

DATA SHEET

JUNE 10, 2003

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REV 1-03

MIK431 • ADJUSTABLE PRECISION SHUNT REGULATOR



REPLACEMENT
of **AS431**
LM431
TL431
SC431

MIK431 ADJUSTABLE PRECISION SHUNT REGULATOR

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GENERAL DESCRIPTION

The MIK431 is three-terminal adjustable shunt regulator with specified thermal stability. The output voltage may be set to any value between V_{REF} (approximately 2.5V) and 36V with two external resistors. These devices have a typical output impedance of 0.2Ω. Active output circuitry provides a very sharp turn-on characteristic, making the MIK431 an excellent replacement for Zener diodes in many applications.

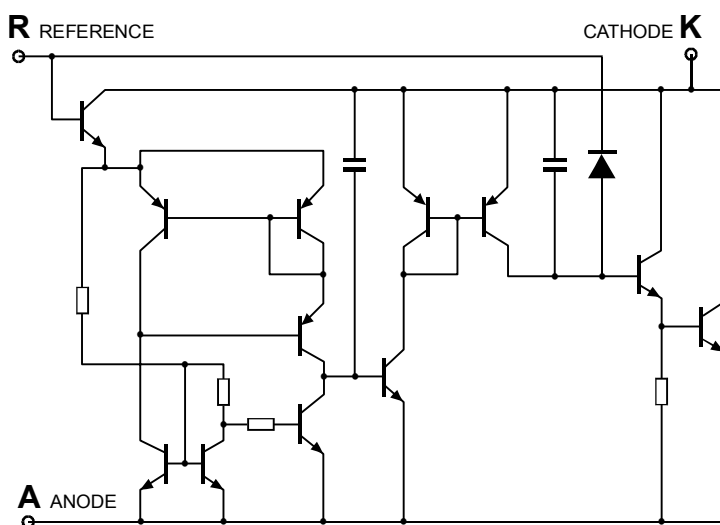
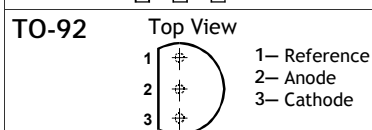
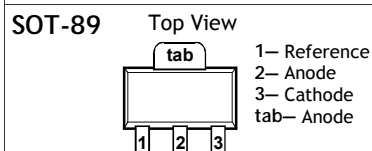
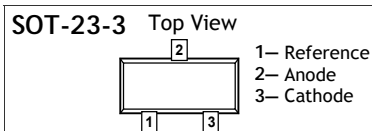
FEATURES

- Equivalent full-range temperature coefficient 30 ppm/°C.
- Temperature compensated for operation over full rated operating temperature range.
- Adjustable output voltage.
- Fast turn-on response.
- Sink current capability 1mA to 100 mA.
- Low (0.2 Ω typ.) dynamic output impedance.
- Low output noise.

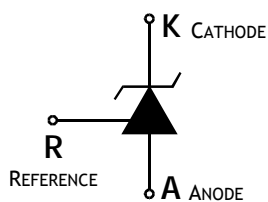
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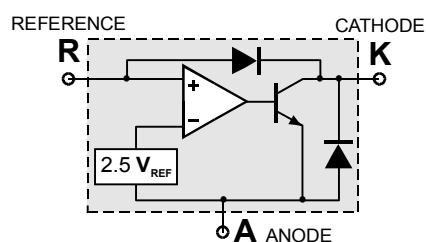
REPRESENTATIVE SCHEMATIC DIAGRAM

SOT-23-3  MIK431xCM3SOT-89  MIK431xCM2TO-92  MIK431xCZ

SYMBOL



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR TEMPERATURE RANGE, UNLESS OTHERWISE NOTED.

SYMBOL	PARAMETER	MAXIMUM	UNIT
V_{KA}	Cathode voltage (Note 1)	37	V
I_K	Continuous cathode current range	-100 to 150	mA
I_{REF}	Reference input current range	-50 μ A to 10mA	
	Operating free-air temperature range	0 to 70	$^{\circ}$ C
	Lead temperature 1.6mm from case for 10 seconds	260	$^{\circ}$ C

Note 1: Voltage values are with respect to the anode terminal unless otherwise noted.

