

Operation

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Introduction

Qualified Persons

WARNING

The equipment covered by this publication must be installed, operated, and maintained by qualified persons who are knowledgeable in the installation, operation, and maintenance of overhead electric power distribution equipment along with the associated hazards.

A qualified person is one who is trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read this Instruction Sheet

NOTICE

Read this instruction sheet thoroughly and carefully before installing or operating an IntelliCap Plus Automatic Capacitor Control. Familiarize yourself with the Safety Information on page 4 and Safety Precautions on page 5. The latest version of this publication is available online in PDF format at sandc.com/en/support/product-literature/.

Retain this Instruction Sheet

This instruction sheet is a permanent part of the IntelliCap Plus Automatic Capacitor Control. Designate a location where you can easily retrieve and refer to this publication.

Proper Application

WARNING

The equipment in this publication must be selected for a specific application. The application must be within the ratings furnished for the selected equipment.

Special Warranty Provisions

The standard warranty contained in S&C's standard conditions of sale, as set forth in Price Sheets 150 and 181, applies to the IntelliCap Plus Automatic Capacitor Control, except that the first paragraph of the said warranty is replaced by the following:

- (1) General:** The seller warrants to the immediate purchaser or end user for a period of 10 years from the date of shipment that the equipment delivered will be of the kind and quality specified in the contract description and will be free of defects of workmanship and material. Should any failure to conform to this warranty appear under proper and normal use within 10 years after the date of shipment, the seller agrees, upon prompt notification thereof and confirmation that the equipment has been stored, installed, operated, inspected, and maintained in accordance with the recommendations of the seller and standard industry practice, to correct the nonconformity either by repairing any damaged or defective parts of the equipment or (at the seller's option) by shipment of necessary replacement parts. The seller's warranty does not apply to any equipment that has been disassembled, repaired, or altered by anyone other than the seller. This limited warranty is granted only to the immediate purchaser or, if the equipment is purchased by a third party for installation in third-party equipment, the end user of the equipment. The seller's duty to perform under any warranty may be delayed, at the seller's sole option, until the seller has been paid in full for all goods purchased by the immediate purchaser. No such delay shall extend the warranty period.

Replacement parts provided by the seller or repairs performed by the seller under the warranty for the original equipment will be covered by the above special warranty provision for its duration. Replacement parts purchased separately will be covered by the above special warranty provision.

Warranty of the IntelliCap Plus Automatic Capacitor Control is contingent upon the installation, configuration, and use of the control or software in accordance with S&C's applicable instruction sheets.

This warranty does not apply to major components not of S&C manufacture, such as communication devices. However, S&C will assign to the immediate purchaser or end user all manufacturer's warranties that apply to such major components.

Warranty of equipment/services packages is contingent upon receipt of adequate information on the user's distribution system, sufficiently detailed to prepare a technical analysis. The seller is not liable if an act of nature or parties beyond S&C's control negatively impact performance of equipment/services packages; for example, new construction that impedes radio communication, or changes to the distribution system that impact protection systems, available fault currents, or system-loading characteristics.

Safety Information

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels attached to the IntelliCap Plus Automatic Capacitor Control. Familiarize yourself with these types of messages and the importance of these various signal words:

DANGER

“DANGER” identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

WARNING

“WARNING” identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

CAUTION

“CAUTION” identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

“NOTICE” identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If you do not understand any portion of this instruction sheet and need assistance, contact your nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C’s website sandc.com, or call the Global Support and Monitoring Center at 1-888-762-1100.

NOTICE

Read this instruction sheet thoroughly and carefully before installing or operating an IntelliCap Plus Automatic Capacitor Control.



Replacement Instructions and Labels

If additional copies of this instruction sheet are needed, contact your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

⚠ DANGER



The IntelliCap Plus Automatic Capacitor Control line voltage input range is 93 to 276 Vac. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

1. **QUALIFIED PERSONS.** Access to the IntelliCap Plus Automatic Capacitor Control must be restricted only to qualified persons. See the "Qualified Persons" section on page 2.
2. **SAFETY PROCEDURES.** Always follow safe operating procedures and rules. Always maintain proper clearance from energized components.
3. **PERSONAL PROTECTIVE EQUIPMENT.** Always use suitable protective equipment, such as rubber gloves, rubber mats, hard hats, safety glasses, arc-flash clothing, and fall protection, in accordance with safe operating procedures and rules.
4. **SAFETY LABELS.** Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE" labels and tags. Remove tags ONLY if instructed to do so.
5. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.

Hardware and Software

Applicable Software

This instruction sheet was prepared for use with IntelliCap Automatic Capacitor Control software: PCSD126S and PCVD126S.

Software identification is available on the IntelliLink® Setup Software *Product Information* screen. For questions regarding the applicability of information in this instruction sheet to future product releases, please contact S&C Electric Company.

Hardware Components

This section describes various capacitor control components. The following section, “Capacitor Control Operation” on page 14, explains how these components work together to monitor the distribution feeder and manage capacitor bank operation. Figure 1 shows hardware components of the capacitor control that may need to be accessed during regular operation and troubleshooting.

SCADA ports—The capacitor control has two SCADA ports. If the control includes communications equipment, it will usually be connected to Port A, labeled SCADA PORT on the faceplate.

Terminal strip—Every capacitor control includes a terminal strip; its configuration is shown on a label on the inside of the enclosure door. See Figure 1. If necessary, reconfigure the wiring to the meter base plug or the connectors on the bottom of the control enclosure.

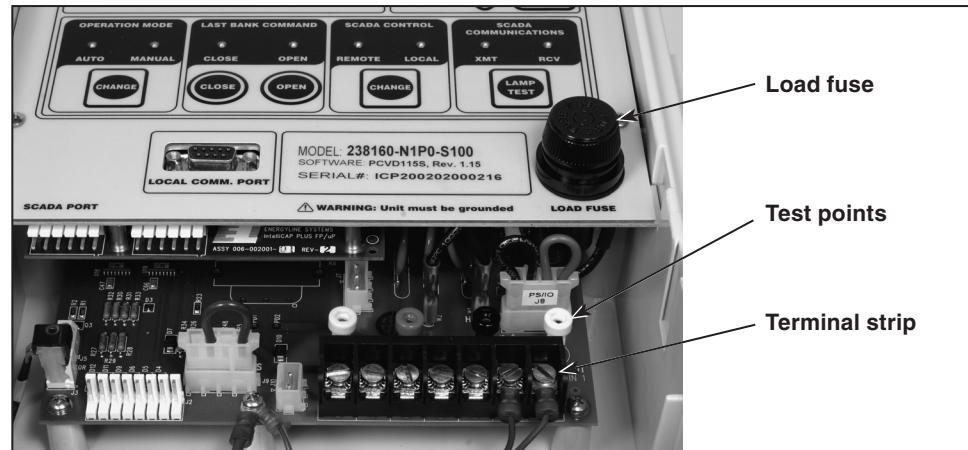


Figure 1. The capacitor control components.

Test points—The test points help check the operation of the capacitor control; the configuration in Figure 1 is shown on a label on the inside of the enclosure door.

Yellow—Current sensor +

Red—Load

Black—Ac line

White—Neutral return

Faceplate

The capacitor control faceplate includes LEDs and buttons that enable monitoring and controlling the capacitor bank and the capacitor control. See Figure 2. It also includes an LCD screen and buttons for scrolling and selecting data.

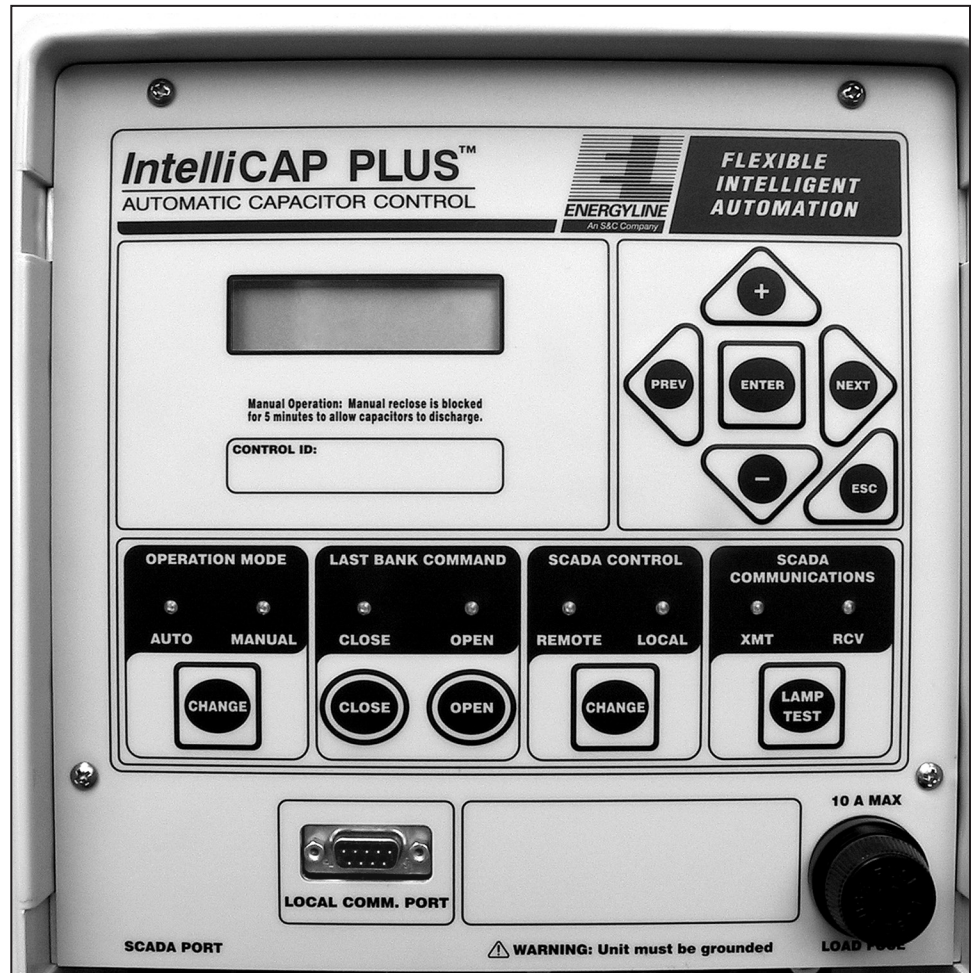


Figure 2. The IntelliCap Plus Automatic Capacitor Control faceplate.

Faceplate LED Displays

The faceplate includes the following LEDs:

Auto LED

This red LED is lit when automatic capacitor bank operation is enabled. Commands from the faceplate CLOSE and OPEN buttons are blocked.

Manual LED

This red LED is lit when automatic capacitor bank operation is disabled. When the LOCAL LED is also lit, the faceplate CLOSE and OPEN buttons can be used to operate the bank.

Close LED

This red LED is lit when the capacitor bank switch is closed. When a Manual Operation Delay period is specified, indicated on page 2 of the *Setup>General* screen, this LED blinks rapidly during the delay period prior to the switch closing.

Open LED

This green LED is lit when the capacitor bank switch is open. When a **Manual Operation Delay** period is configured, indicated on page 2 of the *Setup>General* screen, this LED blinks rapidly during the delay period prior to the switch opening. The LED blinks slowly while a reclose block is in effect.

Remote LED

This red LED is lit when remote (SCADA) control of the capacitor bank is enabled and faceplate operation is disabled.

Local LED

This red LED is lit when remote (SCADA) control of the capacitor bank is disabled and faceplate operation is enabled.

Note: The LOCAL LED must be on before changing between **Automatic** and **Manual** modes from the faceplate or with an IntelliLink software command.

SCADA Communications XMT/RCV LEDs

These LEDs blink when the capacitor control sends or receives signals through remote communications equipment installed in the control enclosure.

XMT LED—Blinks when the capacitor control sends one or more characters

RCV LED—Blinks when the capacitor control detects an incoming character

Note: The XMT and RCV LEDs only blink when remote-communications equipment is installed, properly connected, and receiving power. This optional equipment is usually a radio or modem board installed inside the capacitor control enclosure door.

Faceplate Buttons

The faceplate includes the following buttons. For more information about how to use these buttons to control the capacitor bank, see the “Switching the Capacitor Bank” section on page 30.

Operation Mode CHANGE button

When the LOCAL LED is on, pressing this button toggles between enabling and disabling the **Automatic Operation** mode. When the **Automatic Operation** mode is enabled (the AUTO LED is lit), commands from the faceplate CLOSE and OPEN buttons are blocked.

Last Bank Command CLOSE button

When both the MANUAL and LOCAL LEDs are lit, pressing this button transmits a **Close** command to the capacitor bank switch. When the **Automatic Operation** mode is enabled (the AUTO LED is lit) or when the **Remote Operation** mode is enabled (the REMOTE LED is lit), pressing this button has no effect.

Last Bank Command OPEN button

When both the MANUAL and LOCAL LEDs are lit, pressing this button transmits an **Open** command to the capacitor bank switch. When the **Automatic Operation** mode is enabled (the AUTO LED is lit) or when the **Remote Operation** mode is enabled (the REMOTE LED display is lit), pressing this button has no effect.

SCADA Control CHANGE button

Press this button to enable or disable **SCADA Control** mode. When the REMOTE LED is lit, remote operation of the bank is enabled and faceplate operation is disabled. When the LOCAL LED is lit, remote operation of the bank is disabled and faceplate operation is enabled.

Note: The LOCAL LED must be lit when switching between **Automatic Operation** mode and **Manual Operation** mode from the faceplate or with an IntelliLink software command.

