VarSet™
Low Voltage Automatic Capacitor Banks

Instruction Bulletin
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Retain for future use.

by Schneider Electric
Safety information

Important information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

**DANGER**

**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

**NOTICE**

**NOTICE** is used to address practices not related to physical injury.

Please note

Electrical equipment should be installed, operated, serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.
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Section 0 — Safety Precautions

Installation, wiring, testing and service must be performed in accordance with all local and national electrical codes.

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this device and the equipment in which it is installed before working on the device or equipment.
- After removing power, wait for 5 minutes to allow the capacitors to discharge prior to opening the doors or removing covers.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.
- Carefully inspect the interior for tools left behind before closing and sealing the door.

Failure to follow these instructions will result in death or serious injury.
Section 1 — Introduction

Installation Overview

Physical installation

Connect the incoming power

NOTE: A capacitor bank is a load. The only power cabling to be done is the incoming cable to the line side of the incoming breaker or incoming lugs.

CT and alarm connection

NOTE: You must use a CT if you are using the automatic capacitor banks.

Program the controller

Inspect

Activate
Introduction (Cont’d)

This manual contains instructions for the proper installation, operation, and maintenance of VarSet™ low voltage automatic capacitor bank equipment manufactured by Schneider Electric. The purchaser’s engineering, installation, and operating staff should familiarize themselves with this manual and become acquainted with the appearance and characteristics of each piece of equipment mounted or contained in the capacitor bank.

These instructions and procedures apply to VarSet low voltage automatic capacitor bank installation. When special features or non-standard components are incorporated in the capacitor bank, detailed instructions for these components are included in the instruction material holder.

Document Replacement

Contact your nearest Schneider Electric field office to replace lost or damaged wiring diagrams and instruction sheets. Use the factory order number as a reference.

Section 2 — Receiving, Handling, and Storing

Receiving

Upon receipt, check the packing list against the equipment received to ensure the order and shipment are complete. Also upon receipt, immediately inspect capacitor bank sections for any damage that may have occurred in transit. If damage is found or suspected, file a claim with the carrier immediately and notify the nearest Schneider Electric representative.

Handling

Ensure that proper equipment, such as an overhead crane, is available at the installation site to handle the capacitor bank. This equipment will help avoid injury to personnel and damage to the capacitor bank.

The shipping weight of each shipping section is marked on the packing list. Verify the lifting capacity of the equipment being used to handle the capacitor bank in accordance with the shipping weight of each shipping section. Keep the capacitor bank upright during handling.

Schneider Electric recommends using an overhead crane, lifting straps, and cables or chains to handle the capacitor bank. This method and alternative handling methods are discussed in this section.

NOTICE

HAZARD OF EQUIPMENT DAMAGE

Do not lay the equipment on its back, front, or sides.

Failure to follow these instructions can result in equipment damage.

Handling with Lifting Straps

Schneider Electric provides lifting straps as standard equipment for capacitor bank shipping sections. Instruction labels on each shipping section include drawings and written instructions outlining the proper use of the lifting straps (Figure 1 on page 6). Use rigid spreaders or a spanner bar to provide vertical lift on the lifting straps. This will help to avoid damaging the frame or finish.

Follow these instructions to handle the capacitor bank:

1. Use load-rated cables or chains with safety hooks or shackles. Do not pass cables or chains through holes in lifting straps.
2. Use a load-rated spreader beam to prevent structure damage. Rig so that the minimum angle between the lifting cables or chains and equipment top is 45 degrees.
When elevating a shipping section not equipped with lifting straps, an overhead crane equipped with either of the following may be used:

- A chain coupled to a sling rigging
- A wire cable with safety hooks and shackles

Wrap the sling completely around the capacitor bank and shipping stringers (Figure 2 on page 6).

**Figure 1: Lifting with an Overhead Crane, Lifting Straps, and Cables or Chains**

![Diagram of lifting with an overhead crane](image)

When elevating a shipping section not equipped with lifting straps, an overhead crane equipped with either of the following may be used:

- A chain coupled to a sling rigging
- A wire cable with safety hooks and shackles

Wrap the sling completely around the capacitor bank and shipping stringers (Figure 2 on page 6).

**Figure 2: Capacitor Bank in Sling Rigging**

**CAUTION**

HAZARD OF EQUIPMENT DAMAGE—TOP HEAVY LOAD

Stabilize the shipping section to reduce the possibility of tipping.

Failure to follow these instructions can result in death or serious injury.

Handling with Forklift

A forklift is an alternative method of handling the capacitor bank.

**NOTE:** Always check the fork lengths to ensure that the forks extend under the entire capacitor bank. Carefully balance the load, and always use a safety strap when handling or moving a capacitor bank with a forklift (Figure 2).
Handling without Lifting Straps

Lifting straps are not furnished on rainproof enclosures. Use rollers, slings, or other means to handle the shipping section(s). The handling label (Figure 4) is affixed to each of these sections.

Figure 4: Handling Instruction Label, rainproof enclosure without Lifting Straps

NOTICE

HAZARD OF EQUIPMENT DAMAGE - LIFTING MEANS NOT PROVIDED

This equipment must be handled either by a sling or by rollers.

Failure to follow these instructions can result in equipment damage.

When elevating a shipping section not equipped with lifting straps, an overhead crane equipped with either of the following may be used:

- A chain coupled to a sling rigging
- A wire cable with safety hooks and shackles

Wrap the sling completely around the enclosure and shipping stringers (Figure 2 on page 6).

Storing

When storing the capacitor bank before installation, cover the top and openings of the equipment during the construction period to protect the capacitor bank from dust and debris.

If a capacitor unit is not installed and energized immediately, store it in a climate controlled building with adequate air circulation and protect it from dirt, air born contaminant and water. The acceptable storage temperatures are from -10°C (14°F) to 40°C (104°F).
Storing the capacitor bank outdoors may cause harmful condensation inside the capacitor bank.

**NOTE:** Install portable electric heaters of approximately 100 watts per vertical section in the capacitor bank enclosures for adequate protection during long term storage.

Before energizing the space heaters, remove all loose packing or flammable materials inside the capacitor bank.

After prolonged storage or exposure to high humidity, the main terminals should be subjected to resistance-to-ground measurements.

