

INSTRUCTIONS

For Installation and Operation

GENERAL

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.

The S&C Automatic Control Device – Type VR provides automatic control of capacitor-bank switching to regulate

system voltage. It is a solid-state electronic control device of modular construction which senses the bus voltage (phase-to-ground) appearing across an S&C Potential Device (or other voltage sensor) and actuates the capacitor-bank switching device. This control device includes voltage-level modules for adjustment of both the lower and upper limits of system voltage at which capacitor-bank switching operations are desired. Timing circuits prevent operations due to false signals from transient voltage conditions on the system.

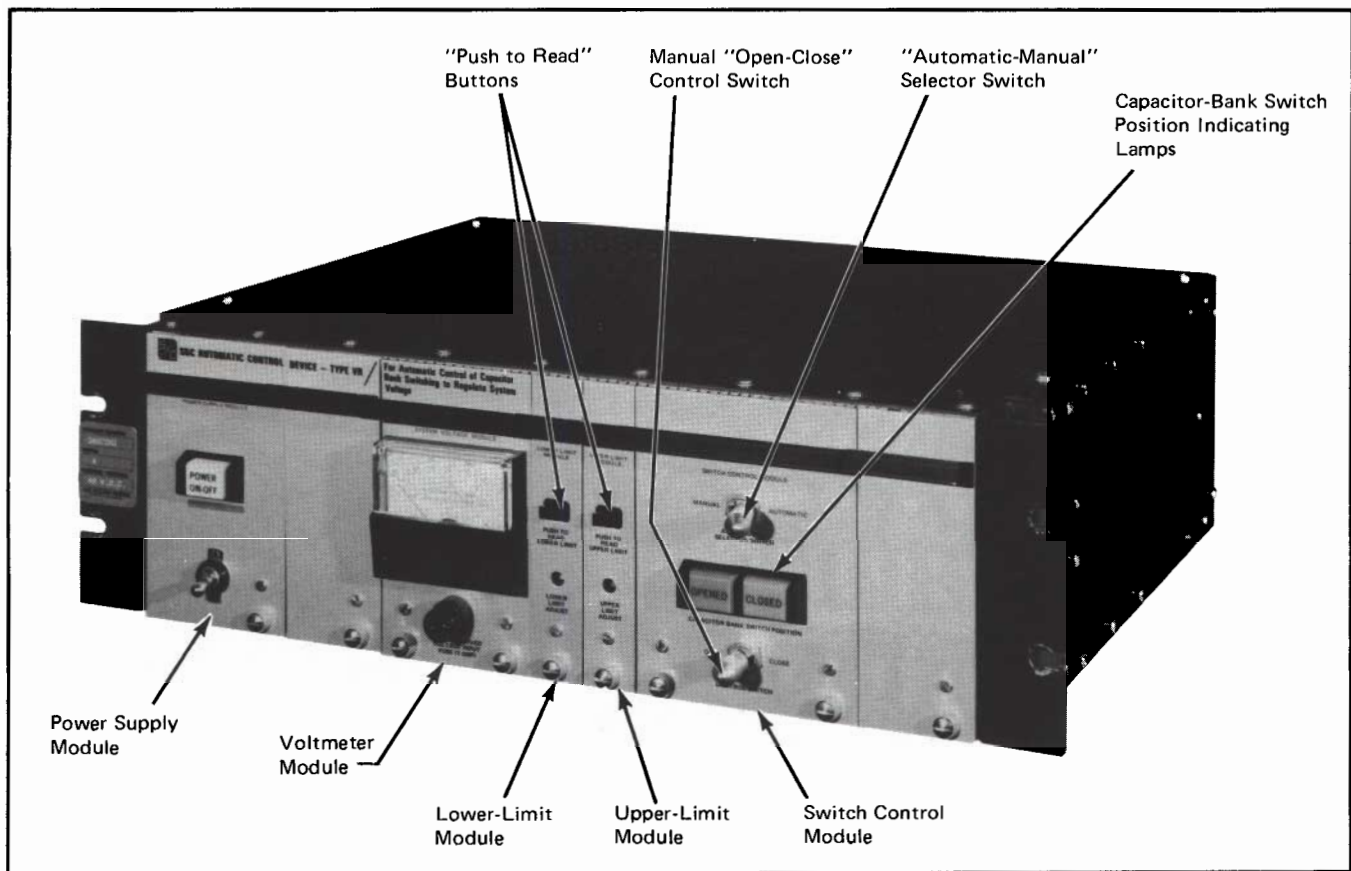


Figure 1. Complete S&C Automatic Control Device – Type VR, ready for mounting in standard 19-inch relay rack, in a weatherproof enclosure, or in a cutout in user's panel.

