



ATL43xx 2.5V 低静态电流可调节精密分流稳压器

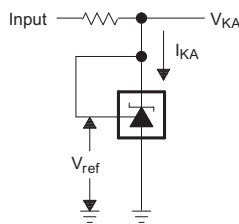
1 特性

- 可调节稳压输出：2.5V 至 36V
- 超低工作电流
 - $I_{KA(min)} = 35\mu A$ （最大值）
 - $I_{REF} = 150nA$ （最大值）
- 内部补偿确保稳定性
 - 无需容性负载即可保持稳定
- 25°C 温度下的基准电压容差
 - 0.5% (ATL43xB)
 - 1% (ATL43xA)
- 温度漂移典型值
 - 5mV (–40°C 至 85°C)；“I”版本
 - 6mV (–40°C 至 125°C)；“Q”版本
- 扩展级阴极电流范围：35μA 至 100mA
- 低输出阻抗：0.3Ω（最大值）
- ATL431AQ、ATL431BI 和 ATL431BQ 目前均为预览状态
- ATL432AI、ATL432AQ、ATL432BI 和 ATL432BQ 目前均为预览状态

2 应用

- 反激式开关模式电源 (SMPS) 中的二次侧稳压
- 工业、计算、消费类和便携式产品
- 可调节电压和电流基准
- 电源管理
- 电源隔离
- 齐纳二极管替代产品

4 简化电路原理图



3 说明

ATL431 和 ATL432 为三引脚可调节分流稳压器，在适用的汽车级、商业级和工业级温度范围内均可满足规定的热稳定性。这两款稳压器均可通过两个外部电阻将输出电压设置为 V_{ref} （约为 2.5V）至 36V 范围内的任意值。其输出阻抗典型值均为 0.05Ω。此类器件的有源输出电路具有出色的导通特性，因此成为了许多应用中齐纳二极管的绝佳替代产品，例如板载稳压器、可调节电源和开关电源。

ATL43X 的阴极电流范围相比其上一代产品 TL43X 有 20 倍以上的提升。另外稳定性也有所提高，可支持范围更为宽泛的负载电容类型和容值。

ATL431 和 ATL432 这两款器件的功能完全相同，只是引脚分配和订货编号有所不同。ATL43X 提供 A 和 B 两个等级，25°C 温度下的初始容差分别为 1% 和 0.5%。此外，这两款器件的输出温度漂移较低，可确保在整个温度范围内保持出色的稳定性。

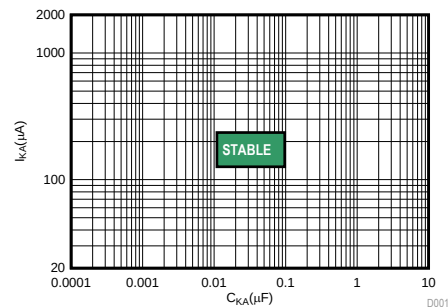
ATL43xxI 器件的额定工作温度范围为 –40°C 至 85°C；ATL43xxQ 器件的额定工作温度范围为 –40°C 至 125°C。

器件信息⁽¹⁾

器件型号	封装	封装尺寸（标称值）
ATL43x	SOT (3)	2.90mm x 1.60mm

(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。

$V_{KA} = 15.0V$ 时的稳定区域



目录

1	特性	1	9.1	Overview	12
2	应用	1	9.2	Functional Block Diagram	12
3	说明	1	9.3	Feature Description	12
4	简化电路原理图	1	9.4	Device Functional Modes	13
5	修订历史记录	2	10	Applications and Implementation	14
6	Pin Configuration and Functions	3	10.1	Application Information	14
7	Specifications	3	10.2	Typical Applications	15
7.1	Absolute Maximum Ratings	3	11	Power Supply Recommendations	20
7.2	ESD Ratings	3	12	Layout	20
7.3	Thermal Information	3	12.1	Layout Guidelines	20
7.4	Recommended Operating Conditions	4	12.2	Layout Example	20
7.5	Electrical Characteristics, ATL431Ax, ATL432Ax	4	13	器件和文档支持	21
7.6	Electrical Characteristics, ATL431Bx, ATL432Bx	4	13.1	相关链接	21
7.7	Notes	5	13.2	商标	21
7.8	Typical Characteristics	6	13.3	静电放电警告	21
8	Parameter Measurement Information	10	13.4	术语表	21
9	Detailed Description	12	14	机械、封装和可订购信息	21

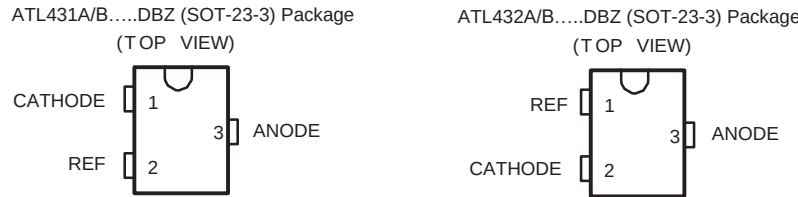
5 修订历史记录

Changes from Original (March 2013) to Revision A

Page

• 最初发布的完整版文档。	1
---------------------	---

6 Pin Configuration and Functions



Pin Functions

NAME	PIN NO.		I/O	DESCRIPTION
	ATL431x	ATL432x		
CATHODE	1	2	I/O	Shunt Current/Voltage input
REF	2	1	I	Threshold relative to common anode
ANODE	3	3	O	Common pin, normally connected to ground

7 Specifications

7.1 Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

	MIN	MAX	UNIT
V_{KA} Cathode voltage ⁽²⁾		40	V
I_{KA} Continuous cathode current range	–100	150	mA
$I_{I(ref)}$ Reference input current range	–0.05	10	mA
T_J Operating virtual junction temperature	–40	150	°C
T_{stg} Storage temperature range	–65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to ANODE, unless otherwise noted.

7.2 ESD Ratings

	VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000
	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Thermal Information

THERMAL METRIC ⁽¹⁾		ATL43xx	UNIT
		DBZ	
		3 PINS	
θ_{JA}	Junction-to-ambient thermal resistance	331.8	°C/W
θ_{JCTop}	Junction-to-case (top) thermal resistance	106.5	°C/W
θ_{JB}	Junction-to-board thermal resistance	64.6	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	4.9	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	62.9	°C/W

- (1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, [SPRA953](#).

7.4 Recommended Operating Conditions

		MIN	MAX	UNIT
V_{KA}	Cathode voltage	V_{ref}	36	V
I_{KA}	Cathode current	.035	100	mA
T_A	Operating free-air temperature	"I" Grade	85	°C
		"Q" Grade	125	

7.5 Electrical Characteristics, ATL431Ax, ATL432Ax

 over recommended operating conditions, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CIRCUIT	TEST CONDITIONS		ATL431Ax, ATL432Ax			UNIT
					MIN	TYP	MAX	
V _{ref}	Reference voltage	图 23	V _{KA} = V _{ref} , I _{KA} = 1 mA		2475	2500	2525	mV
V _{I(dev)}	Deviation of reference input voltage over full temperature range, see Notes section	图 23	V _{KA} = V _{ref} , I _{KA} = 1 mA,	ATL43XAI; T _A = -40°C to 85°C	5	15	mV	
				ATL43XAQ; T _A = -40°C to 125°C	6	34		
ΔV _{ref} / ΔV _{KA}	Ratio of change in reference voltage to the change in cathode voltage	图 24	I _{KA} = 1 mA	ΔV _{KA} = 10 V – V _{ref}	–0.4	–2.7	mV/V	
				ΔV _{KA} = 36 V – 10 V	–0.1	–2		
I _{ref}	Reference input current	图 24	I _{KA} = 1 mA, R1 = 10 kΩ, R2 = ∞		30	150	nA	
I _{I(dev)}	Deviation of reference input current over full temperature range, see Notes section	图 24	I _{KA} = 1 mA, R1 = 10 kΩ, R2 = ∞		20	50	nA	
I _{min}	Minimum cathode current for regulation	图 23 图 6	V _{KA} = V _{ref}		20	35	μA	
I _{off}	Off-state cathode current	图 25	V _{KA} = 36 V, V _{ref} = 0		0.05	0.2	μA	
z _{KA}	Dynamic impedance, see Notes section	图 23	V _{KA} = V _{ref} , f ≤ 1 kHz, I _{KA} = 1 mA to 100 mA		0.05	0.3	Ω	

7.6 Electrical Characteristics, ATL431Bx, ATL432Bx

 over recommended operating conditions, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CIRCUIT	TEST CONDITIONS		ATL431Bx, ATL432Bx			UNIT
					MIN	TYP	MAX	
V _{ref}	Reference voltage	图 23	V _{KA} = V _{ref} , I _{KA} = 1 mA		2487	2500	2512	mV
V _{I(dev)}	Deviation of reference input voltage over full temperature range, see Notes section	图 23	V _{KA} = V _{ref} , I _{KA} = 1 mA	ATL43XBI; T _A = −40°C to 85°C	5		15	mV
				ATL43XBQ; T _A = −40°C to 125°C	6		34	
ΔV _{ref} / ΔV _{KA}	Ratio of change in reference voltage to the change in cathode voltage	图 24	I _{KA} = 1 mA	ΔV _{KA} = 10 V − V _{ref}	−0.4	−2.7	mV/V	
				ΔV _{KA} = 36 V − 10 V	−0.1	−2		
I _{ref}	Reference input current	图 24	I _{KA} = 1 mA, R1 = 10 kΩ, R2 = ∞		30		150	nA
I _{I(dev)}	Deviation of reference input current over full temperature range, see Notes section	图 24	I _{KA} = 1 mA, R1 = 10 kΩ, R2 = ∞		20		50	nA
I _{min}	Minimum cathode current for regulation	图 23 图 6	V _{KA} = V _{ref}		20		35	μA
I _{off}	Off-state cathode current	图 25	V _{KA} = 36 V, V _{ref} = 0		0.05		0.2	μA
z _{KA}	Dynamic impedance, see Notes section	图 23	V _{KA} = V _{ref} , f ≤ 1 kHz, I _{KA} = 1 mA to 100 mA		0.05		0.3	Ω

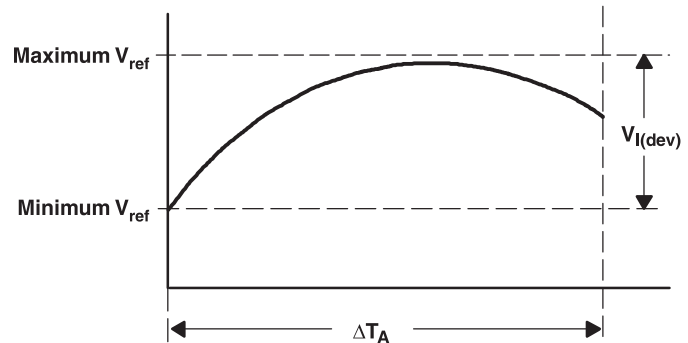
7.7 Notes

The deviation parameters $V_{\text{ref(dev)}}$ and $I_{\text{ref(dev)}}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage $\alpha_{V_{\text{ref}}}$ is defined as:

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

where:

ΔT_A is the rated operating temperature range of the device.



