

## The ZLDO series of Low Dropout Voltage Regulators

David Bradbury

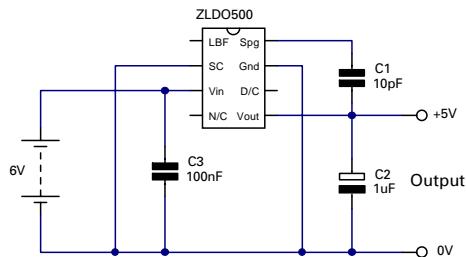
### Introduction

The ZLDO series of low dropout linear regulators operate with an exceptionally low dropout voltage, typically only 30mV with a load current of 100mA. The series feature output voltages in the range 3 to 18V, supply loads up to 300mA, and yet consumes typical quiescent currents of only 630 $\mu$ A. The parts include a logic level shutdown control and provide a low battery warning flag. Designed for where power losses must be minimised for efficiency or thermal reasons, the ZLDO Series regulators have many potential uses.

### Operation From A Low Voltage Battery Pack

Figure 1 shows the ZLDO500 regulator being used to stabilise the output of a 6V battery pack. The ultra low dropout voltage of only 100mV at full load (300mA) given by the regulator, allows the minimum number of cells to be used in the pack, and also maximises the energy that can be removed from the battery before the output of the regulator starts to fail. At a load current of 100mA the dropout voltage falls to around 30mV. The endurance of the battery pack is not only dependent on dropout voltage. When operating, some low

dropout regulators can consume high quiescent currents, sometimes approaching as much as a tenth of their maximum load current specification when approaching dropout conditions. Despite its 300mA output rating, when enabled the ZLDO series of devices consume typically only 600 $\mu$ A when regulating normally, and 3mA when the input falls too low for regulation.



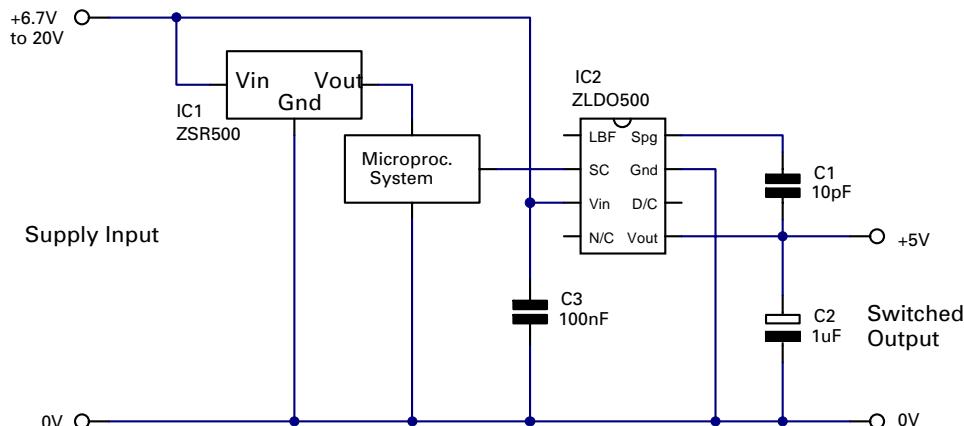
**Figure 1**  
**Basic ZLDO500 Based Battery Powered Supply.**

## Distributed Power Supplies

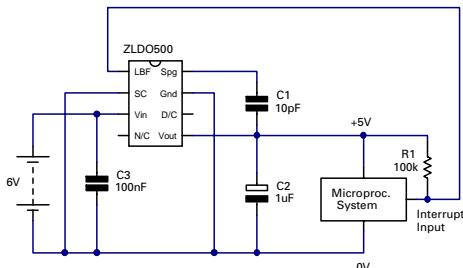
A common problem with large multiple board logic systems is that the total supply current taken at 5V can become excessive, causing voltage drops and noise in the power supply wiring unless heavy cables and large decoupling capacitors are used. A convenient solution to this problem is to provide power using a higher voltage supply locally regulated to 5V. Voltage drops and noise are now eliminated by the regulators but they introduce a new problem of significantly increased power losses if standard regulators are used. By employing the ZLDO500 for the local regulators in a circuit similar to Figure 1 but repeated on each logic board, the power supply to the logic boards can be distributed at a voltage close to 5V. This will largely eliminate the added losses of a distributed power supply system, whilst minimising the supply voltage errors and noise.

## Logic Controlled Power Supply

Figure 2 shows all that is necessary to allow a microprocessor to control a power supply based on the ZLDO500. The Shutdown Control pin (pin 2), is a logic compatible input that disables the regulator when a voltage in excess of 1.5V is applied. The current required to drive this input is less than  $10\mu A$ . When the regulator is shutdown in this way, the quiescent current of the ZLDO500 falls to around  $10\mu A$ . This makes the regulator suitable for a wide range of battery powered applications where intermittent operation occurs. The shutdown control pin should not be taken to a voltage higher than  $V_{in}$  if low quiescent supply current is important. The shutdown control is a high impedance input and so if not required, should be wired to the ground pin (pin 7).



