Instruction Manual **IM02607001E**

Effective July 2019
Supersedes May 2016

AutoVAR 600 and AutoVAR detuned filter automatically switched capacitor and filter bank installation operations and maintenance manual

Contents

Powering Business Worldwide

⚠ WARNING

FAILURE TO INSTALL THE AUTOVAR 600 IN ACCORDANCE WITH THESE INSTRUCTIONS MAY CAUSE DAMAGE TO THE EQUIPMENT AND/OR PERSONAL INJURY.

⚠ WARNING

INCOMING POWER SHOULD BE DISCONNECTED BEFORE MAKING ANY WIRING CONNECTIONS.

⚠ WARNING

AFTER ALL RIGGING, SETTING, AND WIRING HAS BEEN COMPLETED AND BEFORE THE POWER TO THE AUTOVAR IS ENERGIZED, THE INTERIOR OF THE UNIT SHOULD BE CLEARED OF ANY METAL EQUIPMENT, METAL SHAVINGS, TOOLS, AND OTHER DEBRIS.

⚠ WARNING

WHEN THE FRONT DOOR IS OPENED WITH THE MAIN DISCONNECTS CLOSED, THE MAIN POWER BUSBARS, CAPACITOR FUSES, CAPACITOR CONTACTOR LINE SIDE, AND CONTROL TRANSFORMER FUSES ARE ENERGIZED AT LINE VOLTAGE. ONLY QUALIFIED PERSONNEL SHOULD HAVE ACCESS TO THE CABINET INTERIOR.

⚠ WARNING

AFTER DE-ENERGIZING THE UNIT, WAIT FIVE MINUTES BEFORE OPENING THE FRONT DOOR.

Installation overview

The installation of the AutoVAR consists of the following steps:

1. Setting the cabinet(s) in place.
2. Connecting the assembly to the electrical system.
3. Installing the current transformer on the system (checking CT polarity) and terminating secondary in the unit.
4. Programming the controller.
5. Starting and ensuring proper operation.

Handling and installation instructions for low-voltage switched capacitor banks

General

The following handling and installation instructions are intended to help customers install the low-voltage switched capacitor banks properly and efficiently. Handling and installation instructions are only recommendations. They do not relieve the purchaser, customer, installer, or contractor from full responsibility for proper inspection, handling, and installation. Failure by the customer to comply with handling or installation instructions will void the capacitor bank warranty.

Inspection

At the time of delivery, the customer shall be responsible for inspecting all sections of the equipment for damage during transit. Both the inside and outside of the equipment must be inspected. If any damage has occurred, it should be noted on the delivery receipt prior to signing acceptance. If damage has occurred, a claim should be immediately filed by the customer with the delivering carrier. Minor paint scratch or minor dent can be touched up or repaired at the site.

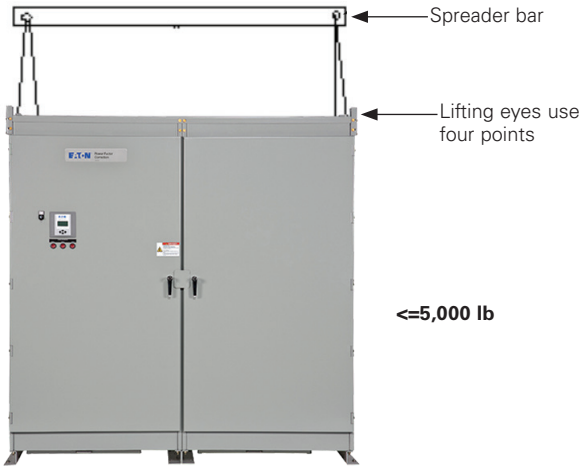
Moving

1. Shipping pallets can be moved using fork lifts on both ends of the wood pallet. Do not use fork lift if the equipment has been un-mounted from the wood pallet.

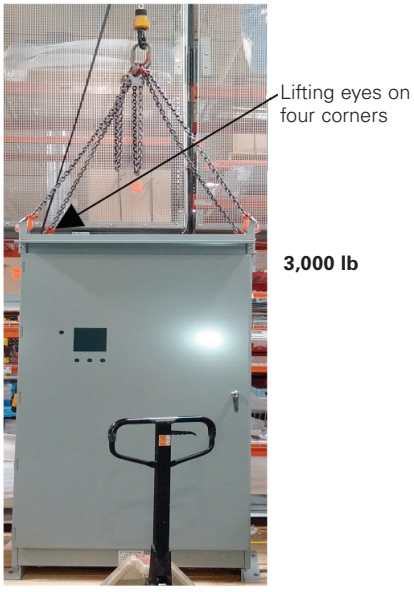
2. Do not drop the equipment.
3. Do not allow hard impact from tools and handling equipment.
4. Never use cables or chains around the equipment.
5. Never fork lift equipment without the wood pallet.
6. Keep equipment upright. Do not tilt or invert the equipment.
7. Use of rollers to allow equipment to roll on base channel is permitted.
8. Weights shown on drawings are estimated weights. Refer to shipping papers for actual weights of shipping sections.

Lifting

1. For 78-inch-wide shipping sections (KK or double door enclosures) weighing up to 5,000 lb (2270 kg), use all four lifting eyes to lift the shipping section as shown below. The use of a spreader bar is required to avoid equipment damage.



2. For 39-inch-wide shipping section (L or single door enclosures) weighing up to 3,000 lb (1,360 kg), use lines attached to all four lifting eyes to move equipment.



Installation

1. The equipment requires a concrete slab for continuous bottom support.
2. Locate and line-up all sections as shown on the equipment drawing. For units shipped in split sections, locate and install the provided conduit interconnecting section.
3. Once the conduit and interconnection is completed, anchor the base channel to the concrete slab with anchor bolts and hold-down hardware. Anchor bolts and hold-down hardware are to be supplied by the customer.
4. The customer can use either external anchor clips or use the holes provided in base channel to anchor this equipment.

Storage and handling instructions for low-voltage PFC

AutoVAR units are shipped on pallets and are provided with lifting eyes.

All PFC units must be stored upright.

Short-term storage

If a capacitor unit is not energized for up to three months, store it in a climate-controlled environment with adequate air circulation so that it is protected from dirt, air born contaminants, moisture/humidity, water, and chemicals. The storage temperatures should be from –40 °C (–40 °F) to +55 °C (+131 °F). The environment humidity should be less than 70%.

If the storage area is cool and/or damp, space heaters should be provided to prevent condensation inside the automatic capacitor bank.

Evaluate and if necessary replace the dust/air filter.

Long-term storage

Store the equipment in a dry, ventilated location protected from dirt, air born contaminants, moisture/humidity, water, and chemicals. The storage temperatures should be from 0 °C (32 °F) to 40 °C (104 °F). The environment humidity should be less than 70%.

Stored equipment could be protected by a water-resistant cover such as a tarp or plastic, providing effective protection against dust, dirt, and water, etc., taking care as to not impede the natural ventilation.

Putting a capacitor bank into service after a prolonged storage requires that the unit be subjected to INSULATION RESISTANCE AND CAPACITANCE measurements. Note: INSULATION RESISTANCE SHOULD ONLY BE PERFORMED BETWEEN TERMINAL AND GROUND. Ensure the control power fuses are disconnected/isolated during and from the test. The test readings should be at least 200 Mohm or greater. If the value is found to be lesser, take steps to trace and eliminate moisture from the unit.

Evaluate and, if necessary, clean or replace the dust/air filter.

After short-term and long-term storage

Follow instructions of individual components such as circuit breakers.

For circuit breakers

Remove dust, dirt, soil, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. Do not blow debris into the circuit breaker. If contamination is found, look for the source and eliminate the problem.

Switch circuit breaker to ON and OFF several times to be sure that the mechanical linkages are free and do not bind. If mechanical linkages are not free, replace the circuit breaker.

With the circuit breaker in the ON position, press the PUSH-TO-TRIP button to mechanically trip the circuit breaker. Trip, reset, and switch the circuit breaker ON several times. If the mechanism does not reset each time the circuit breaker is tripped, replace the circuit breaker.

