

# S&C Potential Devices

Outdoor (23 kv through 138 kv)

- for relaying
- for monitoring
- for nonrevenue metering

Supersedes Descriptive Bulletin 581-30 dated 7-27-81 © 1985



S&C ELECTRIC COMPANY - Chicago  
S&C ELECTRIC CANADA LTD - Rexdale

**DESCRIPTIVE BULLETIN 581-30**

Page 1 of 11  
June 24, 1985

**APPLICATION AND PERFORMANCE**

S&C Potential Devices are resistance-type voltage-sensing units which offer significant savings-up to 70% over conventional single-bushing voltage transformers. They are suitable for a wide range of single-phase and three-phase applications, from 23 kv through 138 kv-including relaying, monitoring, and nonrevenue metering. And because S&C Potential Devices are accurate to within 1½%, they are suitable for virtually any protection scheme. The diagrams on pages 4, 5, and 6 show some of the ways they can be used.

Unlike capacitor-coupled devices, S&C Potential Devices do not possess resonant characteristics and are immune to ferroresonance. Their limited frequency response makes them ideal for service at locations where high-frequency transients might otherwise cause spurious relay operations.

And, unlike voltage transformers, S&C Potential Devices do not saturate when subjected to switching overvoltages. They are therefore better suited to neutral-voltage monitoring applications in shunt capacitor-bank and reactor protection schemes. Typically, in such applications, transient overvoltages on the order of 0.5 to 2.4 per unit can be developed at the neutral of the bank as a result of normal switching operations. S&C Potential Devices are immune to these voltage surges. However, an underrated voltage transformer (used because of its lower turns ratio to obtain sufficient sensitivity in a monitoring scheme using electromechanical relays) can be driven into extreme saturation by these switching overvoltages-with resultant thermal failure of the windings or dielectric failure of the insulation.

S&C Potential Devices, like single-bushing voltage transformers, are rated in terms of system line-to-line voltage, but are connected line-to-ground.† S&C Potential Devices have constant-current output, like current transformers. With a fixed burden connected across the output terminals, S&C Potential Devices produce an output voltage that is directly proportional to the voltage applied to the line terminal.

S&C Potential Devices are very compact (see pages 9 and 10 for dimensions), requiring little room for installation. Although designed for outdoor use, they may be used indoors or in metal-enclosed switchgear. Special consideration to lightning exposure is not necessary. However, it is desirable, as with voltage transformers and other electrical apparatus, to provide surge arresters if the prevalence of lightning warrants.

The basic reliability of S&C resistance-type potential devices has been thoroughly proved in nearly 50 years of satisfactory field experience.

† S&C Potential Devices are rated for application on grounded systems, but application to ungrounded systems may be made through the use of specially applied or specially modified potential devices. A standard 30-volt-ampere potential device applied on an ungrounded system must have a system voltage rating at least equal to the system voltage multiplied by  $\sqrt{3}$ , and the burden impedance must not exceed the normal 480-ohm value (so that the high-voltage resistor assembly will not overheat and the output will not exceed 120 volts in the event of an accidental ground on the system). When a standard 30-volt-ampere potential device is applied as described, the nominal output is typically reduced to a maximum of 60 volts and 7.5 volt-amperes (48 volts and 4.8 volt-amperes for 46-kv ungrounded systems). Specially modified M-volt-ampere potential devices can be provided for ungrounded-system application with nominal output of 70 volts and 10 volt-amperes.

## APPLICATION AND PERFORMANCE

### 30-Volt-Ampere Models

Models having 30-volt-ampere output rating are suitable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. They have a nominal output voltage of 120 volts rms when a 480-ohm resistive burden is connected across the output terminals and line-to-ground voltage corresponding to rated system voltage is applied to the line terminal. These models may be used for any appropriate application requiring a voltage source, provided the burden is fixed and does not exceed the output rating of the potential device. However, larger inductive burdens (e.g., as high as 60 volt-amperes at 60° lagging phase angle) may be easily accommodated by connecting a suitable shunt capacitor across the burden for power-factor correction. Also, an adjustable phase-relation between input and output voltage may be readily achieved by connecting suitable power-factor correction elements across the burden. ▲

When used in conjunction with equipment having high-impedance input circuits, such as the S&C Automatic Control Device-Type GP, or with the unbalance compensation module option of S&C Automatic Control

