Paralleling With Current Sharing And N+M Redundancy

General Description

Paralleling of ***MicroVerter***®DC-DC converters is often used to increase the output power capability of a single unit by connecting the outputs of two or more converters in parallel. By connecting the parallel pin of each module together, the units will share the load current equally within a few percent. With the addition of RO's PDM (patent pending) module and start up assist circuitry, N+M redundancy and Hot Plug-in capability can be achieved.

Implementation

Connections

The modules should be connected in parallel as shown in Figure 13a. A PDM module is inserted between the parallel pin of each module and the shared signal. Or-ing diodes and start up assist resistors are connected to each output.

Parallel Pin

The signal at the parallel pins, shared by parallel connected units, is a DC signal which varies between 1 and 5 volts depending on load. The signal appears between parallel and minus input and is sensitive to both conducted and radiated noise as well as transient voltages. CAUTION: Be sure to read and implement Layout Considerations before attempting to parallel modules.

Layout Considerations

The best results are obtained by implementing the following practical considerations in making a layout for paralleled units, in order to keep the input, output, and parallel signals as noise free as possible.

The minus input pins of the paralleled units should be kept at as near the same potential as possible, preferably by a large plane type connection on the topside of the circuit board. This connection is connected in turn to the minus of the input source. The ***MicroVerter***® input current and input ripple currents flow in this connection and can induce noise on, as well as cause level shifting of the shared signal, resulting in unequal voltages appearing at the parallel pins of the parallel connected units. For this reason, the connection should be as large as possible. A capacitor placed at the input of each unit will reduce the ripple current in the minus input connection and improve paralleled performance. Recommended values for an input capacitor are provided in Table 1 for component C4. Further reduction of the input ripple current can be obtained with a small input choke. A separate application note on ***MicroVerter***® input ripple filtering is available.

The parallel pin connection may be very small, as negligible currents flow between units. The placement of the connection is important though , as it must be shielded from radiated noise as it passes from unit to unit. This can be most easily accomplished by routing the connection away from the unit on the opposite (bottom) side of the PC board and using the minus input plane to provide the necessary shielding.

A small ceramic capacitor, .022µF (NPO type) may be used to bypass any additional noise signals to ground. A capacitor with good high frequency characteristics connected between parallel and minus input and located close to each ***MicroVerter***® DC-DC converter gives best results.

A zener diode connected between the parallel pin and minus input will protect the converter from being damaged by transient voltages induced on this point. A 5.6V, 1 watt type connected close to each converter is generally sufficient. This is an important consideration when transients are likely to occur , for instance in hot plug-in applications.

At the output

Another topside plane provided for minus output will further reduce unwanted signals on both the parallel signal and on the output. This plane can be routed underneath the ***MicroVerter***® converters to provide more shielding. Consideration should be given to grounding the ***MicroVerter***® cases to this plane and to earth ground or to an earth grounding connection (normal practice in many installations).

Remote sensing

Remote sensing is not necessarily required for proper parallel operation if the load leads are reasonably sized and relatively equal in total resistance for each converter. However , with oring diodes, remote sensing is generally desired to compensate for the diode drops.

Output trimming

Output trimming is generally not required in parallel configurations. However, if required, individual trim resistors on each module are recommended. This avoids to the need to hot plug the trim pin.

Shielding of Remote Sense and Trim

If remote sensing or remote trimming is required for a particular application, then the minus output plane should be used to shield the sense and trim lines in a PC board layout. The sense and trim lines should be routed from an individual **M*icroVerter*®** module close to each other on the opposite (bottom) side of the board, away from the unit and under the topside minus output plane. Terminate the respective lines from all units at a single point. A capacitor in the range of 100µF to 4700µF connected across the output at the point where the load leads of the individual converters are joined together is recommended. A small ceramic capacitor with good high frequency characteristics (0.1µF to 1 µF or so) may reduce noise as well. When remote sensing, connect the sense lines to the output at, or close to, the capacitor terminals. Connect the trim network at this point as well, if used.

Oring Diodes

An oring diode can be used in series with the output of each **M*icroVerter*®** unit to prevent a unit which has failed short at the output from shorting out the load. A low voltage schottky diode is recommended for 5V outputs. There are 15V to 30V (Vr) schottky's available with Vf's as low as 0.3V@40A that result in less heat generated, higher efficiency, smaller size, and more reasonable cooling requirements than the 35-40V types. Recommended oring diodes for various output voltages are provided in Table 1 for component D2. **M*icroVerter*®** modules can be individually or'ed, or pairs can be paralleled without oring diodes, and or'ed to other parallel connected pairs.

Fusing

Separate fusing at the input to each **M*icroVerter*®** module is also required to prevent a unit which has failed short at the input from shorting out the input to the other units. Recommended fuses for various input voltages are provided in Table for component F1.

PDM (Paralleling De-coupling Module)

The Paralleling De-coupling Module (PDM) isolates the parallel pins when multiple modules are connected in a paralleling, current sharing configuration. The PDM monitors the parallel pin voltage and compares it to a variable reference. If the parallel pin voltage drops below the reference, a FET opens the connection to the shared connection so that the other modules in parallel are not affected. The PDM in combination with the start up circuitry:

Isolates the Parallel Pin for n+m redundancy

Provides Fault tolerance with no single point of failure

De-couples a faulty module with minimum bus disturbance

Re-couples Replacement module with minimum bus disturbance during hot plug-in.