Check base, cover, and operating handle for cracks, chipping, and discoloration. Circuit breakers should be replaced if cracks or severe discoloration is found.

Check circuit breaker mounting hardware and tighten if necessary.

Check area where the circuit breaker is installed for any safety hazards, including personal safety and fire hazards.

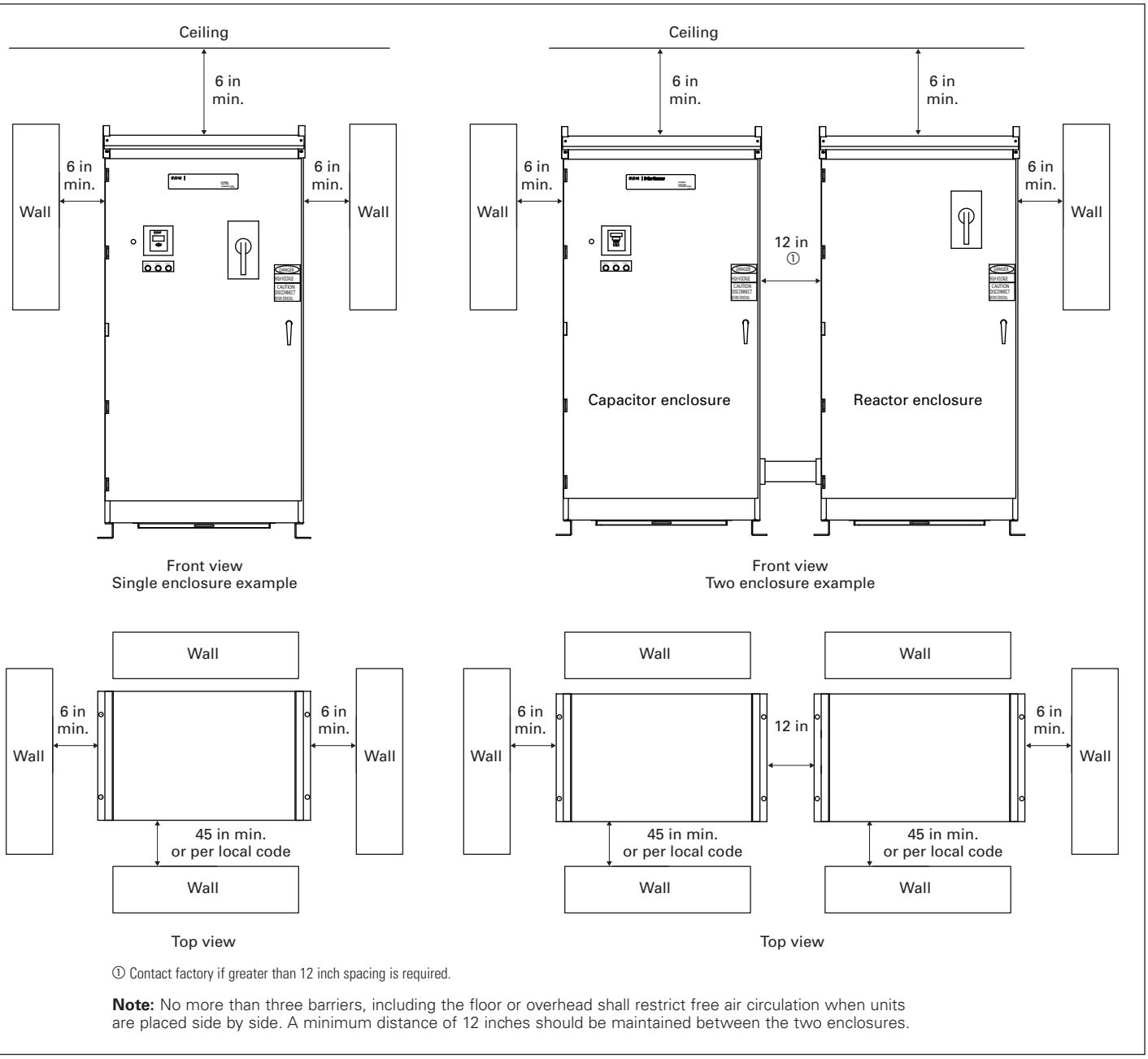
Exposure to certain types of chemicals can cause deterioration of electrical connections.

The operation of circuit breakers with electronic trip units can be field tested using the appropriate test kit.

Positioning

Position the unit so that:

1. Natural ventilation is not impeded.
2. Ambient temperature does not exceed 104 °F (40 °C).
3. Spacing complies with the National Electrical Code®.
4. Follow the clearance requirements as shown in **Figure 1**. Failure to follow the clearance can degrade the capacitance value of the unit, which is not covered under the manufacturer's warranty.



① Contact factory if greater than 12 inch spacing is required.

Note: No more than three barriers, including the floor or overhead shall restrict free air circulation when units are placed side by side. A minimum distance of 12 inches should be maintained between the two enclosures.

Figure 1. Position of the unit

Installation and interconnect instructions for AutoVAR filter in two separate enclosures

When the AutoVAR filter bank is built in two enclosures, with capacitors in one enclosure and reactors in the other, the following instructions will guide in completing the installation and interconnection of the two cabinets.

Capacitor cabinet

Reactor cabinet

Note: NEMA® 3R rated conduit hubs and a loose conduit nipple along with all needed conductor terminating hardware is included with the equipment. The two enclosures must be positioned next to each other and the short length of conduit placed between the two and tighten the conduit fittings to secure the conduit in place and proceed with the electrical wiring as outlined on **page 6**.

Figure 2. Capacitor cabinet and reactor cabinet

The main three-phase 480 V incoming power conductors are terminated in the reactor cabinet at the power conductor mechanical lugs (see **Figure 3**). The lugs are sized to accommodate the maximum sized power conductors sized to the rating of the unit and calculated based on the latest edition of NEC®.

A ground lug is provided for the grounding conductors in both the capacitor and reactor cabinet.

Figure 3. Current transformer and power wiring termination points

The service entrance CT wiring gets connected to terminal block TB1 to terminals 1 and 2 in the capacitor cabinet. The TB1 terminals 1 and 2 also have a temporary (to be removed and stored safely) shorting pin installed that will facilitate reversal of CT lead polarities if required during commissioning and shall be removed after successful commissioning and once the CT polarities are verified.

Both power and control wiring interconnection is required between the two cabinets.

There are three 4 AWG wires per stage that need to be interconnected between the capacitor and reactor cabinet. These wires are labeled, retracted, and coiled inside the capacitor cabinet and are of sufficient length to complete the interconnection (see **Figure 6**). These wires are to be routed through the conduit from the capacitor enclosure to the reactor enclosure. Correctly match and terminate the labeled conductors to the appropriate reactor leads to ensure that the phase sequence is maintained. Use the included hardware to connect each power wire to the proper reactor phase lug, as determined by the labels on the wire (see **Figure 4**) and on the reactors. The recommended torque value is shown in **Table 4**.

Figure 4. Wire labels

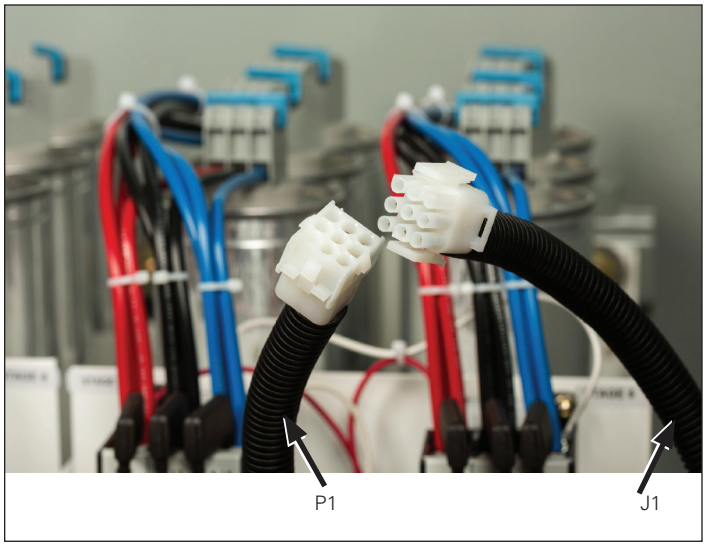


Figure 5. Control wiring interconnection

A control wiring harness is terminated into a male female termination plug. Complete the routing of control wiring harness through the conduit and form the connection between the P1 and J1 end of the control wiring harness (see **Figure 5**).