$\alpha_{V_{\text{ref}}}$ is positive or negative, depending on whether minimum V_{ref} or maximum V_{ref} , respectively, occurs at the lower temperature.

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 [图 24](#)), the total dynamic impedance of the circuit is given by: $|Z| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|Z_{KA}| \left(1 + \frac{R1}{R2} \right)$

7.8 Typical Characteristics

Data at high and low temperatures are applicable only within the recommended operating free-air temperature ranges of the various devices.

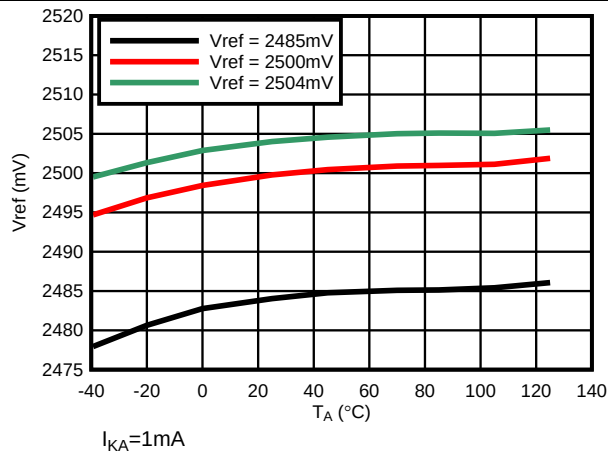


图 2. Reference Voltage vs Free-Air Temperature

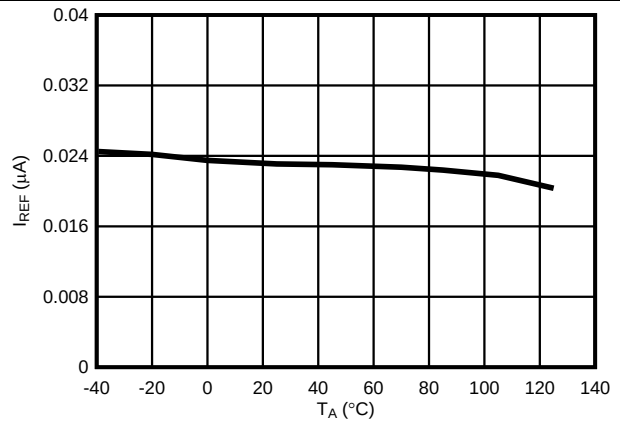


图 3. Reference Current vs Free-Air Temperature

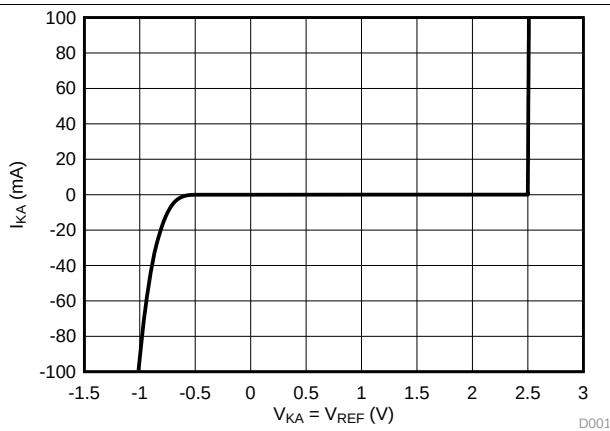


图 4. Cathode Current vs Cathode Voltage

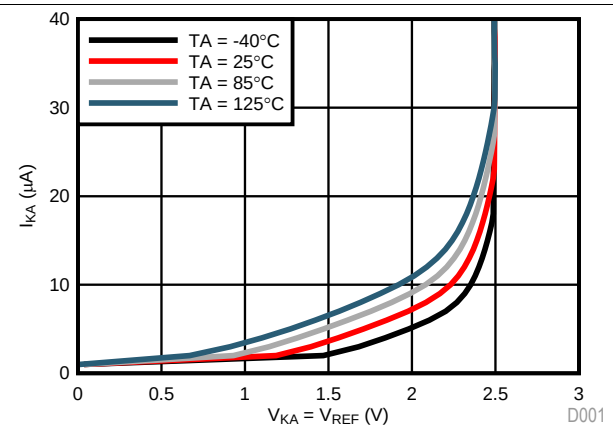


图 5. Cathode Current vs Cathode Voltage

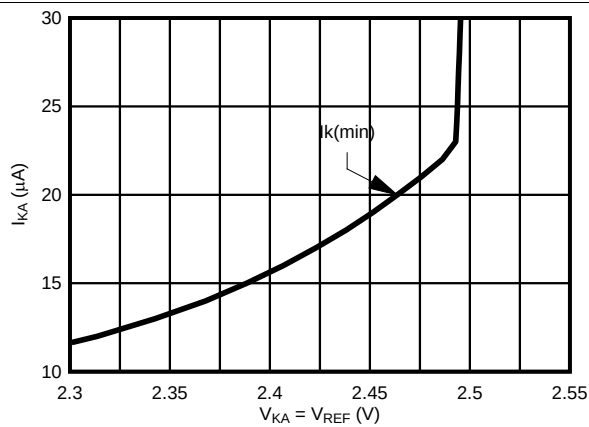


图 6. Cathode Current vs Cathode Voltage

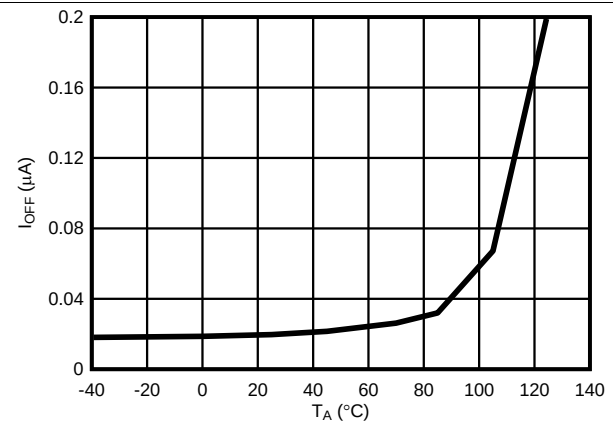


图 7. Off-State Cathode Current vs Free-Air Temperature

Typical Characteristics (接下页)

Data at high and low temperatures are applicable only within the recommended operating free-air temperature ranges of the various devices.

