





# Automatic & Filtered Automatic Power Factor Correction Units

Designers  
and  
Manufacturers  
of  
Power  
Factor  
Correction  
Equipment  
and  
Harmonic  
Filters



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**ELECTROTEKLTD**

**Electrotek Ltd. Automatic and Filtered Automatic Power Factor Correction Units** (APFCU / FAPFCU) are custom designed and manufactured to meet the specific needs of the customers' electrical distribution.

An APFCU / FAPFCU is the most accurate way to correct a system's power factor. They are ideal for distributions which have a fluctuating load, and distributions with numerous motors. An APFCU / FAPFCU is a centralized system solution, eliminating individual motor capacitors scattered throughout a facility, and their associated costly maintenance.

#### **How does an APFCU / FAPFCU work?**

An APFCU / FAPFCU works by constantly monitoring the load on a facility and connecting or disconnecting capacitive kVAR in order to maintain a preset target power factor.

The kVAR within an APFCU / FAPFCU is divided into groups, which are called steps. Each step includes capacitors, a contactor, HRC fuses, an inrush current limiter (in APFCU's) or a filtering reactor (in FAPFCU's). The brain of an APFCU / FAPFCU is the controller. It receives the plant load information from a current transformer which is located on the main busbar, determines if any changes are required to maintain the target power factor, then adjusts the number of steps connected accordingly.

#### **General Design Information**

As a standard, Electrotek Ltd. APFCU / FAPFCU's are housed in NEMA 1 enclosures, with other ratings available upon request.

Enclosures for Electrotek Ltd. APFCU / FAPFCU's are modular in design, which simplifies any future expansions to our equipment. If our standard enclosures are not suitable for a particular application, Electrotek Ltd. will design custom enclosures.

#### **Capacitors - Low Voltage Applications**

For low voltage applications, Electrotek Ltd. offers both oil impregnated and dry type capacitors, complete with discharge resistors. Both lines are manufactured by Vishay (Roederstein), in Germany.

Oil Impregnated      'Ro' series capacitor - this capacitor is mineral oil impregnated under vacuum in a seamless tubular can. These capacitors are available in voltage ratings of 525, 690 or 999, for use on 208, 480 or 600 volt distributions. This provides additional over voltage and over current protection, and makes them suitable for harmonic contaminated networks. This means an increased life expectancy.

Dry Type              'Rg' series capacitor - this capacitor is impregnated with an inert gas under vacuum in a seamless tubular can. These capacitors are available in voltage ratings of 240, 525 or 690, for use on 208, 480 or 600 volt distributions. This provides additional over voltage and over current protection, and makes them suitable for harmonic contaminated networks. This means an increased life expectancy.

Both the 'Ro' and 'Rg' series capacitors are self-healing, self-disconnecting, true 3 phase capacitors, complete with an over-pressure tear-off fuse. This means all 3 phases will disconnect safely in the case of a failure. Disconnection will result in a slight bulge to the top of the capacitor, making it obvious which capacitor is no longer in working order. The over-pressure tear-off fuse also acts as an internal fuse, providing fuse protection to 10kA. Using HRC fusing on each step eliminates the need for individual external HRC capacitor fuses.

The watt losses of the 'Ro' and 'Rg' series capacitors are very low: less than 0.25 watts per kVAR.

#### **Capacitors - Medium / High Voltage Applications**

Electrotek Ltd. also carries capacitors for applications over 1000 volts, manufactured by Vishay (Roederstein), in Germany.

The options available with the 'R' series capacitor are almost endless; single phase or three phase, with internal fusing or without internal fusing, indoor or outdoor rated, air cooled or water cooled. Although 'standard' 4160 volt capacitors are stocked in Calgary, almost everything over 1000 volts is a custom order.

### **Inrush Current Limiters**

Surge Suppression - Each step of capacitors has either an in-line choke coil (for low and medium / high voltage applications) or a pre-charge coil (for low voltage applications only) which limits inrush currents and over voltages caused by the switching of capacitors. This increases the life of the step components and prevents voltage spikes from affecting other equipment connected to the same distribution system. Inrush current limiters and pre-charge coils are substituted with reactors in filtered units.

In all Electrotek Ltd. APFCU's, inrush current limiters are included for each step. Although they are a simple device, they are an invaluable part of our package. Acting as a choke with an inductance of 6-8 mH, they significantly reduce the inrush current a capacitor would draw during switching.

### **Filtering Reactors**

Electrotek Ltd. filtering (detuning, tuning) reactors are designed specifically for each application, ensuring every customer's FAPFCU is doing the best possible job reducing system harmonics for their application. FAPFCU's can be designed and manufactured to target up to seven different tuning frequencies. In addition to the reactors being designed to protect the capacitors (and the rest of the facility), we can design to reduce harmonic distortion to meet utility or IEEE-519 guidelines.