NOTICE

When the **Automatic Operation** mode is enabled, the **Automatic Control** logic may switch the capacitor bank regardless of whether **SCADA Control** mode is enabled or disabled. To have full control of the capacitor bank, the **MANUAL LED** must also be lit.

NOTICE

Hayes-compatible modems connect to the control in a manner similar to IntelliLink software, using the **LOCAL COMM PORT**. Therefore, off-site control of the capacitor bank is not inhibited by the **SCADA CONTROL CHANGE** button. Bank operation is possible even when the **SCADA CONTROL LOCAL LED** is lit.

Lamp Test button

Press this button to test the LEDs on the faceplate. All LEDs should light.

Faceplate LCD Display

The faceplate has a two-line, 16-character LCD screen. When the control is operating normally, the top line of the screen shows ****UNIT OK****. The bottom line cycles through a list of real-time data, setpoints, and logged data as well as other operating information, such as an active alarm or a **Reclose Block** state.

Reclose Block

When the **Reclose Block** state is in effect, the LCD screen shows information on both lines. See Table 1.

Table 1. Reclose Block LCD Screens

Display	Meaning
RECLOSE BLOCKED **seconds left ##**	After opening the capacitor bank, the capacitor control will not reclose it for 5 minutes. This allows the capacitors to discharge. The bottom line shows the time remaining before the control can switch the bank in.
Reset RclBlkDly **Password= **	This appears if the Reclose Block Reset Password setting is enabled and an attempt is made to close the bank while the reclose block is in effect. To bypass the block, press the faceplate NEXT or PREV button to scroll through the password list. Then, press the ENTER button when the LCD display shows the correct password. To end the procedure without bypassing the block, press the ESC button.

Real-Time Data

The LCD screen scrolls through real-time data on the bottom line. See Table 2.

Table 2. Real-Time Data LCD Screens

Display	Meaning
Date	Today's date
Time	Present time
Volt ; **Ovr**	Line voltage (true RMS measured voltage); regardless of whether a voltage override is in effect
NeutRmsAmps	Neutral amps (or voltage) RMS
NeutFundAmp	Neutral amps (or voltage) fundamental
Line kV	Var controls only; voltage level on the distribution line, in kV
Line Amps	Var controls only; current level, in amps
UnCorPh	Uncorrected phase angle
CorrPh	Corrected phase angle
Current Dir	Current flow direction
PFACTOR	Power factor
PF ; <i>direction</i>	Var controls only; power factor; normal or reverse current flow
Line kvar	Var controls only, kvar level
Line kW	Var controls only, kW level
Line kVA	Var controls only, kVA level
Temp ; **Ovr**	Present ambient temperature (in °F or °C, based on the value of the Temperature Readings Conversion setpoint on page 3 of the <i>Setup>General</i> screen); regardless of whether a temperature override is in effect
VoltTHD	Voltage - percent Total Harmonic Distortion
3rdVHarm	Voltage - percent 3rd Harmonic
5thVHarm	Voltage - percent 5th Harmonic
7thVHarm	Voltage - percent 7th Harmonic
CurrTHD	Current - percent total harmonic distortion
3rdCHarm	Current - percent 3rd harmonic
5thCHarm	Current - percent 5th harmonic
7thCHarm	Current - percent 7th harmonic
NeutTHD	Neutral current - percent total harmonic distortion
3rdNHarm	Neutral current - percent 3rd harmonic
5thNHarm	Neutral current - percent 5th harmonic
7thNHarm	Neutral current - percent 7th harmonic
Evt	Any active event messages, such as a low switching delta or a maximum automatic operations limit

TABLE CONTINUED ►

Table 2. Real-Time Data LCD Screens—Continued

Display	Meaning
Active Season	The number of the season presently in effect
Auto	The automatic control strategy for the present season
SoftVer	The ID of the control software in the capacitor control
OperCount	The total number of complete switching cycles since installation
SwIn	The reason for the last switch-in of the bank
SwOut	The reason for the last switch-out of the bank
EstVChg+Mrg	The value of the Estimated Voltage Change + Margin setpoint
NCAIrmLvl	Neutral current (or voltage) alarm level
NCChgTime	Neutral current (or voltage) change time
NCCorr	Neutral current (or voltage) corrective action
NCRetry	Neutral current (or voltage) retry - enable or disable
ZeroDet	Zero neutral sensor alarm (current or voltage)
NSAlarming	Neutral sensing controls only; the component or components of the neutral current/voltage used to trigger the neutral current alarm
NSLoggint	Neutral sensing controls only, the component or components of the neutral current/voltage data logged
Hi VoltOvr	The High-Voltage Override value for the present season
Hi VoltTime	The High-Voltage Override Time setting for the present season
Lo VoltOvr	The Low-Voltage Override value for the present season
Lo VoltTime	The Low-Voltage Override Time setting for the present season
various	Setpoint values for the present season's control strategy

Note: The kvar level shown is calculated from measured sensor values; it is not an adjusted level.

Note: The capacitor control does not display **High-Voltage Override** and **Low-Voltage Override** setpoints when the present control mode is the **Time-Biased Voltage** mode, the **Automatic Offline** mode, or the **Automatic Online** mode.

Alarms

When any alarms are active, the LCD screen displays **ACTIVE ALARMS** on the top line. Scroll through the alarms displayed on the bottom line of the LCD screen using the NEXT button. See Table 3.

To clear a **Neutral Sensing Lockout** condition, press the faceplate ENTER button when the bottom line of the LCD display shows **Ent=RstNSLocout**. If any alarms are still active, the top line displays **ACTIVE ALARMS**. Otherwise, the LCD screen displays **UNIT OK** and scrolls real-time data.

Table 3. Alarm LCD Screens

Display	Meaning
Volt Sensor Err	The voltage sensor is reading outside its range or may be faulty.
Temp Sensor Err	The temperature sensor is reading outside its range or may be faulty.
Neutral Sens Err	Neutral-sensing controls only, this message is displayed before the control locks out the bank following a Neutral Current or Neutral Voltage alarm.
Neutral Sens Lockout	Neutral-sensing controls only, the level of neutral current or neutral voltage has caused the control to lock out the bank. See Instruction Sheet 1023-530, "S&C IntelliCap® Plus Automatic Capacitor Control: Setup" for more information.
HiLoVoltBand Err	The Bank Voltage Change + Margin value is greater than the difference between the High Voltage Override setpoint and the Low Voltage Override setpoint.
HiLoVoltLockout	The control has locked out the bank because of the High/Low-Voltage Band error.
ZeroNeut SensErr	Neutral-sensing controls only, the control detected zero neutral current or neutral voltage for the length of the Zero Neutral Detection setpoint. See Instruction Sheet 1023-530, "S&C IntelliCap® Plus Automatic Capacitor Control: Setup" for more information.
Load Fuse Alarm	The load fuse on the faceplate is blown. A blown load fuse will be alarmed by all wiring options except "-J67." For "-J67," any type of station power, even dc, could be used as wetting voltage, so the sensing input is wired to control power and will not go off if the load fuse is blown. For all other wiring options, the sensing input is wired to the load side of the load fuse, and the alarm will be set for a blown load fuse.

Control Software

S&C capacitor controls are entirely software-driven. Each capacitor control is shipped with control software and IntelliLink Setup Software, both of which can be downloaded from the S&C Automation Customer Support Portal.

The control software is preloaded into the capacitor control at the factory. This software manages control functions. It continually monitors:

- Voltage, current, and/or neutral current/neutral voltage on the feeder
- Incoming SCADA commands
- State of the faceplate LEDs and buttons
- Ambient temperature at the control
- Internal clock/calendar
- Software setpoint values
- Various other setpoints and data values as needed

Based on this information, the control software decides how to respond to a change in voltage, a command from the faceplate or SCADA master station, and other conditions.

The control software, the setpoint values, and historical data are all stored in non-volatile switch control memory. This memory survives power interruptions, including complete loss of the battery system.

IntelliLink® Setup Software

The IntelliLink Setup Software can be downloaded at the S&C Automation Customer Support Portal and runs on IBM/PC-compatible computers. This software allows communication with the control while at the capacitor control site. Using the IntelliLink Setup Software, one can:

- Change control strategies (for example, from **Temperature** to **Time-Biased Voltage**)
- Enter installation-dependent operating parameters (setpoints), such as a network address, the temperature-change time threshold, a voltage-override level, etc
- Monitor real-time data, such as the present line voltage and current
- Examine the performance and operating history of an installed capacitor control
- Transfer all configuration, operating, and historical data from the capacitor control to a report file on your computer
- Download new control software into the capacitor control
- Troubleshoot assorted types of capacitor control installation problems

SCADA Communication Equipment

Most communication equipment can be mounted inside the capacitor control enclosure on the back of the door. This eliminates pole clutter and provides a high level of reliability for the overall installation.

DNP 3.0 is the standard protocol for the IntelliCap Plus capacitor control; other protocol options are also available.

For more information, see Instruction Sheet 1023-561, “S&C IntelliCap® Plus Automatic Capacitor Control: *DNP Points List and Implementation*,” or contact S&C Electric Company.

This section explains how the capacitor control components work together to control the capacitor bank.

Data Acquisition

Signal Processing

The capacitor control reports voltage, current, and phase-related data in units of volts, amperes, kvars, kW, and kVA. The rated accuracy of these measurements is based on the combined accuracy of all the control components (exclusive of the sensor and sensor cable but inclusive of all sensor conditioning components).

Voltage readings are accurate for all distribution voltages. For var controls, phase-angle detection requires a minimum current of 0.5% of full-scale values. Current magnitudes are still detected and displayed below the 0.5% threshold. The capacitor control uses the phase-angle offset values to calculate all ac waveform data sampled from the line sensor.

RMS Ac Displayed and Recorded Values

For real-time, steady-state monitoring and data logging, the capacitor control collects data at 0.3-second intervals. It then averages four samples and reports the 1.2-second averaged value. This results in a net response time of 1.2 seconds.

The capacitor control uses these 1.2-second averaged values for the real-time display, reporting via the faceplate, SCADA communication, and most data logging. Daily highs and lows are the highest and lowest raw sample (unaveraged) values; they are kept for the present day and the preceding 31 days.

The capacitor control also uses the 1.2-second averaged values to create interval averaged values (data averaged over the logging interval) for voltage and temperature, as well as current, kvars, power factor, kW, and neutral current/neutral voltage, if applicable. Choose a data-logging interval of 1, 5, 10, 15, 30, or 60 minutes. The period of logged interval averaged values depends on the interval chosen. See Table 5 on page 33.

The capacitor control logs the RMS value of voltage and current.

Bank switching is based on voltage and current measurements on the fundamental frequency and is not affected by harmonics.

Neutral current switching is also based on the fundamental frequency and is not affected by harmonics. The capacitor control logs the fundamental component of the neutral current.

Phase Angle Measurements

Var controls calculate the phase angle between the voltage and current waveforms. Phase-angle measurements have a 0-360 degree range.

As part of the capacitor control setup, enter an **Installation Phase Offset** angle setpoint to compensate for various installation-dependent phase-angle errors.

Control Strategies

IntelliCap Plus Automatic Capacitor Controls can switch the capacitor bank automatically using a variety of control strategies: **Temperature**, **Timeclock**, **Timeclock with Temperature Override**, **Voltage Only**, **Time-Biased Voltage**, **Time-Biased Temperature**, **Automatic Offline**, or **Automatic Online**. Var controls have four additional control strategies: **Current**, **Current with Temperature Override**, **Var**, and **Var with Temperature Override**. These are all explained in this section. For information about using the faceplate buttons to enable the **Automatic Operation** mode, see the “Switching the Capacitor Bank” section on page 30.

The capacitor control switches the bank based on a prioritized set of conditions. These conditions, from highest to lowest priority, are:

- **5-minute reclose block**—After opening the capacitor bank, the capacitor will not reclose it for 5 minutes. This allows the capacitors to discharge. The bottom line of the LCD screen shows the time remaining until the control can switch the bank in. The time remaining also appears in the Reclose Block field on the *Operation* screen.
- **State of the faceplate LED displays**—When the MANUAL LED display is lit, the capacitor control blocks automatic operation of the capacitor bank. One can only operate the bank from the faceplate CLOSE and OPEN buttons or the *Operation* screen when the LOCAL LED is also lit.
- **Remote commands**—When the REMOTE LED is lit, the capacitor control accepts commands from the SCADA master station.
- **Anti-cycling limit**—When the capacitor control is in **Automatic** mode, the **Maximum Automatic Control Cycles Per Day** setpoint, noted on Page 2 of the *Setup>General* screen, determines the maximum number of automatic switching cycles per calendar day. When this limit is reached, the capacitor bank remains switched out until the next calendar day.
- **High and low voltage override setpoints**—If the voltage remains outside the normal range for a specified period of time, the capacitor control switches the bank. See the *Setup>General* screen setpoints in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.
- **Present control strategy**—The capacitor control switches the bank according to the control strategy presently in effect.

When the capacitor control has been in **Manual** mode and is returned to **Automatic** mode, it waits 60 seconds before switching the bank. This allows the operator to step away from the bank.