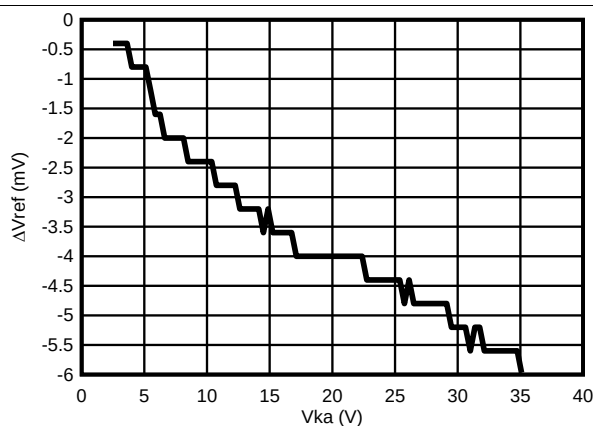


图 8. Delta Reference Voltage vs Cathode Voltage

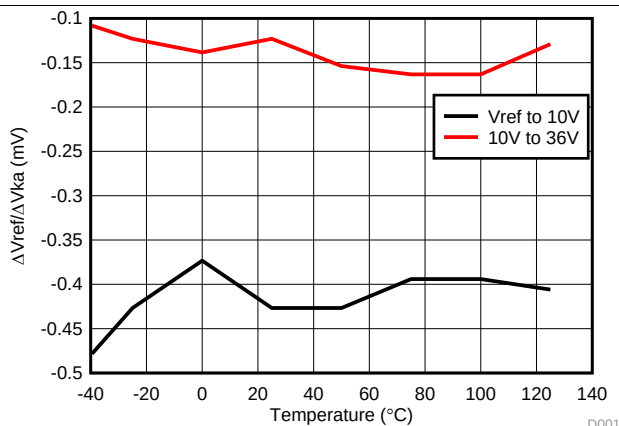


图 9. Delta Reference Voltage vs Cathode Voltage

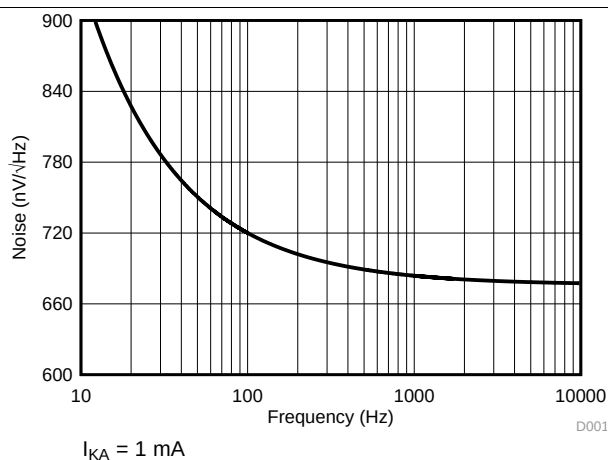


图 10. Noise Voltage

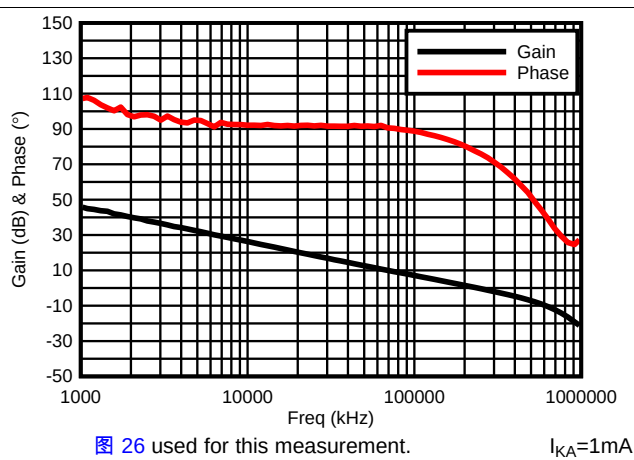


图 11. Small-Signal Voltage Amplification vs Frequency

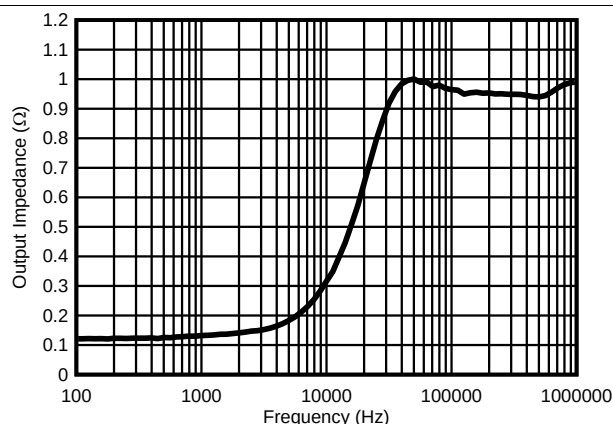


图 27 used for this measurement.

图 12. Output Impedance vs Frequency

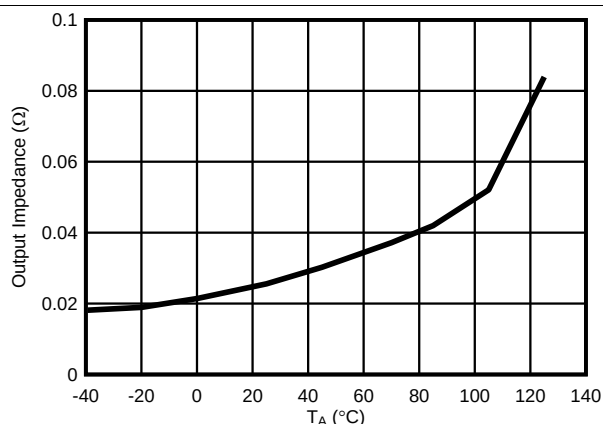


图 27 used for this measurement.

图 13. DC Output Impedance vs Temperature

Typical Characteristics (接下页)

Data at high and low temperatures are applicable only within the recommended operating free-air temperature ranges of the various devices.

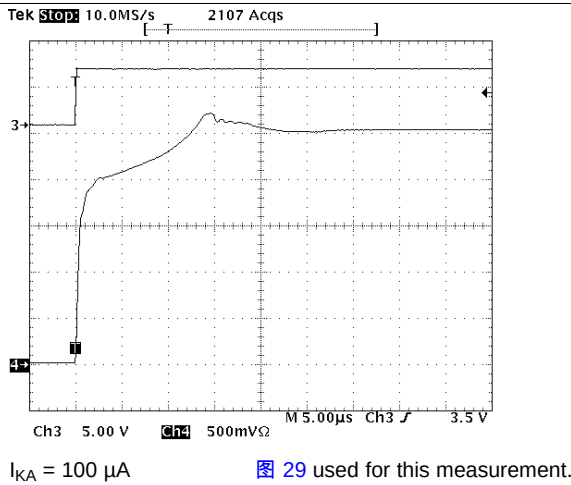


图 14. Pulse Response

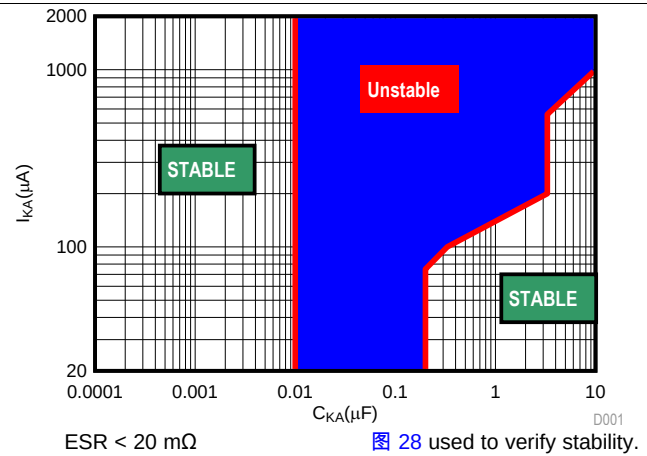


图 15. Low I_{KA} ($V_{KA} = 2.5 V$) Stability Boundary Conditions all ATL43xx Devices

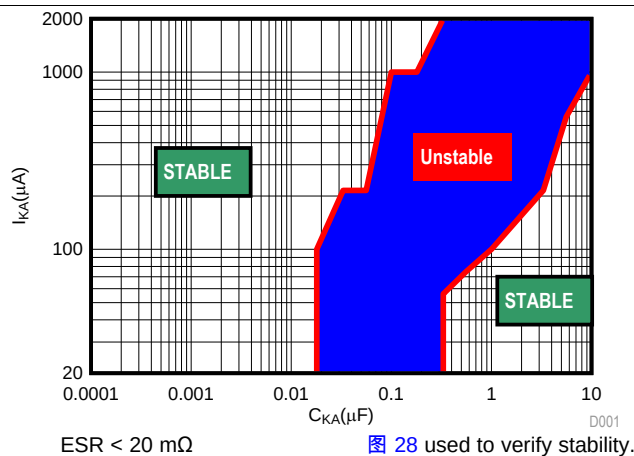


图 16. Low I_{KA} ($V_{KA} = 5.0 V$) Stability Boundary Conditions all ATL43xx Devices

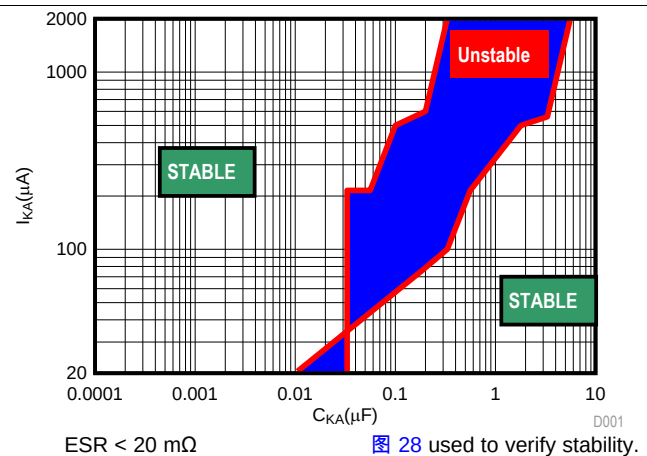


图 17. Low I_{KA} ($V_{KA} = 10.0 V$) Stability Boundary Conditions all ATL43xx Devices

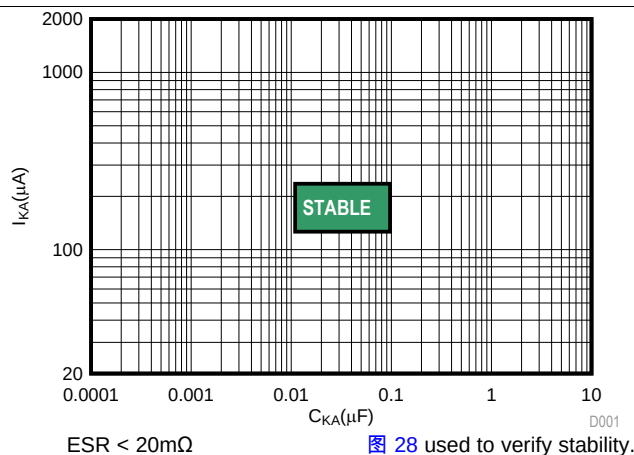


图 18. Low I_{KA} ($V_{KA} = 15.0 V$) Stability Boundary Conditions all ATL43xx Devices

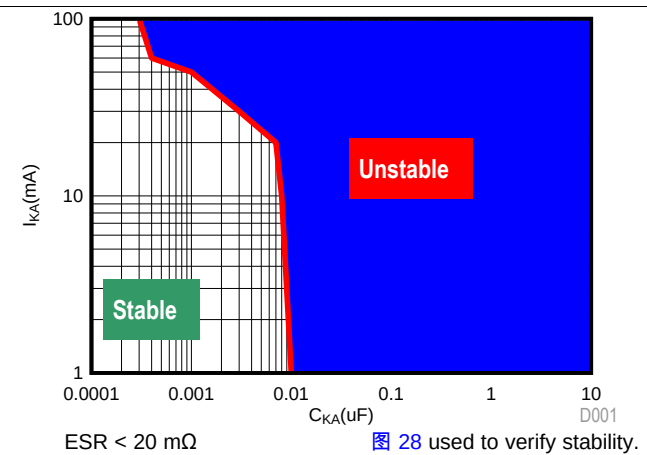


图 19. High I_{KA} ($V_{KA} = 2.5 V$) Stability Boundary Conditions all ATL43xx Devices

Typical Characteristics (接下页)

Data at high and low temperatures are applicable only within the recommended operating free-air temperature ranges of the various devices.

