INSTRUCTIONS

For Installation and Operation

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INTRODUCTION

CAUTION: The equipment covered by this publication must be selected for a specific application and it must be installed, operated, and maintained by qualified persons who are thoroughly trained and who understand any hazards that may be involved. This publication is written only for such qualified persons and is not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

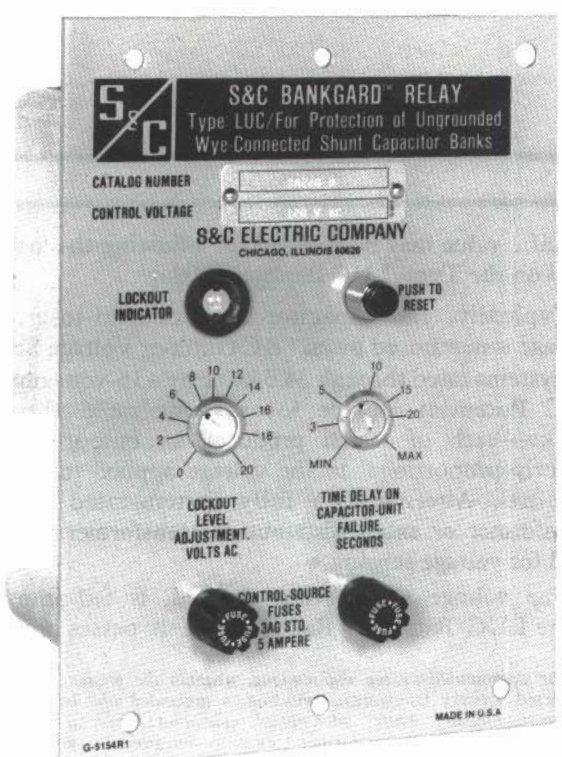

Figure 1. S&C Bankgard Relay—Type LUC.

The S&C Bankgard Relay—Type LUC provides low-cost protection for small- to medium-sized station-type, *ungrounded*, wye-connected shunt capacitor banks having up to five series groups of capacitor units per phase. It is a solid-state electronic device that detects neutral-to-ground voltage increments caused by isolation of faulted capacitor units from the bank by their respective fuses. See Figure 1. When a pre-determined neutral-to-ground voltage is exceeded, the Type LUC Bankgard Relay signals a switching device to disconnect the entire bank, thus protecting the surviving capacitor units in the bank against cascading voltage overstress.

The Type LUC Bankgard Relay does not provide system-voltage or capacitor-bank unbalance compensation. It is therefore applicable only to the sizes and configurations of capacitor banks for which the loss of a single capacitor unit results in a neutral-to-ground voltage increment that is at least twice the maximum expected error voltage. (A certain amount of error voltage is always present between the energized capacitor-bank neutral and ground, due to system-voltage unbalance and to inherent capacitor-bank unbalance resulting from manufacturing-tolerance variations among capacitor units in the bank.) S&C Data Bulletin 532-80 tabulates the capacitor-bank sizes and configurations for which the Type LUC Bankgard Relay is suitable, based on the maximum expected total of percent system-voltage unbalance plus percent inherent capacitor-bank unbalance.

For larger bank sizes, or for applications where system-voltage unbalance may be greater than normal due to presence of single-phase regulators or significant individual single-phase loads, the S&C Automatic Control Device—Type UP is recommended, since it can

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be equipped with unbalance-compensation and alarm options.

The S&C Bankgard Relay—Type LUC is furnished completely assembled and ready for flange mounting in any suitable indoor location (an accessory kit is available for relay-rack mounting). For outdoor use, an accessory weatherproof steel enclosure is available. If the latter accessory is included, the Bankgard relay will be hinge-mounted inside the enclosure.

Time-delay and lockout-level adjustment dials, lockout indicator and reset pushbutton, and control-source fuseholders are located on the front of the device. Readily accessible terminal blocks are at the rear. Control voltage must be provided by an auxiliary power source—typically the source provided for the switching device. The Bankgard relay is available in models for use with control voltage ratings of 48 or 125 volts dc, 120 or 240 volts 60 hertz.

The Bankgard relay, with the precision and compactness of solid-state electronics, offers matchless design features and proven circuits that withstand the rigors of power equipment applications. Superior reliability is assured through use of "enhanced-quality" integrated circuits, and single printed-circuit-board construction that minimizes the number of interconnections. The glass-reinforced epoxy circuit board and all attached components receive a resilient, conformal, silicone-dip coating to provide environmental and vibration protection. The output-relay contacts are of gold-flashed silver-cadmium oxide to ensure long service life. Lockout-level and time-delay adjustments are maintained within 3% of settings over an ambient temperature range of −40°F to +160°F.

Metal-oxide surge protectors at critical points in the control circuits provide the optimum in surge protection. S&C's unique surge-control techniques have been field proven through years of successful application in hostile utility-substation environments. The capability of every S&C electronic device to withstand voltage surges is confirmed by two factory quality-check tests: The ANSI Surge Withstand Capability Test (ANSI Standard C37.90a, 1974); plus a much more severe (5-kv, 3.75-joule) capacitive-discharge test specially developed by S&C to duplicate or exceed voltage surges measured in EHV power substations. The specified surges are applied at all terminals of the device. Additional factory tests include a dielectric test, a 168-hour screening test at maximum-design operating temperatures, and functional checks (both before and after the screening test).

