REDUNDANCY WITH LOW VOLTAGE, HIGH OUTPUT CURRENT DC/DC CONVERTERS

Redundancy using DC/DC converters is necessary when a power system by a DC/DC converter must remain operational in case one of the converters fail. Two or more converters are connected in parallel, but only one supplies the load at any given time while the rest of the converters are in standby mode (no load). When one of the redundant converters fails, one of the standby converters takes over the load.

Figure 1 shows the positive output of two converters OR'ed through a dual, common cathode Schotky diode with the cathode connected to the load. It should be noted that the positive sense pin of each converter is connected not at the load, but at the respective anodes. Connecting the positive sense pins at the anodes side—as opposed to the load side—of the dual diode eliminates any potential chatter. Also note that a trim potentiometer is used to individually adjust each output in order to turn on one of the selected converters.

The trim procedure follows: Trim the output of the ON converter to V_O (measured at the anode side) plus V_D (diode drop) and the standby converter to $V_O+½V_D$. Given 0.5V voltage drop through the diode and the maximum tolerance of the load voltage, make sure V_O tolerance is not violated.

Example:
V_O = 5V ± 0.25 or 4.75V to 5.25V
V_D = 0.5V

The ON converter's output must measure 5.75 - 0.5 = 5.25V. The OFF (standby) converter's output is set for 5.5 - 0.5 = 5.0V. If a third converter is used, its output should be set for 5.25 - 0.5 = 4.75V. If the maximum output current is 10A (PowerWatt 50W converter 5×10), the power dissipation on the diode is 0.5*10=5W (for 20A I_O, the power dissipation would be 10W), a 10% efficiency loss for improving system reliability, while the converters are forced to deliver more power in order to compensate for the power dissipation on the diode, which will reduce the operating life of the converter.

However, the use of ORing diodes is *not recommended* for IO≥2A. A more efficient redundant system is shown in Figure 2, where the ORing diodes are replaced with a low ON resistance N channel MOSFETs. The circuit in Figure 2 requires an external bias supply V_{CC}, which can be generated with a low-power, step-up converter, such as Beta Dyne's SR5.

The control circuit in Figure 2 operates as follows: At turn on, U1 is selected to be on, Q3 pulls the base of Q6 low through D1, forces Q2 off, and V_{CC} is applied at the gate of Q1. If the output of V1 goes to zero, Q3 turns off, which reverses D1, pulls the gate of Q1 low through Q2. The collector of Q6 goes low, and turns Q5 off and Q4 on.

Please note if the output of a converter is short circuited, the parasitic diode of the MOSFET will allow current to flow into the short circuit. Inserting Q1, Q4 at $-V_{OUT}$ and reorganizing the logic will eliminate this potential problem.

The power dissipated power on Q1 or Q4 is given by:

$$\boxed{P = I_O^2 * R_{DS}ON}$$

If a 5mΩ R_{DS}ON MOSFET is used and I_O=10A,
P = 100*0.005 = 0.5W

and the voltage drop is:
V = I×R = 10*0.0050 = 0.05V or 50mV

Therefore, the circuit in Figure 2 offers a 10:1 improvement in voltage drop and power dissipation, and it does not require any output voltage adjustment. Some important things to keep in mind: always use an input fuse for each converter; do not use a single fuse for all converters in a redundant system; and do not try to synchronize the converter as only one is on at a time.

