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INDUSTRIAL ELECTRONICS • FRIEND OR FOE?

**Health Care ideas for Friendlier Electronic
Equipment**

Special Tutorial - Variac & Variable Transformers

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VARIAC - VARIABLE VOLTAGE TRANSFORMERS

(Variac - Trade Mark of Power Designs, Inc.)

Variacs or Variable Voltage Transformers, although fairly common throughout industry, are not widely known or understood.

Actually, Variacs by themselves are not part of the surge, spike, transient or interference scenario, but they are often used to simulate abnormal conditions which have led to equipment operation difficulties. We feel they are an important part of the engineering effort to provide the new and improved technological marvels we all love.

Are Variacs a new device ?

Variacs have been around since the 1930's and have always been somewhat low visibility, although useful tool.

Just Where are Variacs employed?

- Many electronic service departments employ a shop variac to check out equipment at low and high operating voltages
- Engineering departments often check designs to assure new products operate with expected input power variations
- Engineering and Industrial High Current Generator control
- Quality control testing, electronic equipment burn-in and life-tests often utilize variacs in the testing procedures
- Temperature and lighting control, widely used in the early days, are still variac controlled to a limited extent
- Hot wire plastic foam cutting operation control
- Industrial motor speed control

What do Variacs / Variable Transformers look like?

Here are a couple photos of low powered units



Bench Top Model

Device similar to this might typically be used in Service Shops and Engineering Designs Labs.

Unit plugs into normal 120 Volt wall socket. Controlled device would be plugged into Case socket. Off-the-shelf units designed for 240 Volt input / output are available. Custom units with virtually any voltage and input/output connector are routinely designed by Electronic Specialists.

Voltage at socket can usually be internally set to provide an adjustment range from 0 to Input Voltage
or
0 to 15% above Input Voltage

Panel Mount Model

Device like this may be used for small motor speed adjustment, light control or other controller application

This unit would normally be mounted behind an instrument or product panel, with only the knob and dial plate protruding

It is quite possible you have adjusted variacs many times in the past without any realization of what type control was being adjusted

These look quite small; What is maximum size?

Rating of the Bench Top unit shown is 125 Volts input / 140 Volts output at 15 Amps, while the panel mount is 240 volts input, with selection up to 280 Volts output. Panel mount unit shown above has an operating current rating of 3.5 amps.

Variable Transformers are available up to 480 Volts 3-phase at over 300 Amps, obviously considerably larger than units shown in the photos.

3-Phase variable transformers are available in 2 gang "open delta" configuration for controlling output voltage of "delta" 3-phase voltage sources and in 3-gang "wye" assemblies to control 3-phase "wye" voltages.

Single Phase and 3-Phase models are also available for 400 Hz operation.

When combined with a voltage regulator, a well regulated, wide range AC source can be achieved.

Isolation transformer/variatic combinations are employed to "isolate" sensitive

equipment from AC power Line electrical noise and interference, while providing variable voltage capabilities.

In engineering and equipment service environments isolation transformers are often combined with Variable Transformers to provide the ultimate in versatility and personnel safety.

Motor driven variable transformers are available for remote voltage control.

Servo driven units are employed as precise voltage regulators, capable of holding 1% accuracy over limited output voltage range and 2% accuracy over full range operation

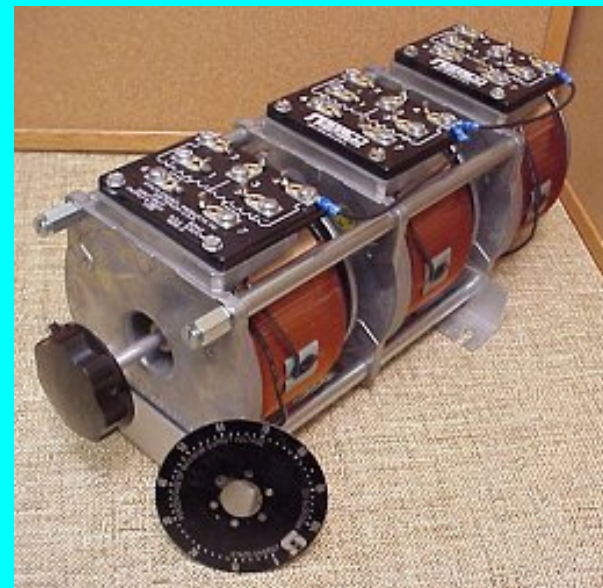
What about 3-Phase Variable Transformers?

