Demo Board DC292

Introduction

Demo board DC292 is a high current, low voltage power supply. Typical applications include power supplies for high speed microprocessors, memory arrays, FPGAs and ASICs. It utilizes the LTC1709EG (or LTC1709EG-7, -8, -9), 2-phase current mode controller to minimize the input and output capacitors and improve load transient response. The input voltage range is 5V to 15V and the typical output voltage is 2V or lower, as programmed by the VID table of the LTC1709.

If an external, low power 5V supply is available, the main input voltage can be below 5V, for example, 3.3V. If VID programming is not required, the LTC1929 can also be installed on this demo board with the output voltage programmed by two discrete resistors (R5 and R20). The optional discrete VID circuit can be used to implement a special VID table (up to 5 bits).

To facilitate the evaluation of different MOSFETs and capacitors, the layout of DC292 allows the use of MOSFETS in both SO-8 and TO-220 packages and capacitors in through-hole or surface mount (D case) forms.

DC292 also includes an onboard dynamic load tester to help evaluate load transient performance. The load step amplitudes, up-slope and down-slope can be programmed individually. The maximum step amplitude is about 52A and the load current slew rate can be as high as 50A/µs. Refer to the following "Quick Start" section for more information.

Gerber files for this circuit board are available. Contact the LTC factory.

Schematic Diagram

Typical Performance

Parameter	Conditions	Value
Input Voltage		5V to 15V, 12V typical
Output Voltage		VID programming, typically 2V or lower
Output Current	Maximum, with Air Flow (200LFM)	52A at 1.6V output
Load Regulation	0 to full load	<20mV
Output Ripple	Full load, peak-to-peak	<40mV_{P-P} typical
Transient Response	Load switch between 0A and 20A, 30A/µs slew rate	<60mV peak typical
Efficiency	Room temperature, V_{IN} = 12V, V_O = 1.6V	87% at 40A load current 85% at 52A load current

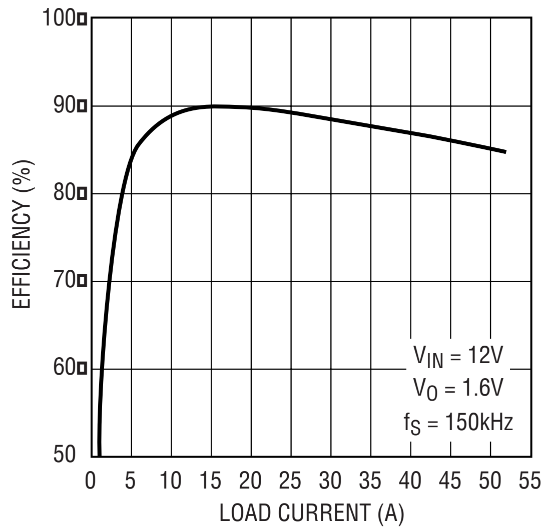

Figure 2. Measured Efficiency vs Load Currents

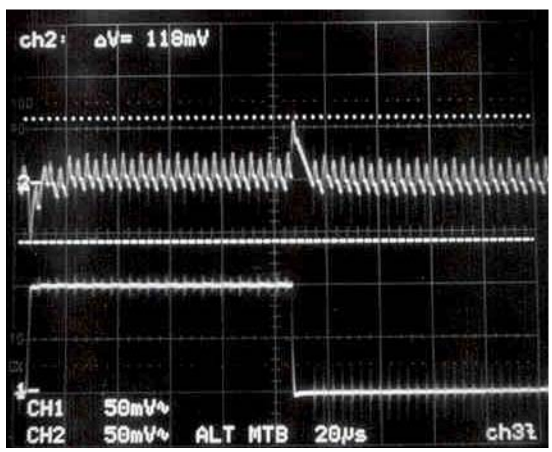

Figure 3. Load Transient Waveform (V_{IN} = 12V, V_O = 1.6V, 20A step, 30A/µs)

Top trace: output voltage (50mV/DIV), Bottom trace: load current (10A/DIV), Time Scale: 20µs/DIV

Operating Principles

The LTC1709 PolyPhase™ dual current mode controller is adopted for this application. LTC1709 is capable of driving two synchronous buck channels 180 degrees out of phase to reduce the input capacitor size and output switching ripple voltage.

Figure 1 shows the schematic diagram of the complete power supply. In order to supply 52A of current to the output, two FDS6680As are paralleled for each top switch and four FDS7760As are paralleled for each bottom switch. The switching frequency is about 150kHz. This results in the use of a 1.0µH/26A inductor. The demo board design uses a Sumida inductor, CDEP149, 0748-519. Any inductor with a similar inductance value and 26A current rating should do the job. The current sense resistor is about 1.5mΩ (the demo board uses two 3mΩ resistors in parallel; PCB trace resistance may be used). Different output currents may require different inductors and current sense resistors. Refer to the LTC1709 data sheet for more design information.

The RMS input ripple current of a 2-phase design is about $12A_{RMS}$ for 52A of output current. If the conventional single-phase operation were used, the input ripple current would be $19A_{RMS}$. Because the input capacitor size is proportional to the ripple current, the 2-phase design reduces the input capacitor requirement by more than 35%.

