

S&C Source-Transfer PMH Pad-Mounted Gear

Outdoor Distribution (14.4 kv and 25 kv)

With Micro-AT™ Control



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S&C ELECTRIC COMPANY • Chicago
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DESCRIPTIVE BULLETIN **663A-30**

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GENERAL**S&C Source-Transfer PMH Pad-Mounted Gear . . . totally self-contained switching and protection packages that provide fully automatic source transfer and fault protection for distribution systems serving small- to medium-sized industrial, commercial, and institutional complexes.**

In the past, many small- to medium-sized installations desiring automatic source transfer for critical loads had to choose between overhead automatic transfer schemes and power-operated metal-enclosed switchgear. Overhead transfer schemes, however, require considerable equipment and space, compromising the aesthetics of the installation, and are vulnerable to the various outages typically associated with overhead equipment. And the simple medium-voltage systems of these small industrial, commercial, and institutional installations often do not require the use of metal-enclosed switchgear with its additional construction features, range of ratings, and design and operating flexibility. For these locations, it is therefore difficult to justify power-operated metal-enclosed switchgear,

with its premium, solely to provide automatic source transfer. Accordingly, for these installations, users often had to choose manual switching equipment such as S&C's Manual PMH Pad-Mounted Gear.

Today, there's a better alternative—S&C Source-Transfer PMH Pad-Mounted Gear. S&C has solved the aesthetic, reliability, and economic problems by offering two Source-Transfer PMH Models. These compact, low-profile, pad-mounted packages achieve the outstanding reliability demanded by automatic source-transfer applications through the use of advanced electronics and field proven components in uniquely rugged, corrosion-resistant enclosures. And through pre-engineering of standardized designs suited to repetitive manufacture, plus a commitment to capital equipment

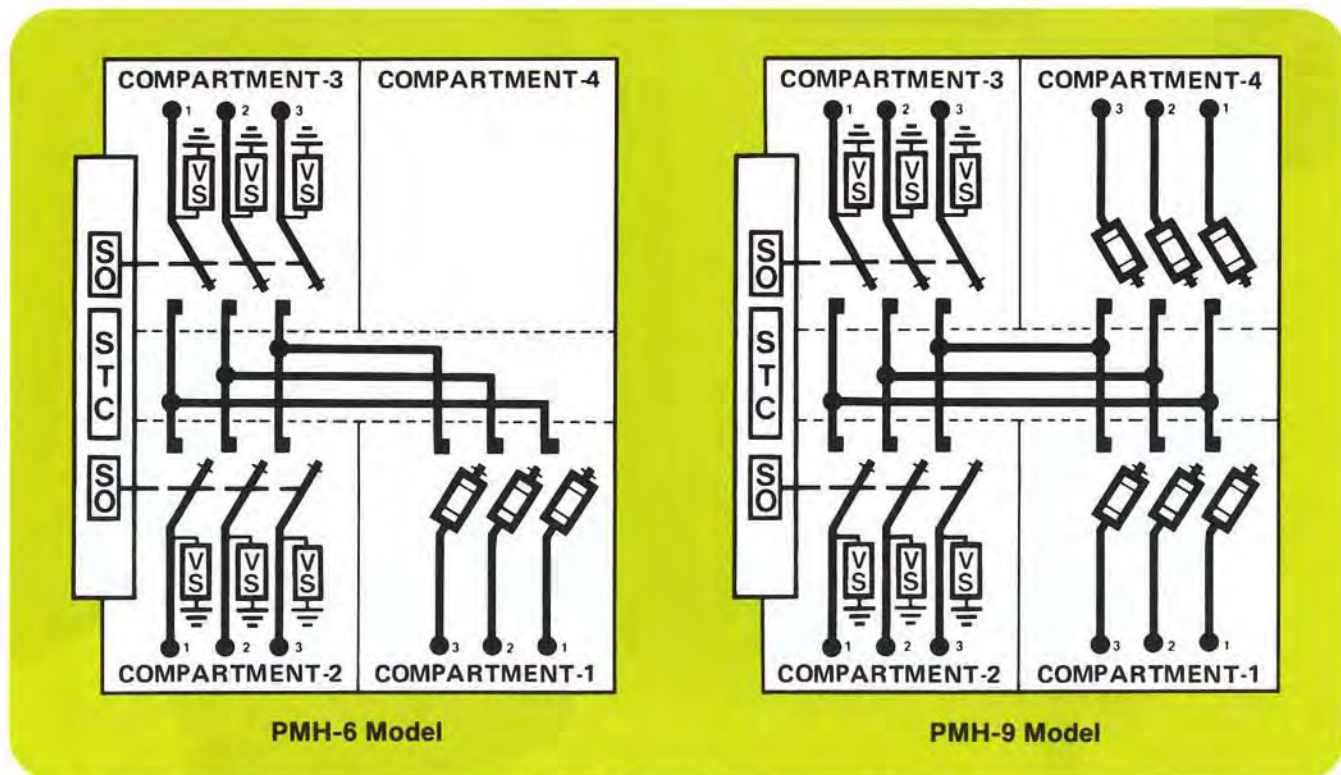


Figure 1. Circuit configurations of the two models of S&C Source-Transfer Pad-Mounted Gear.

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to maximize manufacturing efficiencies, these top-quality packages are available at a cost suited to the economics of smaller automatic source-transfer applications. Source-Transfer PMH Pad-Mounted Gear is designed with an attention to detail available only from S&C, with its nearly 50 years of experience in manufacturing metal-enclosed gear.

