



ATL43xx 2.5V 低静态电流可调节精密分流稳压器

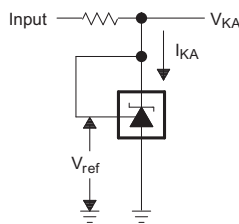
1 特性

- 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。

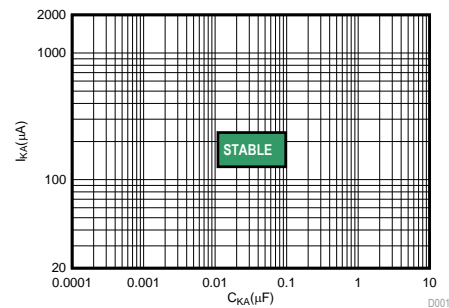
ATL43xxI 器件的额定工作温度范围为 –40°C 至 85°C；ATL43xxQ 器件的额定工作温度范围为 –40°C 至 125°C。

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



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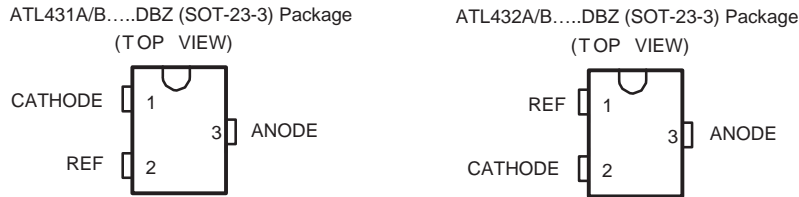
5 修订历史记录

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 | –40 | °C |
| | | "Q" Grade | –40 | |
| | | | 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 | | | 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 |

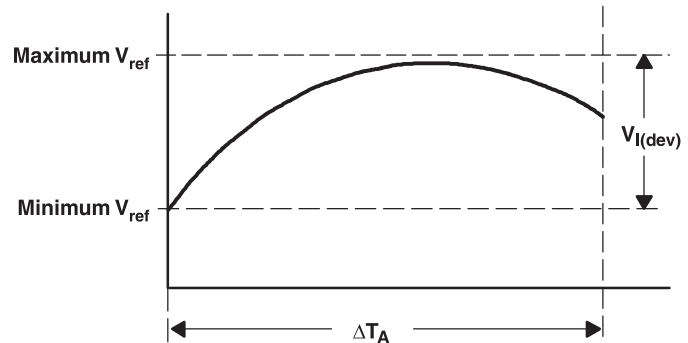
7.7 Notes

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.