Temperature Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Temperature** mode, it switches the capacitor bank based on the present air temperature. The capacitor control can operate in both **High-** and **Low-Temperature** modes. It uses the following logic to determine when to switch the capacitor bank:

- The capacitor control monitors the present air temperature.
- When the capacitor control senses that the temperature has passed the **Temperature at Which Bank Switches In** setpoint (or the **Temperature at Which Bank Switches Out** setpoint), it starts the **High/Low Temperature Change Time Threshold** timer. This is true for either **High-Temperature** or **Low-Temperature** operation.
- For **High-Temperature** operation, when the temperature remains continuously above the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the control switches the bank in. When it remains below the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.
- For **Low-Temperature** operation, when the temperature remains continuously below the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the control switches the bank in. When it remains above the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage Override** condition. Otherwise, to avoid excess cycling the control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Note: A bad temperature sensor does not prevent the control from operating. It will still switch the bank if a **Voltage Override** condition becomes active.

Time-Biased Temperature Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Time-Biased Temperature** mode, it switches the capacitor bank based on two sets of temperature setpoints. The **Time-Biased Temperature** strategy uses the same logic as the **Temperature** strategy, except:

- There is only one set of temperature setpoints in use.
- The capacitor bank is offline during unscheduled times.

Note: If the bank was online when the unscheduled period began and the temperature does not go beyond the switch-out value, the bank switches back in at the start of the next scheduled period. It does not wait for the temperature to go beyond the switch-in value.

For example: The bank is set to switch in at 80°F (27°C) and switch out at 70°F (21°C). The timeclock scheduled period is “8:00 – 17:00.” On Monday at 17:00, the bank switches out. During the unscheduled time, the temperature does not go below 70°F for the length of the **Temperature Time Threshold** setpoint. On Tuesday at 8:00, the bank switches in again, even if the temperature is below 80°F.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, to avoid excess cycling the control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Note: A bad temperature sensor does not prevent the control from operating. It will still switch the bank when a **Voltage-Override** condition becomes active.

Timeclock Control Strategy

When *Automatic Operation* mode is enabled and the capacitor control is in *Timeclock* mode, it switches the capacitor bank based on a time schedule. Enter up to two different time schedules. The capacitor control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control checks to see whether the present time falls within one of the scheduled on periods.
- When the present time is within a scheduled-on period and the calendar day is not a holiday, the capacitor control switches the bank in. If the bank is already active, it remains active.
- When the time is no longer in a scheduled-on period or the calendar day becomes a holiday, the capacitor control switches the bank out. If the bank is already inactive, it remains inactive.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, the capacitor control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Timeclock with Temperature Override Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Timeclock with Temperature Override** mode, it switches the capacitor bank based on a time schedule. Enter up to two different time schedules. The control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control checks to see whether the present time falls within one of the scheduled on periods.
- If the present time is within a scheduled-on period and the calendar day is not a holiday, the capacitor control switches the bank in. If the bank is already active, it remains active.
- When the time is no longer in a scheduled-on period or the calendar day becomes a holiday, the capacitor control switches the bank out. If the bank is already inactive, it remains inactive.
- When the capacitor control senses that the air temperature has passed the **Temperature at Which Bank Switches In** setpoint (or **Temperature at Which Bank Switches Out** setpoint), it starts the **High-/Low-Temperature Change Time Threshold** timer. This is true for either **High-Temperature** or **Low-Temperature** operation.
- For **High-Temperature** operation, when the temperature remains continuously above the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains below the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.
- For **Low-Temperature** operation, when the temperature remains continuously below the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains above the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a Voltage-Override condition. Otherwise, the capacitor control will not switch the bank to avoid excess cycling. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: Setup,” for more information.

Voltage Only Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Voltage Only** mode, it switches the capacitor bank based solely on the **High-** and **Low-Voltage** setpoints. One can also choose the preferred capacitor bank position. The control uses the following logic to determine when to switch the capacitor bank:

The capacitor control monitors the voltage. When the voltage remains within the normal range, the capacitor control switches the bank based on the **Preferred Capacitor Bank Position** setpoint on the *Setup>Voltage Only Strategy* screen. No action is taken if the **Don't Care** setpoint is selected or if switching the bank would cause a voltage override condition.

Figures 3 and 4 on page 18 and Figure 5 on page 19 show when the capacitor bank switches for each setting of the **Preferred Capacitor Bank Position** mode. The capacitor control uses the **Voltage Override** and the **Bank Voltage Change + Margin** setpoints to avoid excess cycling.

- When the capacitor control senses that the voltage has passed the **High-Voltage Override Value** setpoint (or **Low-Voltage Override Value** setpoint), it starts the **High-Voltage Override Time** (or **Low-Voltage Override Time**) timer.
- When the voltage remains continuously above the **High-Voltage Override Value** setpoint for the duration of the **High-Voltage** timer, the capacitor control switches the bank out. When it remains continuously below the **Low-Voltage Override Value** setpoint for the duration of the **Low-Voltage** timer, the capacitor control switches the bank in.

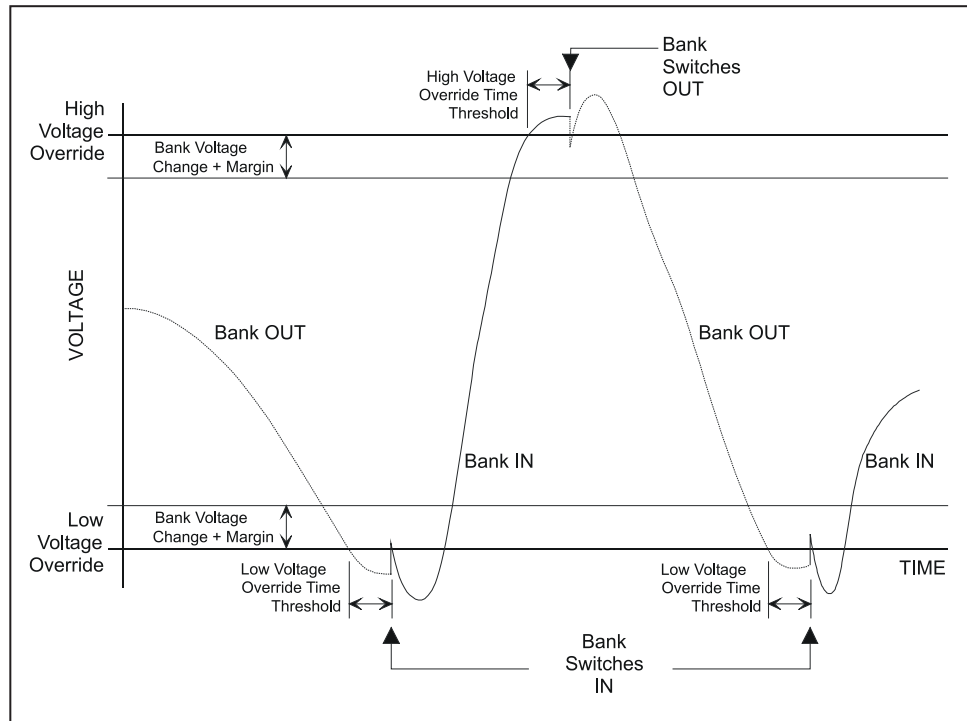


Figure 3. Voltage control switching (no preferred capacitor bank position).

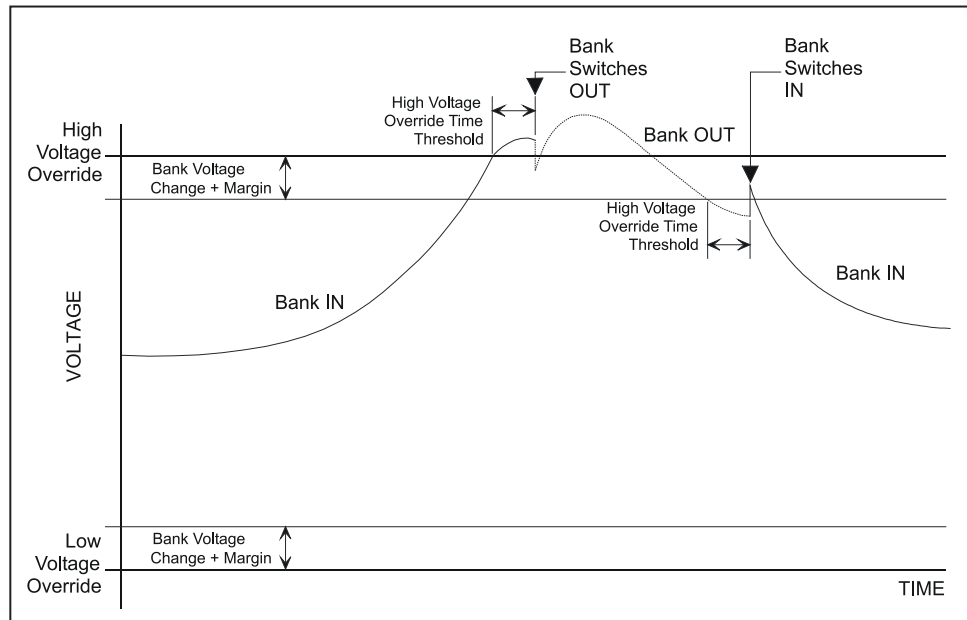


Figure 4. Voltage control switching (preferred capacitor bank position is Online).

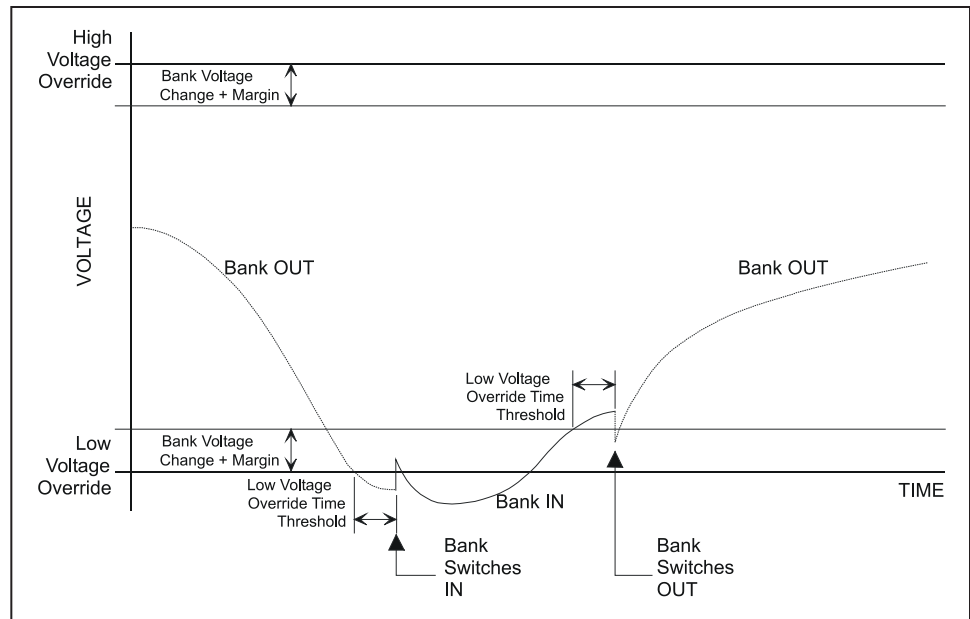


Figure 5. Voltage control switching (preferred capacitor bank position is Offline).

Time-Biased Voltage Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Time-Biased Voltage** mode, it switches the capacitor bank based on two sets of **High-Voltage** and **Low-Voltage** setpoints. The **Time-Biased Voltage** strategy uses the same logic as the **Voltage-Only** strategy, except:

- **Voltage** setpoints are different for scheduled and unscheduled times.
- There is only one **Voltage-Change Time** threshold.
- The capacitor control does not use the **Preferred Capacitor-Bank Position** setpoint.

Automatic Offline Control Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Automatic Offline** mode, the capacitor bank is always switched out. The capacitor control does not even switch the bank for a **Voltage-Override** condition.

When switching the bank online in **Manual** mode, the capacitor control switches it back offline when it returns to the **Automatic Operation** mode after the 60-second safety delay.

Automatic Online Strategy

When **Automatic Operation** mode is enabled and the capacitor control is in **Automatic Online** mode, the capacitor bank is always switched in. The control does not even switch the bank for a **Voltage-Override** condition.

When switching the bank offline in **Manual** mode, the capacitor control switches it back online when it returns to the **Automatic Operation** mode after the safety delay.

Current Control Strategy (var controls only)

When **Automatic Operation** mode is enabled and the capacitor control is in **Current** mode, it switches the capacitor bank based on measured single-phase current flow. The control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control monitors the single-phase line current.
- When the capacitor control senses the current has passed the **Single-Phase Amps at Which Bank Switches In** setpoint (or the **Single-Phase Amps at Which Bank Switches Out** setpoint), it starts the **Current-Change Time Threshold** timer.

