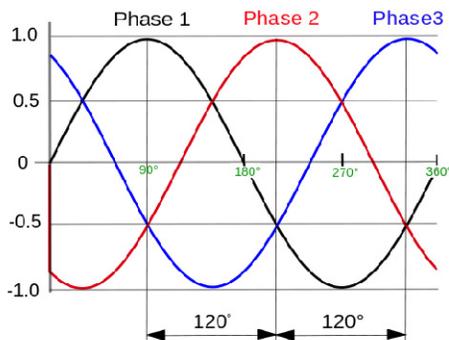


What is 3-phase Power?

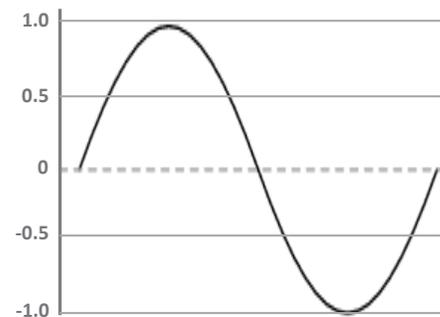
Phases

In the simplest of terms, phases refer to the number of conductors, wires, or lines that carry an electrical current. These conductors can also be referred to as legs, when more than one conductor exists, or phases (ph). Named after the number of conductors, there are three levels of power phases: single-, 2- and 3-phase.

Single-phase power circuits, as the name would suggest, employ one electrical current conductor that carries an alternating current in a timed pattern. Similarly, 2-phase circuits use the same current and pattern as the single-phase just with two separate conductors. Like single- and 2-phase, 3-phase involves three separate conductors that carry alternating electric current from a source in a *staggered* timing pattern.



3-phase Signature



Single-phase Signature

Single-phase

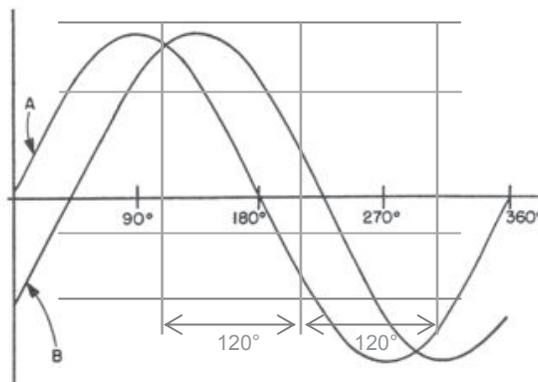
A typical single-phase circuit consists of three distinct conduits: one electrical current conductor, a neutral conductor, and a ground wire or line. Typically in the United States, circuits supporting loads at less than three-thousand watts will provide 120 Volts of Alternating Current (VAC).

Typically, electrical current flows from the conductor wire, through the load, to the neutral conductor with the ground wire providing protection against static charges and electrical shock. This ground wire may be referred to as an Emergency Ground and is not meant to carry current. There are some unique applications where a ground line or wire is not used at all, such as UPS devices installed in automobiles or onboard ships and boats). In some applications, the current on a single-phase conductor may be higher than what a 120 Volt circuit can sustain and may need to be handled by a higher voltage such as 208 or 240 VAC.

2-phase (dual/split phase)

2-phase, sometimes referred to as high-voltage single-phase, or dual/split phase, consists of four conduits: two electrical conductors that are both 120VAC and out of phase with one another, a neutral conductor, and a ground wire. In the U.S., many households are powered from the utility company with 2-phase power, before branching off into single-phase branch circuits.

This type of power source configuration offers a wide variety of voltage options consisting of 120VAC either L to N, or 240VAC L to L and sometimes even 208VAC. 2-phase power voltage flexibility makes it ideal for households. Low-power loads, such as lights and wall outlets, are powered using 120VAC single-phase power circuits. While high-power loads, such as water heaters and A/C compressors, are powered using the 240V 2-phase power circuit.