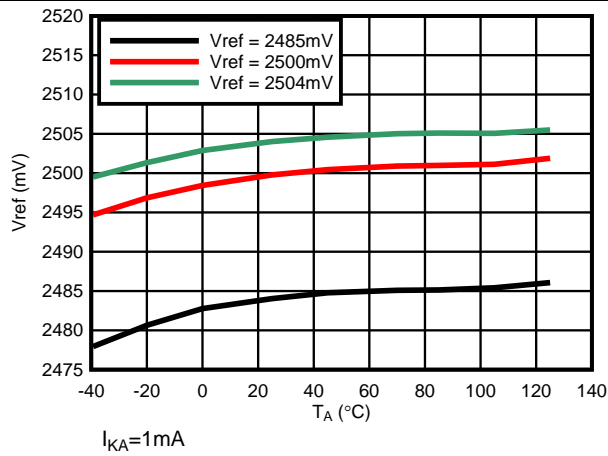


图 2. Reference Voltage vs Free-Air Temperature

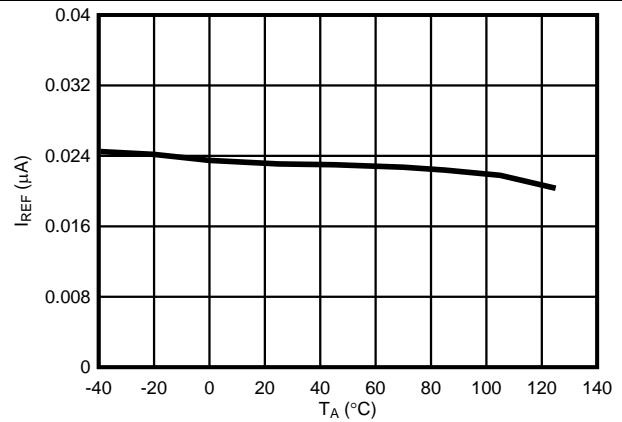


图 3. Reference Current vs Free-Air Temperature

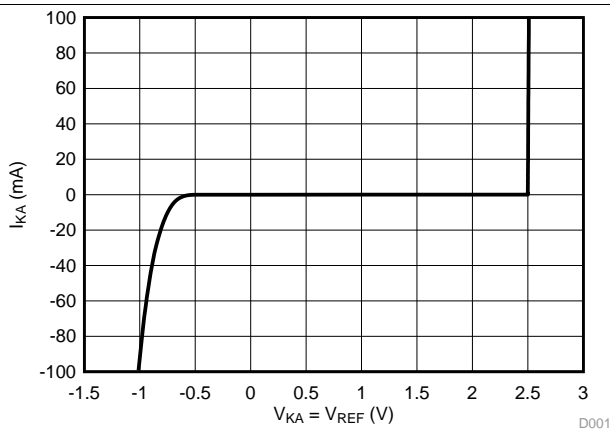


图 4. Cathode Current vs Cathode Voltage

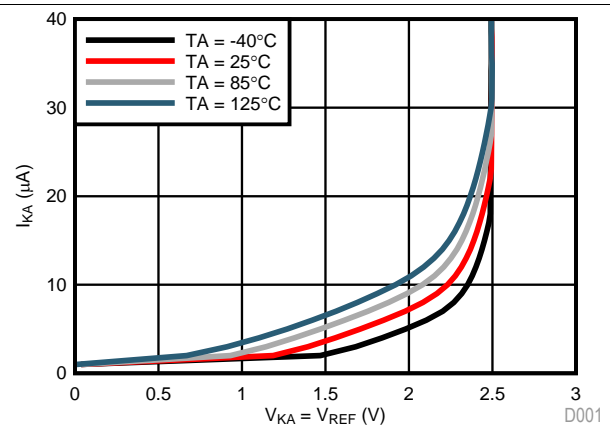


图 5. Cathode Current vs Cathode Voltage

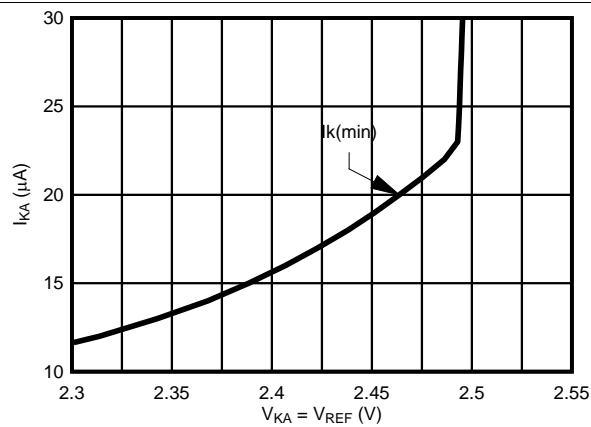


图 6. Cathode Current vs Cathode Voltage

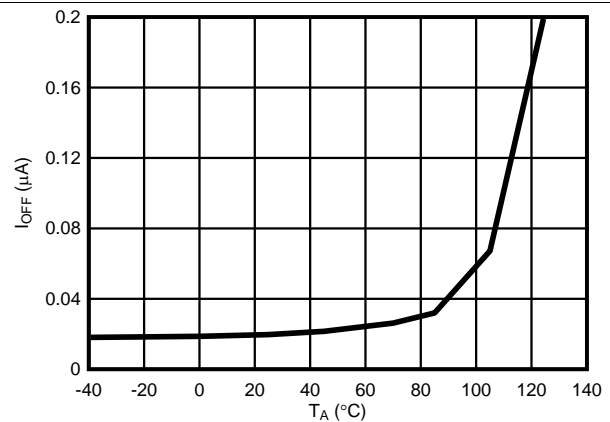


图 7. Off-State Cathode Current vs Free-Air Temperature

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.

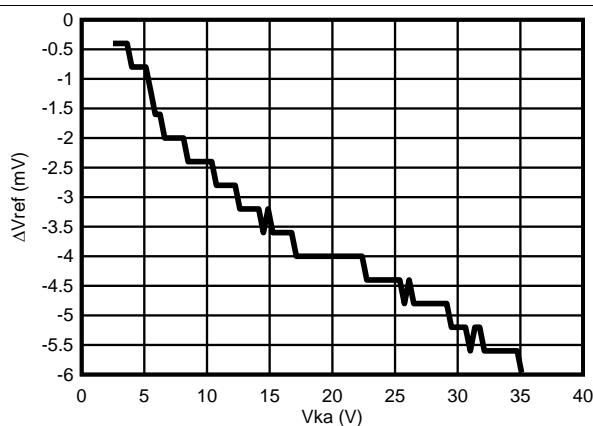


图 8. Delta Reference Voltage vs Cathode Voltage

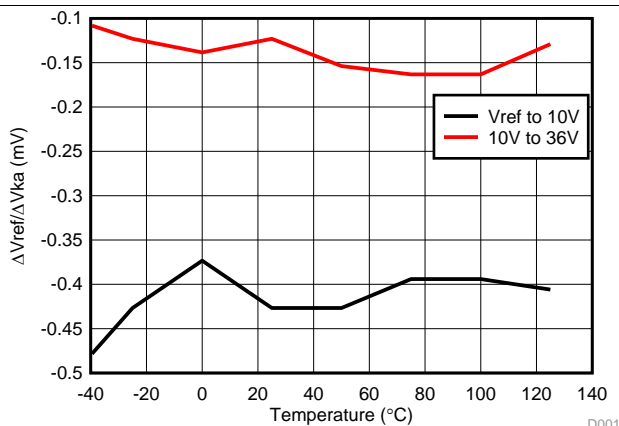


图 9. Delta Reference Voltage vs Cathode Voltage

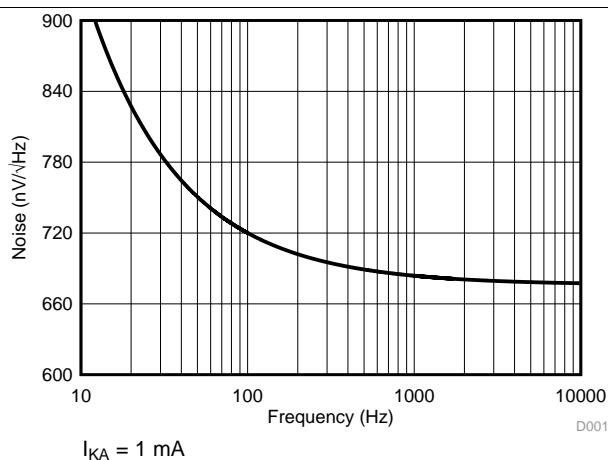


图 10. Noise Voltage

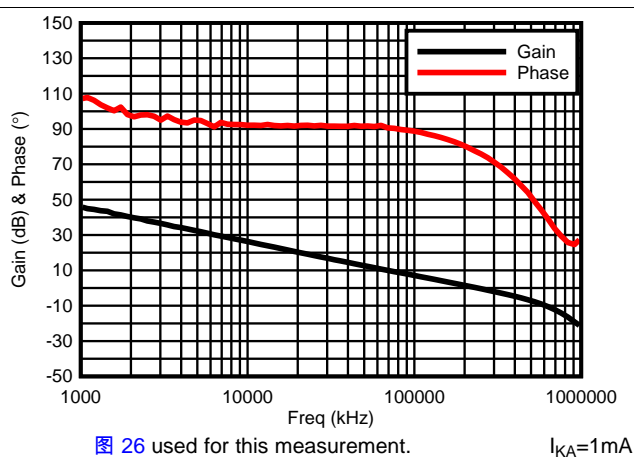


图 26 used for this measurement.

图 11. Small-Signal Voltage Amplification vs Frequency

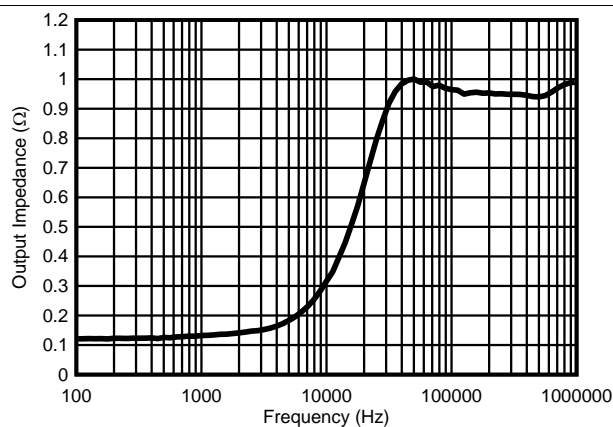


图 27 used for this measurement.