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{KA}	Cathode voltage	V_{ref}	36	V
I_K	Cathode current (for regulation)	1	100	mA



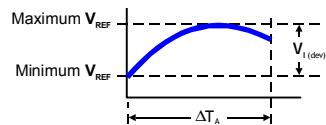
ELECTRICAL CHARACTERISTICS

Electrical characteristics at 25°C free-air temperature (unless otherwise noted)

SYMBOL	PARAMETER	TEST CIRCUIT	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{REF}	Reference input voltage	1	$V_{KA}=V_{REF}, I_K=10mA$				
			MIK431C (0.5%)	2487	2500	2513	mV
			MIK431B (1.0%)	2474	2500	2526	
			MIK431A (2.0%)	2450	2500	2550	
$V_{REF (dev)}$	Deviation of reference input voltage over full temperature range	1	$V_{KA}=V_{REF}, I_K=10mA, T_A=full\ range$		4	17	mV
$\Delta V_{REF} / \Delta V_{KA}$	Ratio of change in reference input voltage to the change in cathode voltage	2	$I_K=10mA$				$\frac{mV}{V}$
			$\Delta V_{KA}=10V\ to\ V_{REF}$	-2,7	-1.0		
			$\Delta V_{KA}=36V\ to\ 10V$	-2	-0.4		
I_{REF}	Reference input current	2	$I_K=10mA, R1=10K\Omega, R2=\infty$		0.7	4	μA
$I_{REF (dev)}$	Deviation of reference input current over full temperature range	2	$I_K=10mA, R1=10K\Omega, R2=\infty, T_A=full\ range$		0.4	1.2	μA
I_{min}	Minimum cathode current for regulation	1	$V_{KA}=V_{REF}$		0.4	1.0	mA
I_{OFF}	Off-state cathode current	3	$V_{KA}=36V, V_{REF}=0$		0.1	1.0	μA
$ Z_K $	Dynamic impedance	1	$V_{KA}=V_{REF}, I_K=1mA\ to\ 100mA, f \leq 1KHz$		0.2	0.5	Ω

The deviation parameters $V_{REF(dev)}$ and $I_{REF(dev)}$ are defined as the differences between the maximum and minimum values obtained over the recommended temperature range. The average full-range temperature coefficient of the reference voltage, αV_{REF} , is defined as:

$$\left| \alpha V_{REF} \right| \left(\frac{ppm}{^{\circ}C} \right) = \frac{\left(\frac{V_{I(dev)}}{V_{REF\ at\ 25^{\circ}C}} \right) \times 10^6}{\Delta T_A}$$



where:

ΔT_A is the recommended operating free-air temperature range of the device.

αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF} , respectively, occurs at the lower temperature.

Example: maximum $V_{REF} = 2496\ mV$ at $30^{\circ}C$, minimum $V_{REF} = 2492\ mV$ at $0^{\circ}C$, $V_{REF} = 2495\ mV$ at $25^{\circ}C$, $\Delta T_A = 70^{\circ}C$ for MIK431C

$$\left| \alpha V_{REF} \right| = \frac{\left(\frac{4\ mV}{2495\ mV} \right) \times 10^6}{70^{\circ}C} \approx 23\ ppm/^{\circ}C$$

Because minimum V_{REF} occurs at the lower temperature, the coefficient is positive.

CALCULATING DYNAMIC IMPEDANCE

The dynamic impedance is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

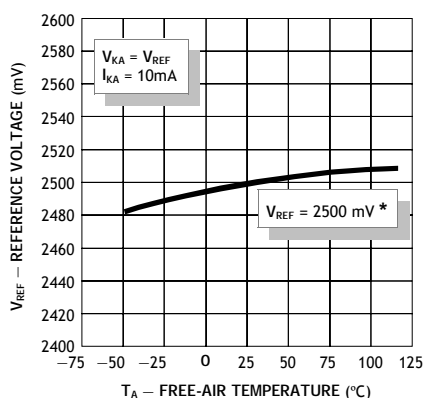
When the device is operating with two external resistors (see Figure 3), the total dynamic impedance of the circuit is given by:

$$|Z'| = \frac{\Delta V}{\Delta I} \approx |Z_{KA}| \left(1 + \frac{R1}{R2} \right)$$



