ATL431 Adjustable Shunt Regulator EVM

1 Overview

The ATL431EVM is an adjustable voltage reference evaluation module that demonstrates the ATL431 integrated circuit from Texas Instruments (TI).

The ATL431 is a low-power counterpart to the TL431 and TLV431, having lower minimum cathode current (Ik_{min} = 35 µA 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.

The ATL431 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 equipment in industrial, auto, telecom, and computing. In order for this device to behave as a shunt regulator or error amplifier, > 35 µA (I_{min}(max)) must be supplied into 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.

The EVM is configured with resistor options to set the cathode current, resistor options to set the cathode voltage, and load capacitor options to check stability. A test point can be connected to an external power supply to provide power. All of the ATL431 input and output pins are accessible for external connection via test points.

1.1 ATL431EVM Features

- Multiple resistor options for cathode current setting
- Multiple resistor options for cathode voltage setting
- Open 0805 footprints for user resistor option
- Multiple capacitor options for stability and transient response measurement
- Test points for voltage measurement

Table 1. ATL431EVM Specification

Key Parameters	
Supply Voltage:	0 V – 40 V
Programmable Cathode Voltage:	2.5 V – 36 V
Cathode Current:	35 µA to 100 mA

CAUTION

Applying voltages above the limitations given in Table 1 may cause permanent damage to your hardware.

Gerber (layout) files are available at www.ti.com.

1.2 Schematic

The schematic for the ATL431EVM is illustrated in Figure 1.

