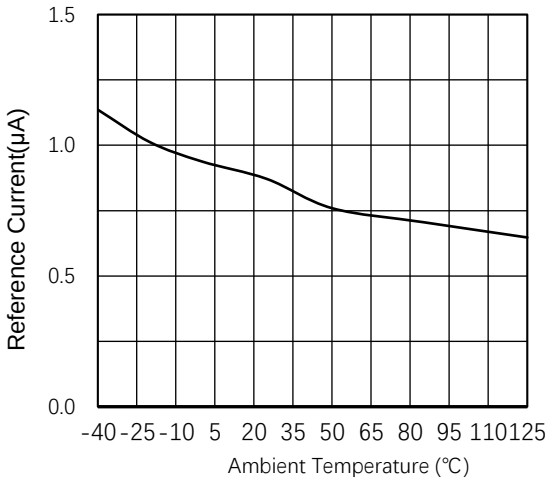
Test Circuit 3 for I_{OFF}

11. Typical Performance Characteristics

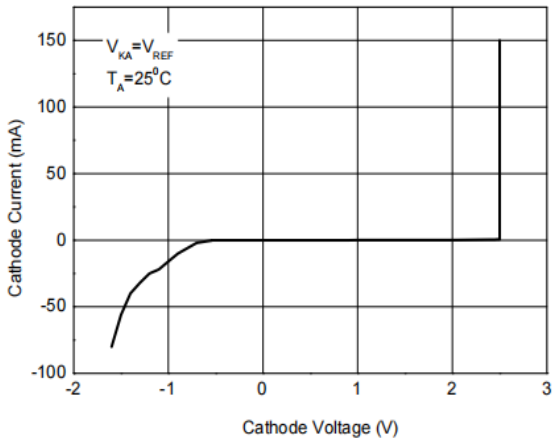
T_A=25ºC, unless otherwise noted.



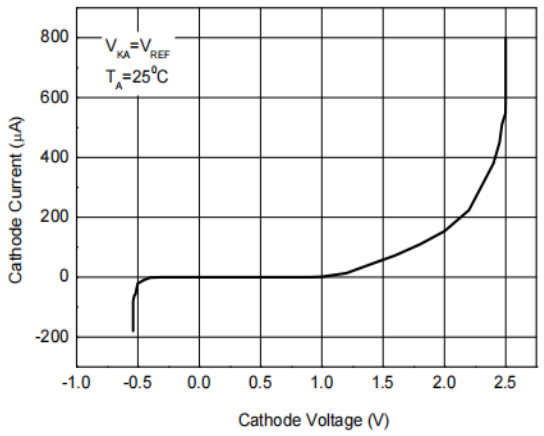
Reference Voltage vs. Ambient Temperature



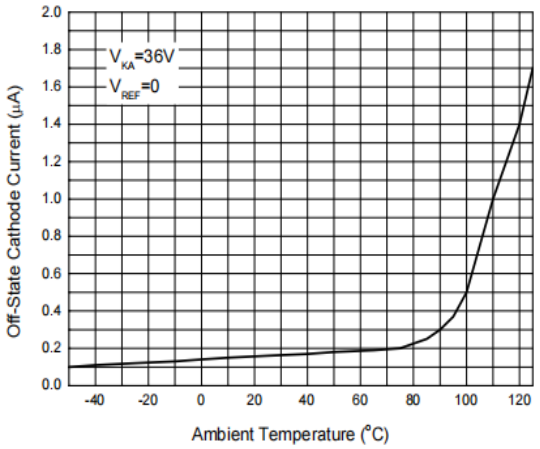
Reference Current vs. Ambient Temperature



