5.0 VOLT ULTRA LOW DROPOUT REGULATOR

ZLDO500

ISSUE 1 - DECEMBER 1995

The ZLDO Series low dropout linear regulators operate with an exceptionally low dropout voltage, typically only 30mV with a load current of 100mA. The regulator series features output voltages in the range 3.3 to 18 volts, this device provides an output voltage of 5.0 volts.

The ZLDO500 consumes a typical quiescent current of only 630μA and is rated to supply load currents up to 300mA. A battery low flag is available to indicate potential power fail situations. If the input voltage falls to within 300mV of the regulated output voltage then the error output pulls low. The device also features an active high disable control. Once disabled the ZLDO quiescent current falls to typically 11μA.

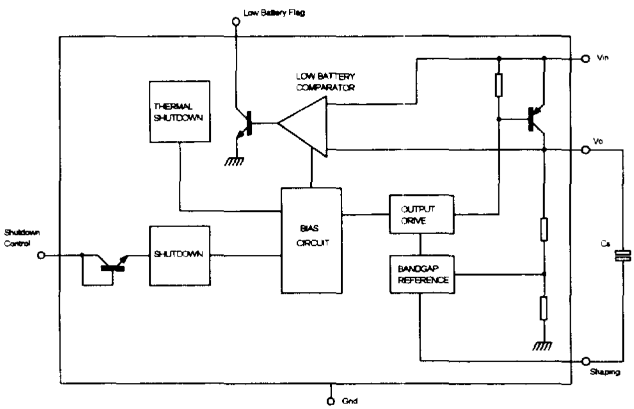
The ZLDO devices are packaged in Zetex SM8 8 pin small outline surface mount package, ideal for applications where space saving is important. The device low dropout voltage, low quiescent current and small size make it ideal for low power and battery powered applications. Battery powered circuits can make particular use of the low battery flag and shutdown features.

FEATURES

- Very low dropout voltage
- 6mV dropout at 10mA output
- 30mV dropout at 100mA output
- 100mV dropout at 300mA output
- 5.0 volt fixed output
- Other voltages available
- Low quiescent current
- Low battery Iflag
- Shutdown control
- Surface mount package

APPLICATIONS

- Battery powered devices
- Portable instruments
- Portable communications
- Laptop/Palmtop computers
- Electronic organisers



CONNECTION TABLE	
Pin	
1	Low Battery Flag
2	Shutdown control
3	Vin
4	N/C
5	Vout
6	**Do not connect**
7	Gnd
8	Shaping
Pack	T8
see Diagrams Page 2 - 5	

ZLDO500

ABSOLUTE MAXIMUM RATING

Input Supply Voltage Range	-0.3 to 20V
Shutdown Input Voltage Range	-0.3 to Vin
Low Battery Output Voltage Range	-0.3 to 20V
Output Current	300mA
Operating Temperature	-40 to 85°C
Storage Temperature	-55 to 150°C
Power Dissipation (Tamb=25°C)	2W (Note 1)

ELECTRICAL CHARACTERISTICS

TEST CONDITIONS (Unless otherwise stated) T_{amb}=25°C,I_L=10mA,C_s=10pF,C_{out}=1µF

