DEMO MANUAL DC198

DESIGN-READY SWITCHERS

LTC1438-ADJ Constant Frequency, Synchronous, Two Output DC/DC Converter

DESCRIPTION

Demonstration Circuit DC198 features the LTC1438-ADJ providing 8A outputs at both 5V and 3.3V from an input voltage range of 5.5V to 28V. Output-current soft start, low-battery comparator and power-on-reset, functions are also implemented on the board.

DC198 is intended for designers of desktop computers, network servers, large memory systems and multiple ASIC applications where the system logic voltages require currents in the 4A to 8A range.

PERFORMANCE SUMMARY Operating Temperature Range 0°C to 50°C

Parameter	Conditions	Value
Input	Input Voltage Range	5.5V to 28V
Outputs	DC Output Voltage, VOUT1	4.95V to 5.15V
	DC Output Voltage, VOUT2	3.23V to 3.39V

	Output Current, 5V	8A Continuous
	Output Current, 3.3V	8A Continuous
	Typical Output Ripple, Both Outputs, Vin = 10V, Io = 8A, 20Mhz BW	$50mV_{P-P}$
Line Regulation	Both Outputs, V_{IN} = 6V to 28V	0.002%/V
Load Regulation	Both Outputs, I_{OUT} = 0A to 8A	1%
POR	Power-On Reset Threshold, $3.3V_{OUT}$	3.05V to 3.17V
Low Battery Detector	Threshold, 5.5V Typical	5.2V to 5.7V
Frequency	Typical Switching Frequency, C_{OSC} = 82pF	140kHz

TYPICAL PERFORMANCE CHARACTERISTICS AND BOARD PHOTO

Show efficiency curves and board photos, both front and back

PACKAGE AND SCHEMATIC DIAGRAMS

Show Figure 1 and LTC1438CG-ADJ package information.

PARTS LIST

Show parts list and manufacturers phone numbers.

QUICK START GUIDE

It is easy to set up DC198 to demonstrate the operation of the LTC1438-ADJ and evaluate the circuit under different load and line conditions. Follow the procedure outlined below for proper operation.

1. Before turning on power, connect the input voltage power supply, output voltage loads and meters as shown in Figure 2. For best accuracy, it is important to connect true-RMS reading voltmeters directly to the PCB terminals where the input and output voltages are connected. True-RMS reading ammeters should be used for current measurements.

2. Turn on the input power supply and adjust it's voltage as required. Set DC load currents to 1.5A or less, for startup. After an output voltage reaches 1.5V the full 8A load current is available.

Note: DC198 incorporates foldback current-limiting to reduce output current under short circuit conditions. Consequently, full output current is not available for output voltages below 1.5V. Since digital circuits don't require full load current at this low voltage, foldback current-limiting doesn't interfere with normal operation. Electronic loads that draw full current regardless of the power supply voltage, can cause startup problems since they hold the output voltage low if the supply current is less than the electronic load is programmed for. If foldback current limiting is

not required, it can be defeated by removing D4 and D6 from the demoboard. Without foldback, the short-circuit current will be about 15A.

OPERATION

The operation of DC198 is best understood by first reading the LTC1438 data sheet.

Introduction

DC198 regulates both 5V and 3.3V outputs from a single input voltage ranging from 5.5V to 28V. These outputs supply load current levels up to 8A. Both regulators use the same configuration and component values, except for the bottom feedback resistor since it determines the output voltage. They share a common bias supply voltage, $INTV_{CC}$, and a common switch-frequency oscillator. Since the operation of both regulators is identical, the reference designators for VOUT1, the 5V regulator, will be used to describe circuit operation.

High Current Components

Capacitors C1, C9, and C10 are input filter capacitors. MOSFETs Q1 and Q4 pulse-width modulate the input voltage to the switch inductor, L1 at a duty cycle determined by the input voltage. Inductor current is measured by the current sense resistor, R1. Capacitors C5 through C7 are output capacitors that smooth the output voltage and supply the leading-edge transient current required by fast switching loads. To avoid MOSFET shoot-through current, a short dead

time exists before each MOSFET is turned on. During this dead-time, commutating diode D1 conducts inductor current to the load.