- When the single-phase current remains continuously above the **Single-Phase Amps at Which Bank Switches In** setpoint for the duration of the timer, the control switches the bank in. When it remains continuously below the **Single-Phase Amps at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, to avoid excess cycling, the capacitor control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Current with Temperature Override Control Strategy (var controls only)

When **Automatic Operation** mode is enabled and the capacitor control is in **Current with Temperature Override** mode, it switches the capacitor bank based on measured single-phase current flow. The capacitor control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control monitors the single-phase line current.
- As soon as the capacitor control senses that the current has passed the **Single-Phase Amps at Which Bank Switches In** setpoint (or the **Single-Phase Current at Which Bank Switches Out** setpoint), it starts the **Current Change Time Threshold** timer.
- When the single-phase current remains continuously above the **Single-Phase Amps at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains continuously below the **Single-Phase Amps at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.
- When the capacitor control senses that the air temperature has passed the **Temperature at Which Bank Switches In** setpoint (or the **Temperature at Which Bank Switches Out** setpoint), it starts the **High-/Low-Temperature Change Time Threshold** timer. This is true for either **High-Temperature** or **Low-Temperature** operation.
- For **High-Temperature** operation, if the temperature remains continuously above the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains below the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.
- For **Low-Temperature** operation, if the temperature remains continuously below the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the control switches the bank in. If it remains above the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, to avoid excess cycling, the capacitor control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Var Control Strategy (var controls only)

When **Automatic Operation** mode is enabled and the capacitor control is in **Var** mode, it switches the capacitor bank based on calculated three-phase kvars, kilovolt-amperes, reactive. The capacitor control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control monitors the 3-phase kvar level.
- When the capacitor control senses that the kvars have passed the **3-Phase kvars at Which Bank Switches In** setpoint (or the **3-Phase kvars at Which Bank Switches Out** setpoint), it starts the **Var Change Time Threshold** timer.
- When the 3-phase kvar level remains continuously above the **3-Phase kvars at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains continuously below the **3-Phase kvars at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, to avoid excess cycling the control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Var with Temperature Override Control Strategy (var controls only)

When **Automatic Operation** mode is enabled and the capacitor control is in **Var with Temperature Override** mode, it switches the capacitor bank based on calculated three-phase kvars, kilovolt-amperes, reactive. The capacitor control uses the following logic to determine when to switch the capacitor bank:

- The capacitor control monitors the 3-phase kvar level.
- As soon as the capacitor control senses that the kvar level has passed the **3-Phase kvars at Which Bank Switches In** setpoint (or the **3-Phase kVARs at Which Bank Switches Out** setpoint), it starts the **Var Change Time Threshold** timer.
- If the 3-phase kvar level remains continuously above the **3-Phase kvars at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains continuously below the **3-Phase kvars at Which Bank Switches Out** setpoint for the duration of the timer, the control switches the bank out.
- When the capacitor control senses that the air temperature has passed the **Temperature at Which Bank Switches In** setpoint (or the **Temperature at Which Bank Switches Out** setpoint), it starts the **High-/Low-Temperature Change Time Threshold** timer. This is true for either **High-Temperature** or **Low-Temperature** operation.
- For **High-Temperature** operation, when the temperature remains continuously above the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains below the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.
- For **Low-Temperature** operation, if the temperature remains continuously below the **Temperature at Which Bank Switches In** setpoint for the duration of the timer, the capacitor control switches the bank in. If it remains above the **Temperature at Which Bank Switches Out** setpoint for the duration of the timer, the capacitor control switches the bank out.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage-Override** condition. Otherwise, to avoid excess cycling the capacitor control will not switch the bank. See the “Voltage Override Operation” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Sensor Location

Current Sensor Location and Reverse Current Flow

For var controls, the preferred location of the current sensor is on the source side of the capacitor bank. This lets the sensor measure the effect of the bank when it is online. However, the capacitor control can still account for the effect of the bank when the sensor is on the load side. This is particularly useful if abnormal circuit switching reverses the direction of power flow, flipping the relative position of the sensor.

When a reverse-current flow condition exists, the value of the **Reverse-Current Strategy** setpoint determines how the control responds. The **Adj. Var** setting is the default.

- **Adj. VAR**—During a reverse-current condition, if the current sensor is on the normal source side, the control calculates the **Adjusted 3-Phase Kars** level by subtracting the **3-Phase Bank Size** setpoint from the **Measured 3-Phase Kvars** value. See the “*Setup: Site-Related*” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*.” When the current sensor is on the normal load side, the control uses the measured kvars.
- **Trip & Inh.**—The capacitor control switches the bank offline during a reverse-current condition and inhibits further switching until the condition clears.
- **Volt Only**—During a **Reverse-Current** condition, the capacitor control switches the bank based only on the presently active **Normal** and **Emergency Voltage Override** setpoints. When any neutral sensor strategies are enabled, they remain in effect.
- When the capacitor control is in one of the **Current** or **Var** control modes when the current reverses, the **Volt Only** logic takes precedence over the **High-/Low-Band Error** logic; if applicable, temperature override is also discontinued. When current flow returns to normal, the capacitor control returns to switching the bank based on its regular control strategy and the present conditions, including the **Bank Voltage Change + Margin** setpoint previously in use; this value does not change while the current is reversed.
- When the capacitor control is not in one of the **Current** or **Var** control modes when the current reverses, it uses the **High-/Low-Band Error** logic in effect.

Figure 6 on page 23 shows the four possible combinations of the current sensor location and direction of current flow.

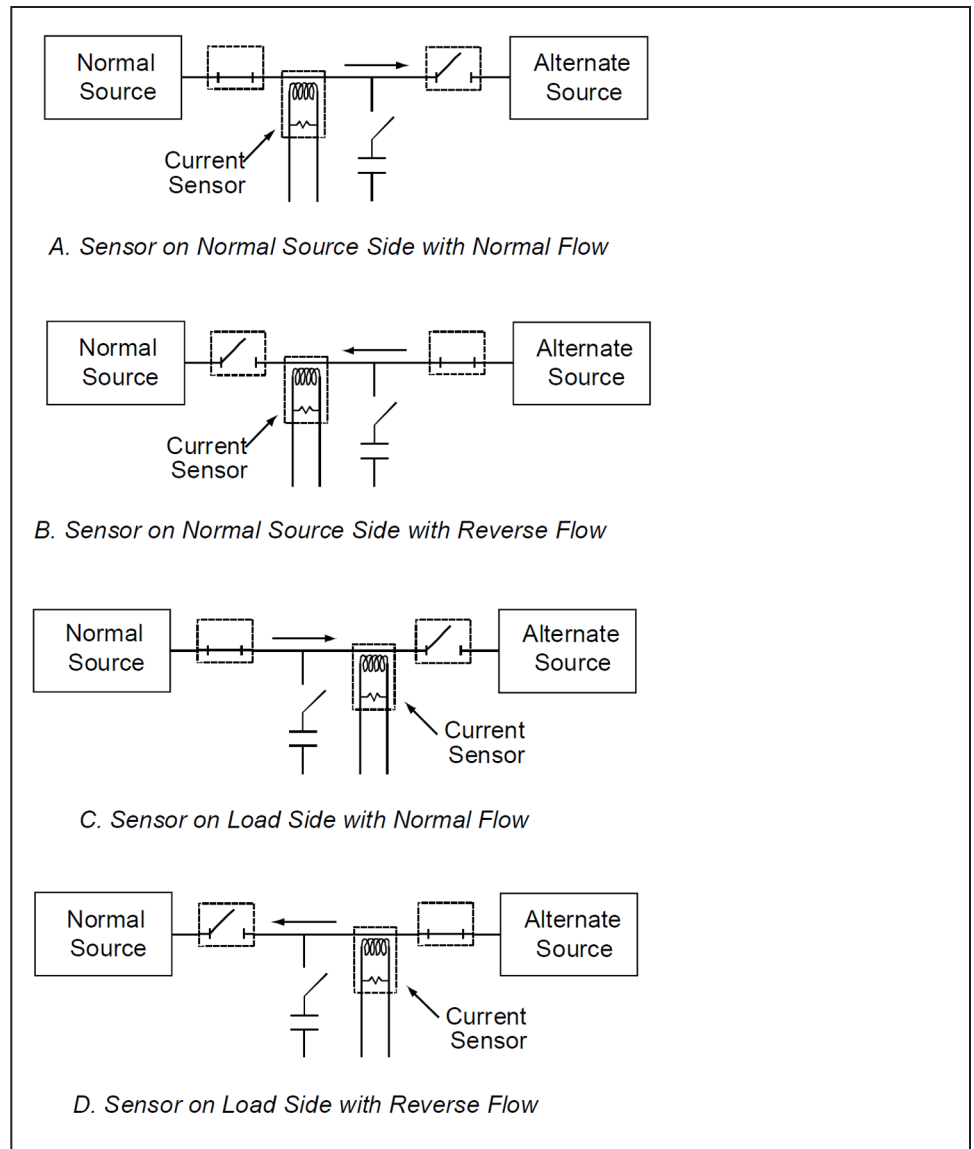


Figure 6. Current sensor location and direction of current flow combinations.

(a) Sensor on Normal Source Side with Normal Current Flow

The kvar level measured at the sensor location already reflects the effect of the bank. The **Adjusted 3-Phase kvars** setpoint equals the **Measured 3-Phase kvars** value.

(b) Sensor on Normal Source Side with Reverse Current Flow

Abnormal circuit switching has caused the current direction to reverse. In this case, the effect of the bank is not reflected in the measured kvars at the sensor location. The control calculates the **Adjusted 3-Phase kvars** value by subtracting the **3-Phase Bank Size** setpoint on the *Setup>Site-Related* screen from the **Measured 3-Phase kvars** value.

For example: An online 1200-kvar capacitor bank is set to switch out at -750 kvar. The sensors are on the source side and current flow is reversed. When the load at the sensor location is 450 kvar, the **Adjusted 3-Phase kvars** setpoint is $450 - 1200 = -750$ kvar and the bank switches out.

(c) Sensor on Load Side with Normal Current Flow

This occurs when the current sensor is on the load side of the bank or if permanent circuit switching causes the sensor to be on the load side of the bank. See the section “B. Sensor on Normal Source Side with Reverse Current Flow” on page 23.

(d) Sensor on Load Side with Reverse Current Flow

See (a) “Sensor on Normal Source Side with Normal Current Flow” section on page 23.

Neutral Current Detection

The **Neutral Current Sensing** option allows the capacitor control to monitor and take action on abnormal levels of current flowing from the starpoint of a grounded, wye-connected bank to the system neutral and/or ground. See Figure 7. The sensed current is the vector sum of the three capacitor phase currents plus harmonic currents. Factors contributing to neutral current include:

- Unequal capacitance between phases of the capacitor bank (This may result from manufacturing tolerances or the partial failure of individual capacitor units.)
- A voltage imbalance between individual phases of the distribution circuit
- Harmonic distortion of the line current (A variety of sources can cause harmonic distortion, such as lightning, welding, solid state variable-speed drives, and equipment using switching power supplies.)
- The opening or disconnection of one or two phases of the capacitor bank due to a blown fuse, a failed switch, or defective wiring

The capacitor control can be configured to detect abnormal levels of neutral current and generate alarms, both in **Automatic** mode and in **Manual** mode. If desired, a capacitor control in **Automatic** mode can also take appropriate corrective action. See the *Setup>Neutral Sensor* screen section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information. Maintenance personnel can then diagnose and correct the identified problem.

⚠ WARNING

The individual capacitor units retain a high-voltage charge for several minutes after they are disconnected and must be short circuited and grounded prior to running tests. Only trained personnel should clear and test the capacitors.

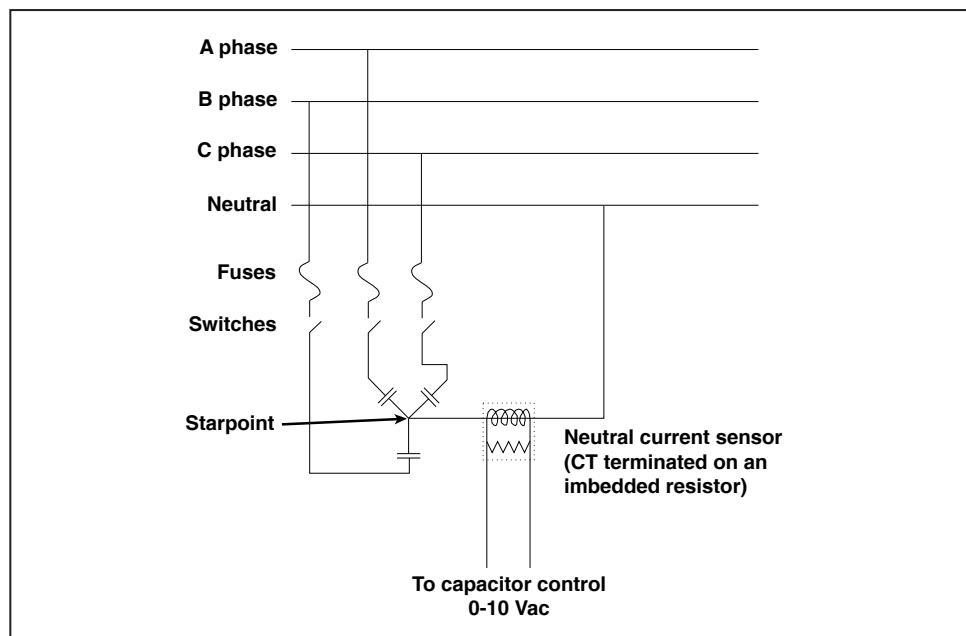


Figure 7. The neutral current sensor and a wye-connected bank with a starpoint.

The capacitor control uses the following logic to determine when to trigger the **Neutral Current** alarm:

- The capacitor control monitors current flowing between the starpoint and the system neutral and ground.
- When the capacitor control senses that current flow has exceeded the **Neutral Current Alarm Level** setpoint, it starts the **Neutral Current Change Time Threshold** timer.
- If the neutral current remains continuously above the setpoint for the duration of the timer, the capacitor control takes one of the following actions:

When the **Neutral Current Corrective Action** setpoint is disabled, the control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen. Automatic control operation is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

When the **Neutral Current Corrective Action** setpoint is enabled and there was no recent switching activity, the capacitor control takes the bank offline, if it is not already offline. The capacitor control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen. **Automatic Operation** mode is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

When the **Neutral Current Corrective Action** setpoint is enabled and there was recent switching activity, the capacitor control tries to reverse the last action after the reclose block, if applicable.

