RELIABLE SOLUTIONS in POWER ELECTRONICS

PMI

EKM-EKT SERIES

Power Management Instruments

ELECTRONIC PF CORRECTOR SYSTEMS

PMI & OES GROUP COMPANIES

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NEW GENERATION ELECTRONIC THYRISTOR CONTROLLED PF CORRECTOR SYSTEMS

Improved operating efficiency is crucial and topical subject around the world. Reduction of energy costs is regarded worldwide as one of the crucial challenges to all branches of the industry. Reactive energy is chiefly regarded as one of the causes for the consumption of unusable energy and that is why reducing reactive energy usage has traditionally been one of the simplest ways to conserve energy. Today, Conventional PF Corrector Systems are the most common solution providers to eliminate the reactive energy. However, Conventional PF Corrector Systems kick in within 5 to 10 seconds when there is a need for reactive energy correction. Such a long time interval causes overloading and significant losses on the network. Considering the sum of all losses caused by hundreds and thousands of end users, the amount of total loss reaches to intolerable levels to electrical distribution companies. This is why it has become a common practice for them to confine the end users in their reactive energy consumption and even reflecting the fines on their electrical bills for their excess usage of reactive energy. Conventional PF Corrector Systems take the current in one phase to correct other two phases. At unbalanced loads it causes capacitive penalty when the current is high and also insufficient compensation when the current is low.

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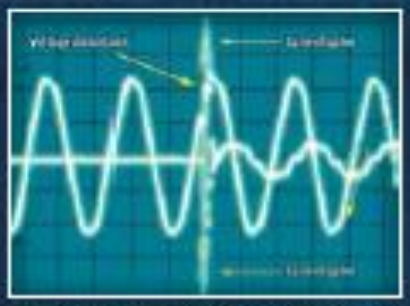
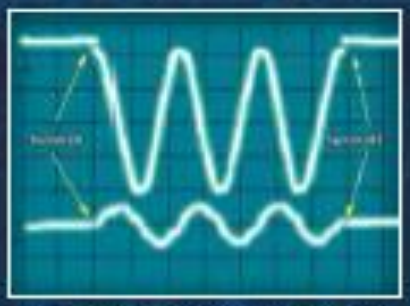
THYRISTOR CONTROLLED PFC: BENEFITS

Since current PF corrector systems make correction by activating / deactivating capacitor blocks with contactors, they cause voltage transients, arcs, spikes and electrical noises during switching. The clear-cut difference between contactor-controlled and thyristor controlled systems is shown in the osciloscope screen shots 1 and 2. When this situation is extrapolated for all industrial users, the corollary is that the mains get congested and it can give drastic damage to critical loads. This uncontrolled switching at capacitor blocks can even cause short circuit, contactor switches getting fused, and even fires. This is why hundreds of contactor switches and capacitor blocks are replaced each year.



Screen Shot 1: Capacitor Activation with Contactor



Screen Shot 2: Capacitor Activation with Thyristor

OVERALL FEATURES

- Each phase controlled independently enabling the device to handle unbalanced loads at optimum level.
- Response time is 20 msec. for fast changing loads
- Increased capacitor life with zero current switching.
- 32 step or 64 step capacitive and 2 step inductive sensitivity correction
- Semiconductor switching increases reliability.
- Periodic test of capacitors and semiconductors gives prior failure detection.
- Modular construction and easy service.
- Remote communication supervision and monitoring.
- Parallel operation with old compensation system to improve total performance.
- Easy construction with standard current transformer.
- Energy saving with unbalanced loads.
- Solves current harmonics with harmonic filters.
- No current peaks, no dangerous transients and line pollution.
- Series inductors for damping PFC capacitors.

With PMI Electronic PF Corrector Systems (EKM), switching is made through 5 thyristor - diode modules positioned at 5 arms with binary logic, which means 32-step capacitive correction. At each arm, also harmonic filters, connected serial to capacitors are used, which not only limits the current going to capacitors but also suppress the system harmonics perfectly. In some models 64-step capacitive correction is used. The performance of this new generation systems during its operation with the line is recorded to Fluke 435 Analyzer (Table 1 and Table 2). Unbalances or distortions are eliminated by the separate correction of each phase.

