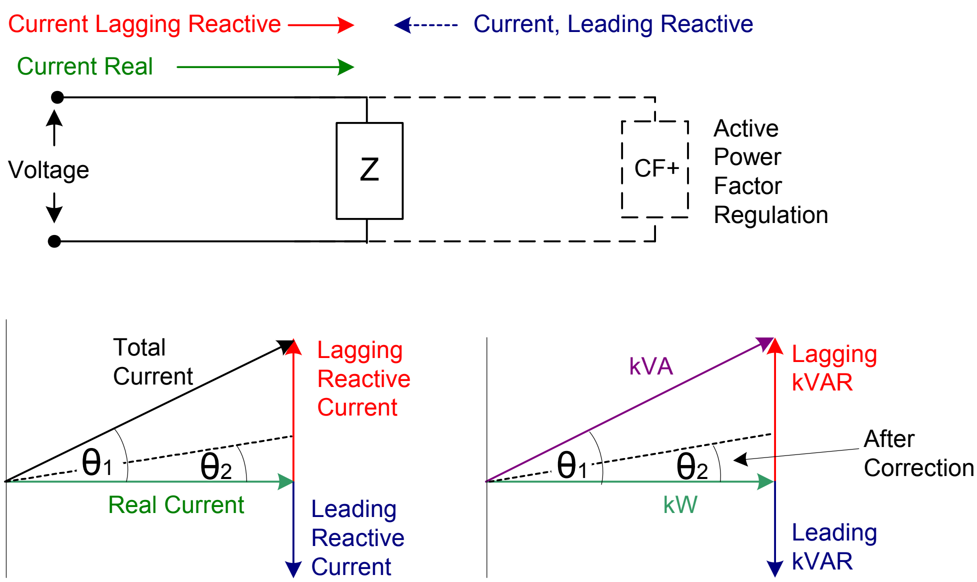
Power Factor Correction

Harmonic currents and low power factor created by non-linear loads not only result in possible power factor penalties, but also increase the power losses in a distribution system. Based on the typical demands of today's container cranes, correction of power factor alone on a quay crane can result in a reduction of system losses that converts to a 6 to 10% reduction in the monthly utility bill.

Whenever electromagnetic equipment such as transformers or electric motors are operating, the total current lags the applied voltage by a phase angle. Part of the current is reactive current, which creates the magnetic field but does not do useful work. For a phase angle of θ, the resulting Power Factor is defined as Cosine θ. A large phase angle with low power factor is undesirable for the container terminal and the utility. In addition, poor power quality impacts the economics of the terminal operation, affects reliability of the equipment, and affects other consumers served by the same utility service.

Figure 1 shows how an active device generating leading VARs reduces the phase angle and increases the power factor.



The Power Factor is Cos θ_1 before correction

The Phase Angle is θ_1 before correction and θ_2 after correction

Figure 1. Power Factor Diagram Before and After Correction

Power Factor Penalties

Many utility companies invoke penalties for low power factor. There is no industry standard followed by utility companies, but some utilities actually meter kVAR usage and establish a fixed rate times the number of kVAR-hours consumed. Other utilities monitor kVAR demands and calculate power factor.

Power Service Initial Installed Capital Investments
In power distribution system design, transformers, switchgear, feeder cables, cable reel trailing cables, collector bars, etc. must be sized based on the kVA demand. Thus cost of the equipment is directly related to the total kVA demand.

$$\text{kVA Demand} = \frac{\text{kW Demand}}{\text{Power Factor}}$$

As the relationship above indicates, a lower power factor demands higher kVA for the same kW load. In the absence of power quality corrective equipment, all the electrical equipment must be larger. Consequently, the cost of the initial power distribution system equipment for a system, which does not address power quality will most likely be higher than the same system with power quality equipment.

Equipment Reliability
Poor power quality can affect machine or equipment reliability. Harmonics, voltage transients, and voltage system sags and swells are all “Partners in Crime”. However, the effects of harmonic distortion, harmonic currents, and line notch ringing can be mitigated using specially designed filters.

Power System Adequacy
Power quality corrective actions may be dictated due to inadequacy of existing power distribution systems to which new or relocated cranes are to be connected. In other words, addition of power quality equipment may render a workable scenario on an existing power distribution system, which would otherwise be inadequate.

Those who have dealt with the design of a conventional, passive power factor correction system appreciate the difficulties. These obstacles can be overcome by the application of “Active Power Factor Regulator” systems.

The CRANE-FACTOR+ ^{TM} System

A typical CRANE-FACTOR+ power unit package is shown in Figure 2. This is an active system, located on the crane, which provides leading VARs (Volt-Amps Reactive) to the system to compensate for lagging VARs drawn by variable speed DC drives, loads, and transformers.