S&C Source-Transfer PMH Pad-Mounted Gear provides both fault protection and automatic primary-selective service on underground distribution systems for small- to medium-sized critical loads requiring a high degree of service continuity. These source-transfer models are completely self-contained switching and protection packages. Each model has built-in voltage sensing, control power, automatic controls, interrupter switches, stored-energy switch operators, and fuse mountings. They are available in two basic circuit configurations (see Figure 1) that provide reliable and flexible three-pole automated switching of source circuits rated up through 600 amperes, and single-pole switching and fault protection for either one or two load feeders rated up through 400 amperes.

Source-Transfer PMH Models are completely factory-assembled, thoroughly checked and tested, and ready for installation. There is no external wiring or control power required. Installation is easy and straightforward—just connect the power cables and program the operating characteristics and parameters, and the gear is ready for service—minimizing the installed cost.

S&C Voltage Sensors, three for each source, provide all the voltage inputs required by the source-transfer scheme. These devices produce an output voltage that is the sensing input to the Micro-AT Source-Transfer Control. They also supply control power for operation of the source-transfer control and stored-energy switch operators.

The S&C Micro-AT Source-Transfer Control continuously monitors the output of the voltage sensors to determine the condition of the two power sources serving the gear. If the source serving the load fails, the control initiates switching to transfer to the alternate source, restoring power to the load. This advanced,

microprocessor-based, electronic control is field programmable to permit the implementation of source-transfer applications that maximize power service to the loads, while conforming to the serving utility's system switching practices. It offers field selection of either power source as the preferred, lets you select automatic or manual return to the preferred source when normal voltage returns, and allows either paralleling or nonparalleling of sources when in the automatic return mode. The source-transfer control also features field adjustable loss-of-source and return-of-source voltage levels, as well as adjustable time delays for coordination.

S&C Mini-Rupter® Switches are three-pole group-operated interrupter switches specifically designed to handle all live-switching duties on incoming source circuits, including full-load and associated transformer-magnetizing and cable-charging currents, with no external arc or flame. They afford maximum operating flexibility because of their exceptional two-time duty-cycle fault-closing ratings—22,400 amperes rms asymmetrical at 14.4 kv, 20,000 amperes rms asymmetrical at 25 kv. These fault-closing ratings represent the available fault currents into which the switches can be closed twice, remaining operable and able to carry and interrupt rated currents. This exceptional ability permits quick restoration of service following a fault—without the need for an extended outage for replacement of switch parts or for temporary restoration of service through an alternate switch until replacement parts can be obtained.

These outstanding duty-cycle fault-closing ratings make S&C Mini-Rupters superior to ordinary switches with simple "fault-closing" or "make-and-latch" ratings which, following an initial fault-closing operation, offer no assurance of an ability to subsequently carry or interrupt rated current—much less any expectation of tolerating a second fault closing. The ability to open following a fault-closing operation is of especial importance where automatic control is utilized for primary-selective service.



GENERAL — Continued

Stored-energy switch operators provide high-speed power operation of the Mini-Rupter Switches. The operators incorporate a quick-make quick-break mechanism that is motor-charged, and opens and closes the Mini-Rupter swiftly and positively when solenoid tripped in response to signals initiated by the source-transfer control, or when manually tripped using either pushbuttons or the dual-purpose manual handle. This high-speed operation contributes to Mini-Rupter's duty-cycle fault-closing ratings and reduces the period of time the load is without power—transfer is achieved in 10 cycles plus any intentional time delay for coordination.

Load feeders are switched and protected using S&C Power Fuses with Uni-Rupter™ (accommodating a choice of S&C Type SML-20 or SML-4Z Power Fuses, Fault Fiter® Electronic Power Fuses, or a variety of single-barrel current-limiting fuses). With S&C's time-tested SML Power Fuses, you can select from a wide variety of ampere ratings and time-current characteristics (TCCs) to achieve close fusing for maximum protection and optimum coordination. These TCCs are precise, with only 10% total tolerance in melting current, compared to the 20% tolerance of many fuses (20% and 40% respectively, in terms of time). And the design and construction features of the fusible elements assure that SML Power Fuses will conform to their TCCs not only initially, but on a sustained basis . . . neither age, corrosion, vibration, nor surges that heat the element nearly to the severing point will affect the characteristics of S&C SML Power Fuses.

S&C Fault Fiter Electronic Power Fuses combine an innovative high-technology electronic control module with a unique interrupting module to solve difficult protection and coordination applications. The control module incorporates a current transformer and

electronic circuitry to provide current sensing and the TCC of the fuse, as well as the energy to initiate the interrupting process. By using electronics, Fault Fiter offers an unprecedented variety of unique TCCs that provide superior protection and precise coordination in a wide range of applications. Moreover, since the fusible elements do not determine the TCC of the fuse, Fault Fiter is not susceptible to the protection vagaries of other types of fuses where the elements are subjected to load cycling or repeated current surges that can alter the TCC.

S&C's Uni-Rupter lets you perform single-pole live switching of fuses on transformers, lines, and cables, with no external arc or flame. Uni-Rupter can carry and interrupt load currents up to and including the emergency peak-load capability of the fuse. Furthermore, S&C Power Fuses with Uni-Rupter have a one-time duty-cycle fault-closing capability equal to the short-circuit rating of the pad-mounted gear and a two-time capability of 13,000 amperes rms asymmetrical. The duty-cycle fault-closing capability is the level of available fault current into which the fuse can be closed the specified number of times with the Uni-Rupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

Specify S&C Source-Transfer PMH Pad-Mounted Gear for all your small- to medium-sized critical loads requiring primary-selective service. It is the simple and economical solution to automatic source-transfer application problems on your power distribution system. The gear is a totally self-contained switching and protection package . . . it has the features you need to achieve a high degree of service reliability and operating flexibility and provides the ultimate in installation and operation simplicity.