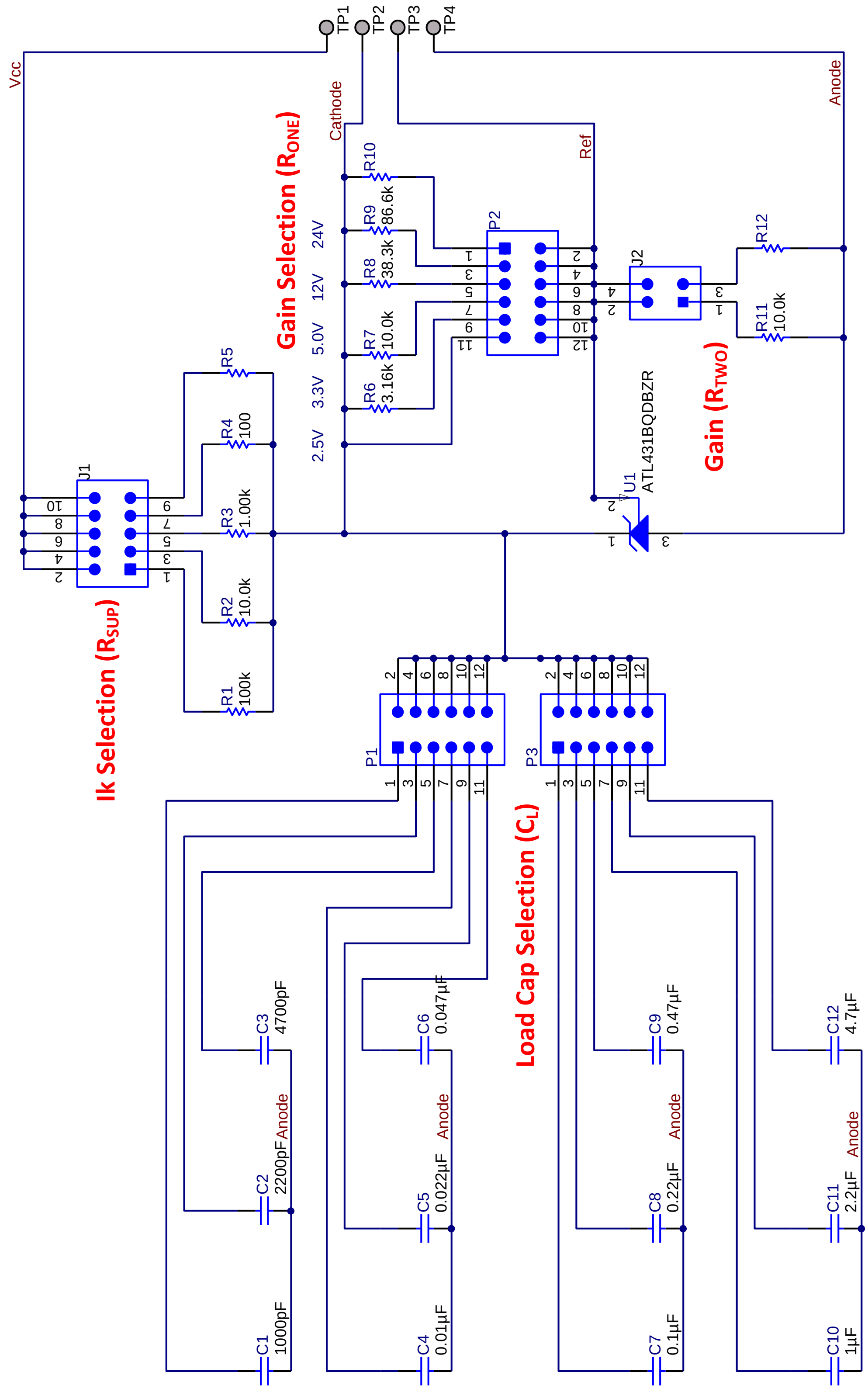

Figure 1. ATL431EVM Schematic

1.3 PCB

The PCB layout for the ATL431EVM is illustrated in Figure 2.

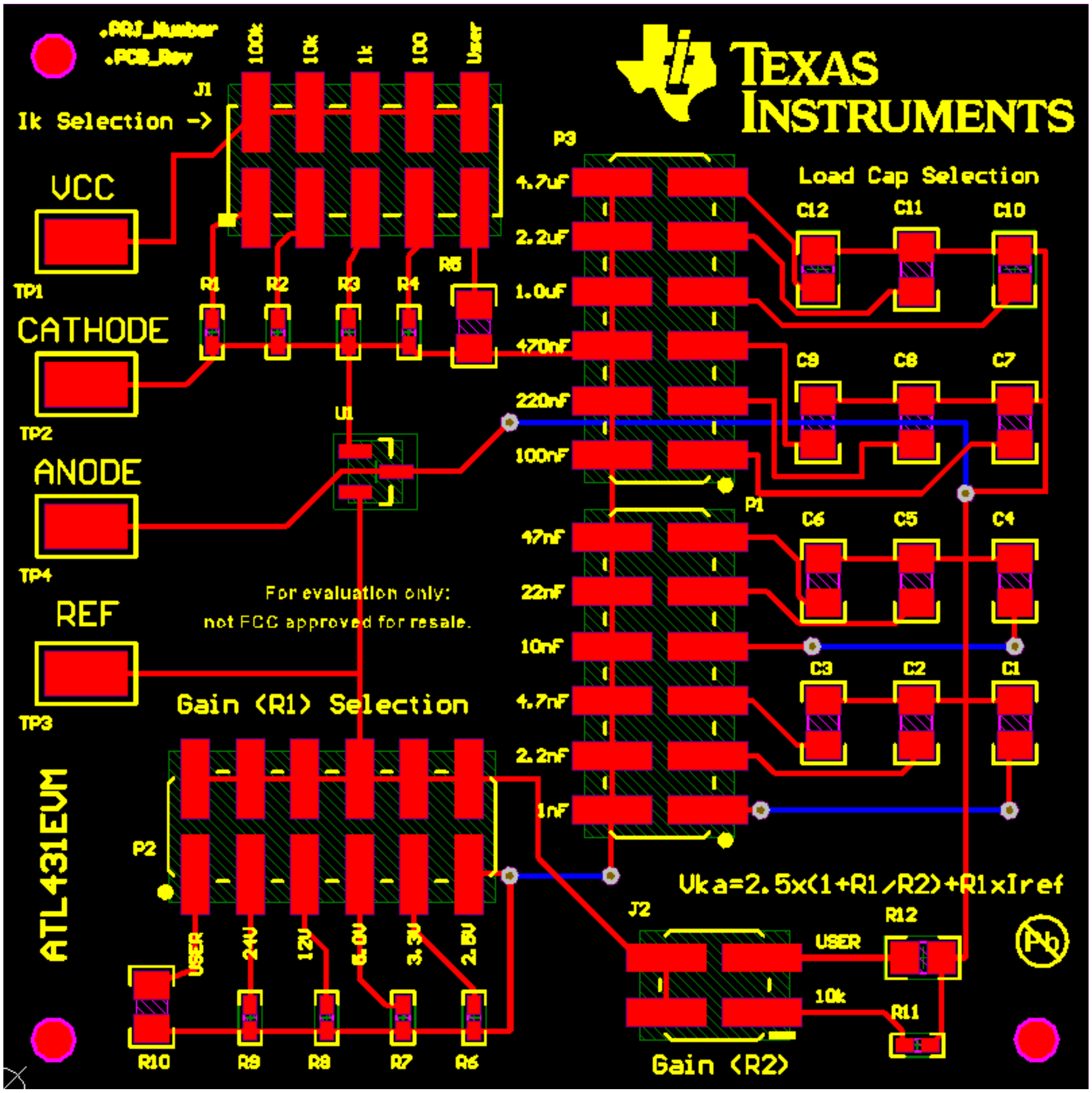

Figure 2. ATL431EVM PCB Layout

2 Quick Setup Guide

This section describes the setup to quickly check the functionality of the ATL431EVM.