**NOTE:** If resistance measurement test shows less than 100 MΩ of resistance, steps must be taken to eliminate the moisture or contaminants causing low resistance to ground. Moisture levels may be reduced by blowing dry air into the cubicle or by the temporary installation of a heat source in the bottom of the cubicle. We recommend a minimum of 100 watts per section for 48 hours. If resistance to ground is still below 100 MΩ, consult Schneider Electric Service.

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**Section 3 — Equipment Description**

**AV5000**

The AV5000 system consists of capacitors controlled by contactors, and a power factor controller to control the operation of the contactors. The power factor controller continually monitors the load power factor, and automatically adjusts the number of capacitors connected to the line to regulate the reactive power compensation level to meet the power factor target.

The AV5000 (Figure 5) is available with a main breaker as option (BV). The AV5000 can be supplied with multiple sections to accommodate more capacitors.
AV6000/7000

The AV6000 is a detuned capacitor bank that consists of capacitors and reactors controlled by contactors, and a power factor controller to control the operation of the contactors. The power factor controller continuously monitors the load power factor, and automatically adjusts the number of capacitor/reactor stages connected to the line to regulate the power factor. Fixed tuned reactor prevents resonance and harmonic magnification at the dominant harmonic frequency, normally at 5th harmonic order.

Main lug incoming connection is standard for AV6000/7000 and main circuit breaker option (BV) is available.

AV7000 series capacitor bank is similar to AV6000 series capacitor bank except it is specially designed to tune closer to the 5th harmonic order current (4.7 tuning is typical).

AT6000/7000

Transient free reactive compensation (TFRC) systems are suitable for nearly all electrical networks and are ideal to correct poor power factor in electrical networks with a high concentration of electronic loads. Traditional electromechanical contactor switching of capacitors generates voltage transients that can impair the operation of sensitive process equipment. In TFRC system, capacitors are kept precharged at all times and connection to the network is performed when the capacitor precharge voltage matches the network voltage to achieve a transient free switch. Transient free switching also reduces wear on capacitors due to switching. This fact ensures longer life of the capacitor system and makes TFRC systems ideal for almost all electrical networks.
Catalog Numbering System

Automatic capacitor banks are standard/custom engineered and built to order equipment. The following catalog numbering system provides the Basic equipment information. Consult Schneider Electric for other number definitions.

**Standard/Configured-To-Order (CTO) Catalog System**

![Diagram of Catalog Numbering System]

**Engineered-To-Order (ETO) Catalog System**

**Table 1.1**

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</table>

**NOTE:** Step size subject to change without notice. Consult factory record drawing for actual step size.
Section 4 — Installation

Correct installation of VarSet™ low voltage automatic capacitor banks is essential for proper operation of all capacitor bank components. Study the associated instruction books and all drawings carefully.

**NOTE:** Do not stand on any part of the capacitor bank.

The location chosen for installation should provide working clearances complying with appropriate section of National Electrical Code® (NEC®) or the Canadian Electrical Code (CEC).

Automatic capacitor banks are assembled in the factory on a smooth level surface to ensure that all sections are properly aligned. A similar smooth and level surface should be provided by the customer for installation. An uneven foundation may cause misalignment of shipping blocks, units and doors.

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**DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- After removing power, wait for 5 minutes to allow the capacitors to discharge prior to opening the doors or removing covers.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.
- Carefully inspect the interior for tools left behind before closing and sealing the door.

Failure to follow these instructions will result in death or serious injury.

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Capacitor banks require field connections, including mains, and ground bus, to be accessible and maintainable from the front and should allow a minimum of three feet of free space from equipment front. For capacitor banks having rear ventilation, allow a minimum 6-inch (15 cm) clearance between the rear of the capacitor bank and the wall for proper ventilation. 24 inches clearance is required if the surface is made of flammable material.

To install NEMA/EEMAC 1 bank in a wet location or outside of the building, enclose the capacitor bank in an outdoor enclosure or equipment to prevent moisture or water from entering and accumulating within the enclosure.

Capacitor banks are not designed to be placed in hazardous locations. The area chosen should be well ventilated, free from excess humidity, dust and dirt. The temperature of the area should be no lower than -10°C (14°F) and no higher than 40°C (104°F). However the amount of time in operation at elevated temperatures should be limited to the following:

- 24 hour average: +40°C (104°F)
- 1 year average: +30°C (86°F)
Foundation Preparation

The floor or foundation must be strong enough to support the weight of the capacitor bank without sagging. The surrounding floor area should gently slope toward a drain.

To ensure correct bus bar alignment, the mounting pad or final installation site must be smooth and level. If parallel steel floor channels are imbedded for mounting the capacitor bank, take extra care to ensure the floor channels are level over their entire length to avoid distortion of the capacitor bank structure. Each channel should be level with the finished floor.

For bottom entry installation, when pouring the foundation, make provisions for conduits entering the capacitor bank from below and carrying the incoming and/or outgoing cables, control wiring, and ground cable. The bottom view in the equipment drawing shows the available conduit area for correct layout.

Conduits should project above the finished floor by about 2 in. (51 mm). However, to simplify moving the shipping sections into place, install the conduits flash with the concrete and, after the sections are in their final position, add the appropriate extension sleeves. Otherwise, raising the shipping section on timbers or lifting it by a crane to clear the conduit hubs will be necessary.

Before pouring the foundation, consider installing additional conduits for future expansion need.
Capacitor Bank Preparation

Remove dirt and debris from the foundation and surrounding area before moving the capacitor bank into final position.

Remove all packing and shipping materials.

The capacitor bank is equipped with a bottom closure plate in each vertical section. For bottom entry cables, remove and retain the plates to make any holes necessary for conduit entering the bottom of the capacitor bank. After making the holes, reinstall the closure plate.

Installation

CAUTION

HAZARD OF EQUIPMENT DAMAGE

Level and align adjacent shipping sections with one another. Ensure proper alignment of horizontal main through bus and proper splice bus connections.

Failure to follow these instructions can result in equipment damage.

Joining Shipping Sections—Indoor Capacitor Banks

Figure 8: Joining Adjacent Sections - Indoor Enclosure

Install the capacitor bank into its final position by leveling progressively each section and bolting the frames together, if separated. Position shipping sections as follows:

1. Maneuver each shipping section into the desired position using the procedures under “Handling” on page 5.
2. For bottom feed installation, carefully lower the section over the conduit stubs to comply with the “available conduit area” as shown in the bottom view of the equipment drawings. Otherwise, there may not be sufficient cable bending space.
3. Level the shipping section.
4. For multiple sections line up, after installation of each section is complete, make the through bus splice connection to the preceding section before installing the next section. Refer to “Joining Shipping Sections—Indoor Capacitor Banks” below for detail.