INSTALLATION

General Installation Requirements

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 tests (both before and after the screening test).

To prevent damage to the control device in the event that surges which exceed factory-tested levels are encountered, S&C's control-circuit fusing recommendations must be followed. The required fuse blocks and fuses are furnished with the control devices. 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.

For all grounded-wye capacitor bank installations the following steps must be taken to ensure that the control device is not subjected to surges in excess of factory-tested levels:

1. Adequate shielding must be provided for control-circuit wiring.
2. For installations involving two or more grounded-wye capacitor banks in the same station, their neutrals must be interconnected and grounded at a single point only. Additionally, for such installations, the capacitor-bank switching devices must be equipped with pre-insertion resistors.

Making the Connections

The S&C Automatic Control Device – Type VR is equipped with a numbered terminal strip (Figure 2) at the rear of the enclosure and a connection diagram* is furnished separately to show all necessary external control-wire connections. Connections are required to the following:

* Detailed diagrams are furnished as part of the instruction manual shipped with each unit.

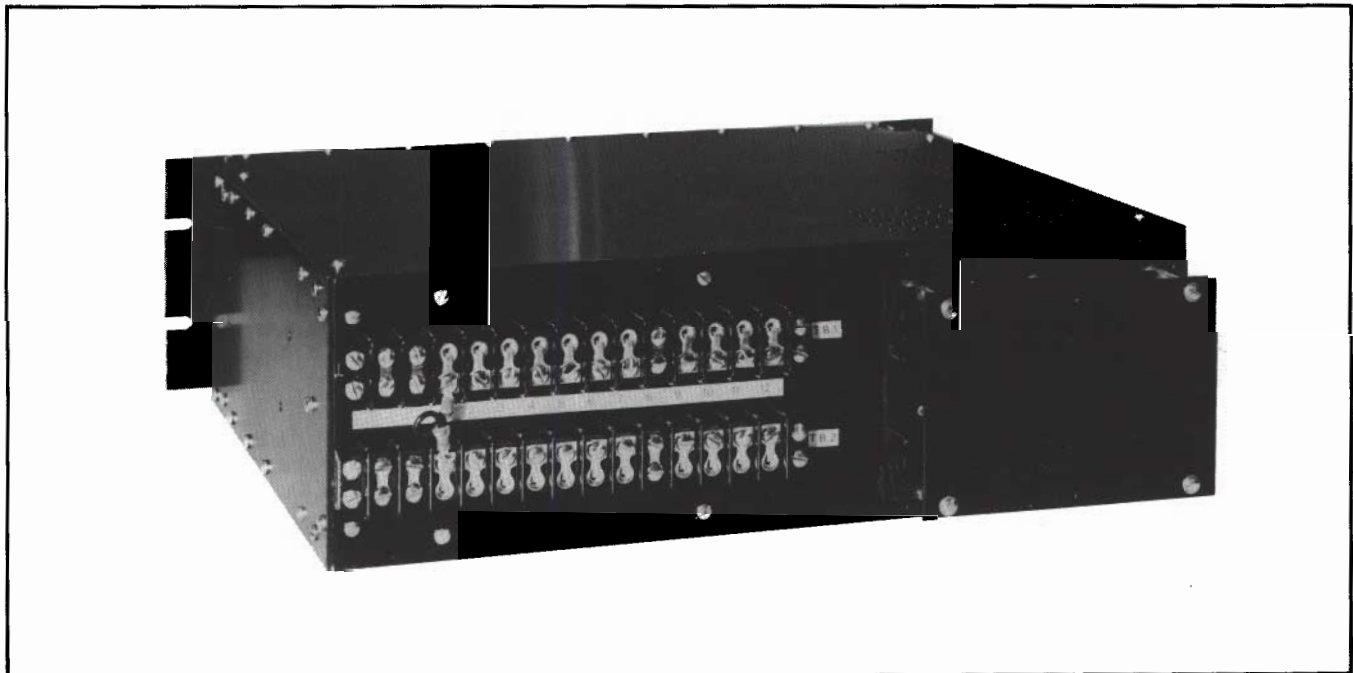


Figure 2. Terminal strips for external control-wire connections.