2.1 Electrostatic Discharge Warning

Many of the components on the ATL431EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

CAUTION

Failure to observe ESD handling procedures may result in damage to EVM components.

2.2 Unpacking the EVM

After opening the ATL431EVM package, ensure that the following is included:

1 pc. ATL431EVM board using one ATL431

2.3 Power Supply Setup and Functional Test

A 40-V power supply capable of 100 mA of current is required.

Connect the positive power supply lead to the “V_{CC}” on TP1. Connect the negative power supply lead to "anode" on TP4.

Place a jumper on the "10k" option of the “Ik Selection” section and set V_{CC} to 5 V. Enable power supply, then place a jumper on the 2.5 V voltage option in the “Gain (R1) Selection” section and measure the voltage coming out of, TP2, the Cathode terminal. If TP2 is equal to 2.5 V (±1%) then the ATL431EVM passes functional testing.

3 EVM Theory and Operation

The following single channel schematic is representative of the ATL431EVM with each passive bank selection.

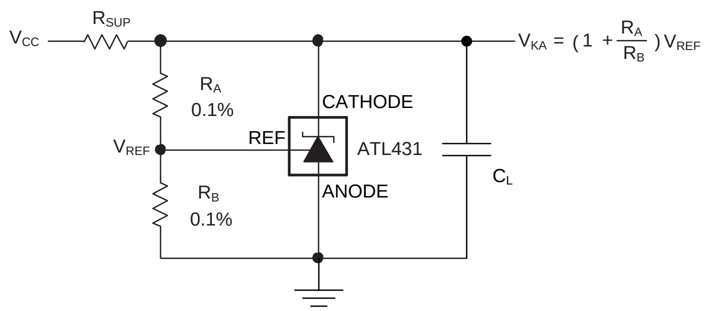

Figure 3. Base Shunt Regulator Schematic

The ATL431EVM is designed to allow users to setup configuration in Figure 3 with multiple options for each passive component and open footprints to test multiple use cases. Table 2 shows a mapping of EVM components to the base components shown in Table 2.

Table 2. EVM Component Mapping

Base Component	EVM Components
R_{SUP}	R1 - R5
R_A	R6 - R10
R_B	R11 and R12
C_L	C1 - C12

As shown in Figure 2, the EVM is designed to allow users to visually map out each jumper connection to its respective passive component by the labeling of the component value next to it.

3.1 *Setting the Cathode Current (I_{KA})*

R_{SUP} should be set in conjunction with V_{CC} and the desired cathode voltage (V_{KA}) to provide enough current for operation. The ATL431 needs > 35 µA in order to operate in the proper gain region for accurate regulation. Use Equation 1 to determine the cathode current.

$$I_{KA} = \frac{V_{CC} - V_{KA}}{R_{SUP}} \tag{1}$$

As shown in Figure 2, this portion is in the top left hand corner and is indicated as "Ik Selection" on the PCB. Each jumper is denoted with its respective resistor value.

When setting I_{KA} with R1 - R5, be sure to not exceed the absolute maximum rating of 100 mA for the cathode current.

3.2 *Setting the Cathode Voltage (V_{KA})*

Once a desirable cathode current is determined. R_A and R_B must be selected to determine the Cathode Voltage. Use Equation 2 to determine the cathode voltage. As I_{REF} is 150 nA maximum, the $I_{REF} \times R_A$ portion of the equation is almost negligible.

$$V_{KA} = \left(1 + \frac{R_A}{R_B}\right) \times V_{REF} + I_{REF} \times R_A \tag{2}$$

As shown in Figure 2, this portion is in the bottom left hand corner and is indicated as "Gain (R1) Selection" on the PCB. Each jumper is denoted with its respective cathode voltage value. Please take in to account that these values are only valid with R_B = 10 kΩ (or jumper connection to R11). If R_B is disconnected or tied to a user setting, use Equation 2 to determine the cathode voltage values.

When setting V_{KA}, be sure to not exceed the absolute maximum rating of 40 V for the cathode voltage. Along with maximum voltage, stability must be taken in to account as there are operating regions that are susceptible to oscillations

3.3 Checking Stability and Transient Response

One of the issues that many designers face designing with shunt regulators is stability and response/clamp time. The ATL431EVM allows users to measure this by setting the load capacitance (C_L).

As shown in Figure 2, this portion is on the right side of the PCB and is indicated as "Load Cap Selection". Each jumper is denoted with its respective capacitance value.

These capacitors are all ceramic and have very low ESR.

4 Test Modes

The ATL431EVM can be configured to measure practically every parameter shown in the typical characteristics of the datasheet. Figure 4 through Figure 10 show the configurations that can be used to take these measurements.