Figure 6. Current transformer wiring for IQ Meter

The internal CT wiring for the IQ Meter (option if ordered) is also retracted and coiled inside the reactor cabinet. Route the CT wires through the conduit and connect it to the shorting terminal block SCTB1 on the control panel inside the capacitor cabinet.

Figure 7. Current transformer shorting block for IQ Meter

This completes the electrical interconnection of the two cabinets.

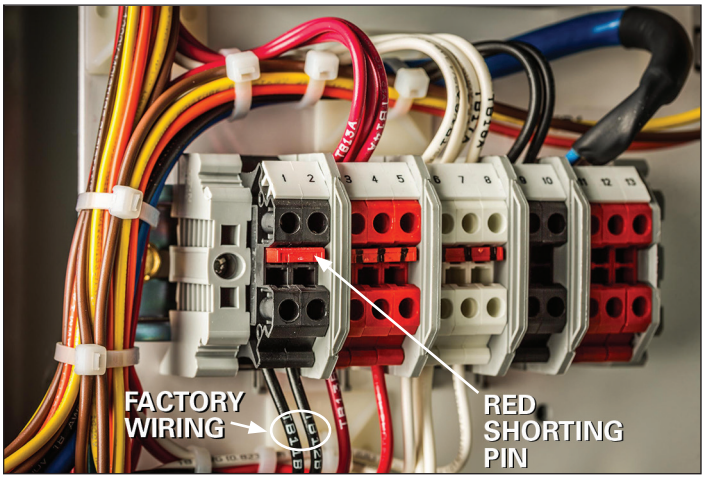


Figure 8. Terminal block TB1

Electrical system connections

When connecting the unit to the power system, the ground lug must be grounded and all applicable NEC codes must be followed.

The AutoVAR must be connected as shown in **Figure 9**. All three phases and a ground connection must be provided to the AutoVAR unit. No neutral connection is provided, because neutral wiring is not required. The lugs that accommodate the incoming conductors are located on the busbars on the right side of the cabinet. Refer to equipment drawings for lug specifications. If the unit is supplied with a disconnect, the incoming conductors are connected directly to the disconnect's line lugs. The lugs shall be torqued as indicated on these devices.

Fused disconnects

Fused disconnects should be sized no less than 165% of the rated capacitor current.

Circuit breaker

The circuit breaker should be sized no less than 135% of the rated capacitor current.

Note: Rated capacitor current = (1000 x kvar) / (√ 3 x voltage) (amps)

Where: Voltage = line-to-line voltage

kvar = Three-phase kvar rating of capacitor (nameplate rating)

Example: 500 kvar capacitor, 480 V system:

Rated capacitor current = (500 x 1000) / (√ 3 x 480) = 601 A

The breaker shall be rated to carry the 601 A x 135% or 811 A continuously in its operating environment. In this case, therefore, a 1000 A 100% rated breaker will be required as a minimum.

Conductor ampacity

NEC Article 460 specifies that the ampacity of capacitor conductors be rated at 135% of rated capacitor current. Our UL® listed units require that only 90 °C copper conductors be used at their 75 °C ampacity rating to supply the units. The ampacity should be derated as necessary for ambient temperature (see NEC).

CT placement

⚠ WARNING

FOLLOW ALL SAFETY PRECAUTIONS AND REGULATIONS FOR WORKING ON ELECTRICAL SYSTEMS RATED UP TO 600 V. ALWAYS WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE). FOLLOW ALL LOCK OUT/TAG OUT PROCEDURES.

⚠ WARNING

FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN MALFUNCTION OF THE EQUIPMENT.

- A current transformer (CT) is required for operation of an automatically switched capacitor bank. If an order for the CT was placed on Eaton to supply a current transformer with the order, it is included within your unit. Please reference AutoVAR Current Transformer Installation Manual IL157001EN for Eaton supplied CTs
- The CT is to be installed on "A-phase" of the main service entrance and wired to the terminal block TB1, terminals 1 and 2 of the capacitor bank (see **Figure 7**)
- The CT should always be installed upstream of the loads and capacitor bank
- CT shall not be installed on the feeder feeding the capacitor bank
- CT polarity must be observed accurately for proper functioning of the capacitor bank. H1 should always face the source (utility) side
- CT rating determined by the mains service entrance rating. If exact rating is not available, select the next higher appropriate rating
- If only transformer rating is known, use the following formula to calculate the maximum current

$$\text{Current for CT rating} = \frac{\text{transformer kVA} \times 1000}{1.732 \times \text{line voltage}}$$

- The CT shall be metering class, primary rating as required, 5 A secondary rating. The minimum Burden designation is B-0.5, as defined in IEEE® Standard C57.13-2008
- The CT secondary current shall not exceed 5 A nominal. CT secondary currents of greater than 6 A can cause damage to the controller

The placement of the CT is critical to the proper operation of the AutoVAR. **Improper location and phasing of the current transformer (CT) causes more startup problems than any other error.**

As shown in **Figure 9**, the CT must be placed upstream of the AutoVAR power connections preferably on phase A of the main incoming bus. In other words, place the CT so that it 'sees' the entire plant load, including the AutoVAR and any other capacitors. The high side of the CT (marked "H1") must face the utility source.

After the CT has been placed on the main incoming bus, the interconnects from the CT secondary should be terminated on the terminal strip (TB) pins #1 and #2 (located on the inside left panel of the capacitor cabinet) (see **Figure 8**). The Terminals TB1 and 2 are factory fitted with a shorting pin (that should be safeguarded until after successful commissioning) to allow for changing any mis-wired CT wiring.

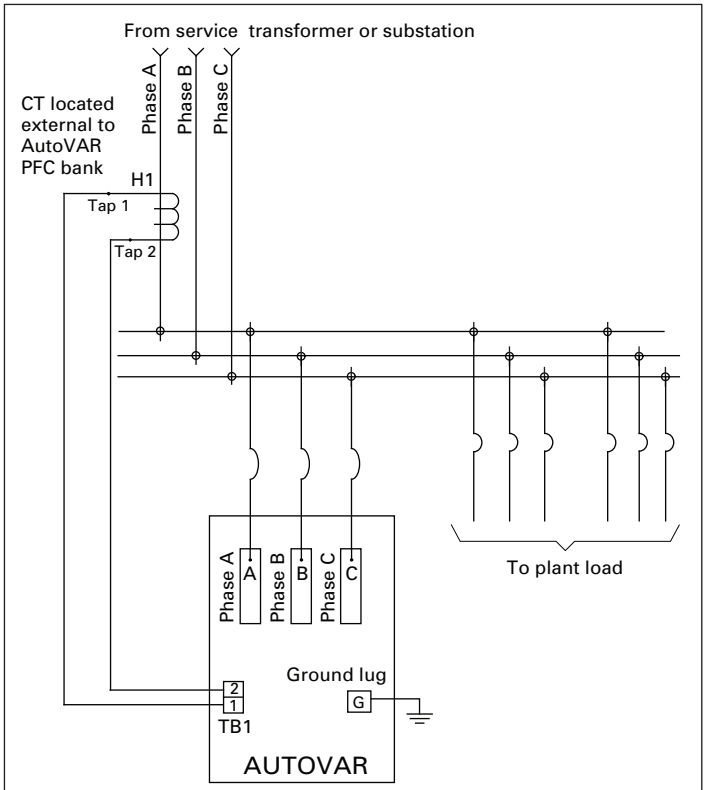
Precaution should be taken to disconnect the factory side wiring when attempting to correct the field wiring in order to avoid an open circuit on the CT secondary. Once the CT polarity and phasing has been verified, the CT shorting pin may then be removed.