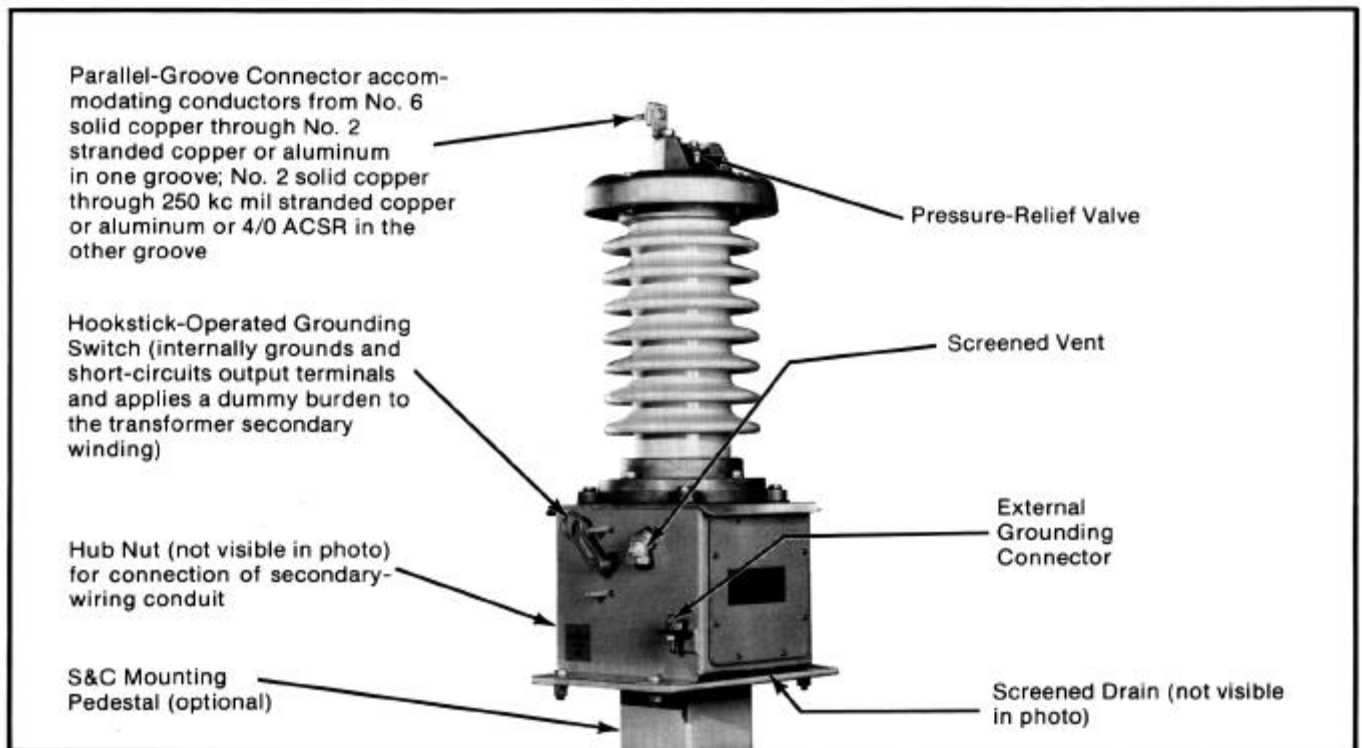
Device-Type UP or UPR, these potential devices must be equipped with a factory-adjusted calibration device (contained within the base of the potential device), catalog number suffix "-T." See page 8.

### 15-Volt-Ampere Models

Models having 15-volt-ampere output rating are applicable for neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors only. This application requires a much more sensitive potential device because of the very low voltage normally present between the neutral and ground. These models provide an output having excellent linearity and minimal phase shift at such low voltages. They have a secondary burden resistor contained within the base which has been factory calibrated to provide a specific voltage ratio. See page 8.

These models are intended for use in conjunction with equipment having high-impedance input circuits, such as S&C Automatic Control Devices-Types UP and UPR, and S&C Bankgard™ Relay-Type LUC.

▲ For information on burden adjustments for these models, refer to S&C Instruction Sheet 581-500.



S&C 30-Volt-Ampere Potential Device, Catalog Number 81473R6-D, rated 23 kv.



**APPLICATION AND PERFORMANCE**

**TYPICAL APPLICATIONS FOR S&C 30-VOLT-AMPERE POTENTIAL DEVICES**

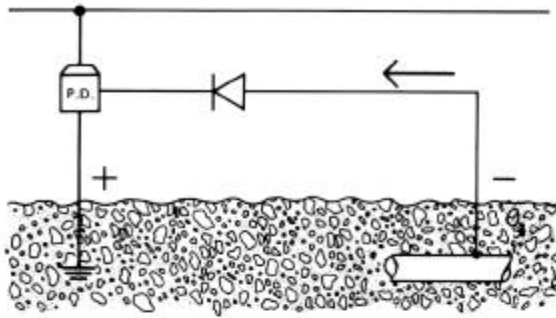
<p>Monitoring intermediate-tap-point-to-ground voltage on grounded, wye-connected shunt capacitor bank, in conjunction with S&amp;C Automatic Control Device—Type GP, for capacitor-bank protection.</p>	<p>Monitoring system line-to-ground voltage, in conjunction with S&amp;C Automatic Control Device—Type VR, for capacitor-bank switching for voltage regulation.</p>
<p>Monitoring system line-to-ground voltage, in conjunction with unbalance compensation module of S&amp;C Automatic Control Device—Type UP or Type UPR, for protection of ungrounded, wye-connected shunt capacitor bank or reactor, respectively.</p>	<p>Providing control voltage to 115 volt, 60 hertz S&amp;C Capacitor-Type Trans-Rupter™ Controller.</p>
<p>Monitoring system line-to-ground voltage, in conjunction with S&amp;C Source-Transfer Control—Type AT, for automatic source transfer.</p>	<p>Monitoring line-to-ground voltage on three-phase load circuit, in conjunction with S&amp;C Open-Phase Detector—Type SPD, for protection from open-phase conditions.</p>