Joining Shipping Sections—Indoor Capacitor Banks

1. Position each adjacent section, carefully leveling and aligning it with the previous section. If lifting straps are provided, completely remove them from the sides being bolted together so the sections can be joined flush.

NOTE: Leave the other lifting straps on the capacitor bank if their removal is not required to join adjacent sections flush.

2. Open the front doors or remove panels, providing access to bolt adjacent shipping sections together.
3. Six bolts (3/8-16 x 1 inch) are provided. Place the bolts through the existing holes in the front and rear vertical corner channels to join adjacent sections (Figure 8).
4. Make the through bus splice connections to the preceding section. Replace all panels removed in step 2, and close front door.

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Joining Shipping Sections—Outdoor Capacitor Banks

1. Remove the center top cap (Figure 9) from the left-hand section, and retain all hardware for reuse.

**Figure 9:** Joining Adjacent Sections—Outdoor Enclosure (Typical)

2. When possible, open or remove the front and rear doors and panels, providing access to bolt adjacent shipping sections together. Leave the side barrier in place when joining multiple sections.

3. Position each adjacent section, carefully leveling it and aligning it with the previous section. If lifting straps are provided, completely remove them from the sides being bolted together so the sections can be joined flush.

4. Look for typical outdoor enclosure drawing **LO6CP295 (3R ENCLOSURE FINAL ASSY)** supplied inside capacitor bank. Under the END USER ASSEMBLY INSTRUCTIONS in the drawing, follow Step #5 thru Step #30 on joining adjacent sections as shown above.

**NOTE:** If lifting strap removal is not required to join sections, leave the lifting strap on the switchboard. Verify the bolt is tight to maintain 3R (Built-To) integrity.
5. Make the through bus splice connections to the preceding section.
6. Replace the center top cap removed in step 1.
7. Replace and secure the front and rear doors and panels removed in step 2.

Anchoring the Capacitor Bank

Although section is freestanding, a hard bump or shifting movement can result in damage to the splice joints between sections and conduit hubs connected to the sections. Therefore, each vertical section must be anchored to the floor.

**Figure 10: Capacitor bank Base Channels**

![Capacitor bank Base Channels Diagram](image)

Formed base channels run the width of the shipping section. The channels have 1.12-in. (28 mm) diameter holes for fastening the section to the floor (Figure 10). Anchor each section to the floor with 1/2-in. (Grade 5 minimum) bolts with one 1.25 in. (32 mm) outer diameter Grade 5 Belleville washer (provided by others) under the head of each bolt or anchor nut.

After all capacitor bank sections are properly joined together and the entire structure is bolted to the floor, install the incoming service conductors and load side cables.

*If the capacitor bank consists of only one shipping section, proceed to “Grounding” on page 16.*

Through Bus Splice Connections

**DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

Do not install through bus splice connectors with the capacitor bank energized.

Failure to follow these instructions will result in death or serious injury.

1. Make sure the capacitor bank frames are bolted together before completing the thru-bus splicing. Refer to Figure 11 while performing the following steps.
2. Remove all packing materials around the splice connectors.
3. Loosen the hex nuts on the ends of the thru-bus to be spliced.
4. Firmly grasp the splice connector and rotate it toward the loosened hardware on the adjacent thru-bus.
5. Grasp the splice connector and slide it toward the adjacent thru-bus.
6. Torque splice bolts to 70 lb-ft (95 N·m)
7. Repeat the above steps on all phases.
Ground Bus Splice Connections

Align and secure the ground bus splice connection between shipping sections. Torque connections to 23 ft-lb (31 N•m) (Figure 12).

Figure 11: Thru-Bus Splice Connections

Figure 12: Ground Bus Splice Connection
Grounding

Run a grounding electrode conductor from the grounding electrode at the installation site to the grounding electrode connector (ground lug) located on the ground bus (Figure 13). Select the material and size of this grounding electrode conductor to comply per NEC or CEC, and install it as specified.

Figure 13: Grounding Electrode Connector

Cable Pulling

VarSet low voltage automatic capacitor banks are constructed to customer specifications for the cable entrance arrangement (for example, top or bottom feed). Capacitor bank section components are arranged to give proper cable clearance and bending space for cables entering the capacitor bank section as specified on the equipment drawing.

DANGER
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Ensure that the equipment is attached to the wall and/or floor before beginning the power cabling procedure.

Failure to follow these instructions will result in death or serious injury.

1. Use only cable sizes suitable for a proper fit with the corresponding lugs.
2. Pull the proper number of cables according to appropriate sections of the NEC or CEC.
3. Position the cables inside the capacitor bank section so that they are not subject to physical damage.
4. Maintain the maximum possible bending radii and proper clearance to bus bars and grounded parts. If any cables are laying or bearing on structural members, support them to relieve this condition or place suitable protective material at the bearing point to protect the cable insulation.
5. Be certain to run all phase conductors through the same opening where cables enter or leave the capacitor bank section, or pass through any metal that has magnetic properties. Otherwise, overheating can result.

6. Refer to Figure 14 for typical cable run with support assembly (clamps) provided in standard AV/AT capacitor banks.

Figure 14: Typical Cable Support

Cable Terminations

1. Use a proper insulation stripping tool to strip a length of insulation from the end of the cable sufficient to fit into the full length of the lug barrel. Be careful not to nick or ring the strands.

2. If compression-type lugs are furnished as the main incoming lugs, unbolt and remove them to create sufficient room for crimping the lugs to the cables with the crimping tool.
   a. Insert the cable into the lug barrel and, using the crimping tool, make the specified number of crimps per the manufacturer’s recommendations.
   b. Wipe excess joint compound from the connector and insulation.

3. With the cables connected, remount the lugs onto the bus bars. Torque the bolts to the values given in “” on page 33.
Current Transformer (CT)

The CT provides a feedback signal required for the operation of the power factor controller. The CT is usually supplied with the bank and it is placed at the bottom of the section (during shipping). Occasionally a customer may request that the CT not be supplied with the unit. Check the order or packing list to see if a CT was supplied. If the existing CT is being used for an ammeter or other device, refer to section 4.6 (Use of an Existing Current Transformer), for connection instructions.

The CT secondary rating must be 5 A, e.g. with ratio such as 2000/5, 1200/5, etc.

