

# PFC Load Restrictions during Startup

## General Description

Astrodyne’s UniVerter® series of PFC modules utilize fold-back current limiting to safely and quickly start-up into large capacitive loads. Non-capacitive loads can prevent the PFC from starting properly by drawing DC current in excess of the PFC’s folded-back current limit at lower output voltages. To prevent this, the PFC modules have a load enable circuit that disables the load until the PFC can supply the rated current. **The load enable must be used in all applications having non-capacitive loads.**

## Implementation

The PFC load enable circuit interfaces with the on/off control input of the load. It is designed for loads that are disabled when the control input is pulled low with respect to the -OUT pin of the PFC. Other loads may require some interface or “glue” circuitry to work properly with the PFC.

On turn-on the LD ENA pin is active low, referenced to the -OUT pin of the PFC, until the PFC output rises above 345VDC. It then becomes an open drain. On turn-off the LD ENA pin remains an open drain until the output drops below 220VDC. The LD ENA pin is capable of sinking up to 90mA continuously and has a maximum voltage rating of 60V with respect to the -OUT pin of the PFC. Its active low voltage is less than 0.3V when sinking 10mA.

The following sections describe the recommended connections to interface the LD ENA pin to various types of loads

including MicroVerter®, NanoVerter®, and PicoVerter® modules as well as resistive loads and other miscellaneous loads.

*\*Note that only the connections and components for the LD ENA function are shown. Other connections and components, such as the holdup capacitors, are not shown except where required for clarity.*

## MicroVerter Modules

The MicroVerter modules have a multifunction control pin, the PARALLEL-ON/OFF pin that provides an on/off control function as well as a paralleling interface. The on/off control function turns the module off if the control pin is pulled below 1V. In a simple PFC system with one MicroVerter module for the load, the LD ENA pin of the PFC can be directly connected to the PARALLEL-ON/ OFF pin of the MicroVerter module as shown in *Figure 23a*. As the PARALLEL-ON/ OFF pin is somewhat noise sensitive this connection should be shielded (connect the shield to the -IN of the load module).

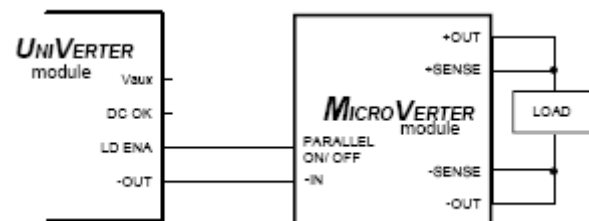
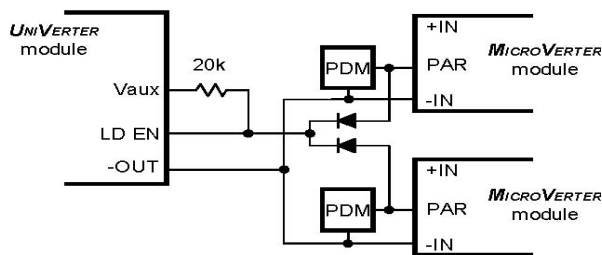


Figure 23a PFC interface to a single MICROVERTER module.

When the load is more complex and includes multiple MicroVerter modules the PARALLEL-ON/ OFF pins must be isolated from each other to prevent unwanted interactions. This includes paralleled MicroVerter systems where the parallel pins are connected together through a disconnect

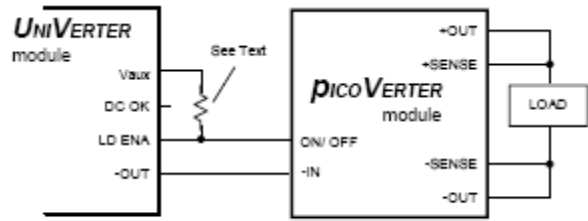
circuit such as the PDM. An example of such a system is shown in *Figure 23b*. Again, the connection to the PARALLEL-ON/ OFF pin should be shielded, at least up to the diode. More advanced module configurations (such as the multi-PFC, multi-module system shown in AP24) can be accommodated as well using similar techniques.