The S&C Source-Transfer Pad-Mounted Gear pictured below (at left) and diagrammed at right provides high-speed automatic source transfer plus switching and protection for two 2500 kva, three-phase 12.47 kv/480 v transformers serving a medium-sized industrial plant.

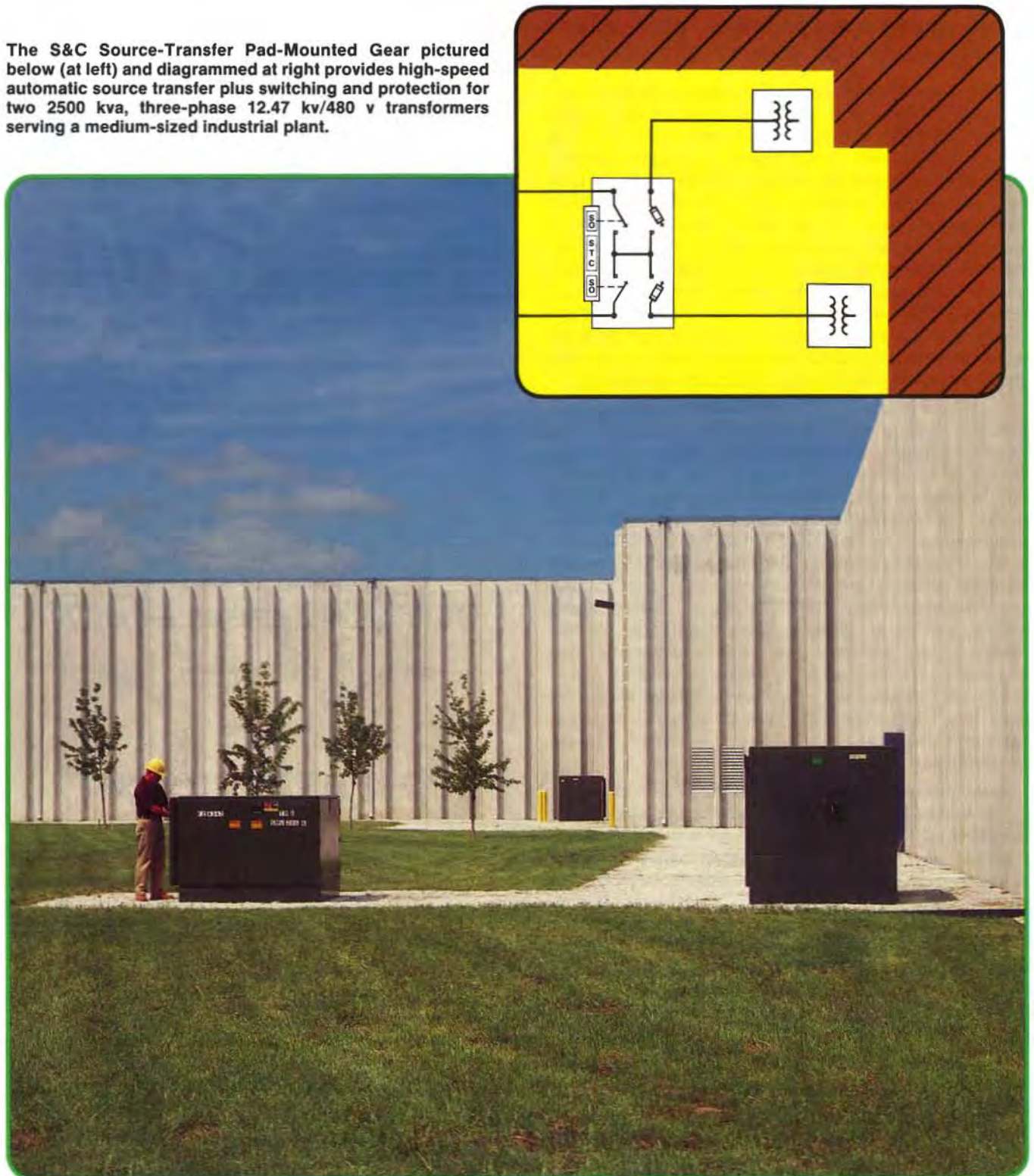


Figure 2. S&C Source-Transfer Pad-Mounted Gear provides fully automatic source transfer for a recently constructed industrial plant.



APPLICATION

S&C's fully automatic Source-Transfer PMH Pad-Mounted Gear brings high-speed source transfer to your small- to medium-sized critical loads requiring a high degree of service continuity.

Certain loads such as hospitals, stadiums, auditoriums, pumping stations, and shopping malls require a high degree of service continuity. This can be achieved by duplicating facilities such as power sources, switchgear, or transformers. System reliability studies indicate that the power sources constitute the major cause of service interruptions due to extensive exposure to such phenomena as lightning, wind, and ice, and also to dig-ins and equipment failure. Accordingly, users with critical loads typically first provide primary-selective service to ensure continuity of the medium-voltage supply before considering other systems that attempt to minimize interruptions due to problems with load transformers or transformer-secondary equipment.