图 12. Output Impedance vs Frequency

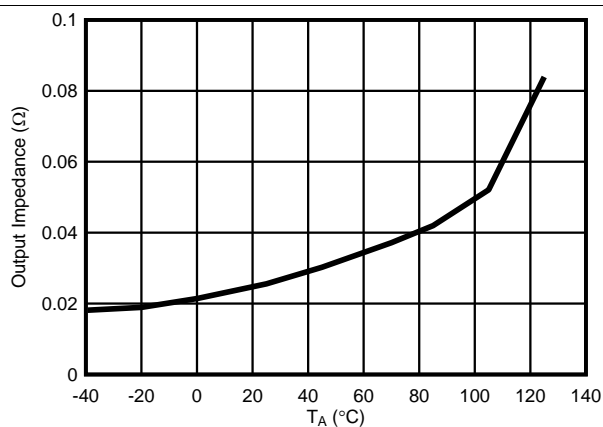


图 27 used for this measurement.

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.

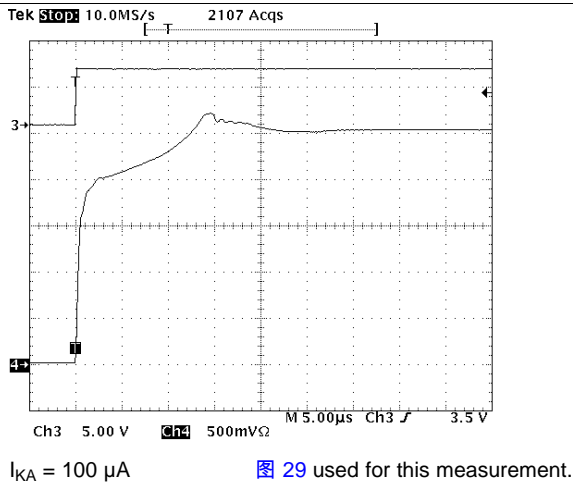


图 14. Pulse Response

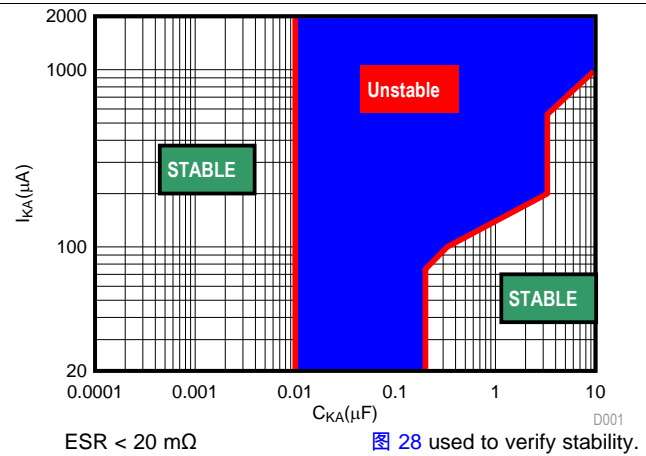


图 15. Low I_{KA} ($V_{KA} = 2.5 V$) Stability Boundary Conditions all ATL43xx Devices

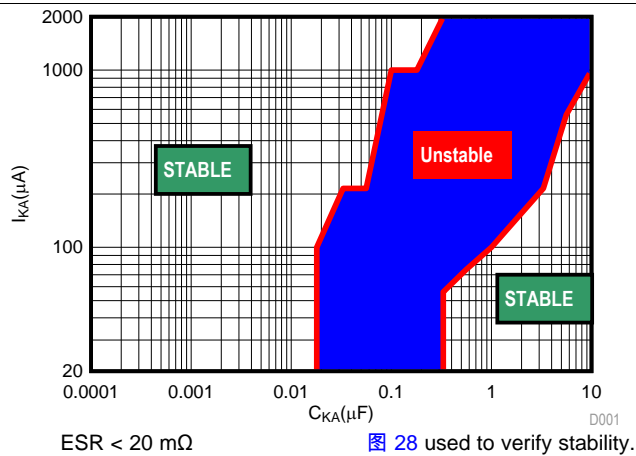


图 16. Low I_{KA} ($V_{KA} = 5.0 V$) Stability Boundary Conditions all ATL43xx Devices

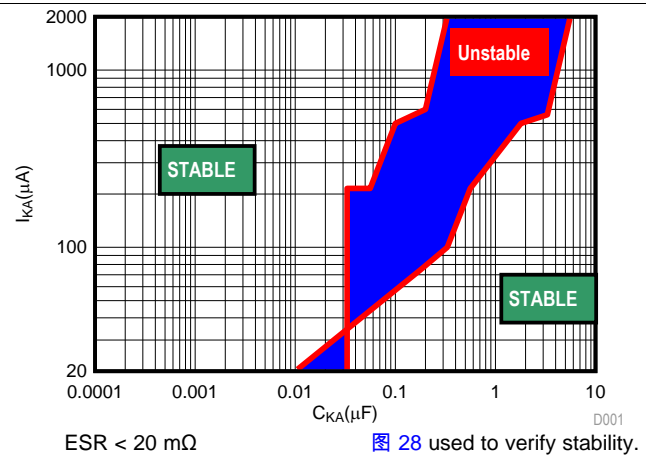


图 17. Low I_{KA} ($V_{KA} = 10.0 V$) Stability Boundary Conditions all ATL43xx Devices

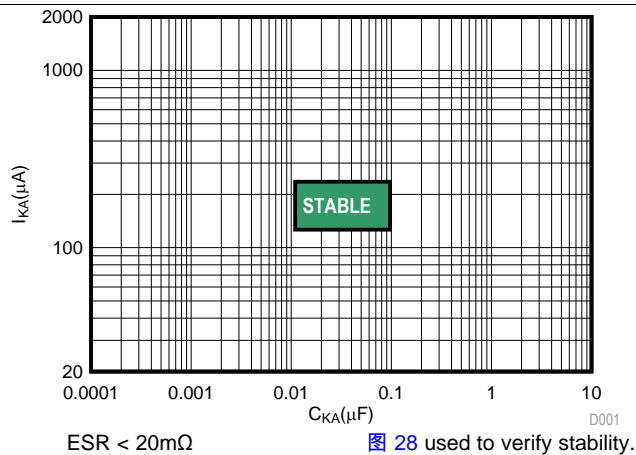


图 18. Low I_{KA} ($V_{KA} = 15.0 V$) Stability Boundary Conditions all ATL43xx Devices