When **Neutral Current Retry** mode is also enabled, the capacitor control operates the bank again. If the neutral current level is normal, the alarms clear and the capacitor control returns to normal operation. Otherwise, the capacitor control returns the bank to the **Corrective Action** state. Further automatic operation of the bank is blocked until someone clears the alarm from the faceplate or from the *Alarm Status* screen. The capacitor control displays error messages on the *Operation* and *Alarm Status* screens, and ****ACTIVE ALARMS**** on the LCD screen.

When **Neutral Current Retry** mode is disabled, the capacitor control blocks further automatic operation of the bank after the corrective action. The capacitor control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen. **Automatic Operation** mode is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

Note: When a switch-out attempt triggers the **Neutral Current** alarm and the Neutral Current Corrective Action setpoint is enabled, the capacitor control switches the bank back online in case one of the bank switches did not operate correctly. The capacitor control does this to avoid system imbalances caused by only some of the phases being online.

- When the control detects zero neutral current for a period of time specified by the **Zero Neutral Current Detection** setpoint (if enabled), it sets the **Zero Neutral Current** alarm. The capacitor control does not try any corrective action or lock out the bank. The alarm clears when the **Zero Neutral Current** condition clears or when a lockout reset procedure is performed.
- The user may select whether the capacitor control alarms on the fundamental (60-Hz) component of the neutral current or on the **Total RMS** value. The user may also select whether the control logs fundamental or **Total RMS** data values.

NOTICE

Do not enable **Automatic Operation** mode until clearing the condition that triggered the **Neutral Current** alarm.

If trying to reset the alarm and the condition is still present, the alarm messages become active again.

Neutral Voltage Detection

The **Neutral Voltage Sensing** option allows the capacitor control to monitor and take action if it detects abnormal levels of voltage on the starpoint of an ungrounded, wye-connected bank. See Figure 8. The sensed voltage is the vector sum of the three capacitor phase voltages plus harmonic voltages. Factors contributing to neutral voltage include:

- Unequal capacitance between phases of the capacitor bank (This may result from manufacturing tolerances or the partial failure of individual capacitor units.)
- A voltage imbalance between individual phases of the distribution circuit
- Harmonic distortion of the line voltage (A variety of sources can cause harmonic currents, which can cause harmonic voltage distortion. Examples include lightning, welding, solid state variable speed drives, and equipment using switching power supplies.)
- The opening or disconnection of one or two phases of the capacitor bank due to a blown fuse, a failed switch, or defective wiring

One can configure the capacitor control to detect abnormal levels of neutral voltage and generate alarms, both in **Automatic** mode and in **Manual** mode. If desired, a capacitor control in **Automatic** mode can also take appropriate corrective action. See the “*Setup: Neutral Sensor*” screen in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information. Maintenance personnel can then diagnose and correct the identified problem.

⚠ WARNING

The individual capacitor units retain a high-voltage charge for several minutes after they are disconnected and must be short circuited and grounded prior to running tests. Only trained personnel should clear and test the capacitors.

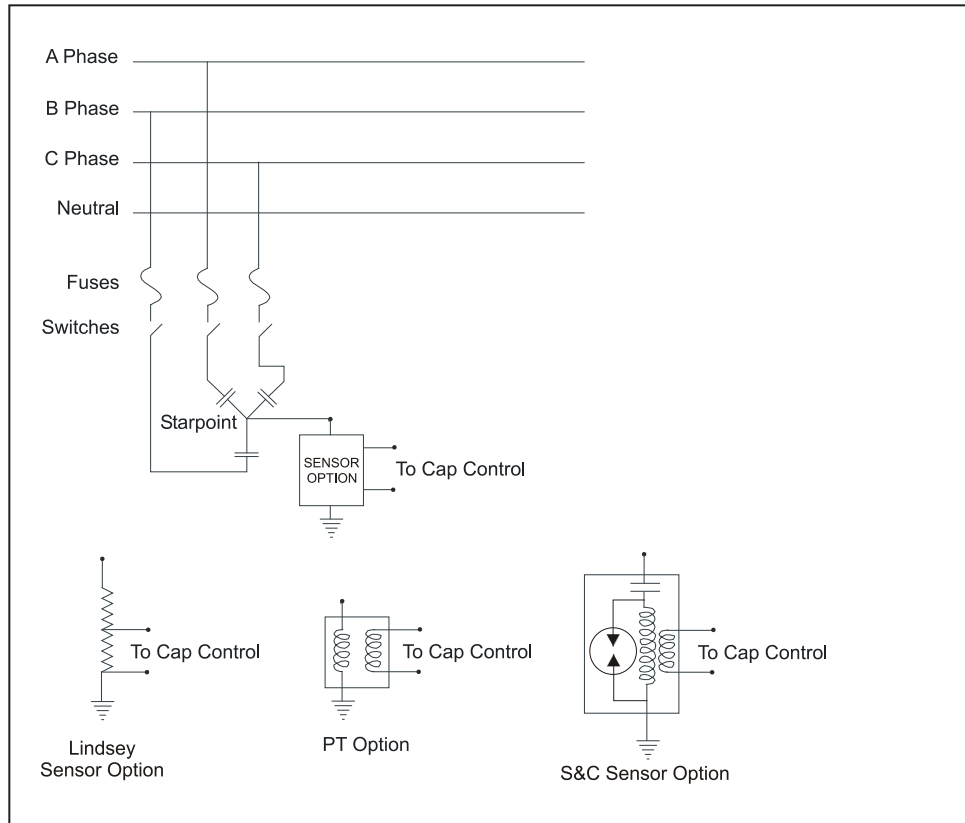


Figure 8. Neutral voltage sensor and wye-connected bank with starpoint.

The capacitor control uses the following logic to determine when to trigger the neutral voltage alarm:

- The capacitor control monitors the voltage between the starpoint and ground.

Note: Neutral voltage monitoring begins 5 minutes after opening the capacitor bank so that trapped voltages can discharge.

- As soon as the control senses that voltage has exceeded the **Neutral Voltage Alarm Level** setpoint, it starts the **Neutral Voltage Change Time Threshold** timer.
- When the neutral voltage remains continuously above the setpoint for the duration of the timer, the control takes one of the following actions:

When the **Neutral Voltage Corrective Action** setpoint is disabled, the control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD display. **Automatic Operation** mode is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

When the **Neutral Voltage Corrective Action** setpoint is enabled and there was no recent switching activity, the capacitor control takes the bank offline, if it is not already offline. The capacitor control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen. **Automatic Operation** mode is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

When the **Neutral Voltage Corrective Action** setpoint is enabled and there was recent switching activity, the capacitor control tries to reverse the last action after the reclose block, if applicable.

When **Neutral Voltage Retry** mode is also enabled, the capacitor control operates the bank again. If the neutral voltage level is normal, the alarms clear and the control returns to normal operation. Otherwise, the capacitor control returns the bank to the **Corrective Action** state. Further automatic operation of the bank is blocked until someone clears the alarm from the faceplate or from the *Alarm Status* screen. The control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen.

When **Neutral Voltage Retry** mode is disabled, the capacitor control blocks further automatic operation of the bank after the corrective action. The capacitor control displays error messages on the *Operation* and *Alarm Status* screens and ****ACTIVE ALARMS**** on the LCD screen. **Automatic Operation** mode is disabled until someone clears the alarm from the faceplate or from the *Alarm Status* screen.

Note: When a switchout attempt triggers the **Neutral Voltage** alarm and the **Neutral Voltage Corrective Action** setpoint is enabled, the capacitor control switches the bank back online in case one of the bank switches did not operate correctly. The control does this to avoid system imbalances caused by only some of the phases being online.

- When the capacitor control detects zero neutral voltage for a period of time specified by the **Zero Neutral Voltage Detection** setpoint, if enabled, it sets the **Zero Neutral Voltage** alarm. The capacitor control does not try any corrective action or lockout the bank. The alarm clears when the **Zero Neutral Voltage** condition clears or when a lockout reset procedure is performed.
- The user may select whether the capacitor control alarms on the fundamental (60-Hz) component of the neutral voltage or on its **Total RMS** value. The user may also select whether the capacitor control data logs fundamental or **Total RMS** values.

NOTICE

Do not enable **Automatic Operation** mode until clearing the condition that triggered the **Neutral Current** alarm.

If trying to reset the alarm and the condition is still present, the alarm messages become active again.

SCADA Override Strategy

When the **SCADA Override** mode is enabled via IntelliLink software or a SCADA command, the SCADA master station can choose the capacitor bank state, as well as the voltage range in which **SCADA Override** mode is active. The capacitor control uses the following logic to determine when to switch the capacitor bank:

- The SCADA master station sends a **Close** or **Open** request to the capacitor control.
- The control switches the bank and stays in that state for the length of the **SCADA Override Timeout Threshold** setpoint. When the setpoint is set to **Latched** mode, the control remains in that state indefinitely, except during **Voltage Override** conditions. When the control does not receive a new **SCADA Override** command during this time period, the SCADA override ends and the capacitor control returns to its regular automatic control logic.

Note: The capacitor control will not switch the capacitor bank if the control is already in **Voltage Override** mode or if switching would put it into **Voltage Override** mode. When the voltage later returns to a level where switching is allowed and **SCADA Override** mode is still active, the capacitor control remembers the SCADA command and switches the bank.

- When the **Use the Following Voltage Overrides** setpoint is set to the **Yes** state, the control uses the **Voltage Override** values on the *Setup>SCADA Override* screen while **SCADA Override** mode is active. Otherwise, it uses the **Voltage Override** values for the present season.

Note: The voltage must remain in a range where switching the capacitor bank will not cause a **Voltage Override** condition. Otherwise, the capacitor control will not switch the bank to avoid excess cycling. See “Voltage Override Operation” in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

Detecting Switching Errors

Review the voltage and/or var values before and after switching in the *Voltage Levels During Switching* and *Kvar Levels During Switching* screens to find possible switching errors. An error condition exists when the change in voltage (ΔV) is less than the **Minimum Percentage of Average Delta Voltage** setpoint over the last four switching operations or when the change in kvars ($\Delta kvar$) is less than the **Minimum Percentage of Average Delta kvars** setpoint over the last four switching operations. These percentages are set on Page 2 of the *Setup>General* screen.

When the average ΔV is at least 0.80 V, then the capacitor control can use ΔV to detect errors. When current sensors are on the source side of the bank, then it can use $\Delta kvar$. When conditions are favorable for both methods, the capacitor control uses ΔV and $\Delta kvar$ and flags an error only when they agree that an error occurred. When conditions are favorable for one method only, the control uses that method to flag errors.

Note: For error-detection analysis, the capacitor control does not use the ΔV and $\Delta kvar$ from a forced retry (an attempt to manually switch the bank into the state already indicated).

High-/Low-Voltage Band Error Options

One can choose how the control responds when a High-/Low-Voltage Band error occurs when the **Bank-Voltage Change + Margin** setpoint is greater than the difference between the **High-Voltage Override Value** setpoint and the **Low-Voltage Override Value** setpoint. The option presently in effect is shown in the **Hi-/Lo-Band Err** field on the *Setup>Seasons* screen and can be:

- **Bank Lockout**—When either of the **Emergency-Voltage Override Time** setpoints is disabled, the capacitor control blocks further automatic operation of the capacitor bank, except to open a closed bank during a **High-Voltage** condition.
- **Change BVC+M**—If both of the **Emergency-Voltage Override Time** setpoints are enabled, the capacitor control uses the emergency-voltage override values to define **Voltage-Override** conditions and to inhibit bank

switching. The strategy for the present season remains in effect. The capacitor control returns to the normal voltage override setpoints when the calculated Bank Voltage Change + Margin is less than the difference between the **High-Voltage Override Value** setpoint and the **Low-Voltage Override Value** setpoint for the present season. However, if it becomes greater than the difference between the **Emergency Voltage-Override** values, the capacitor control blocks further automatic operation of the bank, except to open a closed bank during a **High-Voltage** condition.

The state of the faceplate LEDs determines which method(s) to use to switch the capacitor bank in and out. Table 4 shows the possible combinations and how each affects the ability to operate the bank.

Table 4. Capacitor Bank Operation and Control States

Faceplate State		Control	Operate Bank From		
AUTO/ MANUAL	REMOTE/ LOCAL	Operating Mode	Faceplate	Operation Screen IntelliLink	SCADA Master Station
Manual	Local	Manual	Yes	Yes	No
Manual	Remote	SCADA	No	No	Yes
Auto	Local	Automatic	No	No	No
Auto	Remote	Automatic	No	No	Yes

The following rules apply no matter which method is chosen to switch the bank:

- An energized capacitor bank cannot be reclosed for a period of 5 minutes after being opened. The **Reclose Block** feature provides time for the capacitor charge to bleed off. The bottom line of the LCD screen and the **Reclose Block** field on the *Operation* screen show the time remaining before the capacitor control can switch the bank in. The OPEN LED on the faceplate blinks slowly while a **Reclose Block** condition is in effect.
- One can enable the **Manual Operation Delay** setpoint, noted on Page 2 of the *Setup>General* screen, to add a separate switch delay (for both opening and closing the bank) to allow time for an operator to step away from the bank after pressing the CLOSE or OPEN button. When this delay is enabled, the CLOSE or OPEN LED starts blinking at a fast rate to indicate a pending action. The delay and the requested operation can be cancelled at any time before the output relays are energized by pressing the OPERATION MODE CHANGE button to enter **Automatic Operation** mode.

Note: If cancelling an operation manually, make sure to return to **Manual** mode to prevent the bank from switching automatically.