*Figure 23b PFC interface to multiple MICROVERTER modules using diode isolation.*

### PicoVerter Modules

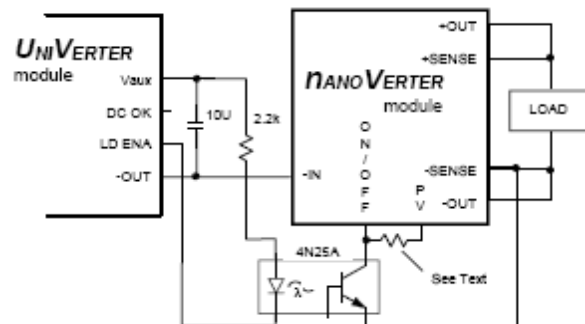
The PicoVerter series of modules has an ON/ OFF pin that functions in a manner similar to the on-off function of the MicroVerter PARALLEL-ON/ OFF pin. When the ON/ OFF pin is pulled high, or left open the module is operational; and when the ON/ OFF pin is pulled low to the -IN pin the module is off. The PicoVerter modules can therefore interface directly to the PFC load enable circuit as shown in *Figure 23c*. Loads with multiple PicoVerter modules can connect the ON/ OFF pins directly together. To minimize interaction between the modules a 20k to 100k pull-up resistor from the LDENA pin to the Vaux pin should be added. The pull-up resistor is optional for single PicoVerter module loads.



*Figure 23c Schematic of the LD ENA interface to a PICOVERTER module.*

### NanoVerter Modules

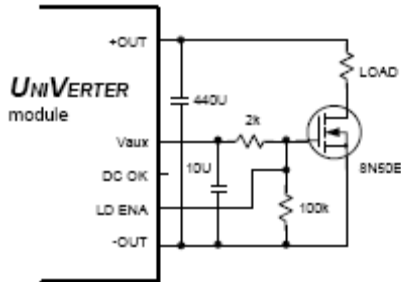
The NanoVerter series of modules PicoVerter has an ON/ OFF control that is referenced to the output of the module. In systems where safety isolation between the DC output and the AC input is required an isolation element such as an opto-coupler will be necessary. *Figure 23d* shows the recommended circuit to interface the PFC LD ENA pin to the NanoVerter ON/ OFF pin. As with the PicoVerter series, the NanoVerter modules are on when the ON/ OFF pin is high, or open; and off when it is low (pulled to -SENSE.). Loads with multiple NanoVerter modules can connect the ON/ OFF pins directly together. To minimize interaction between the modules a single 20k to 100k pull-up resistor from the ON/ OFF bus to one of the PV pins should be added. The pull-up resistor is optional for single NanoVerter module loads.



*Figure 23d Schematic of the LD ENA interface to a NANOVERTER module.*

## Resistive Loads

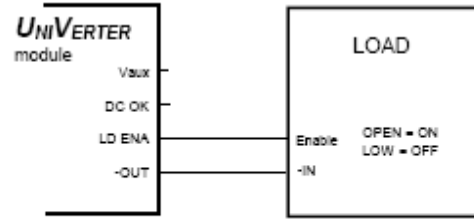
Resistive loads that draw more than 20mA at nominal PFC voltages will require some sort of a switch element to disconnect the load during startup. Relays or MOSFETs are practical implementations for the switch element. *Figure 23e* shows one possible approach. Standard precautions must be observed to prevent any stray or load inductance from creating a potentially damaging voltage spike during turn-off of the load.