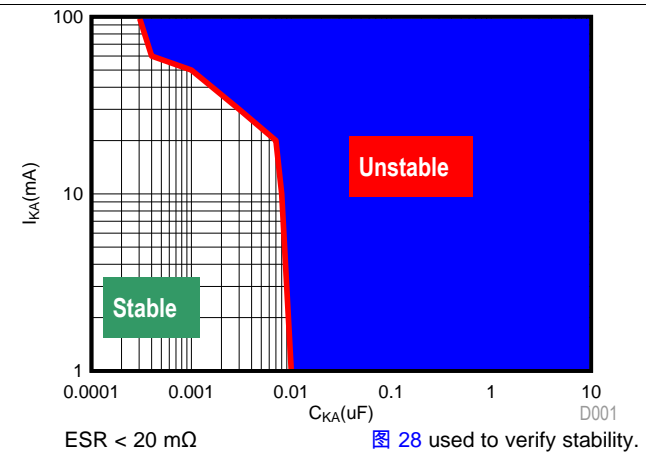


图 19. High I_{KA} ($V_{KA} = 2.5 V$) Stability Boundary Conditions all ATL43xx Devices

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.

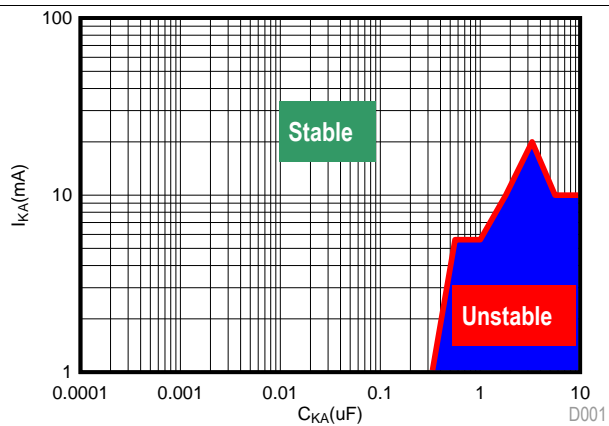


图 20. High I_{KA} ($V_{KA} = 5.0$ V) Stability Boundary Conditions all ATL43xx Devices

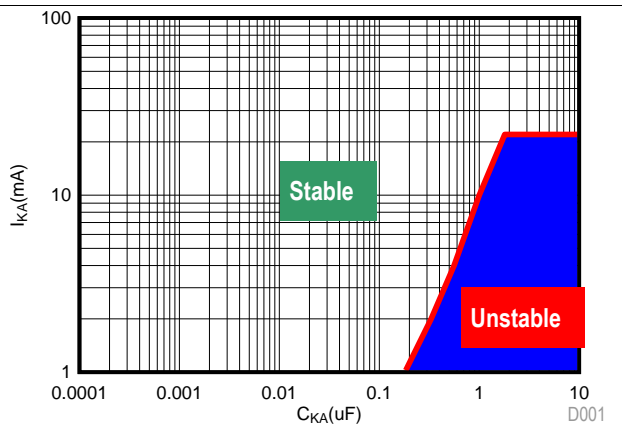


图 21. High I_{KA} ($V_{KA} = 10.0$ V) Stability Boundary Conditions all ATL43xx Devices

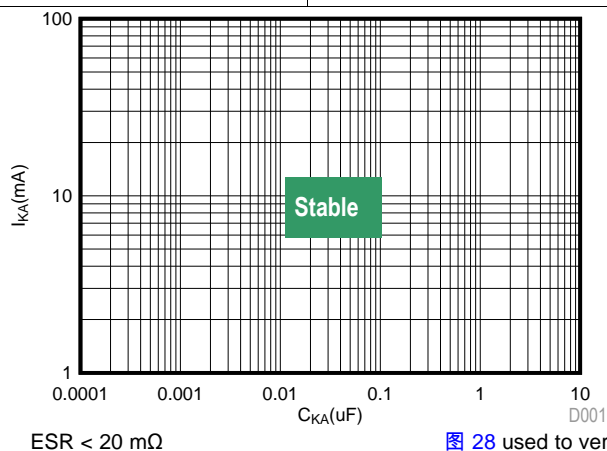


图 22. High I_{KA} ($V_{KA} = 15.0$ V) Stability Boundary Conditions all ATL43xx Devices

8 Parameter Measurement Information

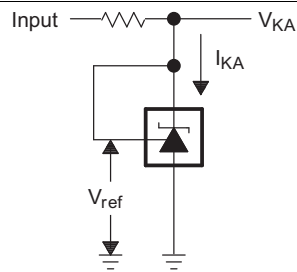
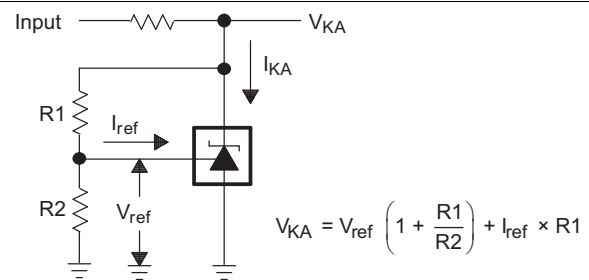
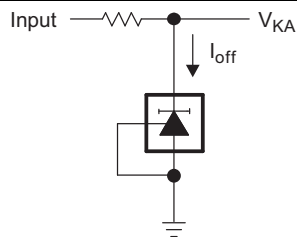
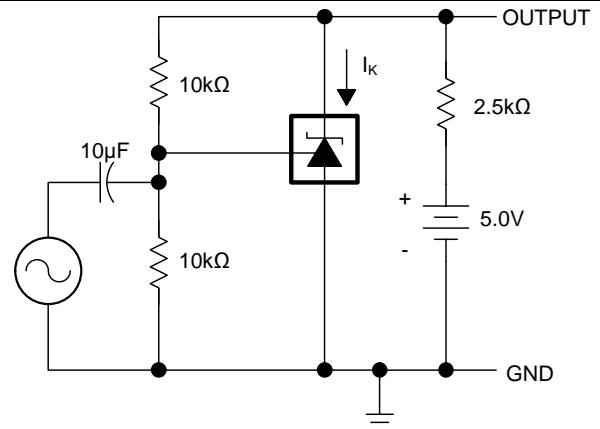

