APPLICATION NOTE

Dual Redundancy and Hot Swap for ABC / MBC Series Power Supplies

Introduction

This application note describes a solution for dual redundancy and hot-swap that can be achieved by using Linear Technology's Proprietary IC LTC4370 load sharing board for ABC/MBC series open frame power supplies. Using this technique the total output power is evenly shared between the two supplies. By utilizing MOSFETs as the or-ring elements, they reduce power dissipation significantly.

PROBLEM

This application note helps customers use Power-One ABC series power supplies in dual redundancy and hot-swap applications.

Dual Redundancy Application – A fault tolerant power system requiring dual redundant power supplies connected in parallel with or-ring MOSFETS so even if one of the paralleled supplies should fail, the system will continue to provide full power to its load.

Hot-Swap Application – The LTC4370 load sharing board allows supplies to be replaced while the system's AC input and DC output power is still on the "ON" state. This hot-swap feature is vital for live equipment that cannot tolerate any down time, whilst being able to replace the faulty power supply without interrupting the system's operation.

COMMON SOLUTION USING DISCRETE DIODES AND ITS DISADVANTAGES

Discrete diodes are often used as an or-ring function for power supplies at the point of load to employ redundancy; however the disadvantage of this approach is the significant forward voltage drop, resulting in power dissipation.
Also, there is not ideal load sharing between the two PSUs relying on forward voltage drop of the diode/droop resistance resulting in one PSU delivering more of the load.

SOLUTION WITH LTC4370

All of the above problems using discrete diode solutions can be eliminated by using LTC4370 load sharing IC as it controls N-Channel or-ring MOSFETs to share the load between two input rails instead of or-ring diodes. A fast gate turn-on reduces the load voltage droop during supply switchover. If the input supply fails or is shorted, a fast turn-off minimizes the transient reverse current. Note: the LTC4370 demo board was used for the testing, however in most applications it is expected that the user will use the discrete components situated in the application.
Note (The LT4370 is only applicable for voltage's up to a max of +18 VDC.)

APPLICATION INFORMATION

The LTC4370 load shares the two supplies by dropping the voltage difference across the MOSFETs in series with them (see Figure 1). The MOSFET on the lower supply drops the minimum servo voltage VFR(MIN) (12 mV or 25 mV depending on supply voltage levels), while the other MOSFET drops VFR(MIN) plus the supply voltage difference. This equalizes both the OUT pin voltages, ensuring the two rail currents are equal. The higher supply's MOSFET forward voltage drop (VFWD) increases to compensate the supply difference up to ±500 mV. The upper limit of the servo command adjustment is the minimum servo plus the RANGE pin voltage. Hence, when the two supplies differ by a voltage equal to VRANGE, the higher supply's VFWD is pinned at the maximum servo

voltage VFR(MAX). If the supplies diverge by more than VRANGE, the OUT pin voltages start diverging, and so too, the supply currents. As the supply voltages separate, the entire load current is steered to the higher supply. Now, the servo command across the higher supply's MOSFET is folded back from the maximum to the minimum servo to minimize power dissipated in the MOSFET. The sharing capture range, ΔVIN(SH), in Figure 2a is ±500 mV, set by VRANGE. Figure 2b will be discussed later in the MOSFET selection section.

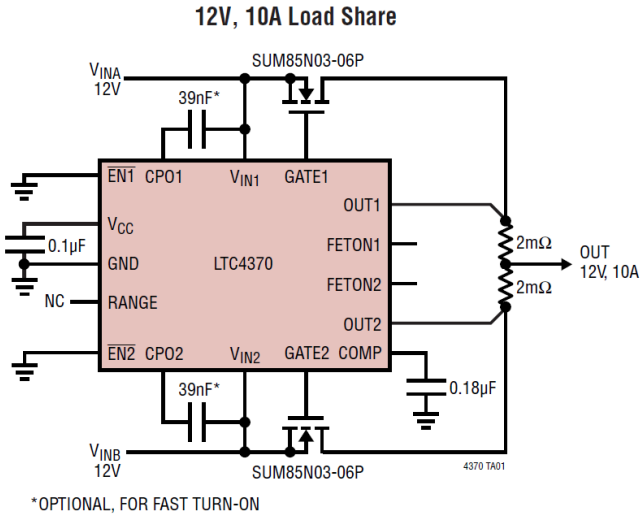

Figure 1 - LTC4370 – Diode OR controller

HOW TO SETUP

Turn both supplies on. Load the LTC4370 output with minimal current so that both supplies contribute current to the common load. Increase load up to 35 A and observe the LTC4370 operation mode with accurate load sharing. It is easy to estimate load share accuracy by measuring a voltage between two sense resistors. Since the MOSFETs will be dissipating excessive power, limit this measurement to 3 to 5 seconds when at the 35 A level or keep 300LFM of air flow.

