

Operation

Table of Contents

Section	Page	Section	Page
Introduction		Generating Reports	15
Qualified Persons	2	Saving And Loading Setup Configurations	
Read this Instruction Sheet	2	Saving the Setup Configuration	16
Retain this Instruction Sheet.	2	Loading a Saved Configuration	16
Proper Application	2	Viewing IntelliLink®	
Warranty	2	Software Without Data	17
Safety Information		Using Snapshots (VM Files)	
Understanding Safety-Alert Messages.	3	Saving Control Settings and Data to a Snapshot.	18
Following Safety Instructions	3	Viewing (Connect To) a Snapshot	18
Replacement Instructions and Labels	3	Saving Changes Made to the Snapshot.	18
Safety Precautions	4	Generating a Report from a Snapshot	18
Control Hardware And Software		Creating a CFG File From a Snapshot.	18
Applicable Software	5	Updating Control Software	19
Hardware and Faceplate	5		
Control Software.	6		
SCADA Communication Equipment.	6		
Control Operation			
Overvoltage Protection for Capacitor Banks	7		
Protection for Reactors.	7		
Automatic Control Features	8		
Ungrounded and Grounded Wye Shunt			
Capacitor Banks.	9		
Ungrounded Wye Shunt Reactors	11		
Signal Processing.	12		



Introduction

Qualified Persons

WARNING

Only qualified persons who are knowledgeable in the installation, operation, and maintenance of overhead and underground electric distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone 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 special precautionary techniques, personal protective equipment, insulated 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

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before installing or operating a BankGuard Plus Control. Familiarize yourself with the Safety Information and Safety Precautions on pages 3 and 4. 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 your BankGuard Plus Control. Designate a location where you can easily retrieve and refer to this publication.

Proper Application

WARNING

The equipment in this publication is only intended for specific application. The application must be within the ratings furnished for the equipment. Ratings for the are listed in the ratings table in Specification Bulletin 1011-31. The ratings are also on the nameplate affixed to the product.

Warranty

The warranty and/or obligations described in S&C's Price Sheet 150, "Standard Conditions of Sale—Immediate Purchasers in the United States," (or Price Sheet 153, "Standard Conditions of Sale—Immediate Purchasers Outside the United States,") plus any special warranty provisions, as set forth in the applicable product-line specification bulletin, are exclusive. The remedies provided in the former for breach of these warranties shall constitute the immediate purchaser's or end user's exclusive remedy and a fulfillment of the seller's entire liability. In no event shall the seller's liability to the immediate purchaser or end user exceed the price of the specific product that gives rise to the immediate purchaser's or end user's claim. All other warranties, whether express or implied or arising by operation of law, course of dealing, usage of trade or otherwise, are excluded. The only warranties are those stated in Price Sheet 150 (or Price Sheet 153), and **THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ANY EXPRESS WARRANTY OR OTHER OBLIGATION PROVIDED IN PRICE SHEET 150 (OR PRICE SHEET 153) IS GRANTED ONLY TO THE IMMEDIATE PURCHASER AND END USER, AS DEFINED THEREIN. OTHER THAN AN END USER, NO REMOTE PURCHASER MAY RELY ON ANY AFFIRMATION OF FACT OR PROMISE THAT RELATES TO THE GOODS DESCRIBED HEREIN, ANY DESCRIPTION THAT RELATES TO THE GOODS, OR ANY REMEDIAL PROMISE INCLUDED IN PRICE SHEET 150 (OR PRICE SHEET 153).**

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to the BankGuard Plus 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 S&C Global Support and Monitoring Center at 1-888-762-1100.

NOTICE	
Read this instruction sheet thoroughly and carefully before installing a BankGuard Plus 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 BankGuard Plus 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 BankGuard Plus 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.

Applicable Software

This instruction sheet was prepared for use with software version **UPPD106S** or later releases.

The release date is available on the setup disk label. For questions regarding the applicability of information in this instruction sheet to future software releases, please contact S&C.

This section describes various control components. The following section, "Overview of Control Operations," explains how these components work together to monitor and manage capacitor bank/reactor operation.

Hardware and Faceplate

Figure 1 shows control hardware components that may need to be accessible during regular operation and troubleshooting.

The BankGuard Plus Control faceplate includes LEDs and buttons for monitoring the capacitor bank/reactor and the control. It also includes an LCD screen and buttons for scrolling and selecting data.

Local communications port. The control has a port on its faceplate for local communication. If the control includes communication equipment, it will usually be connected to the SCADA comm port on the back.

Terminal strips. Every BankGuard Plus Control includes two numbered terminal strips for connecting to the external control wiring. Their configuration is shown in Instruction Sheet 1011-510, "S&C BankGuard Plus® Control: *Installation.*"

