Custom Power, Inc.

Application Guide

1.0 Introduction

Custom Power, Inc. manufactures uninterruptible power supply (UPS) systems capable of providing power ranging from 60 VA to 125 kVA to a critical load. These systems can be constructed with a wide assortment of AC input, DC battery, DC output and AC output voltage and current configurations.

2.0 System Outlines

Generally, a UPS system is composed of a battery charger (AC to DC rectifier), battery bank, DC to AC inverter, static source select switch and a manual bypass switch. The general arrangement of the system components is depicted in the one line diagram in Fig. 1.

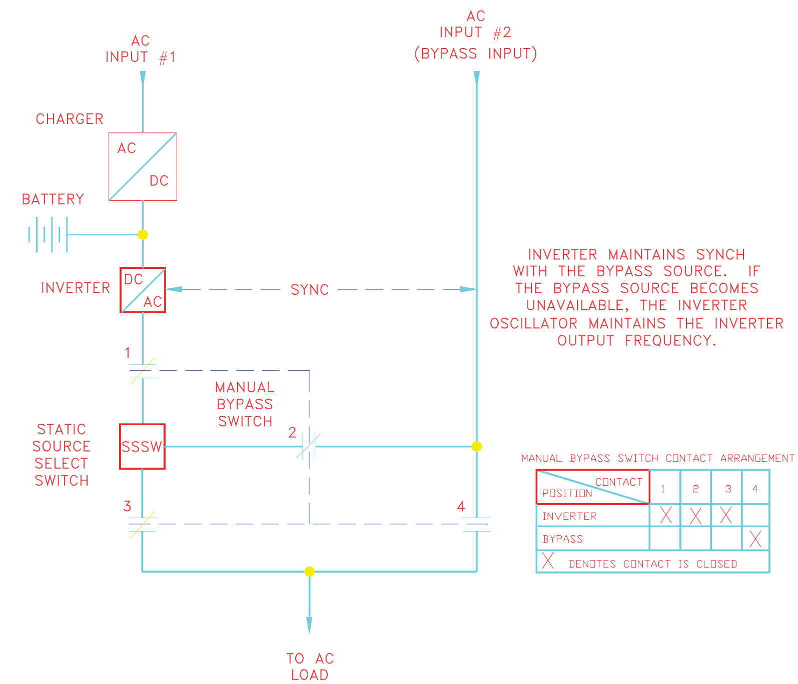

Figure 1. General UPS system one line diagram.

In this a "no break" system, the battery charger normally maintains continual charge power to the battery bank and supplies DC power to the DC to AC inverter. The DC to AC inverter maintains a phase and frequency synchronizing connection with the bypass source. The static source selector switch continually monitors the availability of the inverter output power and the bypass power supply. Under normal operation, the AC load is powered from the inverter output through the static source selector switch. Should some difficulty arise in the output of the inverter, the static source selector switch will disconnect the AC load from the inverter output and apply power from the bypass source. This transfer is a "no break" transfer and is intended to provide continuous power to the AC load. The manual bypass switch allows the UPS system to be disconnected from the load for maintenance. In the bypass position, the AC load is powered from the bypass supply.

Should AC input #1 fail, the DC to AC inverter will immediately begin to draw power from the battery bank with no interruption of power to the AC load. Should the batteries reach their depleted charge point before AC input #1 returns to normal, the batteries can be disconnected from the DC to AC inverter. The static source selector switch will then apply the bypass power supply to the AC load. As stated before, this switching process from inverter power to bypass occurs with no break in the power feed to the AC load. The systems can be configured for either automatic or manual reset to normal operating condition upon the return of AC input #1. Should the bypass source fail, the master oscillator in the inverter is used to maintain the inverter output frequency to within an acceptable tolerance. Upon return of the bypass source, the inverter will realign its frequency and phase with the bypass source.

The system described above can be enhanced by employing an UPS system composed of two sets of the system components. Such a redundant system is depicted in Fig. 2.