Primary-selective service can be provided from two radial feeders or from double-circuit looped-primary feeders. Primary-selective service from two radial feeders is an inexpensive, simple, and direct scheme that is used to serve relatively small, isolated critical loads. Use of radial circuits facilitates quick location and isolation of a faulted feeder. Figure 3 illustrates source-transfer pad-mounted gear applied to provide primary-selective service from two radial feeders. The unit diagrammed is a PMH-9 Model. A source-transfer control and interrupter switches driven by stored-energy switch operators provide fully automatic two-way source transfer with the ability to connect either of the two radial feeders to the pad-mounted gear's main bus. Each load-feeder circuit supplies medium-voltage power to and protects a single remote transformer.

Under normal operating conditions, one switch (for the preferred source) is closed; the other switch (for the alternate source) is open with its associated circuit available as a standby. The source-transfer control monitors the condition of both power sources and initiates automatic switching when the preferred-source voltage has been lost, or reduced to a predetermined level, for a period of time sufficient to confirm that the loss is not transient. The switch associated with the preferred source is automatically opened and the alternate-source switch is then automatically closed, restoring power to the load.

Two-way source transfer provides for automatic retransfer to the preferred source when normal voltage returns for a preset time (*automatic return mode*) . . . or for selection of manual retransfer to the preferred source at a convenient time (*hold return mode*). In

the *hold return* mode, if the alternate source fails and the preferred source has been restored, the switchgear will automatically retransfer to the preferred source. If desired, the source-transfer control can be permanently set at the factory for *hold return* mode.

In the *automatic return* mode, you can select either *open transition* or *closed transition* for automatic retransfer to the preferred source. In *open transition*—which prevents paralleling the power sources—the alternate-source switch opens prior to closing of the preferred-source switch . . . there is only a momentary interruption of service to the load. With *closed transition* retransfer—selected when it is permissible to parallel the two sources—there is no interruption of service to the load as the alternate-source switch opens only after the preferred-source switch has closed.

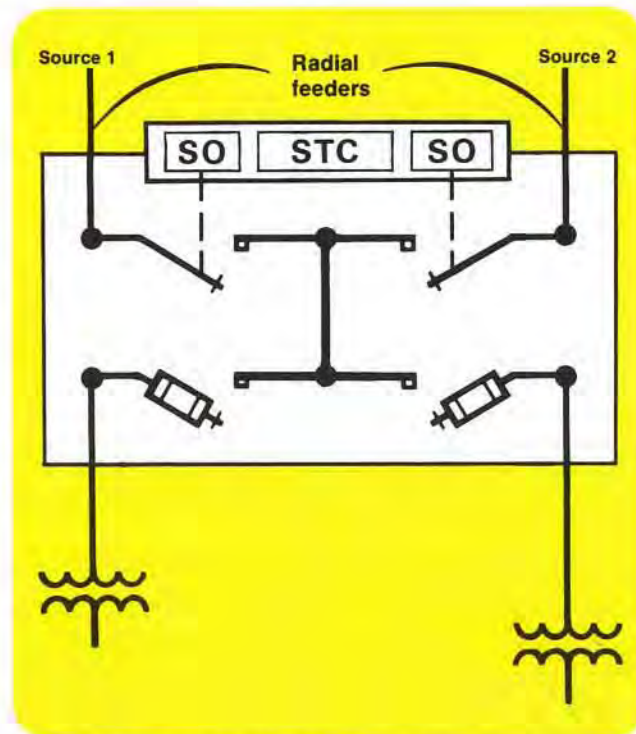


Figure 3. Source-transfer pad-mounted gear applied to provide automatic primary-selective service for critical loads served from two radial feeders. Either of the two sources may be designated as the preferred source, the other source then serves as the alternate source.

If desired, the source-transfer control can be permanently set at the factory for *open-transition* automatic retransfer. And for applications where automatic and manual paralleling of sources is to be denied completely, an optional antiparalleling device is available.

A more complex scheme used to provide primary-selective service for an extensive system of critical loads is illustrated in Figure 4. This scheme is used when providing service to several small- to medium-sized installations in the same locality or to one large installation with widely dispersed loads. Under normal operating conditions, each source serves as the

preferred source for at least one unit of source-transfer gear and as the alternate source for the other(s). Since all source-transfer controls permit field selection of either source as preferred, you have the flexibility to develop a more evenly loaded system and to reduce the likelihood of causing an intolerable system disturbance when a source transfer occurs.

To further complement service continuity and operating flexibility, both ends of the circuits depicted in Figure 4 could be connected through sectionalizing switches to the source circuits. This creates a double-circuit looped-primary system.