CT Shorting Bar

The CT terminal block in the capacitor unit has a CT shorting bar. Until the system is commissioned, the shorting bar should be pushed to the “up” position and tightened in place. This will safely short the CT secondary circuit. See Figure 15.

Figure 15: CT Terminal Shorting Bar Positions

NOTE: The CT shorting bar must be in the DOWN position for the Automatic capacitor bank to operate.

Current Transformer Position

Refer to the single-line in Figure 16 and three-line diagrams in Figure 17. The CT must be located:

• On Phase A (which corresponds to the left-hand-side incoming cable terminal in the bank), and;
• Close to the substation transformer, on the line side of the main bus, ahead of all the loads and the capacitor bank.
Figure 16: Single-line Diagram

Single-line diagram of a typical installation

H1 towards the utility
Correct location of the current transformer
Substation transformer

Load  Automatic Capacitor Bank  Load  Load  Load

Figure 17: Three-line Diagram

Three-line diagram of a typical installation

NOTE: Install the current transformer on Phase A with H1 towards the utility.

In the VarSet unit, Phase A is the left-most bus stub when viewed from the front.

TB2 has a CT Shorting Bar across terminal X1 and X2 from the front.
The CT should be installed with the correct polarity. For the split-core CT normally supplied with the capacitor bank, install the side labeled “H1” towards the utility source and away from the load. Refer to Figure 18 at left to see the “H1” label.

A CT already installed on the busbar and connected to an ammeter or other device, can be used subject to the following conditions:

- The CT must be located upstream of all loads, including the capacitor bank. Refer to Figure 16 on page 19.
- The CT burden rating must be sufficient to support the controller and its connecting wires. See “Current Transformer Position” on page 18 for correct CT location.
- Connect the CT circuit as shown in Figure 19:

**Figure 18: Current Transformer**

**Use of an Existing Current Transformer**

**DANGER**

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

An open circuit CT secondary may develop lethal voltage. Short the CT terminals before and while working on CT circuits.

Failure to follow these instructions will result in serious injury or death.
Sizing Overcurrent Protection Device

Short circuit and overcurrent protection device must be provided upstream from the capacitor bank, especially for the main lug type (AV/AT). Consult appropriate section of National Electrical Code (NEC®) or the Canadian Electrical Code (CEC) for more information about overcurrent protection, cable ratings and wire size determination.

Section 5 — Startup and Commissioning

Instruments Required for Commissioning

- Voltmeter, or Fluke 43b or equivalent multimeter
- Clamp-on ammeter
- Megger

Pre-energizing Procedure

Conduct a complete inspection before the capacitor bank section is energized.

Complete every step of the pre-energizing procedure listed before energizing the capacitor bank section.

1. Ensure that the capacitor bank is de-energized. Ensure that the main breaker (internal or external) feeding the capacitor bank is open. Make sure lockout tag out procedure is followed.

2. Open the front door of the capacitor bank and test for line voltage, L-L, L-Ground at the bottom of F1, aF2, F3 (Figure 20) control fuses). There should be no voltage (0 Volts).

Figure 20: Fuse View

3. Repeat the test above at the top of F1, F2, F3. There should be no voltage (0 Volts).

4. Visual Inspection: Using a flashlight inspects incoming cables, cable lugs, vertical bus, insulators, line and load side breaker (or fuse) cables, line and load side contactor cables, line and load side reactor cables (where applicable) and cables to the capacitors.

5. Pull check all power cabling to the circuit breakers, contactors, reactors and capacitors. Remove internal blanking panels if required.
6. Where equipped, check cable bolted connection to breaker terminations. Check for trapped insulation and reseal cables if necessary. Tighten all cable terminations into the breaker bases. Refer to Table 4 on page 34 for proper torque value.

7. Check all field-installed bus bar connections. Torque values are listed in “Section 7—Torque Values for Mechanical and Electrical Connections” on page 34.

8. Check all accessible connections for tightness.

9. Inspect all contactors, resistors/wires mounted on top of the soft charge contacts (AV5000 only), control fuses, ground fault interrupter. Inspect all associated power and control wiring for loose connections or trapped insulation.

10. Check all factory- and field-installed lug terminations for tightness.

11. Check the rigidity of all bus bar supports.

12. Check the capacitor bank section enclosure for dents or other damage that may reduce electrical clearances inside the capacitor bank section.

13. Remove all foam blocks, or other temporary cushioning or retaining material, from the electrical devices.

14. Manually open and close all stage circuit breakers, check for correct alignment and free operation. Leave all circuit breakers in the open (OFF) position.

15. Confirm that the CT has been installed on phase A of the main incoming bus or main breaker. Refer to Figure 16 on page 19 for correct CT location.

16. Inspect the CT shorting terminal block mounted in the middle of the control section. Make sure that the CT shorting bar is in "Up" position (see Figure 15). Confirm by taking current readings with a clamp on meter. Only the customer supplied wires to the top of the CT shorting terminals should read current in the range of 0-5 Amps. If wires read in excess of 5 Amps, call Schneider Electric service for assistance.

17. Open circuit all control fuses F1, F2, F3 and F4 (Figure 20). Check these fuses for continuity. DO NOT REPLACE THE FUSES.

18. Inspect the rear of the controller for damage. Disconnect all wiring plugs from the rear of the controller.

19. Vacuum to remove any dust, scrap wire, or other debris.

20. Megger (max 1000 V) the 3 phase main bus bars L-L and L-Ground. Record all measurements.

21. Megger (max 1000 V) the bottom cables of the stage breakers) L-L and L-GND. (cables runs from the bottom of molded case circuit breaker to the bottom of respective phase of stage contactor). Record all measurements.

22. Megger (max 1000 V) the cables on the top side of all 3 phase stage contactors (Line to Ground only). Record all measurements.

**NOTE:** All megger values should be 100 megohms or greater.

23. If the resistance reads less than 100 megohm while testing with the branch circuit devices in the open position, the system may be unsafe and should be investigated. Consult Schneider Electric Services for assistance.

24. Reconnect all wiring plugs on the rear side of the controller. Replace all covers; check for any pinched wires, and close doors. Make certain all enclosure parts are aligned properly and securely fastened.
The automatic capacitor bank is ready for startup. Refer to (“Startup Procedure”) below.