To handle the load transients resulting from high current slew rate and large load steps, low ESR capacitors are required at the output terminal. This design uses six aluminum electrolytic capacitors (Sanyo, 6MV1500WX, 1500µF/6.3V) for the output cap. With a 20A load step, as shown in Figure 3, the output voltage variation is less than ±60mV.

Active voltage positioning (AVP) can be implemented with the addition of R6 and R12. This AVP technique reduces the output capacitor with no loss in the efficiency. R40 and R41 can be used to program the voltage positioning at the minimum and maximum load currents. (See Linear Technology Design Solutions 10 for more details on active voltage positioning.)

Figure 2 shows the measured overall efficiency vs load currents. With a 12V input and 1.6V output, the overall efficiency is about 87% at 40A output and 85% at 52A output. Greater than 80% efficiency can be maintained in the load range between 4A and 52A.

Quick Start Guide

Refer to Figure 4 for proper test and measurement equipment setup and follow the procedure outlined below:

1. Connect the input power source to J1 and J2 using wires capable of handling 8A of current.

2. Connect the output load to J4 and J5 using wires with a 52A current rating. If the circuit is to be tested with the constant current mode electronic load, the load current should be preset at a low value, say 1A, to start the circuit. Otherwise, the I-V characteristics of the electronic load will interact with the foldback current limiting function of the control IC.

3. Turn on the input power supply and bring the load up to full load after the output voltage reaches the steady-state value.

4. Load transient test: this demo board has a built-in dynamic load test circuit, which is capable of implementing a 0A to 52A load step. **The step amplitude, up slope and down slope can be adjusted via R24, R28 and R23, respectively**. The step load current and output voltage may be measured from BNC connectors J6 and J7, respectively. The following procedure is recommended for the load transient test:

   4.1. After the output voltage of the LTC1709 circuit reaches the steady state, set the DC output current to the lower level of the load step.

   4.2. Apply ±12V power to the +12V (E7), PGND (E6) and –12V (E5) terminals and open jumper JP2.

   4.3. Adjust R24, R28 and R23 to program the step amplitude, up-slope and down-slope of load step, respectively.

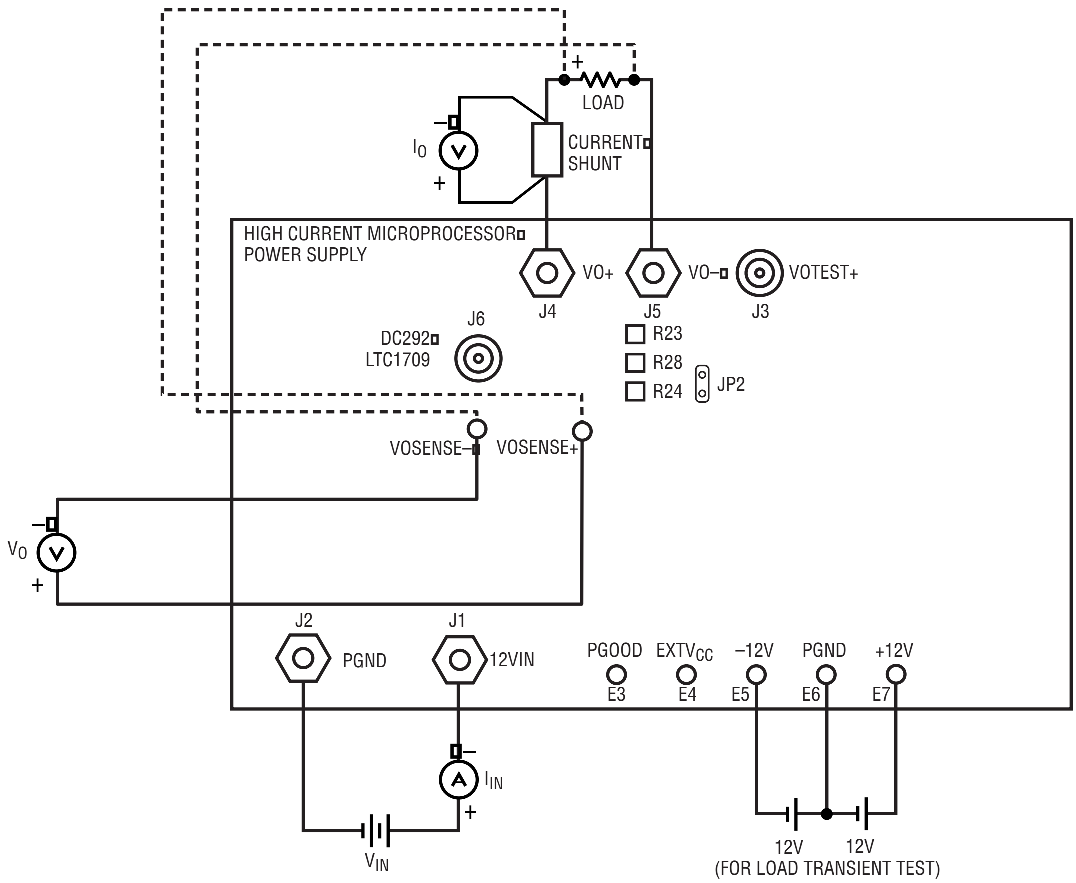

Figure 4. DC292 Test and Measurement Setup