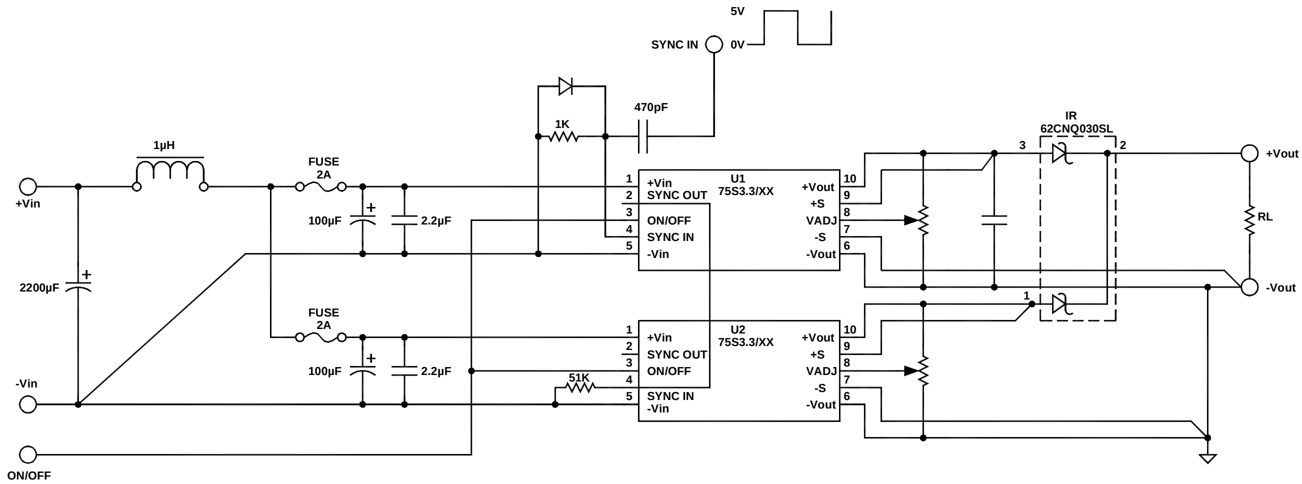

FIGURE 1. Redundancy with ORing diodes
(Not recommended for full power)

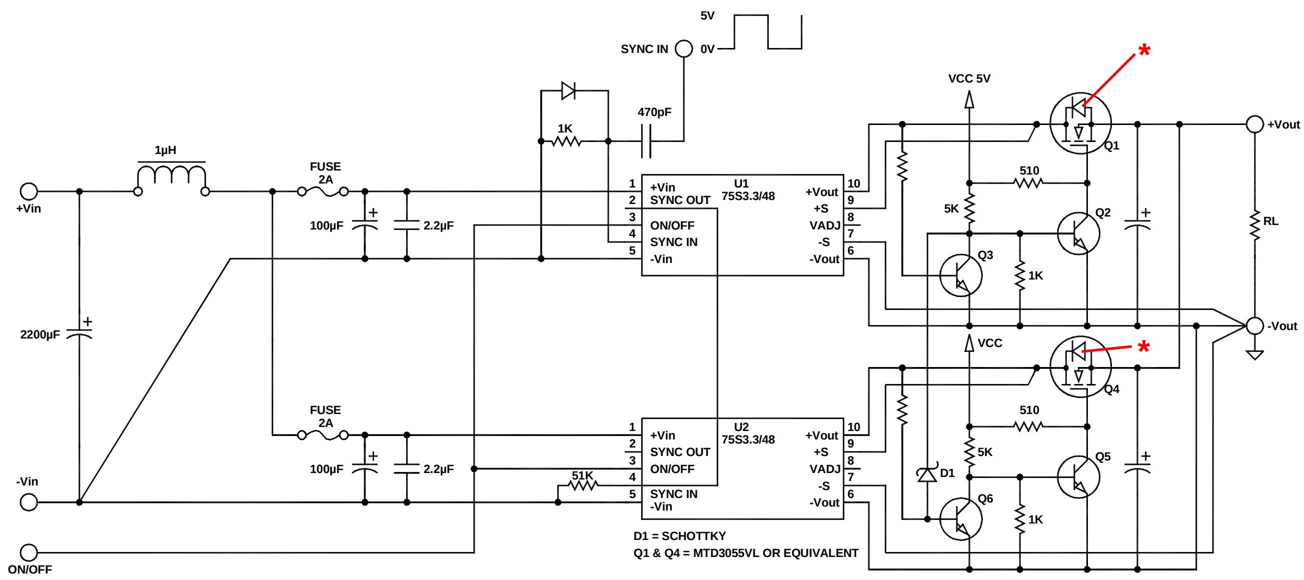

FIGURE 2. Redundancy with MOSFET

* Potential source of problem, please read text.