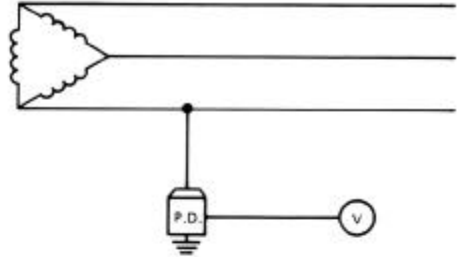
# APPLICATION AND PERFORMANCE

## TYPICAL APPLICATIONS FOR S&C 30-VOLT-AMPERE POTENTIAL DEVICES - continued

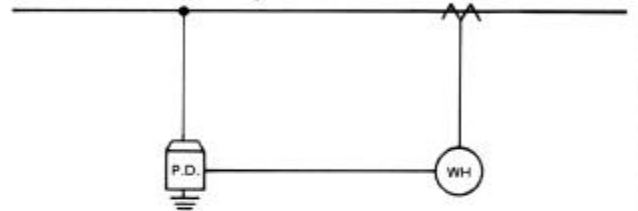
Cathodic corrosion protection. (Necessary burden resistance, surge protection, and rectifier can be included in the base of the potential device.)



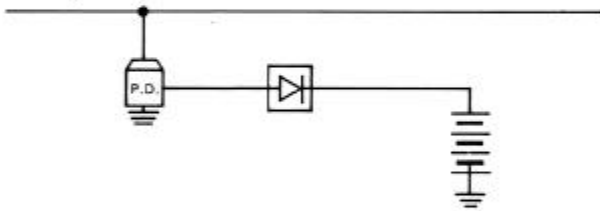
Detecting grounds using voltmeter, relaying, or indicating lamps. (See footnote† on page 2.)



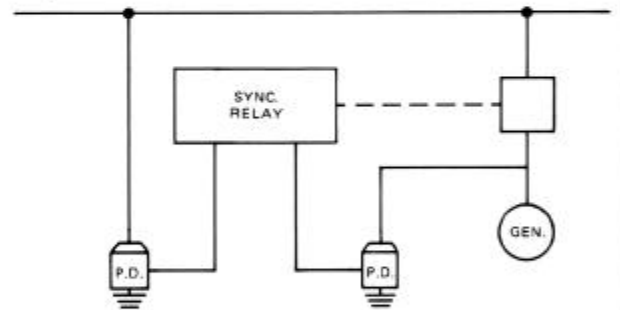
Nonrevenue metering.



Providing input voltage to S&C Constant-Burden Battery Charger.

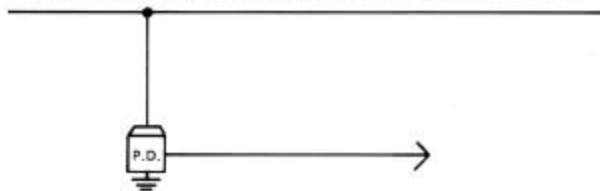


Monitoring system line-to-ground voltage magnitude and phase angle, in conjunction with synchronizing relays, for automatically synchronizing rotating machines onto a system.

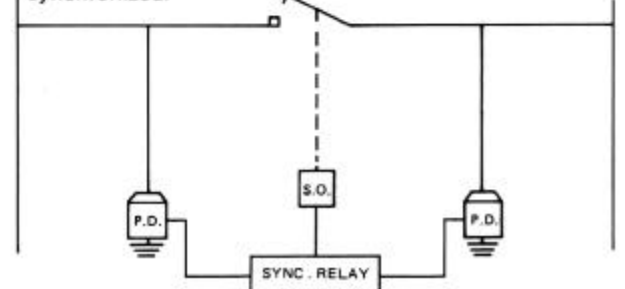


Providing input voltage for:

- Switching intelligence for load-shedding schemes.
- Special-purpose relays, e.g., ground-fault and voltage-unbalance relays.
- Control power at remote locations.
- Measurement with indicating or recording instruments.



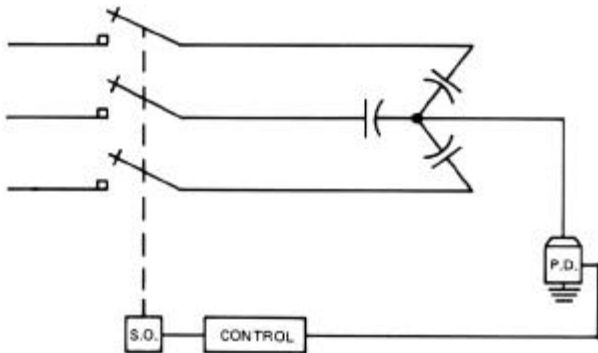
Monitoring system line-to-ground voltage magnitude and phase angle, in conjunction with synchronism-check relays, to permit closure of a switching device to interconnect two sources only when the sources are synchronized.