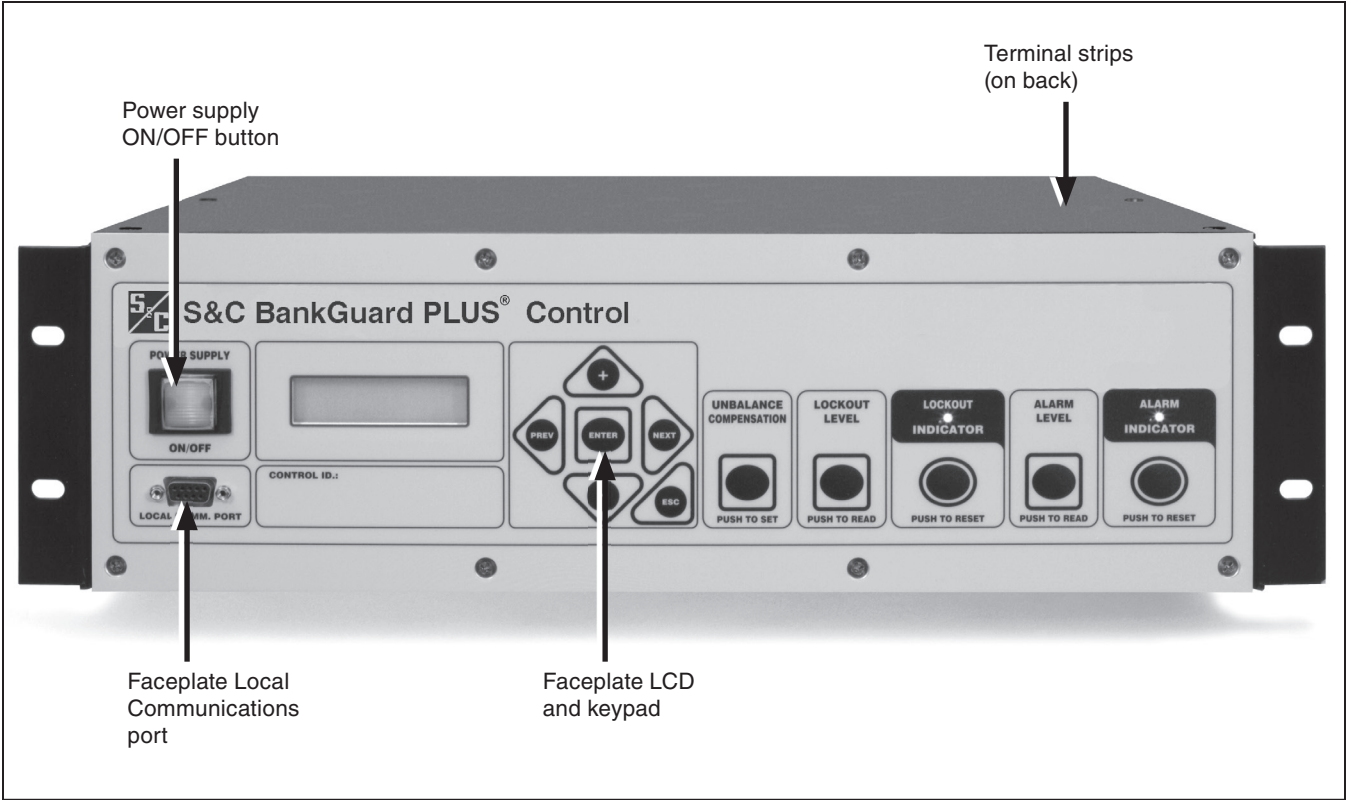


Figure 1. The location of BankGuard Plus Control components.

Control Software

S&C controls are entirely software-driven. Each control is shipped with control software and IntelliLink® Setup software.

Control Software

Control software is preloaded into the control in the factory. This software manages the minute-by-minute functioning of the control. It continually monitors:

- Voltage on the feeder
- Incoming SCADA commands
- The state of the faceplate LEDs and buttons
- The internal control device clock/calendar
- The 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 nonvolatile switch control memory. This memory survives power interruptions, including complete loss of the battery system.

Battery Backed Non-volatile SRAM

The NVSRAM and real time clock/perpetual calendar integrated circuit devices are battery-backed and have a 10-year battery life in the **Non-Powered** state. The real time clock/perpetual calendar integrated circuit counts seconds, minutes, hours, days, days of the week, date, month, and year with leap-year compensation up to 2100.

IntelliLink Setup Software

IntelliLink Setup Software is supplied on the Setup disk and runs on IBM/PC-compatible computers. This software enables onsite communications with the control software. Using the IntelliLink software, users can:

- Enter installation-dependent operating parameters (setpoints), such as a network address, a voltage lockout level, etc.
- Monitor real-time data, such as the present line-to-ground voltage
- Transfer all configuration, operating, and historical data from the control to a “report” file on your computer
- Download new control software into the control device
- Troubleshoot assorted types of control installation problems

SCADA Communication Equipment

Most communication equipment can be mounted near the control device.

DNP 3.0 is the standard protocol for the BankGuard Plus Control; other protocol options are also available.

For more details, see the appropriate communication points list or contact S&C.

This section explains how the BankGuard Plus Controls the capacitor bank or reactor.

Overvoltage Protection for Capacitor Banks

Medium to large wye-connected shunt capacitor banks commonly use twofold protection against short circuits:

- Individual capacitor units are protected by fuse links that clear internal faults, reducing the probability of case ruptures.
- The system is protected against major faults by the bank protective control, such as power fuses or an S&C Circuit-Switcher.

If a fuse link operates to isolate a failed capacitor unit, the voltage across remaining units in the same series group will increase. This increased voltage can overstress and shorten the life of the other capacitor units in the group. As subsequent units fail, their isolation leads to further voltage increase on the remaining units. The result is an accelerating cascade of overvoltage that destroys good capacitor units.

This phenomenon is addressed in IEEE Standard 18-1992, "IEEE Standard for Shunt Power Capacitors." The standard specifies a curve that indicates the permissible capacitor unit operating time at varying per-unit multiples of the capacitor nameplate voltage rating. See Figure 2. This curve applies for up to 300 applications of power-

frequency overvoltages of the magnitude and duration shown. (The standard further requires that capacitors be capable of continuous operation to at least 110% of the rated voltage, including harmonics. Most capacitor manufacturers publish similar data, which may permit higher working voltages.) When the voltage applied to the surviving capacitor units exceeds the manufacturer's maximum recommended working voltage (or in the absence of a recommendation, the IEEE standard), the entire bank should be removed from service.

Thus, large-sized capacitor banks require a third form of protection: a control sensitive enough to detect the isolation of the first failed unit in a capacitor bank but sophisticated enough to disregard system and inherent bank imbalances, spurious transients, and harmonics. Also, the ability to alarm upon isolation of that capacitor unit lets the user replace it before additional failures occur.

Protection for Reactors

When a developing turn-to-turn fault occurs in any phase winding, the ungrounded, wye-connected shunt reactor is protected from further damage by automatic switching initiated by the BankGuard Plus Control. The control also will isolate and lock out the entire shunt reactor when a predetermined neutral-to-ground voltage is exceeded.