**Startup Procedure**

<table>
<thead>
<tr>
<th>DANGER</th>
</tr>
</thead>
</table>

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- After removing power, wait for 5 minutes to allow the capacitors to discharge prior to opening the doors or removing covers.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

The following are steps to startup and commissioning the automatic capacitor banks:

1. Record nameplate details on Table 11 on page 36 for future reference.
2. Close the main disconnect device to energize the automatic capacitor bank.
3. After 1 minute, open the front door of the capacitor bank and confirm the presence of line volts at the top of control fuses F1, F2 and F3, see Figure 20 on page 21. Open the main disconnect device to de-energize the automatic capacitor bank. Repeat step 2 and step 3. on page 21 to confirm line isolation.
4. Reconnect all controller plugs on the rear of the controller. Insert all control fuses, F1, F2, F3 and F4.
5. Close up the capacitor bank unit. Close and engage front doors locks and bolts.
6. Re-energize the capacitor bank unit by closing the main disconnect device. You will have to program the VL12 power factor controller following the step listed in the “Power Factor Controller Programming” on page 24.
7. This applies to AT unit only. With the unit in full operation (all three stages on), wait at least 5 minutes. Each switching module (gray box protruding through front door of cubicles) is equipped with a thermostatically controlled heatsink fan that when running, blows air out of the gray box. The heatsink fan will only run if three stages are running continuously for minimum of 5 minutes. If there are only 2 stages, it will run at least after 10 minutes.

**NOTE:** If the room ambient temperature is below 30°C, then it may take longer for fan to be run. If there are only 1 stage, the fan may not run at all. But this is normal.
Power Factor Controller (Setup)

Figure 21: VarPlus Logic VPL12 Controller

**Fig. 21: VarPlus Logic VPL12 Controller**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARCFLASH**

Never reduce the steps’ connection time under 50s. Failure to follow these instructions will result in death or serious injury.

**NOTICE**

**RISK OF DEGRADATION OF EQUIPMENT PERFORMANCE**

The controller is configured in the factory for normal or optimal operation. The user is liable for any modification of these parameters. Failure to follow these instructions will lead to the total or partial loss of the equipment and non-availability of the installation.

Although the regulator installed in your VarSet capacitor bank had been pre-configured with your equipment it remains following settings to define:
- Target cos φ setting
- Current transformer ratio value (allows to display the measured value correctly).

**Note:** For more detailed information on the controller, please refer to the device manual supplied with the equipment.

**Important**

- If supplied by a summing CT (installation with several CTs), the sum of the ratios of the different CTs must be taken into consideration.
- For an installation equipped with a generator set, the capacitor bank must be taken out of circuit, by breaking the supply to the controller, before switching to the generator set.
Simple Commissioning of VarPlus Logic controller

Before configuring the controller, please ensure that the jumper on KL terminals is removed.

Go to SETUP 100:
1. Setup CT ratio (Ct), cos φ (CP1).
2. If the controller display is showing PFC OFF, set the PFC parameter to ON, before launching Ai.
3. Launch automatic initialization (Ai) by pressing “Ai” from “OFF” to “ON.”

The Ai automatically detects the capacitor steps connected and checks if the phase connection (angle between voltage and CT position) is correct. The Ai sequence switches the steps on and off several times. It will take several minutes to complete this process, and later the relay will stabilize.

During this sequence the controller will display “Ai.”

<table>
<thead>
<tr>
<th>Minimum requirements to launch an Ai</th>
<th>For a successful Ai stop detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage must be within tolerance</td>
<td>CT ratio dimensioning must be in accordance with the transformer dimension</td>
</tr>
<tr>
<td>CT must be connected</td>
<td>Size of the smallest step not too small</td>
</tr>
<tr>
<td>Capacitor protection must be close</td>
<td>Level of loading when Ai is launched</td>
</tr>
<tr>
<td>Input current not too low.</td>
<td>Load variation during the Ai sequence.</td>
</tr>
</tbody>
</table>

At end of “Ai,” the controller will move to “Auto” mode.

<table>
<thead>
<tr>
<th>Successful Ai sequence info</th>
<th>Unsuccessful Ai sequence [*“Abort” (abort) error]</th>
</tr>
</thead>
<tbody>
<tr>
<td>If phase wiring is swapped (incorrectly wired), the controller automatically corrects the phase angle internally and moves to normal mode. “Auto” is displayed.</td>
<td>If unsuccessful, run the Ai again. If the Ai aborts again, the phase connection (angle between voltage and CT position) cannot be detected. The control will move to PFC off mode and phase connection must be set manually. See user manual.</td>
</tr>
<tr>
<td>Final check of step detection:</td>
<td></td>
</tr>
<tr>
<td>□ Go to SETUP 100 -&gt; OUT -&gt; open (right arrow) and check if the status of all steps are correct according to the PFC bank configuration (FIX OFF = Step not detected. AUTO = Step detected)</td>
<td></td>
</tr>
<tr>
<td>□ If necessary, change the OUT status to expected value.</td>
<td></td>
</tr>
</tbody>
</table>
The diagnosis of a problem, during equipment commissioning, generally can be done from the display of the regulator.

- ALARM flashes when there is a alarm.
- Alarm menu lists the 5 last alarms logged.