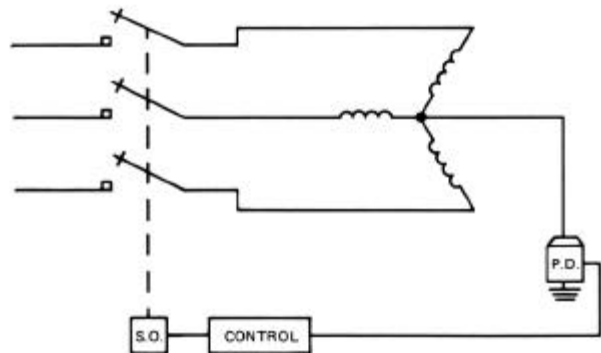
**APPLICATION AND PERFORMANCE**

**APPLICATIONS FOR S&C 15-VOLT-AMPERE POTENTIAL DEVICES**

Monitoring neutral-to-ground voltage on ungrounded, wye-connected shunt capacitor bank, in conjunction with S&C Automatic Control Device—Type UP or S&C Bankgard™ Relay—Type LUC, for capacitor-bank protection.



Monitoring neutral-to-ground voltage on ungrounded, wye-connected shunt reactor, in conjunction with S&C Automatic Control Device—Type UPR, for reactor protection.



S&C Potential Devices utilize a high-voltage resistor assembly immersed in insulating oil and sealed in a wet-process porcelain bushing. A measured amount of air is left above the oil level to permit expansion and contraction of the oil volume with temperature changes; a pressure-relief valve is incorporated in the cover of the potential device to prevent excessive pressure buildup during normal operation under high-ambient-temperature conditions. Since the pressure-relief valve opens only if the internal pressure reaches a level of 9 to 11 psig, and then only momentarily, the resistor assembly is essentially sealed so that moisture contamination and sludging tendencies are virtually eliminated.

The resistor assembly comprises a large number of high-precision thick-metal-film resistors connected in series. Resistance values have been selected so that the current flow through the high-voltage resistor assembly of 30-volt-ampere models is approximately 4 milliamperes (less than 1 milliampere for 15-volt-ampere models). The individual resistors have a temperature coefficient of less than 0.01% per degree C, over a temperature range of  $-55^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$ , assuring an exceptionally high degree of temperature stability.

At the base of the device, a stud connected to the resistor assembly is brought through an O-ring sealed Cypoxy<sup>®‡</sup> insulator plate into the base enclosure, where connection is made to the primary side of the series transformer, and to a sparkover gap which limits high voltages which might appear at the transformer primary due to line surges or an inadvertent open secondary circuit.

The series transformer is of the single-primary-bushing type, oil filled and solder sealed. A nickel-iron core is used in the transformer of the 15-volt-ampere models to minimize the phase shift between the applied voltage and the output voltage and to improve the linearity of the output. The neutral end of the primary winding is permanently connected to the transformer case, which is grounded. The secondary winding is completely isolated and has a low-frequency withstand to ground of 2.5 kv for one minute. A removable jumper is furnished, connected from the X<sub>2</sub> secondary winding terminal to ground. (The jumper may be removed if single-point grounding at another location is desired.)