FUNCTIONAL PERFORMANCE

As failing capacitor units are successively isolated from the same series group by their associated fuses, the voltage applied to the surviving capacitor units in the group increases in discrete steps. Figure 2 indicates permissible capacitor-unit operating time at varying per-unit multiples of capacitor nameplate voltage rating, according to ANSI/IEEE Standard 18-1980, which further states that capacitors shall be capable of continuous operation up to 110% of 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 such a recommendation, the ANSI/IEEE data), the entire bank should be removed from service.

Since predictable discrete increases in capacitor-bank neutral-to-ground voltage result from the isolation of successive capacitor units in the same series group, a specific value may be selected for adjusting the lockout level on the Type LUC Bankgard Relay.

Typically, the capacitor-bank neutral-to-ground voltage is monitored by an S&C Outdoor Voltage Sensor for systems rated through 34.5 kv or by a 15-volt-ampere S&C Potential Device for systems rated through 230 kv—each of which produces an output voltage directly proportional to the voltage applied to its line terminal. Alternately a fully system-rated voltage transformer or small distribution transformer may be used for voltage sensing.*

The voltage signal, thus derived, is fed into the Type LUC Bankgard Relay, where it passes through

* For ungrounded-source applications, wherein the source is a delta-connected tertiary transformer winding, a grounded-wye broken-delta voltage-transformer "bank" with shunt resistor—referred to as a high-impedance grounding transformer (normally required for ground-fault detection)—is required to maintain the stability of phase-to-ground voltage relationships for all but fault conditions. Otherwise, spurious signal voltages could appear at the neutral of, and result in isolation of, the capacitor bank.

an isolation transformer and a bandpass filter to eliminate the effects of harmonic components which may be present at the capacitor-bank neutral. The voltage signal is then compared to the preselected, field-adjustable lockout-level setting. When—as a result of the loss of one or more capacitor units within the bank—the derived voltage signal exceeds the Bankgard relay's lockout-level setting, it activates a built-in electronic timer. The timer (field-adjustable from 2 to 30 seconds) is factory-set for a 10-second delay to allow time for individual capacitor-unit fuses to respond to evolving faults within the units—so as to permit visual identification of the units in need of replacement. When the timer completes its cycle, a latching-type output relay supplies an opening signal to the switching device to effect isolation and lockout of the entire bank. The output relay is provided with an additional isolated contact which can be utilized for remote indication.

In applications where an S&C Outdoor Voltage Sensor or a 15-volt-ampere S&C Potential Device is used as the capacitor-bank neutral-to-gound voltage-sensing device, an auxiliary contact of the switch operator may be used to *short-circuit* the voltage sensor or potential-device output circuit when the switching device is in the open position, to prevent inadvertent Bankgard relay operation due to induced neutral-to-ground voltage on the isolated capacitor bank.

Similarly, in applications where a voltage transformer is used, an auxiliary contact of the switch operator may be used to *open-circuit* the voltage-transformer secondary circuit, to prevent inadvertant Bankgard relay operation.

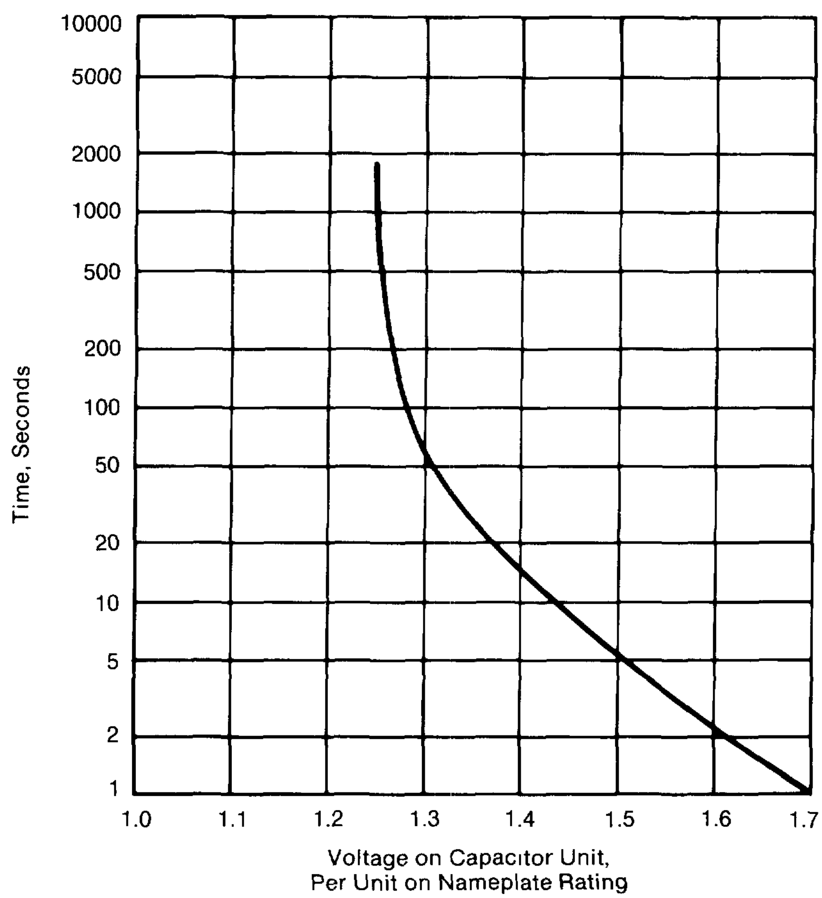

Figure 2. Capacitor-unit power frequency overvoltage versus time, as permitted by ANSI/IEEE Standard 18-1980, "IEEE Standard for Shunt Power Capacitors," which further states that capacitors shall be capable of continuous operation up to 110% of rated voltage, including harmonics. Note: This curve applies for up to 300 applications of power-frequency overvoltages of the magnitudes and durations illustrated. Capacitor manufacturers may publish different recommendations applicable to their particular units.