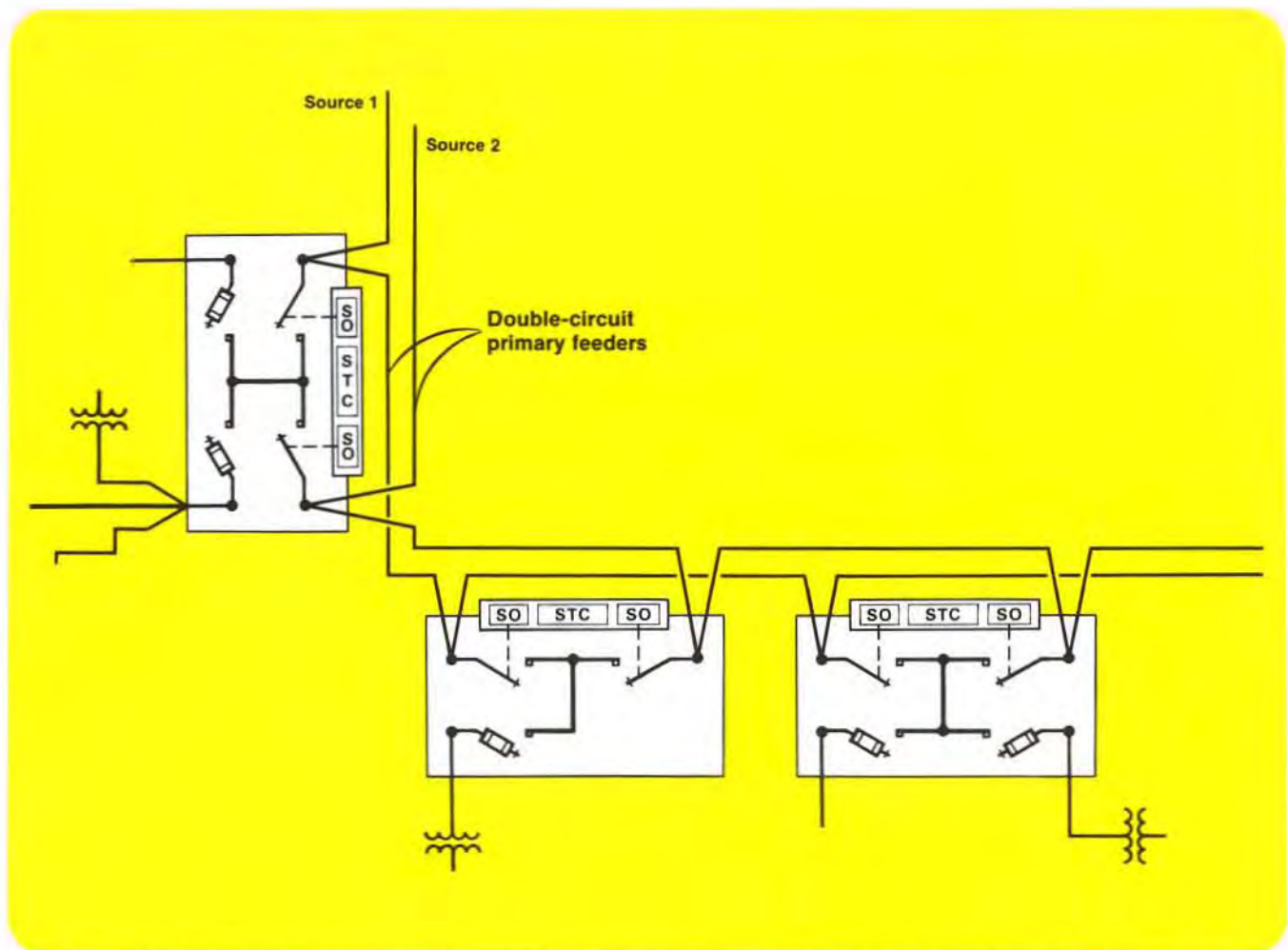


Figure 4. Widely dispersed loads requiring a high degree of service continuity can be served from double-circuit primary feeders, as shown above, with source-transfer pad-mounted gear providing automatic switching of source circuits for primary-selective service. The load-feeder circuits in each unit of source-transfer gear provide switching and protection for cable-connected loads, one of which consists of three single-phase loads.



APPLICATION — Continued

An extensive power distribution system will frequently include critical loads requiring automatic primary-selective service interspersed with loads that can tolerate the delay associated with manual switching to restore power in the event of an interruption. Such systems may be implemented with combinations of source-transfer and manual pad-mounted gear.

The system of double-circuit looped-primary feeders shown in Figure 5 serves dispersed installations requiring different degrees of power availability. Three installations on this system have been deemed critical loads requiring a high degree of service continuity. For these installations, source-transfer pad-mounted gear is applied to provide primary-selective service from the double-circuit looped-primary feeders. Four manual units of pad-mounted gear—two on each looped-primary feeder—are used to serve installations that do

not require primary-selective service, and to sectionalize the loop. Two other manual units, each containing only an interrupter switch, are utilized to switch the ends of the looped-primary feeders.

Under normal conditions, one switch in the manual unit of pad-mounted gear located near the center of each loop is open as shown in the diagram and loads served by source-transfer units receive power from their preferred source. Should power to either loop be lost, the control in each source-transfer unit on the affected circuit will initiate an automatic transfer operation to restore power to the associated critical loads. The loads served by the manual units on the affected circuit will be without power until either the source voltage is restored or, in the case of a fault in the loop, manual switching operations are performed to isolate the faulted section and restore service.