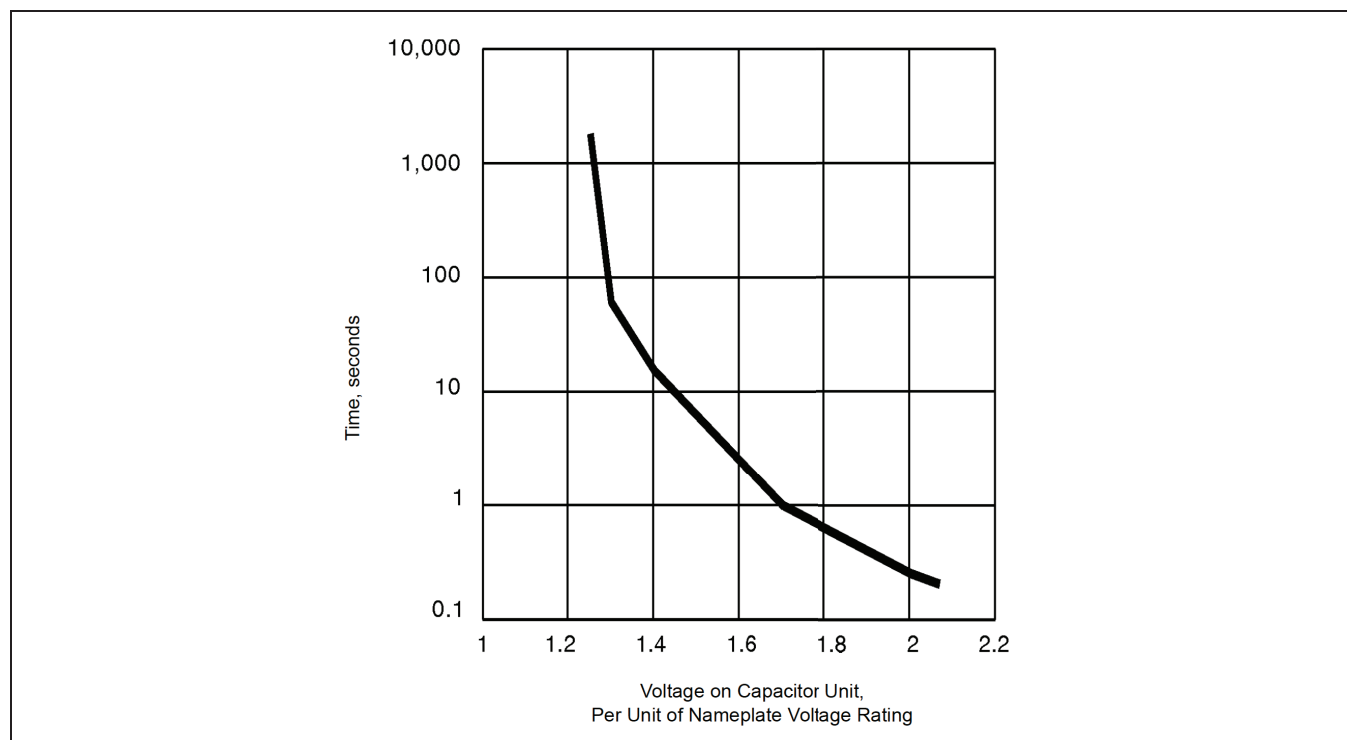


Figure 2. Capacitor unit power-frequency overvoltage versus time (IEEE standard 18-1992).

Automatic Control Features

The BankGuard Plus Control provides the automatic features described in this section.

Bank/Reactor Lockout and Alarm

The **Lockout** logic includes a user-selectable time delay (0.2 to 30 second). The time delay ensures the fuse for the failing capacitor unit operates before the control locks out the bank, so the failed capacitor unit can be quickly located.

The BankGuard Plus Control includes a standard **Alarm** function, which provides an alarm signal (after a time delay) upon the loss of fewer capacitor units than that corresponding to the **Lockout Level** setting. For many capacitor banks it is practical to activate the alarm at the loss of a single capacitor unit. This is a decided advantage because replacement of the failed capacitor unit can be accomplished at a convenient planned time instead of on an urgent basis during a lockout resulting from subsequent failure of capacitor units. If desired, the **Alarm** function can alarm in respond to loss of control power to the BankGuard Plus Control.

Alarms and lockouts are latched and maintained across a software reset. They remain active until the ALARM INDICATOR RESET button or a SCADA command resets them.

Gross Overvoltage

If a flashover of series groups within the capacitor bank or a failure of an entire reactor phase occurs, the **Gross Overvoltage** logic lets the control react more quickly than the normal lockout process. This logic is activated after a field-adjustable time delay of 0.2 to 5 seconds by such faults

producing a capacitor bank neutral-to-ground voltage in excess of an adjustable level of 1000 to 5000 Volts.

The BankGuard Plus Control incorporates a digital input actuated through a contact of the capacitor bank switch-operator auxiliary switch. This digital input prevents nuisance operation of the BankGuard Plus Control **Alarm** or **Lockout** functions resulting from neutral-to-ground voltages of several kilovolts being induced during periods when the capacitor bank has been routinely de-energized.

Unbalance Compensation

In larger capacitor banks, extraneous voltages can introduce significant errors in—or even overpower—the voltage signal created by the loss of individual capacitor units.

For example, a fixed error voltage may be present because of inherent capacitor bank imbalances from manufacturing-tolerance variations among individual capacitor units, or because of system voltage imbalances from non-transposition of overhead lines. A variable error voltage may also be present because of a system load imbalance from changing load conditions. (This error voltage is usually only significant in very large, transmission-voltage level capacitor banks.) Such an error voltage can cause false operations that lock out the capacitor bank/reactor or cause no operation when one is necessary.

The **Unbalance Compensation** feature (with the addition of station-bus voltage monitoring devices on ungrounded capacitor banks/reactors) lets the control detect and compensate for the error voltage.

Ungrounded and Grounded Wye Shunt Capacitor Banks

The BankGuard Plus Control provides protection of ungrounded (Figure 3) and grounded (Figure 4) wye-connected shunt capacitor banks. As individual capacitor units in a series group are isolated from the bank by their respective fuses, the control automatically protects the surviving capacitor units in the group from cascading voltage overstress. The control locks out the entire bank when the neutral-to-ground voltage exceeds the calculated level. See Instruction Sheet 1011-530, "BankGuard Plus® Control: Setup," for more details

In general, the **Unbalance Compensation** feature should be enabled if the magnitude of the error voltage caused by system voltage imbalances and/or inherent capacitor bank imbalances approaches 50% of the value of the neutral-to-ground voltage calculated for one isolated capacitor unit.

For ungrounded wye banks, the control uses an analog input and digital voltmeter to detect the capacitor bank neutral-to-ground voltage, as monitored by an S&C 15-Volt-Ampere Potential Device. A digital filter attenuates harmonics and noise. When the **Unbalance Compensation** feature is disabled, the magnitude of the real-time neutral-to-ground voltage is compared with the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled. Capacitor unit failures will cause the real-time neutral-to-ground voltage magnitude to change. If the real-time neutral-to-ground voltage magnitude exceeds a setpoint value continuously for a time greater than the applicable **Time Delay** setpoint value, the appropriate control action is taken. The control will lock the bank out if the **Gross Over Voltage Level** or the **Lockout Level** setpoint value is exceeded. The control will issue an alarm if the **Alarm Level** setpoint value is exceeded.

