

## The Digital Phase Converter

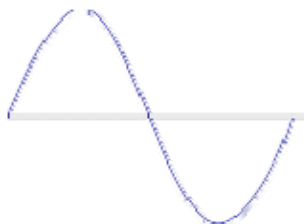
### A New Way To Generate Three-phase Electricity For A Winery

by Ben Guthrie

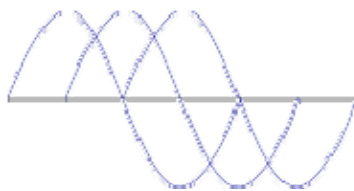
Most small to mid-size wineries need three-phase electricity for part of their operations. It might be for the grape press, must pump, bottling line or the refrigeration to keep it all cold.

#### AT A GLANCE

- Most small to mid-size wineries need three-phase electricity for part of their operations.
- When confronted with the requirement of three-phase for a specific piece of equipment, there are several choices.
- The new solution in these various choices is now one device; a digital phase converter, where the three sine waves created are balanced to within a 1% voltage drop.
- This converter will output steady three-phase power regardless of how small or large the load.
- Phase Perfect is the brand name of the only device on the market that is a digital phase converter.



Single-phase electricity is the familiar two wires and a grounded 110 volts or 220 volts we have in our homes and regular commercial businesses, as in illustration # 1. When a business needs larger motors (over 5 hp) or is purchasing equipment designed for commercial use, three-phase electricity is the standard design.



As the name implies, three-phase has three-phases (or sine waves) of power, as in illustration # 2. The reason for this is more efficient generation and transmission of electrical power, more torque in motors and a simpler design of motor.

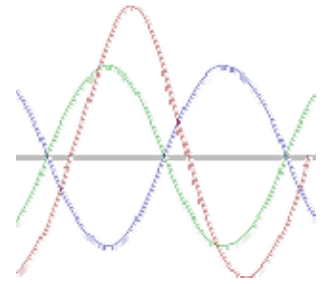
#### Options for Three-Phase

When confronted with the requirement of three-phase for a specific piece of equipment there are several choices:

1) Install a three-phase power entrance from the local electric utility. This can cost as much as \$50,000 depending on how far the new wires have to be run from the three-phase utility grid. In rural areas the costs can be far more. This is not an attractive addition to start-up costs. Many utilities are also charging a higher rate per kilowatt hour for three-phase electricity as an industrial commodity.

2) Install a rotary transformer electrically fed from the single-phase power panel. This is conventional technology that works reliably and is relatively inexpensive. The transformer itself may cost \$1500 and with another two or three thousand in wiring costs you have a reasonable imitation of three-phase power. However, there are important compromises that have to be made. A rotary transformer has to be sized to accommodate the largest single motor you have to start. On a common press deck this might mean a ten hp transformer to run the grape press's air compressor.

Unfortunately the smaller motors and loads like the vacuum pump motor, rotator motor and microprocessor power supply do not work well with a large converter when the balancing load of the air compressor is not running. These smaller loads often see a higher voltage, generated by the converter, of up to 280 volts. It is this high voltage that can cause motors to burn up and electronics to shut down to protect themselves. Importantly, a motor running on a rotary transformer produces significantly less torque (around 20% less) than with balanced three-phase, as in illustration # 3.



3) A relatively new solution is the use of variable frequency drives or VFDs. These devices are designed to provide variable speed control on three-phase motors and if specified correctly, can be used to convert single-phase to three-phase. This is an excellent solution and many of today's pumps use exactly this design.

The drawback here is that a VFD tunes itself to the motor that is its load. Each individual motor requires it's own drive. This can get expensive from a multiple unit perspective and challenging just to find a place to mount these various control boxes. (I proposed retrofitting a new press with three VFDs but the press manufacturer would not approve wiring these new devices into their control circuits.)

### **Technology and Advantages of the Digital Phase Converter**

The new solution to these various problems is now incorporated into one device - a digital phase converter. As the name implies, it incorporates computer technology (along the lines of a VFD) to create three output phases from one input phase. The computing power in a digital phase converter is focused on creating and regulating phase relationships. This means that the three sine waves created are balanced to within a 1% voltage drop.

By comparison, utility specifications generally allow up to 5% voltage variation and a rotary transformer might have a 20% variation. This tightly regulated output means you get full power out of the motor loads. Each phase of the motor winding is pulling evenly and smoothly. This converter will output steady three-phase power regardless of how small or large the load. Up to it's rated limit of course.

As far as voltage is concerned, the digital phase converter is a pass-through device. If the input is 220 volts the output will be 220 volts. If you need to vary the voltage, you use a buckboost transformer.

Phase Perfect is the brand name of the only device on the market that is a digital phase converter. It is 100% designed and manufactured in the USA (South Dakota to be exact).

Costing \$3000 for a 10 hp frame size, it is about \$1000 more than a rotary transformer the same size but it has many advantages. As described above it provides regulated output for any size load to prevent premature failure from high voltages.

In addition it is highly efficient when compared to rotary transformers. A typical ten hp rotary transformer has standby losses of up to eight amps or 1840 watts. Phase Perfect has standby losses of 100 watts. This has impact on your demand charges on your electric bill when you lower the total amp draw of your large motors with the balanced voltages and subtract the standby losses right off the top of your total demand load calculation.

### **An Example of Old Technology and Issues vs. the New Solution**

An example of the benefits of the Phase Perfect is the installation I performed at the Three Brothers Winery in Geneva, NY last September.

This winery had used a Euro Press EHP 3000 for 10 years on a traditional rotary transformer. Everything worked but you often had to run the crusher/stemmer on idle when the press was operating in order to keep the press from kicking out on an overload safety during the automatic cycle. The rotary transformer was sized for the large air compressor in the press, a load of 6.6kw or about 9 hp.

While the press was rotating, the small rotating motor was the only motor load on the 15 hp rotary transformer and it could not balance against it. One of the three motor windings of the rotator motor would see a voltage of approximately 280 volts, greatly stressing the insulation designed for a maximum of 240 volts.

At the same time the manufactured leg was lagging in voltage, causing high amps and an overheating in another winding. Running the crusher/stemmer added motor load to the rotary transformer to help bring it into balance but at the cost of the electricity needed to run the crusher and simple wear on the machine as it was idling.

I reviewed the main circuit breaker and wire sizes to make sure they were sufficient, and they were correctly sized and installed. It then took about two hours and two extra conductor wires to replace the old rotary transformer with the new DPC - 10. Just two wires in and three wires out of the new device. No programming or settings to deal with as you have with VFDs.

The improved performance in the operation of the press was immediately apparent. Not only would it complete a full press cycle without tripping out on safeties (even without the crusher running) but it ran with the smoothness of a Swiss watch. We completed the whole harvest season without any trouble and even the cellar workers were pleased to not have to listen to the rotary transformer buzzing all afternoon.

This installation convinced me that this new device was the best way to generate the three phase electricity for wineries - or any other business - that needs three phase electricity. I have since installed three more.

*Ben Guthrie got his start working in the vineyards and building the Wagner Winery in 1978. Since then he has worked in the wine industry in many areas but for the last 20 years he has owned Upstate Service and specialized in the design and construction of glycol systems for small wineries. Since September he has become a distributor of Phase Perfect Digital Phase Converters. You can find more information on Phase Perfect at [www.phaseperfect.com](http://www.phaseperfect.com) or contact Ben Guthrie at Upstate Service in the Finger Lakes of NY.*