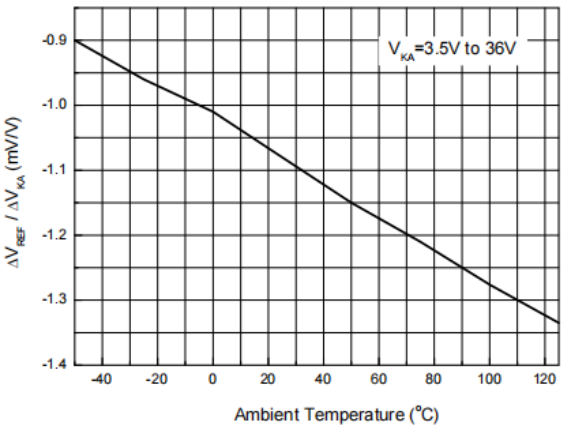
Cathode Current vs. Cathode Voltage



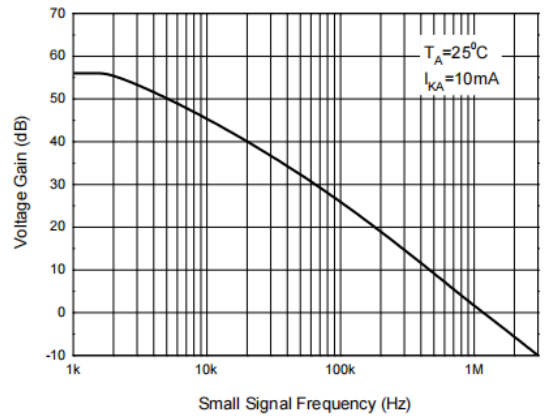
Cathode Current vs. Cathode Voltage

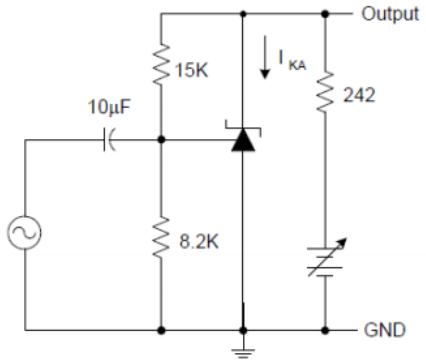


Off-State Cathode Current vs. Ambient Temperature

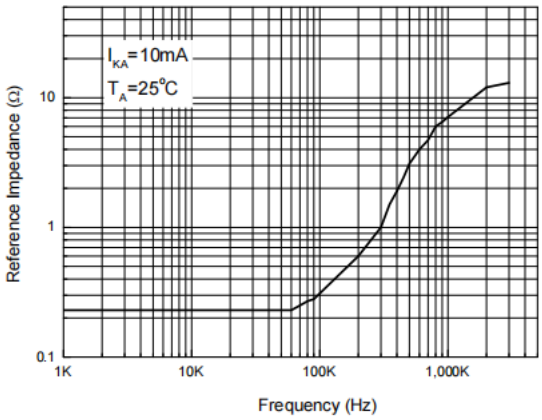


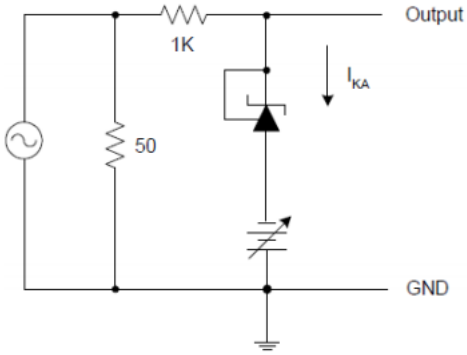
Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage