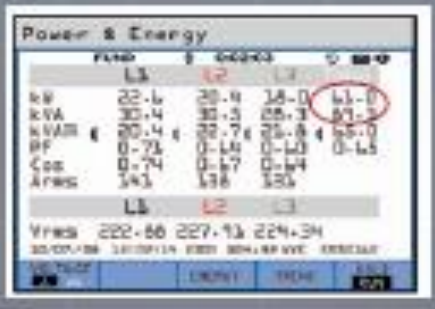


Table 1: Electronic PF Corrector System is OFF

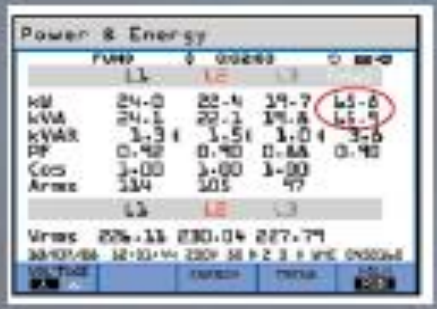


Table 2: Electronic PF Corrector System is ON

As can be observed in Tables 1 and 2, while the active total power is steady (61 kW – 65 kW), total active and reactive power drops significantly to prevent the overloading at mains and transformers.

CUTTING EDGE TECHNOLOGY

Thyristor controlled three phase electronic PF corrector with 32 step and 64 step sensitivity

New generation Electronic PF Corrector Module (EKM) and Electronic PF Corrector Three Phase (EKT) are designed in such a way that they completely eradicates the energy losses caused by classical PF Corrector systems.

32 & 64 Step

at 5 Arms/6 Arms with Binary Logic

The 5 arms are switched via thyristor-diode modules with binary logic, thus the resulting step value is calculated to be $2^5 = 32$. For example, when the capacitor value at first arm starts with 200 uF (4 kvar), the value at the final arm would be 3200 uf (64 kvar) and the resulting total capacity of the module becomes 124 kvar (4+8+16+32+64) with 4 kvar sensitivity. To match 75 kvar need, 1.,2. and 5. arms are switched and the 76 kvar monophase capacitor is activated.
6 arms are used in higher powers for 2^6=64 step correction and better sensivity.

HARMONIC SUPPRESSION

At each arm, installed harmonic filters (being serial to capacitors) not only limit the current going to capacitors but also suppress the system harmonics and the resulting harmonics of fast switching perfectly.

SEPARATE CORRECTION OF EACH PHASE (EKM) – CAPACITIVE AND INDUCTIVE CORRECTION WITH 20 MSEC. CORRECTION SPEED (EKM-EKT)

Load unbalances among phases are perfectly eliminated with separate correction of each phase. The number of activated capacitors is limited to the actual requirement at each phase. Capacitive reactive load correction is also maintained at each phase with a similar logic. Added reactor to sixth arm can also be set in motion via thyristor module if inductive kvar is needed.

LONGER COMPONENT LIFE WITH ZERO CURRENT SWITCHING

Zero current switching of thyristor diode modules enables the current at capacitors to increase gradually, starting from zero to maximum level, which in turn prolongs the overall lifetime of capacitors significantly. In addition, the current is also limited thanks to harmonic filters that are connected serial to capacitors.

MODULAR ARCHITECTURE, EASY INSTALLATION

Thanks to its modular configuration, modules can be connected in parallel to EKM and EKT series when there is a need for capacity increase, bringing lower investment cost for the long term. Its configuration is with wiring to current modules and bars only. In case of a failure with one of the modules, the other two continue to operate with no disruption.