- The red CLOSE LED is lit when the capacitor bank switch is closed; it blinks rapidly while it is timing to close. The green OPEN LED is lit when the capacitor bank switch is open. It blinks rapidly while it is timing to open; it blinks slowly while a **Reclose Block** condition is in effect.
- When powering the capacitor control for the first time or when the capacitor control software has been reloaded (not updated), the LEDs *do not* indicate the bank state until a switching operation is performed. To make the LED displays match the switch condition, operate the bank manually or wait for an automatic operation to occur. When the capacitor control is in **Manual** mode and is changed to **Automatic** mode, it waits 60 seconds before switching the bank. This allows the operator to step away from the bank.

Switching the Capacitor Bank

Manual Operation

IMPORTANT: When the MANUAL and LOCAL LEDs are lit, the capacitor control blocks automatic and SCADA operation of the capacitor bank. Operating the bank can only be done from the faceplate or from the *Operation* screen.

To use the faceplate buttons to switch the capacitor bank in or out, confirm:

- The faceplate LCD screen shows ****UNIT OK****. If the LCD screen does not show ****UNIT OK****, see Instruction Sheet 1023-550, “S&C IntelliCap® Plus Automatic Capacitor Control: *Troubleshooting*,” for more information.
- The OPEN LED is *not* blinking. When the OPEN LED is blinking slowly, the **Reclose Block** condition is in effect. Wait until it stops blinking before trying to switch the bank.
- The MANUAL LED is lit. When the AUTO LED is lit, pressing the CLOSE or OPEN button has no effect.
- The LOCAL LED is lit.

Following your company’s procedures, press the CLOSE or OPEN button on the control faceplate to operate the capacitor bank.

- To send a **Close** command to the capacitor bank switch, press the CLOSE button.
- To send an **Open** command to the capacitor bank switch, press the OPEN button.

Local Bank Operation from the IntelliLink Software

To use the IntelliLink software to switch the capacitor bank:

On the *Operation* screen, confirm:

- The OPEN LED display is *not* blinking. When the OPEN LED is blinking slowly, the Reclose Block delay is in effect. Wait until it stops blinking before trying to switch the bank.
- The MANUAL LED is lit. When the AUTO LED is lit, commands from the **Close** and **Open** fields have no effect.
- The LOCAL LED display is lit.

Following your company’s procedures, click on the **Close** or **Open** field on the *Operation* screen to operate the capacitor bank.

- To transmit a **Close** command to the capacitor bank switch, click on the **Close** button. Click on the **OK** button in the dialog box to confirm the command.
- To transmit an **Open** command to the capacitor bank switch, click on the **Open** button. Click on the **OK** button in the dialog box to confirm the command.

Remote Bank Operation from the SCADA Master Station or WinMon Graphical User Interface Software

The capacitor bank can be opened or closed from a SCADA master station or with the WinMon Graphical User Interface software. The capacitor control must be in **Remote Operation** mode (the REMOTE LED is lit) to accept commands from the SCADA master station or the WinMon interface. For more information on the WinMon interface, contact S&C Electric Company.

Automatic Operation

To enable the **Automatic Operation** mode, confirm the faceplate AUTO LED is lit. The software in the capacitor control switches the bank automatically based on the values entered when the capacitor control was configured. For an explanation of the available switching strategies, see the “Control Strategies” section on page 14.

Routine Data Logging

The data-logging screens show high and low values and trend data for voltage and current amplitude, phase, and related parameters. When a customer complains about a service outage or low voltage, the information in the data-logging screens can help determine what happened and why.

Except for operation counters, the data logs are shown in a browser window. Internet Explorer 5.0 or higher is the recommend browser for these html screens. The IntelliLink software opens the browser automatically when viewing logged data. To access the help text for these screens, using IntelliLink Setup Software in the menu, click on the “Help” entry, click on the “Contents” entry, and click on the software type (for example, PCSD---S).

Displaying the Operation Counters Screen

The *Operation Counters* screen shows the number of capacitor bank switching cycles for each day of the preceding 31 days during this calendar year and since installation. Each cycle consists of a **Close** operation and an **Open** operation. See Figure 9.

To open the *Operation Counters* screen, click on the **Operation Counters** button on any IntelliLink screen.

Date	Cycles	Date	Cycles	Date	Cycles	Date	Cycles
	0		0		0		0
	0		0		0		0
	0		0		0		0
	0		3		0		0
	0		0		0		
	0		0				
	0		0	Total This Year			9
	0		0	Total Since Installation			9
	0		0	Reset All Cycle Counters			Disabled
	6		0				

NOTE: All counters are updated when the bank switches out.

Figure 9. The *Operation Counters* screen.

The counters record both automatic and manual switching operations. The screen includes the following fields:

Total This Year

This is the total number of switching cycles completed during this calendar year. The capacitor control updates the counters when it switches the bank out.

Note: If the capacitor control’s software is reloaded (not updated) or the **Reset All Cycle Counters** field is enabled, this counter is reset to zero.

Total Since Installation

This is the total number of switching cycles completed since installation of the capacitor control. The capacitor control updates the counters when it switches the bank out.

Note: If the capacitor control’s software is reloaded (not updated) or the **Reset All Cycle Counters** field is enabled, this counter is reset to zero.

Reset All Cycle Counters

When this field is set to the **Enabled** state, the capacitor control clears all bank switching cycle counters. This is a momentary operation. Once executed, the field shows “Cleared” until the first switchout. The field then shows “Disabled.”

Sensor Profiles

The *Sensor Profiles* screen shows the sensor profiles for voltage and temperature and, if applicable, current, power factor, kvars, kW, and neutral current or neutral voltage, as well as the bank state (**Closed** or **Open**). The capacitor control uses the **Extended Data Logging Interval** setpoint (noted on Page 2 of the *Setup>General* screen) to record data. See Figure 10.

Note: The **Neutral Sensor** values logged may be either **Fundamental** or **Total RMS**, which is selected using the **Neutral Sensor Data Logging** setpoint on the *Setup>Neutral Sensor* screen.

Displaying the Sensor Profiles screen

To display the *Sensor Profiles* screen, from the **Data** menu, choose the **Event/Data Logs** option. Then, double-click on the “Data_Logs” entry. Click on the **All Sensors** option. Then, choose which profiles to view. If desired, enter a date range for the data to view. Then, click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

Note: To view the voltage profile only, click on the **Voltage Profile** option instead of the **All Sensors** option.

DATA LOGGING: Sensor Profiles

PROFILES ON 5-MINUTE INTERVALS

Timestamp	Volts	Temperature	Neutral	Current	Power Factor	kVARs	kW
123.5	68	0	49	0.087	3559	265	
123.7	68	0	49	0.087	3562	265	
124.8	68	0	50	0.087	3578	266	
124.0	69	0	50	0.087	3568	265	
124.6	69	0	50	0.087	3576	268	
122.4	69	0	49	0.087	3555	265	
125.0	69	0	50	0.087	3587	265	
126.5	69	0	50	0.087	3610	268	
126.1	69	0	50	0.087	3600	270	
126.3	69	0	50	0.087	3611	268	
127.4	69	0	50	0.087	3644	269	
127.2	69	0	50	0.087	3655	276	
126.5	69	0	50	0.087	3646	271	
125.9	70	0	50	0.087	3619	271	
125.3	70	0	50	0.087	3597	270	
125.3	70	0	50	0.087	3591	270	
10/09/01 04:00:00 pm	123.7	70	0	50	0.087	3570	266
125.0	70	0	50	0.087	3599	270	
124.0	70	0	50	0.087	3579	268	
126.1	70	0	50	0.087	3623	271	
125.9	70	0	50	0.087	3623	273	
125.7	70	0	50	0.087	3626	273	
125.7	70	0	50	0.087	3623	272	
125.0	70	0	50	0.087	3599	271	
126.5	70	0	50	0.087	3644	275	

Figure 10. The Sensor Profiles screen (var with neutral current control).

The Sensor Profiles log includes data for 120 time-stamped records. Each record contains 24 data samples. When the log is full, each new sample overwrites the oldest sample in the log. The most recent sample is shown at the top of the log.

The control uses the **Extended Data Logging Interval** setpoint, configured on Page 2 of the *Setup: General* screen, for recording these numbers, which are interval-averaged values. The control collects data at 0.3-second intervals. It averages four samples to yield the 1.2-second averaged value. Then, it adds together all the 1.2-second averaged values in the interval (for example, 2:46 a.m. to 3:00 a.m. for a 15-minute data-logging interval) and divides the total by the number of values.

The number of days of data logged depends on the interval chosen. The capacitor control can log data in 1-, 5-, 10-, 15-, 30-, or 60-minute intervals. Table 5 shows how many days of data are logged, and how often the data is timestamped for each interval.

Changing the data-logging interval, some data may be lost. The control calculates where the sample for the present time should appear using the new interval. It then logs the present sample in the correct location without clearing the entire record or time stamp. This means a single record could contain data using two different logging intervals. Make sure to note the time at which the interval changed (for use during later data analysis).

Note: If the capacitor control has a power outage, up to 48 hours of data can be lost. Whenever possible, generate all necessary reports before powering down the capacitor control. If bringing a capacitor control in from the field, generate all necessary reports as soon as possible. This minimizes the amount of lost data.

If the power fails and then returns within the time span of a single record, the control clears that entire record and time stamp. It then logs the present sample in the correct location within the record. Time stamping begins with the next record.

If the power fails and returns the same day or the next day, the capacitor control clears all the records (including time stamps) between the one in which the power failed and the one in which power was restored. It then logs the present sample in the correct location. Time stamping begins with the next record.

If the power fails and returns several days later, the capacitor control clears all the records (including time stamps) between the one in which the power failed and the end of that day. The next day of data in the log is for the day on which power was restored. This discontinuity minimizes the amount of data overwritten. The capacitor control clears all records up to the one in which power was restored and logs the present sample in the correct location. Time stamping begins with the next record.

Table 5. Data-Logging Intervals for Sensor Profiles.

Data Logging Interval	Days of Data Logged	Record Timestamp Period
1 minute	2 days	Once every 24 minutes
5 minutes	10 days	Once every 2 hours
10 minutes	20 days	Once every 4 hours
15 minutes	30 days	Once every 6 hours
30 minutes	60 days	Once every 12 hours
60 minutes	120 days	Once every 24 hours

Viewing Data

Harmonics Data

Users may choose the type of harmonic data the control logs: Voltage, Current, or Neutral Voltage/Neutral Current, as applicable. The values are shown in the *Selected Sensor Harmonics Analysis* screen. See Figure 11.

Displaying the Selected Sensor Harmonics Analysis screen

To display the *Selected Sensor Harmonics Analysis* screen, from the **Data** menu, choose the “Event/Data Logs” entry. Then, double-click on the **Data_Logs** option. Click on the “Harmonics” entry. If desired, enter a date range for the data to view. Then, click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

THD in percent, Harmonics are percentage of the fundamental					
Date and Time	Sensor Type	THD	3rd Harmonic	5th Harmonic	7th Harmonic
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00
	Voltage	0.00	0.00	0.00	0.00

Figure 11. The Selected Sensor Harmonic Analysis screen.

The capacitor control calculates the 1st (fundamental), 3rd, 5th, and 7th harmonics, as well as the total harmonic distortion (THD), every 15 minutes. The date and time of the calculated harmonics are shown as well as the sensor type logged. See the **Power Harmonics Data Logged** setpoint on the *Metering* screen. Once the log is full, each new value overwrites the oldest value in the log.

Harmonics are expressed as a percentage of the fundamental. Total harmonic distortion is calculated as the ratio of the total RMS harmonic content to the RMS level of the fundamental.

Daily High-Low for Last Month

The *Daily High and Low* screens show the daily high and low values for a 24-hour period (12 midnight to 12 midnight) for **Voltage** and **Temperature** values and, if applicable, current, power factor, kvars, kW, and neutral current or neutral voltage. One can view the high/low data for today and for each of the preceding 31 days. See Figure 12 on page 35.

Displaying one of the Daily High and Low screens

To display the *Daily High and Low* screen, from the **Data** menu, choose the “Event/ Data Logs” entry. Then, double-click on the **Data_Logs** option. Click the type of high/ low data to view. If desired, enter a date range for the data to view. Then, click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

Date	Voltage			Temperature				
	Min	Time	Max	Min	Time	Max	Time	
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
	N/A		N/A	N/A		N/A		
01/29/02	122.6	02:38:21 pm	124.0	02:27:06 pm	N/A	02:26:43 pm	73	02:26:44 pm
	N/A		N/A		N/A		N/A	
	N/A		N/A		N/A		N/A	

Figure 12. One of the *Daily High and Low* screens.

Each displayed value is the highest or lowest raw sample value for that parameter for the specified day. The capacitor control takes a measurement every 0.3 seconds.

A temperature sensor located on the bottom of the capacitor control enclosure measures external temperature.

Switching Events

Every time the capacitor bank switches in or out (manually or automatically), the capacitor control records the time, date, and request type. These values are shown on the *Switching Events* screen. See Figure 13.

Displaying the Switching Events screen

To open the *Switching Events* screen, from the **Data** menu, choose the “Event/Data Logs” entry. Then, double-click on the **Event_Logs** option. Click on the “Switching Events” entry. If desired, enter a date range for the data to view. Then click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

Switch-In		Switch-Out	
Date and Time	Request Type	Date and Time	Request Type
01/29/02 02:29:02 pm	Timeclock Mode		

Figure 13. The *Switching Events* screen.

Viewing Data

Data for 14 complete switching cycles is included. When the log is full, each new event overwrites the oldest event in the log. The most recent event is always at the top of the list.