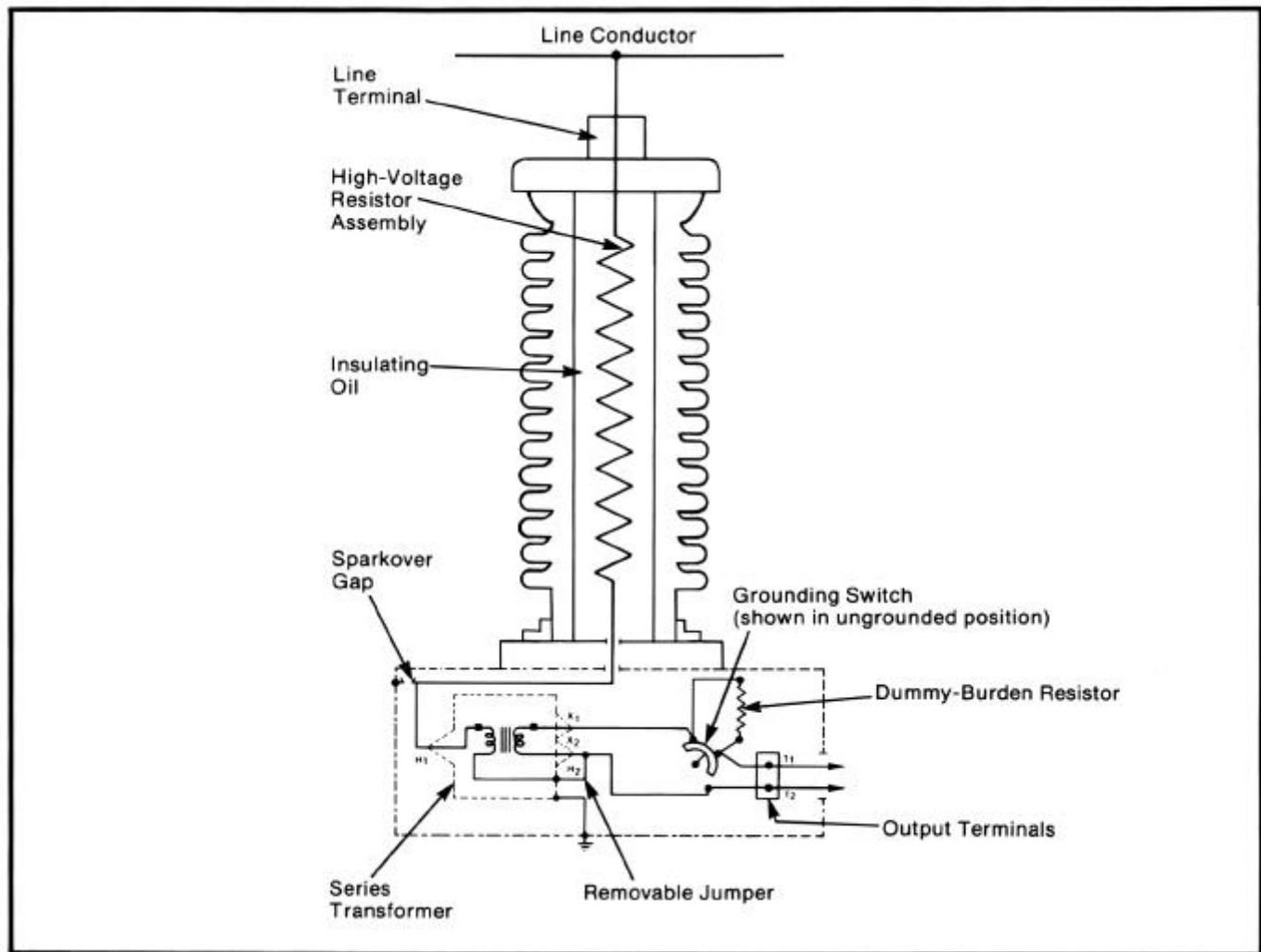
The top cover of the device, to which the resistor assembly is internally connected, is provided with a choice of two connector arrangements—a parallel-groove type for use with wire conductors, or a vertical-pad line terminal with standard four-hole drilling for use with bus or pad-terminal connectors.

To allow removal of the connected burden without open-circuiting the transformer secondary winding, a hookstick-operated grounding switch is provided in the base of the potential device. The switch, when placed in the “ground” position, short-circuits and grounds the potential-device output terminals and at the same time connects an internal dummy-burden resistor across the secondary winding of the transformer.

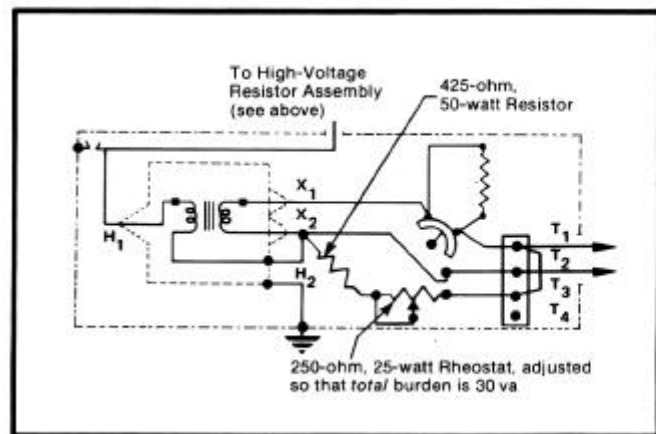
<sup>‡</sup> Cypoxy is the S&C trademark for S&C's cycloaliphatic epoxy resin system.

S&C Potential Devices  
Outdoor (23 kv through 138 kv)

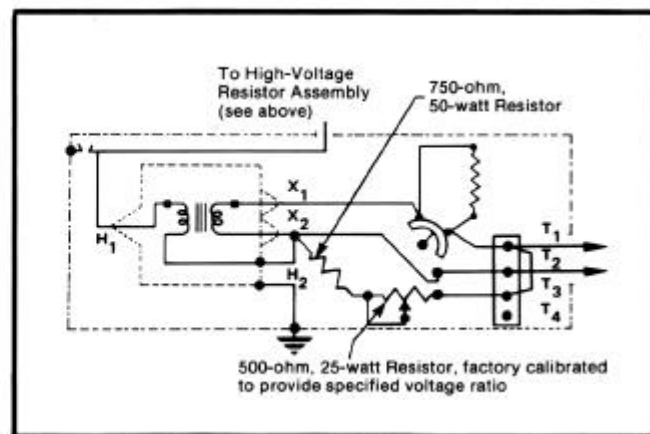
**CONSTRUCTION**



Schematic of S&C 30-Volt-Ampere Potential Device.



