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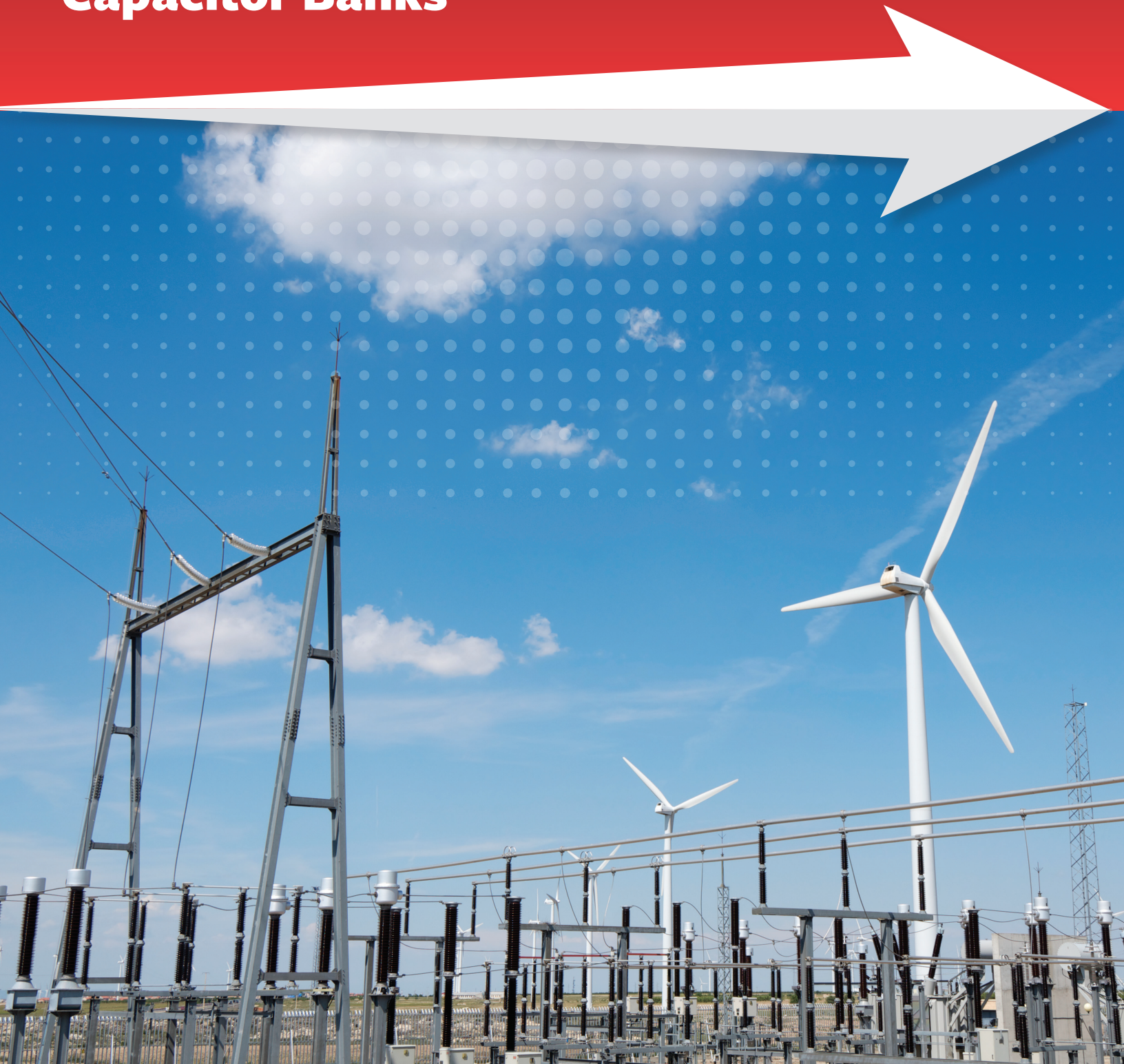
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# Medium-Voltage Metal-Enclosed Capacitor Banks



# OVERVIEW / KEY FUNCTION

**System-fit, medium-voltage metal-enclosed capacitor banks** designed to provide highly reliable reactive compensation, power factor correction, and voltage support for heavily loaded medium-voltage power systems.