Input voltage to the LTC1438-ADJ is decoupled by resistor R11 and capacitor C27. Capacitors C25 and C26 filter the $INTV_{CC}$ bias supply and provide the energy source for the D3/C22 charge pump that powers the Q1 gate driver.

Output Voltage Programming

The output voltages controlled by the LTC1438-ADJ can be programmed to any voltage from 1.5V to 9V using external resistors. Feedback resistors R5 and R10 program the output voltage to 5V. Capacitor C18 adds phase lead to the control loop for improved transient response while C21 provides local decoupling of the feedback signal at the $V_{OSENSE1}$ pin.

If it is necessary to change the voltage on either output, make sure that the other components in the circuit are appropriate for the new design. The $EXTV_{CC}$ pin is connected to VOUT1 and must be connected to the highest output voltage, if that voltage is 5V or more.

Control Loop

A thorough discussion of control systems and loop stability is beyond the scope of this demo manual. The LTC1438-ADJ provides access to the output of the error amplifier, at the I_{TH} pin, so its frequency response and phase response can be adjusted to optimize the overall control-loop operation. The error amplifier is a transconductance type with a g_m of 1mS and an output

impedance of 210k Ohm. Briefly, the values of C23, C24, and R12 determine the voltage gain and phase of the error amplifier at different frequencies. C23 determines the low frequency break point, R12 controls mid-frequency gain and C24 reduces gain at high frequencies.

Switching Frequency

The 140kHz switching frequency of the LTC1438-ADJ is determined by the 82pF value of C28. This frequency was chosen to limit the switching losses of the top MOSFET to a reasonable value. For lower input voltage applications or lower output current applications, the switching frequency can be increased by decreasing the value of C28. Refer to the LTC1438 data sheet for more information.

Run/Soft Start

The dual-purpose RUN/SS pin allows the user to program the startup-current rise time or to turn off the output. At startup, the beginning of the output voltage ramp is delayed and the slope of the output current ramp is controlled by the value of capacitor C19. The voltage across C19 is developed by a 3μA current source and must rise to 1.3V before the output voltage will start to rise. The delay is approximately 0.5s/μF. As the voltage across C19 continues to rise, the maximum output current capability increases from zero to full current during a period also equal to 0.5s/μF. Forcing the RUN/SS pin below 1.3V will turn off the output.

Both outputs have a RUN/SS pin so both outputs can be individually controlled by changing RUN/SS capacitor values. Forcing both RUN/SS pins below 1.3V shuts down the LTC1438-ADJ and decreases the input current to about 16μA.

Low-Battery Comparator

An input voltage threshold of 5.5V was chosen to demonstrate the low-battery comparator operation. Resistors R19 and R20 attenuate the 5.5V input to the 1.19V switching threshold of the LBI pin. For input voltages lower than 5.5V, the low-battery comparator pulls the LBO pin low. When the input voltage exceeds 5.5V, R8 pulls the LBO pin to 5V. Hysteresis is built into the comparator to ensure oscillation-free switching.

Power-On Reset

The power-on reset circuit in the LTC1438-ADJ has two functions. It sends a time-delayed signal indicating that VOUT2 is within operable limits after startup and it raises a flag if VOUT2 falls 7.5% out of tolerance. VOUT2 is frequently used to power the microprocessor core so the POR2 signal can be used to monitor the microprocessor core voltage.

At startup, the POR2 pin is low, indicating that VOUT2 is out of regulation. When VOUT2 reaches 95% of its normal value, an internal counter in the LTC1438 counts 65536 cycles of C_{OSC} before releasing the low voltage on the POR2 pin. The POR2 output is pulled up by resistor R7. If VOUT2 drops 7.5% lower than the regulated value, the POR2 pin goes low.

SFB1

The SFB1 pin can be used to force continuous inductor current operation on the VOUT1 circuit, by installing a jumper or resistor less than 2k at location R13. Refer to the LTC1438 data sheet for more information about the SFB1 pin.

PCB LAYOUT AND FILM

Show PCB layout here.