3-Phase Variable Transformers

- Precise, continuous voltage control
- 50, 60 & 400 Hz Models available
- Bench-Top and Panel-Mount Models
- Motorized Models can be factory ordered
- Autotransformer design gives voltage boost



Typical Bench Top
3-Phase Model



Panel Mount 3-Phase Wye

Most Variable Transformers offered by Electronic Specialists are available in delta or wye 3-Phase configuration.

How are Variable Transformers & Variacs constructed?

At the heart of a Variable Transformer is the toroidal (doughnut shaped) magnet steel

core.

A single layer of enameled covered magnet wire is tightly wound upon the core. Each end of the winding is securely fastened and the entire winding is lacquered locking the winding to the core.

After final finishing, a track is carefully machined around the toroid periphery. A carbon brush is positioned to be rotated around this track, bringing variable output voltage to a separate terminal.

Most variable transformers are used as "auto-transformers" permitting units to be wired in a configuration yielding a higher voltage out than applied as input voltage. Typically, the increased voltage is 15% above the applied voltage; where output can be varied between 0 Volts and 15% above the Input voltage.

Of course, the variable transformer can also be configured to provide variable output from 0 Volts to input Voltage.

In some cases, input voltage is applied more than 15% lower than the maximum turns, providing an even greater step-up output voltage. This is very attractive if one needs to step up 120 volts to 280 volts or more. A 240 Volt variable transformer can be employed to achieve 280 volts from 120, while a 480 volt transformer can be configured to provide approximately 560 volts from a 120 volt input.

Maximum output current is reduced when variable transformers are operated as voltage doubler, tripler or quadrupler. In general, for a 120 volt input, maximum rated current can be drawn up to about 140 volts output. In a doubler arrangement (280 volts output) maximum current should be held to about 45% of rated current, While for a tripler configuration, maximum current at maximum voltage should not exceed 30% rated current and for a quadrupler current load should not exceed 20% rated current.

Power Line Frequency

By far, the greatest number of variable transformers are utilized for use with commercial power, either 50 or 60 Hz. However, 400 Hz is often used in aircraft and ship applications because generators and transformers are considerably smaller and lighter for a given amount of power.

We have 400 Hz variac models [available](#) to supply needed control at these frequencies.

Development laboratories and Test/Repair facilities will often require a variable transformer that can be used for 50/60 Hz and 400 Hz. We have developed a [Cross Reference Chart](#) to show suitability of various models for multiple frequency operation

Variable Voltage Isolation Transformers and Voltage Regulators

A variac combined with the isolation transformer or ferroresonant voltage regulator can be used for any of the engineering, testing or control functions described above. Although custom designs are commonly requested, variable voltage isolation transformers and voltage regulators usually revolve around our 125 Volt and 250 volt designs. Check here for more information on [variable voltage](#) isolation transformers and voltage regulators. Or, Contact the factory with your requirements.



Variac controlled Variable Voltage Isolation transformers and voltage regulators are similar in appearance

Dial normally indicates % of available output voltage.

Units normally come equipped with 4 sockets, but this was a special design - the customer specified output voltage to be accessed via an internal terminal board

This brief overview was presented to acquaint you with variable voltage transformers. Over 50 years old, the Variac was at the cutting edge when introduced. It is still often incorporated into some present day equipment. And it is widely employed in test equipment used for putting today's cutting edge stuff through its paces.

3-Phase models, both wye and delta, are available for a wide voltage and operating current range.

Cyber travel to [this page](#) for more Variac information

Special Variable Transformer Tutorial Page

Although part of our regular tutorial series, this page is offered as a Stand Alone Variable Transformer / Variac Tutorial to accommodate the many request we have had for basic information on the subject.

You are invited to subscribe to our **Free** Tutorial (**\$400 Value**) series. [Sign up HERE](#) for over 20 insightful, practical segments designed to help you get maximum service from your Hi-Tech equipment

Learn more about Variable Transformer products we offer -

Click here for [Variacs](#)

Click here for [Variable Voltage Isolation Transformers and Voltage Regulators](#)

Click here for [3-Phase Variable Transformers](#)

Click here for [400 Hz Variac Models](#)

Click here for [50 / 60 / 400 Hz Multiple Frequency capable variable transformer cross reference](#)

Click here for [Stepper Motor Voltage Regulators](#)

And here for [Packaged Stepper Motor Voltage Regulators](#)

Also, our FAQ pages discuss a wide range of practical problems and solutions based upon countless hours I have spent beating spikes, transients, surges and interference into submission. [Check 'em out!](#)

Useful Application Notes will help identify problems and solutions. [Take a look](#)

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