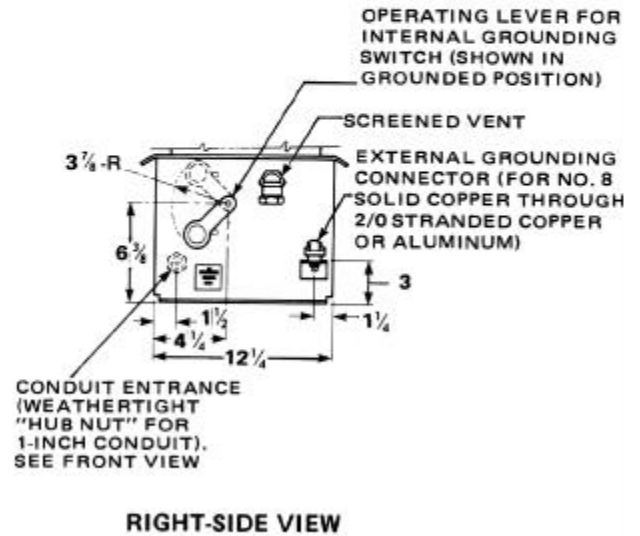
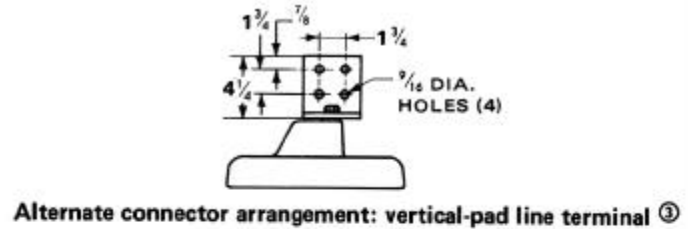
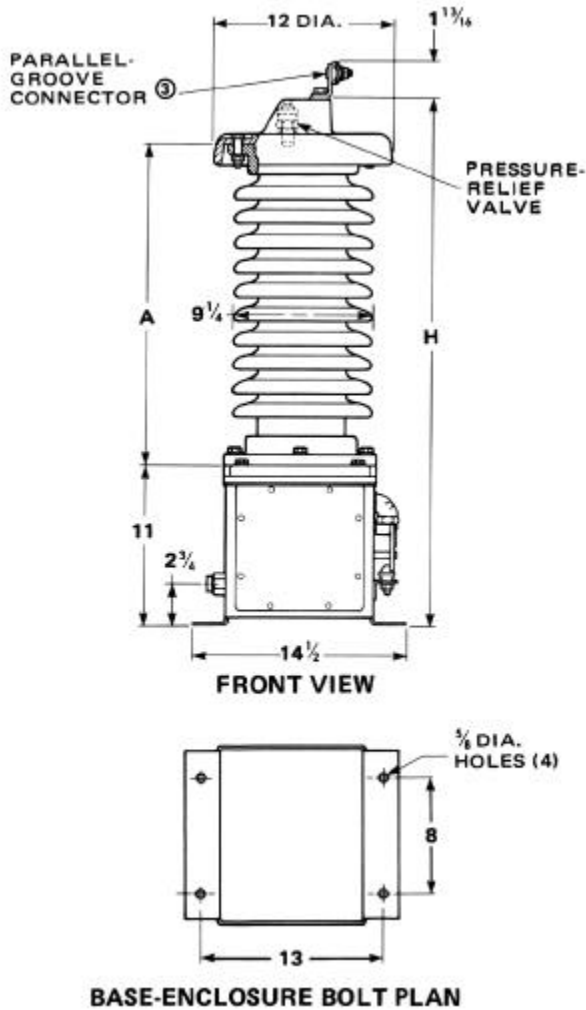
Schematic of S&C 30-Volt-Ampere Potential Device equipped with optional factory-adjusted calibration device, catalog number suffix "-T."



Schematic of S&C 15-Volt-Ampere Potential Device.



# SPECIFICATIONS



## S&C 30-VOLT-AMPERE POTENTIAL DEVICES ①

Rating, Kv, Nominal		Applied Line-to-Ground Voltage, Kv ②	Resistance of High-Voltage Resistor Assembly, Megohms	Catalog Number ③④	Dimensions, Inches		Net Wt., Lbs.
System	Device (BIL)				A	H	
23	150	13.3	1.5	81473R6	18	32	115
34.5	200	19.9	3.0	81344R6	18	32	115
46	250	26.6	4.5	81475R6	28	42	165
69	350	39.8	8.0	81346R6	28	42	165
115	550	66.4	15.0	81478R6	48	62	275
138	650	79.6	17.6	81349R6	48	62	275

① Applicable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. For neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors, S&C Potential Devices rated 15 volt-amperes are to be used.

② The output voltage of an S&C Potential Device rated 30 volt-amperes is nominally 120 volts rms with a 480-ohm resistive burden connected across the output terminals and with line-to-ground voltage corresponding to rated system voltage applied to the line terminal.

