Engineering Bulletin

SunWize Power & Battery

Remote System Monitoring for PV Systems

Using Low Voltage Alarms

PV controller, load management controller and LVA in an aluminum enclosure.

A SunWize customer recently purchased six large, standalone photovoltaic (PV) systems for deployment in an extremely remote area of the American Southwest to power critical sensors as part of a data collection network. Given the important nature of the application we worked with the customer to add a low voltage alarm function at each site. If an alarm is transmitted to their control center, the customer has sufficient time to dispatch a technician to the site to repair the problem before the load is automatically disconnected.

A well designed PV system will successfully power equipment loads for many years with very little maintenance. PV systems have been powering loads in all types of environments around the globe for over 30 years.

Even with this high level of performance and reliability, we can benefit from some level of PV system monitoring using low voltage alarms, especially for a large-scale network involving multiple sites, as described above.

Battery State-of-Charge

The most important information concerning a PV system's state of health is the battery state-of-charge (SOC). The battery is the only component that directly relates to the load's ability to operate. Also, all other PV system performance criteria can be inferred from the battery's SOC.

While the 24/7 source of power to a remote site piece of load equipment is the battery bank, the PV array is the source of renewable energy. The PV array's primary job is to replenish energy consumed daily by the load into the battery bank. Therefore the battery remains the primary source of power to the load. If we can track the SOC of the battery in a meaningful way, we can infer the state of the load.

Low Voltage Disconnect and Alarm

Batteries in most PV systems are designed to operate from a full SOC of 100% down to 20% SOC, which we refer to as the low voltage disconnect point (LVD). Systems employ an LVD function at 20% SOC by disconnecting the load from the battery via a disconnect switch, which is usually integrated into the system controller. This is done to protect the battery from a severe discharge which could physically damage the battery internally, causing a permanent loss of capacity. A typical battery bank cycles between 100% and 80% SOC on a day to day basis. A well designed system will retain at least 90% SOC day to day.

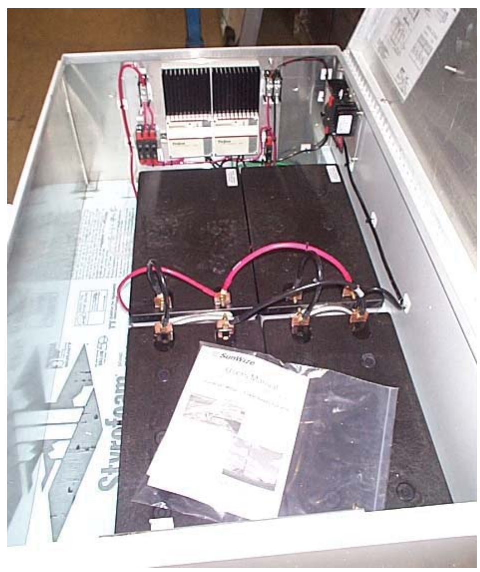
The simplest form of system monitoring is to wait for an LVD and to be "notified" of that event by a loss to your load. Of course, that loss may be unacceptable, making the LVD event something we need to know about in advance. If so, a second level of data can be introduced in the form of a low voltage alarm (LVA). By setting the LVA at a higher SOC than the LVD we receive a low voltage alarm in advance of a loss of load. That advance notice allows us to proactively address the cause for the low state-of-charge condition before it reaches the load disconnect point.

Setting the Low Voltage Alarm

How much advance notice is adequate and appropriate? We address that by considering two questions:

1. How much time is needed to dispatch a technician to a site once notified by a low voltage alarm?
2. What is the battery SOC profile for a typical site within the network?

Knowing the answers to the questions above insures the typical SOC profile for the battery is well above whatever SOC point we select for the LVA function. We don't want to trigger false LVA's by designing them to react within the battery's normal operating range. The battery bank in a PV system cycles up and down on a daily



Battery bank inside an aluminum enclosure with controllers mounted on the far end of the enclosure..

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basis. We use statistical analysis tools to predict the daily profile which avoids nuisance trips due to the LVA function.

If we are careful to select an LVA level that is below the typical range of daily cycling for the battery, thereby indicating an anomaly, and if we select an LVA point that offers enough time for a technician to reach the site before the load is disconnected, an LVA becomes a key data point. The LVA point also allows the end-user to predict the end of the useful life for the battery by proactively checking and, if needed, replacing batteries once a series of alarms are received.

PV systems have shown themselves to be an exceptionally reliable source of power. As a result, single systems often do not include an LVA function. However, we recommend system monitoring, especially a low voltage alarm, for large networks involving large numbers of PV systems.

SunWize® Power Ready System providing power for oil and gas pipeline monitoring equipment.