**Figure 2**  
**Employing the Shutdown Pin to Conserve Battery Capacity.**



**Figure 3**  
Use of the Low Battery Flag (LBF) to  
Low Battery Flag

The ZLDO500 series provides an output called Low Battery Flag (LBF). Unlike many regulators that only signal that they are falling out of regulation, the LBF output of the ZLDO series indicates that the voltage drop across the regulator has fallen to less than 400mV and so supply failure is imminent. This improved warning gives both more time for the system to shutdown gracefully, and maintains regulation while this happens. This could be a vital point for instance if measurements are under way and must be completed accurately. The LBF output is driven by an open collector NPN transistor which pulls low when the supply to the regulator is failing. Figure 3 shows this output being used. Note that resistor R1 is necessary only if the interrupt logic does not include a pull-up resistor.

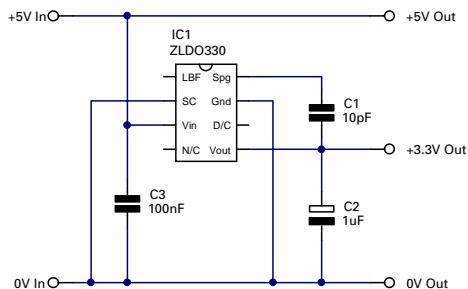
### Simple 3.3V Supply

Using a circuit such as Figure 4, the ZLDO330 can easily provide a 3.3V logic supply from an available 5V rail where most standard regulators could not

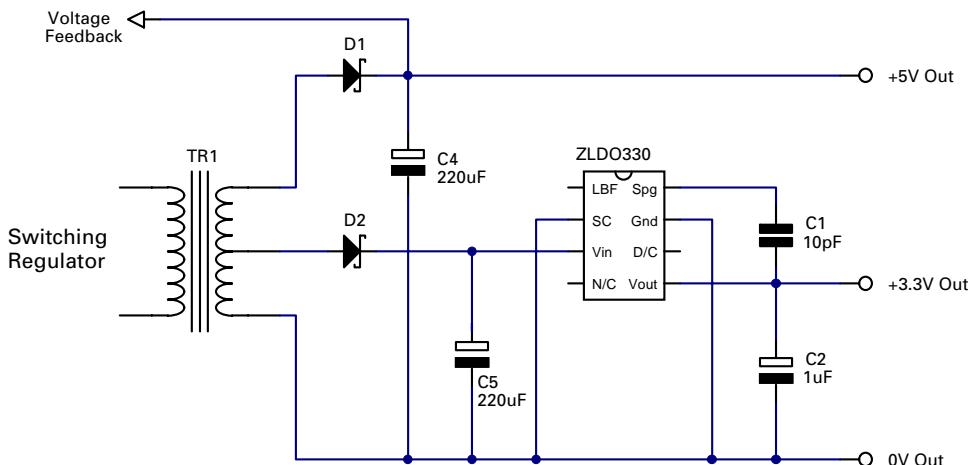
guarantee correct operation. Although this approach is not particularly energy efficient, if the load taken at 3.3V is not too large, then the added complexity and cost of a 3.3V switching converter may not be justifiable and so this linear solution can be preferable. This circuit will also give far less noise than a switching regulator which can be important when handling low level analogue signals or low voltage measurements.

### Post Converter Regulation

A common problem with multiple output switch mode converters is that only one output can be used in the feedback control loop of the switching regulator. Thus only one output is fully regulated. All other outputs are prone to tracking errors that occur if the load on any output changes significantly. By ensuring close coupling of all transformer windings and minimising the impedance of all outputs, these errors can be reduced but never eliminated. A simple solution to this problem is to wind the switching regulator



**Figure 4**  
ZLDO330 Used to Regulate 5V to 3.3V.



**Figure 5**  
**ZLDO Switched Mode Supply Post-Regulator to Improve Output Impedance and Noise Performance.**

transformer to give a slightly higher voltage than required and regulate down from this to the desired voltage with a linear regulator. To keep losses low and so maintain the advantages of a switch mode supply, it is important that the voltage drop across this regulator is kept as low as possible, i.e. just high enough to compensate for the poor output impedance of the switching power supply but no higher. The low dropout voltage of the ZLDO330 allows this circuit technique to be implemented very effectively, giving a highly stable and accurate low noise supply. Figure 5 shows this technique being implemented.

### Over Temperature Shutdown

The ZLDO regulator series include an over temperature shutdown circuit that disables the regulator if its chip temperature should exceed 125°C for

any reason. Although intended to provide a limited guard against excessive internal power dissipation, this circuit will shut down the regulator if the ambient rises above 125°C. Thus, the regulator could be used to disable a circuit in the event of the ambient temperature within which the circuit is mounted becoming too high. Any internal power dissipation due to load current will reduce the ambient temperature at which shutdown occurs to some extent. A consequence of achieving the extremely low dropout voltage and high current performance provided by the ZLDO series, is that the parts can be damaged by sustained output shorts or excessive loads when combined with high input supply voltages. To ensure reliable operation, keep loads within the SOA graph boundaries provided on the data sheet for the respective part.