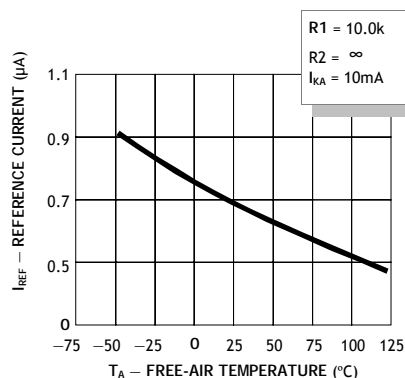
TYPICAL CHARACTERISTICS

REFERENCE VOLTAGE versus FREE-AIR TEMPERATURE

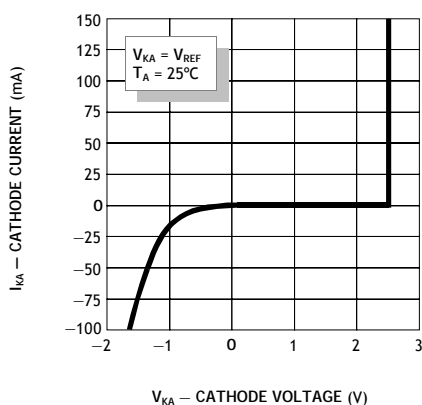


* Data is for devices having the indicated value of V_{REF} at $I_{KA} = 10 mA$, $T_A = 25^{\circ}C$

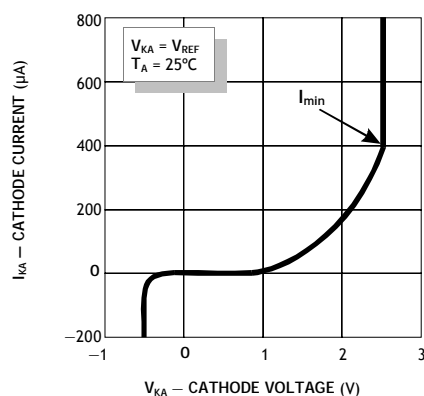
REFERENCE CURRENT versus FREE-AIR TEMPERATURE



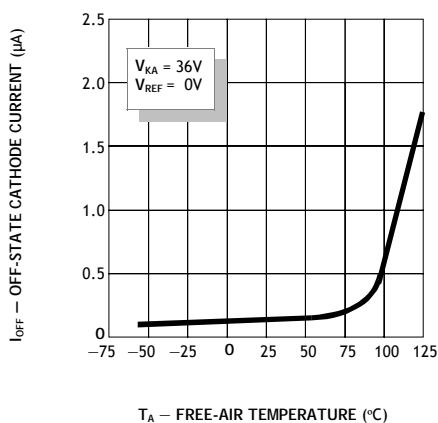
CATHODE CURRENT versus CATHODE VOLTAGE (1)



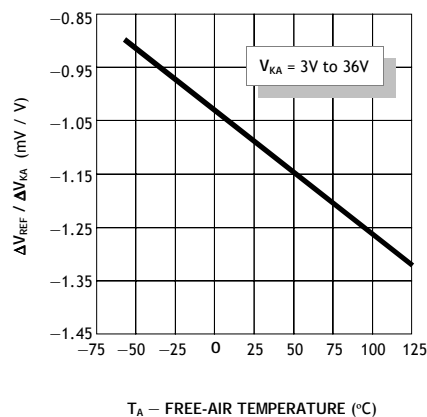
CATHODE CURRENT versus CATHODE VOLTAGE (2)



OFF-STATE CATHODE CURRENT versus FREE-AIR TEMPERATURE



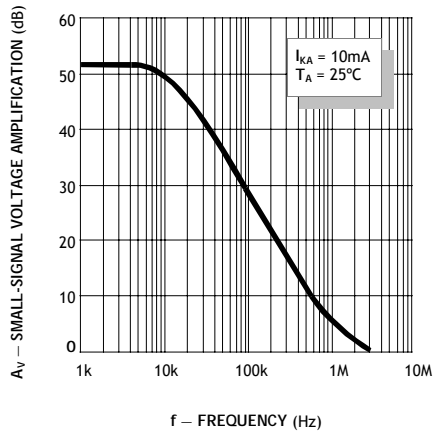
RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE versus FREE-AIR TEMPERATURE



