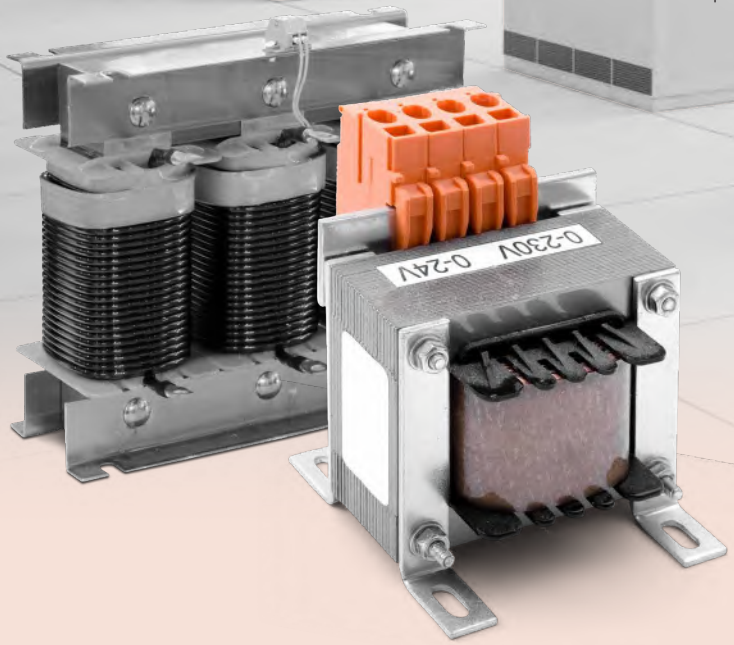
Control Transformers

The step-down system of power grids is what makes transformers so critical from generation to distribution, to power industrial and commercial equipment, and ultimately to light the lights that the world relies upon. In many cases we lose site of the seemingly insignificant control transformer as we pay attention to the big brother of the transformer family, both fluid filled and dry type.

But control transformers have their own important part to play. Control transformers are transformers that are used to step down the voltage to power the control devices of a circuit or machine, considering that the reduced voltage provides a much safer environment for technicians working on or around the equipment.

They are also referred to as industrial control transformers, control power transformers, machine tool transformers and isolation transformers, providing much needed voltage regulation where they are designed to produce a high level of secondary voltage stability during brief periods of overload condition, typically known as inrush current.

Alan Ross, CRL, CMRP, is the Technical Director of APC Media and the Editor in Chief and Chair of the Technical Advisors Board of Transformer Technology magazine. Alan has decades of experience in the power systems industry and is one of the greatest reliability experts out there.



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Additionally, control transformers are used to reduce or eliminate harmonics or transients – power quality issues that can have a significantly negative affect on solid state production equipment, an ever-increasing evolution within the move to "everything digital".

Growing Demand – Growing Criticality

A recent marketing report indicated that "the industrial control transformer market is expected to grow at a CAGR of around 3.5% over the next decade. Factors such as the increasing number of industries (such as chemical, and metal and mining), and the demand to reduce equipment failure on account of frequent voltage fluctuations are likely to drive the market, especially in the emerging economies. However, due to the outbreak of COVID-19, slow down, or delay of different industrial projects are likely to hinder the market growth during the forecast period."

Now that the effects of Covid seem to be waning, will we see a rebounding effect, where the actual growth rate for the next few years will rebound beyond 3.5%? It is more likely to happen than not to happen.

Applications

Control transformers are most often used in an electronic circuit that requires constant voltage or constant current with a low power or volt-amp rating when power quality issues impact the circuit whether due to harmonics or transients. Capacitors are also used to minimize the variations in the output.

Where electromagnetic devices like solenoid switches or relays are used, especially in industrial applications, the control transformer maximizes inrush capability and output voltage regulation when electromagnetic devices are initially energized.

Control transformers utilize high-quality insulating materials to insulate turn-to-turn windings; layer-to-layer windings, primary-to-secondary windings; and for grounding. Control transformers are vacuum impregnated with VT polyester resin and oven-cured, which seals the surface and eliminates moisture. The resin creates a strong mechanical bond and offers protection from the environment.