<table>
<thead>
<tr>
<th>Alarm</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI/Abt ALARM</td>
<td>Abort of auto-initialization</td>
<td>Variations in the load or too small measured current signals may abort auto initialization.</td>
</tr>
<tr>
<td>U ALARM</td>
<td>Measured voltage is outside the voltage tolerance.</td>
<td>Check settings for nominal voltage and voltage transformer.</td>
</tr>
<tr>
<td>I LO ALARM</td>
<td>Measured current is too low (CT current &lt; 15 ma).</td>
<td>Connection error of CT; short-link of CT is not removed; CT ratio is too high compared to real current; no current.</td>
</tr>
<tr>
<td>I Hi ALARM</td>
<td>Measured current is too high.</td>
<td>Load is too high or improper CT selection.</td>
</tr>
<tr>
<td>PFC ALARM</td>
<td>The controller cannot achieve the target cos φ. Over or under compensation.</td>
<td>Check if all steps are correctly defined and working. Check if sizing of the PFC bank is enough compared to KVAR required by the load.</td>
</tr>
<tr>
<td>HAr ALARM</td>
<td>THDU limit is exceeded. Controller disconnects the steps to correct THDU.</td>
<td>Check installation, THD U too high or possible resonance.</td>
</tr>
<tr>
<td>Step/Fly ALARM (faulty step is blinking)</td>
<td>One or more steps are defective (detected as faulty after connecting the step 3 times without any measurements).</td>
<td>Check steps connection, molded-case circuit breakers (MCCBs) or fuses position and capacitor status.</td>
</tr>
<tr>
<td>SPL/Nr ALARM</td>
<td>Step detected with remaining power less &gt; 75 % of initial value.</td>
<td>Check settings and check capacitance of the capacitor.</td>
</tr>
<tr>
<td>Thi ALARM</td>
<td>The alarm temperature limit is exceeded.</td>
<td>Check fans and ambient temperature.</td>
</tr>
<tr>
<td>OPH ALARM</td>
<td>Set limit for max. allowable operation hours limit is exceeded.</td>
<td>Check the MCCBs/Fuses, contactors and capacitors in the step. Check the capacitance value and replace capacitors if the capacitance has fallen below tolerance limit.</td>
</tr>
<tr>
<td>OPC/Nr ALARM</td>
<td>Set limit for max. allowable operation cycles limit is exceeded.</td>
<td>Check the MCCBs/Fuses, contactors and capacitors in the PFC Bank. Check the capacitance value and replace capacitors if the capacitance has fallen below tolerance limit.</td>
</tr>
<tr>
<td>OL ALARM</td>
<td>Limit of Capacitor overload current ratio (based on THDU calculation) is exceeded.</td>
<td>Check installation, THD U too high, or possible resonance.</td>
</tr>
<tr>
<td>HU ALARM</td>
<td>One or more steps are detected in hunting mode. Step number and error code will flash.</td>
<td>Check steps connection, molded-case circuit breakers (MCCBs) or fuses position and capacitor status.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anomaly</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>No indication AUTO</td>
<td>Relays do not switch.</td>
<td>In SETUP/100 menu, the selection for PFC is set to OFF or HOLD; CT ratio is not set; temperature is too high; current is &lt; 15 ma; voltage, THD U, or overload current ratio is out of tolerance.</td>
</tr>
<tr>
<td>EXPORT</td>
<td>kW export.</td>
<td>If there is no real kW export, check the voltage and current connections to the controller.</td>
</tr>
<tr>
<td>Wrong Cos φ indication</td>
<td>Wiring does not correspond to controller settings.</td>
<td>Check voltage and current connections to the controller.</td>
</tr>
<tr>
<td>Frequent switching of steps</td>
<td>Size of capacitors is not completely detected / capacitors are inoperable.</td>
<td>Check size of capacitor in INFO menu.</td>
</tr>
<tr>
<td>All steps are set to “Fix off”</td>
<td>CT not correctly located or connected, short link not removed.</td>
<td>Check CT connection and position.</td>
</tr>
</tbody>
</table>
Section 6 — Preventive Maintenance (PM)

First Scheduled PM (3 months after commissioning)

The interval between maintenance checks can vary depending upon the amount of usage and environmental conditions of each installation. The following preventative maintenance procedure should be carried out by qualified personnel 3 month after commissioning of the new unit, and at least once every 6-12 months thereafter.

1. Check the controller display is active and no alarm condition is present.

2. Check that cubicle ventilation fans are active (when unit is in operation for at least 2 hours with full load, the fans are normally on). All fans can be turned on and off by the fan thermostat(s).

3. Check that all ventilation openings are clear.

4. With the unit in full operation (all stages on), listen and identify the source of any loud noise, i.e., >50dB. Those identified noise sources are possible maintenance items which require further investigation, i.e., detuned stages, improperly seated contactors, loose components or panels. If nothing is found and noise persists, contact SE service.

5. Open the disconnect to de-energize the capacitor bank. Ensure that the main breaker (internal or external) feeding the capacitor bank is open. Make sure lockout tag out procedure is followed.

6. Open the front door of the capacitor bank and test for line voltage, L-L, L-Ground at the bottom of F1, F2, F3 (Figure 20) control fuses). There should be no voltage (0 Volts)

7. Use an infrared scanner to scan all accessible current carrying components including control wiring, power cabling, fuses, breakers contactors, capacitors, and incoming power cabling terminations. Ideally the heat scanner can record a scaled infrared image for future reference.

   a. Any component/locations showing a noticeable higher temperature (5-10°C) than identical adjacent components, that component must be de-energized/line isolated for future inspection or maintenance. These components must remain line isolated until the cause of the excessive temperature rise is determined and corrected.

   b. Capacitor tubes showing a temperature rise greater than 5 °C or 9 °F than any other capacitor tubes are suspect and must be de-energized or isolated until the cause of the excessive temperature rise is determined and corrected.

   c. To scan the switching module in AT/BT unit, remove the bolt connected to the bracket and switching module, swing the module outward around 30-45 degree (Figure 23), scan the cable connections.

8. Manually trip all stage breakers. For AT unit, the stage breaker is behind the switching module, see Figure 23.

9. Close and engage front doors locks and bolts.

10. Re-energize the capacitor bank unit.

11. Open the front door while unit is energized.

12. Use the Step 11 on page 28 to manually turn one stage on at time. Initiate a thermistor trip for each stage by disconnecting the wire at T1 of each respective thermistor relay(Figure 24). This will immediately open that stage contactor, thus confirming the circuit is active. Re-connect wire at T1. Reset the thermistor relay by pushing the “Reset” button, the stage contactor should reclose immediately. Repeat for all stage thermistor pairs.
**NOTE:** Signs of over-temperature on components are changing appearance of their surface, such as duller, shinier, cracked, brittle or burnt. Any change of color or appearance that differs from other identical components should be investigated.

If the section internal temperature exceeds 122°F (50°C), the over-temperature thermostat(s) will initiate a thermal trip function, shutting down the control power for entire unit. A manual reset procedure will need to be initiated. Refer to “Thermal Relay Reset Procedure” on page 33 for detail.

**Regularly Scheduled PM (Every 6-12 Months)**

Ensure that the capacitor bank is de-energized and wait five minute before opening the front door. Ensure that the main breaker (internal or external) feeding the automatic capacitor bank is open.

