

PROGRAMMABLE VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE: 2.5 to 36V
- SINK CURRENT CAPABILITY: 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE: 0.22Ω
- 1% AND 2% VOLTAGE PRECISION

DESCRIPTION

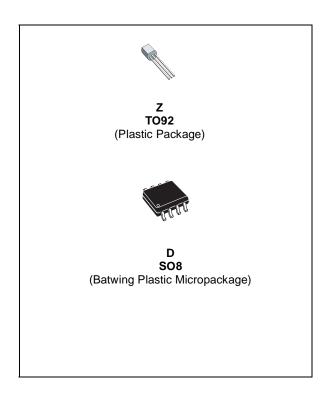
The TL431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation. The output voltage may be set to any value between 2.5V and 36V with two external resistors. The TL431 operates with a wide current range

from 1 to 100mA with a typical dynamic

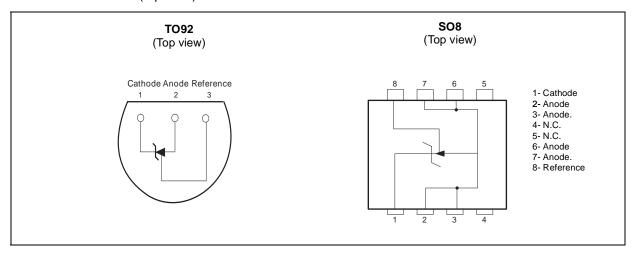
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impedance of 0.22Ω .

Part			kage
Number	Range	Z	D
TL431C/AC	0°C, +70°C	•	•
TL431I/AI	-40°C, +105°C	•	•



PIN CONNECTIONS (top view)



1/10 March 2002

ABSOLUTE MAXIMUM RATINGS

Symbol	Para	meter	Value	Unit
V_{KA}	Cathode to Anode Voltage		37	V
I _k	Continuous Cathode Current Rar	nge	-100 to +150	mA
I _{ref}	Reference Input Current Range		-0.05 to +10	mA
p _d	Power Dissipation 1)	TO92 SO8 batwing	625 960	mW
T _{stg}	Storage Temperature Range		-65 to +150	°C

^{1.} Pd is calculated with T_{amb} = +25°C, T_j = +150°C and R_{thja} = 200°C/W for TO92 package = 130°C/W for SO8 batwing package

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{KA}	Cathode to Anode Voltage	V _{ref} to 36	V
I _k	Cathode Current	1 to 100	mA
T _{oper}	Operating Free-air Temperature Range TL431C/AC TL431I/AI	0 to +70 -40 to +105	°C

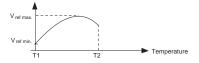
ELECTRICAL CHARACTERISTICS

 $T_{amb} = 25$ °C (unless otherwise specified)