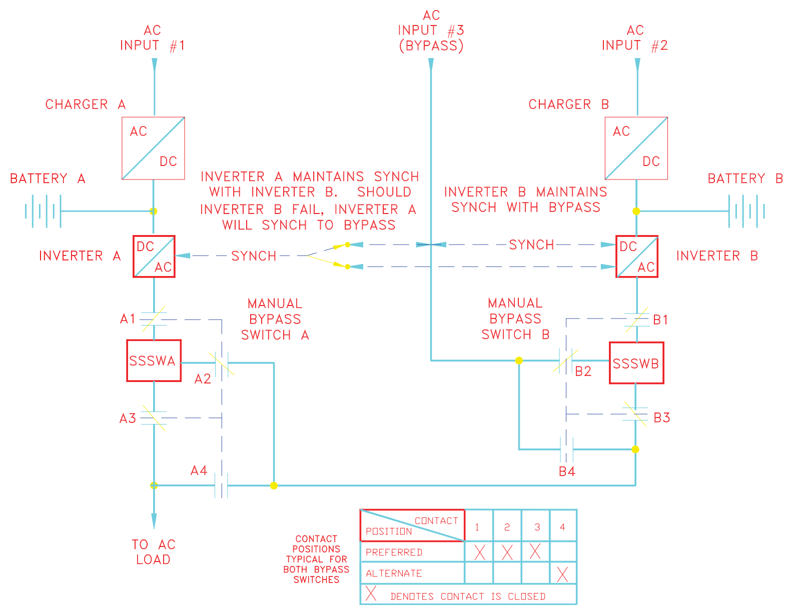

Figure 2. Generalized redundant UPS system one line diagram.

The primary source of power to the AC load in this scheme is inverter A. The first backup source is inverter B. The bypass source is to be connected to the load only upon loss of output from both inverters. The battery chargers and batteries in the system in Fig. 2 behave just like their counterparts in the system in Fig. 1. However, the frequency and phase synchronizing scheme for the inverters is more detailed. Inverter B continually attempts to synchronize its output with the bypass source. Inverter A maintains a synchronizing signal with inverter B as long as inverter B is the output of static source selector switch B (SSSWB). Should SSSWB switch to the bypass supply, inverter A will synchronize its output to the bypass source. Static source selector switch A (SSSWA) chooses between the outputs of inverter A & and the output of SSSWB. At SSSWA, inverter A is considered the primary source and inverter B the secondary source. Switch SSSWB chooses between the output of inverter B and the bypass source. At SSSWB, the output of inverter B is considered the primary source and the bypass source is considered the secondary source. As before, each manual bypass switch can be used to isolate the individual UPS systems from the load.

In both of the afore mentioned systems, the number of AC input sources can be arranged in various ways. For example, both AC inputs for the system in Fig. 1 could be the same source (though this would reduce the reliability of the system). Even though three AC sources are shown for the system in Fig. 2, it is not uncommon to only provide two AC sources. One of these sources would then be selected for use as the bypass power supply as well.

3.0 DC to AC inverter.

3.1 Inverter Selection

A DC to AC inverter should be sized to provide sufficient power to operate the load under a worst case scenario. It is recommended an inverter be sized at least 25% greater than the presently anticipated load. This allows some reserve for future additional load. Custom Power, Inc. inverters are available with output power ratings ranging from 60 VA to 125 kVA at 50 or 60 Hz.

3.2 Input Power Requirements

Custom Power, Inc. inverters have minimum typical efficiency of 86% at full load and nominal input voltage. The inverters are designed to operate at –12% to +17% of the selected battery voltage.

3.3 Typical Inverter Output Specifications

A. Output voltage range: 70 to 600 VAC.
B. Output voltage regulation: ±2.5% with full line and load changes.
C. Frequency stability: 50 or 60 Hz ±1/2% (±0.1% optional)
D. Total harmonic distortion: 5% maximum at nominal input, and full load output. 8% maximum with line and load changes.
E. Step load transient recovery time: 30 milliseconds for 80% load change, 20 milliseconds for 50% load change.
F. Bypass to inverter transfer transient recovery time: 30 milliseconds with response limited to 10% for 100% load application.
G. Overload capabilities: 125% of the full load rating continuously.
150% of the full load rating for 30 seconds.
200% of the full load rating for 10 cycles.