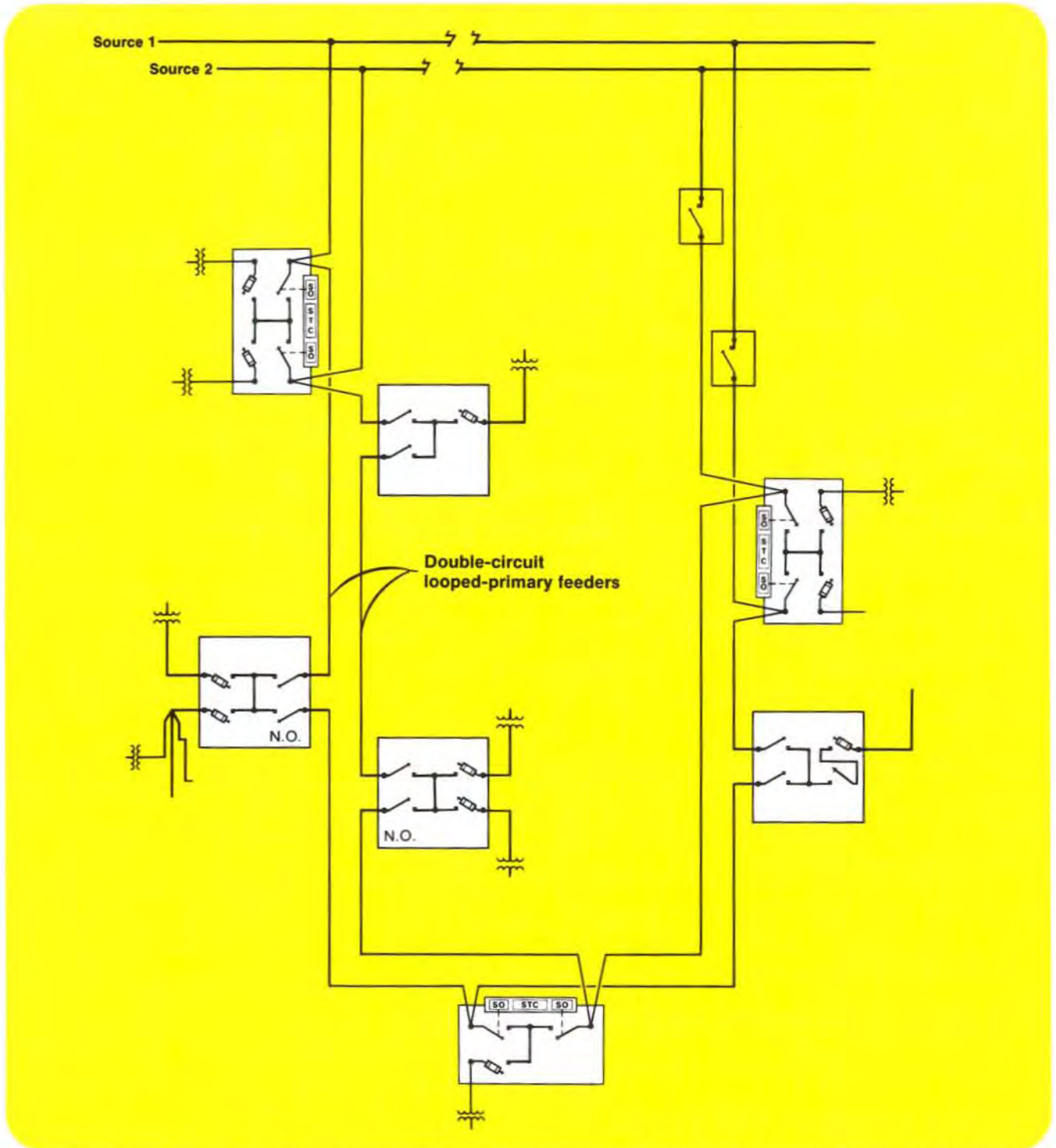


Figure 5. On medium-voltage distribution systems, pad-mounted gear is used to serve widely dispersed loads requiring different degrees of service continuity. Source-transfer gear served from double-circuit looped-primary feeders provides primary-selective service to critical loads. Manual gear serves to sectionalize each loop and to provide service to installations that do not require primary-selective service.



APPLICATION — Continued

Source-transfer pad-mounted gear may also find application on in-plant industrial, commercial, and institutional installations in combination with metal-enclosed switchgear. A system used to serve an industrial complex having a geographically isolated critical load is illustrated in Figure 6. In the system

depicted, two source circuits provide medium-voltage power to a nine-bay lineup of power-operated metal-enclosed switchgear consisting of two entrance bays, a tie-switch bay, and six feeder bays. The switchgear is configured in a split-bus arrangement to provide primary-selective service to the loads served by each