1. Control-power source (48 volts dc, 125 volts dc, 120 volts ac, or 240 volts ac)
2. Output terminals of an S&C Potential Device connected to the station bus, any phase-to-ground. Alternately, any 120-volt sinusoidal ac source with at least 1 va output which accurately reflects the system voltage may be utilized as the input signal.
3. Opening circuit of the switch operator
4. Closing circuit of the switch operator
5. "b" contact of switch operator's auxiliary switch
6. Station ground
7. Space heater source, where applicable (120 volts ac or 240 volts ac).

The automatic control device is suitable for mounting in a standard 19-inch relay rack. When so furnished, fuses and fuse blocks for the control source and for bus-derived potential circuits (when unbalance compensation is used)

are provided. For flush-mounting of the control device on switchboards, control consoles, or other enclosures, a mounting bezel (optional) is available.

If the control device is furnished in a weatherproof enclosure, four knockouts for 1½-inch conduit are located in the bottom of the enclosure, and a pre-wired auxiliary, front-access, covered terminal strip is provided. Fuses and fuse blocks for the control source, for all bus-derived potential circuits, and for the space heater source are included. The heater is factory-connected for 240-volt ac operation, but it is readily field-reconnected for 120-volt ac operation. When the S&C Automatic Control Device – Type UP/VR or Type GP/VR is furnished in a weatherproof enclosure, similar auxiliary, front-access, covered terminal strips and conduit knockouts are provided. Additionally, when so furnished, the two control devices are provided with all necessary interconnections pre-wired (see S&C Instruction Sheet 531-500 for the S&C Automatic Control Device – Type UP, or S&C Instruction Sheet 531-505 for the S&C Automatic Control Device – Type GP).

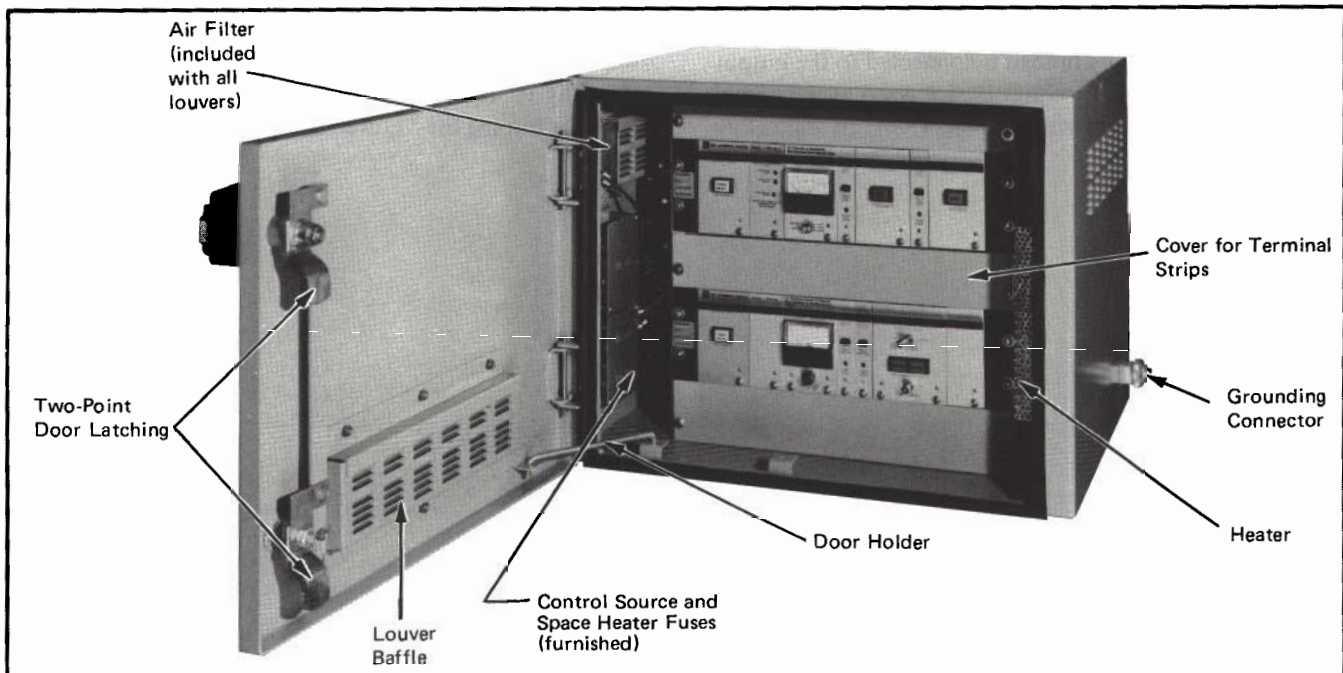


Figure 3. S&C Automatic Control Device – Type UP/VR, mounted in weatherproof enclosure.