3.4 Standard (UPS) Inverter Features

The following features are an integral part of the standard UPS Inverter:

A. DC input circuit breaker
B. AC output circuit breaker
C. Overload and short circuit protection
D. Output voltmeter and ammeter.
E. An "In Sync" LED indicating synchronization between the inverter output and the bypass source.
F. An automated "Low DC Shutdown" to terminate further draw on a depleted battery bank.

4.0 BATTERY CHARGER

4.1 Battery Charger Considerations

The type of UPS required and the recharge time of the battery selected determines the size (current capability) of the battery charger. The battery charger should be sized to deliver sufficient power to drive the inverter at full load, recharge the battery in prescribed time period and supply any required DC load.

4.2 Input Specifications

Battery chargers can typically by supplied to operate from input sources ranging from 100-600 VAC (±10%), 50/60 Hz (±5%), single or three phase. Wider ranges in the voltage and frequency windows can also be accommodated.

4.2.1 Isolation

For protection, the input transformer for Custom Power battery chargers is an isolation transformer.

4.2.2 Input Power Factor and Harmonics.

When operating at its nominal input and output levels, the typical input power factor for Custom Power battery chargers is 0.9 lag. With this same input, the input voltage harmonic feedback does not exceed 10%. Power factor correction and feedback suppression are available when required.

4.3 Output Specifications

Custom Power battery chargers can be designed to charge any number of lead acid or nickel cadmium batteries and simultaneously power an AC to DC inverter and any other DC load. The output battery charging voltage level available from the charger is adjustable to optimize the charger power output. Each charger has the capability of supplying "float" and "equalize" charge voltages. For lead acid batteries, the output voltage window is generally 2.20 VDC to 2.33 VDC per cell. For nickel cadmium batteries, this window is generally 1.42 VDC to 1.52 VDC per cell. Overall, the output voltage of Custom Power battery chargers can be adjusted from 50% to 125% of the nominal output voltage. The prime consideration then becomes the required battery voltage level.

4.3.1 Regulation

The float and equalize voltages are generally regulated to within ±1% with full line and load changes. A voltage regulation on the order of ±1/2% is also available.

4.3.2 Ripple

The maximum AC ripple on the float and equalize voltages is typically 2% RMS when used with a battery whose ampere-hour rating is at least 2.5 times the charger current rating. For applications requiring it, 30 mVAC ripple can usually be achieved.

4.3.3 Efficiency

The efficiency of Custom Power battery chargers depends upon the design used for a particular application. However, in all cases the efficiency exceeds 90%.

4.3.4 Current Limit

Custom Power battery chargers are capable of continuously supplying current to an absolute short circuit without engaging any of the charger protective devices. Electronic control is used to limit the output current from 100% to 125% of the nominal output current. This adjustment is typically factory set to 110%.

4.4 Current Capability

Battery Charger current ratings of 3 amps to 6000 amps are available. An UPS system battery charger must provide the current required by the AC to DC inverter, any DC load and also supply the current necessary to recharge the battery following a power outage.

4.5 Standard Battery Charger Features

The following features are included as an integral part of a Custom Power battery charger:

A. Input AC circuit breaker.
B. Output DC circuit breaker.
C. Current limiting on the total battery charger output current to protect the charger.
D. Battery float adjustment.
E. Output voltmeter and ammeter. (3 1/2" size with 2% accuracy)

5.0 BATTERY BANK

5.1 Battery Bank Considerations

There are four important factors to consider when sizing a battery bank for operation as part of an UPS. The first is the length of time the UPS will be required to operate from battery power. The second factor is the operating ambient temperature range for the battery bank. Since battery capacity is directly related to temperature, the battery bank must be sized to provide the required power at the lowest anticipated operating temperature. The third factor is and aging factor. Battery performance tends to decrease with time. Finally, an overall design margin is recommended. Proper consideration of these factors will help to ensure an acceptable system performance over the life of the UPS system.

5.2 Lead Acid Batteries

Lead acid batteries are the most common type of batteries used for UPS applications. They provide good operating characteristics as well as long life with minimal maintenance. Some lead acid batteries, like lead antimony batteries, require a periodic equalizing charge to prolong battery life. Lead antimony batteries or other batteries requiring an equalize charge need more maintenance than batteries which do not require a periodic equalize charge, such as lead calcium batteries. Lead acid batteries are also available in a sealed, maintenance free form. These types of lead acid batteries are sometimes referred to as valve regulated batteries.