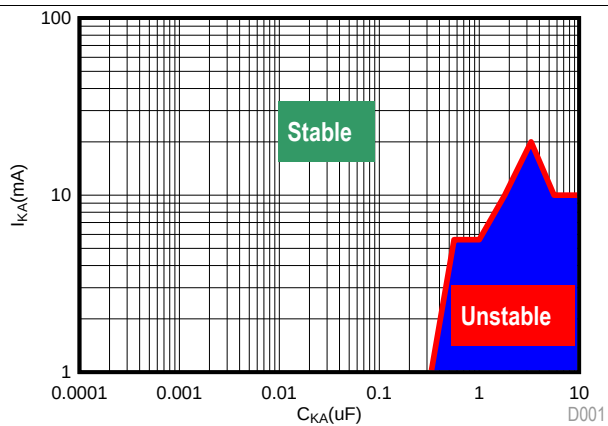


图 20. High I_{KA} ($V_{KA} = 5.0$ V) Stability Boundary Conditions all ATL43xx Devices

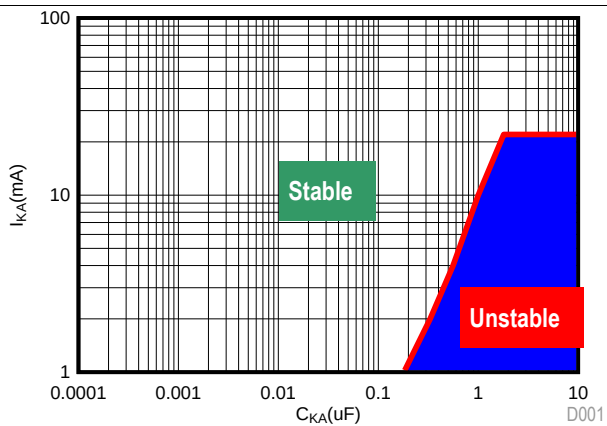


图 21. High I_{KA} ($V_{KA} = 10.0$ V) Stability Boundary Conditions all ATL43xx Devices

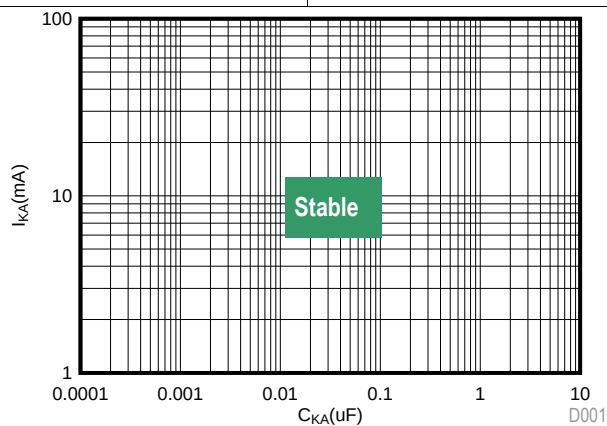


图 22. High I_{KA} ($V_{KA} = 15.0$ V) Stability Boundary Conditions all ATL43xx Devices

8 Parameter Measurement Information

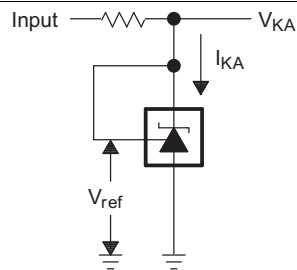


图 23. Test Circuit for $V_{KA} = V_{ref}$

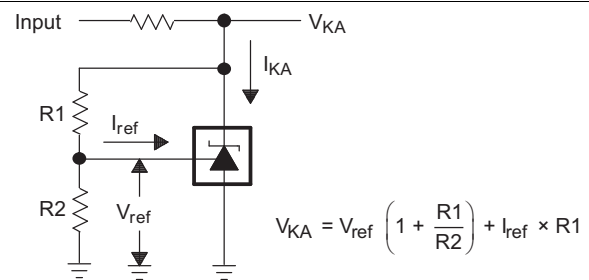


图 24. Test Circuit for $V_{KA} > V_{ref}$

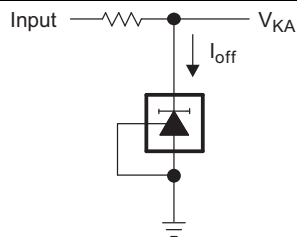


图 25. Test Circuit for I_{off}

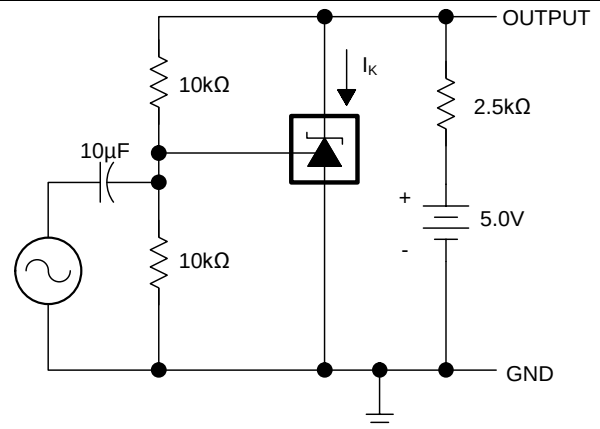


图 26. Test Circuit for Phase and Gain Measurement

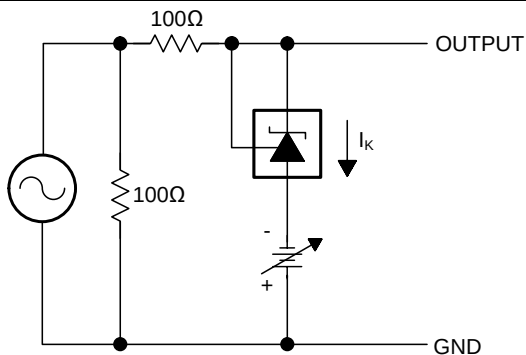


图 27. Test Circuit for Reference Impedance (Z_{KA})

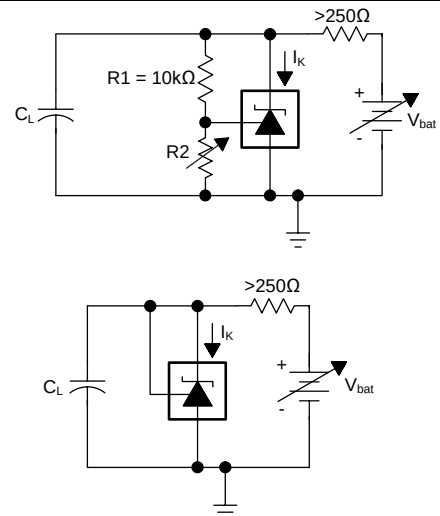


图 28. Test Circuit for Stability Boundary Conditions

Parameter Measurement Information (接下页)

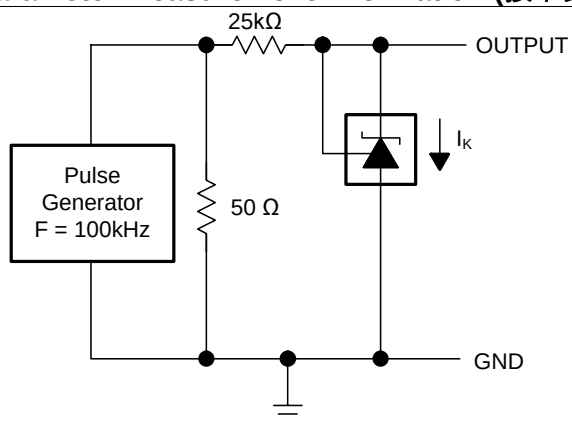


图 29. Test Circuit for Pulse Response

9 Detailed Description

9.1 Overview

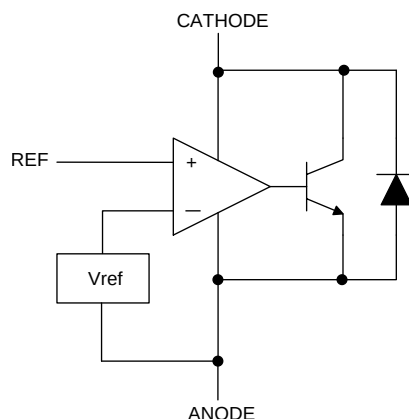
ATL43x is a low power counterpart to TL431 and TLV431, having lower minimum cathode current ($I_{k(min)} = 35 \mu A$ vs 0.1/1.0 mA). Like TL431, ATL43x is used in conjunction with its key components to behave as a single voltage reference, error amplifier, voltage clamp or comparator with integrated reference.

ATL43x can be operated and adjusted to cathode voltages from 2.5 V to 36 V, making this part optimum for a wide range of end equipments in industrial, auto, telecom & computing. In order for this device to behave as a shunt regulator or error amplifier, $> 35 \mu A$ ($I_{min(max)}$) must be supplied in to the cathode pin. Under this condition, feedback can be applied from the Cathode and Ref pins to create a replica of the internal reference voltage.

Various reference voltage options can be purchased with initial tolerances (at 25°C) of 0.5% and 1.0%. These reference options are denoted by B (0.5%) and A (1.0%) after the ATL43x.

The ATL43xxI devices are characterized for operation from $-40^{\circ}C$ to $85^{\circ}C$, and the ATL43xxQ devices are characterized for operation from $-40^{\circ}C$ to $125^{\circ}C$.

9.2 Functional Block Diagram



9.3 Feature Description

ATL43x consists of an internal reference and amplifier that outputs a sink current based on the difference between the reference pin and the virtual internal pin. The sink current is produced by an internal Darlington pair.