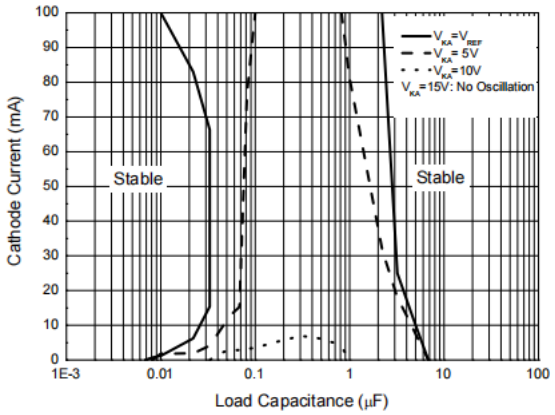


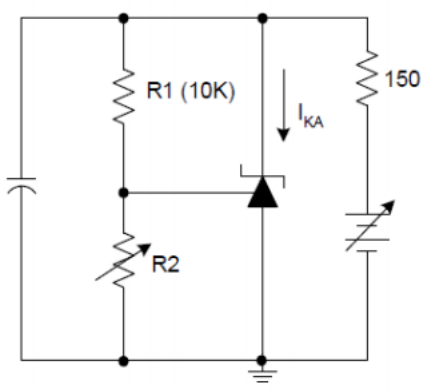
Small Signal Voltage Gain vs. Frequency



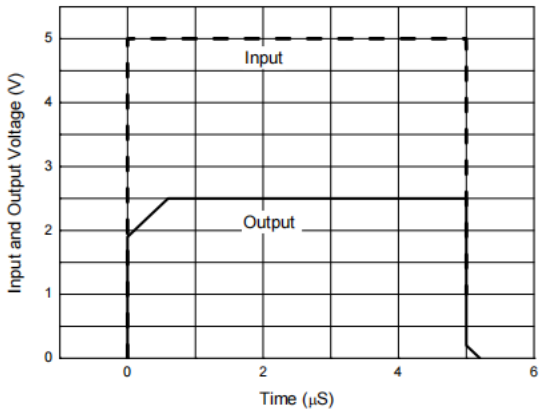


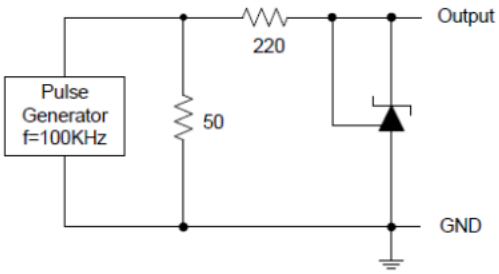
Reference Impedance vs. Frequency





Stability Boundary Conditions vs. Load Capacitance





Pulse Response of Input and Output Voltage

12. Device Functional Modes

12.1 Open Loop (Comparator)

When the cathode/output voltage or current of WR431 is not being fed back to the reference/input pin in any form, this device is operating in open loop. With such high gain in this configuration, WR431 is typically used as a comparator. With the reference integrated makes WR431 the preferred choice when users are trying to monitor a certain level of a single signal.

12.2 Closed Loop

When the cathode/output voltage or current of WR431 is being fed back to the reference/input pin in any form, this device is operating in closed loop. The majority of applications involving WR431 use it in this manner to regulate a fixed voltage or current. The feedback enables this device to behave as an error amplifier, computing a portion of the output voltage and adjusting it to maintain the desired regulation. This is done by relating the output voltage back to the reference pin in a manner to make it equal to the internal reference voltage, which can be accomplished through resistive or direct feedback.