 图 23. Test Circuit for $V_{KA} = V_{ref}$

 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

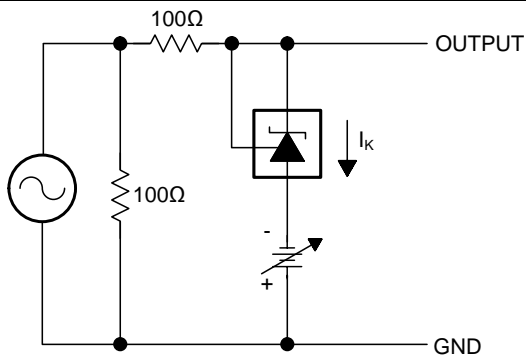
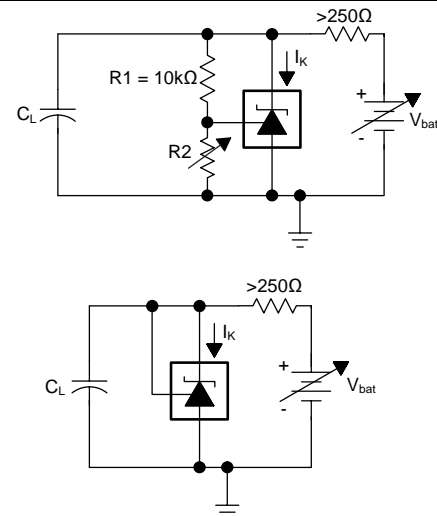

 图 27. Test Circuit for Reference Impedance (Z_{KA})


图 28. Test Circuit for Stability Boundary Conditions

Parameter Measurement Information (接下页)

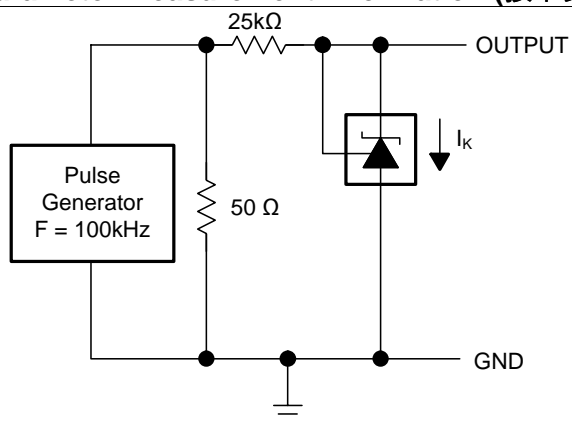


图 29. Test Circuit for Pulse Response

9 Detailed Description

9.1 Overview

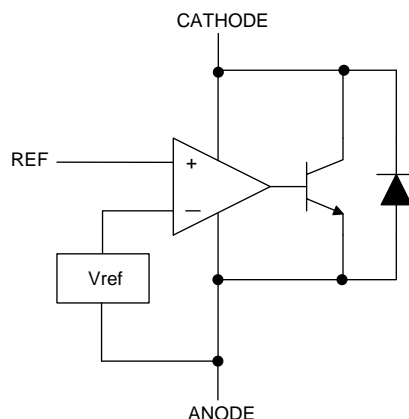
ATL43x is a low power counterpart to TL431 and TLV431, having lower minimum cathode current ($I_{k(min)} = 35 \mu A$ vs 0.1/1.0 mA). Like TL431, ATL43x is used in conjunction with its key components to behave as a single voltage reference, error amplifier, voltage clamp or comparator with integrated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

Figure 30 shows the AT43x 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 Figure 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 > 20x 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](#).

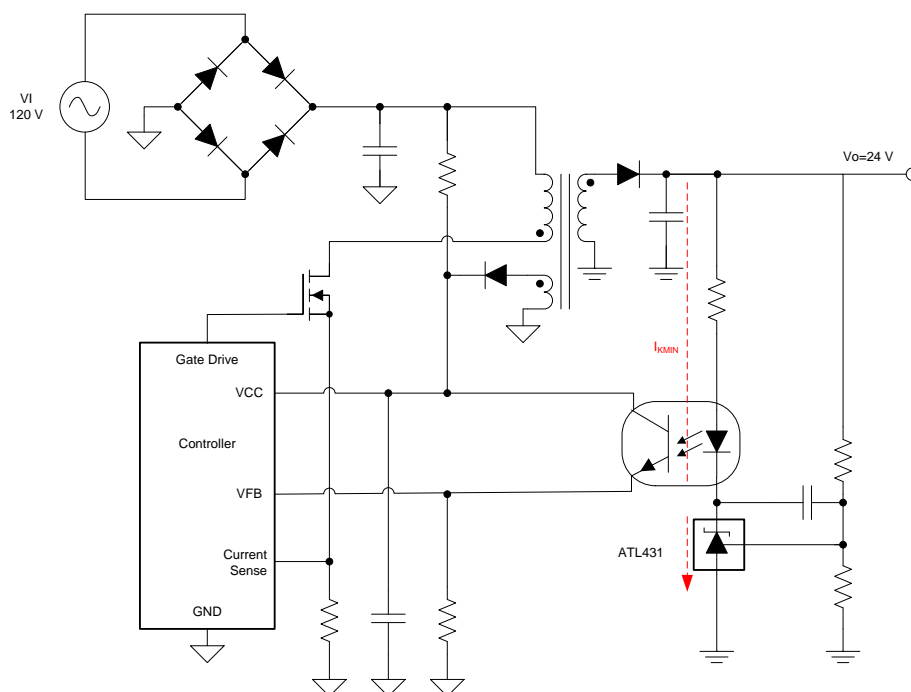


图 30. Flyback With Isolation Using ATL43x as Voltage Reference and Error Amplifier

10.2 Typical Applications

10.2.1 Comparator with Integrated Reference (Open Loop)

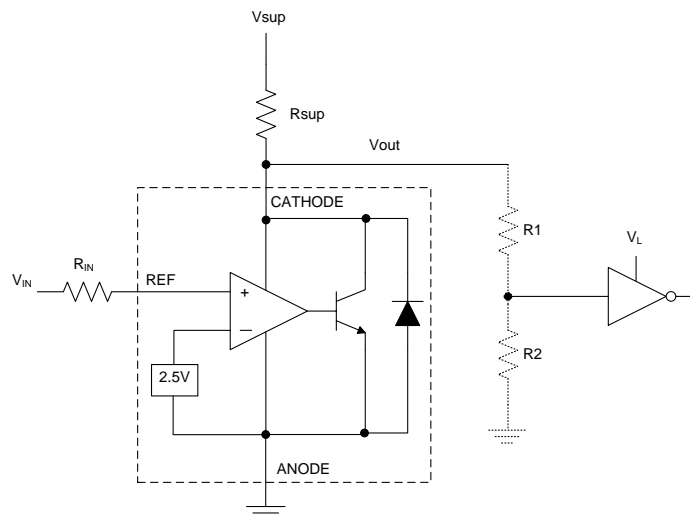


图 31. Comparator Application Schematic

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.