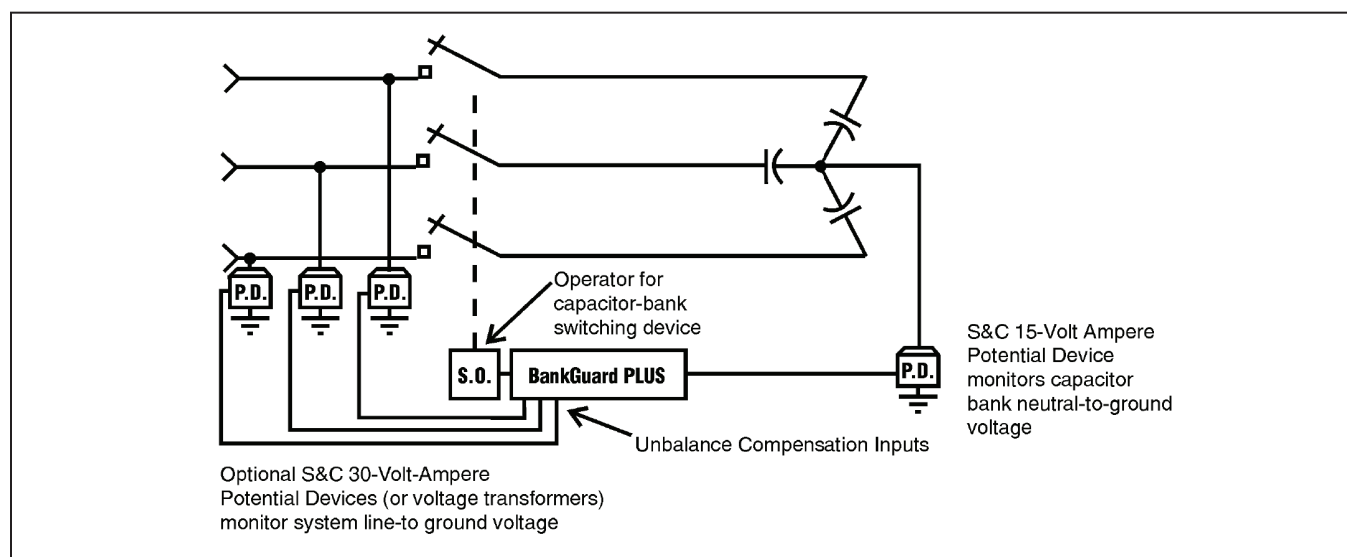


Figure 3. A system diagram of a BankGuard Plus Control for ungrounded wye-connected capacitor banks.

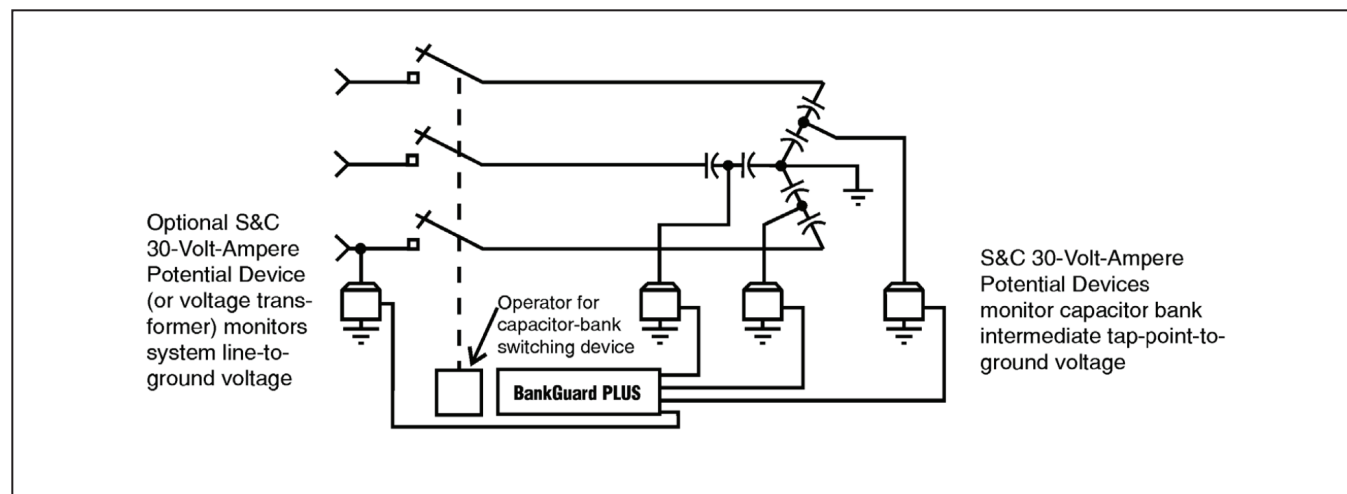


Figure 4. A system diagram of a BankGuard Plus Control for grounded wye-connected capacitor banks.

Control Operation

In addition to the neutral-to-ground potential device, one 30-Volt-Ampere S&C Potential Device is required to be installed on any one of the line phases to obtain a reference angle when the **Unbalance Compensation** feature is set in the **Cap Only** setting. During the setup of the **Unbalance Compensation** feature, a neutral-to-ground voltage magnitude sample and a reference angle (Aref) sample are used to obtain and store an approximate magnitude correction value. See the “Signal Processing” section on page 12 for an explanation of how the value is calculated.

Setup of the **Unbalance Compensation** feature should be accomplished during a time when any voltage unbalances caused by the loads are minimal. During each control cycle, the stored approximate magnitude correction value is subtracted from the real-time neutral-to-ground voltage magnitude to obtain a compensated neutral-to-ground voltage magnitude. Capacitor unit failures will cause the real-time neutral-to-ground voltage magnitude to change and, therefore, change the compensated neutral-to-ground voltage magnitude.

The control compares the compensated neutral-to-ground voltage magnitude with the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled. If the compensated neutral-to-ground magnitude exceeds a setpoint value continuously for a time greater than the applicable **Time Delay** setpoint value, the appropriate control action is taken. The control will lock out the bank if the **Gross Over Voltage Level** or the **Lockout Level** setpoint value is exceeded or issue an alarm if the **Alarm Level** setpoint value is exceeded. The **Cap Only** value is generally selected when the voltage variations between the line phases are expected to be negligible in comparison to the neutral-to-ground voltage changes resulting from the loss of capacitor units.

In addition to the neutral-to-ground potential device, three S&C 30-Volt-Ampere Potential Devices are required to be installed on each line phase when the **Unbalance Compensation** feature is in the **Cap/Line** setting. The control uses the three potential devices to obtain the sum of the line voltages magnitude and a reference angle. Because the sum is obtained from all the line voltages, compensation for fixed system imbalances is provided.

During the setup of the **Unbalance Compensation** feature, a neutral-to-ground voltage magnitude sample, a sum of the line voltages sample, and the reference angle are used to calculate and store a magnitude correction value. See the “Signal Processing” section on page 12 for an explanation of how the value is calculated. During each control cycle, the stored magnitude correction factor is subtracted from the real-time neutral-to-ground magnitude to obtain a compensated neutral-to-ground voltage magnitude. Capacitor unit failures will cause the real-time line-to-neutral voltage to change and, therefore, change the compensated neutral-to-ground voltage magnitude.

The control compares the compensated neutral-to-ground voltage magnitude to the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled. If the compensated neutral-to-ground voltage

magnitude exceeds a setpoint value continuously for a time greater than the applicable **Time Delay** setpoint value, the appropriate control action is taken. The control will lock out the bank if the **Gross Over Voltage Level** or the **Lockout Level** setpoint values are exceeded. The control will issue an alarm if the **Alarm Level** setpoint value is exceeded.

For grounded wye banks, the control uses **Tap Voltage Calibration** logic. This logic develops the sum of the intermediate tap-point voltages on the three-phase legs, as monitored by the S&C 30-Volt-Ampere Potential Devices. A digital filter attenuates harmonics and noise.