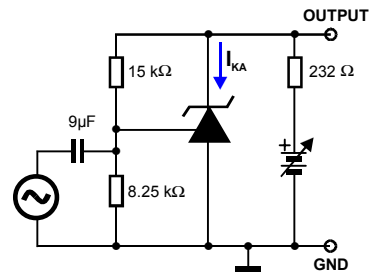


TYPICAL CHARACTERISTICS (CONTINUED)

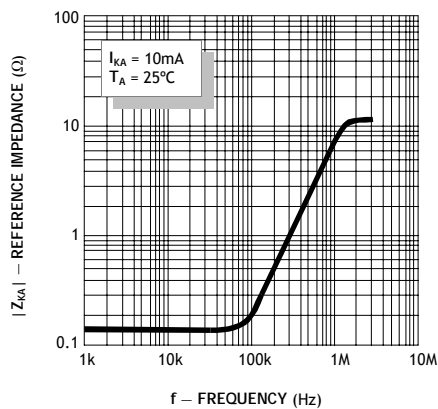
SMALL-SIGNAL VOLTAGE AMPLIFICATION versus FREQUENCY



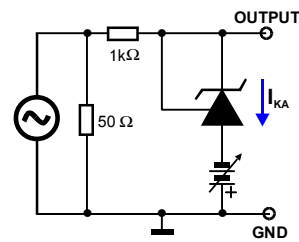
TEST CIRCUIT FOR VOLTAGE AMPLIFICATION



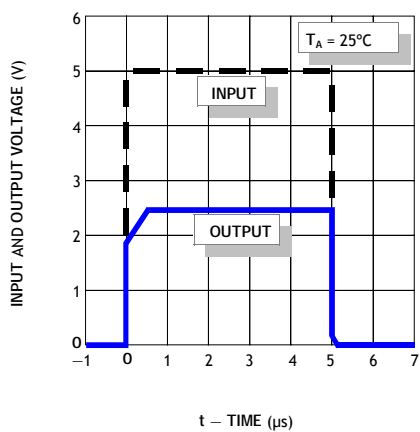