13. Naming conventions

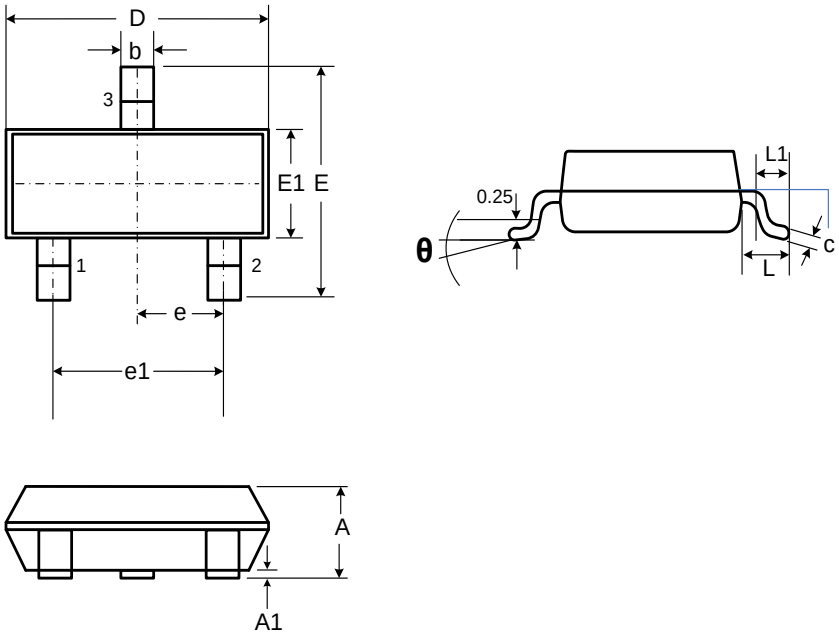
WR AAA-B CCC D
WR: WAYON Regulator
AAA: 431
B: Accuracy, A: 0.4%, B: 0.8%
CCC: S30/S31- Package, SOT-23
A20- Package, SOT89-3
A50- Package, SOT23-5
NM1- Package, TO-92
S80- Package, SOP8
D: R-Reel & B-Box

14. Electrostatic Discharge Warning

ESD can cause irreversible damage to integrated circuits, ranging from minor performance degradation to device failure. Precision ICs are more susceptible to damage because very minor parameter changes can cause the device to be out of compliance with its published specifications. WAY-ON recommends that all ICs be handled with proper precautions. Failure to follow proper handling practices and installation procedures may damage the IC.