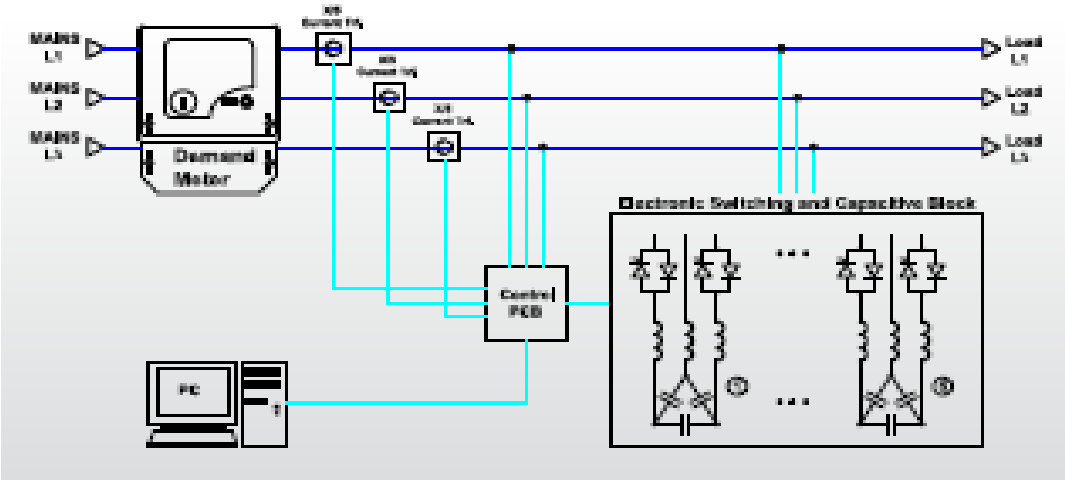
PARALLEL OPERATION

The system can work in parallel up to 4 units. This allows us to increase the power and allow redundancy. In addition to that when the system comprises fast changing loads with stable ones, EKM module working in parallel with the conventional system would be the best solution to correct the changing load.

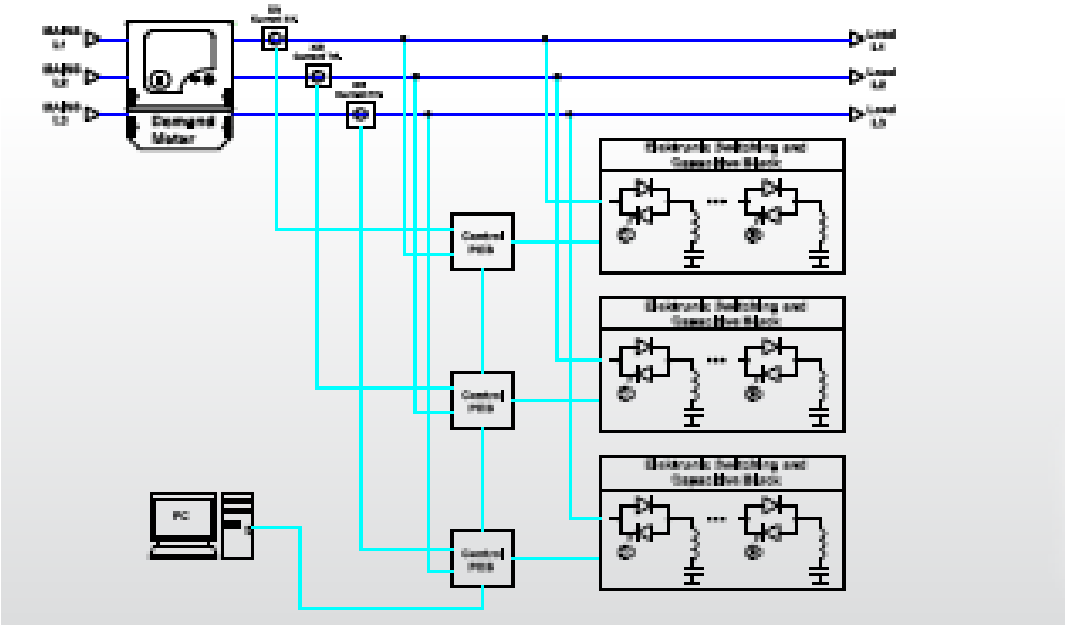
NETWORK ANALYZER AND EASY CONTROL

All energy parameters (i.e. cosφ, PF, KVAR, KVA, kW...) can be observed and tracked via LCD panel. In addition all parameters can be monitored and reported via remote communication interface through RS232, RS485, TCP/IP, Modbus and Profibus.