When the **Unbalance Compensation** feature is disabled, the magnitude of the sum of the intermediate tap-point-to-neutral voltages is compared (in percent) with the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled. Capacitor unit failures will cause the magnitude of the sum of the intermediate tap-point-to-neutral voltages to change. If the real-time magnitude of the sum exceeds a setpoint value continuously for a time greater than the applicable **Time Delay** setpoint value, the appropriate control action is taken. The Control will lock the bank out if the **Gross Over Voltage Level** or the **Lockout Level** setpoint value is exceeded. The control will issue an alarm if the **Alarm Level** setpoint value is exceeded.

In addition to the three 30-Volt-Ampere Potential Devices, one 30-Volt-Ampere S&C Potential Device is required to be installed on any one of the line phases to obtain a reference angle when the **Unbalance Compensation** feature setpoint value is set in the **Cap Only** setting. During setup of the **Unbalance Compensation** feature, a sample of the magnitude of the sum of the intermediate tap-point-to-neutral voltages and a reference angle sample are used to obtain and store an approximate magnitude correction value. See the “Signal Processing” section on page 12 for an explanation of how the value is calculated. Setup of the **Unbalance Compensation** feature should be accomplished during a time when any voltage unbalances caused by the loads are minimal. During each control cycle, the stored approximate magnitude correction value is subtracted from the magnitude of the real-time intermediate tap-point-to-neutral voltages sum.

Capacitor unit failures will cause the magnitude of the real-time tap-point-to-neutral voltages sum to change, and therefore, change the magnitude of the compensated tap-point-to-neutral voltages sum. The control compares the compensated intermediate tap-point-to-neutral voltages sum magnitude with the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled.

If the compensated intermediate tap-point-to-neutral magnitude exceeds a setpoint value continuously for a time greater than the applicable time delay setpoint value, the appropriate control action is taken. The control will lockout the bank if the **Gross Over Voltage Level** or the **Lockout Level** setpoint value is exceeded or issue an alarm if the **Alarm Level** setpoint value is exceeded.

Ungrounded Wye Shunt Reactors

The BankGuard Plus Control provides protection of ungrounded, wye-connected shunt reactors--either three-phase reactors or three-phase banks of single-phase reactors. See Figure 5. The control detects turn-to-turn faults in the windings of these shunt reactors, the most common mode of reactor failure.

When a developing turn-to-turn fault occurs in any phase winding, the shunt reactor is protected from further damage by automatic switching provided by the control. The control locks out the entire shunt reactor when the neutral-to-ground voltage exceeds the calculated level. See Instruction Sheet 1011-530, "BankGuard Plus® Control: Setup," for more details. In general, enable the **Unbalance Compensation** feature if the magnitude of the calculated error voltage caused by inherent reactor unbalance resulting from manufacturing-tolerance variations among the phase windings approaches 50% of the desired **Lockout Level** setting.

For ungrounded, wye-connected shunt reactors, the control uses an analog input and digital voltmeter to detect the reactor neutral-to-ground voltage, as monitored by an S&C 15-Volt-Ampere Potential Device. A digital filter attenuates harmonics and noise.

When the **Unbalance Compensation** feature is disabled, the magnitude of the real-time neutral-to-ground voltage is compared with the "Gross Over Voltage Level", "Lockout Level", and "Alarm Level" setpoint values, if enabled. Reactor-turn failures will cause the real-time neutral-to-ground voltage magnitude to change. If the real-time neutral-to-ground voltage magnitude exceeds a setpoint value continuously for a time greater than the applicable time delay setpoint value, the appropriate control action is taken. The control will lock the reactor out if the **Gross Over Voltage Level** or **Lockout Level** setpoint value is exceeded. The control will issue an alarm if the **Alarm Level** setpoint value is exceeded.

In addition to the neutral-to-ground potential device, one 30-Volt-Ampere S&C Potential Device is required to be installed on any one of the line phases to obtain a reference angle when the **Unbalance Compensation** feature is set in the **Reactor** setting only. During the setup of the **Unbalance Compensation** feature, a neutral-to-ground voltage magnitude sample and a reference angle (Aref) sample are used to obtain and store an approximate magnitude correction value. See the "Signal Processing" section on page 12 for an explanation of how the value is calculated.

The **Unbalance Compensation** feature set-up should be accomplished during a time when any voltage unbalances caused by the loads are minimal. During each control cycle, the stored, approximate **Magnitude Correction** value is subtracted from the real-time neutral-to-ground voltage magnitude to obtain a compensated neutral-to-ground voltage magnitude. Reactor-turn failures will cause the real-time neutral-to-ground voltage magnitude to change and, therefore, change the compensated neutral-to-ground voltage magnitude. The control compares the compensated neutral-to-ground voltage magnitude with the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled.

If the compensated neutral-to-ground magnitude exceeds a setpoint value continuously for a time greater than the applicable **Time Delay** setpoint value, the appropriate control action is taken. The control will lockout the bank if the **Gross Over Voltage Level** or **Lockout Level** setpoint value is exceeded, or issue an alarm if the **Alarm Level** setpoint value is exceeded. The **Reactor Only** value is generally selected when the voltage variations between the line phases are expected to be negligible in comparison to the neutral-to-ground voltage changes resulting from the loss of reactor turns.

In addition to the neutral-to-ground potential device, three S&C 30-Volt-Ampere Potential Devices are required to be installed on each line phase when the **Unbalance**

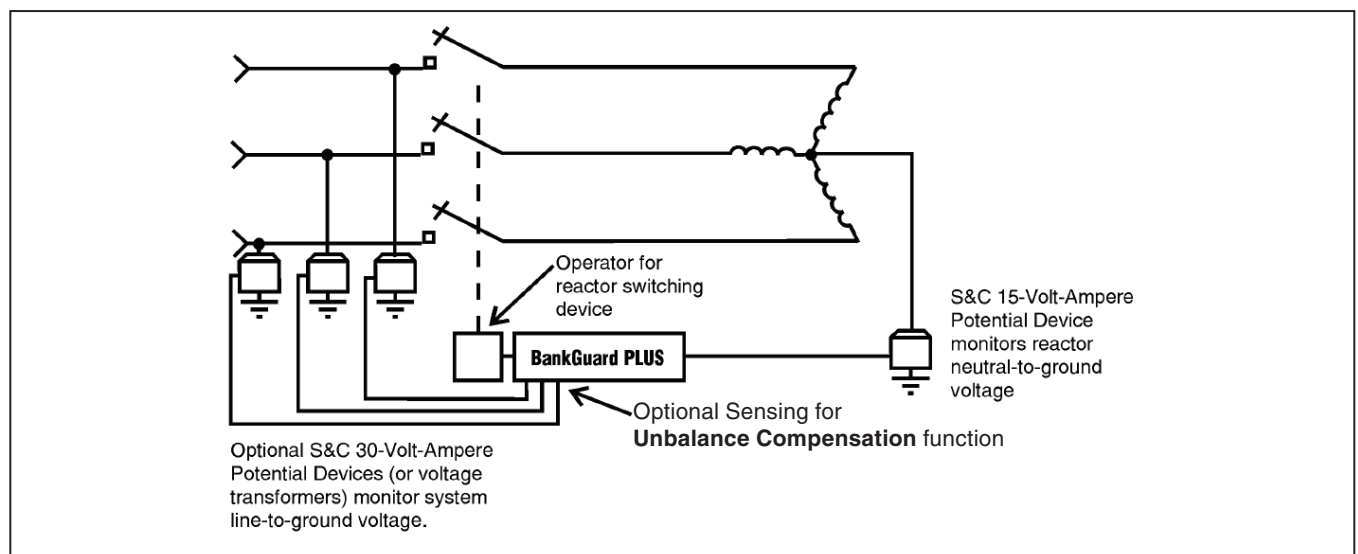


Figure 5. A system diagram of a BankGuard Plus Control for ungrounded wye-connected shunt reactors.