General Installation Requirements

To prevent damage to the Bankgard relay in the event that surges which exceed factory-tested levels are encountered, S&C's control-circuit fusing recommendations must be followed. The required fuseholders and fuses are furnished with the device. If frequent surges in excess of factory-tested levels are anticipated, S&C should be advised as to the severity of the surges so that special recommendations can be made.

To ensure that the Bankgard relay is not subjected to surges in excess of the level defined in ANSI Standard C37.90a, adequate shielding should be provided for the control-circuit wiring. Refer to the interconnection diagram furnished.

Making the Connections

The S&C Bankgard Relay—Type LUC is equipped with a numbered terminal strip at the rear of the device. See Figure 3. Using the connection drawing in the instruction manual furnished with the device, make the following external connections:

1. Control source (48 volts dc, 125 volts dc, 120 volts 60 hertz, or 240 volts 60 hertz, as appropriate).
2. Output terminals of the S&C Outdoor Voltage Sensor or 15-volt-ampere S&C Potential Device having a system voltage rating as follows:

Nominal Source Voltage, Kv	S&C Potential Device System Voltage Rating, Kv, Nominal	S&C Outdoor Voltage Sensor System Voltage Rating, Kv, Nominal
14.4 (and below)	23	14.4
25	23	14.4
34.5	23	25
46	23	—
69	34.5	—
115	69	—
138	69	—
161	138	—
230	138	—

Alternately, a fully system-rated voltage transformer or small distribution transformer can be used.

3. Opening circuit of the switch operator.
4. Closing circuit of the switch operator.
5. "a" contact of the switch-operator auxiliary switch. This contact should be set to close near the fully closed position of the capacitor-bank switching device.
6. Station ground.
7. Remote indicating means (if applicable).