Specification

For proper control transformer specification, three characteristics of the load circuit must be determined in addition to the minimum voltage required to operate the circuit.

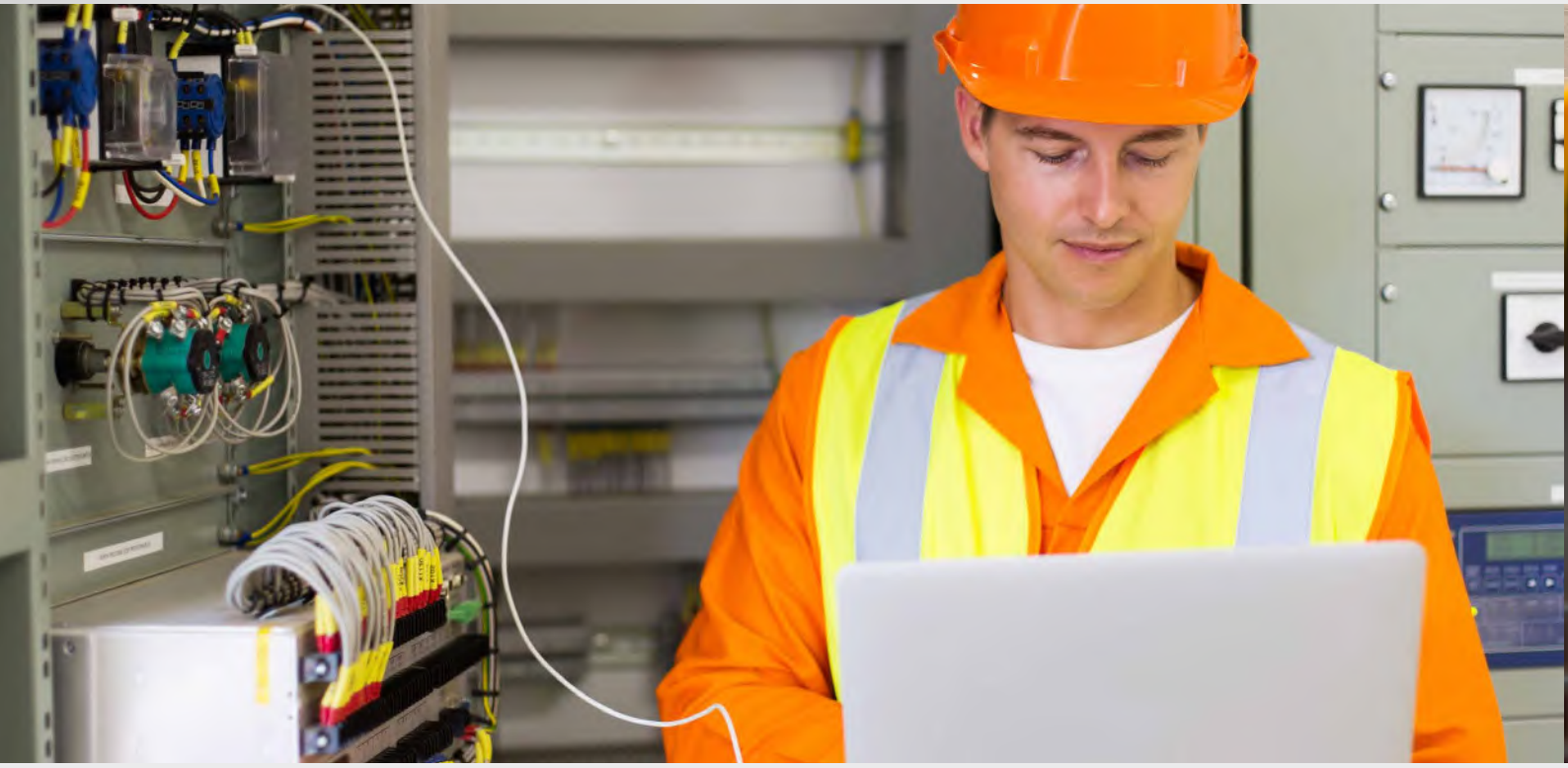
These are total steady-state (sealed) VA, total inrush VA, and inrush load power factor as follows:

- Total steady-state (sealed) VA is the volt-amperes that the transformer must deliver to the load circuit for an extended period — the amount of current required to hold the contact in the circuit.
- Total inrush VA is the volt amperes that the transformer must deliver upon initial energization of the control circuit. Energization of electromagnetic devices takes 30-50 milliseconds. During this inrush period, the electromagnetic control devices draw many times normal current — 3-10 times normal is typical.
- Inrush load power factor is difficult to determine without detailed vector analysis of all the load components. Since such an analysis is typically not feasible, a safe assumption is 40% power factor.

A great example of an isolation transformer in action is the use of power adapters for laptops since there is a difference between the voltage levels supplied to homes and the lower voltage levels required by the laptop itself.

The concept of inrush current can be seen in heavy electricity-powered machinery when the start button is pushed to power a high-voltage motor and the contactor coil is energized. The overload condition is handled far more efficiently by control transformers than a conventional supply, making them efficient power supplies that can be safely used by workers that use start and stop buttons in dangerous work environments.

The control transformer, like the ordinary transformer,



Instrument Transformers

Another type of control transformer is the instrument transformer, which is a general term applied to current and voltage devices used to change currents and voltages from one magnitude to another or to perform an isolating function: to isolate the utilization current or voltage from the supply voltage for the safety of both the operator and the end device in use.

Instrument transformers are designed specifically for use with electrical equipment falling into the broad category of devices commonly called instruments such as voltmeters, ammeters, watt-meters, watt-hour meters, protection relays, and more.
Instrument transformers are an important and essential component for safe and efficient operation of transmission and grid networks. They provide accuracy and reliability for the measurement of current and voltage in secondary equipment, like meters, protection relays, bay computers and a growing number of other devices. They are also used to provide energy to protective relays. Accuracy, the degree to which instrument transformers produce a current or voltage that is proportional to the monitored value, varies among devices.

allows for the transformation of high-voltage electricity from the main circuit into a lower voltage that is used to operate the switching components within the main circuit itself.