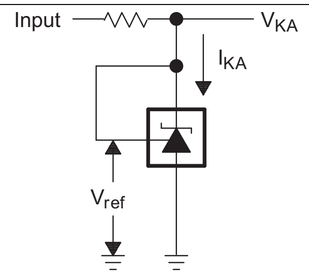

Figure 4. Test Circuit for $V_{KA} = V_{ref}$

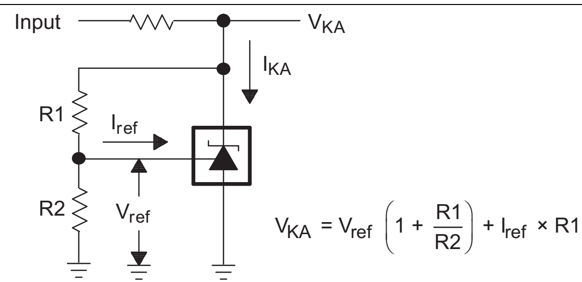

Figure 5. Test Circuit for $V_{KA} > V_{ref}$

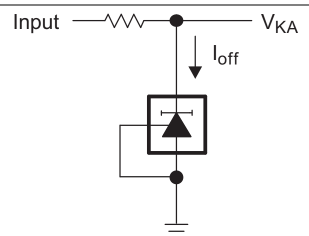

Figure 6. Test Circuit for I_{off}

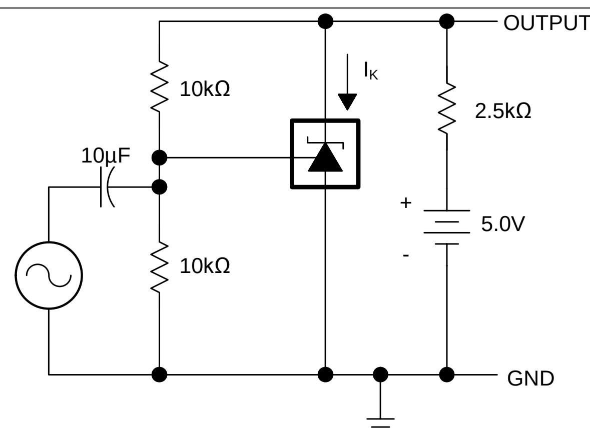

Figure 7. Test Circuit for Phase and Gain Measurement

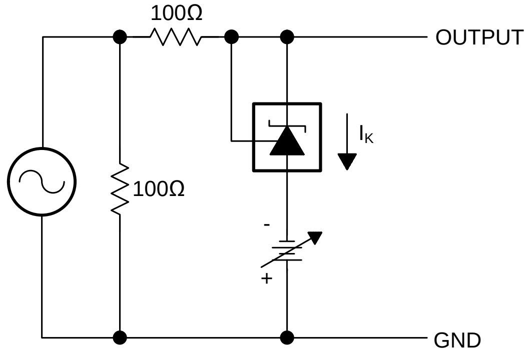

Figure 8. Test Circuit for Reference Impedance (Z_{KA})

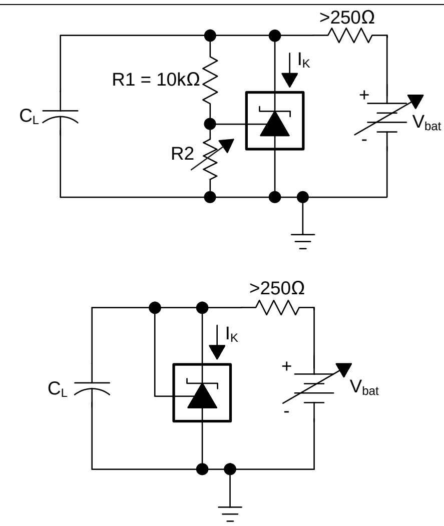

Figure 9. Test Circuit for Stability Boundary Conditions

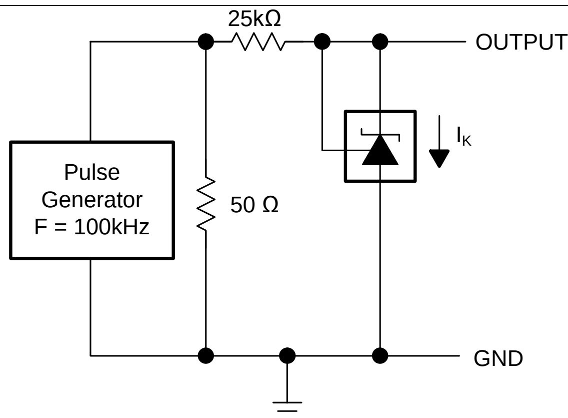

Figure 10. Test Circuit for Pulse Response

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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Concernant les EVMs avec antennes détachables

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