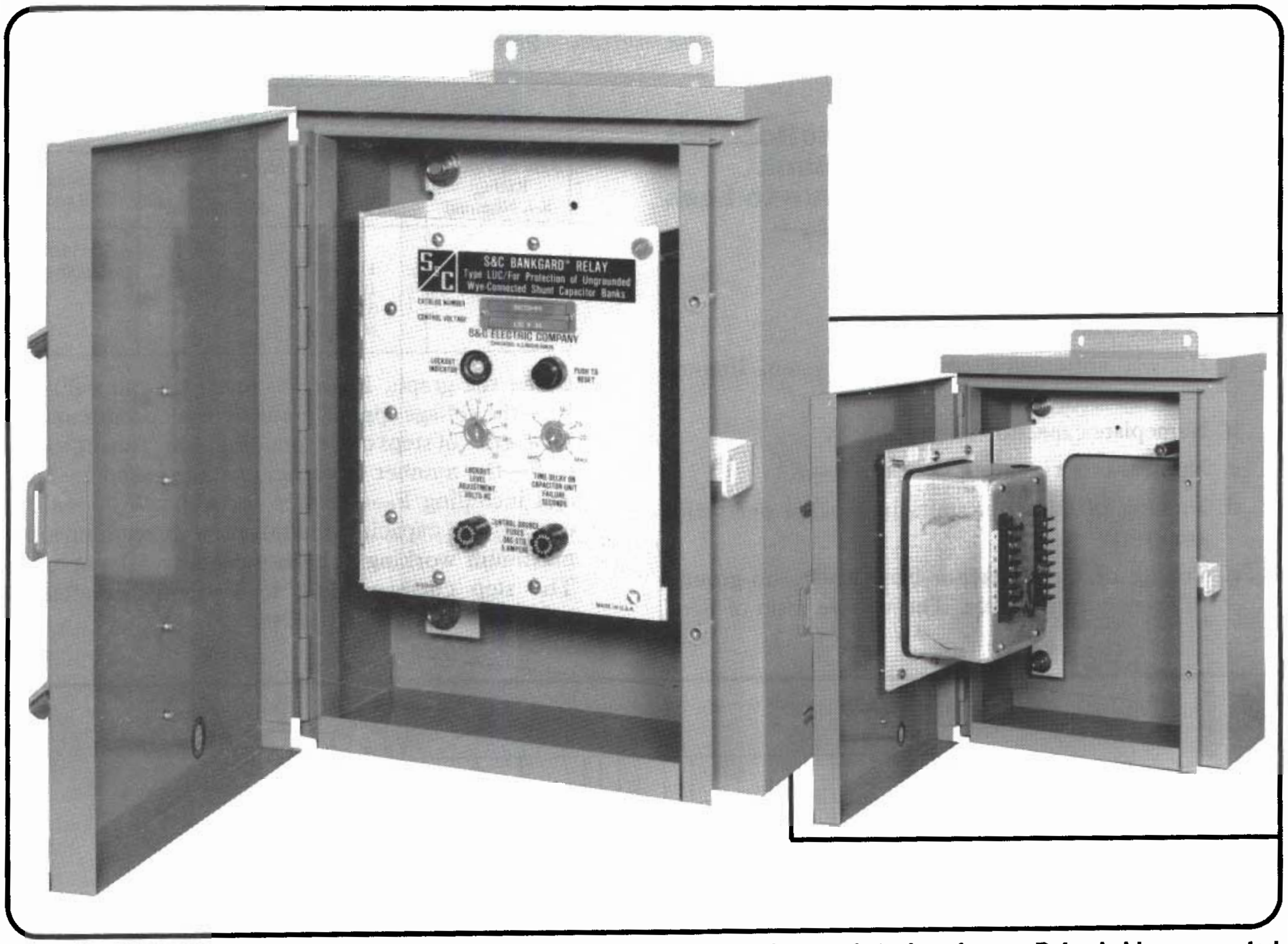

Figure 3. S&C Type LUC Bankgard Relay mounted in the accessory weatherproof steel enclosure. Relay is hinge-mounted to facilitate access to the terminal blocks.

ESTABLISHING THE SETTINGS

Two methods of establishing the capacitor-bank lockout level are given on this and succeeding pages—one utilizing graphs and one utilizing formulas.

Determine Incremental Capacitor-Unit Overvoltage and Capacitor-Bank Neutral-to-Ground Voltage Due to Loss of Successive Capacitor Units—Graphical Method

Step-by-step Procedures

1. Collect installation data, including:
   a. Highest anticipated continuous system line-to-neutral voltage, kv
   b. Nameplate capacitor-unit rating, kv
   c. Number of series groups per phase—S
   d. Number of capacitor units in parallel per series group—P
   e. Voltage ratio of capacitor-bank neutral-to-ground voltage-sensing device. The voltage ratio of S&C Outdoor Voltage Sensors and 15-volt-ampere S&C Potential Devices are as follows:

S&C Potential Device		S&C Outdoor Voltage Sensor	
System Voltage Rating, Kv, Nominal	Voltage Rating	System Voltage Rating, Kv, Nominal	Voltage Ratio
		14.4	130:1
23	111:1	25	200:1
34.5	166:1		
69	332:1		
138	664:1		

2. Using the graph, Figure 4, read per-unit values of V_O—the voltage applied to surviving capacitor units—for a series of steps corresponding to increasing values of F—the number of capacitor units isolated—up to and including F_C—the step for which V_O equals or exceeds the capacitor manufacturer's recommended maximum working voltage (generally 1.1 per unit). The step corresponding to F_C will hereafter be referred to as the "critical step."

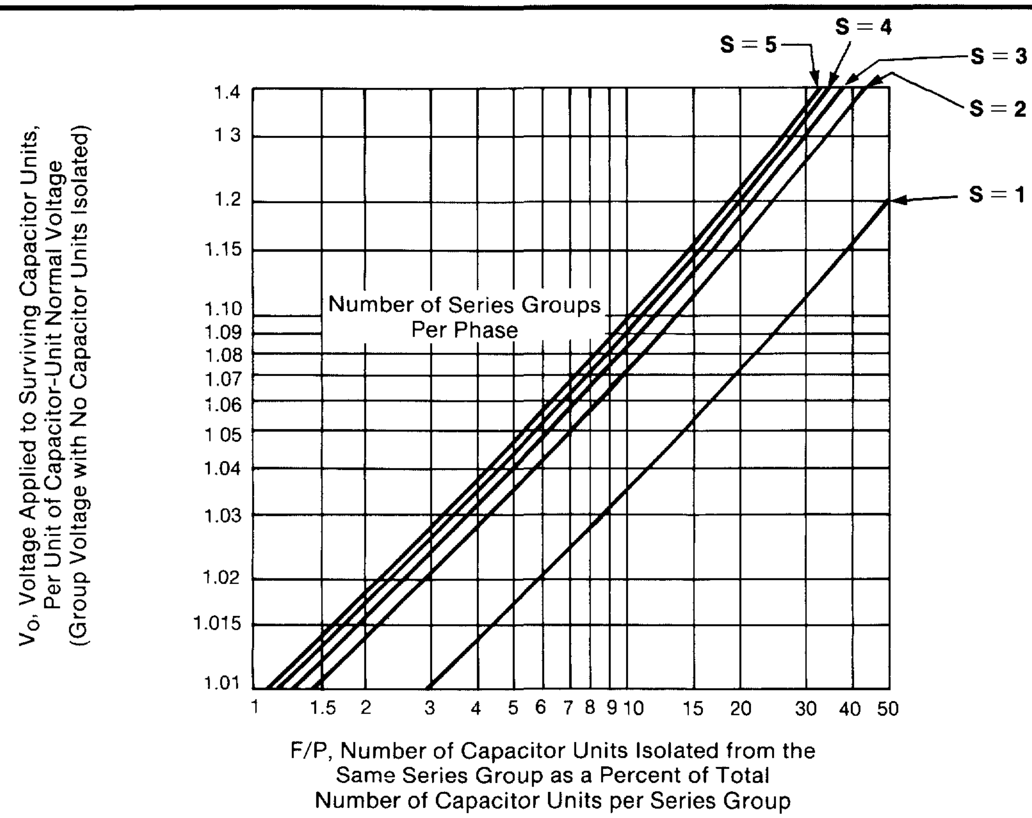

Figure 4. Per-unit voltage applied to surviving capacitor units in a series group versus percentage of capacitor units isolated from the same series group.