CT cabling and connections

CT wires should be minimum #12 AWG up to 100 ft of wire length and #10 AWG up to 150 ft. CT wires will need to be routed separately from the power conductors in a separate conduit. Shielded type cable will be required if the CT conductors are not routed in a metal conduit.

The length and gauge of wire is applicable for up to ANSI C57 B-0.5 burden. CT lead resistance will be kept to a minimum and calculated at expected overload capacity of up to 120%.

The AutoVAR electrical connections are now complete.



CT installed by customer on Phase A of the facility's service entrance/ main incoming gear. The CT must measure the entire current of the facility.

Figure 9. Connection schematic

Startup and commissioning

ON/OFF switch

Ensure the ON/OFF switch located on the door is in the OFF position. Before energizing the unit, please verify that all connections within the unit are secure. Tighten any loose connections to the specified values (see **Table 4**) using a calibrated tool. The upstream or (optional integral) disconnect or circuit breaker can now be closed to energize the unit. Once energized, turn the ON/OFF switch to the ON position and the unit is ready to begin operation as indicated by the illuminated light within the ON/OFF switch.

Cleared fuse indicator lights

The three lights on the door are cleared fuse indicator lights. These lights come on when a power fuse inside the unit is cleared. If the door of the unit is opened (with unit still energized), the cleared fuse can be identified by the red light(s) that are illuminated (a light is located next to each fuse).

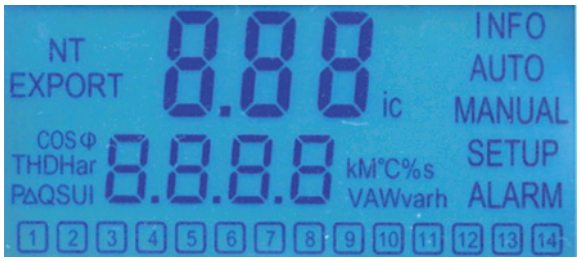
Ensure that the internal and external cleared fuse indicator lights are not brightly lit before beginning the commissioning.

Controller setup procedure

Instructions henceforth are only applicable for the factory standard (default) controller. For Option C controller, please refer to the separately included instructions on Modbus enabled controller.

Eaton BLR-CX Plus quick commissioning guide

Screen legends



INFO	Capacitor database
AUTO	Automatic mode
MANUAL	Manual mode
SETUP	Setup mode
ALARM	Blinking during alarm
NT	Second target-pf is active
EXPORT	Export of active energy
1-12	Capacitor stage number indication

Figure 10. Digital display

Operation

Operation of BLR-CX Plus is done by 4 keys.

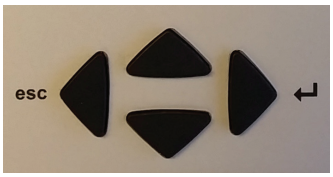


Figure 11. Operational keys

Submenus are scrolled through by pushing the ▲ (up) key or ▼ (down) key.

Pressing ▶ (↵ right / Enter) key allows selection, entering the edit mode or accepts the edited values.

In edit mode, the ◀ (left / esc) key or ▶ (↵ right / Enter) key scroll left and right to allow setting of the appropriate digit.

Outside of edit mode, the ◀ (left / esc) key exits to the next higher level.

Press and hold the ◀ (left / esc) key for approximately 3 seconds to silence any alarms.

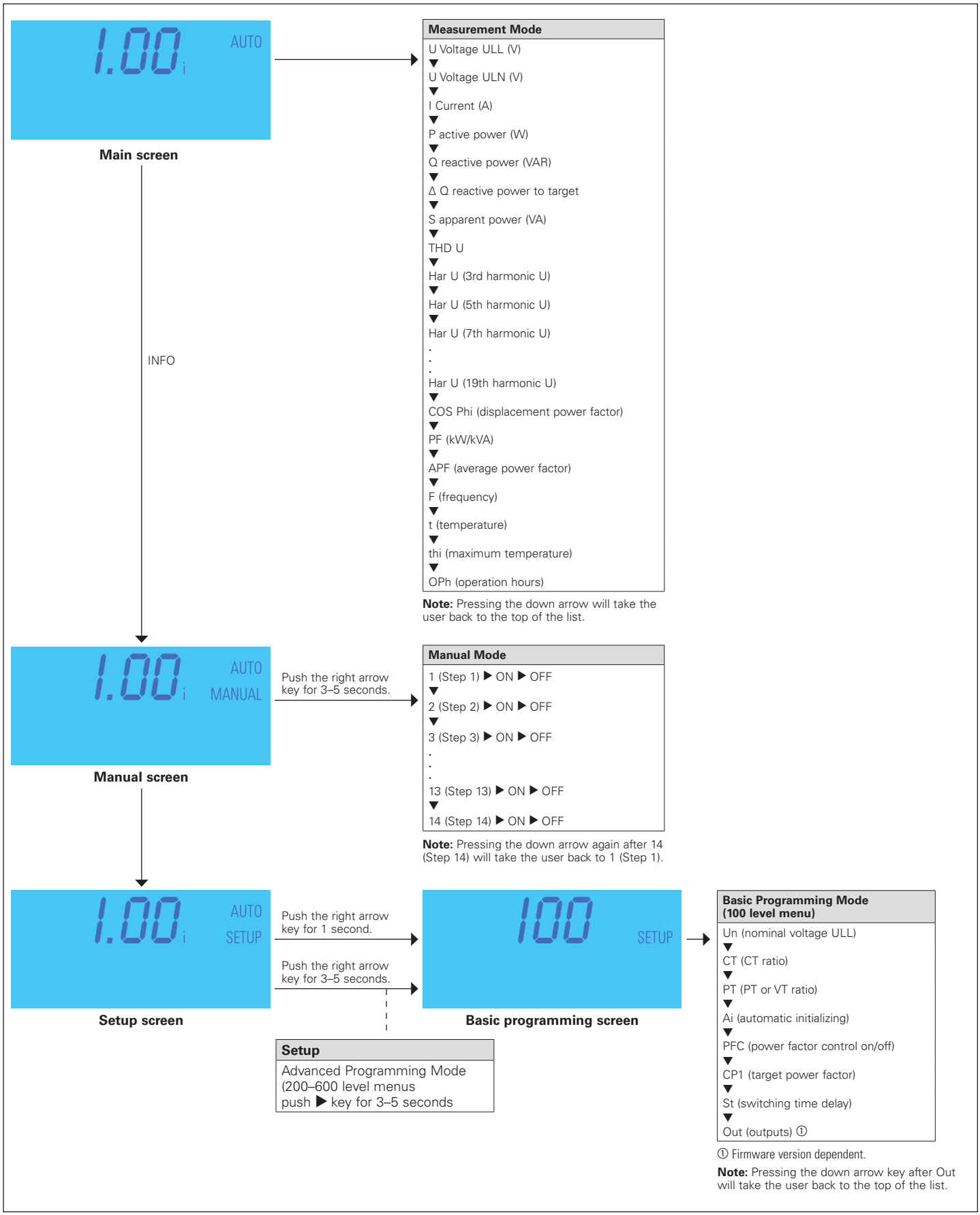


Figure 12. Menu map

Programming the controller

Step 1

Upon power on the controller displays the existing power factor value "X.XX i" and enters the Automatic Control mode.

The 'i" at the end indicates an inductive power factor and would be appropriate for most installations. A "c" at the end indicates capacitive power factor and suggests reactive power export and may not be appropriate. Refer to the troubleshooting section for resolution steps.

Step 2

Next step is to set up the basic parameters in the controller.

From the main screen, press the ▼ (down) key to step through the "INFO", "MANUAL" and to "SETUP" mode. When "SETUP" is shown, press the ▶ (↵ right /Enter) key to enter the Menu 100. Press the ▶ (↵ right /Enter) key and program and or verify the following values.

Un Nominal voltage (factory programmed, customer may verify)

Ct CT-ratio (factory set to 600, which corresponds to 3000:5 current transformer ratio. Changing the CT ratio will change the capacitor step sizes in 402 and those values will have to be re-programmed.