REFERENCE IMPEDANCE versus FREQUENCY



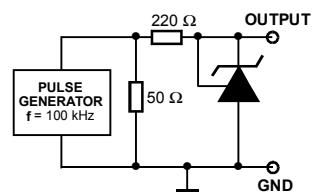
TEST CIRCUIT FOR REFERENCE IMPEDANCE



PULSE RESPONSE

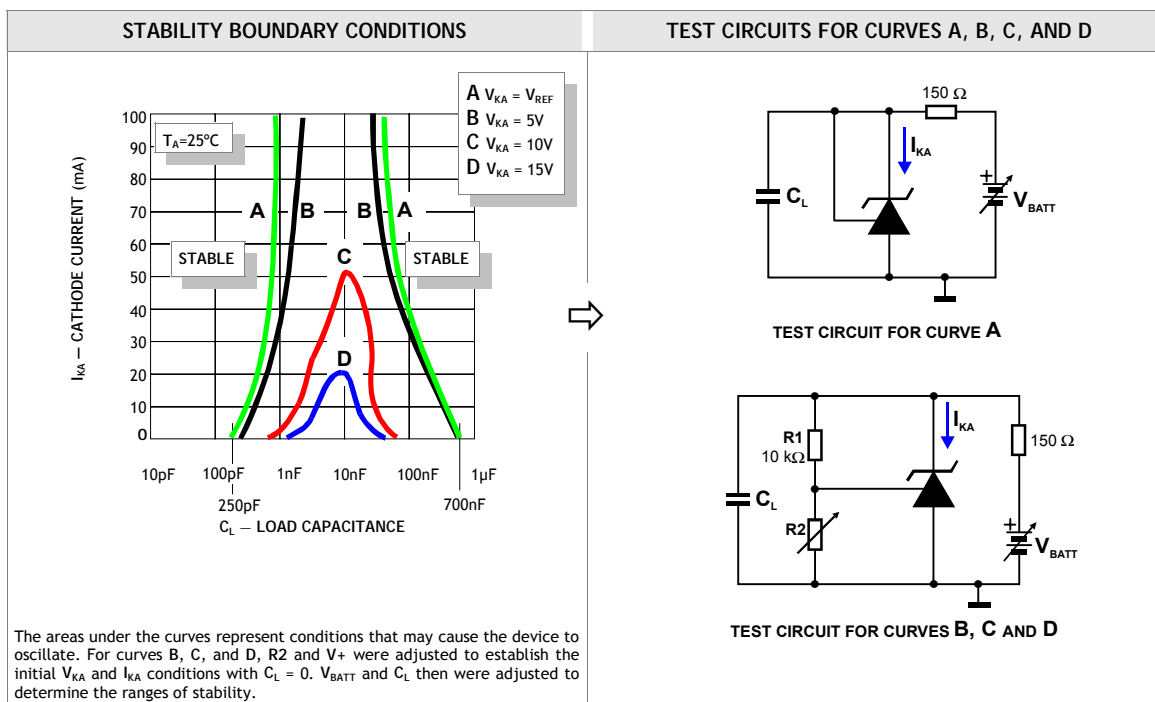


TEST CIRCUIT FOR PULSE RESPONSE

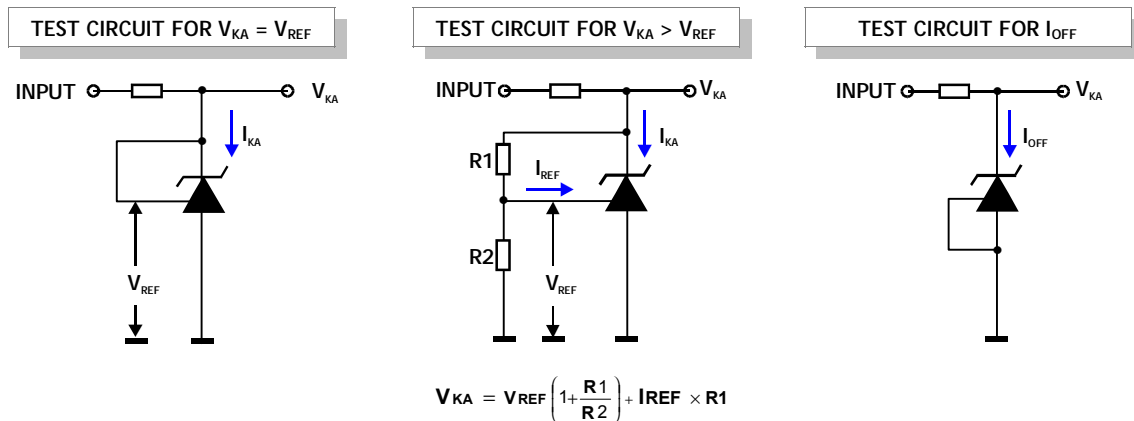




TYPICAL CHARACTERISTICS (CONTINUED)