Cumbal	Devemates	Parameter TL431C			TL431AC	;	Unit	
Symbol	Parameter	Min.	Тур.	Max.	Min.	Тур.	Max.	Offic
	Reference Input Voltage							
V_{ref}	$V_{KA} = V_{ref}$, $Ik = 10 \text{ mA}$ $T_{amb} = 25^{\circ}\text{C}$	2.44	2.495	2.55	2.47	2.495	2.52	V
	$T_{min} \le T_{amb} \le T_{max}$	2.423		2.567	2.453		2.537	
	Reference Input Voltage Deviation Over-							
ΔV_{ref}	Temperature Range - note 1							
	$V_{KA} = V_{ref}$, $I_{k} = 10 \text{ mA}$, $T_{min} \le T_{amb} \le T_{max}$		3	17		3	15	mV
	Ratio of Change in Reference Input							
ΔVref	Voltage to Change in Cathode to Anode							
$\frac{\Delta V I G I}{\Delta V ka}$	Voltage - (figure 2)							
Δνκα	Ik = 10mA $\Delta V_{KA} = 10V$ to Vref		-1.4	-2.7		-1.4	-2.7	mV/V
	$\Delta V_{KA} = 36V \text{ to } 10V$		-1	-2		-1	-2	
	Reference Input Current							
I _{ref}	Ik = 10mA, R1 = 10k Ω , R2 = ∞							
ret	$T_{amb} = 25^{\circ}C$		1.8	4		1.8	4	μΑ
	$T_{min} \le T_{amb} \le T_{max}$			5.2			5.2	
	Reference Input Current Deviation							
ΔI_{ref}	Over Temperature Range							
	Ik = 10mA, R1 = 10kΩ, R2 = ∞		0.4	4.0		0.4	4.0	
	$T_{min} \le T_{amb} \le T_{max}$		0.4	1.2		0.4	1.2	μΑ
I _{min}	Minimum Cathode Current for Regulation							
	$V_{KA} = V_{ref}$		0.5	1		0.5	0.6	mA
l _{off}	Off-State Cathode Current		2.6	1000		2.6	1000	nA
ZKA	Dynamic Impedance - note 2							
1211//	$V_{KA} = V_{ref}$, $\Delta Ik = 1 to 100 mA$, $f \le 1kHZ$		0.22	0.5		0.22	0.5	Ω

 $^{1)\,\}Delta V_{\text{ref}} \text{ is defined as the difference between the maximum and minimum values obtained over the full temperature range.}$

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²⁾ The dynamic Impedance is definied as $\, \big| \, ZKA \, \big| = \frac{\Delta VKA}{\Delta IK} \,$

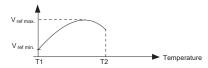
 $[\]Delta V_{ref} = V_{ref max.} - V_{ref min.}$

ELECTRICAL CHARACTERISTICS

 $T_{amb} = 25$ °C (unless otherwise specified)

Comple al	Bernanden		TL431I			TL431AI Min. Typ. Max. 2.47 2.495 2.52 2.44 2.55 2.55		11
Symbol	Parameter	Min.	Тур.	Max.	Min.	Тур.	Max.	Unit
V _{ref}	$\begin{aligned} & \text{Reference Input Voltage} \\ & V_{KA} = V_{ref} \text{ , Ik} = 10 \text{ mA} T_{amb} = 25^{\circ}\text{C} \\ & T_{min} \leq T_{amb} \leq T_{max} \end{aligned}$	2.44 2.41	2.495	2.55 2.58		2.495	-	V
ΔV_{ref}	Reference Input Voltage Deviation Over- Temperature Range - note 1 $V_{KA} = V_{ref}$, $I_{K} = 10 \text{ mA}$, $T_{min} \le T_{amb} \le T_{max}$		7	30		7	30	mV
<u>ΔVref</u> ΔVka	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage Ik = 10mA $\Delta V_{KA} = 10V \text{ to } V_{ref}$ $\Delta V_{KA} = 36V \text{ to } 10V$		-1.4 -1	-2.7 -2		-1.4 -1	-2.7 -2	mV/V
Iref	Reference Input Current Ik = 10mA, R1 = 10k Ω , R2 = ∞ $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		1.8	4 6.5		1.8	4 6.5	μΑ
Δ lref	Reference Input Current Deviation Over Temperature Range Ik = 10mA, R1 = $10k\Omega$, R2 = ∞ $T_{min} \le T_{amb} \le T_{max}$		0.8	2.5		0.8	1.2	μΑ
lmin			0.5	1		0.5	0.7	mA
loff	Off-State Cathode Current		2.6	1000	_	2.6	1000	nA
ZKA	Dynamic Impedance note 2 $V_{KA} = V_{ref}$, Δ Ik = 1 to100mA, f \leq 1kHZ		0.22	0.5		0.22	0.5	Ω

1) ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range. $\Delta V_{ref} = V_{ref}$ max. $^{-}$ V_{ref} min.