Pt PT-ratio (factory programmed)

Ai Start of automatic initialization (factory programmed)

PFC PF-control ON/OFF/ HOLD (factory programmed)

CP1 Target-PF (customer to program)

St Switching time delay (factory programmed, customer may verify)

Out Output type of each stage (Auto/Alarm/Fixed Off/Fixed On) (factory programmed, customer may verify)

Once the Menu 100 is programmed, press the ◀ (left / esc) key three times to return to the main screen that displays the existing PF.

Overview

BLR-CX Plus is factory preset to the default values shown in the **Table 1**. Customer to program and verify the values set to meet the specific conditions of each installation.

Step 3

The next step is to verify the measured values.

From the main screen, press the ▶ (↵ right / Enter) key to enter the Measurement mode. See menu map for a list of designated parameters.

Press the ◀ (left / esc) key to return to the main screen that displays the existing PF.

Step 4

The final programming step is to verify the working of the capacitor bank. This is done by activating the controller in manual control mode and cycling through all the available steps.

Note: The steps will switch on only after the factory set capacitor stage discharge time has elapsed.

After each manual operation of the stage, the PF should change in the right direction (for example, 0.70 i >> 0.78 i >> 0.85 i…).

If the PF changes in the right direction, the capacitor bank has been correctly commissioned. If not, please refer to the troubleshooting section.

To switch the controller in manual control mode, press the ▼ (down) key to step through the "INFO" mode to "MANUAL" mode. Press and hold the ▶ (↵ right /Enter) key for approximately 3 seconds until "1" displays, indicating the stage number 1 is available for control.

Note: In manual mode, the controller freezes the stages in their existing state (ON, OFF, or HOLD). Therefore, it is important to ensure that at the end of this Step 4, the controller is returned back to the automatic control mode by pressing the ◀ (left / esc) key to return to the main screen that displays the existing PF.

After activating all available steps, one should make note of the displayed PF value as that reading should be greater than or equal to the target PF desired. If the displayed PF with the electrical system fully loaded and all steps energized is less than the target PF, then the selected capacitor bank is not sized adequately to raise the PF to the desired value. The customer should either upgrade the capacity of the capacitor bank or the target PF value should be decreased to prevent "PF alarms".

Menu structure

The following table provides an overview about the basic and advanced programming parameters of BLR-CX Plus.

Menu 100 is the Basic Menu. Menu 200 through 800 is for advanced users only and requires a PIN access (242). The settings in these submenus should only be accessed and changed after consulting with Eaton. Menu 700 is Modbus setting menu. It is only available on capacitor banks with the "C" suffix.

Table 1. Programming mode detailed menu map

Menu	Function	Default	Customer settings
100	**Quick start setup**		
Un	Nominal voltage (phase-phase)	208 V / 240 V / 480 V / 600 V	
Ct	CT-Ratio	600 (corresponds to 3000:5 CT ratio)	
Pt	VT-ratio	1.7 (240 V unit) 3.7 (480 V unit) 4.7 (600 V unit)	
Ai	Start automatic initializing	N	
PFC	Start/Stop/Hold PF-control	On	
CP1	Target-PF 1	0.95i	
St	Switching time delay	60 s	
Out	Type of each step (1, 2, 3…12)	Auto (for each step installed in unit), Fixed Off (for unused controller outputs)	
200	**Setup measuring system**		
201	Nominal voltage (phase-phase)	208 V / 240 V / 480 V / 600 V	
202	CT-ratio	600 (corresponds to 3000:5 CT ratio)	
203	VT-ratio	1.7 (240 V unit) 3.7 (480 V unit) 4.7 (600 V unit)	
204	Tolerance nominal voltage	20%	
205	Voltage measuring	Y = L–L	
206	Phase-offset	90	
207	Start automatic initializing	N	
208	Synchronization to frequency	60 (60 Hz unit)	
209	Temperature offset	0 °C	
300	**Setup control system**		
301	Switching threshold	55%	
302	Target-PF 1	0.95i	
303	Target-PF 2	0.95i	
304	Target-PF 2 at KW-export	N	
305	Switching time delay	60 s	
306	Switching time delay for fine control	10 s	
307	Fine control active	N (for units with equal stage sizes), Y (for units with multiple stage sizes)	
308	Automatic Stage detection	N	
309	Block defective Capacitors	N	
310	Start/Stop/Hold PF-control	On	
311	Control algorithm	1	
312	Reactive-power offset	0	
313	Asymmetrical switching time delay	1	
314	Switch-off capacitors in leading condition	N	
315	Distribute sw. operations	N	
316	Detect faulty stages	Y	
400	**Setup capacitor database**		
401	Discharge time	60 s	
402	Capacitor size: step 1…max. 12	Varies (see equipment drawings for step size, typically 25, 50, or 100 kvar capacitive)	

Menu	Function	Default	Customer settings
400	**Setup capacitor database, continued**		
403	Type of exit: step 1…max. 12	Auto (for each step installed in unit), Fixed Off (for unused controller outputs)	
404	Switching operations: step 1…max. 12	0	
405	Operations hours counter: step 1…max. 12	0 h	
406	Fan relay as stage output	N	
500	**Setup alarm system**		
501	Reset alarms manually	N	
502	THD-U threshold	6%	
503	Disconnect capacitors when THD >	N	
504	THD alarm delay	120 s	
505	Stop control if I=0	N	
506	Service alarm	N	
507	Max. operations per step	262 k	
508	Max. operation hours of BLR-ACX-V	65.5 k	
509	Max. operation hours per step	65.5 k	
510	THD-I threshold	20%	
511	Digital input logic	Y	
512	Temp. threshold level 1 (fan control, type of exit: AL)	40 °C	
513	Temp. threshold level 2, disconnect capacitors	55 °C	
514	Control alarm (target cannot be reached)	Y	
515	Faulty stages alarm	Y	
516	Stage power loss alarm	Y	
517	Flashing display	N	
518	Digital input function	CP2	
519	I-Low alarm suppr.	Y	
520	Switch off active stages if digital input alarm	N	
521	I-Low alarm	Y	
522	I-High alarm delay	10 s	
523	Switch-off interval	60 s	
600	**Reset**		
601	Reset to default values	N	
602	Reset capacitor database to default	N	
603	Reset operation hours	N	
604	Reset average PF	N	
605	Reset max. temperature	N	
606	Reset alarm	N	
607	Info firmware	—	
608	Change password	242	
609	Restart first setup	N	
700	**Modbus**		
—	Baud rate	19.2 k	
—	Parity and stop bits	EVEN	
—	Slave address	1	
800	**System**		
801	Backlight during commissioning mode	N	
802	Backlight delay time	0.25 h	

Troubleshooting

⚠ CAUTION

WHILE ATTEMPTING ANY TROUBLESHOOTING STEPS THAT REQUIRE ACCESS INTO THE CAPACITOR BANK, ALWAYS FOLLOW ALL SAFETY PRECAUTIONS AND REGULATIONS FOR WORKING ON ELECTRICAL SYSTEMS. ALWAYS WEAR PROPER PPE AND FOLLOW APPROPRIATE LOCK OUT AND TAG OUT PROCEDURES.

Automatic control mode

The controller should display status "Auto," which indicates that the controller is working in automatic mode. This is the desired mode of operation. If "Auto" is not displayed, then the power factor control is not working. Reasons for this are:

- Manual mode is active
- Control mode has been switched off
- Temperature is too high (if temperature input is provided)
- Current from the CT is less than 15 mA
- Voltage is out of range
- Harmonic level of voltage is too high

Alarms and description

The controller has an extended alarm system. When an alarm is active, the sign ALARM in the display blinks and an error code is shown on the screen. Possible error codes are shown in the table below.