The *Switching Events* screen includes the following fields:

Date and Time

This is the date and time when the switching operation occurred.

Request Type

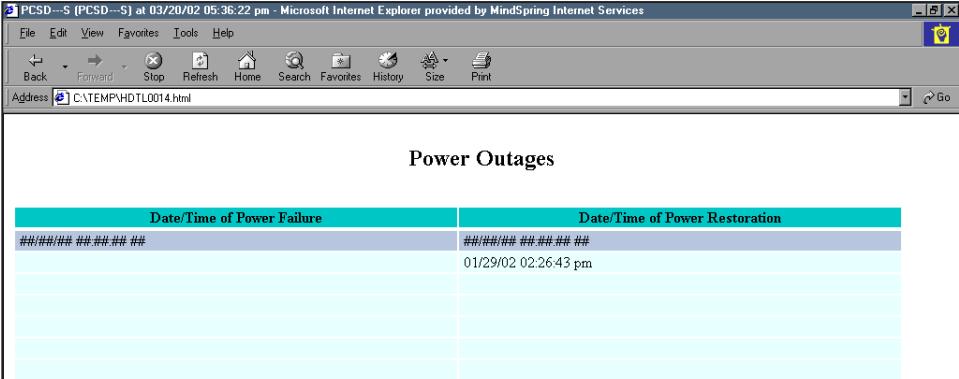
This is the type of request (manual, voltage override, etc.) that caused the capacitor bank to switch.

Power Outages

The *Power Outages* screen shows the date and time of the last 15 power cycles. See Figure 14.

Displaying the Power Outages screen

To display the *Power Outages* screen, from the **Data** menu, choose the “Event/Data Logs” entry. Then, double-click on the “Event_Logs” entry. Click on the **Power Outages** option. If desired, enter a date range for the data to view. Then, click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.



Date/Time of Power Failure	Date/Time of Power Restoration
#####	#####
	01/29/02 02:26:43 pm

Figure 14. The *Power Outages* screen.

This log can hold information for 15 power failures and 15 power restorations. When the log is full, each new event overwrites the oldest event in the log. The most recent event is always at the top of the list.

Voltage Levels During Switching

Every time the capacitor bank switches in or out (manually or automatically), the control records the line voltage before and after switching, as well as the time, date, and request type. These values are shown in the *Voltage Levels During Switching* screen. See Figure 15 on page 37.

Displaying the Voltage Levels During Switching screen

To display the *Voltage Levels During Switching* screen, from the **Data** menu, choose the “Event/Data Logs” entry. Then, double-click on the “Event_Logs” entry. Click on the **Voltage Switching Deltas** option. If desired, enter a date range for the data to view. Then click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

Voltage During Switch-In					Voltage During Switch-Out				
Date and Time	Before	After	Delta	Request Type	Date and Time	Before	After	Delta	Request Type
01/29/02 02:29:02 pm	123.5	123.6	0.1	Timeslock Mode		0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	
	0.0	0.0	0.0			0.0	0.0	0.0	

Figure 15. The *Voltage Levels During Switching* screen.

This log includes data for 14 complete switching cycles. When the log is full, each new event overwrites the oldest event in the log. The most recent event is always at the top of the list.

For the voltage measurements both before and after switching, the capacitor control takes a measurement every 0.3 seconds. It adds together four consecutive samples and divides the total by four to yield a 1.2-second averaged value. The first measurement is taken just before the capacitor bank switches are energized. The second measurement is taken approximately 3 seconds after the switches are de-energized.

Use the information on this screen to look for possible error conditions during switching (see the “Switching Events” section on page 35) and to check the switching times. It is also useful for determining the **Bank Voltage Change + Margin: Estimated Value** setpoint, on Page 1 of the *Setup>General* screen. When the **Bank Voltage Change + Margin: Automatic Calculation** setpoint is enabled, the capacitor control uses these delta values in its calculation. See the Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*,” for more information.

This window includes the following fields:

Date and Time

This is the date and time when the switching operation occurred.

Before

This is the line voltage before the capacitor control switched the bank.

After

This is the line voltage after the capacitor control switched the bank, approximately 3.5 seconds after the end of a pulse.

Delta

This is the change in voltage due to switching the bank. If the bank is operating normally, this is a positive number when the bank is switched in and a negative number when the bank is switched out.

Note: Because of the way the capacitor control rounds and stores voltage values, the delta value displayed may be slightly different from the **Before** value minus the **After** value.

Request Type

This is the type of request (manual, voltage override, etc.) that caused the capacitor bank to switch.

Kvar Levels During Switching

For var controls, every time the capacitor bank switches in or out (manually or automatically), the control records the kvar levels before and after switching, as well as the time, date, and request type. These values are shown in the screen. See Figure 16.

Display the Kvar Levels During Switching screen

To display the *Kvar Levels During Switching* screen, from the **Data** menu, choose the “Event/Data Logs” entry. Then, double-click on the “Event_Logs” entry. Click on the **kvar Switching Deltas** option. If desired, enter a date range for the data to view. Then, click on the **OK** button. The IntelliLink software automatically opens a browser window to display the data.

kVARs During Switch-In					kVARs During Switch-Out				
Date and Time	Before	After	Delta	Request Type	Date and Time	Before	After	Delta	Request Type
	0	0	0		01/24/02 07:23:05 pm	0	0	0	Timeclock Mode
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	
	0	0	0			0	0	0	

Figure 16. The *Kvar Levels During Switching* screen.

The *Kvar Levels During Switching* screen includes data for 14 complete switching cycles. When the log is full, each new event overwrites the oldest event in the log. The most recent event is always at the top of the list.

For the kvar measurements both before and after switching, the capacitor control takes a measurement every 0.3 seconds. It adds together four consecutive samples and divides the total by four, to yield a 1.2-second averaged value. The first measurement is taken just before the capacitor bank switches are energized. The second measurement is taken approximately 3 seconds after the switches are de-energized.

Use the information in this screen to look for possible error conditions during switching (see the “Switching Events” section on page 35) to check the switching times and to monitor the health of the capacitor bank.

This screen includes the following fields:

Date and Time

This is the date and time when the switching operation occurred.

Before

This is the kvar value before the capacitor control switched the bank.

After

This is the kvar value after the capacitor control switched the bank.

Delta

This is the change in kvars due to switching the bank. If the bank is operating normally, this is a negative number when the bank is switched in and a positive number when the bank is switched out.

Request Type

This is the type of request (manual, voltage override, etc.) that caused the capacitor bank to switch.

Data Graphing

The *Data Graphing* screens provide quick access to historical data in graph form. One can view graphs of daily highs and lows for the last month and graphs of sensor profiles. See Figure 17.

The capacitor control automatically scales each graph to show as much detail as possible. To rescale a graph, from the **Data** menu select the “Graphing Options” entry. Deselect the **Use Auto Scaling** feature. Then, enter the values for the desired Y-axis range.

Note: To produce a continuous scale graph of the power factor from full lag to full lead, leading power factors are plotted from 1 to 2 (instead of -1 to 0). The rescaled values are calculated as their difference from 2 (for example, a leading power factor of -0.8 is graphed as 1.2). A value of “1” equals unity power factor (zero var).

Displaying the daily high/low graphs

Do open the *Daily High/Low Graph* screens, from the **Data** menu, click on the “Graphs” entry. Then, double-click on “High-Low Graphs” entry. Select the graph to view (for example, Figure 17). Then, click on the **OK** button.

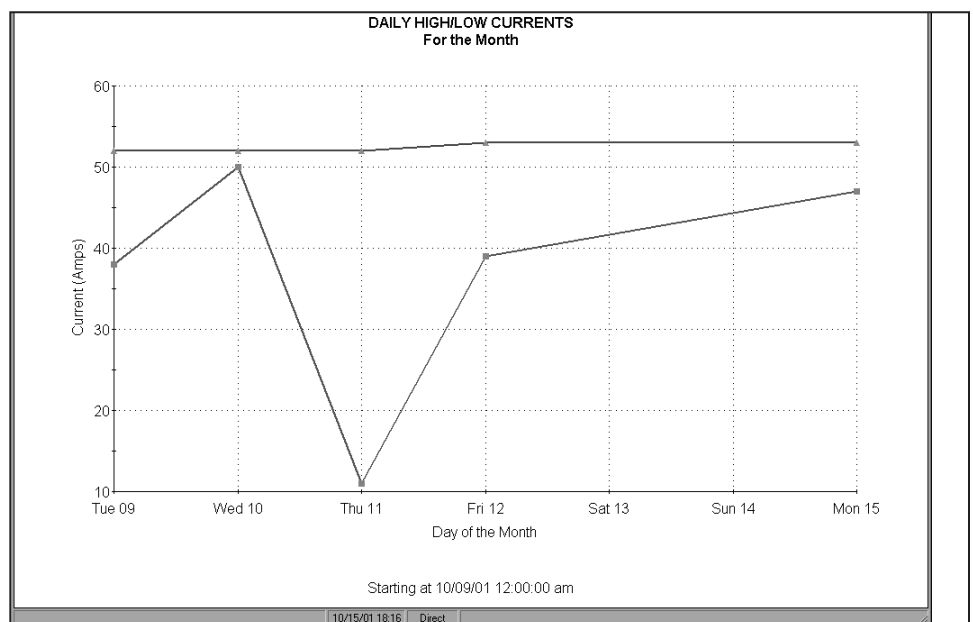


Figure 17. One of the *Daily High/Low Graph* screens.

Displaying the sensor profile graphs

To open the *Sensor Profile Graph* screen, from the **Data** menu, click on the “Graphs” entry. Then, double-click on the “Sensor Graphs” entry. Select the graph to view (for example, Voltage Profile). To move through all the graphs for the data, click on the **First**, **Previous**, **Next**, and **Last** buttons. See Figure 18.

Note: The amount of data in the sensor profile graphs depends on the data-logging interval. (See the “Sensor Profiles” section on page 32 for more details.)

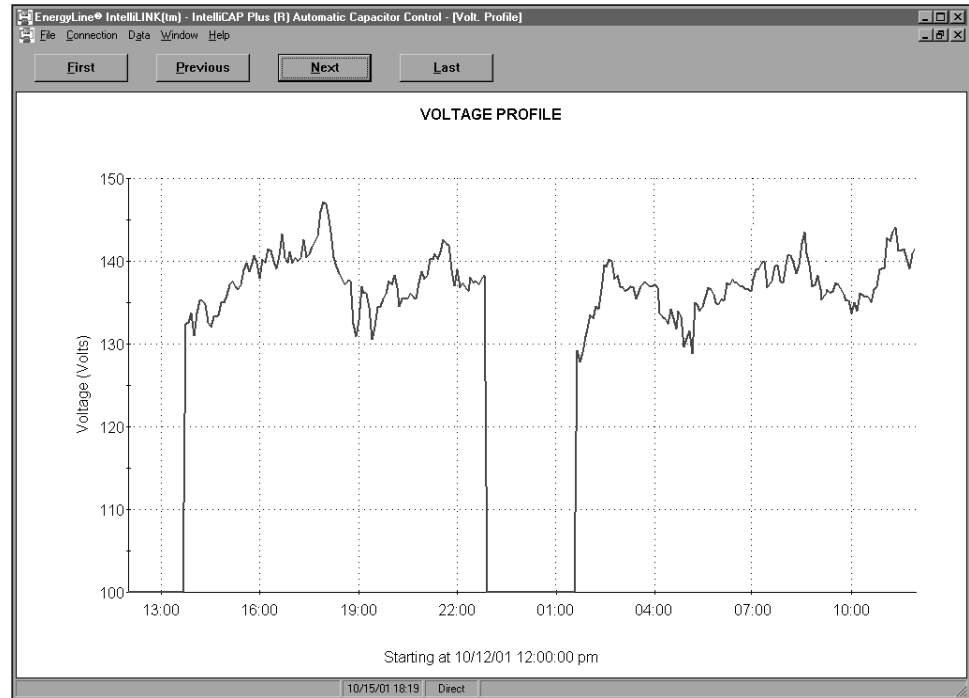


Figure 18. One of the *Sensor Profile Graph* screens.

Use the **Report** feature to save the capacitor control's software settings and stored data to your computer as a CSV (comma-separated value) file. Users may keep the report as a permanent record and use the report data in spreadsheets or other types of programs.

Follow these steps to save control data in a CSV file:

STEP 1. Connect a portable computer to the capacitor control and start the IntelliLink software.

STEP 2. From the **Data** menu, choose the **Reports** option.

STEP 3. In the dialog box, select the type of report to generate. Then, click on the **OK** button.

There are four report types:

Full—Includes all the information contained in the capacitor control

System Setup and Operation—Contains the configuration data for the capacitor control

Troubleshooting Information—Contains the information recorded in the troubleshooting logs

Historical Data—Contains the daily statistics, the sensor profiles, the switching data, and the log of power outages

STEP 4. In the Save Report dialog box, specify a name and location for this report, and then click on the **OK** button.

If the file location is not specified, the file is saved to the same directory as the program files for this for this type of control (for example, the default location for PCSD1--S report files is C:\ELINE\PCSD---S\). The extension ".CSV" is added automatically. When the report is complete, the message "Task completed" appears on the status line of the Writing Report dialog box.

If several capacitor controls use a similar setup configuration, the configuration file can be saved from one control and loaded it into the others replicating the saved configuration. Specific setpoints can then be manually adjusted in each control.

