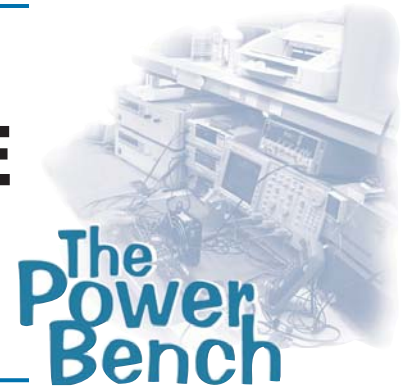


# COMPONENT POWER SOLUTION FOR INDUSTRIAL HIGHER VOLTAGE APPLICATIONS

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TPB 104

State-of-the-art Vicor Maxi, Mini, Micro Series DC-DC converters offer many features that facilitate their integration into a complete power solution. Foremost of these is a unique current sharing scheme<sup>1</sup> which allows for increased power capability, with current sharing accuracy between modules better than 5%.

The inherently accurate current sharing capability between modules affords designers the opportunity to place the inputs in series to increase the operating voltage of the system.

This issue of The Power Bench describes a 110 Vdc input power supply application based on the 48 V input V300 series of converters.

## SYSTEM REQUIREMENTS

A conventional multi-converter design places the inputs of the DC-DC converters in parallel with the same voltage appearing across each converter. Connecting the inputs of the converters in series, and having the array behave as a single power source, requires that the converters share the load equally under all operating conditions, ensuring that the voltage which appears across each converter's input will be the same.

With the series connection of the converters, the input capacitance used ahead of the DC-DC converters must be split equally across the input of each converter. The use of shunt resistors will help to offset the leakage current of the capacitors. (See Figure 1.) A supervisory circuit is used with the converters to monitor the voltage balance of the converters and control their operation.

Input overvoltage protection must be provided to prevent excessive voltage on the capacitors during a fault condition. This protection is usually provided by using transient voltage suppressors (TVS).

Figure 1 is an example of the basic series input connected approach. Close inspection of the diagram reveals subtle differences in the way the modules are configured as compared to an array in which the inputs are connected in parallel. Notice that Module 1 has its SC pin connected to the -Sense and -Output pins. This connection forces the module into a "slave" mode. Module 2 is then the "master" of the array; that is to say that only Module 2 controls the output voltage of the array.