1. Repeat steps outlined in 3 month PM above.
2. Use the Step 11 on page 28 to manually turn the first stage on. Measure and record line to line voltage by using Fluke 43b or equivalent multimeter in harmonic mode on Table 15 on page 38.
3. Use the Step 11 on page 28 to manually turn one stage on at time. With the stage energized, measure and record the stage’s 3 phase line currents using a Fluke43b clamp-on rms ammeter in harmonic mode and record the results on Table 15 on page 38. Manually turn the stage off before turning on the next stage. Repeat the measurement for each stage as above.
4. Open the main disconnect device to de-energize the automatic capacitor bank and wait 5 minutes
5. Open the front door of the capacitor bank and test for line AC voltage, L-L, L-Ground at the bottom of F1, F2, F3 (Figure 20) control fuses). There should be no AC voltage (0 Volts).
6. Repeat the test above at the top of F1, F2, F3. There should be no AC voltage (0 Volts).
7. Using DC voltage meter, or multimeter set to DCV (1000VDC capable) to test each capacitor stage for residual DC voltage:
   a. At top of each stage contactor (load side), measure line to line and line to ground voltages (A-B, A-C, B-C, A-GND, B-GND, C-GND).
   b. For AT series unit, measure line to line and line to ground voltage from the capacitor terminals Figure 25.
   c. If any reading is higher than 1 volt, the capacitor is not fully discharged and should be isolated for further investigation.

8. Inspect the capacitor bank for any signs of overheating. Discoloration and flaking of insulation or metal parts are indications of overheating.

   **NOTE:** If overheating occurs, be sure that all conditions that caused the overheating have been corrected. Loose or contaminated connections can cause overheating.

9. Inspect all insulating materials. Before re-energizing the capacitor bank, replace insulators with any visible damage (such as cracks).

10. Check all field-installed bus bar connections. Torque values are listed in “Section 7—Torque Values for Mechanical and Electrical Connections” on page 34.

11. Check all bus bar joints and terminal lugs for any pitting, corrosion, or discoloration resulting from high temperatures or subjection to high fault conditions. If any damage has occurred, replace the bus bars or lugs.

12. If equipped with power fuses, remove each power fuse and inspect the fuse, fuse holder, fuse base and connected power terminations for thermal damage. Check the fuse for continuity, inspect the fuse for cracks in the fuse body, tighten the fuse in the fuse holder and then tighten the cable terminations into the fuse base. Reinstall the fuse holder back into its original fuse base.

   **NOTE:** Do not use excessive force to reinstall the fuse holder into the fuse base. Such action can damage the fuse holder spring clips, causing high resistance at connection point, resulting possible thermal failure of the fuse components.

13. Using a screwdriver to ensure all contactor armatures have full travel and do not bind at any time.

14. Check that all contactor charge resistors (AV5000 only) are intact. There are 6 soft charge resistors mounted between each of the main phase contacts and the corresponding phase of each auxiliary contact block. See Figure 26. Visually inspect all capacitors for cracked or split tubes. A flashlight and mirror may be required. As an alternative, run your fingers along the surface of the capacitor tubes to feel any cracks or splits. Pay special attention to any capacitor blocks which have measured low currents. If access is available, remove side and rear panel(s).

15. Open all control fuses holders and remove fuses F1, F2, F3 and F4 (Figure 20 on page 21). Check the fuses for continuity. **DO NOT REPLACE THE FUSES.**

16. Replace the fuses back to the fuse holders and close them.

17. Vacuum to remove any dust or other debris.

18. Check the capacitor bank interior carefully for moisture, condensation build-up, or signs of any previous wetness. Moisture can cause insulation failures and rapid oxidation of current-carrying parts. Inspect all conduit entrances and cracks between the enclosure panels for dripping leaks. Condensation in conduits may be a source of moisture and must not be allowed to drip onto live parts or insulating material. Take the necessary steps to eliminate the moisture and seal off all leaks.
Thermal Relay Reset Procedure

**DANGER**

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- After removing power, wait for 5 minutes to allow the capacitors to discharge prior to opening the doors or removing covers.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

An internal thermostat (TR1, TR2, etc) will be installed in each section of the capacitor bank to monitor internal temperature. Once the temperature reaches 50°C, this thermostat will trigger a latching relay which will de-energize the capacitor bank control circuit, thus shut down the entire bank operation. To reset the relay, the following procedure should be followed:

1. Check the fan inlets for any debris blocking the vent.
2. Check the vent outlet for any debris.
3. Check ambient temperature at inlet point (<40°C).
4. Check overheated internal components. Refer to steps listed in “Regularly Scheduled PM (Every 6 -12 Months)” on page 31.
5. Once the internal temperature drops below 50°C, internal thermostat will reset itself.
6. Manually reset the latching relay located at top right hand side of the section (see Figure 27 or Figure 28).
7. Energize the capacitor bank per “Section 6 — Preventive Maintenance (PM)” on page 30

**Figure 26: Thermostat and Latching Relay (older model)**

**Figure 27: Thermostat and Latching Relay (new model)**
### Section 7—
Torque Values for Mechanical and Electrical Connections

#### Table 2: Incoming Lug (ILSCO) Torque Value

<table>
<thead>
<tr>
<th>Socket Size Across Flats</th>
<th>Torque Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb-in</td>
<td>lb-ft</td>
</tr>
<tr>
<td>3/16 in.</td>
<td>120</td>
<td>10</td>
</tr>
<tr>
<td>7/32 in.</td>
<td>150</td>
<td>12.5</td>
</tr>
<tr>
<td>1/4 in.</td>
<td>200</td>
<td>16.6</td>
</tr>
<tr>
<td>5/16 in.</td>
<td>275</td>
<td>23</td>
</tr>
<tr>
<td>3/8 in.</td>
<td>375</td>
<td>31</td>
</tr>
<tr>
<td>1/2 in.</td>
<td>500</td>
<td>41</td>
</tr>
<tr>
<td>9/16 in.</td>
<td>600</td>
<td>50</td>
</tr>
</tbody>
</table>

#### Table 3: Connection to Bus Bars Torque Value

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Hardware size</th>
<th>Torque Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexhead</td>
<td>1/4-20</td>
<td>72</td>
<td>6</td>
</tr>
<tr>
<td>Hexhead</td>
<td>5/16-18</td>
<td>155</td>
<td>12.9</td>
</tr>
<tr>
<td>Hexhead/Carriage Bolt</td>
<td>3/8-16</td>
<td>280/216</td>
<td>23.3/18</td>
</tr>
<tr>
<td>Hexhead/Carriage Bolt</td>
<td>1/2-13</td>
<td>600/350</td>
<td>50/29</td>
</tr>
</tbody>
</table>