Control Operation

Compensation feature is set in the **Reactor/Line** setting. The control uses the three potential devices to obtain the sum of the line voltages magnitude and a reference angle. Because the sum is obtained from all the line voltages, compensation for fixed-system imbalances is provided.

During the set-up of the **Unbalance Compensation** feature, a neutral-to-ground voltage magnitude sample, and a sum of the line voltages sample and the reference angle are used to calculate and store a magnitude correction value. See the “Signal Processing” section for an explanation of how the value is calculated.

During each control cycle, the stored magnitude correction factor is subtracted from the real-time neutral-to-ground magnitude to obtain a compensated neutral to ground voltage magnitude. Reactor-turn failures will cause the real-time line-to-neutral voltage to change and, therefore, change the compensated neutral-to-ground voltage magnitude. The control compares the compensated neutral-to-ground voltage magnitude to the **Gross Over Voltage Level**, **Lockout Level**, and **Alarm Level** setpoint values, if enabled. If the compensated neutral- to-ground voltage magnitude exceeds a setpoint value continuously for a time greater than the applicable time delay setpoint value, the appropriate control action is taken. The control will lock out the bank if the **Gross Over Voltage Level**

or the **Lockout Level** setpoint values are exceeded. The control will issue an alarm if the **Alarm Level** setpoint value is exceeded.

Signal Processing

The BankGuard Plus Control hardware samples the sensor(s) analog output waveform and then converts the samples to digital values. See Figure 6. The control’s software processes the digital values using a Discrete Fourier Transform algorithm and compares the results to the applicable setpoint value. The comparisons are made at 200 millisecond intervals. Upon completion of the comparisons, control action is then taken, if appropriate.

When an ungrounded wye capacitor bank installation has the **Unbalance Compensation** feature disabled, the Discrete Fourier Transform algorithm yields the magnitude of the neutral-to-ground voltage. This magnitude is then compared to the setpoint value(s) to determine whether any control action is to be executed.

When an ungrounded wye capacitor bank has the **Unbalance Compensation** feature set in the **Cap Only** setting, the Discrete Fourier Transform algorithm yields the magnitude of the neutral-to-ground voltage (V_{N-G}) and the value of the phase angle (A_{ref}) between the neutral-

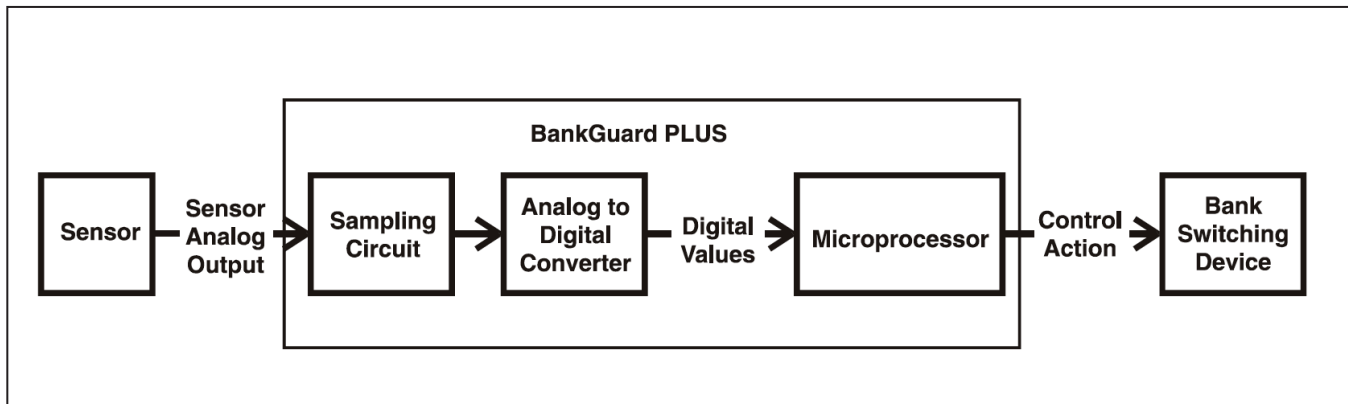


Figure 6. A BankGuard Plus Control diagram.

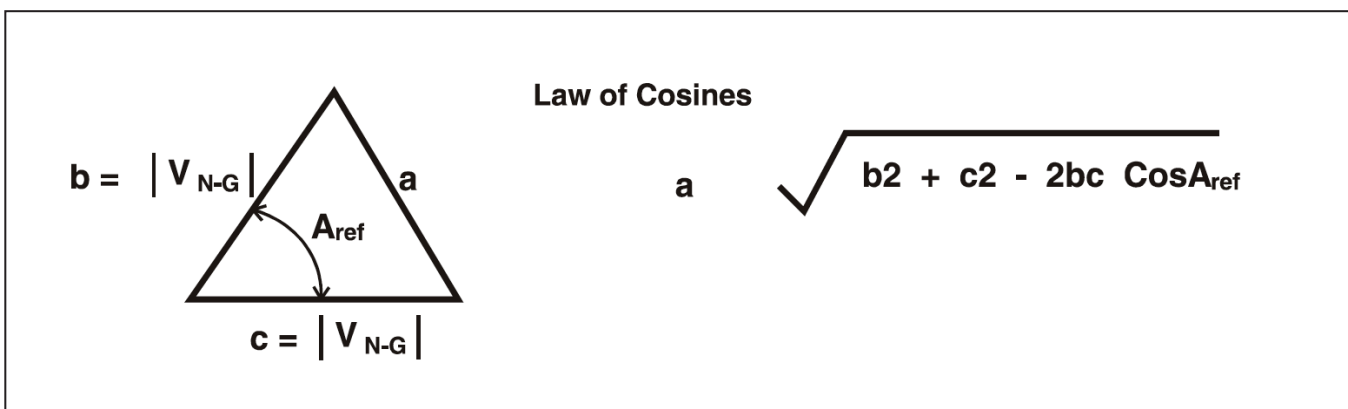


Figure 7. An approximate corrected magnitude.

to-ground voltage and the reference line voltage. Using the Law of Cosines, an approximate correct magnitude is obtained using the reference angle. See Figure 7 on page 12.

