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DN0027
Design note

DESIGNS from our LABS

Setting Vout below the reference using LC29300

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Main components	
LD29300	3A very low drop voltage regulators
TL431	Programmable voltage reference

Specification

- Vin = 2.6V to 13V
- Vout = 1.2V to 0.2V

Circuit description

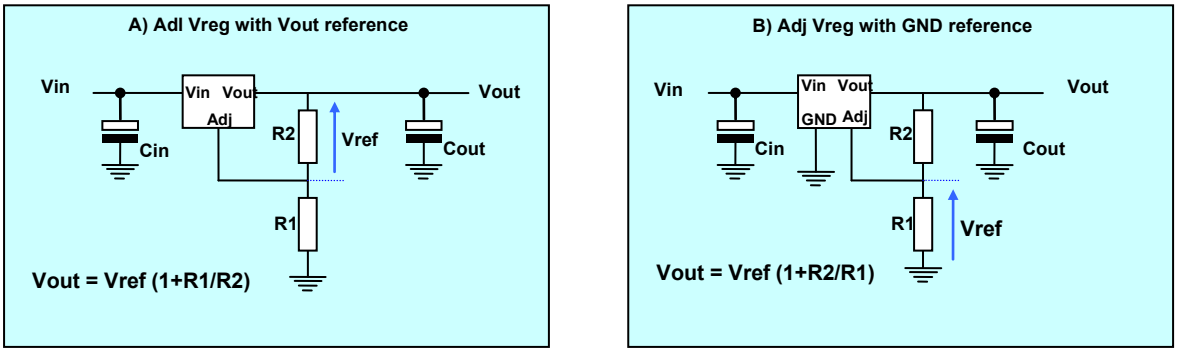
Three pin adjustable voltage regulators don't have a GND pin connection, and the internal reference is floating (linked to Vout). For those types of voltage regulators, the output voltage reaches the stable condition when the voltage drop across the resistor, between output and adj pin, is equal to the internal voltage reference.

Adjustable voltage regulators with a GND connection (4 pin or more) such as the LD29300 have the internal reference referred to GND, and the output is set when the voltage drop across the resistor between adj pin and GND is equal to the internal voltage reference.

Figure 1 shows the two types of adjustable voltage regulators:

- one with reference to Vout
- one with reference to GND

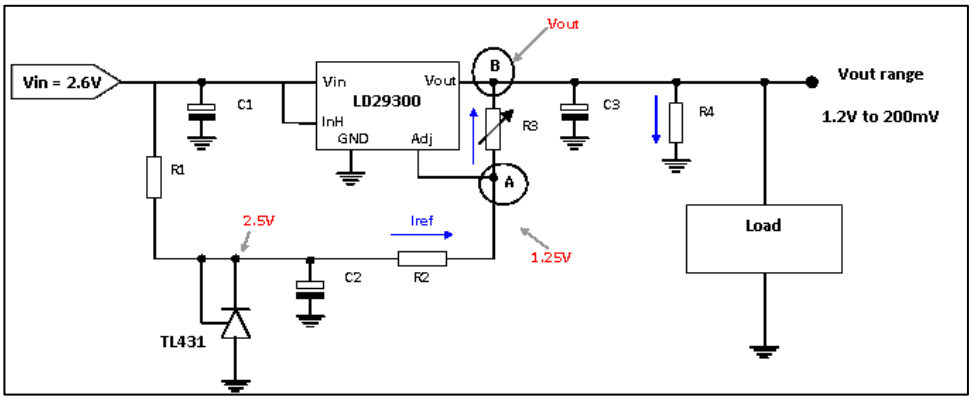
Figure 1. A) adj with reference to Vout, B) adj with reference to GND



When the internal reference is linked to GND, it is possible to set an output voltage lower than the internal reference, using an additional voltage reference higher than the internal reference.

Figure 2 shows this configuration. The resistor divider (R2 and R3) is now connected between the external reference TL431, the adj pin (A) and the output (B). In a standard configuration like in figure 1B, the current in the resistor divider flows from the output to GND. While using the external reference, the current flows from the reference to Vout, therefore the regulator drops the Vout (at point “B”) below the internal reference until the voltage on the adjustable pin reaches the value of the internal reference.

Figure 2. Circuit for Vout lower the Vref



The TL431 reference is configured for 2.5V.

The Vout level is set through the following formula:

$$Vout = 1.25 - R3 * Iref$$

$$Iref = (2.5 - 1.25)/R2$$

In the above formula, Iref is in the range of a few mA (2.375mA), 2.5V is the external voltage reference and 1.25V is the voltage on the adj pin.

R4 is needed to provide a minimum load so that, in absence of load, the Iref current can still flow to GND. To keep the system stable, the maximum value of R4 is given by the equation.

$$R4 < Vout/(Iref + Vreg\ Iout\ min)$$

Variations

The same technique can be used with any of the LDO regulators shown in Table 1

Table 1. LDO regulators with reference to ground

LDO	Vin range	Iout	Vout accuracy
L6932	2V to 14V	2A	±1%
LD29080	2.5V to 13V	0.8A	±1%
LD29150	2.5V to 13V	1.5A	±1%
LD29300	2.5V to 13V	1.5A	±1%
LD39080	2.5V to 6V	0.8A	±1.5%
LD39150	2.5V to 6V	1.5A	±1.5%
LD39300	2.5V to 6V	1.5A	±1.5%
ST1L05	3Vto 5.5V	1.3A	±2%
Voltage Reference	Vref range	IK min (µA)	Precision
TL431	2.5V - 36V	1000	1%
TL1431	2.5V - 24V	1000	0.25%
TS2431	2.5V - 24V	1000	0.5
TS822	2.5V	40	0.5%
TS824-2.5	2.5V	50	0.5%
TS4040	2.5V	40	0.5%

Support material

Datasheet • LD29300: 3A very low drop voltage regulators • TL431: Programmable voltage reference
Application note • AN1761: TL431 accuracy of shunt voltage references in programmable mode

Revision history

Date	Version	Changes
06-August-2014	1	Initial release