When operated with enough voltage headroom (≥ 2.5 V) and cathode current (I_{KA}), ATL43x forces the reference pin to 2.5 V. However, the reference pin can not be left floating, as it needs $I_{ref} \geq 0.1 \mu A$ (please see the [Functional Block Diagram](#)). This is because the reference pin is driven into an NPN, which needs base current in order to operate properly.

When feedback is applied from the Cathode and Reference pins, ATL43x behaves as a Zener diode, regulating to a constant voltage dependent on current being supplied into the cathode. This is due to the internal amplifier and reference entering the proper operating regions. The same amount of current needed in the above feedback situation must be applied to this device in open loop, servo or error amplifying implementations in order for it to be in the proper linear region giving ATL43x enough gain.

Unlike many linear regulators, ATL43x is internally compensated to be stable without an output capacitor between the cathode and anode; however, if it is desired to use an output capacitor [Figure 15](#) through [Figure 22](#) can be used as a guide to assist in choosing the correct capacitor to maintain stability.

9.4 Device Functional Modes

9.4.1 Open Loop (Comparator)

When the cathode/output voltage or current of ATL43x 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, ATL43x is typically used as a comparator. Due to the integrated reference, the ATL43x allows users to monitor a certain level of a single signal.

9.4.2 Closed Loop

When the cathode/output voltage or current of ATL43x is being fed back to the reference/input pin in any form, this device is operating in closed loop. The majority of applications involving ATL43x 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 via resistive or direct feedback.

10 Applications and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

图 30 shows the ATL43x used in a 24-V isolated flyback supply. The output of the regulator, plus the forward voltage drop of the optocoupler LED ($2.5 + 0.7 = 3.2$ V), determine the minimum voltage that can be regulated in an isolated supply configuration. Regulated voltage as low as 5.0 Vdc is possible in the topology shown in 图 30.

The 431 family of devices are prevalent in these applications, being designers go to choice for secondary side regulation. Due to this prevalence, this section will further go on to explain operation and design in both states of ATL43x that this application will see, open loop (Comparator + Vref) & closed loop (Shunt Regulator).

ATL43x's key benefit in isolated supplies is the no load power savings gained by the $> 20\times$ decrease in I_{Kmin} from TL431. More information about this and other benefits can be found in the application note *Designing with the "Advanced" TL431, ATL431* [SLVA685](#). Further information about system stability and using a ATL43x device for compensation can be found in the application note *Compensation Design With TL431 for UCC28600*, [SLUA671](#).

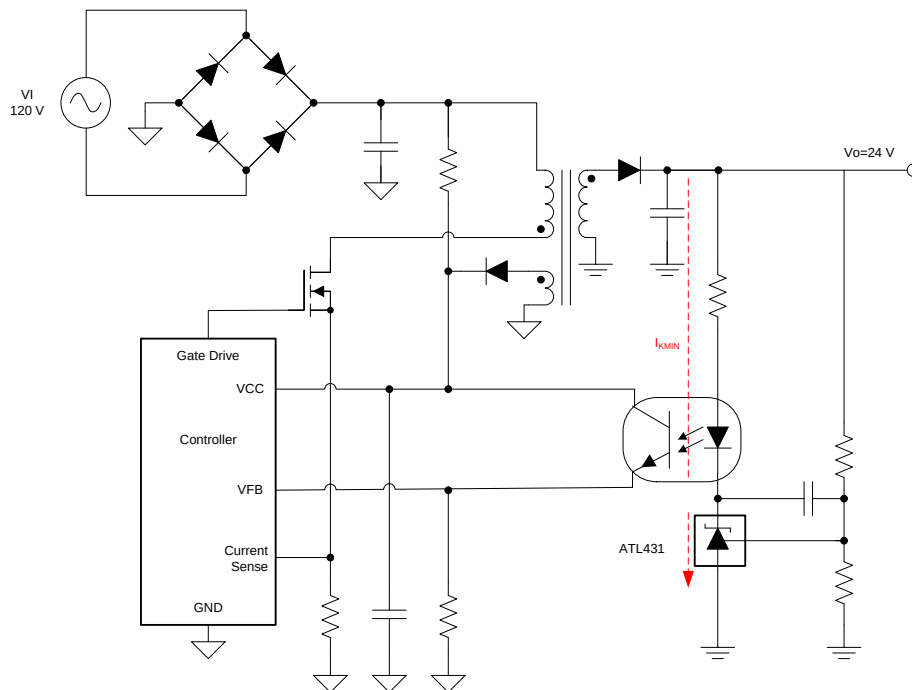


图 30. Flyback With Isolation Using ATL43x as Voltage Reference and Error Amplifier

10.2 Typical Applications

10.2.1 Comparator with Integrated Reference (Open Loop)

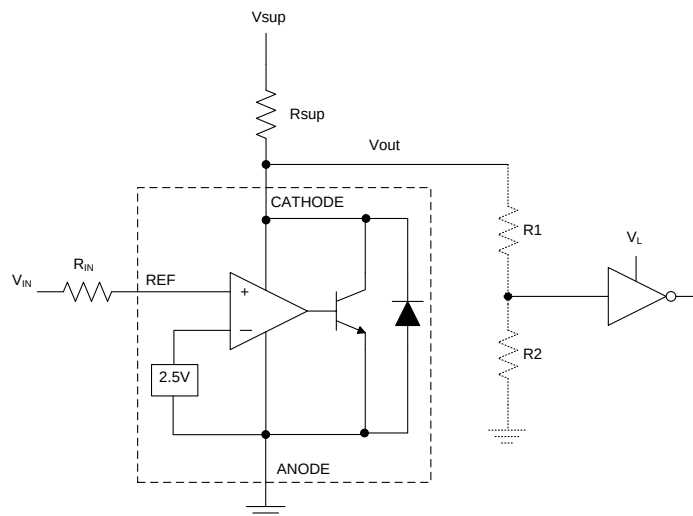


图 31. Comparator Application Schematic

10.2.1.1 Design Requirements

For this design example, use the parameters listed in 表 1 as the input parameters.

表 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0 V to 3.3 V
Input Resistance	100 kΩ
Supply Voltage	5 V
Cathode Current (I_K)	50 μA
Output Voltage Level	~2 V - V_{SUP}
Logic Input Thresholds V_{IH}/V_{IL}	1.5 V / 0.8 V

10.2.1.2 Detailed Design Procedure

When using ATL43x as a comparator with reference, determine the following:

- Input voltage range
- Reference voltage accuracy
- Output logic input high and low level thresholds
- Current source resistance

10.2.1.2.1 Basic Operation

In the configuration shown in 图 31 ATL43x will behave as a comparator, comparing the V_{REF} pin voltage to the internal virtual reference voltage. When provided a proper cathode current (I_K), ATL43x will have enough open loop gain to provide a quick response. With the ATL43x's max Operating Current (I_{min}) being 35 μA and up to 40 μA over temperature, operation below that could result in low gain, leading to a slow response.

10.2.1.2.2 Overdrive

Slow or inaccurate responses can also occur when the reference pin is not provided enough overdrive voltage. This is the amount of voltage that is higher than the internal virtual reference. The internal virtual reference voltage will be within the range of $2.5\text{ V} \pm (0.5\% \text{ or } 1.0\%)$ depending on which version is being used.

The more overdrive voltage provided, the faster the ATL43x will respond.

For applications where ATL43x is being used as a comparator, it is best to set the trip point to greater than the positive expected error (i.e. +1.0% for the A version). For fast response, setting the trip point to $> 10\%$ of the internal V_{ref} should suffice. 图 32 shows the transition from V_{OH} to V_{OL} based on the input voltage and can be used as a guide for selecting the overdrive voltage.

For minimal voltage drop or difference from V_{in} to the ref pin, it is recommended to use an input resistor $< 1\text{ M}\Omega$ to provide I_{ref} .

10.2.1.2.3 Output Voltage and Logic Input Level

In order for ATL43x to properly be used as a comparator, the logic output must be readable by the receiving logic device. This is accomplished by knowing the input high and low level threshold voltage levels, typically denoted by V_{IH} & V_{IL} .

As seen in 图 32, ATL43x's output low level voltage in open-loop/comparator mode is $\sim 2\text{ V}$, which is sufficient for some $\geq 5.0\text{ V}$ supplied logic. However, would not work for 3.3 V and 1.8 V supplied logic. In order to accommodate this, a resistive divider can be tied to the output to attenuate the output voltage to a voltage legible to the receiving low voltage logic device.

ATL43x's output high voltage is approximately V_{sup} due to ATL43x being open-collector. If V_{sup} is much higher than the receiving logic's maximum input voltage tolerance, the output must be attenuated to accommodate the outgoing logic's reliability.

When using a resistive divider on the output, be sure to make the sum of the resistive divider (R_1 & R_2 in 图 31) is much greater than R_{sup} in order to not interfere with ATL43x's ability to pull close to V_{sup} when turning off.

