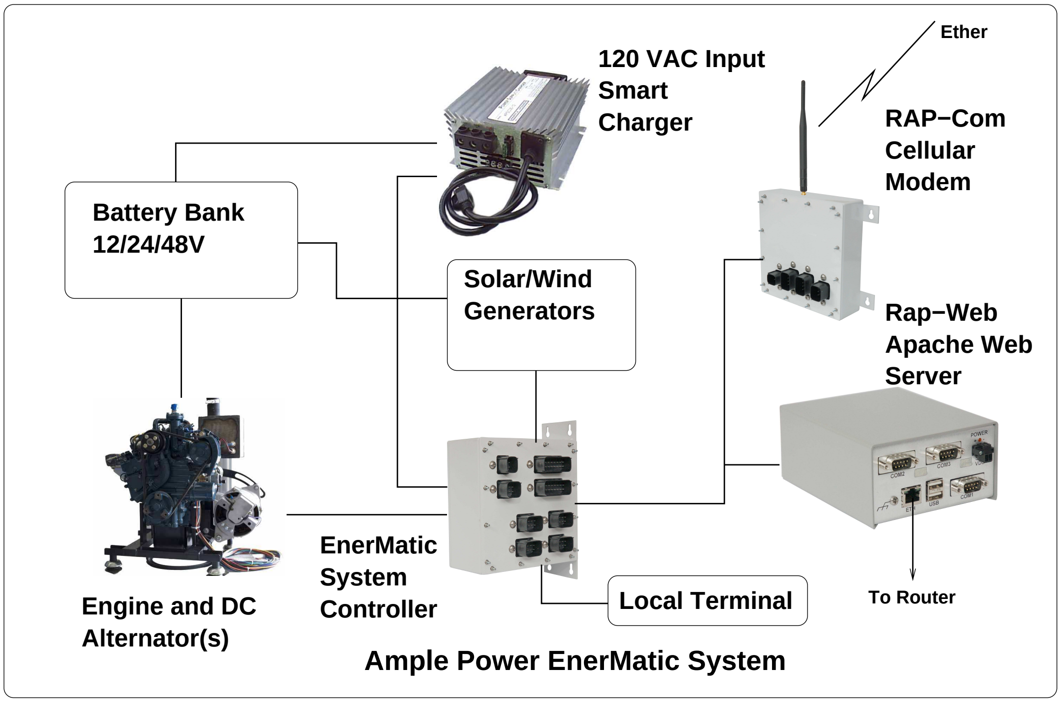
Ample Power EnerMatic System



Introduction

Computers have been managing large scale energy systems for decades . . . tuning armature RPM to maintain frequency and phase correlation between generators, controlling distribution switches, and when necessary, controlling start–up and shut–down of different systems.

Like its larger brethren, the EnerMatic System is designed to provide total management functions for small and medium scale energy systems, automatically, manually, or via remote controls.

Unlike its larger brethren, which operate generators producing AC, the EnerMatic System is primarily designed to manage DC generation. More on this subject later.

The EnerMatic System:

- Monitors battery Amp–hour state–of–charge;
- Starts an engine when necessary to charge the battery;
- Stops the engine when it is no longer needed;
- Gives charge priority to solar or wind charge source;
- Smartly regulates DC alternator(s) to match battery needs;
- Monitors engine operating conditions;
- Provides a menu–driven interface to a local operator, if any;
- Provides a second communications port for computer interface;
- Provides optional features such as oil change devices; and
- Contains a powerful ARM processor that permits custom site management functions.

Remote Monitoring and Control

The EnerMatic System Controller has two serial ports. One of them is used to provide a terminal interface to a PC. The other port communicates with other computer equipment using a *Remote Access Protocol*, RAP.

Ample Power optionally provides two communication devices:

- An embedded cellular modem for text messaging; and
- A very low power embedded web server.

Remote monitoring and control can be done from either the cellular modem, or the web server. In the case of the cellular modem, communications take place using SMS text messages. The web server, of course, provides monitoring and control pages using a browser.

The web server requires a link to a router that provides server access to the Internet. Communications between the router and the web server can be wired ethernet or WiFi.

Typically one or the other communications device is used, however, it is possible to use both where redundancy is desired.

Why DC rather than AC?

Most electronic equipment needs a constant source of power. If the only source of that power is an engine with an AC generator, that engine has to run 24/7. How often is that engine running when the load is minimum? It's still burning fuel, and at a rate much higher per energy production than it would if the engine was running under a nominal load.