Parameter	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output voltage	V_o	V_{in}=6.0V	4.9	5.0	5.1	V
Output voltage temperature coefficient	$\frac{V_o}{\Delta T}$	V_{in}=6.0V (Note 2, Note 4)		100	250	ppm/ °C
Line regulation	$\frac{V_{in}}{\Delta V_o}$	V_{in}=6.0 to 20V		5		mV/V
Load regulation	ΔV_o	I_L=10 to 300mA V_{in}=4.3V		100		mV
Dropout voltage (Note3)	V_{in}-V_o	I_L=10mA I_L=100mA I_L=300mA		6 30 100	10 75 200	mV
Quiescent current	I_q	V_{in}=6.0V, I_L=0		0.63	1	mA
Quiescent current at shutdown	I_{qs}	V_{in}=6.0V, I_L=0, V_{shdn}=V_{in}		11	30	µA
Shutdown control input current	I_{ins}	V_{shdn}=V_{in}=6.0V		2	10	µA
Shutdown control threshold voltage	V_{ts}	V_{in}=6.0V low(on) high(off)	 1.5		 0.4	V
Output current in shutdown mode (Note4)	I_{Ls}	V_{in}=20V V_o=Gnd		50	100	nA
Output noise voltage (Note4)	e_n	V_{in}=6.0V f=10Hz to100kHz, I_L=100mA		190		µV RMS
Low battery detect voltage	$V_{in(bld)}$		5.2	5.3	5.4	V
Low battery flag output voltage	V_{bl}	I_{bl}=100µA, V_{in}<V_o+200mV		0.16	0.4	V
Low battery flag leakage current	I_{bl}	V_{bl}=6V, V_{in}>V_o+400mV		0.1	1	µA

NOTES.

1. Maximum power dissipation of the device is calculated assuming the package is mounted on a PCB measuring 2 inches square.

2 Output voltage temperature coefficient is calculated as:- $\dfrac{V_O\ change \times 1000000}{V_O \times temperature\ change}$

3. Dropout voltage (See Definition of Terms (below))

4. Guaranteed by design.

DEFINITION OF TERMS

Dropout Voltage: The minimum input to output voltage differential for which the circuit will continue to regulate. The value is measured when the output voltage has dropped by 100mV from the nominal value obtained at Vin=6V.

Input Voltage: The DC voltage applied to the device input terminal with respect to ground.

Input To Output Voltage Differential: The difference between the applied unregulated input voltage and the regulated output voltage.

Line Regulation: The change in output voltage for a given change in input voltage.

Load Regulation: The change in output voltage for a given change in load current.

Output Noise Voltage: The R.M.S. AC output voltage measured over a defined frequency range, at constant load current and no input ripple.

Quiescent Current: The device input current minus the load current.

Output Voltage Temperature Coefficient: The change in output voltage with temperature over the operating temperature range of the device.

PIN DEFINITIONS

Pin 1 LBF - Low Battery Flag. An open collector NPN output which pulls low on failing input supply.

Pin 2 SC - Shutdown Control. This high impedance logic compatible input disables the regulator when taken high. It includes a diode wired to Vin and so will pass current if taken more than 0.5V above Vin.

Pin 3 Vin - Voltage Input. The power supply to the regulator. The permissible input voltage range is -0.3 to 20V. An input capacitor is not mandatory but will be useful in reducing the coupling of noise from input to output and minimising the effect of sudden changes in load current on the input voltage.

Pin 4 N/C - Not Connected. Not internally connected and so can be left open or wired to any pin without affecting the performance of the regulator.

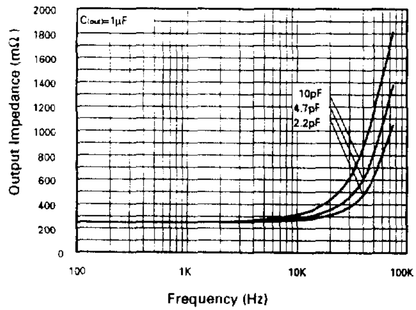
Pin 5 Vout - Voltage Output. The output of the regulator. An output capacitor of 1uF or greater and having low ESR should be wired in close proximity to the regulator to ensure stability for all loads.

Pin 6 D/C - Do Not Connect. This pin is wired to an internal circuit node of the regulator. No external connection should be made to this pin.

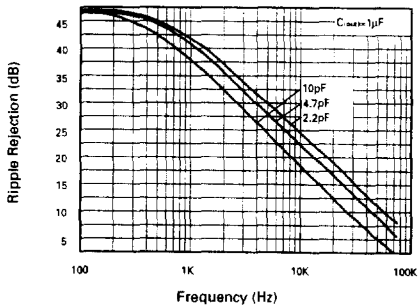
Pin 7 Gnd - Ground. The ground connection of the regulator against which the output voltage is referenced.