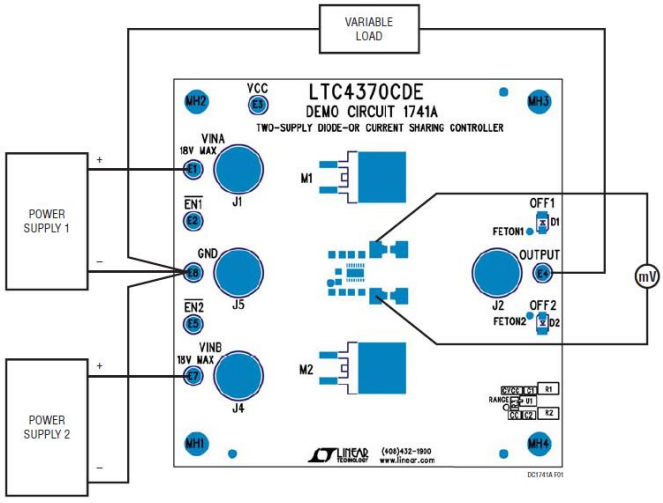

Figure 2 - LTC4370 demo board

PRACTICAL ANALYSIS

The scope capture below shows the redundant operation when PS1 fails and the PS2 takes over the load and Hot Swap operation. Readings shown using 12 V output PSUs with 10 A total load current.

CH1: PS1 Iout CH2: PS2 Iout CH3: Load Current CH4: Vout

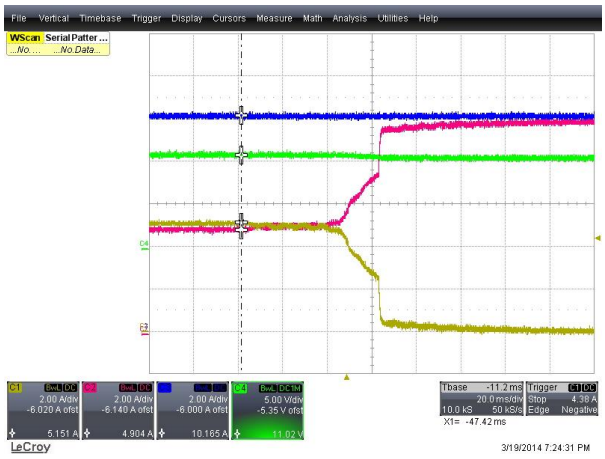

Figure 3 - Scope reading showing the current share and redundant operation

CH1: PS1 Iout CH2: PS2 Iout CH3: Load Current CH4: Vout

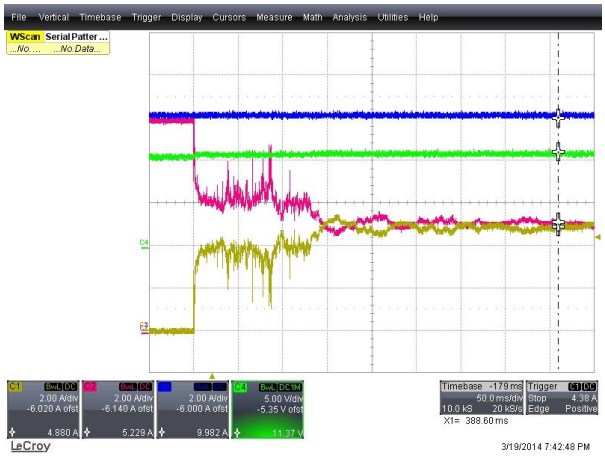

Figure 4 - Scope reading showing the hot swap condition

REFERENCES

DC1741A – LTC4370 Linear Technology Demo Manual

http://cds.linear.com/docs/en/demo-board-manual/dc1741af.pdf