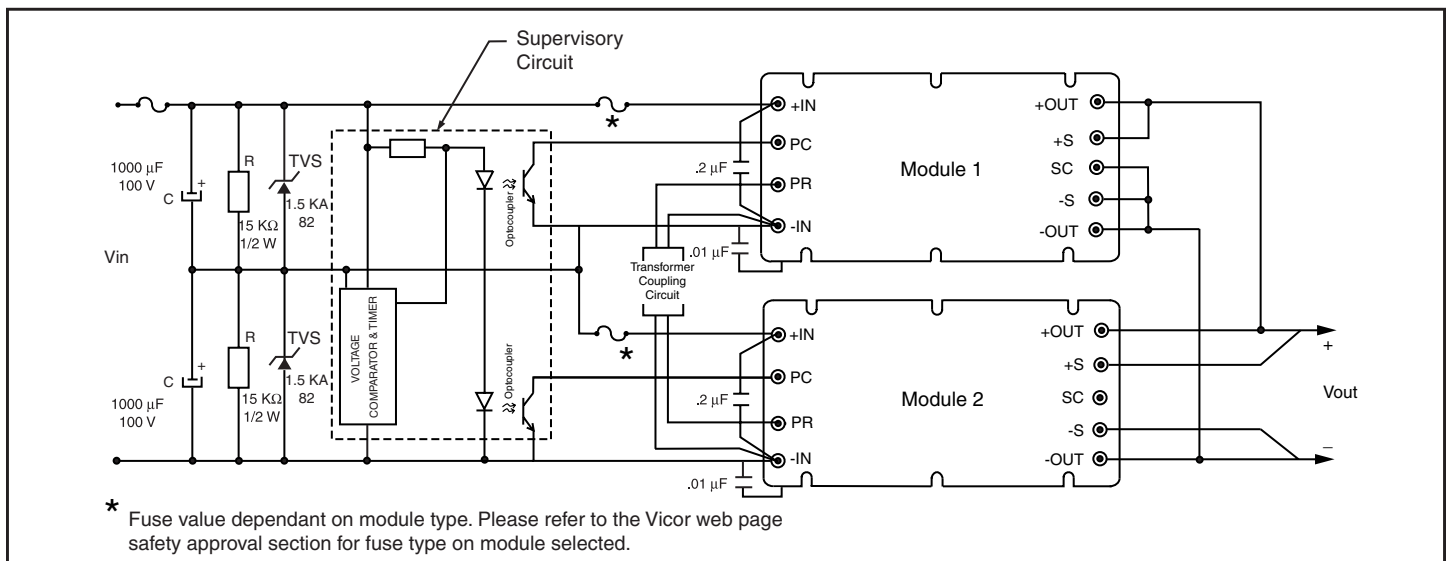


Figure 1. Basic Serial Input Array

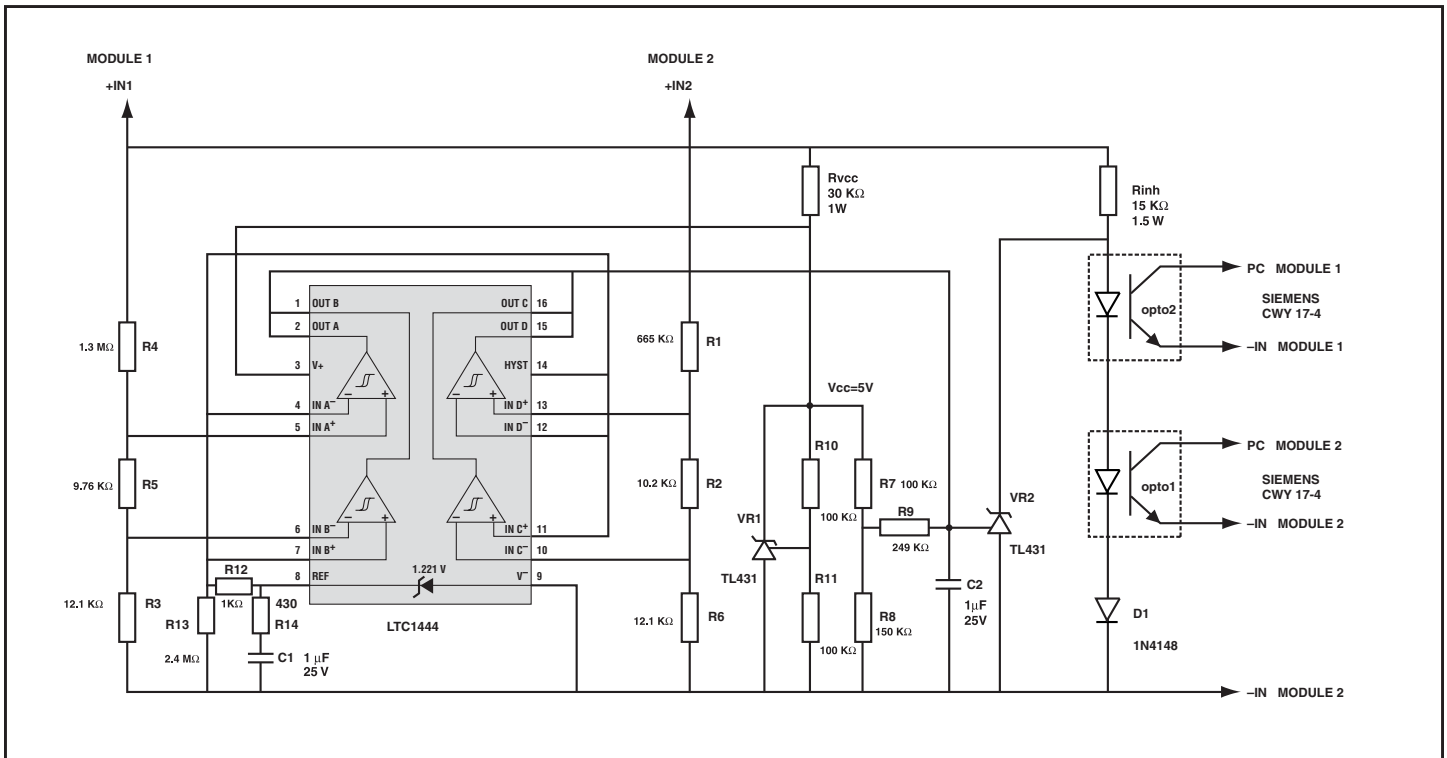


Figure 2. Supervisory Circuit

The PR signal, which ensures load balancing of the array, must be transformer coupled using the Vicor P/N 22400 transformer. Transformer coupling provides the required galvanic isolation and, as an added benefit, high noise immunity.