OPERATION AND ADJUSTMENT

Step 1

Move the "Automatic-Manual" selector switch to the "Manual" position. NOTE: The selector switch is "locked" against inadvertent operation. To operate the selector switch, pull its toggle lever outward about 1/8 inch.

Step 2

The voltmeter gives a continuous reading of the system voltage (on a 120-volt basis) without the requirement to actuate the power "On-Off" toggle switch. Adjustment to achieve proper voltmeter response is required when the input from the station bus is derived from an S&C Potential Device but *is not required* when the input from the bus is derived from a voltage transformer or other "stiff" source having metering accuracy.

When using an S&C Potential Device, make the required adjustment at the adjustable dummy burden (located in the control device) as follows:

1. Unlock the extreme-right module by turning the locking screw (lower right-hand corner of module face) one-quarter turn counterclockwise and withdraw the module to its stop position, thereby exposing the "Burden Adjust" knob.
2. Turn the "Burden Adjust" knob until the voltmeter reading corresponds to that of an independent voltmeter which reflects or directly reads the system voltage on a 120-volt basis.
3. Close and lock the module. *Further adjustment is not required* unless more burden is connected to the output circuit of the S&C Potential Device, such as additional instrumentation, a battery charger, or an indicating

lamp. Note: The addition of non-linear loads, such as a rectifier with a capacitive filter, can severely distort the output signal of an S&C Potential Device, thus leading to incorrect operation of the control device.

Having established the required relationship between the control-device voltmeter readings and the system voltage, proceed with Step 3.

Step 3

If it is desired to either close or open the capacitor-bank switching device, operate the manual "Open-Close" control switch as required. NOTE: The manual "Open-Close" control switch is "locked" against inadvertent operation. To operate the manual "Open-Close" control switch, pull its toggle lever outward about 1/8 inch.

Step 4

Operate the power "On-Off" toggle switch and observe the indicator status (illuminated) to verify the presence of station control power at the automatic control device. (NOTE: Manual control of the capacitor-bank switching device does not require the presence of station control power at the automatic control device since the manual "Open-Close" control switch is connected to the open and close circuits of the switch operator.)

Step 5

With the "Automatic-Manual" selector switch still set on "Manual," adjust the lower voltage limit to the required setting by depressing the "Push to Read Lower Limit" button while turning the "Lower Limit Adjust" screw.



Step 6

Repeat the above procedure (Step 5) to adjust the upper voltage limit. NOTE: Maintain at least a 2-volt spread (or greater, depending on the size of the capacitor bank) between upper voltage-limit and lower voltage-limit settings on the voltmeter scale to prevent excessive switching of the capacitor bank "on and off" of the system.

Step 7

Reset the "Automatic-Manual" selector switch to "Automatic." The capacitor-bank switching device is now under automatic control.

NOTE: The system voltage must remain below the lower voltage-limit setting for at least 5 minutes* before a capacitor-bank closing operation is automatically initiated. This factory-set time-delay is to allow time for the individual capacitor units to discharge through their built-in discharge resistors in the event the capacitor bank has been recently energized and to ensure that short-duration system-voltage fluctuations do not initiate a capacitor-bank switching operation. Similarly, the system voltage must remain above the upper voltage-limit setting for at least 90 seconds* before the capacitor-bank switching device is automatically actuated to open.

* To adjust for different time-delay intervals, proceed as follows:

1. Withdraw the Lower Limit Module or Upper Limit Module.
2. Adjust the single-turn potentiometer (located on the printed-circuit board) to the desired time-delay setting. (The scale is accurate to $\pm 20\%$.)
3. Reinsert the module in the automatic control device.

Note: In either module the timing range is 10 seconds to 450 seconds. However, unduly short time-delay intervals may lead to the generation of severe switching transient voltages and/or unnecessary capacitor bank cycling.