#### Table 4: Circuit Breaker Terminal Nuts Torque Value

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Tap</th>
<th>Torque Value (Line/Load Connector Bolts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-Frame Terminal Nut Insert - English</td>
<td>1/4-20</td>
<td>80-90 lb-in/6.6-7.5 lb-ft (9 - 10 N(\cdot)m)</td>
</tr>
<tr>
<td>H-Frame Terminal Nut Insert - Metric</td>
<td>M6</td>
<td></td>
</tr>
<tr>
<td>J-Frame Terminal Nut Insert - English</td>
<td>5/16</td>
<td></td>
</tr>
<tr>
<td>J-Frame Terminal Nut Insert - Metric</td>
<td>M8</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 5: Contactor Power Connection Torque Table

<table>
<thead>
<tr>
<th>Contactor Type</th>
<th>Torque</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LC1F150</td>
<td>200</td>
<td>16.6</td>
</tr>
<tr>
<td>LC1F115</td>
<td>120</td>
<td>10</td>
</tr>
<tr>
<td>LC1D50</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>LC1DWK</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>LC1DMK</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>LC1D80</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>LC1D25</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>CONTROL CONNECTION, All Type of Contactor and Relays</td>
<td>10.5</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 6: Capacitor Connection Torque Table

<table>
<thead>
<tr>
<th>Capacitor Type</th>
<th>Torque</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ib-in</td>
<td>Ib-ft</td>
<td>N·m</td>
</tr>
<tr>
<td>Varplus 2 - Assembly</td>
<td>60</td>
<td>5</td>
<td>6.7</td>
</tr>
<tr>
<td>Varplus 2 - Electrical</td>
<td>168</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>EPCO - Assembly</td>
<td>88</td>
<td>7.3</td>
<td>10</td>
</tr>
<tr>
<td>EPCO - Electrical</td>
<td>10.6</td>
<td>0.88</td>
<td>1.2</td>
</tr>
<tr>
<td>Varplus CAN - Assembly</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Var plus CAN-Electrical</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

### Table 7: Reactor Connection Torque Table

<table>
<thead>
<tr>
<th>Hardware Size</th>
<th>Torque</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ib-in</td>
<td>Ib-ft</td>
<td>N·m</td>
</tr>
<tr>
<td>5/16-18</td>
<td>96</td>
<td>8</td>
<td>10.8</td>
</tr>
<tr>
<td>3/8-16</td>
<td>168</td>
<td>14</td>
<td>19</td>
</tr>
</tbody>
</table>

### Table 8: Control Transformer Connection Torque Table

<table>
<thead>
<tr>
<th>Hardware Size</th>
<th>Torque</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ib-in</td>
<td>N·m</td>
<td></td>
</tr>
<tr>
<td>6-32</td>
<td>9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8-32</td>
<td>16</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>10-24</td>
<td>19</td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 9: Other Auxiliary Device Torque Table

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Torque</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ib-in</td>
<td>N·m</td>
<td></td>
</tr>
<tr>
<td>GFI</td>
<td>24</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Control Fuse</td>
<td>10.5</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Controller</td>
<td>10.5</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Control Terminal Block</td>
<td>10.5</td>
<td>1.1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 10: Power Fuse Connection Torque Table

<table>
<thead>
<tr>
<th>Fuse Name</th>
<th>Torque</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ib-in</td>
<td>Ib-ft</td>
<td>N·m</td>
</tr>
<tr>
<td>200 AMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Connection</td>
<td>216</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Fuse Connection</td>
<td>120</td>
<td>10</td>
<td>13.5</td>
</tr>
<tr>
<td>100 AMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Connection</td>
<td>36</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Fuse Connection 30A</td>
<td>12</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>Fuse Connection 40A - 60A</td>
<td>16</td>
<td>-</td>
<td>1.8</td>
</tr>
<tr>
<td>Fuse Connection 80A - 100A</td>
<td>30</td>
<td>-</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Section 8 — Maintenance Record

Equipment Information

Write down equipment nameplate information to Table 11.

Table 11: Capacitor Bank Information

<table>
<thead>
<tr>
<th>Factory No.</th>
<th>Equipment Type</th>
<th>Voltage Rating</th>
<th>Maximum kVAR Installed</th>
<th>Current Rating (Amps)</th>
<th>I_{eff}</th>
<th>Smallest Step Size (kVAR)</th>
</tr>
</thead>
</table>

Installation and Maintenance Log

Maintenance log table.

Table 12: Installation and Maintenance log

<table>
<thead>
<tr>
<th>Date</th>
<th>Job Description</th>
<th>Name/Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Use this log to record installation and maintenance activities performed on the unit.
Table 13 and 14 are dielectric resistance measurement record tables.

Table 13: **Main bus Insulation Resistance Record**

<table>
<thead>
<tr>
<th>Date</th>
<th>Main bus Phase to Ground</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a-ground MΩ</td>
<td>b-ground MΩ</td>
<td>c-ground MΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14: **Contactor Insulation Record**

<table>
<thead>
<tr>
<th>Date</th>
<th>Contactor number</th>
<th>Contactor phase to ground</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>a-ground MΩ</td>
<td>b-ground MΩ</td>
<td>c-ground MΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 9 — Dimension and Weight Information

5000, 6000 and 7000 series capacitor section dimension and weight information are listed in the table below.

### Table 15: Voltage and Stage Current Record Log

<table>
<thead>
<tr>
<th>Date</th>
<th>Stage number</th>
<th>Va-b</th>
<th>Va-c</th>
<th>Vb-c</th>
<th>Ia</th>
<th>Ib</th>
<th>Ic</th>
</tr>
</thead>
</table>

### Table 16: Section Dimension and Weight Table

<table>
<thead>
<tr>
<th>Frame Size</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
<th>Weight(Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inch</td>
<td>mm</td>
<td>Inch</td>
<td>mm</td>
</tr>
<tr>
<td>AV5000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
<tr>
<td>AV6000/7000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
<tr>
<td>BV5000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
<tr>
<td>BV6000/7000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
<tr>
<td>AT6000/7000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
<tr>
<td>BT6000/7000</td>
<td>91.5</td>
<td>2324</td>
<td>30</td>
<td>762</td>
</tr>
</tbody>
</table>

* Main breaker section weight

**NOTE:** Weight information is approximate and subject to change without notice.
VarSet Low Voltage Automatic Capacitor Bank
Instruction Bulletin

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