3. If the capacitor units are operated at other than rated voltage, correct the values read in (2), above, by multiplying by the ratio of the "normal" (highest anticipated) applied voltage (all capacitor units operating) to nameplate voltage rating of the capacitor units.
4. Using the graph, Figure 5, read per-unit values of V_n—capacitor-bank neutral-to-ground voltage—for the same series of steps corresponding to increasing values of F up to and including F_c.
5. Convert the per-unit values of V_n read in (4) above to actual V_n voltage values by multiplying by the highest anticipated system line-to-neutral voltage.
6. Determine the lockout level—the midpoint between V_n for the critical step, F_c, and V_n for F_c-1.
7. Determine the setting by dividing the lockout level by the voltage ratio of the capacitor-bank neutral-to-ground voltage-sensing device.

Using the Graphical Method—First Example

1. Installation Data
   a. Highest anticipated continuous system line-to-neutral voltage, kv 20.2
   b. Nameplate capacitor-unit rating, kv 19.92
   c. Number of series groups per phase 1
   d. Number of capacitor units in parallel per series group 5
   e. Voltage ratio of neutral-to-ground voltage-sensing device 200:1
2. For F = 1, enter the graph, Figure 4, at 20 on the horizontal scale (1/5 = 20% of capacitor units isolated from a series group). Follow up to a point corresponding to 1 series group per phase (curve labeled "S = 1") and read V_o = 1.072 per unit on the vertical scale.

   For F = 2, in like manner, enter the graph, Figure 4, at 40 on the horizontal scale (2/5 = 40% of capacitor units isolated from the same series group). Follow

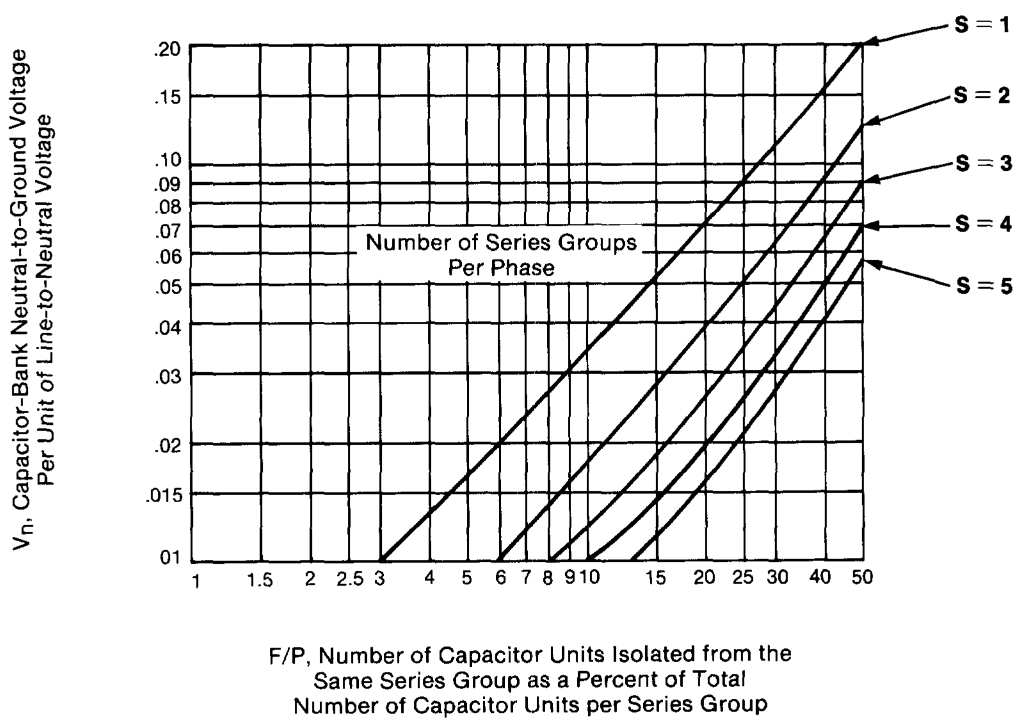

Figure 5. Per-unit capacitor-bank neutral-to-ground voltage versus percentage of capacitor units isolated from the same series group.

up to a point corresponding to 1 series group per phase (curve labeled "S = 1") and read $V_O = 1.16$ per unit on the vertical scale. Obviously, F = 2 is the critical step, F_C, if it is desired to limit V_O to 1.1 per unit or less.

3. With an anticipated system line-to-neutral voltage of 20.2 kv and with 1 series group per phase, the capacitor units are normally operated at 20.2 kv. Therefore:

   For F = 1,

   $$V_O = \frac{1.072 \text{ X } 20.2 \text{ kv}}{19.92 \text{ kv}} = 1.09 \text{ per unit}$$

   For F = 2,

   $$V_O = \frac{1.16 \text{ X } 20.2 \text{ kv}}{19.92 \text{ kv}} = 1.18 \text{ per unit}$$

4. For F = 1, enter the graph, Figure 5, at 20 on the horizontal scale (1/5 = 20% of capacitor units isolated from a series group). Follow up to a point corresponding to 1 series group per phase (curve labeled "S = 1") and read V_n = .07 per unit on the vertical scale.

   For F = 2, in like manner, enter the graph, Figure 5, at 40 on the horizontal scale (2/5 = 40% of capacitor units isolated from the same series group). Follow up to a point corresponding to 1 series group per phase (curve labeled "S = 1") and read V_n = .155 per unit on the vertical scale.

