

# Improving Power Quality with Voltage Regulators

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Over the past several decades, the need for voltage regulation has increased dramatically. Voltage regulators play a key role in maintaining the tight voltage tolerances that much of the electrical grid relies upon. If tight voltage tolerances aren't maintained, power quality is affected and equipment could potentially be ruined.



Single-phase step voltage regulator configuration.

## Focus: Single-Phase Regulators

Regulators are available in three-phase and single-phase configurations. The focus of this article is single-phase step voltage regulators, which monitor output voltage and can respond to changes in load on individual phases by decreasing (bucking) or increasing (boosting) voltage via a tap-changer. Central to maintaining a circuit's desired voltage profile is the regulator control, which has the task of monitoring the input voltage versus the output voltage and controlling the tap-changer accordingly. The desired voltage to be maintained (set point), when compared to the actual input voltage (which is affected by load), will determine the amount of buck or boost required.

Modern regulator controls handle a multitude of other tasks including providing extensive current and historical information relative to the state of the electrical system to which it is connected. This information can be captured and is invaluable for troubleshooting, load planning, maintenance planning, and system analysis. In recent years, controls have advanced to the point whereby they can sense and regulate reverse power flow, without the need for additional hardware.

Single-phase regulators can be applied in grounded wye or delta configurations to cost-effectively handle three-phase applications. Regulators connected to grounded wye systems can maintain a stable voltage output with input voltage varying up to 10 percent. Delta connected regulators can maintain a stable output with input voltage varying from 10 percent (open delta) to 15 percent (closed delta). If additional regulation is needed, regulators may be placed in series. Voltage regulators, if installed with bypass/disconnect switches, may be placed into and taken out of service with no electrical interruption to the customer. Pad-mounted regulators, developed for underground and low-profile applications, feature a modular design.



Pad-mounted regulator.

## A Key Component

The application of voltage regulators is often a key component in maintaining the proper voltage in a multi-voltage system. Many times, voltage drop is too significant to be cured by the raising of the substation transformer's primary tap setting, or by the use of power factor capacitors alone; capacitors can contribute to voltage improvement, but cannot correct for resistive voltage drop. The use of voltage regulators is easier and less expensive than upgrading power lines, changing the system voltage, or adding a new primary substation.



Successfully used worldwide for more than 50 years, voltage regulators ensure a voltage profile within defined limits under varying loads and cost-effectively provide both the utility and its customers with reliable, quality electric power. ■