PARAMETER MEASUREMENT INFORMATION





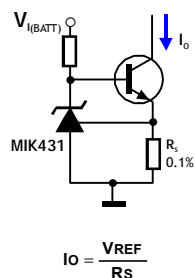
APPLICATION INFORMATION

SHUNT REGULATOR	SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD	PRECISION HIGH-CURRENT SERIES REGULATOR
$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$ <p>* R should provide cathode current ≥ 1 mA to the MIK431 at minimum $V_{I(BATT)}$</p>	$V_{ON} \approx 2V$ $V_{OFF} \approx V_{I(BATT)}$	$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$ <p>* R should provide cathode current ≥ 1 mA to the MIK431 at minimum $V_{I(BATT)}$</p>
OUTPUT CONTROL OF A THREE-TERMINAL FIXED REGULATOR	HIGH-CURRENT SHUNT REGULATOR	CROWBAR CIRCUIT
$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$ <p>Minimum $V_O = V_{REF} + 5V$</p>	$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$	<p>* Refer to the stability boundary conditions (see page 6) to determine allowable values for C.</p>
PRECISION 5-V 1.5-A REGULATOR	EFFICIENT 5-V PRECISION REGULATOR	PWM CONVERTER WITH REFERENCE
$V_O = 5V; 1.5A$	<p>* Rb should provide cathode current ≥ 1 mA to the MIK431</p>	<p>Feedback</p> <p>NOT USED</p>
VOLTAGE MONITOR	DELAY TIMER	PRECISION CURRENT LIMITER
$\text{Low Limit} = \left(1 + \frac{R_{1B}}{R_{2B}}\right) V_{REF}$ $\text{High Limit} = \left(1 + \frac{R_{1A}}{R_{2A}}\right) V_{REF}$ <p>LED on when Low Limit $< V_{I(BATT)} <$ High Limit.</p> <p>* R3 and R4 are selected to provide the desired LED intensity and cathode current ≥ 1 mA to the MIK431 at the available $V_{I(BATT)}$.</p>	$\text{Delay} = R \times C \times \ln \left(\frac{12V}{12V - V_{REF}} \right)$	$I_{OUT} = \frac{V_{REF}}{R_{CL}} + I_{KA}$ $R_1 = \frac{V_{I(BATT)}}{\frac{I_O}{hFE} + I_{KA}}$

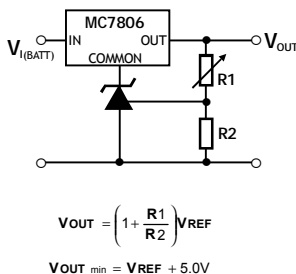


APPLICATION INFORMATION (CONTINUED)