EKT SERIES - SINGLE PHASE CONTROL PFC



EKM SERIES - INDEPENDENT PHASE CONTROL PFC



ELECTRONIC PF CORRECTOR MODULE (EKKM)

UNIQUE SOLUTION for ELECTRIC PANEL APPLICATIONS

- Relay and 64 Step Thyristor Block in a Single Module
- Thyristor switching technology and high speed control relay in a single module
- Three phase power control module: 64 Step sensitivity with binary logic (2^6)
- Longer component life with zero current switching
- Switching at 20 msec.
- Integrated power control relay
- Off-set setting to eradicate phase displacement caused by current transformer
- Easy service with self test
- Compact structure, easy connection
- 2 years guarantee

EKM MODULE 360 kVAR

THE OPERATION OF EKM AND EKT SERIES PF CORRECTOR SYSTEMS WITH GENERATORS

Classical pf corrector systems are widely used being directly connected to mains with no link to generator sets. The reasons for such an application are shown as;

1 – Resonance current at generator mainly caused by generator's limited output power and its higher impedance than the mains

2 – Voltage harmonics at contactor controlled pf corrector systems due to uncontrolled switching

Contrary to above, with zero current switching and harmonic filter topology, thyristor controlled EKM-EKT series electronic pf corrector systems create no distortion on generator output values and boost power factor value. Tables on the next page illustrate the active power (kW) and the power (kVA) when electronic pf corrector system is ON and OFF while connected to a generator set.

As demonstrated below, while the active power remains stable (81 kW-83 kW), the kVA value diminishes by more than 25% (116 kVA – 84 kVA). Such a significant difference can be explained by as follows;

1. Additional Power Capacity: Generator's consumed power for reactive energy (over 25%) can be used for active energy (pf corrected from 0.7), so that it will be possible to have more loads with the same generator set.

2. Energy Saving: Since the reactive power is eliminated, the current at mains will decrease at the same rate, which will bring savings on energy usage.

3. More efficient Operation of the Generator Set: Thanks to the drop in phase current values, overheating of the alternator is prevented.

Electronic PF Corrector System is OFF

Electronic PF Corrector System is ON

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THYRISTOR CONTROLLED PFC CORRECTOR DATASHEET

GENERAL	
Model	EKM (Independent Phase Control) / EKT (Single Phase Control)
Monophase Powers	22,5 / 45 / 90 / 135 / 180 / 270 / 360 kVAR at 440VAC
Threephase Powers	75 / 150 / 230 / 310 / 460 / 620 kVAR at 440VAC
Operation	Diode/Thyristor: Zero Current Switching
Measurement Technique	Current level for each phase independently
Control	DS PIC controlled
Isolation Voltage	2500 VAC (Input-Input, Input-Chassis, Output-Chassis)
Harmonic Filters	Suppression at 189 Hz, %p = 7
Correction Tolerance	±2% VAR (up to 5% adjustable)
Capacitive Step	32 Steps upto 75 kVAR / 64 Steps above 150 kVAR
INPUT	
Input Voltage	220/230 VAC (1 Phase) ; 380/400 VAC (3 Phase)
Input Voltage Window	±15%
Input Frequency	50 or 60 Hz (To be specified)
Input Frequency Tolerance	±5%
Input Protections	MCB (Optional), Overvoltage and EMI-RFI Filter
Surge Protection Class	IEEE 587 (4500 A, 110 Joules)
DIGITAL FRONT PANEL	
Front Panel	2 x 16 LCD Panel, Menu Selection and Parameter Setting Buttons
Warning Messages	Line Normal/High/Low, Input Fuse Close/Open, Overtemperature, Temperature Normal, Insufficient Correction, High THD, Correction Normal, Communication Normal, System Failure/Normal, Self Test Start/Finish
Monitored Parameters	Cos FI L1/L2/L3, PF L1/L2/L3/TOTAL, Line Voltage L1/L2/L3, Apparent Power (VA) L1/L2/L3/TOTAL, Active Power (W) L1/L2/L3/TOTAL, Reactive Power (VAR) L1/L2/L3/TOTAL
Set Parameters	Capacitive / Inductive Operation, Date/Hour, Alarm Sound Level, Communication Address
Sound Alarm	For Warning Messages in each 2 sec
Communication (Option)	Remote monitoring via RS-485 Module, Parameter Setting and Event History for the last 256 Events, GSM Module (Real time failure detection and messaging)
ENVIRONMENTAL DATA	
Cooling	Forced Fans
Electrical Noise Reduction	FCC Part 15 Class B
Enclosure Protection Degree	IP20 / IP31 (Option) / IP 42 (Option)
MTFB	50000 Hours
Color	RAL 7035
Operational Temperature	-10 / +50 °C
Relative Humidity	90%
Operational Altitude	Max 2.000 Mt
Noise Level	Less than 60dB

Key Global References