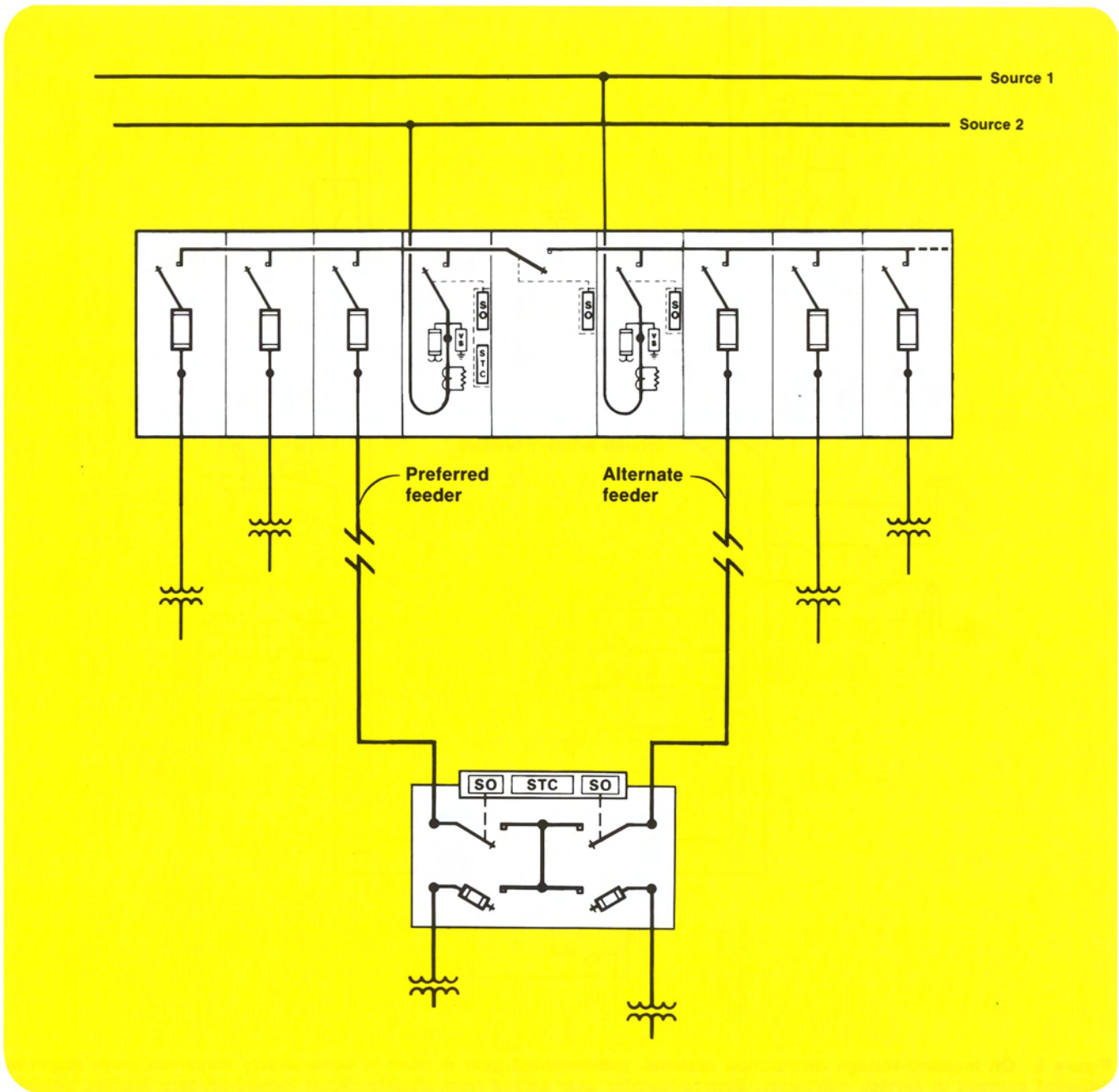


Figure 6. Source-transfer pad-mounted gear is used in conjunction with metal-enclosed switchgear to serve geographically isolated critical loads.

feeder bay. Four of the feeder bays provide switching and protection for cable-connected transformers. The remaining two feeders serve as the preferred and alternate sources for a unit of source-transfer pad-mounted gear, which provides primary-selective service for a remote critical facility on the complex.

For faults on the source circuits, the source-transfer control in the switchgear lineup is programmed so that transfer occurs before automatic switching is initiated in the source-transfer pad-mounted gear. And for faults on the preferred feeder cable, the pad-mounted gear will transfer to the alternate cable. The use of metal-enclosed switchgear provides the ability to switch to a second utility incoming source in the event one is lost. Placing the source-transfer pad-mounted gear close to the critical load allows recovery in the event of a cable fault. This capability is particularly useful in the case of long cable runs.

The source-transfer controls of the metal-enclosed switchgear and source-transfer pad-mounted gear can be permanently set at the factory for *open transition* to prevent the possibility of an automatic retransfer that would parallel the two utility sources. In addition, the pad-mounted gear can be equipped with a mechanical antiparalleling device to prevent manual and automatic operations that would result in both switches being closed. Use of such a device would eliminate the possibility of backfeeding a bus section in the metal-enclosed switchgear through the pad-mounted unit and inadvertently paralleling the utility sources.

Other Considerations for Primary-Selective Systems

In developing power distribution systems that provide automatic primary-selective service, consideration should be given to the addition of other features that provide protection against certain special conditions that may occur on the system. For three-phase loads, in particular, consideration should be given to providing a scheme that initiates a source transfer in the event an open-phase condition occurs on one or two phases of a source circuit energized at the same voltage as the pad-mounted gear. It would also be desirable to include a lockout scheme to prevent automatic switching operations that would transfer an overcur-

rent condition to an otherwise unfaulted source circuit. To protect against these special conditions, source-transfer pad-mounted gear should be equipped with an unbalance detection scheme and overcurrent-lockout feature. These circuits can be incorporated in the source-transfer control.

Optional Unbalance Detection. This feature initiates automatic transfer in the event one or two phases of a source are opened as a result of single-pole switching, broken conductors, blown fuses, or equipment malfunctions. Such a feature is applied where it is desirable to protect three-phase loads from all source-side open-phase conditions. The unique scheme used in S&C's source-transfer control continuously develops and monitors the negative-sequence voltage of each source to detect the three-phase voltage unbalance that occurs as a result of an open-phase condition. This protection scheme, unlike methods that depend upon current sensing, is not affected by unbalanced load currents or circuit load levels. And unlike simple methods employing voltage-magnitude sensing, this scheme is not defeated when voltage backfeed results in normal-magnitude voltage appearing on the opened phases, such as can occur on a delta-connected transformer when fuses on two phases operate.

Optional Overcurrent Lockout (with remote reset if specified) may be included in the source-transfer control to prevent a transfer operation that would close a source switch into a fault, thereby avoiding introduction of a disturbance on the utility's distribution system.