Adding batteries and an inverter to an AC system can allow the engine to rest between battery charges. This can cure the problem of running with a minimal load, but other problems are introduced. Efficiency suffers because AC is being produced by the engine/generator just to be converted back to DC by the charger.

Switchover transients are produced every time the AC load circuit changes from the generator to the inverter. These transients can cause unstable operation, and possibly damage of attached electronic equipment.

Yet another problem is the stability of AC produced by an AC generator. It will vary in both frequency and voltage, which doesn't do the equipment connected to it any good.

The engine on an AC generator has to operate at a constant RPM to maintain AC frequency. That RPM is either too low, or too high to minimize fuel consumption.

Driving a DC alternator avoids the problems with AC gensets:

- The engine RPM can be chosen to minimize fuel consumption;
- The DC alternator charges the batteries directly without an extra conversion loss;
- There are no switchover transients . . . the AC loads operate only from precisely regulated voltage and frequency provided by the inverter;
- The engine is operated under a constant load until the batteries are charged . . . and then it is turned off.
- The engine is allowed to warm up and cool down before the DC alterator is turned on or off.

Battery Management

Since 1987, Ample Power Company has been the technology leader in battery management systems. Core principles established over years and thousands of applications have been honed to maximize battery life and minimize fuel consumption.

- To minimize fuel consumption engine horsepower is carefully matched against alternator and battery capacity;
- Batteries are charged as fast as possible without compromising long term battery life;
- Amp–hour state–of–charge is precisely tracked so that charge regimen can be adapted as required;
- Long term data logs can be analyzed for advance notice of battery failures; and
- Optionally, the Electrical System Monitor measures individual voltages of series connected batteries for signs of unbalance . . . a leading indicator of impending failure.

Redundant Systems

The Ample Power EnerMatic System has been designed from the ground up to seamlessly add redundant elements. The Remote Access Protocol, RAP, has routing features that allow units to broadcast messages to all units or to communicate with specific units.

In some circumstances, engine failure could last beyond the ability of the batteries to power the load. When total power failure cannot be tolerated, additional engine/alternators can be added to the system.

Under normal operation, two or more engine/alternator systems communicate and the unit with the least engine hours will be run when the batteries need to be charged . . . wear leveling the systems.

In very critical situations, additional ESM units can be added, either to operate in parallel on the same battery bank, or to monitor an additional battery bank.

Solar, Wind, Hydro Generators

The EnerMatic System Controller has outputs to independently control solar panels and wind or hydro generators. The power handling elements are remote from the EnerMatic and sized as required for the charge sources.

Custom Hardware/Software

Ample Power engineers and programmers have extensive background in computer technology, specifically as it relates to real-time process control systems.

Present software is highly structured with a clean division between general purpose and application specific features. This provides a broad foundation to build new application functions and integrate them into the system.

Such functions include controllers heating or air conditioning equipment, controllers for pumps and valves, sensors for human presence and other security devices. The RAP-Web device has USB ports that can directly interface to cameras.

Any custom devices designed and supplied by Ample Power would instantly be available for remote access, either via the RAP-Com modem, or the RAP-Web server.

System and Site Packaging

Engine/Alternator systems and battery banks are normally supplied ready to be installed in existing enclosures or shelters. Vandal resistant enclosures for engine/alternators are available. These are designed to be bolted directly onto a concrete pad, free standing in open air.

In severe weather conditions, such as mountain top sites, other shelters are more appropriate, especially in deep snow. Ample Power can design and construct custom shelters, not only for Ample equipment but also to contain heating/cooling gear and payload gear, i.e. communications equipment.

Adding, Updating Firmware

Realistically, the only bug-free software program is one that hasn't been written yet. Some bugs may never show up because the right set of edge cases doesn't occur at the same time. Show stopping bugs in a well tested unit are unlikely, however, nuisance bugs may cause work-arounds requiring some manual operations.

All Ample Power equipment can be upgraded in the field without mechanical dissassembly, and by a person who knows how to use a computer. New firmware releases can be downloaded from an Ample Power website and installed into the unit via a serial port. Each stage of the process undergoes integrity checks to make sure that files are intact and correct for the device being re-programmed.

Energy Conciousness

From the beginning in 1987, Ample Power engineers and programmers have focused on energy conservation and energy production with the least amount of energy input. How can a battery be charged with the least amount of fuel?

Making equipment last is part of that quest . . . it takes energy to make batteries and replace them frequently because they were not managed properly. How can the life of a battery be extended for years of service?

How do we make our controllers stand up to temperature and humidity extremes, and survive electrical transients common to marine and industrial environments?

Those questions will never be answered to *our* satisfaction.