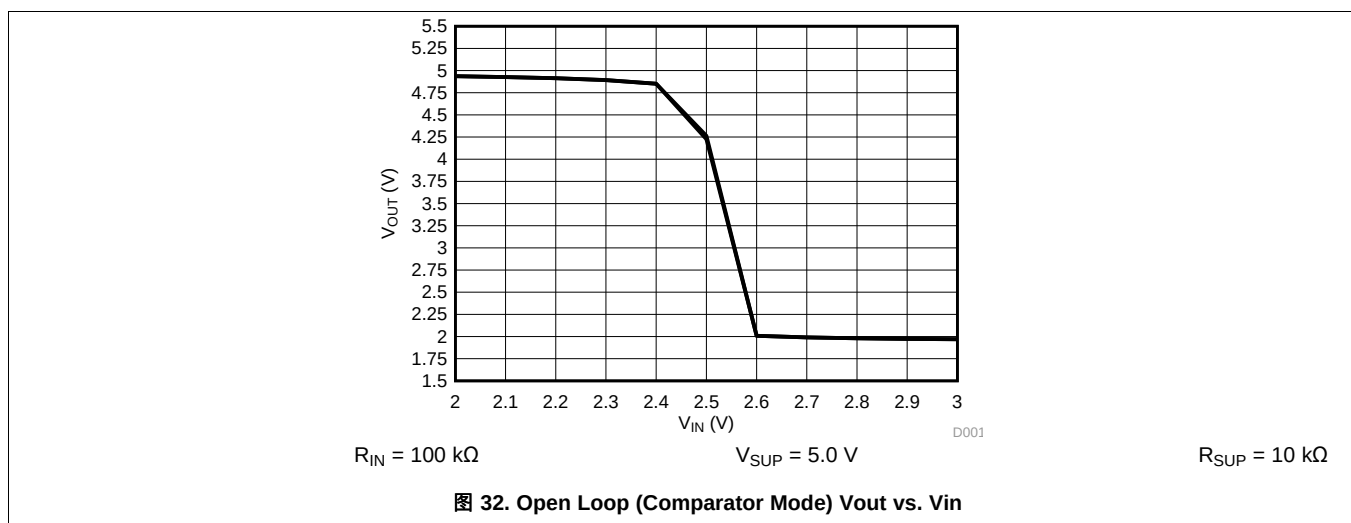
10.2.1.2.3.1 Input Resistance

ATL43x requires an input resistance in this application in order to source the reference current (I_{ref}) needed from this device to be in the proper operating regions while turning on. The actual voltage seen at the ref pin will be:

$$V_{\text{ref}} = V_{\text{in}} - I_{\text{ref}} \times R_{\text{in}} \quad (1)$$

Since I_{ref} can be as high as $0.15\text{ }\mu\text{A}$ it is recommended to use a resistance small enough that will mitigate the error that I_{ref} creates from V_{in} . Also, the input resistance must be set high enough as to not surpass the absolute maximum of 10mA .

10.2.1.3 Application Curves



10.2.2 Shunt Regulator/Reference

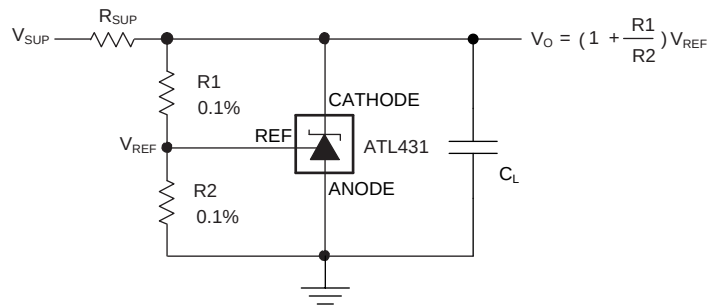


图 33. Shunt Regulator Schematic

10.2.2.1 Design Requirements

For this design example, use the parameters listed in [表 2](#) as the input parameters.

表 2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Reference Initial Accuracy	1.0%
Supply Voltage	48 V
Cathode Current (I_K)	50 μ A
Output Voltage Level	2.5 V - 36 V
Load Capacitance	1 nF
Feedback Resistor Values and Accuracy (R1 & R2)	10 k Ω

10.2.2.2 Detailed Design Procedure

When using ATL43x as a Shunt Regulator, determine the following:

- Input voltage range
- Temperature range
- Total accuracy
- Cathode current
- Reference initial accuracy
- Output capacitance

10.2.2.2.1 Programming Output/Cathode Voltage

In order to program the cathode voltage to a regulated voltage a resistive bridge must be shunted between the cathode and anode pins with the mid point tied to the reference pin. This can be seen in [Figure 33](#), with R1 & R2 being the resistive bridge. The cathode/output voltage in the shunt regulator configuration can be approximated by the equation shown in [Figure 33](#). The cathode voltage can be more accurately determined by taking into account the cathode current:

$$V_O = (1 + R1/R2) \times V_{ref} - I_{ref} \times R1 \quad (2)$$

In order for this equation to be valid, ATL43x must be fully biased so that it has enough open loop gain to mitigate any gain error. This can be done by meeting the I_{min} spec denoted in [Electrical Characteristics, ATL431Ax, ATL432Ax](#) table.

10.2.2.2.2 Total Accuracy

When programming the output above unity gain ($V_{KA} = V_{ref}$), ATL43x is susceptible to other errors that may effect the overall accuracy beyond V_{ref} . These errors include:

- R1 and R2 accuracies
- $V_{I(dev)}$ - Change in reference voltage over temperature
- $\Delta V_{ref} / \Delta V_{KA}$ - Change in reference voltage to the change in cathode voltage
- $|Z_{KA}|$ - Dynamic impedance, causing a change in cathode voltage with cathode current

Worst case cathode voltage can be determined taking all of the variables into account. Application note [SLVA445](#) assists designers in setting the shunt voltage to achieve optimum accuracy for this device.

10.2.2.2.3 Stability

Though ATL43x is stable with no capacitive load, the device that receives the shunt regulator's output voltage could present a capacitive load that is within the ATL43x region of stability, shown in [Figure 15](#) through [Figure 22](#). Also, designers may use capacitive loads to improve the transient response or for power supply decoupling.

[Figure 15](#) through [Figure 22](#) should be used as a guide for capacitor selection and compensation. It is characterized using ceramic capacitors with very low ESR. When it is desirable to use a capacitor within the unstable region, higher ESR capacitors can be used to stabilize ATL43x or an external series resistance can be added. For more information and guidance on ESR values, please refer to the application note *Designing with the "Advanced" TL431, ATL431* [SLVA685](#).

Unlike TL431, the stability boundary is characterized and determined with resistors 250Ω and greater. Which is more suitable for low cathode current applications.

10.2.2.3 Application Curves

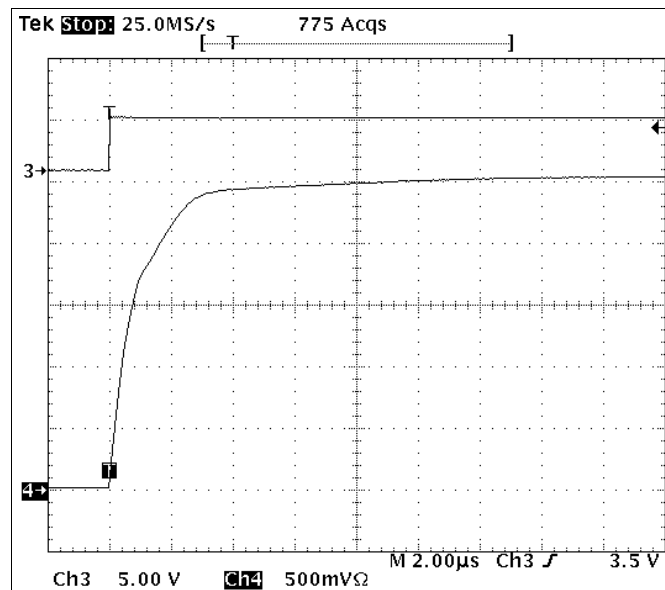


图 34. ATL43x Start-up Response $I_{KA} = 50 \mu A$

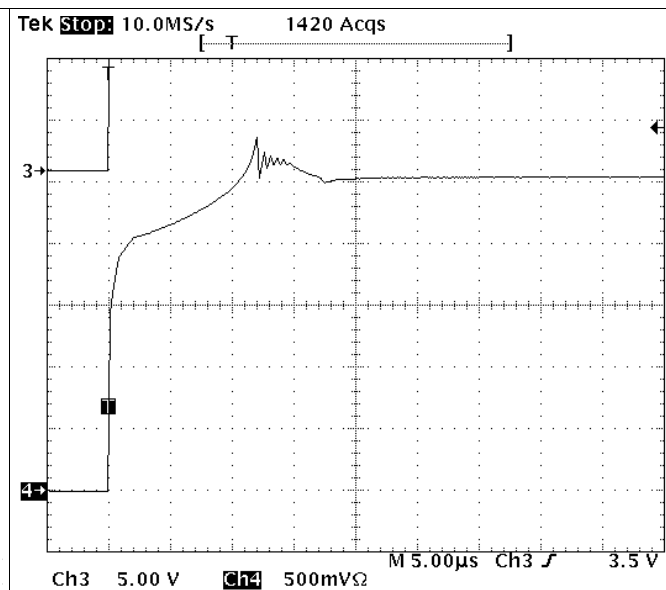


图 35. ATL43x Start-up Response $I_{KA} = 1 mA$

11 Power Supply Recommendations

When using ATL43x as a Linear Regulator to supply a load, designers will typically use a bypass capacitor on the output/cathode pin. Be sure that the capacitance is within the stability criteria shown in [图 15](#) through [图 22](#).

In order to not exceed the maximum cathode current, be sure that the supply voltage is current limited. Also, be sure to limit the current being driven into the Ref pin, as not to exceed its absolute maximum rating.

For applications shunting high currents, pay attention to the cathode and anode trace lengths, adjusting the width of the traces to have the proper current density.

12 Layout

12.1 Layout Guidelines

Place decoupling capacitors as close to the device as possible. Use appropriate widths for traces when shunting high currents to avoid excessive voltage drops.

12.2 Layout Example

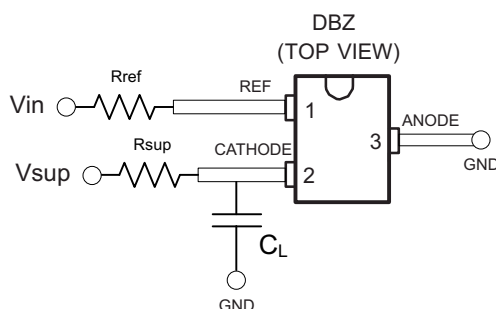


图 36. DBZ Layout Example

13 器件和文档支持

13.1 相关链接

以下表格列出了快速访问链接。范围包括技术文档、支持与社区资源、工具和软件，并且可以快速访问样片或购买链接。

表 3. 相关链接

器件	产品文件夹	样片与购买	技术文档	工具与软件	支持与社区
ATL431	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处
ATL432	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处

13.2 商标

All trademarks are the property of their respective owners.