5.3 Nickel Cadmium Batteries

Nickel Cadmium Batteries are sometimes preferred over lead-acid type. Advantages of this type of battery include longer life, corrosive fume free charging, less required ventilation and cleaner operation. Some disadvantages are higher cost, lower charging efficiency, long charging time and the inability to determine the state of charge while "floating" on the battery charger.

5.4 Specifying A Battery Bank

In order for Custom Power to recommend a battery, the following information is needed:

A. The required stand-by time.
B. The ambient temperature range.
C. The planned physical location and type of operation environment.
D. The desired aging and design margins.
E. The system voltage level.

6.0 Methods Of Control

6.1 Static Source Selector Switch.

A static source selector switch is used to automatically select between two power sources to power a load. These switches are sometimes referred to as static transfer switches, static bypass switches or simply static switches. The model manufactured by Custom Power, Inc. is a "no break" switch that can transfer from one source to another with no interruption of power to the load supplied by the switch output. It is usually intended to normally connect the inverter output to the load. The load is transferred from the primary source to an alternate source should a fault condition arise or upon manual initiation of a transfer. When the primary source returns to normal operating parameters, the static source select switch can be set to either automatically return the power feed to the load to the primary source or to wait for a manual initiation of that transfer. While this is the recommended operation mode of the static source selector switch, the system can be configured to meet the requirements of the application.

Since the inverters manufactured by Custom Power, Inc. employ ferroresonant technology, the transfer from alternate source back to the inverter is closely regulated. This transfer takes place at a voltage zero crossing to allow the load to "ramp" onto the inverter. This allows for a predictable and improved transient response to the loading applied to the inverter.

6.2 Manual Transfer Switch (Manual Bypass Switch).

A manual transfer switch serves to disconnect the critical load from the inverter output and transfer it to the primary power source. This allows routine maintenance operations to be completed on the inverter without danger of shock. Custom Power, Inc. employs mechanical cam type, make-before-break switches with grip handles. These switches are typically mounted on the front of the UPS cabinet, but may also be housed separately. As with the static source selector switch, the actual operation of the manual bypass switch can be configured to meet the application.

7.0 Environmental Parameters.

A. Operating temperature range: 0° C to 40° C (excluding batteries). Models capable of operating in 50° C environments are also available.
B. Storage temperature: -30° C to +70° C.
C. Relative humidity: up to 95% @ 25° C without condensation
D. Housings can be constructed to allow Custom Power components to be placed in general, classified, outdoor and corrosive environments.

8.0 OPTIONS TO THE BASIC UNITS

8.1 Example Battery Charger Options (Others Available)

A. Equalizing switch or timer.
B. AC. pilot light.
C. AC. failure alarm.
D. DC. failure alarm.
E. 30 mVDC filtration.
F. DC ground fault detection alarm.
G. High and Low DC voltage alarms.
H. Multiple AC input sources.

8.2 Example Inverter Options (Others Available)

A. DC. input voltmeter.
B. DC. input ammeter.
C. Low input voltage (DC) alarm indicator -- Relay contact indicating the approach to the end point discharge of batteries.
D. Elapsed time meter.
E. Output frequency meter.
F. Inverter output failure alarm indicator -- Relay contact closure indicating an inverter malfunction.
G. External frequency synchronization. Provided for synchronizing Inverter frequency to line frequency.
H. Frequency stability: ± 0.1% or .01%.

9.0 INFORMATION NEEDED FOR UPS SELECTION / QUOTE

Due to the numerous types of systems and options available, the following information is needed to quote a system to meet your requirements.

A. Type of utility power available: ___VAC:___tolerance;___Hz.
B. Required battery recharge time: ___ hours.
C. Length of time inverter must run off batteries: ___ minutes / hours.
D. Lowest operating temperature of battery bank: ___ degrees Fahrenheit.
E. Output rating of Inverter required: ____KVA.
F. Battery voltage: ____VDC.
G. Type of load: ______________________________
____
H. Options required - refer to Section 8.0: ______________________________