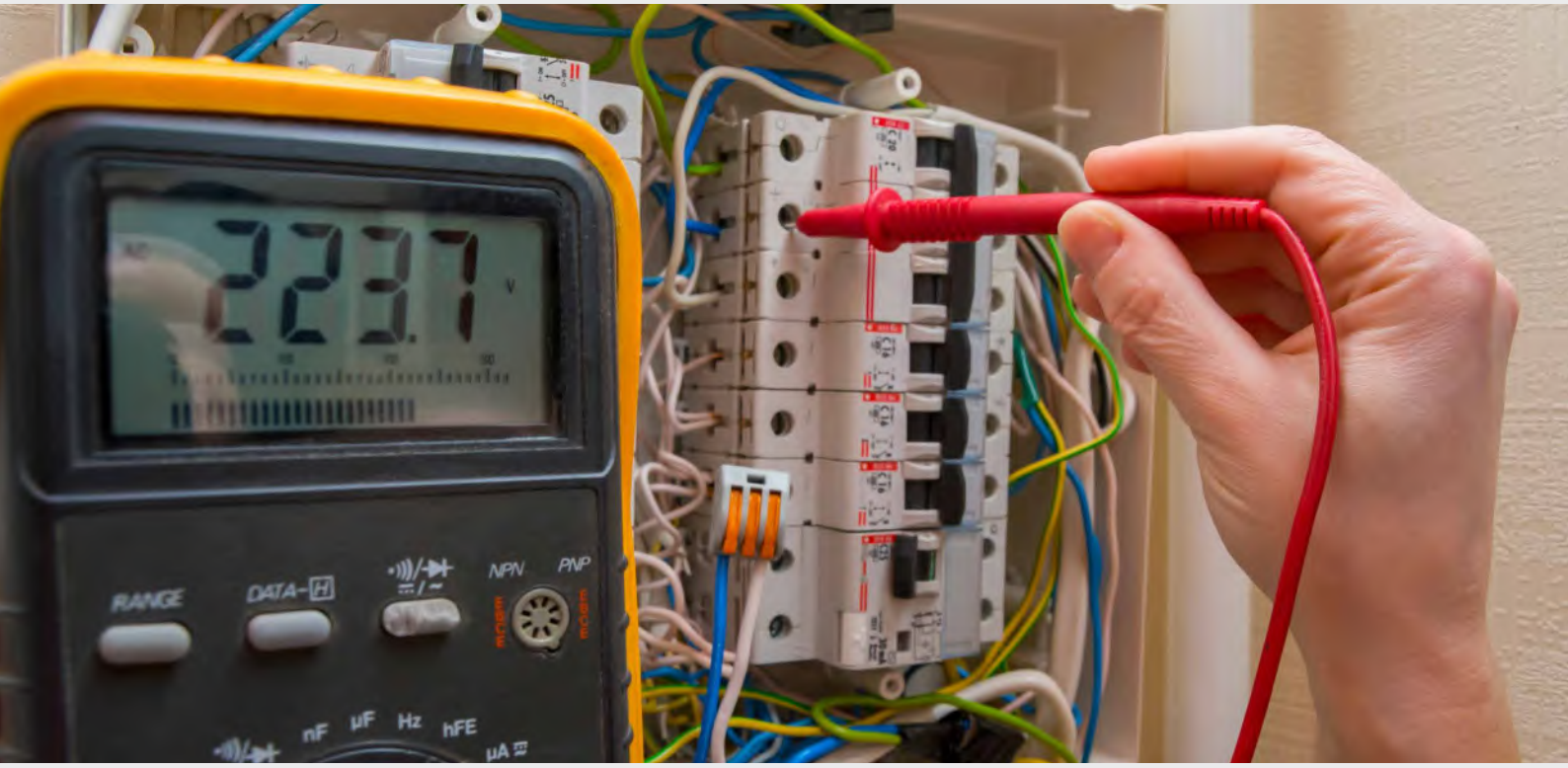
If you take a look at a machine that is powered by a 600-volt motor, the contactors used to turn the machine on and off are powered by electro-magnetic coils that operate at voltages that are far lower. In other words, the voltage coming from the main circuit can't be used in the control circuit. The typical solution would be to install more bus bars or run separate cables through a separate power feed, but anyone with experience will tell you that this option is impractical.

Likewise, it is unsafe to have high voltage electricity flowing through tightly packed wiring with a control panel. The easier and more effective solution is to keep the main circuit voltage and pass it through a control transformer that can then provide the control circuit with the appropriate amount of voltage.

Control transformers are typically more expensive as they tend to use insulating materials of the highest quality.

For example, some brands sell control transformers that are oven-cured and impregnated with vinyl toluene polyester resin, which allows for the elimination of moisture while keeping the surface sealed and protected from environmental damage.

Most control transformers are sold in a variety of forms, being classified by secondary – 240 primary & secondary, and 480 primary & secondary are just a sample of the variety that is currently available on the market. These transformers are being used in a wide variety of applications that include (but are not limited to) schools, shopping centers, apartment complexes, industrial plants and hospitals.



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Conclusion

Control transformers have many names based on their purpose, but they all allow for low control circuit voltage to be safely used in applications where high voltages are required through the supply of control power. The next time you power a heavy-duty construction machine or anything else that uses high-voltage electricity through a control panel, you will be able to see their magic in action.

The complexity of the future grid is changing as Distributed Energy Resources Management (DERM), the electrification of transportation with the adoption of EVs and efforts to bring more reliability and resilience to the system, brings the need for more and more complex controls.

Control transformers, while not considered as important as their "big brothers" – fluid filled or dry type transformers, are an increasingly important part of grid and industrial networks.