An approximate corrected magnitude is calculated and stored in the control's memory during the feature's set-up procedure. When the control is operating, the stored, approximate corrected magnitude is subtracted from the real-time neutral-to-ground voltage magnitude during each 200 milliseconds to obtain a compensated neutral-to-ground voltage magnitude. The compensated neutral-to-ground voltage magnitude is then compared to the setpoint value(s). If the compensated neutral-to-ground voltage magnitude exceeds a setpoint value, then the appropriate control action will be taken.

For an ungrounded wye capacitor bank with the **Unbalance Compensation** feature in the **Cap/Line** setting, the Discrete Fourier Transform algorithm yields the magnitude of the neutral-to-ground voltage, the magnitude of the sum of the line voltages (VL-G sum) and a reference angle (Aref). Because the sum is obtained from the three line voltages, compensation for fixed system voltage imbalances is provided in addition to capacitor unit manufacturing tolerance. Using the Law of Cosines, a corrected magnitude is obtained. See Figure 8. A corrected magnitude is calculated and stored in the control's

memory during the feature's setup procedure. When the control is operating, the stored corrected magnitude is subtracted from the real-time neutral-to-ground voltage each 200 milliseconds to obtain a compensated neutral-to-ground voltage magnitude. The compensated neutral-to-ground voltage magnitude is then compared to the setpoint value(s).

Capacitor unit failures will cause a change to the real-time neutral-to-ground voltage magnitude. Therefore, the compensated neutral-to-ground voltage will also change. If the compensated neutral-to-ground voltage magnitude exceeds a setpoint value, then the appropriate control action will be taken.

For a grounded wye capacitor bank installation with the **Unbalance Compensation** feature disabled, the Discrete Fourier Transform algorithm yields the magnitude of the sum of the tap-point-to-ground voltages (in percent). Capacitor unit failures will cause a change to the magnitude of the real-time sum of the tap-point-to-ground voltages. If the magnitude of the sum of the tap-point-to-ground voltages exceeds a setpoint value(s), then the appropriate control action will be taken.

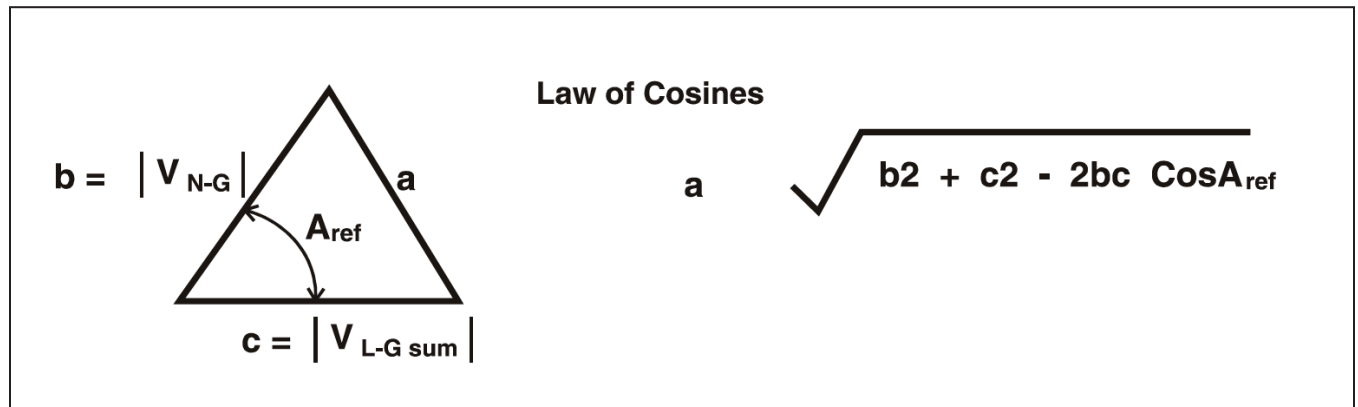


Figure 8. A corrected magnitude.

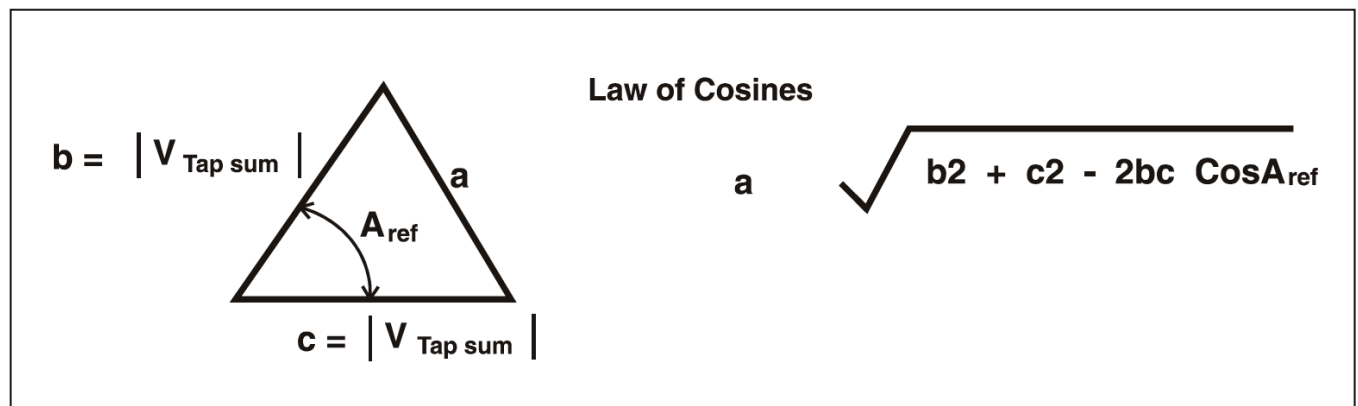


Figure 9. An approximate corrected magnitude.

For a grounded wye capacitor bank with the **Unbalance Compensation** feature in **Enable** mode, the Discrete Fourier Transform algorithm yields the magnitude of the sum of the intermediate tap-point voltages (IV tap sum) and the value of the phase angle (Aref) between the tap-point voltages sum and the reference line voltage. Using the Law of Cosines, an approximate corrected magnitude is obtained using the reference angle. See Figure 9 on page 13. An approximate corrected magnitude is calculated and stored in the control's memory during the feature's setup procedure.

When the control is operating, the stored, approximate corrected magnitude is subtracted from the real-time tap-point-to-ground voltages magnitude (in percent) during each 200 milliseconds to obtain a compensated neutral-to-ground voltage magnitude. The compensated neutral-to-ground voltage magnitude is then compared to the setpoint value(s).

The calculation on the compensated **Neutral-To-Ground Voltage** value is the same as for an ungrounded, wye-connected shunt capacitor bank. Capacitor unit failures will cause a change to the magnitude of the real-time tap-point-to-ground voltages sum and the reference angle. Therefore, the magnitude of the compensated neutral to ground voltages sum magnitude will also change. If the magnitude of the compensated tap-point-to-ground voltages sum magnitude exceeds a setpoint value, the appropriate control action will then be taken.