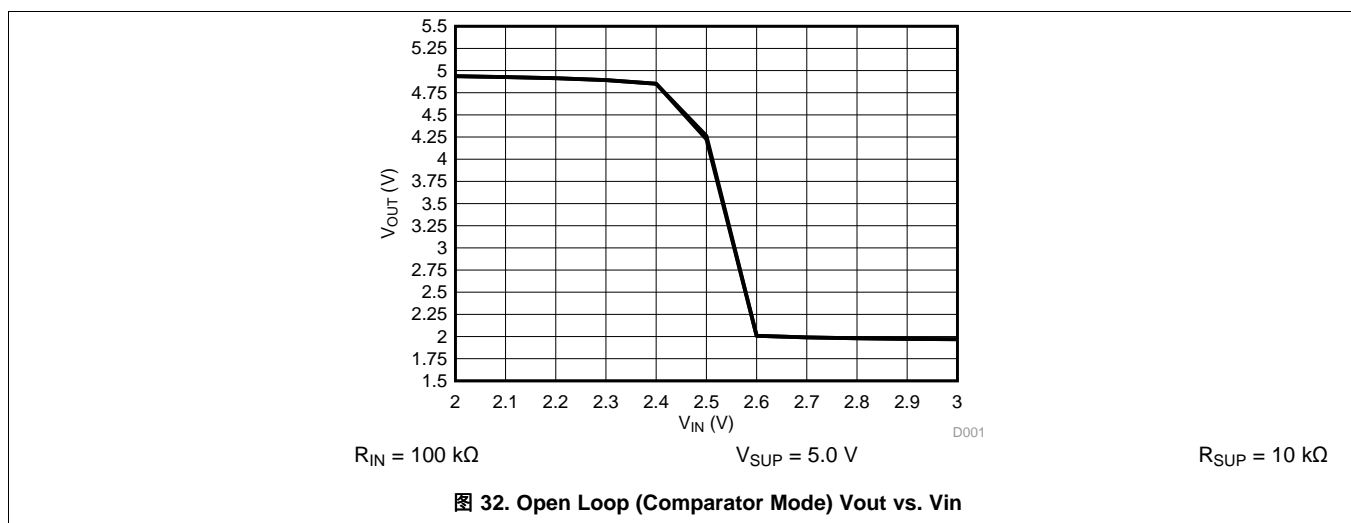
10.2.1.2.3.1 Input Resistance

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

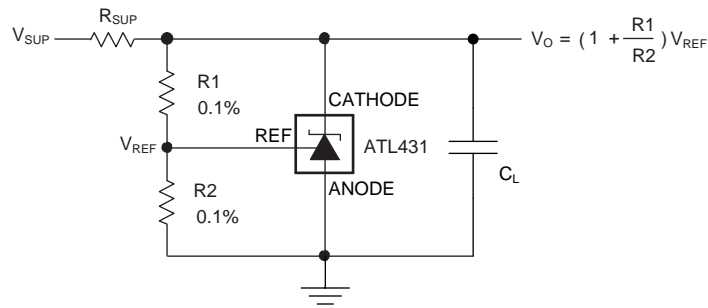


图 33. Shunt Regulator Schematic

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

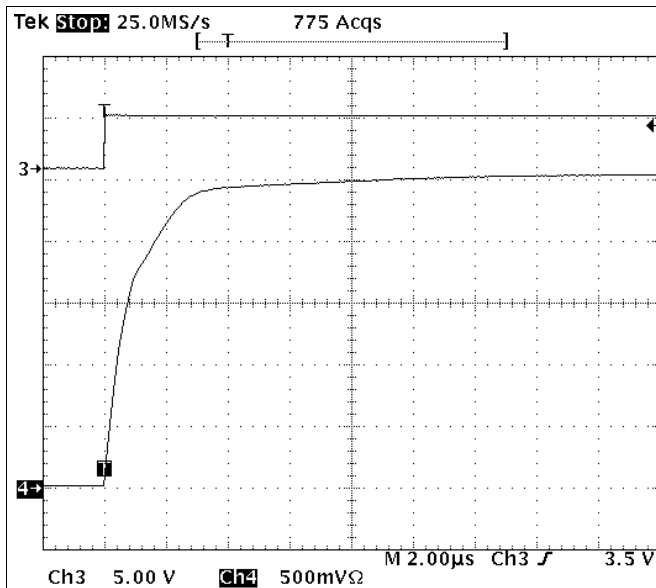


图 34. ATL43x Start-up Response $I_{KA} = 50 \mu A$

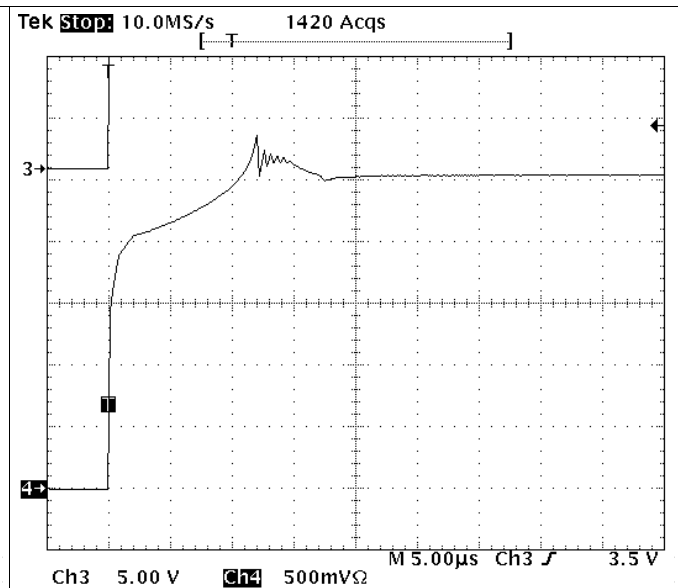


图 35. ATL43x Start-up Response $I_{KA} = 1 mA$

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 it's 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

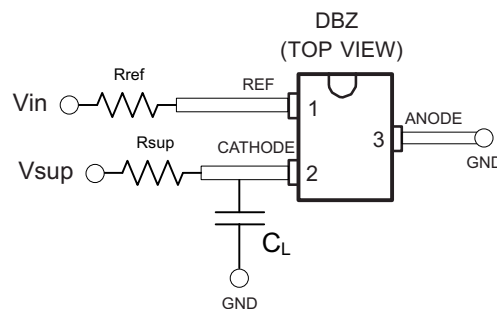


图 36. DBZ Layout Example

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 |

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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。

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| 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 | | |
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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.