Modern electrical grids and heavily loaded industrial facilities require precise reactive compensation to maintain stability and operational efficiency. VarStec's medium-voltage capacitor banks are fully integrated, custom-engineered solutions designed to deliver highly reliable power factor correction, voltage support, loss reduction, and improved voltage performance across the load cycle, while helping industrial and renewable customers meet utility power factor penalties and interconnection requirements.

Because standard equipment configurations frequently fail to account for unique site constraints, we practice true system-fit engineering. By evaluating your specific load profile and system requirements, we design a compensation strategy and deliver a fully integrated, factory-tested system complete with all switching, all protection, and all control functions. Our approach establishes technical accountability early in the project lifecycle, shifts the burden of assembly and testing away from the field, and reduces unpredictable on-site variables.

**IMAGE/S HERE TBD**

# INDUSTRY APPLICATIONS & SPECIALIZED SOLUTIONS

**Our capacitor banks** are engineered for demanding power systems where reliable reactive compensation is critical and execution risk must be minimized. Because standard catalog equipment frequently falls short in complex environments, we build solutions specifically tailored for a wide spectrum of demanding applications. For example:

- **Heavy Industrial, Mining & Manufacturing**  
Managing the fluctuating reactive power demands of large motors and cyclic loads to optimize capacity and avoid utility power factor penalties.
- **Oil, Gas & Petrochemical**  
Supporting continuous production and stable voltage profiles for pipeline pumping stations, refineries, and offshore facilities by delivering reliable reactive power on weak or remote grids.
- **Renewable Energy & Distributed Generation**  
Providing essential reactive compensation to meet grid interconnection requirements for wind, solar, and battery storage collector systems.
- **Mission-Critical Infrastructure & Data Centers**  
Supporting sensitive computing and data processing infrastructure with reactive compensation and transient-free switching technologies designed to maintain stable system voltage and minimize power quality disturbances.

- **Utility & Municipal Distribution**

Enhancing grid efficiency and voltage regulation in increasingly constrained distribution networks while supporting the modernization of legacy reactive compensation equipment with fully integrated, system-fit solutions.

- **Specialized & Complex Grids**

Meeting the demands of specialized and complex power systems through system-fit engineering led by subject matter experts who understand the electrical, physical, and operational constraints of each application.

## TECHNICAL DETAILS & ENGINEERING RIGOR

**VarStec applies uncompromising engineering rigor and practical experience** within a disciplined framework to deliver system-fit solutions aligned with the specific objectives, constraints, and operating requirements of each project.

### **Metal-Enclosed Integration (Scope)**

VarStec capacitor banks are fully compartmentalized, metal-enclosed, and ready-to-install solutions that house all switching, all protection, and all control functions within a single integrated package. This approach reduces the safety risks, delays, and variables associated with traditional open-air or field-assembled banks. Each system is engineered to seamlessly integrate with your existing infrastructure, ensuring reactive compensation and safe, reliable operation from day one.

### **Adaptive & Filter-Ready Designs**

Our capacitor banks feature adaptive, scalable configurations, including filter-ready designs that can be seamlessly upgraded to harmonic filter banks if plant expansions or changing grid conditions introduce new resonance risks.

### **Advanced Switching Integration**

Designed to incorporate advanced transient-free switching technologies to eliminate the damaging inrush currents and voltage transients that can plague sensitive site infrastructure.



# STRATEGIC BENEFITS & VALUE ENGINEERING

## Reduced Installation Risk & Faster Project Execution

VarStec capacitor banks are delivered as fully integrated, factory-assembled systems that reduce field assembly, simplify interconnection, and shift critical integration and testing work away from the job site. This shortens installation schedules, reduces startup uncertainty, and improves overall project execution.