2) The dynamic Impedance is definied as $\left| \, \text{ZKA} \, \right| = \frac{\Delta \text{VKA}}{\Delta \text{IK}}$

Figure 1 : Test Circuit for $V_{KA} = V_{REF}$

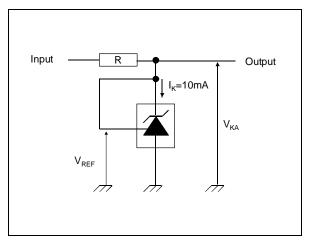


Figure 3 : Test Circuit for I_{OFF}

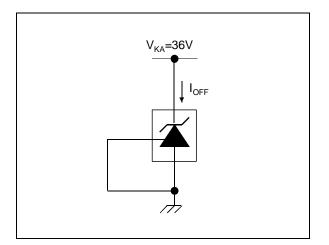


Figure 5: Block diagram of TL1431

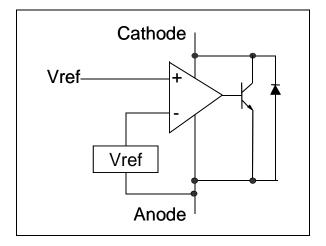


Figure 2 : Test Circuit for $V_{KA} > V_{REF}$

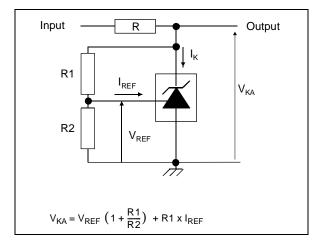


Figure 4 : Test Circuit for Phase Margin and Voltage Gain

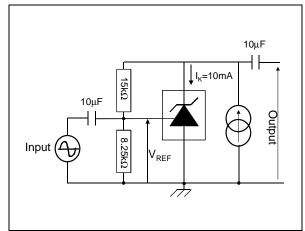
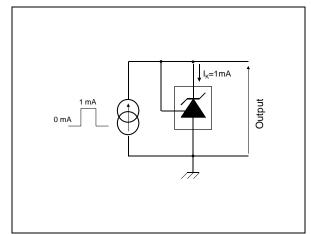
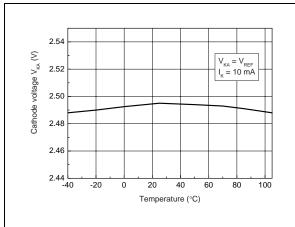


Figure 6: Test Circuit for Response time

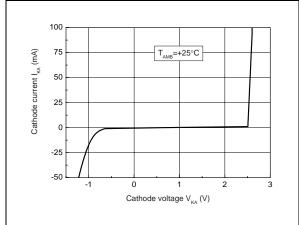


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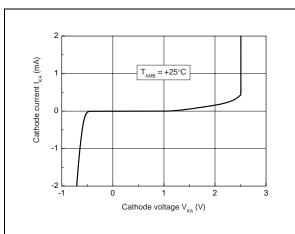
Reference voltage vs Temperature



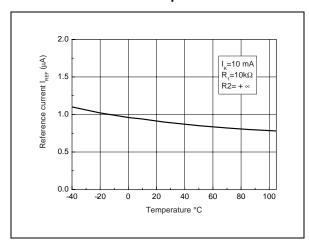
Reference voltage vs cathode current



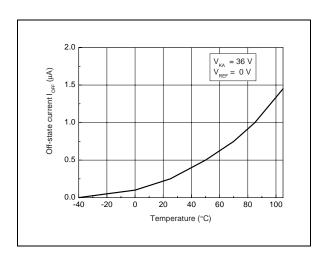
Reference voltage vs cathode current



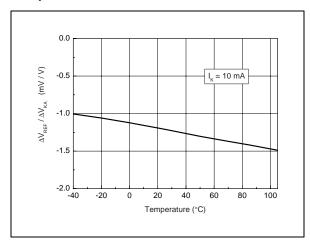
Reference current vs temperature



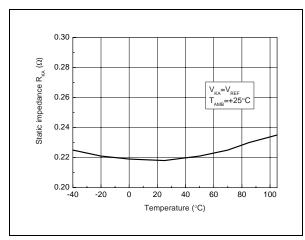
Off-state cathode current vs temperature



