The ZR2431 Low Reference Voltage Shunt Regulator

Shunt Regulator

The ZR2431 is ideal for providing low voltage stabilised supplies or references. Low output voltage supplies can be difficult to design as the components normally used, such as zener diodes or band gap references, are either too poor in performance or not available at the desired voltage (band-gap devices are usually fixed at 1.2V or 2.5V with no intermediate values). The circuit in Figure 1 shows a 1.5V shunt regulator utilising the ZR2431. The output of this supply can be set to any voltage in the range 1.23V to 20V by adjusting the ratio of R1 and R2, following the relationship:-

$$V_{out} = V_{ref} \frac{(R1+R2)}{R1}$$

Where V_{ref} is the reference voltage of the ZR2431.

Note that a small correction to this formula is required if R1 and R2 are given very high values, since the reference input current of the ZR2431 flows through R2 but not R1 causing a small error. This reference current is only 200nA maximum for the ZR2431 so as long as a current of at least 20μA is passed through R1, setting its maximum
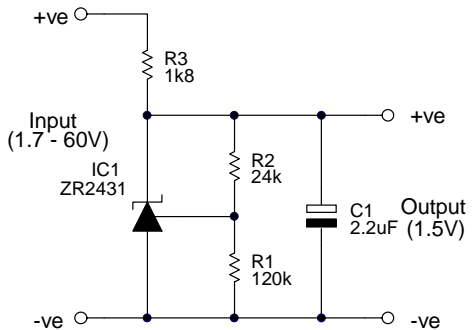

Figure 1
1.5V Shunt Regulator.

value at 60k ohms, the reference current can be ignored. For very low current applications where it is advantageous to set R1 and R2 at a level where the reference current must be considered, the following formula takes this input current into account:-

$$V_{out} = I_{ref} \, x \, R2 + V_{ref} \frac{(R1+R2)}{R1}$$

Where I_{ref} is the reference input current of the ZR2431.

R3 is selected so as to support the maximum load current at minimum input voltage, yet still maintain adequate

operating current for the ZR2431. Since the minimum cathode current of the ZR2431 is only 100µA, it rarely has an effect on the choice of R3.

$$R3 = \frac{V_{in_{(min)}} - V_{out}}{I_{out_{(max)}} + I_{z_{(min)}}}$$

Where $I_{z(min)}$ is the minimum cathode current of the ZR2431.

The low series resistance of the ZR2431 not only gives the shunt regulator good load regulation but also a line rejection of over 60dB. In this circuit, capacitor C1 both maintains this rejection figure at high frequencies and ensures the ZR2431 is stable should the load of the regulator be reactive. The value of C1 necessary to ensure stability varies with the regulator's output voltage (set by R1 and R2). The value shown is sufficient for all voltages but the size of this capacitor can be reduced for higher output voltages e.g. only 47nF is necessary at the highest working output voltage of 20V.

ZETEX