

# Metal-enclosed capacitor banks



## General

Eaton's metal-enclosed capacitor banks feature the latest capacitor technology from its Cooper Power™ series product line based on over 70 years of experience in design and manufacture of power capacitors. The capacitor banks are designed to meet or exceed all applicable ANSI®, IEEE®, NEMA®, NEC®, and IEC® standards. Metal-enclosed capacitor banks from Eaton are engineered-to-order to meet customer system requirements and indoor or outdoor site conditions. Metal-enclosed banks are fully assembled and tested which significantly reduces site installation costs and time. Custom designs are available for utility, commercial, and industrial applications globally. The banks can be designed to the requirements of IEEE Std 693™-2005 for seismic conditions.

Metal-enclosed capacitor banks—the sustainable solution—improve efficiency in the power system by reducing losses from point of application to the generator, saving money and decreasing CO<sub>2</sub> emissions. Capacitor banks also improve power quality by supporting voltage and mitigating harmonic issues—when applied as harmonic filters.

Metal-enclosed banks are typically\* offered in the following ratings:

- 2.4 kV to 38.0 kV
- -50 °C to +55 °C (-58 °F to +131 °F)
- Up to 200 kV BIL
- Up to 63 kA (sym)

Metal-enclosed designs are available as single-step, multi-stepped, de-tuned, and with harmonic filtering. Compared to traditional open rack substation designs, metal-enclosed banks can provide the same benefit but within a smaller footprint.

\*Consult factory for special ratings or design considerations not included above.

**EATON**

*Powering Business Worldwide*

## Metal-enclosed capacitor bank features

Eaton's exclusive all-film, extended foil/mechanically connected capacitors provide:

- Low dielectric losses (0.05 watts/kvar)
- Superior electrical performance and reliability
- Proprietary Edisol® VI, dielectric fluid that provides the best balance between low and high ambient temperature operation

Three capacitor duty options are provided depending on the customer's application needs:

- Standard-duty capacitor
  - Meets or exceeds the requirements of IEEE Std 18™-2002 standard
  - Meets or exceeds the requirements of IEC 60871-1
  - 10 kA tank rupture curve coordination
- Heavy-duty capacitor
  - Meets or exceeds the requirements of IEEE Std 18™-2012 standard
  - Meets or exceeds the requirements of CAN/CSA-C60871-1
  - 125% continuous overvoltage capability 10 kA tank rupture curve coordination
- Extreme-duty capacitor
  - Meets all of the requirements of IEEE Std 18™-2012 standard
  - Meets all of the requirements of CAN/CSA-C60871-1
  - Meets or exceeds the requirements of IEC 60871-1, 2 for -50 °C to +55 °C
  - 125% continuous overvoltage capability
  - Eaton's exclusive 15 kA tank rupture curve coordination
  - 15% higher routine test voltages
- Internally fused capacitors
  - Meets all of the requirements of IEEE Std 18™-2012 standard
  - CLEANBREAK™ element fusing system

Construction features of Eaton's power capacitors include:

- Mechanical crimping connection system (exclusive to Eaton). Provides solderless internal connections that eliminate localized heating and cold solder joints.
- Stainless steel tank with light gray finish for resistance to severely corrosive atmospheres. Tank is finished with an epoxy primer and a urethane topcoat coating system. This system has been tested to IEEE Std C57.12.31™-2010 and the IEEE Std C57.12.29™-2005 standards.
- Light-gray, porcelain bushings are blazed for high strength and durability and hermetically sealed to the capacitor tank.

## Protection and control

Protection and control requirements are often unique to each customer and application. Eaton can provide complete protection and control systems designed to operate independently and/or integrate with the customer's protection and control scheme. Control panels can be integrated as part of the bank enclosure or provided separately for mounting inside a remote control room.

Intelligent automatic capacitor step controllers can be provided to select which steps to switch on or off to optimize system performance. Controllers can be provided to switch manually, remotely, or automatically on voltage, vars, current, temperature and time control. Remote switching can be easily integrated into advance automation schemes such as Eaton's Cooper Power series

Yukon® Integrated Volt/VAR Control Application, SCADA, Distribution Management System, or on-site DCS system.

Protection and control equipment is fully assembled, tested and can include (but not limited) to the following:

- Manual and automatic control
- Supervisory Control and Data Acquisition (SCADA)
- Protective relaying
- Annunciation panel
- Capacitor unbalance detection
- Fusing with blown fuse detection
- Coordination with upstream protective devices
- Safety interlocking
- Temperature, humidity, and condensation control
- Timers and auxiliary equipment

## Installation, maintenance and reliability

Metal-enclosed banks are fully assembled and tested at the factory before delivery to the site. Compared to typical open air racks the site preparation, engineering time, installation time, and commissioning time can be greatly reduced.