Alarm				Description
U	ALARM			The measured voltage is out of the set tolerance.
I LO	ALARM			Measuring current is less than 15 mA (please check CT signal and verify that CT shorting pin has been removed).
I HI	ALARM			Measuring current is too high.
PFC	ALARM			Target cannot be reached.
HARU	ALARM			The set THD voltage threshold has been exceeded.
HARL	ALARM			The set THD current threshold has been exceeded.
STEP	ALARM	FLTY	ALARM	One or more steps are defective. The defective steps are blinking together with the ALARM sign.
SPL	ALARM	/11	ALARM	One or more steps have less than 70% of original size. Number of step and alarm text are blinking alternately.
THI	ALARM			Over temperature alarm. Threshold level 2 exceeded. The steps will be switched-off step-by-step.
OPH	ALARM			The set operating hours of the controller have been exceeded.
OPC	ALARM	/11	ALARM	The maximum switching cycles threshold of at least one stage has been exceeded.
OPH	ALARM	/11	ALARM	The set operating hours of at least one stage have been exceeded.
AI/ABRT	ALARM			The Automatic initialization has been aborted due to an error. The control is switched off.

Current and voltage monitoring

The controller is equipped with current and voltage monitoring to ensure it is within its operating parameters. The controller will show "I LO" alarm if there is no measured current or the magnitude sensed is less than 15 mA. If the current is greater than 6 A, the controller will show "I Hi alarm".

If either of these alarms are displayed, check the CT current path, verifying that the correct CT ratio is selected, the CT is in the correct position, and the current input and shorting jumpers at the terminal block are removed.

The allowed range of voltage depends on nominal voltage. When nominal voltage is out of range, "U Alarm" is shown. If this alarm is seen, then the setting of nominal voltage has to be adjusted. Nominal Voltage is measured and entered phase to phase.

Capacitor stage database

A step fault ("STEP / FLTY") or step low ("SPL") alarm indicates problems with the sensed capacitor size. To check the capacitor stages, switch the controller into the INFO mode by pressing the ▼ (down) key. In the INFO submenu, by pressing the ▲ (up) or ▼ (down) key, the steps can be chosen and once the steps are indicated in the display, pressing the ▶ (↵) (right/enter) key displays the information for the selected steps.

CC C INFO 50 kvar ①	▼	INFO 99.9% ①	▼	OC INFO 10.12 k ①	▼	i INFO AUTO ①
actual power of step		percentage actual to nominal power		number of operations		step type

It's possible to have capacitive steps as well as inductive steps. Ensure the steps show capacitive ("C") kvar).

High temperature alarm

1. Replace dust filters (Catalog Number AUTOVAR6FX8).
2. Verify proper operation of fans.
3. Verify that measured ambient temperature does not exceed 40 °C (104 °F).
4. Check for external sources of heat such as direct sunlight.

PFC alarm

Possible reasons could be:

1. Insufficient capacitance available or target PF set too high.
2. Capacitor stages deteriorated.
3. Capacitor stages sensed or set incorrectly (both in terms of type (inductive or capacitive) and value (100 kvar instead of 50 kvar).

PF value incorrect, decreases as steps are added or shows X.XX"c"

1. CT polarity is incorrect.
2. CT leads are swapped.
3. CT is not mounted on A phase.

Adjust the Phase-Offset menu parameter according to the following chart.

CT installed phase (with respect to incoming AutoVAR bus)	CT polarity	Controller phase-offset
A	Straight	90
A	Reverse	270
B	Straight	330
B	Reverse	150
C	Straight	210
C	Reverse	30

PF value shows unity or does not change even after steps are engaged

1. Location of CT is incorrect. Ensure that the CT is connected electrically ahead of the capacitor bank (at the service entrance panel or switchgear) and is not connected on the feeder that supplies power to the capacitor bank.
2. Steps have failed.

Incorrect measurement values

1. Check that CT and PT ratios are programmed correctly in Menu 100.
2. Check that Nominal voltage is programmed correctly in Menu 100.

Controller not switching on additional steps and does not reach target PF

This usually happens when the amount of capacitance available does not match the amount of kvar required. This can happen especially in low load situations when the amount of kvar required is very low compared to the smallest available step size (for example, total kvar required is 12 kvar and the smallest step size available is 60 kvar). The controller will not bring on any step to prevent overcompensation.

1. Check that the sensed and programmed capacitor step sizes are set and match the actual value.
2. Check that the setting in 314 is set to N.
3. Check the amount of shortfall kvar (▲Q) in the measurement menu and program this value in menu 312.
4. If all above fails, one may need to install smaller kvar size steps to allow the controller to switch them during low demand.

BLR-CX Plus controller technical data

Description	Specification
Measuring and supply voltage	Connection: Single-phase Range: 90 – 550 V AC, 45 – 65 Hz Protection: Max. 6 A Power consumption: 6 VA Transformer factor: Adjustable 1.0 to 350.0
Current measurement:	Connection: Single-phase Range: 5 mA – 5 A Transformer factor: Adjustable 1 to 9600
Stage outputs: Option -xxR	6 or 12 Stage outputs Type: Relay, normally-open, potential-free Supply: Common, max. 10 A Switch capacity per relay: 250 Vac / 5 A 400 Vac/ 1 A 48 Vdc / 1 A 110 Vdc / 0.2 A Type: Transistor, normally-open, open collector output Supply: Common, max. 1,2 A Switching capacity per transistor: 100 mA/8–48 Vdc
Temperature measurement:	NTC: Under the housing cover Accuracy: ± 5 °C
Alarm output: Default Option -nc	Type: Relay, normally-open, potential-free Switching capacity: 5 A / 250 Vac Type: Relay, normally-closed, potential-free Switching capacity: 5 A / 250 Vac
Digital input:	Logic: Adjustable, high- or low-active Input signal: 90 – 250 Vac
Service Interface:	For service purpose only
Modbus: Default Option -MB	Unassembled protocol: Modbus-RTU Interface: RS485 Common-mode range: -7 – 12 V Differential-mode range: -12 – 12 V Output current: -60 – 60 mA
Ambient temperature:	Operating: -20 °C – 70 °C Storing: -40 °C – 85 °C
Humidity:	Range: 0 % – 95 % Condensation: Not allowed
Overvoltage category:	300 VLN / 519 VLL CAT III519 V – 550 V CAT II Degree of contamination 2

BLR-CX Plus controller technical data, continued

Description	Specification
Standards:	IEC 61010-1, IEC 61000 6-2, IEC 61000 6-4: Level B, IEC 61326-1, UL 61010
Compliance and listing:	CE, c NRTL us (c UL us), EAC
Connections:	Type: Screw terminals, pluggable Cross section: Max. 4 mm2
Housing:	Front: Plastic housing (UL94 V-0)Back: Metal cover
Protection class:	Front: IP41 Back: IP20
Weight:	Approx. 0.6 kg
Dimensions	Device: H x B x T: 144 x 144 x 58 mm Cut-out: H x B: 138 (+0.5) x 138 (+0.5) mm

Retrofit installations with BLR-CX Plus controller

Please retain and follow all instructions and safety precautions during and after installation.

1. Compare voltage and current ratings of BLR-CX Plus with data of mains and installation.
2. Mount the relay in the control panel with the two mounting clips.
3. Connect protection GROUND to PE connection of metal case.
4. BLR-CX Plus is to be connected according to the wiring diagram.
5. Ensure that the short-link for CT input signal is removed.
6. Typical wiring diagram of the controller is shown below. This may not match the existing installation. Please consult Eaton for retrofitting this into existing Eaton capacitor banks.

