APPLICATION NOTE 1135
LOAD CAPACITOR STABILITY BOUNDARY OF SHUNT REGULATOR

Introduction

Industry standard 431 has a band-gap voltage reference and error amplifier. It features sharp turn-on characteristics, low temperature coefficient and low output impedance, which make it ideal substitute for Zener diode in applications such as switching power supply, charger and other adjustable regulators.

This article is mainly describing the application considerations of how to choose the proper load capacitor where accurate voltage reference is needed.

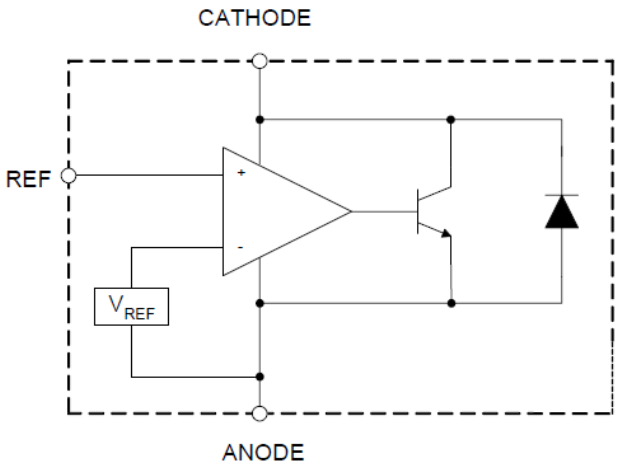

Figure 1. Function Block of AZ431-A

Typical Application Circuits

Figure 2 and Figure 3 are typical shunt regulator applications with load capacitor.

In Figure 2, $V_{KA} = V_{REF}$. In Figure 3, $V_{KA} = V_{REF}(1+R3/R2)+I_{REF}\times R3$.

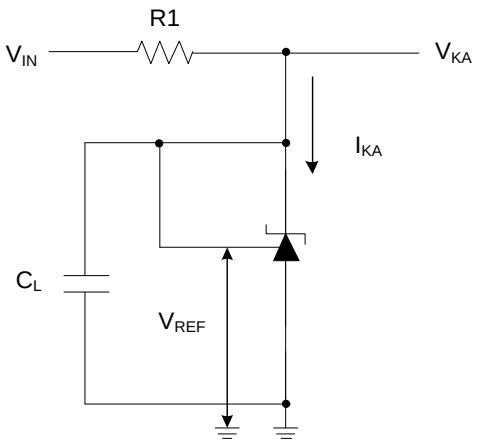

Figure 2. $V_{KA} = V_{REF}$

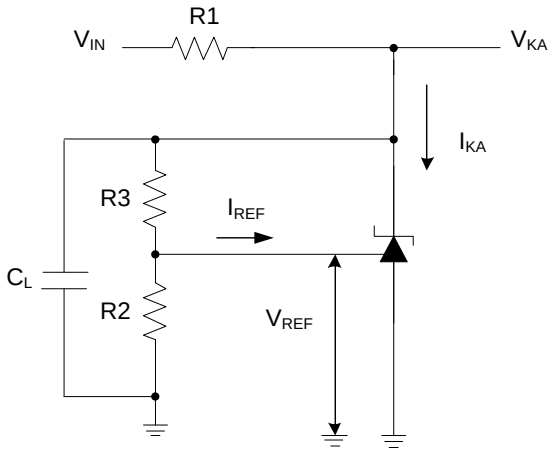

Figure 3. $V_{KA} > V_{REF}$

Application Hints

For the proper work of shunt regulator at this application, load capacitor should be set carefully for good output precision.

Usually, a Load Capacitor vs. Cathode Current curve can be found at the datasheet. If not, please ask related engineer for the graph. Take AZ431-A for example (Figure 4), this diagram shows four different V_{KA} conditions, that is $V_{KA} = V_{REF}$, V_{KA} = 5V, V_{KA} = 10V and V_{KA} = 15V. For each condition, the area between the boundary curves is unstable. That means you can't choose the capacitor value work at that cathode current condition. For example, if the load capacitor is 0.022μF, cathode current = 1mA is unstable while 10mA is stable. If V_{KA} > 15V, there will be no capacitor limit, all capacitor is stable.

Generally, different shunt regulator has different load capacitor boundary, though they have the same function or performance. Figure 5 is AZ431-B load capacitor boundary graph, apparently it is different from AZ431-A. The reason is that this capacitor will affect the Zero/pole of circuit, some capacitors may cause the circuit oscillation.

To ensure the good regulation of shunt regulator, it is high recommended choosing the capacitor to keep a distance from the unstable area for the capacitor error limit or other worse case conditions.