OBSOLETE: 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.

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

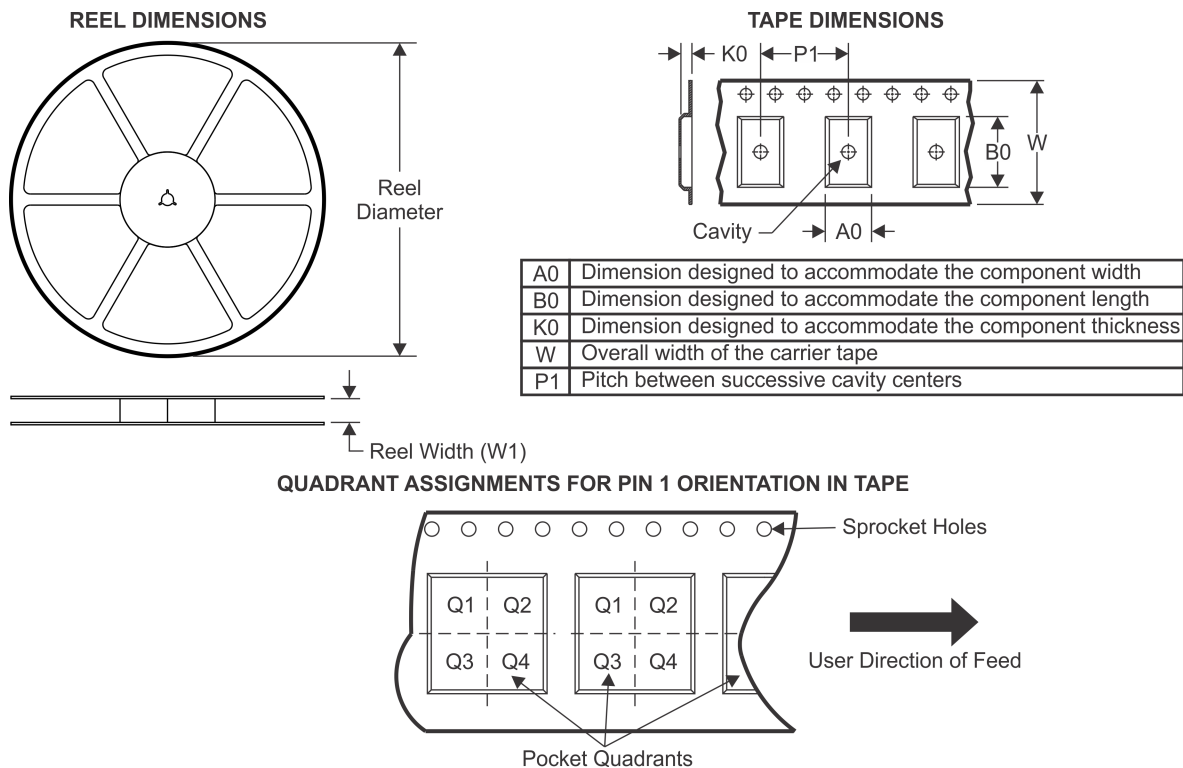
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

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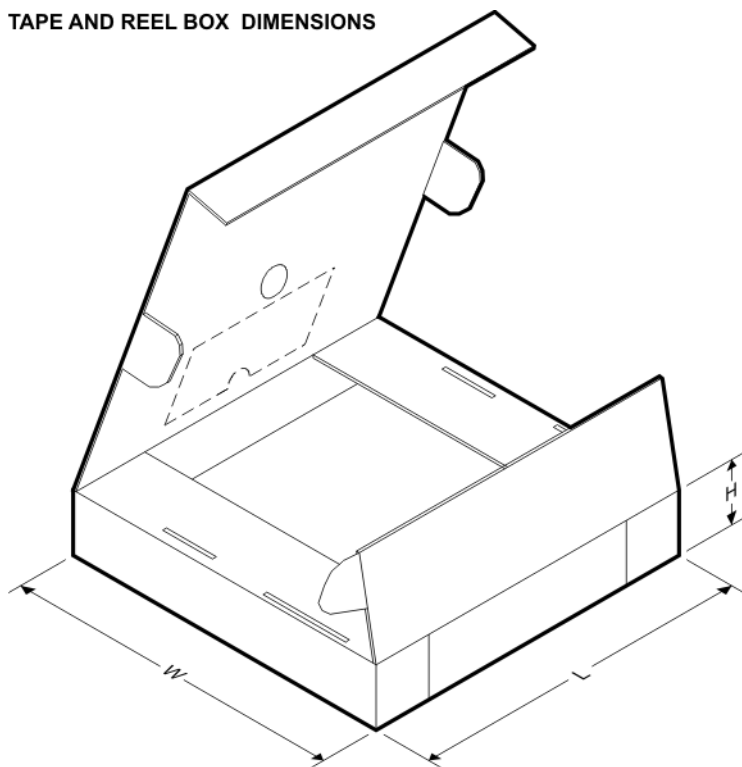
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TAPE AND REEL INFORMATION


*All dimensions are nominal

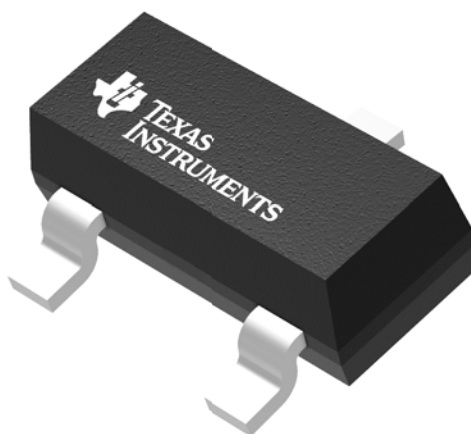
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 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 |