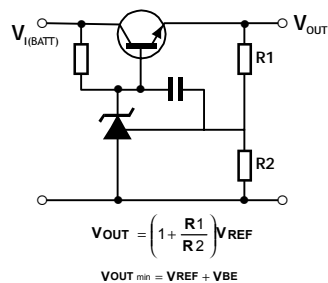
PRECISION CONSTANT-CURRENT SINK



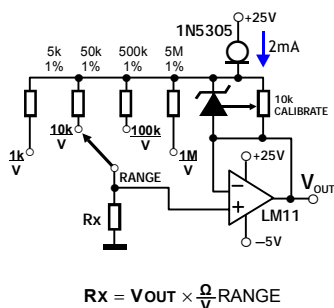
OUTPUT CONTROL FOR A THREE-TERMINAL FIXED REGULATOR



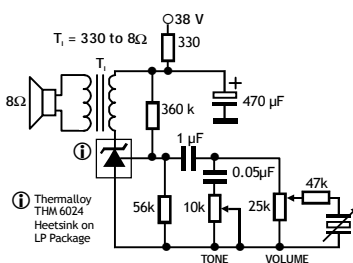
SERIES PASS REGULATOR



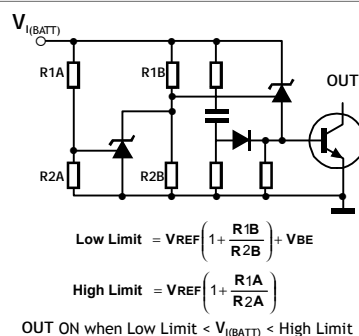
LINEAR OHMMETER



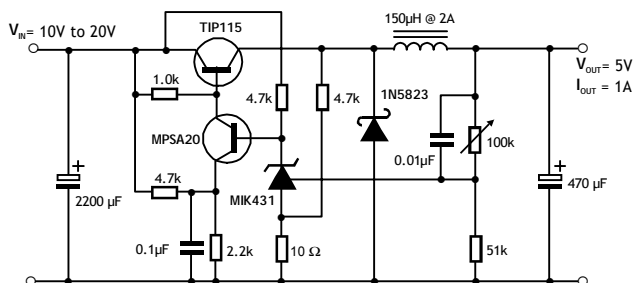
SIMPLE 400 mW PHONO AMPLIFIER



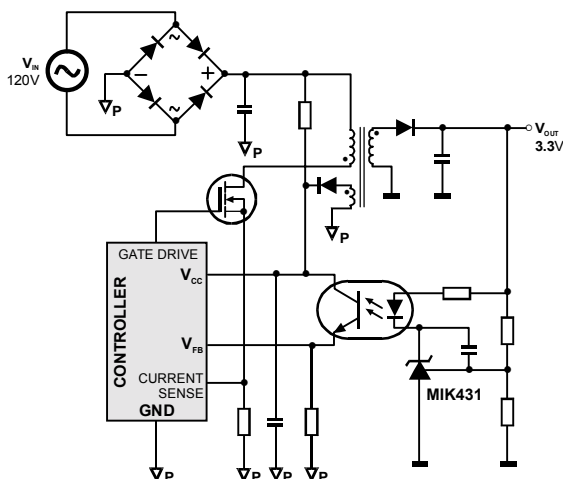
OVER VOLTAGE/UNDER VOLTAGE PROTECTION CIRCUIT



HIGH EFFICIENCY STEP-DOWN SWITCHING CONVERTER



FLYBACK WITH ISOLATION USING MIK431 AS VOLTAGE REFERENCE AND ERROR AMPLIFIER

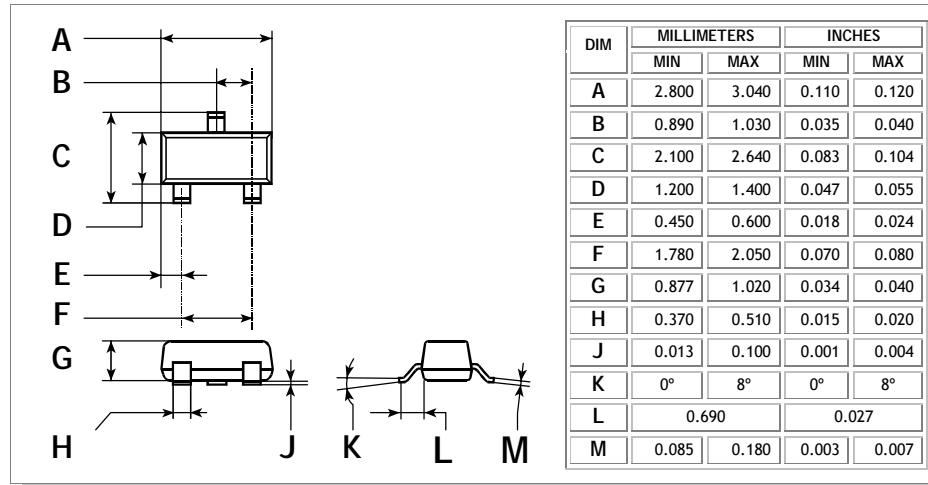


This figure shows the MIK431 used in a 3.3-V isolated flyback supply. Output voltage V_{OUT} can be as low as reference voltage V_{REF} ($1.24\text{ V} \pm 1\%$). The output of the regulator plus the forward voltage drop of the optocoupler LED ($1.24 + 1.4 = 2.64\text{ V}$) determine the minimum voltage that can be regulated in an isolated supply configuration.