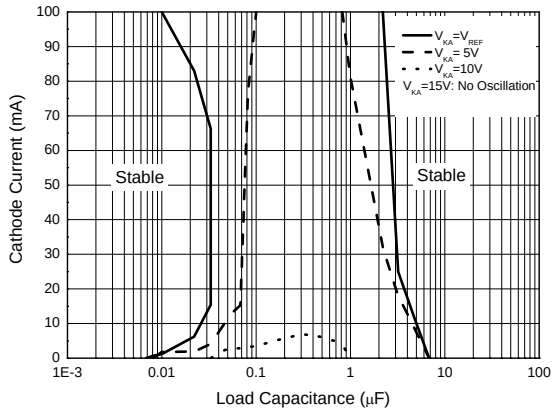

Figure 4. AZ431-A

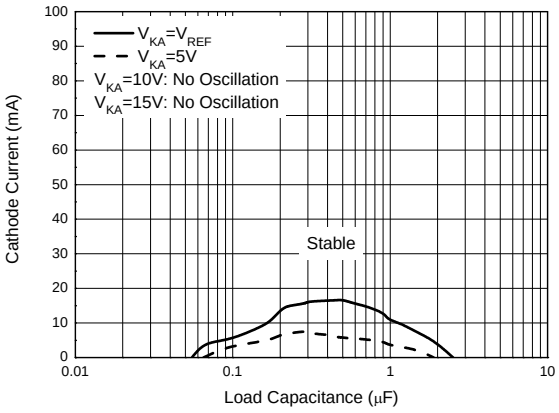

Figure 5. AZ431-B

In summary, load capacitor may cause the output oscillation of system. Please make sure to choose the right capacitor value at the stable area.

Appendix

Generally, IC provider datasheet shows a typical stability boundary at room temperature. Actually, this boundary may slightly shift by temperature or fabrication process. So here, we provide a fully stability boundary taking temperature (T_A = -40°C to +85°C) and other relative factors into account.

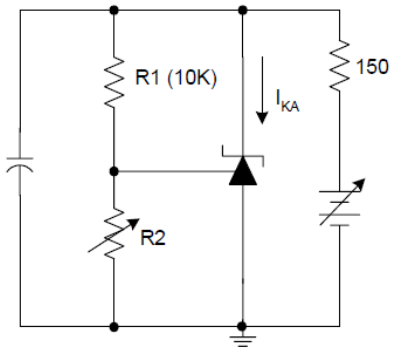

Figure 6. Test Circuit

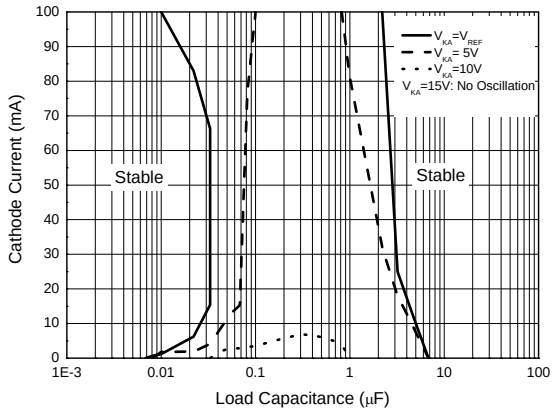

Figure 7. AZ431-A Stability Boundary

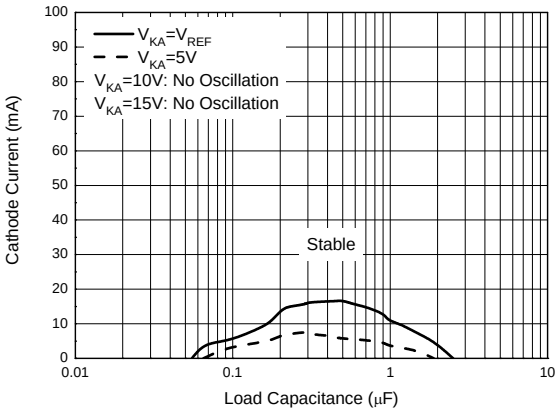

Figure 8. AZ431-B Stability Boundary

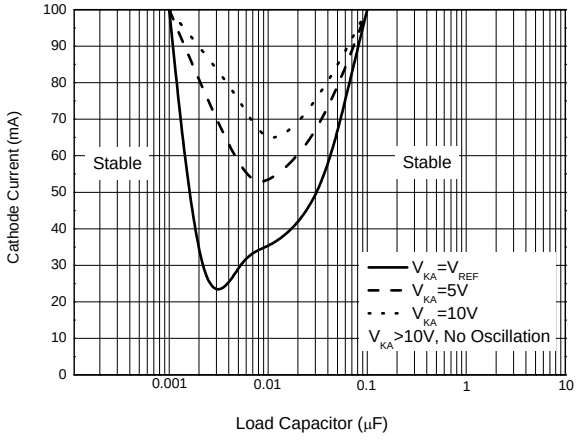

Figure 9. AS431I Stability Boundary

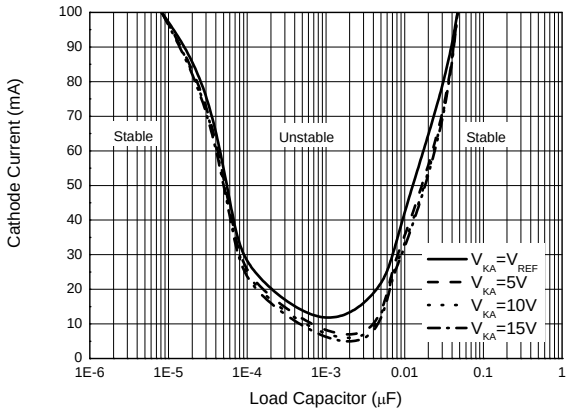

Figure 10. AZ431L Stability Boundary

AZ431-A covers AN431 stability conditions and AZ431L covers AZ432 stability conditions.

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