Further guards against undesirable capacitor-bank switching operations include (1) the blocking of any closing operation whenever the system voltage drops lower than $33\frac{1}{3}\%$ below nominal (equivalent to 80 volts on the control-device voltmeter) and (2) immediate automatic opening of the capacitor-bank switching device whenever the station control power is lost at the capacitor bank control device or whenever the power "On-Off" toggle switch is used to turn off the control device. These control-device functions (effective only when the control device is set for automatic operation) may be individually verified[†] by (1) removing the "System Derived Voltage Input" fuse located just below the voltmeter, thereby simulating low system voltage and (2) (after replacing the "System Derived Voltage Input" fuse) by using the power "On-Off" toggle switch to simulate loss of station control power at the control device.

When the S&C Automatic Control Device – Type UP/VR or Type GP/VR is used, the two units are electrically interconnected to ensure that the protective control function overrides the voltage regulation function. Following such protective control function (as indicated by the "Lockout Indicator" lamp on the S&C Automatic Control Device – Type UP or Type GP) and subsequent maintenance work to replace the isolated capacitor units and their fuses, the capacitor bank may be put back in service only after depressing the "Lockout Indicator" pushbutton on the S&C Automatic Control Device – Type UP or Type GP.

[†] When verifying such control-device functions, it is possible to decouple the S&C Switch Operator – Type CS-1A or Type CS-2A from the bank-switching Circuit-Switcher, thereby eliminating unnecessary switching of the capacitor bank.



MAINTENANCE

No routine maintenance is recommended for the S&C Automatic Control Device – Type VR. Normal day-to-day operation will verify the operational capability of the control device. However, the S&C Switch Operator – Type CS-1A or Type CS-2A is equipped with a convenient means for mechanically decoupling it from the Circuit-Switcher, thereby making it possible to test the S&C Automatic Control Device – Type VR without actually switching the capacitor bank.

For example, after decoupling the switch operator, the “Lower Limit Adjust” screw can be turned while depressing its “Push to Read Lower Limit” button until the lower voltage limit is set slightly above the prevailing system voltage reading as indicated on the control-device voltmeter.

After such setting has been sustained for the required 5 minutes, the switch operator will be actuated automatically for a closing operation. Reset the “Lower Limit Adjust” screw to its normal setting. Next, the “Upper Limit Adjust” screw can be turned while depressing its “Push to Read Upper Limit” button until the upper voltage limit is set slightly below the prevailing system voltage reading. After such setting has been sustained for the required 90 seconds, the switch operator will be actuated automatically for an opening operation. Following such testing, readjust both limit settings to their normal values, recouple the switch operator, and verify that the “Automatic-Manual” selector switch is set at “Automatic” to ensure that the capacitor bank has been restored to automatic operation.



Control Source

Automatic Control-Device Catalog Number Suffix	Control Source Voltage		Control Source Current, Amperes
	Nominal	Operating Range	
A	48 v dc	38.5 – 56 v dc	1
B	125 v dc	100 – 140 v dc	1
D	120 v ac	102 – 132 v ac	½
E	240 v ac	204 – 264 v ac	½

Ambient Temperature

Operating range -40°F to +160°F

System-Voltage Input Circuit

Nominal voltage 120 v ac
 (Special tap provided to accommodate input voltage equal to $120/\sqrt{3}$ v ac)

Burden 1 va maximum

System-Voltage Meter

Range (expanded scale) 100 to 130 v ac
 Accuracy ±½% of full scale reading

Timing Circuits

Upper limit (opening time)

Factory setting 90 seconds
 Adjustment range 10 seconds to 450 seconds

Lower limit (closing time)

Factory setting 300 seconds
 Adjustment range 10 seconds to 450 seconds

Accuracy (both circuits) ±3% of setting
 (for any combination of control-source voltage and ambient temperature within specified ranges)

Upper- and Lower-Limit Circuits

Accuracy (both circuits) ±1% of setting
 (for any combination of control-source voltage and ambient temperature within specified ranges)

Undervoltage Blocking Circuit

Blocks closing of bank-switching Circuit-Switcher if system voltage drops below 66% of nominal value

Output Relay, Contact Ratings

Interrupting 1.0 ampere at 48 v dc,
 0.5 ampere at 125 v dc, or
 10 amperes at 120 v ac†

Current carrying

Continuous 10 amperes
 1 Second 50 amperes

† The interrupting rating of the output relay is also 10 amperes at 240 v ac when the Automatic-Control-Device Catalog Number Suffix “-E” is specified.