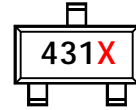
PHYSICAL DIMENSIONS AND MARKING DIAGRAMS

SOT-23-3 PACKAGE



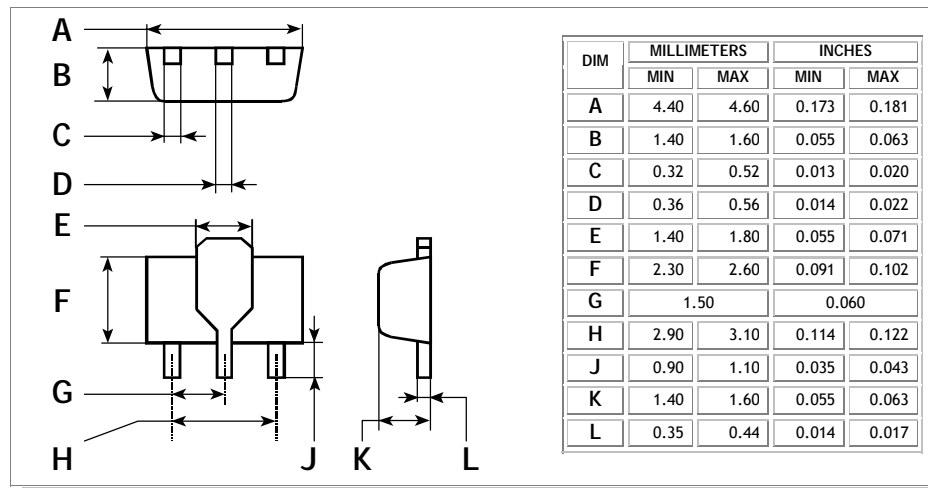
SOT-23-3

MARKING DIAGRAM



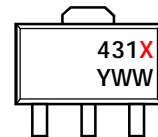
X	INITIAL TOLERANCE
431A	2%
431B	1%
431C	0.5%

SOT-89 PACKAGE



SOT-89

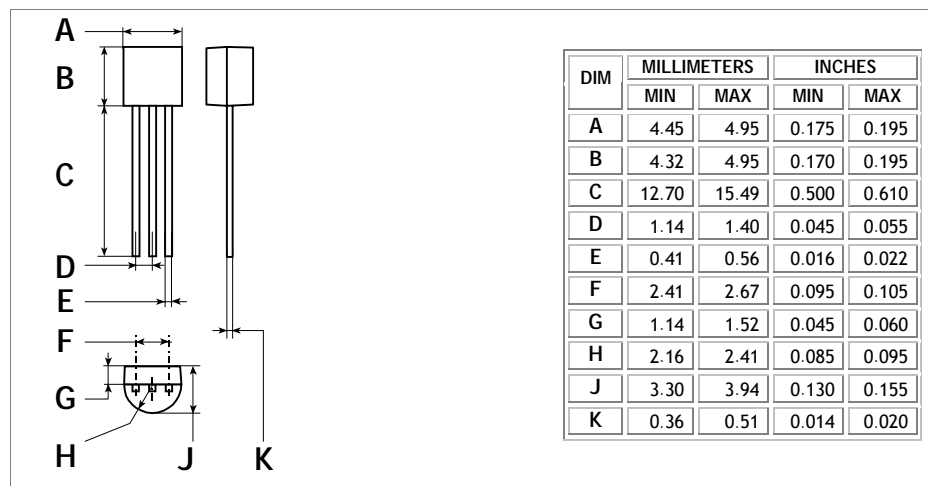
MARKING DIAGRAM



Y — year
WW — work week

X	INITIAL TOLERANCE
431A	2%
431B	1%
431C	0.5%

TO-92 PACKAGE



TO-92

MARKING DIAGRAM



YY — year
WW — work week
n — assembly location

X	INITIAL TOLERANCE
431A	2%
431B	1%
431C	0.5%



ORDERING INFORMATION





DEVICE	TOLERANCE (%)	OPERATING TEMPERATURE	PACKAGE	SHIPPING
MIK 431 ACM3	2.0	0°C - + 70°C	SOT-23-3	Units/Rail & Units/Reel
MIK 431 BCM3	1.0	0°C - + 70°C	SOT-23-3	Units/Rail & Units/Reel
MIK 431 CCM3	0.5	0°C - + 70°C	SOT-23-3	Units/Rail & Units/Reel
MIK 431 ACM2	2.0	0°C - + 70°C	SOT-89	Units/Rail & Units/Reel
MIK 431 BCM2	1.0	0°C - + 70°C	SOT-89	Units/Rail & Units/Reel
MIK 431 CCM2	0.5	0°C - + 70°C	SOT-89	Units/Rail & Units/Reel
MIK 431 ACZ	2.0	0°C - + 70°C	TO-92	Units/Bag & Units/Reel
MIK 431 BCZ	1.0	0°C - + 70°C	TO-92	Units/Bag & Units/Reel
MIK 431 CCZ	0.5	0°C - + 70°C	TO-92	Units/Bag & Units/Reel

NOTE: The form of packing is stipulated in the contract.




The information presented in this Data sheet is believed to be accurate and reliable. However, MIKRON can assume no responsibility for its use as well as for use of the circuits or devices described herein.

In the interest of product improvement, MIKRON reserves the right to change specifications and data without notice.

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