5. Multiply the values read in (4) above by the system line-to-neutral voltage to convert the per-unit V_n values to actual V_n voltage values. Thus:

   For F = 1,

   V_n = 0.07 X 20,200 volts = 1414 volts

   For F = 2,

   V_n = 0.155 X 20,200 volts = 3131 volts

6. Determine the lockout level by calculating the midpoint value between V_n for F = 1 and V_n for F = 2, the critical step F_C. Thus, the desired lockout level is

   $$\frac{1414 \text{ volts} + 3131 \text{ volts}}{2} = 2273 \text{ volts}$$

7. Determine the setting by dividing the lockout level by the voltage ratio of the neutral-to-ground voltage-sensing device. The setting is thus 2273 volts ÷ 200 = 11.37 volts.

Using the Graphical Method—Second Example

1. Installation Data
   - a. Highest anticipated continuous system line-to-neutral voltage, kv 40.8
   - b. Nameplate capacitor-unit rating, kv 19.92
   - c. Number of series groups per phase 2
   - d. Number of capacitor units in parallel per series group 12
   - e. Voltage ratio of neutral-to-ground voltage-sensing device 332:1

2. For F = 1, enter the graph, Figure 4, at 8.33 on the horizontal scale (1/12 = 8.33% of capacitor units isolated from a series group). Follow up to a point corresponding to 2 series groups per phase (curve labeled "S = 2") and read V_O = 1.058 per unit on the vertical scale.

   For F = 2, in like manner, enter the graph, Figure 4, at 16.67 on the horizontal scale (2/12 = 16.67% of capacitor units isolated from the same series group). Follow up to a point corresponding to 2 series groups per phase and read V_O = 1.13 per unit on the vertical scale. Obviously, F = 2 is the critical step, F_C, if it is desired to limit V_O to 1.1 per unit or less.

3. With an anticipated system line-to-neutral voltage of 40.8 kv and with 2 series group per phase, the capacitor units are normally operated at 20.4 kv. Therefore:

   For F = 1,

   $$V_O = \frac{1.058 \text{ X } 20.4 \text{ kv}}{19.92 \text{ kv}} = 1.083 \text{ per unit}$$

   For F = 2,

   $$V_O = \frac{1.13 \text{ X } 20.4 \text{ kv}}{19.92 \text{ kv}} = 1.157 \text{ per unit}$$

4. For F = 1, enter the graph, Figure 5, at 8.33 on the horizontal scale (1/12 = 8.33% of capacitor units isolated from a series group). Follow up to a point corresponding to 2 series groups per phase (curve labeled "S = 2") and read V_n = .0145 on the vertical scale.

   For F = 2, in like manner, enter the graph, Figure 5, at 16.67 on the horizontal scale (2/12 = 16.67% of capacitor units isolated from the same series group). Follow up to a point corresponding to 2 series groups per phase and read V_n = .031 per unit on the vertical scale.

5. Multiply the values read in (4) above by the system line-to-neutral voltage to convert the per-unit V_n values to actual V_n voltage values. Thus:

   For F = 1,

   V_n = .0145 X 40,800 volts = 592 volts

   For F = 2

   V_n = .031 X 40,800 volts = 1265 volts

6. Determine the lockout level by calculating the midpoint value between V_n for F = 1 and V_n for F = 2, the critical step F_c. Thus, the desired lockout level is

$$\frac{592 \text{ volts} + 1265 \text{ volts}}{2} = 929 \text{ volts}$$

7. Determine the setting by dividing the lockout level by the voltage ratio of the neutral-to-ground voltage-sensing device. The setting is thus 929 volts ÷ 332 = 2.80 volts.

Determine Incremental Capacitor-Unit Overvoltage and Capacitor-Bank Neutral-to-Ground Voltage Due to Loss of Successive Capacitor Units—Formula Method

Step-by-step Procedures

1. Collect installation data, including:
   a. Highest anticipated continuous system line-to-neutral voltage, kv
   b. Nameplate capacitor-unit rating, kv
   c. Number of series groups per phase
   d. Number of capacitor units in parallel per series group
   e. Voltage ratio of capacitor-bank neutral-to-ground voltage-sensing device

2. Calculate per-unit values of V_o—the voltage applied to surviving capacitor units—for a series of steps corresponding to increasing values of F—the number of capacitor units isolated—up to and including F_c—the step for which V_o equals or exceeds the capacitor manufacturer's recommended maximum working voltage (generally 1.1 per unit). The step corresponding to F_c will hereafter be referred to as the "critical step." Use the formulas:

$$V_o \text{ (volts)} = \frac{(3P)\,(V_{L\text{-}n})}{2F + 3S(P\text{-}F)}$$

$$V_o \text{ (per unit)} = \frac{V_o \text{ (Volts)}}{\text{Nameplate voltage rating of capacitor units}}$$

   where $V_{L\text{-}n}$ = Highest anticipated continuous system line-to-neutral voltage

   S = Number of series groups per phase

   P = Number of capacitor units in parallel per series group

   F = Number of capacitor units isolated from bank (and from the same series group)

3. For each value of F used in (2) above, calculate the neutral-to-ground voltage, V_n. Use the formula:

$$V_n = \frac{(F)\,(V_{L\text{-}n})}{2F + 3S(P\text{-}F)}$$

   where $V_{L\text{-}n}$ S, P, and F are defined as in (2) above.