An additional bypass capacitor (0.2 µF ceramic or film) connected locally to the input of each module provides a low AC impedance for high frequencies. The layout of the power supply should be symmetric in order to balance circuit impedances. Careful attention should be paid to the creepage and clearance distances between line to line circuit traces as well as isolation to earth ground.

## SUPERVISORY CIRCUIT

The supervisory circuit (see Figure 2) monitors the input voltage of each module and ensures that both modules work within their rated input range. The circuit also provides a delay at start up and enables each module in unison.

The comparators of the LTC1444 circuit separately monitor the input voltage of each converter, and will disable the converters when the monitored voltage is outside the operating range.

The comparator reference is derived from the internal reference of the LTC1444 (pin 8). Reference noise suppression is accomplished by R14 and C1. The hysteresis of the voltage comparators can be increased by incrementing R12 (1 kΩ/mV of hysteresis at the input of the comparators).

When the bus voltage is outside the operating range, the comparator is in the low state, the converters are off, and the timer capacitor is discharged. When the input voltage is in range, capacitor C2 is allowed to charge. When the voltage on C2 exceeds the reference voltage of VR2, the current flowing through the optocouplers is shunted and the converters are enabled.

The delay must be set equal to or higher than 500 ms. The source voltage for the timer is derived from Vcc through the voltage divider of R7, R8. Using a divided down reference allows for detection of low Vcc to the LTC1444 and allows for a smaller timer capacitor.

As previously mentioned, the PR signal must be transformer coupled between modules. Figure 3 shows the required circuitry.

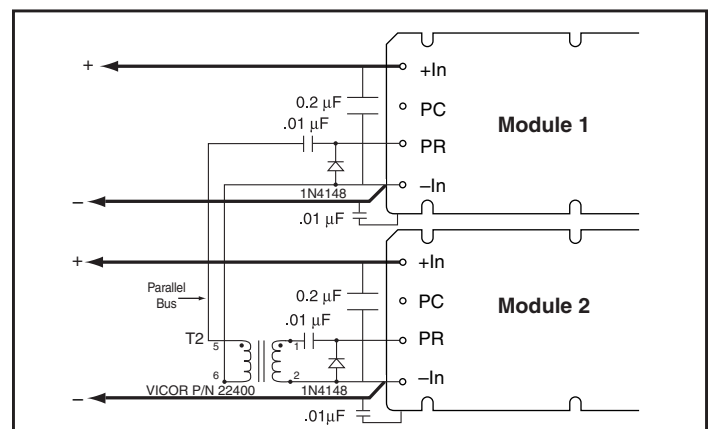


Figure 3. Transformer Coupling Circuit

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## 110 VDC INPUT POWER SUPPLY APPLICATION

The serial input array uses standard off-the-shelf DC-DC converter modules and offers high power density, high efficiency, and increased input voltage.

The DC-DC converter modules suitable for such an application are Vicor's Maxi, Mini, Micro Series 48 V family. The modules used in the array must be the same part number.

The standard input range of the 48 V family is 36 Vdc to 75 Vdc; in this serial input array example the input range will be approximately 76 Vdc to 137 Vdc. The serial input array based on the 48 V family gives a suitable solution for building a power system for an industrial or railway 110 Vdc application.

### FOR OTHER INPUT VOLTAGE APPLICATIONS, PLEASE CONSULT WITH VICOR APPLICATIONS ENGINEERS.

1 Refer to Vicor's Application Note on parallel operation, "Converter PR Pin Facilitates Parallel Operation for Power Expansion or Redundancy", available at [vicorpower.com](http://vicorpower.com). From the home page, click on Design Tools, then Application Notes.

**NOTE:** No warranty is expressed or implied for this circuit and is provided for information only. Always fully evaluate the performance of this circuit relative to your requirements.

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