The **Report** feature can be used to save the control software settings and stored data to a computer as a CSV (comma-separated value) file. The report can be kept as a permanent record and the report data used in spreadsheets or other types of programs.

Complete the following steps to generate report:

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

For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.” If the computer is already connected to the control, this step can be skipped.

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

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

There are four types of reports:

Full. Includes all the information contained in the control

System Setup and Operation. Contains the configuration data for the control

Troubleshooting Information. Contains the information recorded in the troubleshooting logs

Historical Data. Contains the daily statistics, the potential device 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 a location is not specified, the file is saved to the same directory as the program files for this for this type of control. 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.

Saving and Loading Setup Configurations

If several controls use a similar setup configuration and the same software version, the configuration can be saved from one control and loaded into the others. Then, only the setpoints that are different for each control must be manually adjusted.

Saving a Setup Configuration

Complete the following steps to save a setup configuration:

- STEP 1.** Determine which control contains the configuration to be saved.
- STEP 2.** Connect the computer to the selected control and start the IntelliLink software.
For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.” If the computer is already connected to the control, this step can be skipped.
- STEP 3.** From the **File** menu, choose the **Save Setpoints** option.
- STEP 4.** In the Save Setpoints dialog box, specify a name and location for this configuration file, and then click on the **Save** button.

If a location is not specified, the file is saved to the same directory as the program files for this for this type of control. The extension “.CFG” is added automatically.

Note: This process does not save the **Location** setting (on the *Setup* screen) or the **Communications RTU Address** setting (on Page 1 of the *Communications Setup* screen).

Loading a Saved Configuration

Complete the following steps to load a saved configuration:

- STEP 1.** If necessary, connect the computer to the control where the configuration will be loaded, and then start the IntelliLink software.
For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.” If the computer is already connected to the control, this step can be skipped.
- STEP 2.** From the **File** menu, choose the **Open Setpoints** option.
- STEP 3.** In the dialog box, select the CFG file for the configuration you want to load, and then click on the **Open** button.
- STEP 4.** Make any setpoint changes that are required for this control.

For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.”

NOTICE

Be sure to enter the correct values for **Location** setting (on the *Setup* screen) and, if necessary, the **Communications RTU Address** setting (on Page 1 of the *Communications Setup* screen).

To view the IntelliLink software screens and Help file without connecting to a 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 from the **Connection** menu, and then choose the **Close Screenset** option from the **File** menu to clear the present screenset from memory.
- STEP 3.** From the **File** menu, choose 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 disk for this control.

Using Snapshots (VM Files)

Operational and data-logging information can be saved in “snapshots” (VM, virtual memory files). These snapshots let users view data, generate a report, and save or change setpoint configurations even when not connected to a control. To access the stored information, “connect” to the snapshot instead of the physical control. Each control Setup disk includes a sample snapshot.

Saving Control Settings and Data to a Snapshot

Use the following procedure to save operational and data-logging information:

STEP 1. Connect a computer to the control whose information is to be saved, and then start the IntelliLink software.

For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.” If the computer is already connected to the control, this step can be skipped.

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

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

If a location is not specified, the file is saved to the same directory as the program files for this for this type of control. The extension “.VM” is added automatically.

Viewing (Connect To) a Snapshot

Use the following procedure to view or connect to a snapshot:

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, choose the **Disconnect** option from the **Connection** menu, and then choose the **Close Screenset** option from the File menu to clear the present screenset from memory.

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

The Open Controller Data File dialog box opens.

STEP 3. Select the snapshot desired to use, and then click on the **Open** button.

STEP 4. If the configuration settings in the snapshot are to be changed, click on the **Yes** button at 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.

Saving Changes Made to the Snapshot

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 connecting to a control. For details, see the “Generating Reports” section on page 15.

Creating a CFG File From a Snapshot

Complete the following procedure to prepare a setpoint configuration for a control in the field while not having access to a comparable device:

STEP 1. Connect to the snapshot.

For details, see the “Viewing (Connect To) a Snapshot” section.

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

For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.”

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

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

If a location is not specified, the file is saved to the same directory as the program files for this for this type of control. The extension “.CFG” is added automatically.

NOTICE

This process does not save the **Location** setting (on the *Setup* screen) or the **Communications RTU Address** setting (on page 1 of the *Communications Setup* screen).

Occasionally, the software stored in the control (the control software) may need to be updated. The Update program, installed with the IntelliLink software, enables the earlier control software to be replaced with the later version.

NOTICE

The setpoint values and historical data stored in the control may be lost during the update process. Generate all required reports using the original IntelliLink and control software before updating the control software.

Complete the following steps to update the software:

STEP 1. Install the contents of the new Setup disk on the computer.

For details, see the “To Start the IntelliLink Software” section in Instruction Sheet 1011-530, “BankGuard Plus Control: *Setup*.”

STEP 2. Connect the computer to the LOCAL COMM PORT or optical port on the control.

STEP 3. Start the Update program.

- (a) In Windows, choose Start menu > Programs > EnergyLine > Update.

The Update window appears (Figure 10).

- (b) Select the desired options, and then click on the **Start Update** button.

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

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

NOTICE

If the **Update** process is cancelled once it has started, the software in the control can be deactivated. If the process must be cancelled, start the **Update** process again.

Note: If the software on the disk is not the same type as the software in the control, an error message appears. Note which software version is in the control, and then press <Enter> key to abort the **Update** process. When the correct new software version is obtained, repeat the steps above.

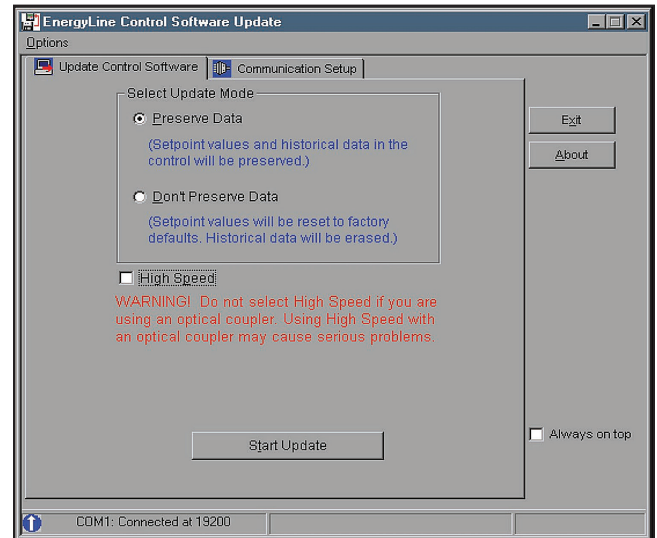


Figure 10. Control Device Software Update Window