## Safer, More Maintainable Metal-Enclosed Construction

Fully compartmentalized metal-enclosed construction provides a higher level of personnel protection, environmental protection, and maintainability than traditional open-air approaches. Ground-level access to key components, combined with integrated isolation and protection provisions, supports safer inspection, maintenance, and long-term operation.

## System-Fit Performance for Real-World Power Systems

Every VarStec capacitor bank is engineered around the electrical, physical, and operational realities of the application. Instead of forcing the site to accept a catalog configuration, VarStec delivers a system-fit solution aligned with the customer's voltage profile, load behavior, switching duty, protection philosophy, and future expansion needs.

## Lower Lifecycle Cost Through Reliability & Serviceability

By integrating proven components within a coordinated, factory-tested design, VarStec helps reduce unplanned outages, maintenance complexity, and premature component failure. The result is a more reliable reactive compensation system with better long-term serviceability and lower total cost of ownership.

## Improved Power System Performance

VarStec capacitor banks help improve power factor, support system voltage, reduce losses, release usable system capacity, and minimize exposure to utility penalties. For heavily loaded industrial and utility systems, these benefits translate into stronger electrical performance and more efficient use of existing infrastructure.

## Direct Access to Senior Technical Leadership

VarStec customers gain direct access to senior technical leadership with decades of hands-on experience in the design, manufacture, application, and commissioning of medium-voltage capacitor banks and harmonic filter systems. This depth of expertise helps identify issues early, avoid misapplication, reduce execution risk, and deliver a more reliable system-fit solution aligned with the realities of the site.

# RATINGS, CONFIGURATION & OPTIONS SYSTEM-FIT TO SPECIFICATIONS

## Electrical Ratings & Configuration

- **Capacitor Bank Type:** Fixed | single-stage | multiple-stage | filter-ready
- **Capacitor Connection:** Single-wye ungrounded | single-wye grounded | split-wye ungrounded | delta
- **Operating Voltage (L-L):** 2.4 kV to 38 kV
- **Maximum Operating Voltage:** +10%
- **Operating Frequency:** 50 Hz | 60 Hz
- **Reactive Power Output:** 1 MVAR to 100+ MVAR
- **Number of Stages / Steps:** As specified
- **Reactive Power per Step:** As specified
- **Short-Circuit Rating (Asymmetrical Momentary):** 16 kA to 61 kA
- **Impulse Withstand Voltage (BIL):** 60 kV to 200 kV
- **Short-Time Withstand Voltage (1 minute):** 19 kV to 105 kV
- **Control Voltage:** 120 VAC | 125 VDC | 220 VAC | Other

## Switching, Protection & Control

- **Control Mode:** Fixed | manual | SCADA | remote | automatically switched
- **Switching Devices:** Vacuum contactor | vacuum switch | C2-rated breaker | transient-free switching device
- **Controllers:** Major industry manufacturers supported
- **Automatic Functions:** Power factor control | kvar control | voltage control | time scheduling
- **Disconnecting Means:** Incoming air disconnect switch | Incoming draw out breaker | none
- **Ground Switch:** 3-pole incoming | 4-pole capacitor grounding | none
- **Protection Functions:** Overcurrent | overvoltage | unbalance | neutral voltage, split-wye neutral current | direct-fuse sensing | fuse-failure detection | VTHD | ITHD | over-temperature | other
- **Branch / Stage Fusing:** As specified
- **Incoming Fuses:** As specified

- **Capacitor Fusing:** Externally fused | internally fused
- **Unbalance / Blown Fuse Detection:** Neutral voltage | split-wye neutral current | unbalance transformer | Direct Fuse Sensing | other approved methods
- **Instrument Transformers / Sensors:** CTs | PTs/VTs | CPTs | neutral current sensors | line-post current sensors | unbalance transformers
- **Protection Relays:** Major industry manufacturers supported
- **Interlocks:** Mechanical | electrical | key