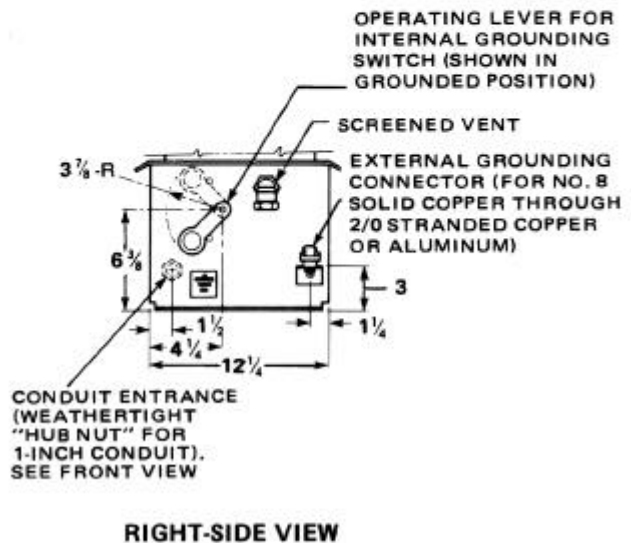
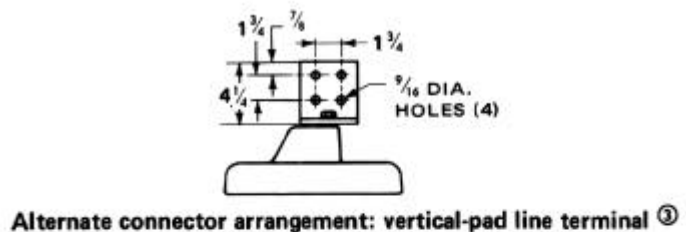
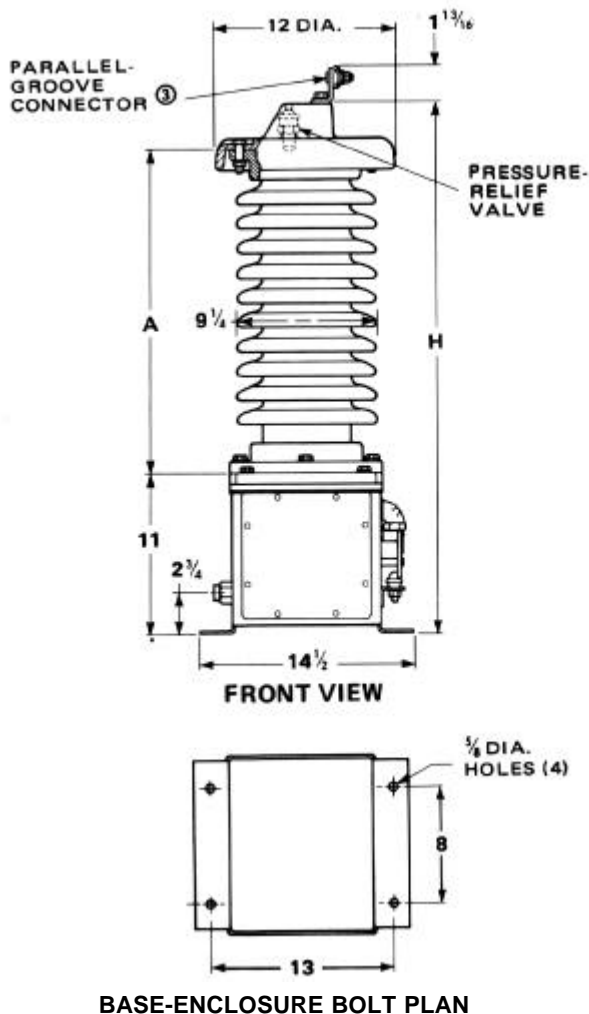
③ To specify a parallel-groove connector accommodating conductors from No. 6 solid copper through No. 2 stranded copper or aluminum in one

groove; No. 2 solid copper through 250 kc mil stranded copper or aluminum or 4/0 ACSR in the other groove-add suffix "D" to the catalog number of the selected potential device. To specify a vertical-pad line terminal with standard four-hole drilling, add suffix "-G" to the catalog number of the selected potential device.

④ S&C Potential Devices rated 30 volt-amperes ordered for use with S&C Automatic Control Device-Type GP or for use with the unbalance compensation module option of S&C Automatic Control Device-Type UP or UPR must be equipped with a factory-adjusted calibration device (contained within the base of the potential device). To order, add suffix "-T" to the catalog number.

S&C Potential Devices  
Outdoor (23 kv through 138 kv)

**SPECIFICATIONS**



**S&C 15-VOLT-AMPERE POTENTIAL DEVICES ①**

Rating, Kv, Nominal		Voltage Ratio②	Catalog Number③	Dimensions, Inches		Net Wt., Lbs.
System	Device (BIL)			A	H	
23	150	111:1	81573R1	18	32	115
34.5	200	166:1	81574R1	18	32	115
69	350	332:1	81576R1	28	42	165
138	650	664:1	81579R1	48	62	275