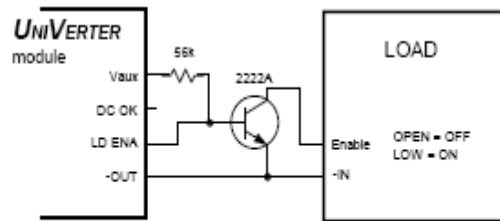
*Figure 23e Schematic of a LD ENA interface to a resistive load.*

## Other Loads

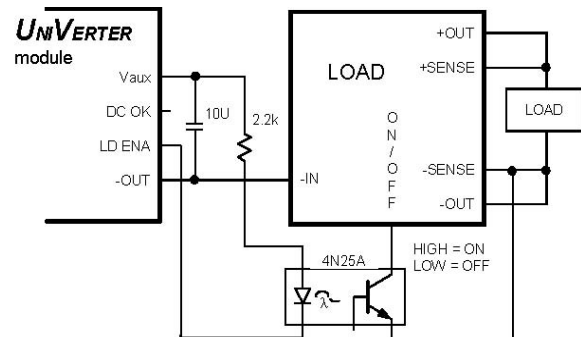
Other loads, such as custom DC-DC converters, will require some sort of an on/off or enable function to work properly with the PFC modules. Loads with input referenced on/off or enable pins can either interface directly with the PFC or with a logic inverter. Loads with an output referenced on/off or enable pin will require an opto-isolator. Loads without an on/off or enable function will require some sort of a switch element. *Figure 23f* through *Figure 23i* show some common interface circuits.



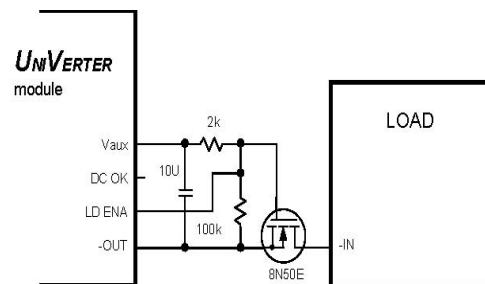
*Figure 23f PFC interface to a load with an active high, input referenced enable.*



*Figure 23g PFC interface to a load with an active low, input referenced enable.*



*Figure 23h PFC interface to a load with an active high, output referenced enable.*



*Figure 23i PFC interface to a load with no enable.*

## Possible Applications

### AC front end for 300V input DC-DC Converters -

The PFC module converts AC to 380V to drive the 300V input DC-DC converters.

**Power Factor Correction** -The PFC provides power factor correction to meet the harmonic distortion requirements of IEC1000-3-2. The PFC can be used to provide power factor correction for switching power supplies.

**Universal Input** - The PFC-600 can provide universal AC input from 85-265VAC for DC-DC converters or for switching power supplies.

**Custom Power Supplies** The PFC can be used in conjunction with a variety of DC-DC converter output modules to create a custom power supply with a very short design time.

## Precautions

**Hazardous Voltages** - When implementing the PFC there may be exposed AC input voltage and exposed 380VDC voltage. Care should be taken to provide insulation, protective covers, and warning labels.

### Control Spikes of Switched Loads -

Switched loads can generate significant voltage spikes when turned off. Clamps, controlled turn-off slew rates, or snubbers may be necessary to limit voltage spikes to safe levels. Voltage spikes can damage the switch, the load, or even the PFC module.

**Hold Up Cap** - A hold up cap ***must*** be used on the load side of the PFC to provide an acceptable ripple voltage for the DC-DC converters and to provide hold up time during power outages.

**Protection of the PARALLEL ON/OFF Signal** - The PARALLEL ON/ OFF pin(s) of the MicroVerter modules must be protected from transients and noise. Shield wires and traces to keep noise off of the parallel pin(s) and use a Zener diode from each PARALEL ON/OFF pin to -IN. A coax cable with the shield tied to -IN of the modules or a separate layer of a multi-layer PC board will provide adequate shielding. See AP-13 for further information.

**Fuse the Input** - The PFC must have an 8A, 250VAC fuse between the AC source and the PFC. Most output modules also require an individual fuse for each module. See the data sheet of the modules that you are using for fusing requirements.

## Related Topics

AP-13 Paralleling with Current Sharing and n+m Redundancy  
AP-24 Power Factor Correction (PFC) Modules