Pin 8 Spg - Shaping. The shaping node for the error amplifier of the regulator. A capacitor of 10pF wired from this pin to the output pin (pin 5) gives optimum stability. Improved AC can be achieved by reducing the value of this capacitor but stability may be impaired for some load conditions.

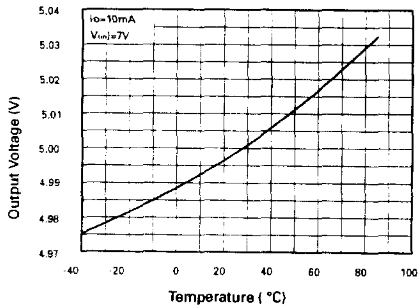
TYPICAL CHARACTERISTICS



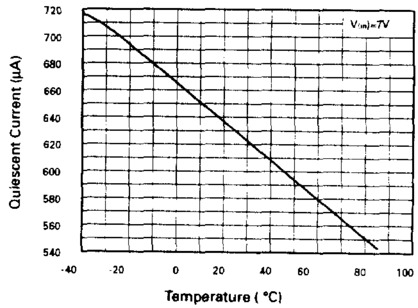
Output Impedance vs. Frequency



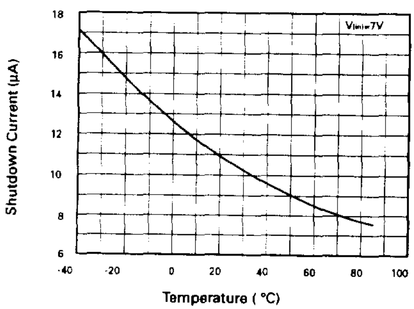
Ripple Rejection vs. Frequency



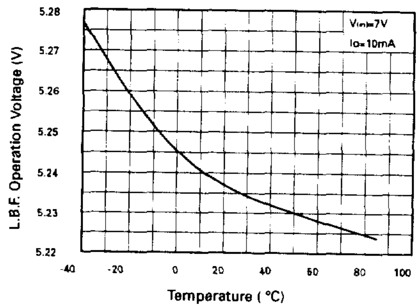
Output Voltage Temperature Coefficient



Quiescent Current vs. Temperature

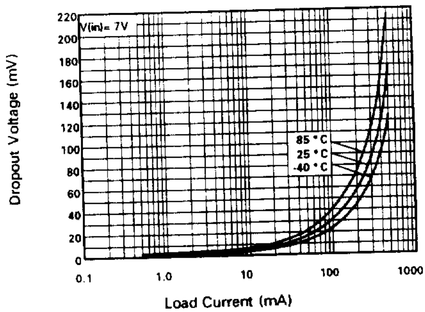


Shutdown Current vs. Temperature

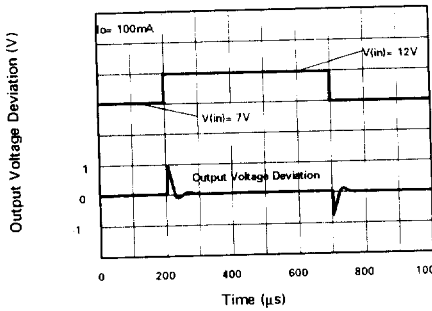


Low Battery Flag Operating Point

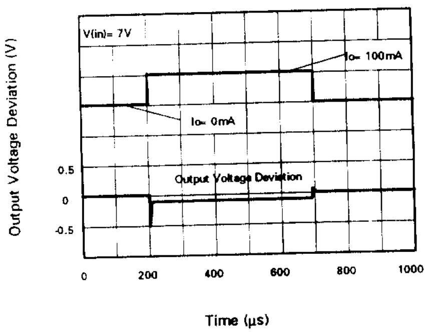
TYPICAL CHARACTERISTICS



Dropout Voltage vs. Load Current

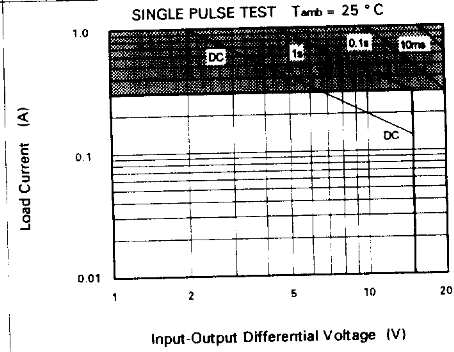


Line Transient Response



Load Transient Response

SINGLE PULSE TEST T_{amb} = 25 °C



Safe Operating Area

Operation in shaded area is not guaranteed

APPLICATIONS

1). 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.

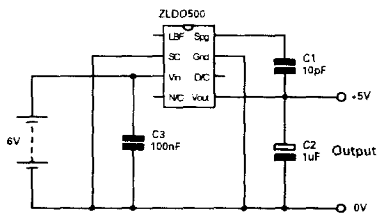


Figure 1

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 ZLDO500 consumes typically only 630µA regulating normally and 3mA when the input falls too low for regulation.

2). 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 10µA. When the regulator is shutdown in this way, the quiescent current of the ZLDO500 falls to around 11µA. 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 Vin 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).