The banks are low profile and easily accessible to field maintenance crews. Performing routine maintenance is easier since heavy equipment is not required to maintain the banks and crews can access equipment from the ground.

Metal-enclosed banks are commonly used in areas where wildlife related outages is a concern, in highly corrosive or contaminated site locations or when environmental conditions are an issue. Depending on the degree of protection specified the metal enclosure can offer protection for electrical equipment from these potential hazards which increase reliability.

## Harmonic filters

In locations where harmonic producing loads are a concern metal-enclosed de-tuning or harmonic filter banks are becoming a preferred solution due to the reduced installation time and significant space savings compared to traditional open rack filters. Air core reactors are commonly used to mitigate back-to-back switching transients; however when rated for tuning, air core reactors can require large magnetic field clearances which can greatly increase the size of the enclosure.

As an alternative, iron core reactors can be used in place of air core reactors due to the high permeability of the iron core which confines the magnetic field.

## Multiple-step capacitor banks

Metal-enclosed banks can be provided as a single-step or with multiple steps for optimal flexibility. Electric systems often need versatile solutions to meet the demands of the system's requirements. Utilizing multi-step banks offer flexibility and significant space savings. Multi-step banks using different rated var steps offer even more versatility due to the different var stage combinations available.

## Enclosure

The enclosure is a self-supporting structure manufactured of 12-gauge mild steel (standard). Aluminum 304L and 316L stainless steel are available as options. Structures are typically mounted on a heavy-duty rectangular steel channel base with an open bottom for mounting on a concrete pad. Each enclosure is finished in ANSI® 70 Gray or Guardian Green conforming to Munsell 7.0GY3.29/1.5. Other colors are available upon request. The coating is tested to IEEE Std C57.12.28™-2005 standard, including ASTM B1117 1000-hour 5% salt spray corrosion test, ASTM D2247 1000-hour humidity test, ASTM G53 500-hour ultraviolet accelerated weathering test, and ASTM D2794 impact testing.

## Accessories

The following accessories can be provided and installed with the capacitor banks:

1. Protection and control equipment including instrument transformers
2. Control power transformer
3. Isolating and grounding switches
4. Switching devices/circuit breakers
5. Interlocks
6. Surge arresters
7. Reactors for current-limiting, de-tuning or harmonic filtering
8. Fusing (externally or internally fused)
9. Resistors for harmonic filtering
10. Discharge coils
11. Temperature and condensation control equipment
12. Fire Protection
13. Removable lifting eyes

## Ordering information

When ordering substation metal-enclosed banks, or when requesting proposals, please specify the following:

1. System information
  - A. Nominal operating voltage
  - B. Maximum operating voltage
  - C. System BIL
  - D. System frequency
  - E. System connection; solidly-grounded, ungrounded, etc.
  - F. Available fault current, magnitude and duration
2. Var requirements
  - A. Desired total three-phase kvar
  - B. Desired total three-phase kvar per step (multiple-step banks)
  - C. System study to be performed by Eaton (consult factory for details)
3. Capacitors
  - A. Type of duty – heavy-duty is recommended (consult factory for details)
  - B. Special requirements, if any, such as preferred voltage rating, kvar rating, number of bushings, or extra creepage
  - C. Capacitor connection; grounded-wye, ungrounded-wye, split-wye, delta
  - D. Capacitor fusing; externally fused, fuseless, internally fused
4. Enclosure construction
  - A. Color of enclosure, or non-painted
  - B. Type of enclosure, mild-carbon steel, 304SS, 316SS, aluminum; 12-gauge, mild carbon steel (standard), specify all enclosure construction requirements
  - C. Maximum or preferred enclosure dimensions
  - D. Seismic, wind, snow loading conditions
  - E. Environmental conditions, e.g. contamination, temperature, coastal, elevation
5. Accessories and miscellaneous details
  - A. See **Accessories** previously listed.
  - B. Applicable standards
6. De-tuning and harmonic filtering
  - A. Harmonic Current Spectrum and Study if available
  - B. Preferred equipment ratings if available
  - C. Desired tuning frequency
  - D. Desired effective output kvar (per step)
  - E. Number of steps

## Additional information

Refer to the following literature for application recommendations.

S230-70-1	Metal-Enclosed Capacitor Bank Installation Instructions
CA230006EN	Metal-Enclosed, Pad-Mounted Capacitor Banks
CA230003EN	Medium Voltage, Standard-Duty, Heavy-Duty, and Extreme-Duty, Single-Phase, Unfused Capacitor Units and Accessories
CA230004EN	Single-phase Internally Fused Capacitor Units
B230-14052	Meet Higher Power Quality, Efficiency, Safety and Reliability Demands

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