4. Determine the lockout level by calculating the midpoint between V_n for F_c, the critical step, and V_n for F_c-1.

Using the Formula Method—First Example

1. Installation Data
   a. Highest anticipated continuous system line-to-neutral voltage, kv 20.2
   b. Nameplate capacitor-unit rating, kv 19.92
   c. Number of series groups per phase 1
   d. Number of capacitor units in parallel per series group 5
   e. Voltage ratio of neutral-to-ground voltage-sensing device 200:1
2. For F = 1,

$$V_O \text{ (volts)} = \frac{(3)\,(5)\,(20{,}200)}{(2)\,(1) + (3)\,(1)\,(5-1)} = 21{,}643 \text{ volts}$$

$$V_O \text{ (per unit)} = \frac{21{,}643}{19{,}920} = 1.086 \text{ per unit (or 8.6\% overvoltage)}$$

   For F = 2,

$$V_O \text{ (volts)} = \frac{(3)\,(5)\,(20{,}200)}{(2)\,(2) + (3)\,(1)\,(5-2)} = 23{,}308 \text{ volts}$$

$$V_O \text{ (per unit)} = \frac{23{,}308}{19{,}920} = 1.170 \text{ per unit (or 17.0\% overvoltage)}$$

   Obviously, F = 2 is the critical step, F_C, if it is desired to limit V_O to 1.1 per unit or less.
3. For F = 1,

$$V_n = \frac{(1)\,(20{,}200)}{(2)\,(1) + (3)\,(1)\,(5-1)} = 1443 \text{ volts}$$

   For F = 2,

$$V_n = \frac{(2)\,(20{,}200)}{(2)\,(2) + (3)\,(1)\,(5-2)} = 3108 \text{ volts}$$

4. Determine the lockout level by calculating the midpoint between V_n for F = 1 and V_n for F = 2, the critical step F_C. Thus, the desired lockout level is 2276 volts.
5. Determine the setting by dividing the lockout level by the voltage ratio of the neutral-to-ground voltage-sensing device. The setting is thus 2276 volts ÷ 200 = 11.38 volts.

Using the Formula Method—Second Example

1. Installation Data
   a. Highest anticipated continuous system line-to-neutral voltage, kv 40.8
   b. Nameplate capacitor-unit rating, kv 19.92
   c. Number of series groups per phase 2
   d. Number of capacitor units in parallel per series group 12
   e. Voltage ratio of neutral-to-ground voltage-sensing device 332:1
2. For F = 1,

$$V_O \text{ (volts)} = \frac{(3)\,(12)\,(40{,}800)}{(2)\,(1) + (3)\,(2)\,(12-1)} = 21{,}600 \text{ volts}$$

$$V_O \text{ (per unit)} = \frac{21{,}600}{19{,}920} = 1.084 \text{ per unit (or 8.4\% overvoltage)}$$

   For F = 2,

$$V_O \text{ (volts)} = \frac{(3)\,(12)\,(40{,}800)}{(2)\,(2) + (3)\,(2)\,(12-2)} = 22{,}950 \text{ volts}$$

$$V_O \text{ (per unit)} = \frac{22{,}950}{19{,}920} = 1.152 \text{ per unit (or 15.2\% overvoltage)}$$

   Obviously, F = 2 is the critical step, F_C, if it is desired to limit V_O to 1.1 per unit or less.
3. For F = 1,

$$V_n = \frac{(1)\,(40{,}800)}{(2)\,(1) + (3)\,(2)\,(12-1)} = 600 \text{ volts}$$

   For F = 2,

$$V_n = \frac{(2)\,(40{,}800)}{(2)\,(2) + (3)\,(2)\,(12-2)} = 1275 \text{ volts}$$

4. Determine the lockout level by calculating the midpoint between V_n for F = 1 and V_n for F = 2, the critical step F_C. Thus, the desired lockout level is 938 volts.
5. Determine the setting by dividing the lockout level by the voltage ratio of the neutral-to-ground voltage-sensing device. The setting is thus 938 volts ÷ 332 = 2.83 volts.

LOCKOUT-LEVEL ADJUSTMENT

Step 1

Turn the 0-20 volt lockout-level adjustment dial to the voltage setting determined from the graphs or formulas in the section headed "ESTABLISHING THE SETTINGS."†

Step 2

Verify the presence of control-source voltage.

Step 3

Verify that no capacitor units have been isolated from the bank (check for blown fuses).

Step 4

Close the capcitor-bank switching device to energize the bank, using the *"open-close"* control at the switch operator.

Step 5

Using a voltmeter having a minimum input impedance of 5000 ohms per volt, measure the capacitor-bank neutral-to-ground signal voltage at the input terminals of the Bankgard relay, to determine the magnitude of error voltage present. The error voltage should not exceed 50% of the capacitor-bank neutral-to-ground voltage which would result from isolation of one capacitor unit from the bank.

Typically, the error voltage will be within the limit stated above for the capacitor-bank sizes and ratings for which the Bankgard relay is recommended. However, it is possible for an error voltage to appear that exceeds the above limit, due to greater-than-normal system-voltage unbalance—as would result from the presence on the system of single-phase regulators or significant individual single-phase loads. Where this degree of unbalance exists, three possible courses of action can be considered:

1. Take appropriate steps to reduce the system unbalance.
2. Reduce the inherent capacitor-bank unbalance by a suitable exchange of individual capacitor units between phase legs.
3. If the number of required units previously determined as required to lock out the bank is two or more, reduce the lockout level to a value lower than the lowest reading obtained in Steps 7 through 13 (which follow)—with the knowledge that automatic lockout may occur with a lesser number of individual capacitor units isolated from the bank.