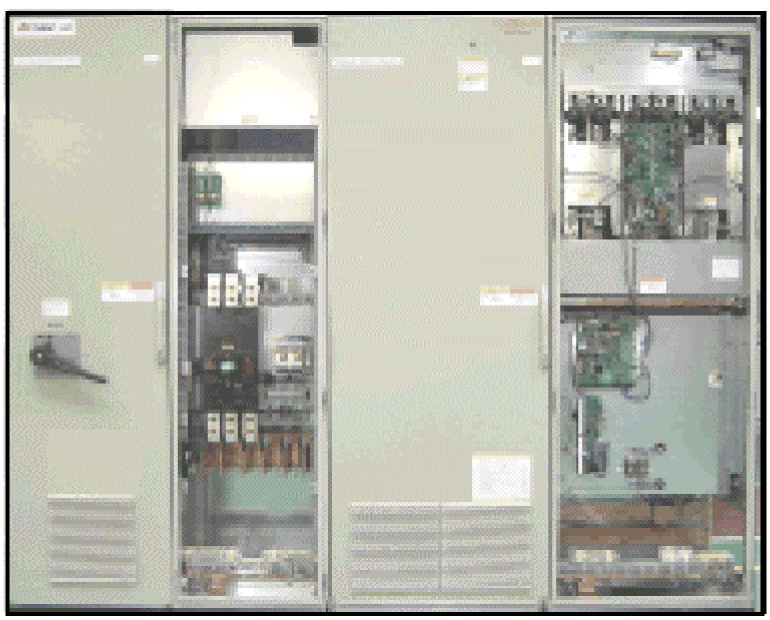


Figure 2. CRANE FACTOR+ Power Unit

Configuration

The CRANE-FACTOR+ connects to the low voltage or secondary side of the drive isolation and/or auxiliary power transformer(s) on board the crane. It utilizes a unique, zero maintenance, sealed, heat pipe cooling system for the power semi-conductor devices. The heat transfer efficiency is so high, that very little cooling air is required and there are no pumps or compressors.

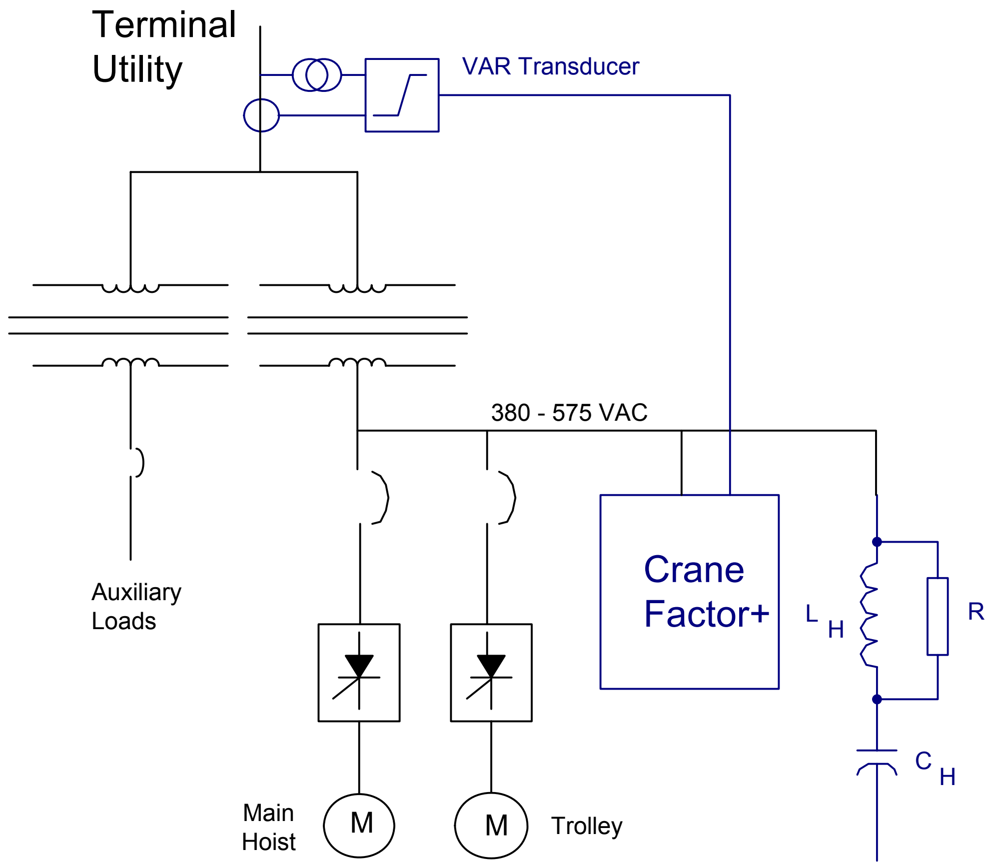


Figure 3. Simplified One-Line Diagram showing CRANE-FACTOR+ Application

End User Benefits

- **Reduction in utility billings**. Significant reduction in utility billings is the primary benefit. The typical Return on Investment is less than three years.
- **Improved power system stability and quality**. CRANE-FACTOR+ improves power system stability and quality, increasing crane reliability and decreasing downtime. Reduction in line voltage transients, sags, and swells lowers the risk of SCR commutation faults or mis-operation of auxiliary equipment.
- **True power factor regulation**. CRANE-FACTOR+ can be selected to regulate any desired lagging or leading power factor either on a 15 minute demand basis or on an instantaneous basis.

- **Precludes overcompensation during crane idle periods**. CRANE-FACTOR+ is continuously variable with load and supplies only the leading VARs required to maintain power factor based on the actual crane kVAR demands. As a result, capacitor switching devices and their related switching transients are eliminated.

TMEIC GE will be pleased to quote a CRANE FACTOR+ for your system. Contact Javier Rizo in the Material Handling business unit in Salem, Virginia at (540) 387-7357.