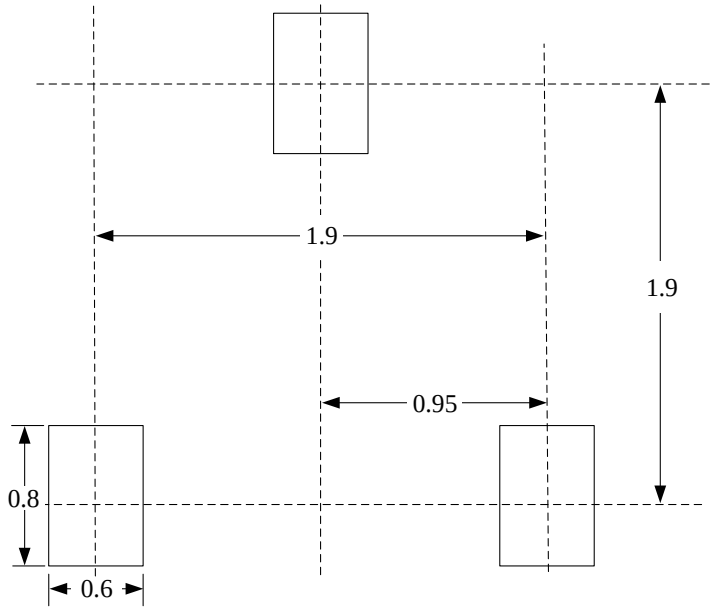
15. Package Information

SOT-23



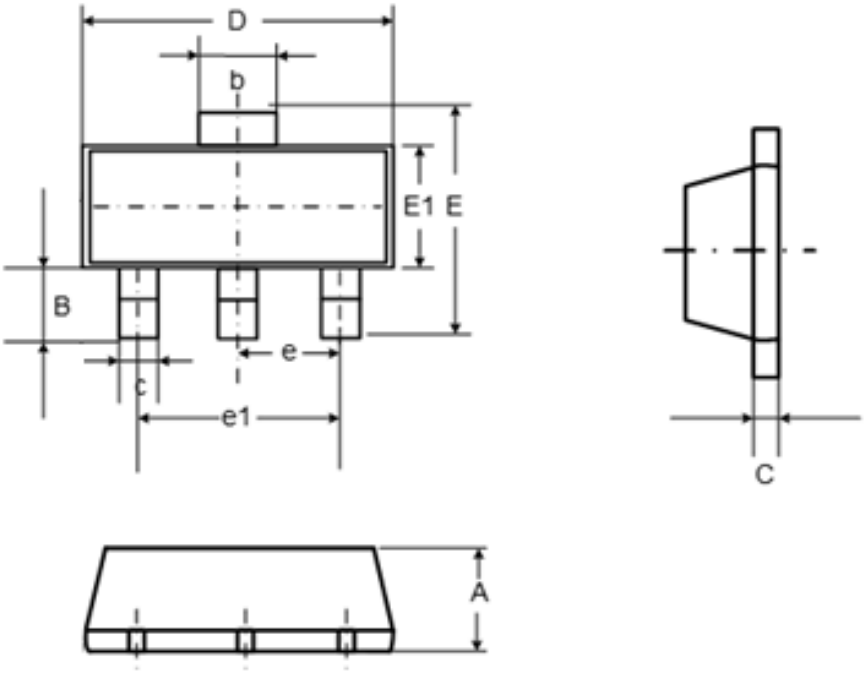
SYMBOL	DIMENSIONS IN MILLIMETERS	
	MIN	MAX
A	0.90	1.15
A1	0.00	0.15
b	0.30	0.50
c	0.05	0.25
D	2.70	3.10
E	2.25	2.64
E1	1.20	1.40
e	0.95BSC	
e1	1.80	2.00
L	0.55REF	
L1	0.30	0.50
θ	0°	8°

