Many circuits today not only require voltage regulation but they also need current regulation. Some systems draw excessive current during power on, which can cause expensive system components to burn up due to improper powering of supplies. This is not the only problem associated with excessive currents. Some applications need to limit the current an op amp can provide to a specific load. This circuit can provide this type of function by making constant current sources out of simple regulators.

The REG1117 is a low cost, low drop out, adjustable regulator that can be used for both voltage and current regulation. In the normal mode of operation, applying a fixed voltage on the input pin will provide a fixed voltage between V_OUT and Adj. Placing a resistor across V_OUT and Adj will limit the amount of current delivered to the load by making the regulator appear as a constant current source.

Figure 1 shows two REG1117s (U₁, U₂) with R₁, from the V_OUT pins to the Adj pins allowing

\[ I_{\text{REG(MAX)}} = \left( \frac{1.25V}{R_1} \right) - 50 \mu A \]

to be sources from the floating output to the system. If the system does not sink or source more than or equal to \( I_{\text{REG(MAX)}} \), the regulators will be out of regulation and will drop its voltage across V_OUT to Adj equalling 1.25V + \( I_{\text{REG}} \) • R₁, where \( I_{\text{REG}} \) is equal to the current demands of the system. When the current demands of the system rise and approach 1.25V/R₁, the regulator will begin to maintain its regulation and provide a maximum current, limited by R₁. At this point, the maximum voltage drop will be equal to 1.2V + 1.25V or 2.45V from V_IN to Adj. The supply voltage minus 2.45V will determine the compliance voltage of the current regulator. The REG1117 can source from 10mA to 800mA using the circuits shown.

Two problems can arise from creating a circuit such as the one described in Figure 1. The first problem is that the REG1117s have a transient response that will affect the output of the amplifier. Figure 2 shows the output voltage deviation in millivolts versus time from the REG1117. This voltage transient will appear as a ringing voltage to the load of the amplifier. If bypass capacitors are added on the power supply pins of an amplifier (A₁), the ringing can be reduced at the cost of greater overshoot and longer settling times. Remember that bypass capacitors are on the supply leads of
the amplifier not only insures stability but also reduces noise and provides the amplifier with a reservoir of current for high speed requirements. The manufacturers recommended bypass capacitors from the amplifier supply pins to ground will have the capability of supplying the load with the charges from the capacitors, rendering a "soft" current limit. They can be removed from the circuit if caution is used with extensive bench testing.

Problems can also arise from placing a capacitor across the REG1117. This configuration is not advised because the regulator may be forced to sink instead of source current. The REG1117 has a tendency to oscillate under these conditions. The best alternative to this problem is to place a diode (D2 and D3) in series with an R || C low pass filter (R2 || C2 and R3 || C3) as shown in Figure 3.

A second problem is when the circuit goes into current limit, forcing the amplifier to operate in its nonlinear region. As in all current limit circuits, the amplifier is forced to do things it would not normally do. The output of the amplifier is limited from driving the load to the proper voltage. The input stage of the amplifier can not follow the load, forcing the amplifier to function as a nonlinear device. FET input amplifiers can exhibit some problems when taken outside their linear region. For instance, phase reversal is common among older FET input devices when this overload occurs. Newer FET input amplifiers, like Burr-Brown’s OPA2604 or the OPA627 have been designed to prevent this condition from occurring. Also, since the amplifier is operating in a nonlinear region, there will be a finite amount of time needed for the amplifier to recover. Often FET op amp’s overload recover time is longer than Bipolar amplifiers, such as the industry standards OPA27 or OPA1013. Care should be taken in selecting the op amp in this circuit to insure reliable operation.

FIGURE 3. A Diode is Used to Prevent Reverse Bias Operation of the REG1117.
IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI’s standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer’s applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI’s publication of information regarding any third party’s products or services does not constitute TI’s approval, warranty or endorsement thereof.

Copyright © 2000, Texas Instruments Incorporated