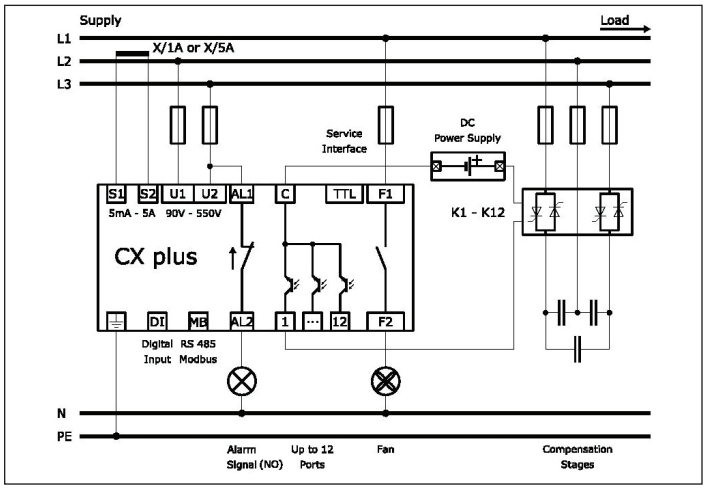


Figure 13. Connection diagram: CX plus -12T

Troubleshooting

Symptom	Correction
No control power	Check primary control fuses (three fuses located in fuse holder) and secondary fuse located on control transformer.
	Check disconnect or circuit breaker is ON.
	Check GFCI located on control panel inside cabinet.
	Check the reactor thermal switches status (open if operated, closed if healthy).
Displayed power factor is obviously wrong or decreases as stages engage	CT secondary current is too low (check CT tap setting and plant load).
	CT polarity is incorrect or leads are reversed.
Stages do not engage and target power factor has not been reached	Confirm that an inductive power factor is being displayed (i.e., 'i.73', not 'c.73').
	Confirm that the required reactive power is at least 60% of the smallest step size available for switching.
	Confirm availability of capacitor stages and there is no stage alarm.
	Confirm "AUTO" is being displayed on the controller.
Blown fuse lights on front cabinet are lit (w/no blown fuses)	Check 3 primary control fuses (on control panel) if check system voltage matches the nameplate voltage.
Displayed power factor does not change as stages engage	Review 'Current transformer placement and connection'
Controller troubleshooting	Refer to "Controller setup procedure" section.

Fuse (clearing)

Capacitor fuses may clear for many reasons. An occasional cleared fuse may be the result of a switching 'spike', lightning strike, or other electrical disturbance. However, frequent fuse clearing may be a sign of a more serious problem. Please contact your Eaton representative or Eaton's Technical Resource Center at 1-800-809-2772 option 4, sub-option 2 for assistance if frequent fuse clearing occurs.

Temperature control

The controller is fitted factory default with an ambient temperature alarm and trip option. The controller is also fitted with a non-reversing temperature sticker that helps monitor the highest reached temperature inside the cabinet.

The alarm and trip options are field adjustable and are set at the values shown in the controller set point table (see **Table 1**).

When the cabinet temperature exceeds the trip set point, the controller will shut down all the stages until the cabinet temperature falls below the trip set point, at point which the controller will resume the control of the stages.

If the PFC unit appears not to bring on any stages or is otherwise inoperable, check the temperature indicator on the back of the controller and verify that the temperature is within the specified limits of the unit.

Options

Remote alarm relay (option code A)

Remote alarm relay provides a single Normally Open volt-free 250 V / 5 A contact wired to a terminal block for customers' use.

Communications controller (option code C)

Selecting option code C provides the user with our advanced controller that is equipped with Modbus® RTU RS-485 communications capability and additional advanced features. See IB157002EN.

HOA switches (option code H)

The HOA switches provide external control of the capacitor stages. The following switch positions are available:

- Hand—turns stage on
- Off—turns stage off
- Auto—controller activated stages

Circuit breaker (option code M or M1)

The trip settings on the circuit breakers shall be set in accordance with the NEC and coordination requirements within the facility.

IQ Meter (option code Q)

The IQ 250 Meter provides an electronic panel meter to those who wish to monitor various electrical parameters of the capacitor bank. The IQ Meter cannot display the system parameters and thus should not be used for displaying the system parameters such as power factor, power, voltage, current, etc. For operation of the IQ Meter, please refer to the IQ manual.

Detuned (applies to AutoVAR filters only, code Y)

Detuned code Y supplies a 4.2 (5.67% reactors) tuned unit instead of 4.7 (4.53% reactors).

Custom options (option code S)

Non-standard options including remote shutdown command, external interlock, etc. Consult with factory.

Weather-resistant (option code W)

Allows the enclosure ingress protection rating to be NEMA 3R.

Maintenance

The AutoVAR requires very little maintenance to operate reliably. However, please follow the Startup and Maintenance Schedule included.

De-energize unit before withdrawing tray to access dust filter.

NOTICE

IF ANY LARGE NONLINEAR LOADS (ADJUSTABLE SPEED DRIVES, VFDS, DC DRIVES, BATTERY CHARGERS, ETC.) ARE INSTALLED IN THE PLANT AFTER INSTALLATION, PLEASE CONTACT YOUR EATON SALES REPRESENTATIVE TO ENSURE THAT THE CAPACITOR WILL NOT BE ADVERSELY AFFECTED.

Dust filters—Strata density panel air filters UL Class 2—1-inch H x 25 inches W x 18-1/2 inches D.

The dust filter is located at the bottom of the equipment enclosure and does not require opening the cabinet door.

Dust filters should be replaced at least quarterly as suggested in our preventive maintenance guidelines and more often if the unit is located in a polluted environment. Eaton stocks and sells replacement air filter part number AUTOVAR6FX8. Contact your Eaton distributor or sales team to order.

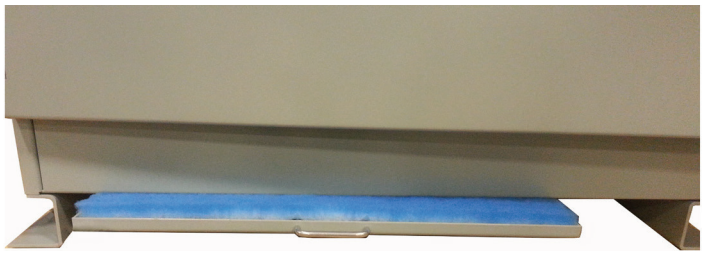


Figure 14. Dust filter location

Table 2. Low-voltage capacitor bank startup inspection and maintenance schedule

CUSTOMER:	
UNIT SERIAL NUMBER:	

Qtr: Every 3 months Semi: Every 6 months Ann: Every 12 months	C	Clean	P	Touch-up Paint
	F	Check for Open/Damage Fuse	R	Replace parts or component
	I	Inspection of Component/Equipment	S	Apply Silicone Caulk (Outdoor Unit)
	L	Lubricate	T	Test component
	O	Torque Connections	V	Verify Operation

	Routine				**Service Schedule Years From Installation Date**							
Component	**Startup**	**Quarterly**	**Semi-Annually**	**Annually**	**2.5**	**5**	**7.5**	**10**	**12.5**	**15**	**17.5**	**20**
Date of Service:												
Service Performed By:												
Air Filters	I	R										
Alarm Indication	V			V								
Bus Connections	O				O	O	O	O	O	O	O	O
Bushings	I			I, C								
Cable Terminations	O			I	O	O	O	O	O	O	O	O
Capacitor	I			I		T		T		T		T, R
Control & Timing Relays	V					T		T		T		T, R
Controller	V			V		T		T		T		T, R
Corrosion / Condensation	I			I, P								
CT Circuit	V			V				T				
Enclosure	I, S, P			I, P				S				S
Fans	V		I	I, V				T				R
Fuses	T			F								R
Insect Screens	I, C				C	C	C	C	C	C	C	C
Insulators and Supports	I, C			I, C								
Power & Control Cables	I			I				T				T
Reactor	I			I, C				T				T
Contactors	V			V				T				T, R
Test CT Polarity (optional)	T											

(Perform inspection and maintenance service per above schedule and record service dates)

Table 3. Low-voltage AutoVAR commissioning checklist

Note: Form and photograph of installation must be completed and returned to Eaton Power Factor Correction Product Line (pfcwarranty@eaton.com) for activation of extended warranties, if purchased.