Allows for Individual Module Turn on/off.

Provide low impedance for Precise Current Sharing

The PDM is powered from input voltage source. Recommended values for the input resistor are provided in Table 1 for component R1.

Start up Assist Circuitry

Sense resistor R5 allows for a lower output module to rejoin the operating paralleled units. R5 provides enough voltage drop (about 150mv) to make the lower voltage unit turn on even though the sensed voltage at the bus is higher than the lower voltage units output.

Resistor R6 compensates for the loss of regulation that resistor R5 creates by zeroing the sum of the current flowing in the node of R5 and R6. R6 is selected on the basis of the voltage drop across D2 to equal the current that would flow in R5. Recommended resistor values are provided in Table 1 for components R5 and R6.

Possible Applications

Paralleling for Increased Power

Configuring Output Power

Providing n+m Redundancy

Hot plug-in Applications

Related Topics

AP-3 Input Ripple Measurement and Filtering

AP-4 Logic On-Off

AP-18 Board Layout Considerations and Recommendations

Input Voltage

Component	28V	48V	300V
C4	22µF,50V	15µF,100V	0.1µF,600V
R1	5.6K,¼W	24K,¼W	160K,2W
FI	15A	8A	2A

Output Voltage

Component	5V	12V,15V	24V,28V
D2	85CNQ015	80CNQ035	63CNQ100
R5	3.3	10	27
R6	47,1W	100,5W	120,12W

Table 1

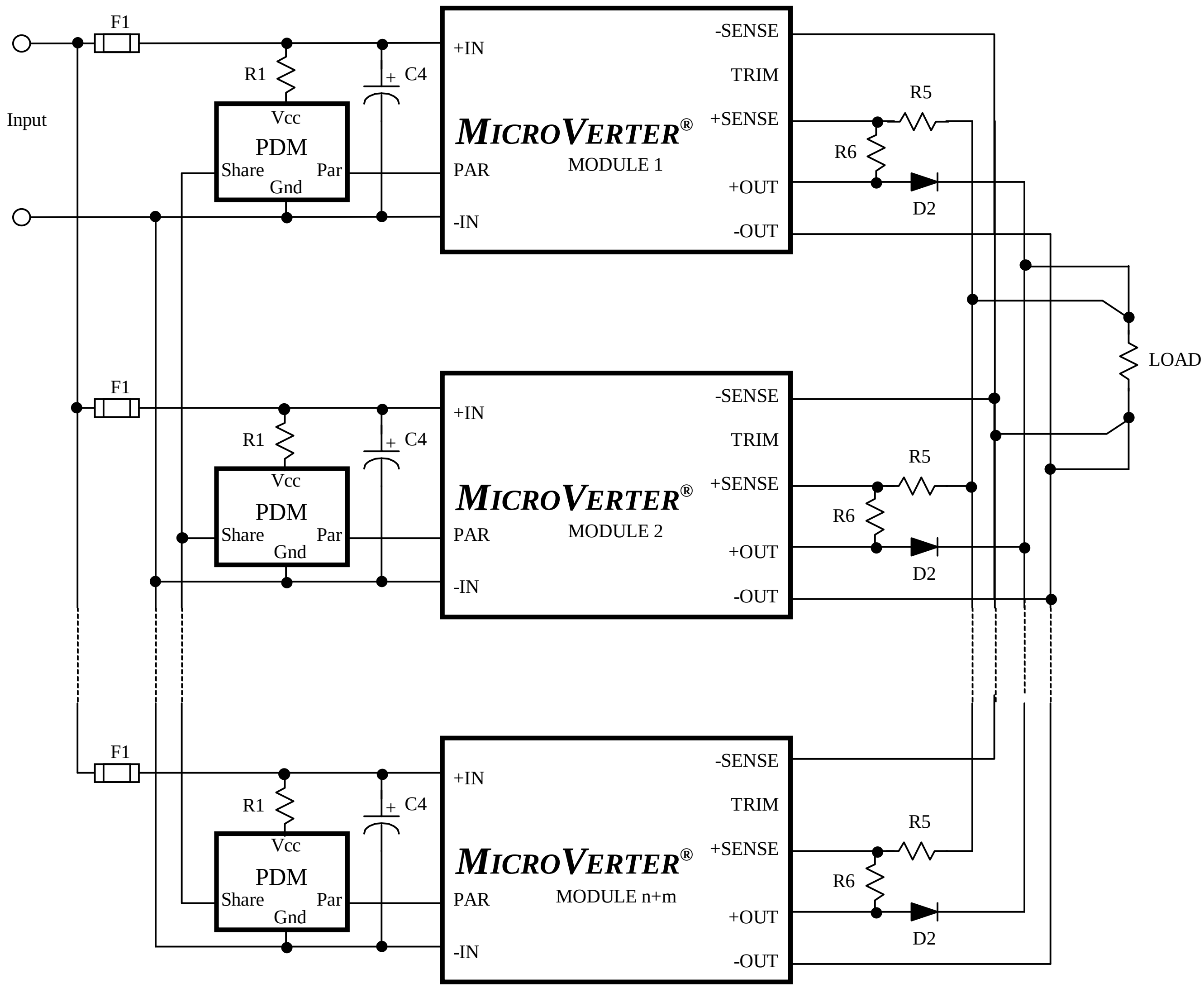

Figure 13a