3). Low Battery Flag

The ZLDO500 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 ZLDO500 indicates that the voltage drop across the regulator has fallen to less than typically 300mV and so supply failure is imminent. This improved warning gives both more time for the system supplied to shutdown gracefully and maintains regulation while this happens. This could be a vital point if measurements are under way and must be completed accurately for instance. The LBF output is driven by an open collector NPN

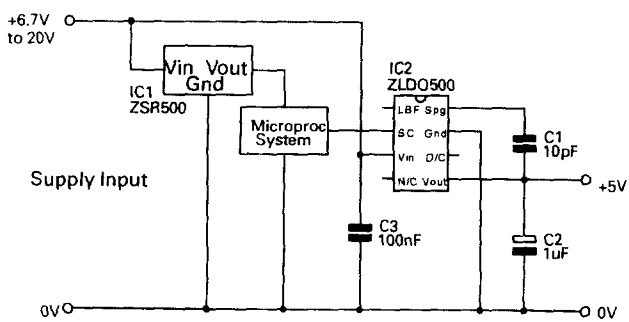


Figure 2

APPLICATIONS

transistor which pulls low when the supply to the regulator is failing. Fig.3 shows this output being used. Note that resistor R1 is necessary only if the interrupt logic does not include a pull-up resistor.

4). 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 ZLDO500's as the local regulators in a circuit similar to the low voltage battery pack regulator 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 eliminating the added losses of a distributed power supply system yet still eliminating the supply voltage errors and reducing noise.

5). Over Temperature Shutdown

The ZLDO500 regulator includes 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 its 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 caused as a result of supplying load current, will reduce the ambient temperature at which shutdown occurs. Note that to achieve the extremely low dropout voltage and high current performance provided by the ZLDO500 devices, 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 indicated in the typical characteristics.

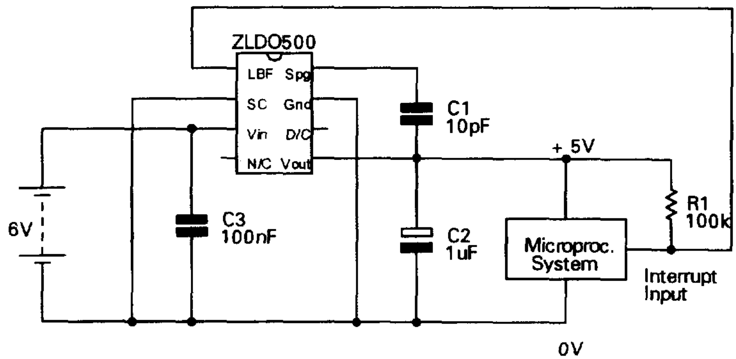


Figure 3