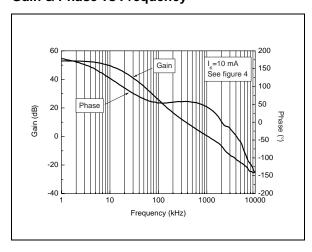
Ratio of change in $\rm V_{REF}$ to change in $\rm V_{KA}$ vs **Temperature**



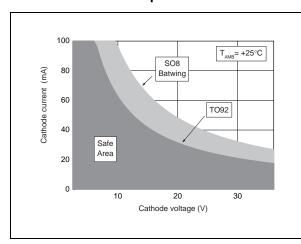
Static impedance $R_{\mbox{\scriptsize KA}}$ vs Temperature



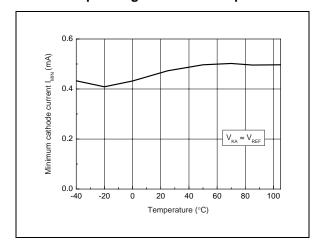
Gain & Phase vs Frequency



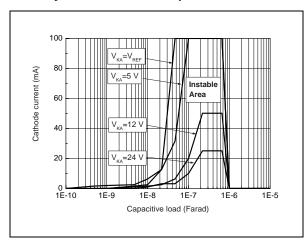
Maximum Power dissipation



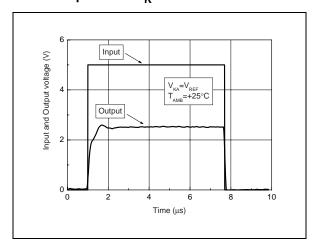
Minimum operating current vs temperature



Stability behaviour with capacitive loads

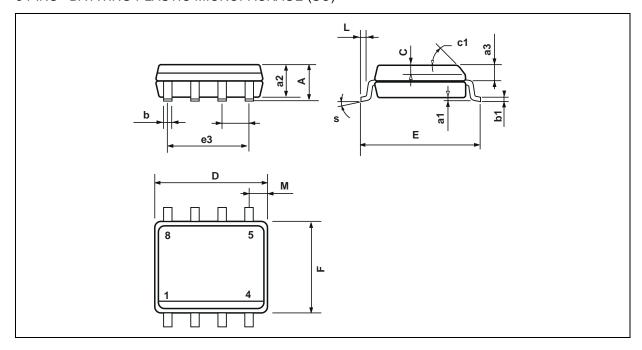


Pulse response for I_K=1mA



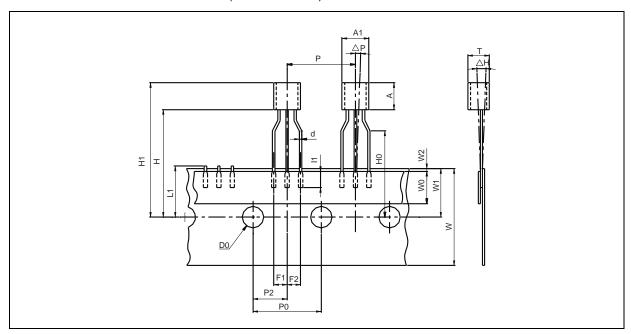
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8 PINS - BATWING PLASTIC MICROPACKAGE (SO)