## Communications & Integration

- **Communication Protocols:** Modbus RTU | Modbus TCP | DNP3 | IEC 61850 | IEC 60870-5-103/101/104 | Ethernet/IP | SEL-specific legacy protocols | SNTP | IEEE 1588 PTP | RSTP | FTP | Telnet
- **Network Media:** Copper | fiber | managed Ethernet | redundant Ethernet | protocol conversion
- **Local Interface:** Control switches | annunciation | metering display | HMI | SCADA interface
- **Remote Monitoring:** Alarm reporting | event recording | waveform capture | remote engineering access
- **Utility / Plant Integration:** Coordination with utility interlocks | feeder relaying | plant control systems | substation automation architecture

## Power Components & Accessories

- **Control Power Transformer (CPT):** As specified
- **CT's/Current Sensors:** As specified
- **Capacitor Units:** As specified, by Hitachi Energy, Eaton, GE
- **Transient Inrush Reactors:** As required for back-to-back or multi-stage switching duty
- **Current-Limiting Oustrush Reactors:** As specified
- **Detuning:** As specified
- **Surge Arresters:** Station-class | distribution-class
- **Power Fuses:** Current-limiting, by SIBA

# RATINGS, CONFIGURATION & OPTIONS SYSTEM-FIT TO SPECIFICATIONS (CONT'D)

## Connections & Construction

- **Incoming Connections:** Roof bushings | bus duct | cable entry through bottom, top, side, or rear
- **Terminal Style:** Cable lugs | bus pads | custom terminations
- **Enclosure Type:** NEMA 1 | 3R | 4X | 12 | or IP equivalent
- **Service Location:** Indoor | outdoor
- **Sheet Metal:** 11-gauge cold-rolled galvanized steel standard | 12-gauge 304, 316, or 409 stainless steel for corrosive environments
- **Enclosure Construction:** Compartmentalized metal-enclosed construction
- **Internal Enclosure Compartments:** Incoming | main fuse | capacitor | control
- **Structural Construction:** All-welded construction with structural steel for base and all major components
- **Coating System:** High-solid epoxy siloxane marine coating with 5,500-hour salt-spray resistance | other as specified
- **Color:** ANSI 61 | ANSI 70 | Munsell 7GY 3.29/1.5 | customer-specified
- **Doors & Access:** Hinged, 3-Point latching, gasketed, pad lockable
- **Lifting Provisions:** Removable lifting plates at base

## Environmental & Site Conditions

- **Operating Temperature Range:** -50°C to +55°C (-58°F to +131°F)
- **Maximum Altitude Without De-Rating:** Up to 1,000 m (3,300 ft), or higher with VarStec surge arrester mitigation and insulation coordination
- **Humidity:** As specified
- **Pollution Level / Contamination Severity:** As specified
- **Bushing Creepage Distance:** As specified for site conditions

- **Wind Load:** As specified
- **Seismic Qualification:** As specified, up to Zone 4
- **Corrosion Environment:** Standard industrial | coastal | chemical | other

## Thermal Management & Safety

- **Cooling / Heating:** Exhaust fans | strip heaters | unitized air conditioning | hazardous-location cooling system
- **Ventilation:** Natural | fan-assisted | forced-air
- **Condensation Control:** Space heaters | thermostat | humidistat
- **Temperature Monitoring:** Compartment temperature monitoring
- **Arc-Flash Mitigation:** Passive | active

## Standards, Testing & Documentation

- **Applicable Standards:** IEEE Std 18-2012, IEEE 1036, IEEE C37.99, IEEE PES-TR16, IEEE C37.20.2, IEEE C37.20.3, IEEE C37.012, IEEE 519, IEEE C37.011, IEEE C37.010, and IEEE C37.100.2 | IEC equivalents
- **Code Compliance:** NEC Article 460 | other applicable requirements
- **Listing / Certification:** UL | NRTL | CSA | CE
- **Factory Testing:** Routine electrical and control-functional testing
- **Documentation:** Drawings, wiring diagrams, logic documents, relay settings, test reports, manuals, and startup support documentation

*\* Every metal-enclosed capacitor bank is engineered and configured to the specific electrical system, site conditions, operating philosophy, and project specification. The ratings, construction features, protection functions, and accessories listed are provided as system-fit, application-specific selections rather than fixed catalog limitations.*