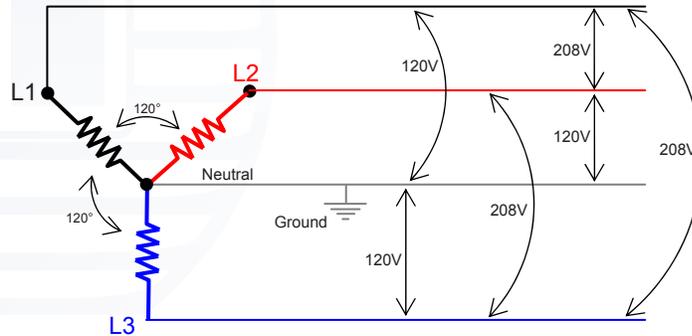
Two-phase Signature

3-phase (three phase)

3-phase power is configured using 5 conduits: three electrical current conductors, (also referred to as lines, phases or Legs), each at a specific voltage but out of phase from one another, one neutral conductor and a ground wire. 3 ph 4 w + G.

Consider a 3-phase, four-wire 208VAC/120VAC “Wye” power circuit. The “Wye” designation refers to the structure of the circuit as defined by the L1, L2, L3 illustration below, (which looks like the letter Y), and is used in the vast majority of 3-phase installations in the U.S. (208/120Y). Each L is also often referred to as a Leg.

Besides powering a single 3-phase load, requiring all three phases, i.e. a 3-phase motor, this configuration can provide three 120VAC single-phase power circuits, each providing electrical current to connected loads with a return to the neutral conductor line. It can also support three 208VAC single-phase power circuits, when each electrical conductor passes through the load to another electrical conductor, (L1 to L2, L2 to L3 and L3 to L1, see illustration on the next page).



The same diagram can apply to higher three-phase voltages based on 480VAC/277VAC. Typically, UPS systems based on 480VAC are found on installations larger than 100kVA and in some manufacturing or industrial installations below 100kVA.

A second type of 3-phase installation, less frequently found in the U.S. is called a “Delta” connection. A “Delta” connection design will not have a neutral wire and offer the same line-to-line voltage on all three legs. Typically, Delta-based 3-phase power connections are found in Europe and less frequently in the U.S. These may be referred to as 3 ph 3 w or 3 ph 4 w, (with ground) no Neutral.

Sizing a 3-Phase vs Single-Phase UPS

In a single-phase installation, the formula for calculating the connected loads attached to a UPS is fairly straightforward. Called the apparent power, the input voltage is multiplied to the sum of the current draws on the connected equipment and is represented by the term Volt-Amps, (VA).

Apparent Power: VA = Input Voltage (V) x Current Draw in Amps (A)

Then depending on how efficient the connected devices are at utilizing the input current, the VA rating is multiplied by a power factor, (pf), that can typically average between 0.65 – 1.00). The sum of this equation is represented in Watts. This is called the actual or real power.

Real Power: Watts = (VA) x power factor (pf) (0.65-1.0)

Today, most UPS models available on the market are represented by their VA rating. For instance, the Minuteman E3000RT2U is a 3000VA-rated UPS. Its pf is .85 so it is rated at 2560 Watts.

A 3-Phase system can provide power to a number of single- and/or 3-phase loads. Adding one conductor can increase the capacity or ampacity of power to an area dramatically verse adding additional circuits and multiple conductors. Despite this flexibility and increased capacity, it can be difficult, in laymen’s terms, to calculate a total 3-phase load from a combined Amp-rating of connected 120VAC/208VAC devices.

Additionally, there are other considerations for levels of reliability and runtime, including bypass and generator capability, as well as cost of operation due to efficiencies.

The management and maintenance of a growing power system should also be considered. With so many variables in play, a Minuteman sales professional can help analyze customer requirements and recommend the best available solution uniquely designed for that specific installation.

One-on-one Support for Selecting Your 3-phase UPS System

There are some automated tools available for less complicated single-phase sizing questions. Located at www.sizemyups.com.

www.sizemy3phaseups.com is under development to offer suggestions based on some basic criteria as well as considerations for more complex applications.

When discussing a 3-phase installation, connected load sizing is just a piece of the overall solution puzzle. If you need a 3 phase solution please email us at 3phase@minutemanups.com