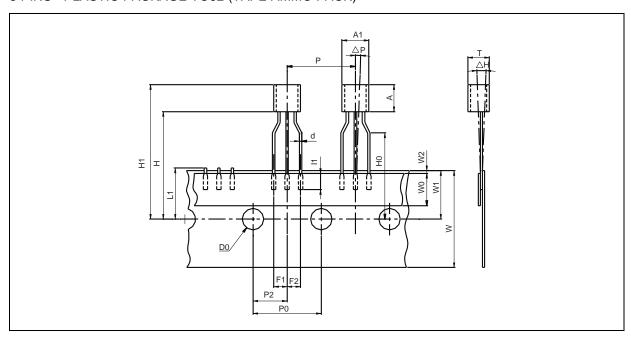
Dim		Millimeters			Inches			
Dim.	Min.	Тур.	Max.	Min.	Тур.	Max.		
Α			1.75			0.069		
a1	0.1		0.25	0.004		0.010		
a2			1.65			0.065		
a3	0.65		0.85	0.026		0.033		
b	0.35		0.48	0.014		0.019		
b1	0.19		0.25	0.007		0.010		
С	0.25		0.5	0.010		0.020		
c1			45°	(typ.)				
D	4.8		5.0	0.189		0.197		
E	5.8		6.2	0.228		0.244		
е		1.27			0.050			
e3		3.81			0.150			
F	3.8		4.0	0.150		0.157		
L	0.4		1.27	0.016		0.050		
М			0.6			0.024		
S			8° (max.)		•		

3 PINS - PLASTIC PACKAGE TO92 (TAPE & REEL)



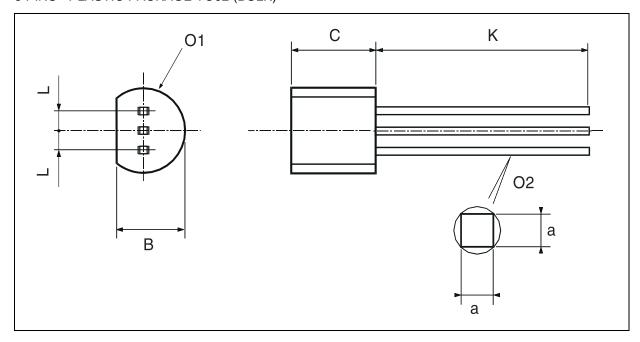
D'	Millimeters				Inches	
Dim.	Min	Тур.	Max.	Min.	Тур.	Max.
AL			5.0			0.197
А			5.0			0.197
Т			4.0			0.157
d		0.45			0.018	
I1	2.5			0.098		
Р	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔΡ	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
Н			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

3 PINS - PLASTIC PACKAGE TO92 (TAPE AMMO PACK)



Dim.	Millimeters			Inches			
Dilli.	Min	Тур.	Max.	Min.	Тур.	Max.	
AL			5.0			0.197	
Α			5.0			0.197	
Т			4.0			0.157	
d		0.45			0.018		
I1	2.5			0.098			
Р	11.7	12.7	13.7	0.461	0.500	0.539	
PO	12.4	12.7	13	0.488	0.500	0.512	
P2	5.95	6.35	6.75	0.234	0.250	0.266	
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110	
Δh	-1	0	1	-0.039	0	0.039	
ΔΡ	-1	0	1	-0.039	0	0.039	
W	17.5	18.0	19.0	0.689	0.709	0.748	
W0	5.7	6	6.3	0.224	0.236	0.248	
W1	8.5	9	9.75	0.335	0.354	0.384	
W2			0.5			0.020	
Н			20			0.787	
H0	15.5	16	16.5	0.610	0.630	0.650	
H1			25			0.984	
DO	3.8	4.0	4.2	0.150	0.157	0.165	
L1			11			0.433	

3 PINS - PLASTIC PACKAGE TO92 (BULK)



Dim		Millimeters		Inches			
Dim.	Min	Тур.	Max.	Min.	Тур.	Max.	
L		1.27			0.05		
В	3.2	3.7	4.2	0.126	0.1457	0.1654	
01	4.45	5.00	5.2	0.1752	0.1969	0.2047	
С	4.58	5.03	5.33	0.1803	0.198	0.2098	
K	12.7			0.5			
O2	0.407	0.5	0.508	0.016	0.0197	0.02	
а	0.35			0.0138			

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