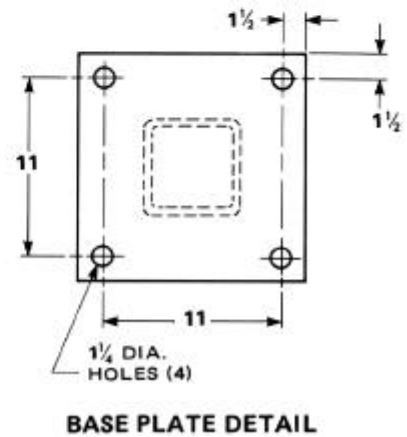
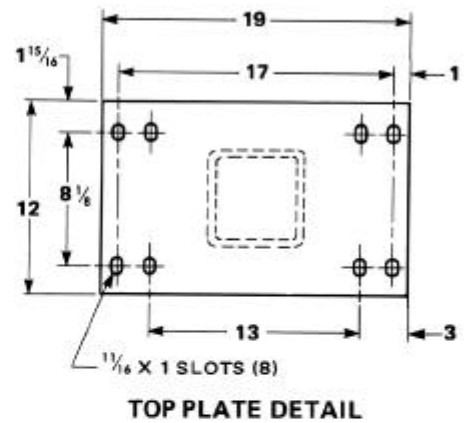
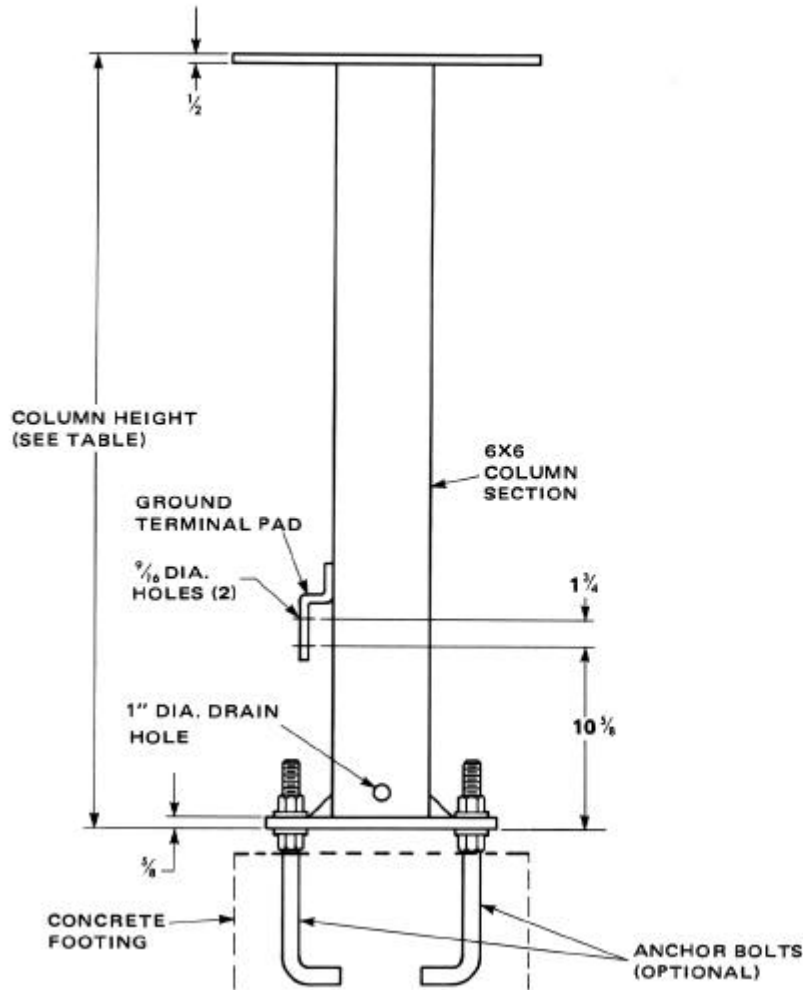
① Applicable only for neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors. For line-to-ground connection, as well as intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, S&C Potential Devices rated 30 volt-amperes are to be used.

② These potential devices include a factory-adjusted burden resistor which provides the specified input-to-output voltage ratio.

③ To specify a parallel-groove connector accommodating conductors from No. 6 solid copper through No. 2 stranded copper or aluminum in one groove; No. 2 solid copper through 250 kc mil stranded copper or aluminum or 4/0 ACSR in the other groove-add suffix "-D" to the catalog number of the selected potential device. To specify a vertical-pad line terminal with standard four-hole drilling, add suffix "-G" to the catalog number of the selected potential device.



# SPECIFICATIONS



## MOUNTING PEDESTALS

Item	Column Height, Feet ①	Catalog Number	Anchor Bolts, ② Nominal Size and Quantity Required
Mounting Pedestal (one per set), square steel tube construction, galvanized finish	8	92430R1-G	1" X 2'-9" 4 Required
	9	92431R1-G	
	10	92432R1-G	
	11	92433R1-G	
	12	92424R1-G	

① Intermediate heights (less than 12 feet) are available in 3-inch increments. Specify by adding one of the following suffixes to the catalog number of the mounting pedestal of nearest lower height:

- S3 Three inches additional height
- S6 Six inches additional height
- S9 Nine inches additional height

Note: Maximum available column height is 12'-0".

② Specify anchor bolts, if desired, by adding suffix "-A" to the catalog number, for example, 92424R1-GA. Note: Each anchor bolt includes a set of two nuts and two washers to facilitate leveling. Nuts, washers, and threaded portion of anchor bolts are furnished galvanized.

