

## ZLDO Series

### Quiescent Current vs. Dropout Voltage Trade-Offs

It is a common misconception that low quiescent current is a vital characteristic in a regulator, and dominates the endurance of any battery powered equipment using it. Whilst this is certainly true to a degree, once the factor has been reduced below a reasonable level (dependent on load and battery characteristics), further reduction provides no useful benefits, so improvements should be made in other areas. By comparing the relative gains to be made in minimising quiescent current losses and dropout voltage losses, this note demonstrates how the ultra-low dropout voltage of the Zetex ZLDO regulator series can provide optimum equipment endurance.

#### Quiescent Current Losses

When considering quiescent current losses, it can be useful to express it as a percentage of the load. To do this, divide the quiescent current of the regulator by (the average load current of the application + regulator  $I_q$ ), which will give a fraction that represents the loss of operating life caused by quiescent current.

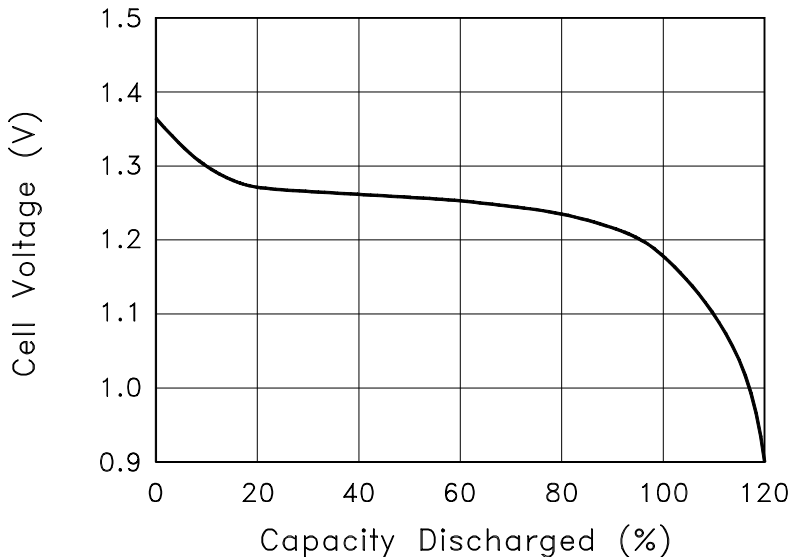
i.e.:-

Efficiency loss = Regulator  $I_q$  / ( $I_{load} + I_q$ )

The quiescent current of the ZLDO series varies with load current, rising linearly from its zero load value of 550 $\mu$ A by an additional 500 $\mu$ A for the maximum load current of 300mA. With a load current of 60mA, the  $I_q$  of a ZLDO500 is around 600 $\mu$ A, losing 0.01 or 1% of equipment operating life to quiescent losses. For a load of 120mA, quiescent current is around 750 $\mu$ A, losing 0.63% operating life and similarly, at 300mA losses would be 0.37%. These percentages represent the maximum gain possible if quiescent current losses could be eliminated completely.

#### Dropout Voltage Losses

It is an obvious consequence of improving the dropout performance of a regulator that the operating endurance achieved with a given battery source will increase. However, it is fairly difficult to quantify this improvement due to its dependence on cell characteristics and the number of cells used to provide the unregulated supply. The following gives a realistic if not pessimistic example of the advantages of improved regulator dropout performance. Figure 1 shows the discharge curve of a typical Ni-Cd cell operated at a discharge rate of 0.2C.



**Figure 1**  
**Ni-Cd Cell Voltage During Discharge.**

If five of these cells are wired in series to make a battery pack of nominally 6V, the battery could be used as a source for the ZLDO500 5V regulator. This regulator will operate at its maximum specified load current of 300mA with an input voltage down to only 5.1V yet still maintain regulation. This is around 200mV lower than most competing parts and so will allow cells in the battery pack to operate down to a final voltage of 5.1/5 V or 1.02V each, instead of 5.3/5 V or 1.06V as would be permissible for standard LDO regulators. Figure 1 shows that this will increase operating life and this improvement is around 1.5 to 2% for the example discussed.

#### **Quiescent Current/Dropout Voltage Trade-Off**

It is immediately apparent that for all but very low loads, the savings that can be made using a low dropout regulator such as the ZLDO series rather than a standard LDO, are far more worthwhile than the gains that could be obtained by reducing or even eliminating quiescent current losses. Also, it should be noted that Ni-Cd cells used in this example have a particularly flat discharge curve with a rapid fall of voltage at end-of-life. For most other battery technologies, the terminal voltage falls more gradually over the cells' life with a much slower fall at end-of-life. With these alternative cell technologies the improvement given by the use of ultra low dropout regulators such as the Zetex ZLDO series will be increased greatly.



## Notes