Recommended Pad Layout: SOT-23



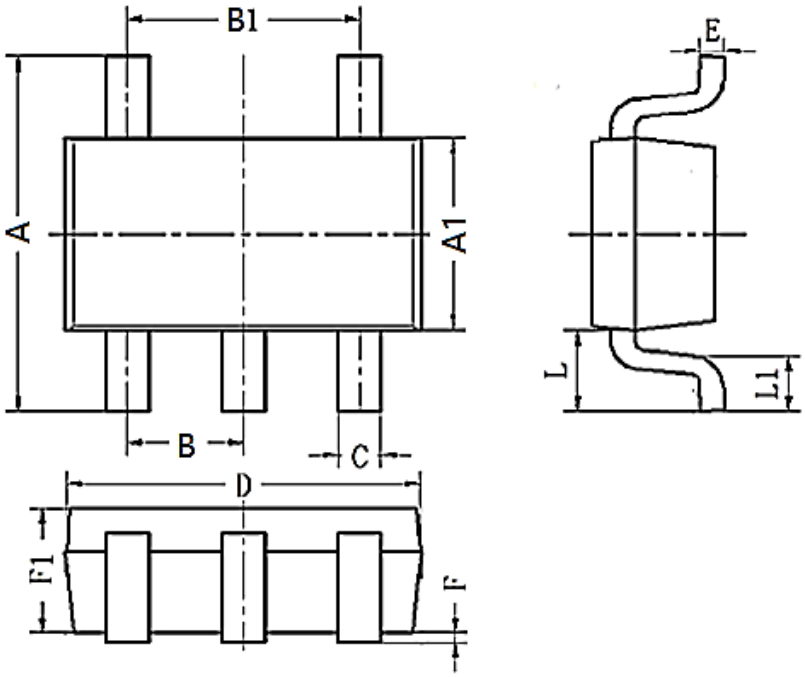
NOTE: Dimensions In Millimeters

SOT89-3



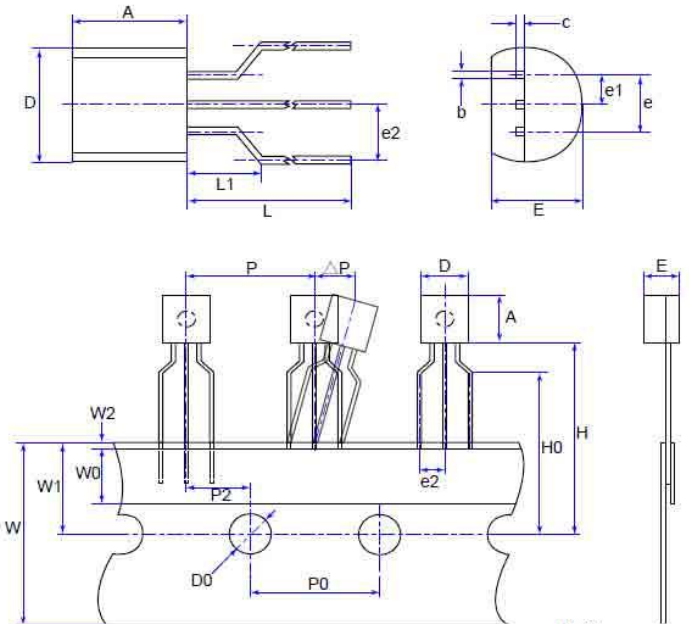
SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.40	1.50	1.60
B	0.80	1.00	1.20
b	1.50	1.65	1.80
C	0.35	0.405	0.46
c	0.32	0.42	0.52
E	3.94	4.12	4.30
E1	2.30	2.45	2.60
D	4.40	4.50	4.60
e	1.50BSC		
e1	3.00BSC		

SOT23-5



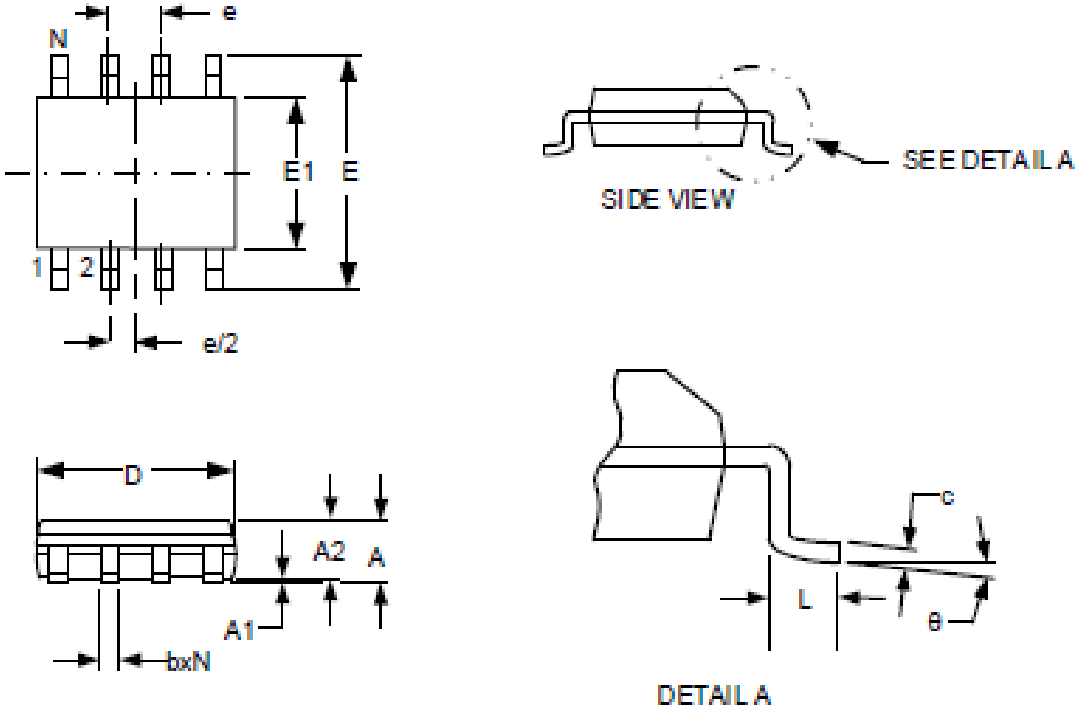
SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	2.60	2.80	3.00
A1	1.50	1.60	1.70
B	0.85	0.95	1.05
B1	1.80	1.90	2.00
C	0.25	0.37	0.50
D	2.79	2.90	3.02
E	0.10	0.15	0.20
F	0.00	0.10	0.20
L	0.60REF		
L1	0.30	0.45	0.60
F1	0.85	1.10	1.30