A configuration file should be used with control software that is the same revision as the software used to create the configuration file. However, a file created by a different software revision can be used. Software revisions can add setpoints for new features. If the configuration file was created with older software, only the setpoints available in the older software will be configured, and setpoints for new features will be set to the default value. If the configuration file was created by newer software, setpoints not present in the target control will not be added by the configuration file.

Refer to Table 6. Configuration files are compatible between software revisions 115 through 118; however, these features were added or revised for software revision 116:

Table 6. Instruction Sheet References for Various Features

Feature	Reference Page
Optional second neutral current retry	1023-530 pg 49
Optional second neutral voltage retry	1023-530 pg 52
First and second neutral current retry changed from Enable mode to a time value selectable from 0 to 48 hours	1023-530 pg 49
First and second neutral voltage retry changed from Enable mode to a time value selectable from 0 to 48 hours	1023-530 pg 52
Neutral Sensing alarm method is user-selectable: Fundamental harmonic or total RMS	1023-530 pgs 50 & 53
Neutral-sensing data logging is user-selectable: Fundamental harmonic or total RMS	1023-530 pgs 50 & 53
Default harmonics calculation method changed from IEEE to IEC	1023-550 pg 22
SCADA Override Time-Out setpoint changed from 3-hour increments to 1-hour increments above the 1-hour setting	1023-530 pg 54

Saving a Setup Configuration

Follow these steps to save a setup configuration:

- STEP 1.** Determine which capacitor control contains the configuration being saved.
- STEP 2.** Connect a computer to the selected control and start the IntelliLink software. For details, see the “Start IntelliLink Software” section in Instruction Sheet 1023-530, “IntelliCap® Plus Automatic Capacitor Control: *Setup*.” If the computer is already connected to the capacitor control, skip this step.
- STEP 3.** Click on the **Save Data** button (from most IntelliLink software screens). Another option is to click on “Save Setpoints” entry in the **File** menu. Then, click on the **OK** button.
- STEP 4.** In the Save Setpoints dialog box, specify a name and location for this configuration file. Then, click on the **Save** button. If the file location is not specified, the file is saved to the same directory as the program files for this type of control (for example, the default location for PCSD1--S report files is C:\ELINE\PCSD--S\). The extension “.CFG” is added automatically.

Note: This process does not save the “Physical Location” entry (configured on Page 2 of the *Setup>General* screen) or the “Communications RTU Address” entry (configured on Page 1 of the *Communications>Setup* screen).

Loading a Saved Configuration

Follow these steps to load a saved configuration:

STEP 1. Connect a computer to the control where the configuration will be loaded. Then, start the IntelliLink software.

For details, see the “Start IntelliLink Software” section in Instruction Sheet 1023-530, “IntelliCap® Plus Automatic Capacitor Control: *Setup*.”

STEP 2. From the **File** menu, click on the **Load Setpoints** option.

STEP 3. In the dialog box, select the CFG file for the configuration. Then, click on the **Open** button.

STEP 4. Make any setpoint changes required for this capacitor control. For more information, see Instruction Sheet 1023-530, “IntelliCap® Plus Automatic Capacitor Control: *Setup*.”

Note: Be sure to enter the correct values for the “Physical Location” entry (configured on Page 2 of the *Setup>General* screen) and, if necessary, the “Communications RTU Address” entry (configured on Page 1 of the *Communications>Setup* screen).

When loading a configuration file saved from a previous software revision, it may not configure all the setpoints included with the newer software. The older configuration file will successfully load the data it contains, and the new setpoints will remain set at their default values. If changes are needed in the default values, they must be manually configured. Refer to the “ReadMe.txt” file that is included with the new software for information about newly added setpoints.

Using IntelliLink Software Without a Control

Using a Screenset

Follow these steps to view the IntelliLink screens and Help file without connecting to a capacitor control or a snapshot:

STEP 1. Start the IntelliLink software on a computer.

STEP 2. During startup, click on the **Cancel** button to close the Connect dialog box.

If the IntelliLink software is already running, choose the **Disconnect** option on the **Connection** menu. Then, click on the **Close Screenset** option on the **File** menu to clear the present screenset from memory.

STEP 3. From the **File** menu, click on the **Open Screenset** option.

STEP 4. In the Open Screenset dialog box, find and select the WMN file whose name matches the version name on the setup software for this control.

Using a Snapshot

Operational and data-logging information can be saved in snapshots, which are “.vm” virtual memory files. The snapshots enable users to view data, generate a report, and save or change setpoint configuration files, even when not connected to a capacitor control. To access the stored information, connect to the snapshot instead of a physical capacitor control. Each capacitor control software installer includes sample snapshots.

Saving Control Settings and Data to a Snapshot

Follow these steps to save control settings and data to a snapshot:

STEP 1. Connect a computer to the control from which the information will be saved. Then, start the IntelliLink software.

For details, see the “Starting IntelliLink Software” section in Instruction Sheet 1023-530, “IntelliCap® Plus Automatic Capacitor Control: *Setup*.”

STEP 2. From the **File** menu, click on the **Save Snapshot** option.

STEP 3. In the dialog box, specify a file name and location for this snapshot. Then, click on the **Save** button.

If the location to save the file is not specified, the file is saved to the same directory as the program files for this for this type of control (for example, the default location for PCSD---S report files is CAELINE\PCSD---S). The extension “.vm” is added automatically.

Viewing (connecting to) a Snapshot

Follow these steps to view a snapshot file:

STEP 1. Start the IntelliLink software on a computer. During startup, click on the **Cancel** button to close the Connect dialog box.

If the IntelliLink software is already running, click on the “Disconnect” entry on the **Connection** menu. Then, click on the **Close Screenset** option on the **File** menu to clear the present screenset from memory.

STEP 2. From the **File** menu, click on the **Open Snapshot** option.

The Open Controller Data File dialog box opens.

STEP 3. Select the snapshot to use. Then click on the **Open** button.

STEP 4. To change the configuration settings in the snapshot, click on the **Yes** button on the Connect to File dialog box. To avoid accidentally changing a setting, click on the **No** button.

The IntelliLink software opens and displays the contents of the selected snapshot.

Snapshot Changes are Saved Immediately

All changes made to configuration settings in the snapshot are automatically saved to disk immediately. There is no need to save the changes in a separate operation.

Generating a Report From a Snapshot

Follow the same procedure used when connected to a capacitor control. For details, see the “Generating Reports” section on page 41.

Creating a CFG File From a Snapshot

This procedure prepares a setpoint configuration for a capacitor control in the field without the need to have access to a comparable device.

STEP 1. Connect to the snapshot.

For details, see the “Viewing (connecting to) a Snapshot” section on page 44.

STEP 2. Change the configuration settings in the snapshot as needed.

For details, see Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*.”

STEP 3. From the **File** menu, click on the **Save Setpoints** option.

STEP 4. In the Save Setpoints dialog box, specify a name and location for this configuration file. Then click on the **Save** button.

If a file location is not specified, the file is saved to the same directory as the program files for this type of control (for example, the default location for PCSD---S report files is C:\ELINE\PCSD---S\). The extension “.cfg” is added automatically.

Note: This process does not save the “Physical Location” entry (configured on Page 2 of the *Setup>General* screen) or the “Communications RTU Address” entry (configured on Page 1 of the *Communications>Setup* screen).

Updating Capacitor Control Software

Follow these steps to update the capacitor control's software. The Update program, installed with the IntelliLink software, easily replaces the existing software with a newer revision.

NOTICE

The setpoint values and historical data stored in the capacitor control may be lost during the update process.

To capture the data, always generate all needed reports using the IntelliLink software and the existing control software before updating the control software.

STEP 1. Download the new installer from the S&C Automation Customer Support Portal and run the installer on a computer.

For details, see the “Start IntelliLink Software” section in Instruction Sheet 1023-530, “S&C IntelliCap® Plus Automatic Capacitor Control: *Setup*.”

STEP 2. Connect the computer to the LOCAL COMM port on the capacitor control.

STEP 3. Start the Update program.

(a) In Windows, select *Start menu>Programs>EnergyLine.Update*. The **Update** window will open. See Figure 19.

(b) Select the desired options. Then, click on the **Start Update** button.

Note: If the software is being downloaded as part of a troubleshooting procedure, selecting the **Don't Preserve Data** option is recommended.

Note: If the capacitor control is not connected to COM1 on the computer, click on the **Communication Setup** tab, select the correct comm port, and click on the **Connect** button. Then return to the **Update Control Software** tab and click on the **Start Update** button.

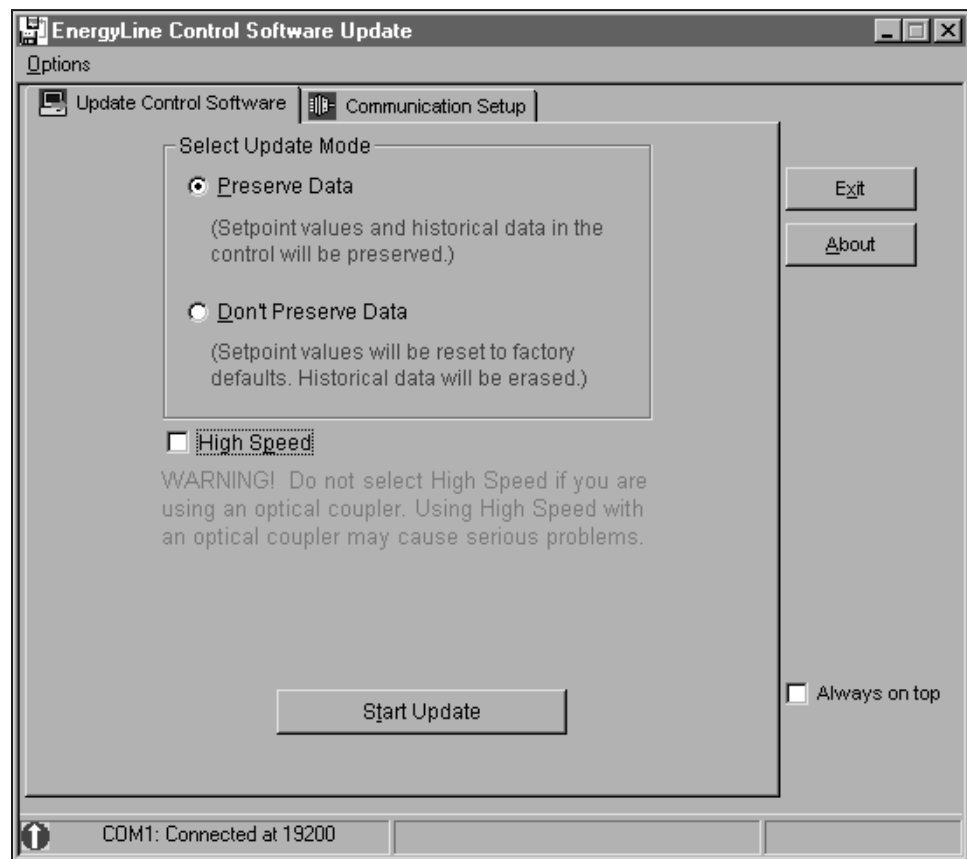


Figure 19. The Control Software Update dialog box.

The update process takes 5 to 10 minutes. Follow the progress in the lower right corner of the window. When the update is complete, the window closes automatically.

NOTICE

If the update process is cancelled after it starts, the software will be deactivated in the capacitor control. If cancelling the process, start the update process again.

Note: When the software in the capacitor control is not installed on the computer, an error message similar to Figure 20 will open. Obtain the correct software and restart this procedure at Step 2.

STEP 4. Check the Close/Open relays by operating the capacitor bank.

- (a) Make sure the LOCAL and MANUAL LEDs are lit.
- (b) Follow your company procedures. Press the CLOSE or OPEN button on the faceplate to operate the capacitor bank. Verify visually that the faceplate LEDs correctly indicate each capacitor bank switch position.
- (c) Visually check that the switch-position indicators on the capacitor bank switches for all three phases match the **Close** or **Open** indication of the faceplate LEDs.

The CLOSE and OPEN LEDs indicate the last requested operation. Neither LED will be on until the bank is switched for the first time.

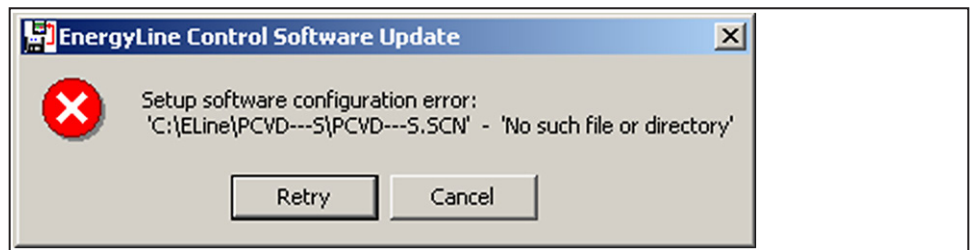


Figure 20. Software not installed message.

Note: The capacitor bank **Close** command is blocked for a period of 5 minutes after an **Open** command is issued. This delay provides time for the capacitor charge to bleed off. For more information, see the “Switching the Capacitor Bank” section on page 30.

STEP 5. Check the **Neutral Current/Voltage** indication on the faceplate LCD screen.

- (a) Check to see that the LCD screen shows: ****UNIT OK****. If the LCD screen shows ****ACTIVE ALARMS****, check the capacitor bank for a problem. The alarm condition must be corrected before the control will operate correctly.
- (b) Press the ENTER button on the faceplate twice. The LCD screen will show: ****DATA****.

STEP 6. Press the NEXT button on the faceplate to scroll the data to: ****NCAIrmLvl=****, and note the value displayed.