Electrotek Ltd. provides high quality, low loss iron core reactors with taps for easy on site adjustments of filter tuning frequencies. This makes the FAPFCU flexible for future load considerations, since it can be used with many different harmonic load conditions. Thermostats provide alarms and trip the associated filter step in order to avoid damage due to prolonged over current and over temperature conditions. All reactors are sized to match the maximum continuous current overload ratings of the capacitors.

### **Contactors**

As a standard, Electrotek Ltd. uses IEC rated contactors suitable for capacitor switching (not all contactors are suitable for capacitor switching).

In our FAPFCU's, Electrotek Ltd. sizes the contactors to match the maximum rms current of the capacitors. This means contactors may be sized larger in our FAPFCU's than what they would be for an identical step size in our APFCU's, since higher currents and voltages are expected due to harmonic absorption by the filter.

### **SCR Switches**

For applications requiring high speed switching of capacitors (filtered or unfiltered) Electrotek Ltd. uses SCR switching modules suitable for an infinite amount of switching operations. SCR switching modules are used with a special controller which is designed to switch the capacitors on and off at zero crossing of the current sine wave for a completely transient free system. For more details on high speed designs see our Real Time Power Factor equipment brochure.

### **Fusing**

As a standard, all Electrotek Ltd. APFCU / FAPFCU's are supplied with HRC fusing for each step (3 per contactor). Blown fuse indication and touch safe designs are available upon request.

### **Disconnecting Means**

As a standard, the disconnecting means for Electrotek Ltd. APFCU / FAPFCU's are supplied by others and are not housed inside our enclosure. However, upon request we will include the disconnecting means in our enclosure.

### **Estamat PFC Digital Microprocessor Controller**

The Estamat PFC digital microprocessor controller is manufactured by Vishay (Roederstein), in Germany, exclusively for the purpose of controlling APFCU / FAPFCU's. The Estamat controller automatically adjusts the amount of capacitance energized based on continuous measurements of the reactive power of the system. It will maintain a power factor within 1% of the target power factor. In automatic startup mode, the controller will program itself, allowing unassisted startup.

The Estamat controller displays the individual harmonic current distortion on the main bus bar up to the 17<sup>th</sup> harmonic. It also has provisions for communications and full remote control via RS232 or RS485 Modbus RTU.

## Switching Options with the Estamat PFC Digital Microprocessor Controller

The Estamat controller is a 12 step controller with settings for linear or circular switching, as well as single or double step switching.

When each step of an APFCU / FAPFCU is equal in kVAr, the unit is described as being single step switched. For example; a 100 kVAr unit could be designed with 5\*20 kVAr steps. With each step being the same size, this switching style also incorporates circular switching. This means the first step energized is the first step de-energized. This switching method results in an extended life for all mechanical and electrical components, since there is even wear on all the capacitor steps.

When the steps of an APFCU / FAPFCU are not equal in kVAr, the unit is described as being double step switched. These units are designed with steps sized as multiples of one another. For example; a 100 kVAr unit could be designed with 1\*20 kVAr and 2\*40 kVAr steps. This is a 1:2:2 switching ratio; the unit would have 3 steps, but 5 switching increments, as it can still achieve 20, 40, 60, 80 or 100 kVAr online. This unit can also incorporate circular switching with the steps of equal kVAr size. Double step switching is particularly economical in applications where a small step size is required due to small load changes, but the total kVAr size of the bank is relatively large.

Examples of these two switching options are illustrated below, in Table 1.

	kVAr required					
	0 kVAr	20 kVAr	40 kVAr	60 kVAr	80 kVAr	100 kVAr
Single Step Switched Unit, steps on line	no steps	1*20	2*20	3*20	4*20	5*20
Double Step Switched Unit, steps on line	no steps	1*20	1*40	1*20 and 1*40	2*40	1*20 and 2*40

Table 1

In Table 1, as the load increases and the kVAr requirements slowly change from 0 kVAr to 100 kVAr, the contactors in the single step switched unit would operate a total of 5 times. The contactors in the double step switched unit would have operated 7 times. However, if the load increases and the kVAr requirements quickly change from 0 kVAr to 100 kVAr, the contactors in the single step switched unit will still operate 5 times, but the contactors in the double step switched unit will only operate 3 times.

Since the 20 kVAr step in the double step switched unit operates in a linear mode, this 20 kVAr step would require a new contactor approximately 33% sooner than the circularly switched 40 kVAr steps in the same APFCU / FAPFCU. With the double step switched unit having only 3 steps, rather than 5 in the single step switched unit, it has fewer contactors, fuses, fuse holders, inrush current limiters or filtering reactors, and possibly a smaller enclosure; resulting in a lower initial cost but could require maintenance more often.

If you think an Electrotek Ltd. APFCU / FAPFCU may benefit your facility, please contact us. Using a copy of your last 12 power bills, we can conduct a preliminary evaluation. With this we can tell you how much kVAr your facility requires, and your resulting annual savings. This is a no charge / no obligation service. Calculations can be done with fewer bills, if the last 12 are not available.

If the preliminary evaluation indicates an APFCU / FAPFCU is suitable for your facility, we will provide you with a complete design. **An Electrotek Ltd. solution. Your solution.**