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

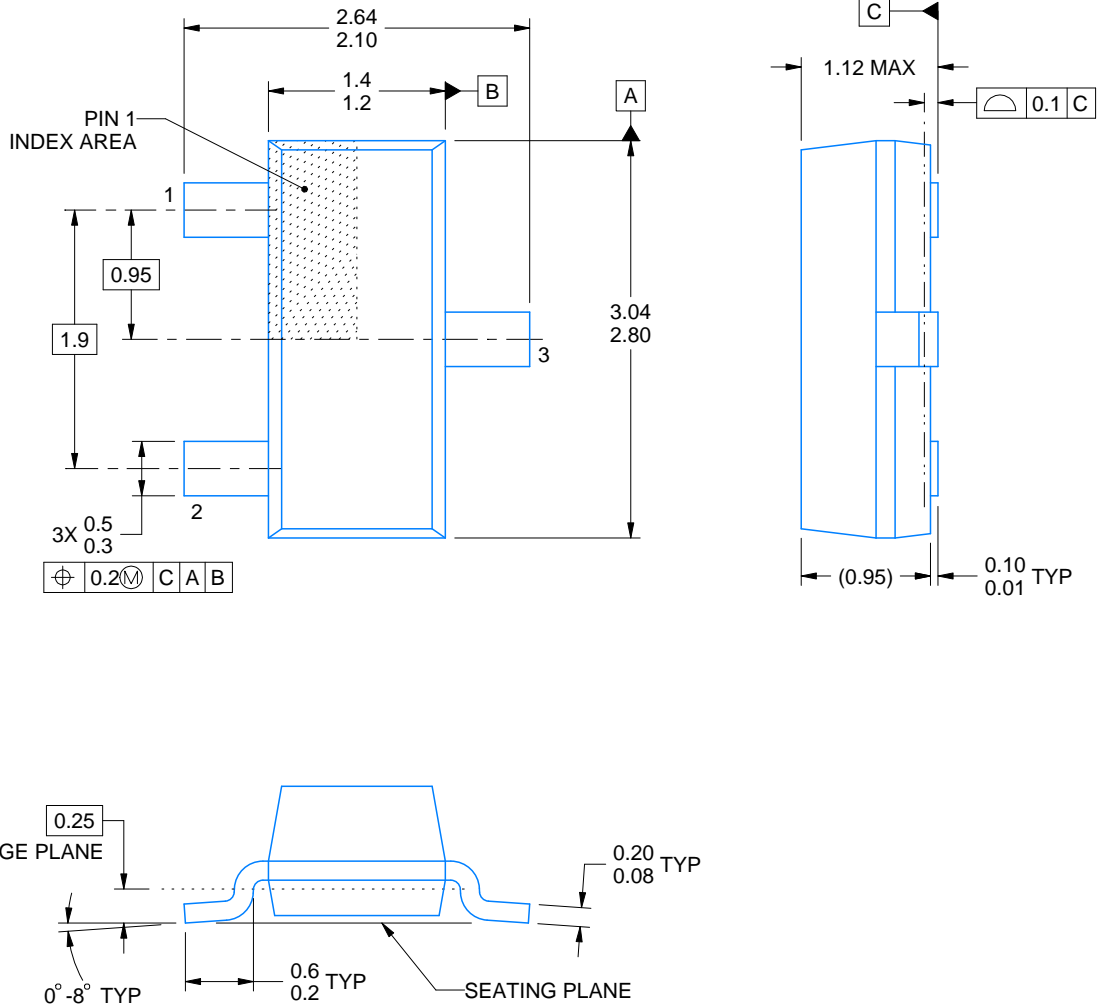
DBZ0003A



PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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NOTES:

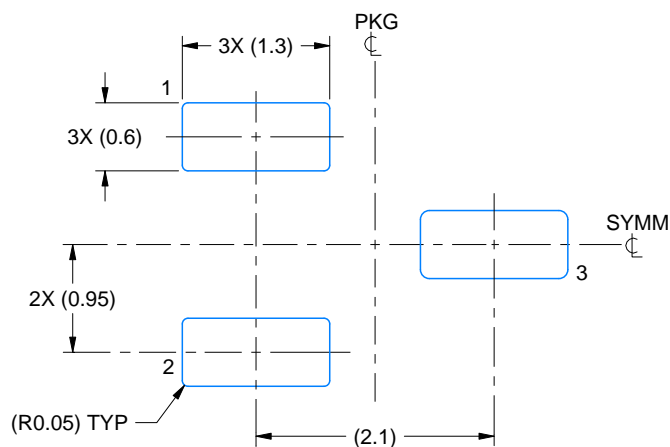
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.

EXAMPLE BOARD LAYOUT

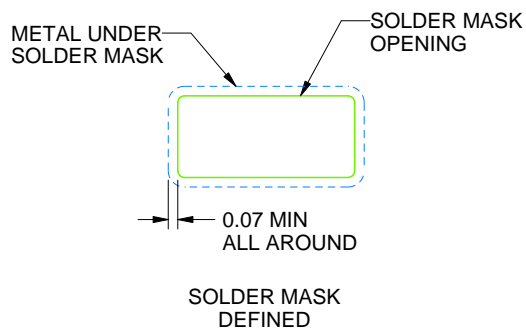
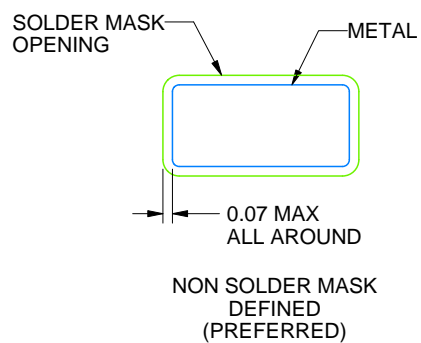
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

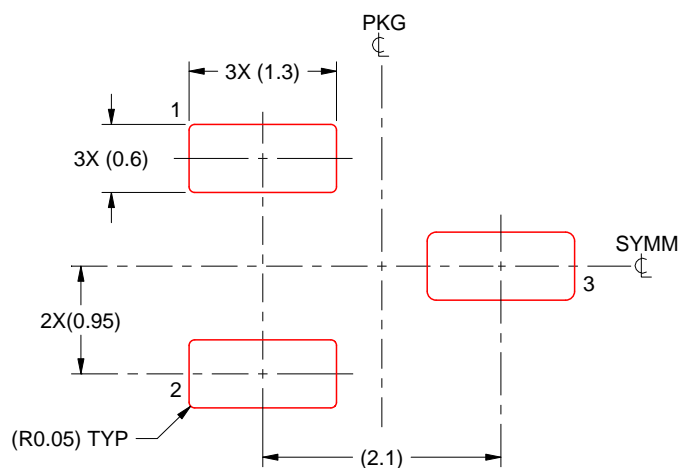
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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

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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.

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