TO-92



SYMBOL	DIMENSIONS IN MILLIMETERS	
	MIN	MAX
A	4.30	4.70
b	0.38	0.55
c	0.36	0.51
D	4.30	4.70
D0	3.80	4.20
E	3.30	3.70
e	2.44	2.64
e1	1.27TYP	
e2	2.20	2.96
H	18.00	21.00
H0	15.50	16.50
L	12.70	-
L1	2.50	4.50
p	12.40	13.00
p0	12.50	12.90
p2	6.05	6.65
W	17.50	19.00
W0	5.50	6.50
W1	8.50	9.50
W2	-	1.00
Δp	-	1.00

SOP-8



SYMBOL	DIMENSIONS IN MILLIMETERS	
	MIN	MAX
A	1.25	1.90
A1	0.00	0.25
A2	1.25	1.65
b	0.31	0.51
c	0.15	0.30
D	4.70	5.20
E1	3.70	4.10
E	5.75	6.25
e	1.27BSC	
L	0.4	1.27
θ	0°	8°
N	8	

16. Ordering Information

PART NUMBER	VOLTAGE TOLERANCE	OUTPUT VOLTAGE	PACKAGE	PACKING QUANTITY	MARKING*
WR431-AS30R	0.4%	2.5V	SOT-23	3K/Reel	WR431 A XXXX
WR431-BS30R	0.8%	2.5V	SOT-23	3K/Reel	WR431 B XXXX
WR431-AS31R	0.4%	2.5V	SOT-23	3K/Reel	WR431 A XXXX
WR431-BS31R	0.8%	2.5V	SOT-23	3K/Reel	WR431 B XXXX
WR431-AA20R	0.4%	2.5V	SOT89-3	1K/Reel	WR431 A XXXX
WR431-BA20R	0.8%	2.5V	SOT89-3	1K/Reel	WR431 B XXXX
WR431-AA50R	0.4%	2.5V	SOT23-5	3K/Reel	WR431 A XXXX
WR431-BA50R	0.8%	2.5V	SOT23-5	3K/Reel	WR431 B XXXX
WR431-ANM1B	0.4%	2.5V	TO-92	2K/Tape box	WR431 A XXXX
WR431-BNM1B	0.8%	2.5V	TO-92	2K/Tape box	WR431 B XXXX
WR431-AS80R	0.4%	2.5V	SOP8	4K/Reel	WR431 A XXXX
WR431-BS80R	0.8%	2.5V	SOP8	4K/Reel	WR431 B XXXX

* XXXX is variable.

Contact Information

No.1001, Shiwan(7) Road, Pudong District, Shanghai, P.R.China.201207
Tel: 86-21-50310888 Fax: 86-21-50757680 Email: market@way-on.com
WAYON website: http://www.way-on.com
For additional information, please contact your local Sales Representative.
WAYON® is registered trademark of Wayon Corporation.

Product Specification Statement

1.The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.

2.The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. WAYON shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and WAYON assumes no responsibility for the application of the product.

3.WAYON strives to provide accurate and up-to-date information to the best of our ability. However, due to technical, human, or other reasons, WAYON cannot guarantee that the information provided in the product specification is entirely accurate and error-free. WAYON shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications. WAYON reserves the right to revise or update the product specification and the products at any time without prior notice, and the user's continued use of the product specification is considered an acceptance of these revisions and updates. Prior to purchasing and using the product, users should verify the above information with WAYON to ensure that the product specification is the most current, effective, and complete. If users are particularly concerned about product parameters, please consult WAYON in detail or request relevant product test reports. Any data not explicitly mentioned in the product specification shall be subject to separate agreement.

4.Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.

5.The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. WAYON shall assume no responsibility for any consequences resulting from such usage.

6.Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third-party legal rights. WAYON shall assume no responsibility for any disputes or controversies arising from the above-mentioned issues in any form.