† Adjustment-dial scales are accurate to ±20%. Refer to the "SPECIFICATIONS" section for repetitive accuracy of the settings.

LOCKOUT-TIMER ADJUSTMENT

Step 6

An important consideration in the application of the Type LUC Bankgard Relay is that of coordinating capacitor-bank isolation and lockout with operation of the individual capacitor-unit fuses. It is desirable for the Bankgard relay to initiate lockout only after the fuse for the last-failing capacitor unit has had sufficient time to operate—thus ensuring indication as to which capacitor unit was in the process of failing. Generally, coordination will be achieved provided:

1. The lockout level is set as described in the example given in the section headed "ESTABLISHING THE SETTINGS,"
2. The lockout time delay is adequate, and
3. A fusing ratio of 1.25 or less is used for individual capacitor-unit fuses.

If other than the factory-set time delay of 10 seconds is desired, it may be selected by means of the 2-30 second timer adjustment dial.†

† Adjustment-dial scales are accurate to ±20%. Refer to the "SPECIFICATIONS" section for repetitive accuracy of the settings.

VERIFICATION OF CALCULATED LOCKOUT LEVEL

Lockout level can be checked as follows:

Step 7

Verify that no capacitor units have been isolated from the bank.

Step 8

De-energize the capacitor bank by opening the capacitor-bank switching device. Then ground the bank, observing established operating procedures and safety precautions. Connect a voltmeter having a minimum input impedance of 5000 ohms per volt to the input terminals of the Type LUC Bankgard Relay.

Step 9

Isolate the number of capacitor units (all in the same series group) previously determined as required to lock out the bank, by removing their respective fuses.

Step 10

Remove the temporary grounds, re-energize the bank, and record the voltmeter reading. (If the voltmeter reading exceeds the lockout-level setting, an automatic switching operation will occur to isolate the entire capacitor bank after the lockout timer has completed its cycle.) In any event, de-energize the bank by opening the capacitor-bank switching device as soon as the voltmeter reading has been obtained, to avoid shortening the life of the capacitor units. Verify that no other capacitor units have been isolated.

Note: Following automatic lockout of the capacitor bank (as indicated by a red target at the "Lockout Indicator" window) and subsequent maintenance work to replace the isolated capacitor units and their fuses, the capacitor bank can be returned to service *only after depressing the reset pushbutton.* This allows closing of the capacitor-bank switching device.

Step 11

De-energize (if necessary) and ground the capacitor bank, observing established operating procedures and safety precautions. Reconnect the fuses which were previously removed to isolate the capacitor units.

Step 12

Repeat Steps 7 through 11 for each of the remaining two phase legs of the capacitor bank.

Step 13

Verify that the lockout level, as determined from the graphs or formulas in the section headed "ESTABLISHING THE SETTINGS," is lower than the lowest voltmeter reading obtained in Steps 9 through 12. A lockout level higher than one or two of the readings obtained in those steps is an indication that system-voltage unbalance and/or inherent capacitor-bank unbalance is creating an error voltage, appearing between the capacitor-bank neutral and ground, of sufficient magnitude to obscure the neutral-to-ground voltage due to the loss of individual capacitor units. In this event, the corrective procedures listed in Step 5 may be taken.

MAINTENANCE

No routine maintenance is recommended for the S&C Bankgard Relay—Type LUC other than an occasional exercising (about once per year) to verify that it is operational. This can be done by temporarily adjusting the lockout level downward until lockout of the capacitor bank occurs.

At installations utilizing an S&C Circuit-Switcher as the capacitor-bank switching device, the associated S&C Switch Operator—Type CS-1A may be conveniently decoupled from the Circuit-Switcher. This capability makes it possible to check out the Type LUC Bankgard Relay without actually switching the capacitor bank.

SPECIFICATIONS

S&C Bankgard Relay—Type LUC

Catalog Number	Control Circuit		
	Voltage		Current Requirement Milliamperes, Nominal
	Nominal	Operating Range	
38220-A	48 v dc	39—56 v dc	250
38220-B	125 v dc	100—140 v dc	250
38220-D	120 v 60 hz	102—132 v 60 hz	200
38220-E	240 v 60 hz	204—264 v 60 hz	100

Operating Temperature Range

Ambient Adjacent to Device ....−40°F to +160°F

Neutral-to-Ground Input Circuit

Normal Operating Voltage Range ....1 to 20 v ac
Frequency Range....................60 ±0.3 hertz§
Burden ....0.5 ohm

Lockout Circuit

Voltage Level
Adjustment Range ....0 to 20 v ac
Accuracy........................ ±3% of setting‡
Timing
Factory Setting........................ 10 seconds
Adjustment Range.................. 2 to 25 seconds
Accuracy........................ ±3% of setting‡

§ For 50-hertz applications, refer to the nearest S&C Sales Office.

‡ For any combination of control-source voltage and ambient temperature within specified range.

Output-Relay Contact Ratings

Current Carrying
Continuous ....10 amperes
1-Second ....50 amperes
Interrupting ....1 ampere at 48 v dc;
0.5 ampere at 125 v dc;
10 amperes at 120 v 60 hz;
10 amperes at 240 v 60 hz

Approximate Shipping Weight

Bankgard Relay Only ....4 lbs.
Bankgard Relay in Weatherproof Enclosure...12 lbs.