13.3 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

13.4 术语表

[SLYZ022](#) — TI 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

14 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

重要声明

德州仪器(TI) 及其下属子公司有权根据 JESD46 最新标准, 对所提供的产品和服务进行更正、修改、增强、改进或其它更改, 并有权根据 JESD48 最新标准中止提供任何产品和服务。客户在下订单前应获取最新的相关信息, 并验证这些信息是否完整且是最新的。所有产品的销售都遵循在订单确认时所提供的TI 销售条款与条件。

TI 保证其所销售的组件的性能符合产品销售时 TI 半导体产品销售条件与条款的适用规范。仅在 TI 保证的范围内, 且 TI 认为 有必要时才会使用测试或其它质量控制技术。除非适用法律做出了硬性规定, 否则没有必要对每种组件的所有参数进行测试。

TI 对应用帮助或客户产品设计不承担任何义务。客户应对其使用 TI 组件的产品和应用自行负责。为尽量减小与客户产品和应用相关的风险, 客户应提供充分的设计与操作安全措施。

TI 不对任何 TI 专利权、版权、屏蔽作品权或其它与使用了 TI 组件或服务的组合设备、机器或流程相关的 TI 知识产权中授予 的直接或隐含权限作出任何保证或解释。TI 所发布的与第三方产品或服务有关的信息, 不能构成从 TI 获得使用这些产品或服务 的许可、授权、或认可。使用此类信息可能需要获得第三方的专利权或其它知识产权方面的许可, 或是 TI 的专利权或其它 知识产权方面的许可。

对于 TI 的产品手册或数据表中 TI 信息的重要部分, 仅在没有对内容进行任何篡改且带有相关授权、条件、限制和声明的情况 下才允许进行复制。TI 对此类篡改过的文件不承担任何责任或义务。复制第三方的信息可能需要服从额外的限制条件。

在转售 TI 组件或服务时, 如果对该组件或服务参数的陈述与 TI 标明的参数相比存在差异或虚假成分, 则会失去相关 TI 组件 或服务的所有明示或暗示授权, 且这是不正当的、欺诈性商业行为。TI 对任何此类虚假陈述均不承担任何责任或义务。

客户认可并同意, 尽管任何应用相关信息或支持仍可能由 TI 提供, 但他们将独力负责满足与其产品及其应用中使用的 TI 产品 相关的所有法律、法规和安全相关要求。客户声明并同意, 他们具备制定与实施安全措施所需的全部专业技术和知识, 可预见 故障的危险后果、监测故障及其后果、降低有可能造成人身伤害的故障的发生机率并采取适当的补救措施。客户将全额赔偿因 在此类安全关键应用中使用任何 TI 组件而对 TI 及其代理造成的任何损失。

在某些场合中, 为了推进安全相关应用有可能对 TI 组件进行特别的促销。TI 的目标是利用此类组件帮助客户设计和创立其特 有的可满足适用的功能安全性标准和要求的终端产品解决方案。尽管如此, 此类组件仍然服从这些条款。

TI 组件未获得用于 FDA Class III (或类似的生命攸关医疗设备) 的授权许可, 除非各方授权官员已经达成了专门管控此类使 用的特别协议。

只有那些 TI 特别注明属于军用等级或“增强型塑料”的 TI 组件才是设计或专门用于军事/航空应用或环境的。购买者认可并同 意, 对并非指定面向军事或航空航天用途的 TI 组件进行军事或航空航天方面的应用, 其风险由客户单独承担, 并且由客户独 力负责满足与此类使用相关的所有法律和法规要求。

TI 已明确指定符合 ISO/TS16949 要求的产品, 这些产品主要用于汽车。在任何情况下, 因使用非指定产品而无法达到 ISO/TS16949 要求, TI 不承担任何责任。

	产品		应用
数字音频	www.ti.com.cn/audio	通信与电信	www.ti.com.cn/telecom
放大器和线性器件	www.ti.com.cn/amplifiers	计算机及周边	www.ti.com.cn/computer
数据转换器	www.ti.com.cn/dataconverters	消费电子	www.ti.com.cn/consumer-apps
DLP® 产品	www.dlp.com	能源	www.ti.com.cn/energy
DSP - 数字信号处理器	www.ti.com.cn/dsp	工业应用	www.ti.com.cn/industrial
时钟和计时器	www.ti.com.cn/clockandtimers	医疗电子	www.ti.com.cn/medical
接口	www.ti.com.cn/interface	安防应用	www.ti.com.cn/security
逻辑	www.ti.com.cn/logic	汽车电子	www.ti.com.cn/automotive
电源管理	www.ti.com.cn/power	视频和影像	www.ti.com.cn/video
微控制器 (MCU)	www.ti.com.cn/microcontrollers		
RFID 系统	www.ti.com.cn/rfidsys		
OMAP应用处理器	www.ti.com.cn/omap		
无线连通性	www.ti.com.cn/wirelessconnectivity	德州仪器在线技术支持社区	www.deyisupport.com

邮寄地址: 上海市浦东新区世纪大道1568号, 中建大厦32楼邮政编码: 200122
Copyright © 2015, 德州仪器半导体技术(上海)有限公司

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
ATL431AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(ZCKS, ZCR3)	Samples
ATL431AQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	(ZCLS, ZCS3)	Samples
ATL431BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(ZCMS, ZCT3)	Samples
ATL431BQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	(ZCJS, ZCU3)	Samples
ATL432AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(ZCNS, ZCV3)	Samples
ATL432AQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	(ZCOS, ZCW3)	Samples
ATL432BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(ZCPS, ZCX3)	Samples
ATL432BQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	(ZCQS, ZCY3)	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

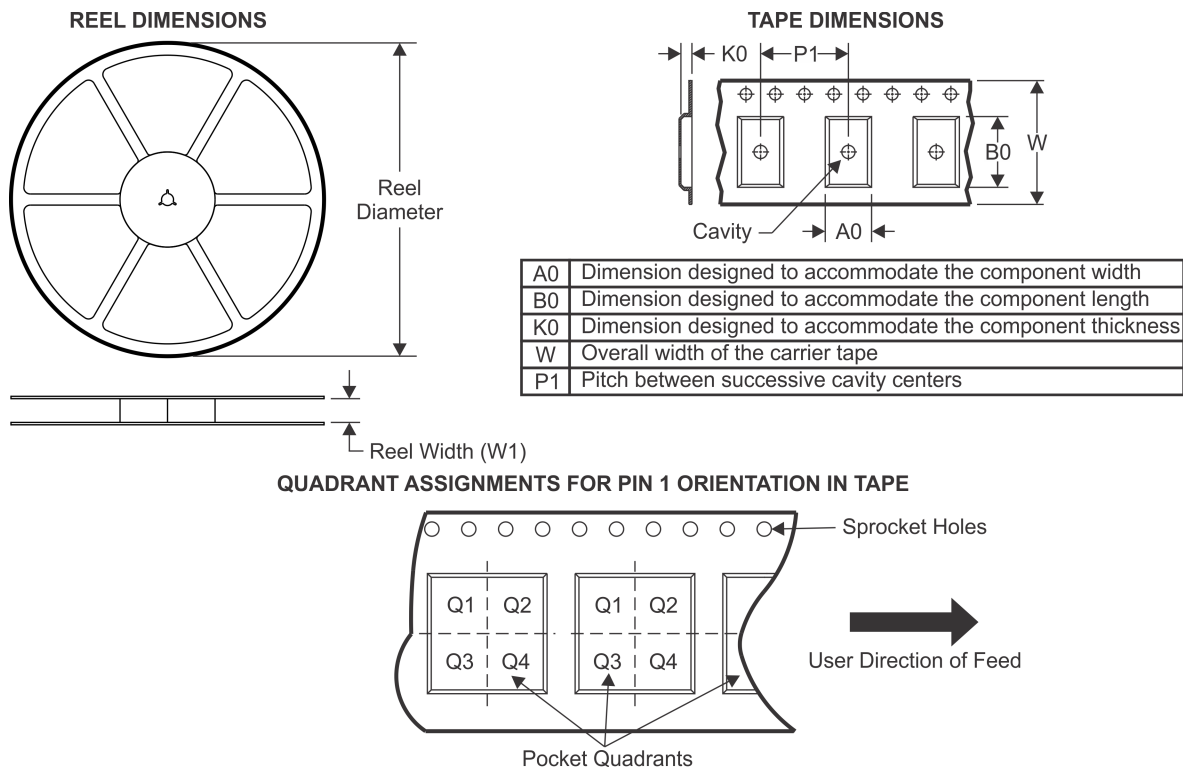
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

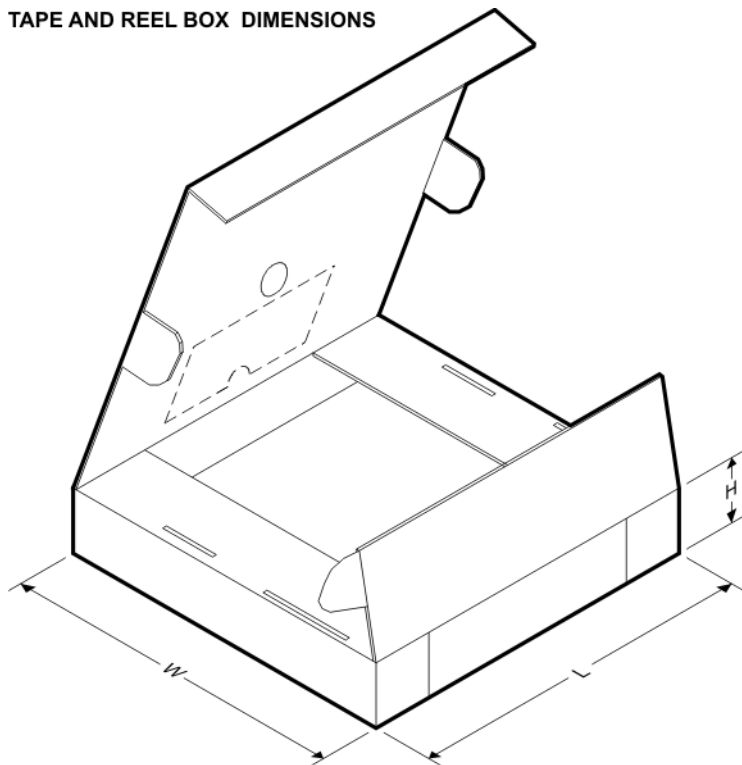
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ATL431AIDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL431AIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL431AQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL431AQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL431BIDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL431BIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL431BQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL431BQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL432AIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL432AIDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL432AQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL432AQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL432BIDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
ATL432BIDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL432BQDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
ATL432BQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

