



Technical Note TN-002

Ridethrough During Shore Power Transients and Dropouts

A primary function of AC power source (*shore power converter*) is the ability to sustain output power during short disturbances in input power. This is called ridethrough. As its name suggests, ridethrough is a converter(s) ability to *ride through* these short disturbances without being adversely affected, or affecting the load in any substantive way. Such transient events may vary in magnitude (*how large*), frequency (*the repetition rate*), and duration (*time*). Line disturbances may be caused by the utility company or natural events such as lightning, but more common in marinas will be events due to insufficient, antiquated, or poorly maintained electrical distribution systems (*wiring, connectors, circuit breakers, etc.*).

In a marina environment, a major source of brown-out events are the neighboring boats. Due to the electrical impedance (*resistance*) inherent in distribution wiring, when one boat abruptly transfers from generator to shore power, a step in the current flowing from the utility service occurs. This step in current then causes a drop in voltage along the entire electrical distribution system, most commonly observed as a momentary Adimming@ of a boats lighting system.

(A simple analogy of the phenomena would be of a tree with birds sitting on a branch. When a new bird lands on the branch, the additional step load on the branch causes movement of the branch that will settle with time. The birds closest to the trees trunk (the utility mains) will be least affected, while birds at the end of the branch (the boats at the end of a dock) will experience the greatest disturbance. And of course, the larger the bird the larger the resulting disturbance.)

The manner in which a converter's capacity for ridethrough is generally characterized is by the length time that a total absence of input power can be tolerated without causing an abnormality in the output waveform. Typically, it is measured in units of line frequency periods, that is, so many cycles of input power. The standard, always measured at maximum rated output power, is one or sometimes two cycles. For 60 Hz power this equates to 17ms and 34ms, respectively. This method provides information for what is the worst-case

event, a total loss of input service. For brown-out events, where the input voltage drops 20% or less, the holdup time is extended greatly. On an average, shore power converters manufactured by ASEA Power Systems will support a complete loss of shore power for three cycles without degrading the converters output power quality. The use of the wide-range PFC (*Power Factor Corrected*) power supplies in all ASEA Power Systems converters input circuits further allows effective use of whatever shore power voltage is available, even if substantially below the published minimum.

For a power converter to isolate the loads from input disturbances, it must possess the capacity of *energy storage* to sustain the load during the input power interruption. A bulk storage capacitor can provide a small *battery* of energy to maintain output power. These devices work in a manner similar to ordinary batteries, the major difference being that they store much less energy for a given volume and require no maintenance. They are internal to the converter and the amount of energy they store may be measured in joules. One joule is equal to one watt/second, or one watt of power supplied for one second. In the case of the ASEA Power Systems Model AC12 (12kVA converter), the storage is 3.5kj (*kilo joules*) or 3.5kW for 1 second. Unfortunately, not all the energy stored by the capacitors can be effectively converted to output power by the inverter stage, after depletion of approximately 30% of the initial amount, the converter will be shut off.

A related measure of a converters energy storage is *holdup*. Holdup is a measure of how long a converter can "hold up" the output in the face of an interruption of input power. The difference from ridethrough is that, in the case of holdup, input power is not coming back and a converter reset and interruption of power to the load is eminent. Holdup times are longer than ridethrough times because there is a period, after the ridethrough interval, when the converters internal energy store is so depleted that a converter reset is initiated, although there is some small amount still left that is delivered to the output. Typically during this period, as the internal supplies are decaying, the output voltage will become distorted with the peaks of the voltage waveform becoming clipped or flattened off.

ASEA Power Systems offers two separate product lines which address the discussed problems, either in part or in whole. The classical shore power converter models such as the AC12, AC24, etc., offer nearly complete protection from shore power problems, limitations being only the complete loss of input voltage for an extended period of time. This loss can be complete, or below the specified minimum voltage levels required by the converter to satisfy the yachts critical loads.

A new alternative is the LVR Series of Line Voltage Regulators. Unlike a full shore power converter, the line voltage regulator is unable to modify the basic line frequency, 50Hz to 60Hz as an example. Its main purpose is to isolate and regulate the shore power over a wide range of load and line conditions. The Line Voltage Regulator offers certain advantages over the full converter

however, these being lighter weight, smaller size, higher conversion efficiency, and lower cost. For many users the LVR provides the best technical and cost effective solution for shore power problems where frequency conversion is not required.

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