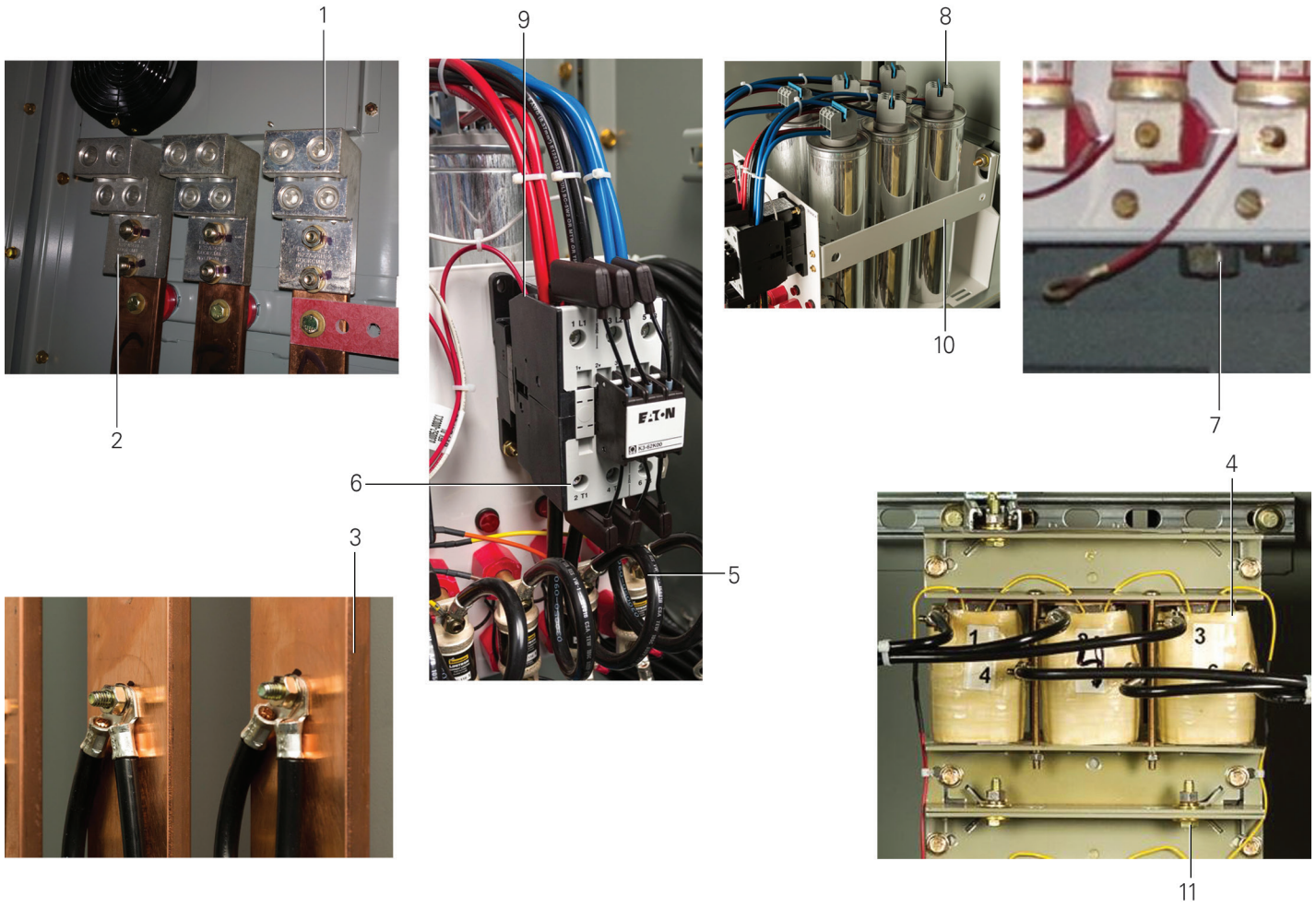
Project information	
Name of qualified individual	
Company name for qualified individual	
Customer name	
Customer location (city and state or province)	
Unit catalog number	
Unit general order number	
Unit serial number	
Current transformer information	
CT installation location (example switchboard main breaker)	
CT primary tap selected	A
CT secondary rating	A
CT ratio for controller (example 600 = 3000/5)	
Physical clearances for ventilation	**Measured values**
Top clearance (please specify units)	
Left side clearance (please specify units)	
Right side clearance (please specify units)	
Clearance between cabinets, if applicable (please specify units)	
Environmental considerations	
Installation type (indoor our outdoor)	
Measured ambient temperature, please specify C or F with measured value	
Sources of particulate buildup	
Sources of heat (e.g., direct sunlight)	

Attach a photograph of the installation here.

Table 3. Low-voltage AutoVAR commissioning checklist, continued

Inspection (for each item, please note 'Acceptable' or list any deficiencies)	
Air filter(s)	
Bushings	
Capacitor cells	
Corrosion/condensation	
Enclosure	
Vents/screens	
Insulators and supports	
Power and control cables	
Reactor(s), applicable only to filtered units	
Fastener torque	
Bus connections	
Cable terminations	
Testing	
Control power fuses	
Contactor fuses	
CT ratio and polarity (test is optional)	
Controller settings	
System nominal voltage	V
CT ratio	
VT/PT ratio	
Automatic initialization (verify that this is set to No or Off)	
CP1 (Cos Phi 1)—target power factor, please specify number and I or C	
Switching time delay	
If CT ratio has been changed from factory default, have the capacitor step sizes in the 402 menu been re-set accordingly?	
If any modifications have been made to parameters in the advanced menus (with the exception of 402), please note the modifications	
Verification	
Does each contactor function properly during operation in the controller's manual mode?	
Does the power factor measured by the controller go in the correct direction when the contactors are closed in the manual mode?	
Does the voltage measured by the controller match the system voltage, within 10%?	
Does the current measured by the controller match the system current, within 10%?	
Does the controller show ALARM or EXPORT condition?	
Do the fans run?	
Do the push-to-test cleared fuse indicator lamps on the capacitor enclosure door glow brightly when pushed?	

Table 4. Torque chart



Location identifier	Torque table	Torque value	Remarks
1	Customer incoming conductor to mechanical lug (customer wiring)	275 in-lb	For lug size suitable to accommodate conductors maximum up to 350 kcmil
		375 in-lb	For lug suitable to accept conductors greater than 350 kcmil up to 750 kcmil
2	Mechanical lug to bus bar (factory wiring)	20 ft-lb	
3	4 AWG wire terminated onto bus (factory wiring)	60 in-lb	
4	4 AWG wire terminated onto reactor (if applicable) (factory wiring)	60 in-lb	
5	4 AWG wire terminated onto fuse (factory wiring)	60 in-lb	Bottom terminals
6	4 AWG (pigtail) wire terminated onto contactor (factory wiring)	45 in-lb	Bottom terminals
7	Capacitor mounting M8/M10 stud (factory wiring) ①	14.8 ft-lb	Stud on bottom of capacitor
8	8 AWG wires to capacitor contactors (factory wiring) ①	22 in-lb	Top terminals
9	8 AWG wires to contactors (factory wiring) ①	45 in-lb	Top terminals
10	Nest assembly mounting bolt (not a factory torqued live part)	20 ft-lb	Rear of nest
11	Reactor mounting bolt (not a factory torqued live part)	20 ft-lb	

① Customer wiring if expanding unit in field.

AutoVAR 600 and AutoVAR detuned filter automatically switched capacitor and filter bank installation operations and maintenance manual

Warranty

Standard warranty is 1 year, parts only, against manufacturing defects for entire unit. For units with standard-duty capacitor cells, the capacitor cells provided with the unit have a standard 2-year warranty against manufacturing defects, parts only. For units with heavy-duty capacitor cells, the capacitor cells have a standard 5-year warranty against manufacturing defects, parts only.

This instruction manual is published solely for information purposes and should not be considered all-inclusive. If further information is required, you should consult an authorized Eaton sales representative.

The sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between the parties. This literature is not intended to and does not enlarge or add to any such contract. The sole source governing the rights and remedies of any purchaser of this equipment is the contract between the purchaser and Eaton.

NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS, AND DESCRIPTIONS CONTAINED HEREIN. In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and description contained herein.

For technical support and application engineering assistance, please contact Eaton's TRC at
1-800-809-2772 option 4, option 2
or email **pfc@eaton.com**

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Printed in USA
Publication No. IM02607001E / Z22995
July 2019

Powering Business Worldwide