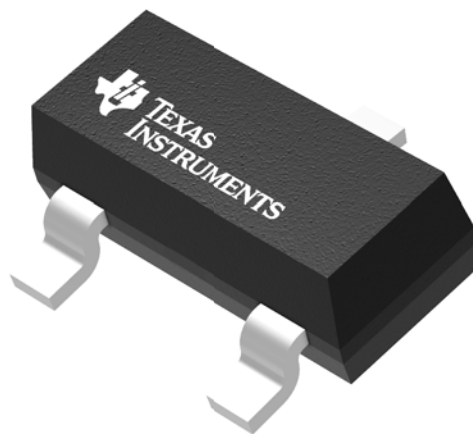
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ATL431AIDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL431AIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL431AQDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL431AQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL431BIDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL431BIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL431BQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL431BQDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL432AIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL432AIDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL432AQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL432AQDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL432BIDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
ATL432BIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL432BQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
ATL432BQDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0

GENERIC PACKAGE VIEW

DBZ 3

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4203227/C

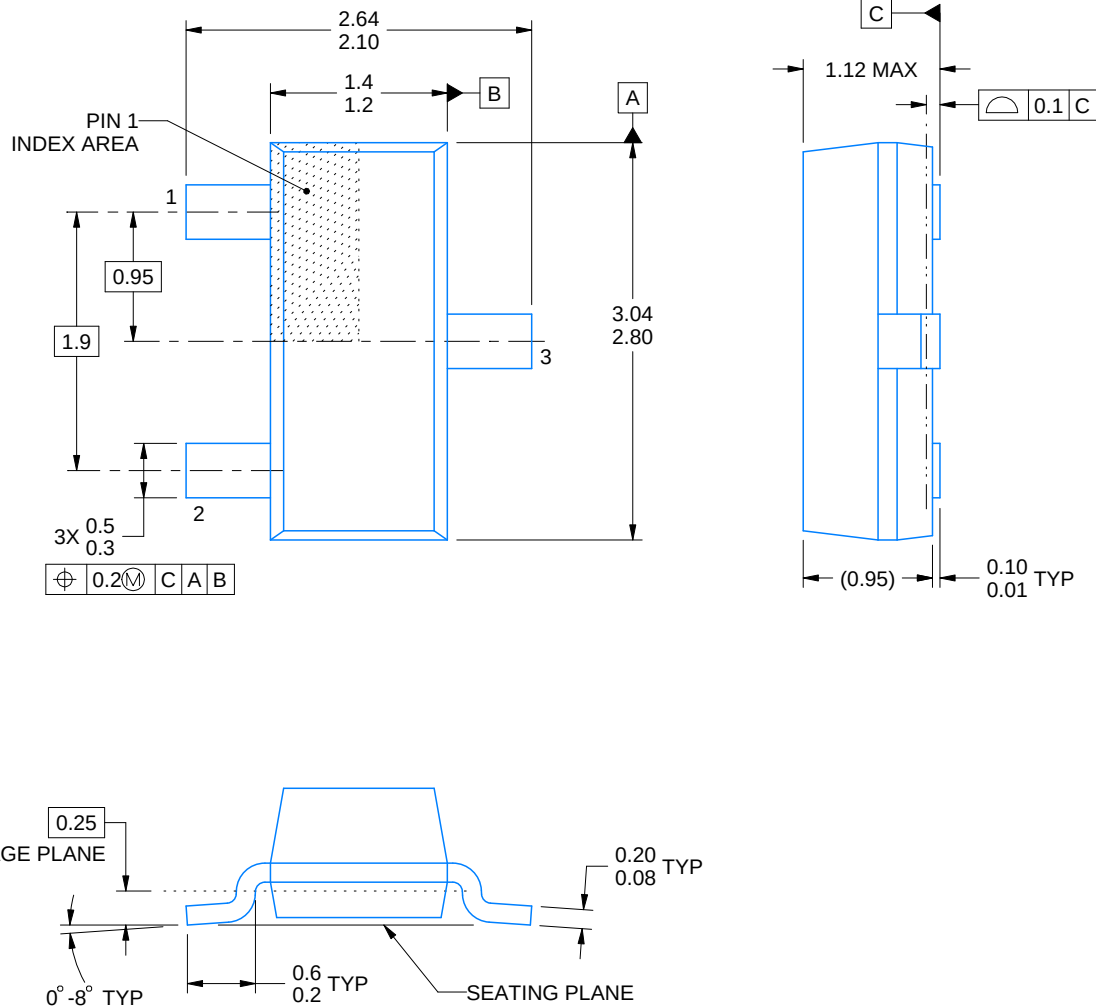
DBZ0003A



PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



4214838/C 04/2017

NOTES:

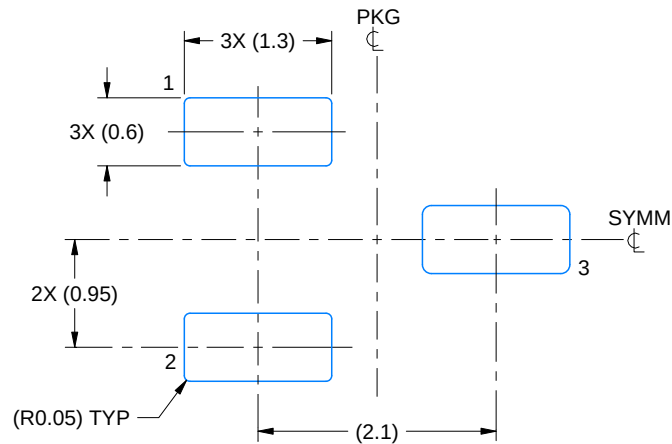
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.

EXAMPLE BOARD LAYOUT

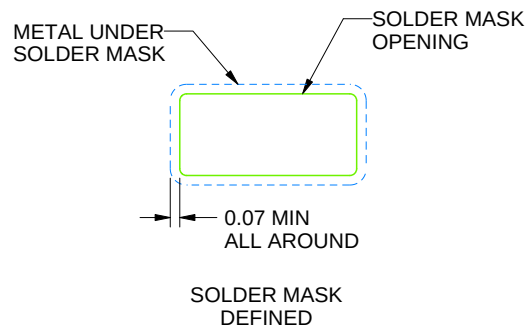
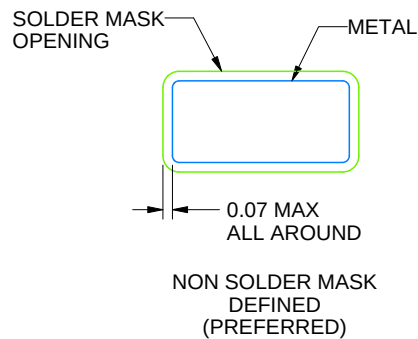
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/C 04/2017

NOTES: (continued)

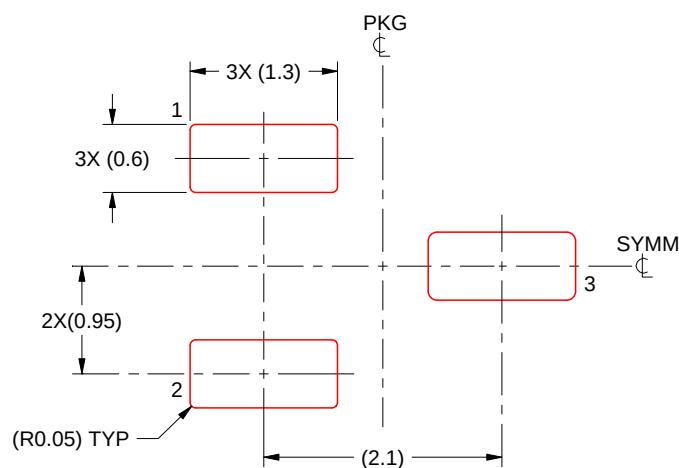
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/C 04/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

重要声明和免责声明

TI 均以“原样”提供技术性 & 可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证其中不含任何瑕疵，且不做任何明示或暗示的担保，包括但不限于对适销性、适合某特定用途或不侵犯任何第三方知识产权的暗示担保。

所述资源可供专业开发人员应用 TI 产品进行设计使用。您将对以下行为独自承担全部责任：(1) 针对您的应用选择合适的 TI 产品；(2) 设计、验证并测试您的应用；(3) 确保您的应用满足相应标准以及任何其他安全、安保或其他要求。所述资源如有变更，恕不另行通知。TI 对您使用所述资源的授权仅限于开发资源所涉及 TI 产品的相关应用。除此之外不得复制或展示所述资源，也不提供其它 TI 或任何第三方的知识产权授权许可。如因使用所述资源而产生任何索赔、赔偿、成本、损失及债务等，TI 对此概不负责，并且您须赔偿由此对 TI 及其代表造成的损害。

TI 所提供产品均受 TI 的销售条款 (<http://www.ti.com.cn/zh-cn/legal/termsofsale.html>) 以及 [ti.com.cn](http://www.ti.com.cn) 上或随附 TI 产品提供的其他可适用条款的约束。TI 提供所述资源并不扩展或以其他方式更改 TI 针对 TI 产品所发布的可适用的担保范围或担保免责声明。

邮寄地址：上海市浦东新区世纪大道 1568 号中建大厦 32 楼，邮政编码：200122
Copyright © 2020 德州仪器半导体技术（上海）有限公司