To implement this scheme, three-phase current sensing is employed to detect overcurrents that involve one or more phases. For faults producing overcurrents that are cleared by source-side protective devices, the resulting prolonged loss of voltage will cause the associated source interrupter switch to open. At the same time, a lockout mode is set up in the source-transfer control, so that the alternate-source switch operator will not automatically close its switch into the fault. For faults producing overcurrents that are cleared by feeder fuses, there is no prolonged loss of voltage and, hence, the control does not initiate any switching operations.



COMPONENTS

Enhance service continuity and improve operating flexibility for your critical loads with these built-in features . . .

- 1 **Insulated roof**—"no-drip" compound on underside of roof guards against formation of condensation that could drip onto energized parts.
- 2 **Glass-reinforced polyester barriers** do not absorb moisture, will not warp. And they're track-resistant and flame-retardant.
- 3 **Segregated circuits**—full-length steel barriers separate side-by-side compartments. Fiberglass-reinforced polyester barriers isolate the tie-bus, separating front compartments from rear compartments, and serve as interphase and end barriers (where required to achieve BIL ratings) for switches and fuses.
- 4 **Cypoxy®**, S&C's cycloaliphatic epoxy resin system, insulates all live parts from ground.
- 5 **Compartment- and phase-identification labels.**
- 6 **Aluminum bus connections** (inside enclosure) are bolted at a uniform torque of 50 ft.-lbs; two spring washers per bolt maintain optimum contact pressure.
- 7 **Switch interphase and end barriers** (where required for BIL ratings) are easily removed to facilitate cable termination.
- 8 **Door holders** store above door openings, in full view with doors open, behind doors when closed.
- 9 **Aluminum hinges and stainless-steel pins.**
- 10 **Circuit diagram** provides instant view of circuit configuration. Label also gives complete switch and fuse ratings.
- 11 **Ground pads** (inside enclosure) accommodate connectors for attachment of ground leads and optional ground studs.
- 12 **Mini-Rupter Switch.**
- 13 **Terminals** can accommodate a variety of cable-terminating devices for cable sizes through 1000 kc mil on switch terminals, 4/0 maximum on two-position fuse terminals.
- 14 **S&C Power Fuses with Uni-Rupter**—SML Power Fuses or Fault Fiter Electronic Power Fuses (shown).
- 15 **Grappler**—the S&C fuse handling fitting provides effortless balance, a sure grip, and positive control . . . it takes the work out of fuse handling so that opening, closing, installing, and replacing fuses is easy.
- 16 **Storage racks** accommodate up to six SM-4® Refill Units or three SMU-20® Fuse Units per rack . . . you can easily restore service without delay.

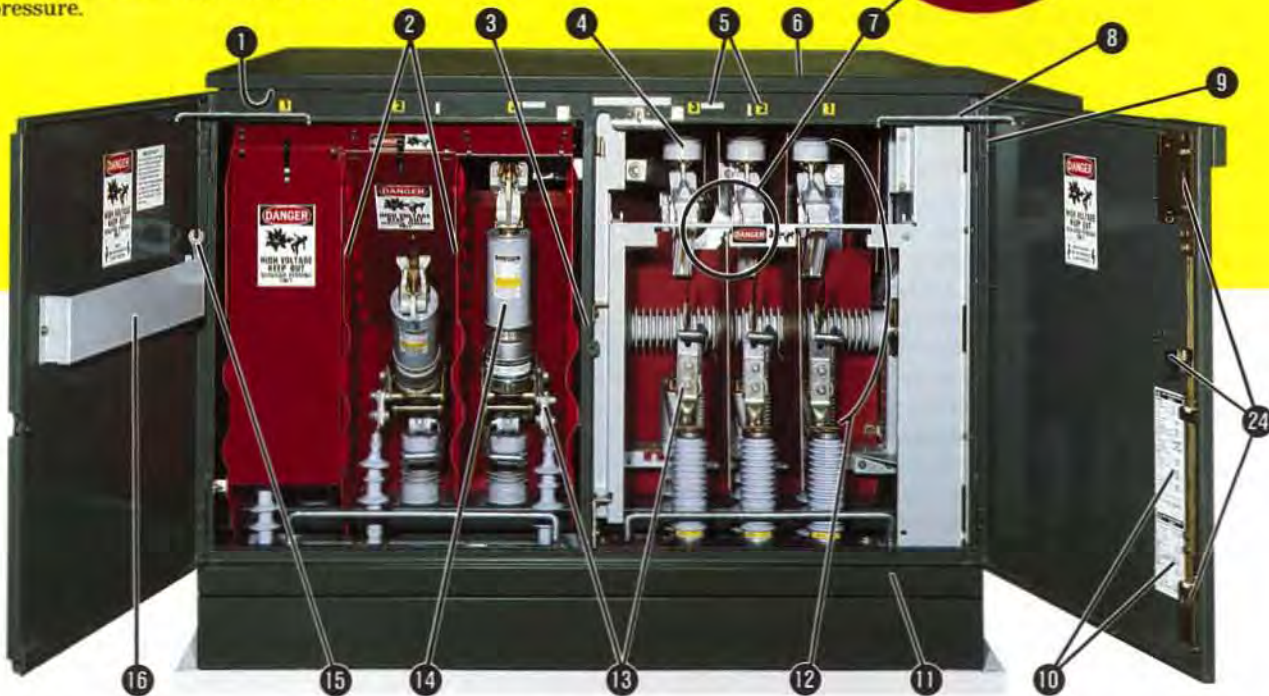


Figure 7. High-voltage compartments in source-transfer pad-mounted gear with switch compartment at right, fuse compartment at left.

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- 17 **S&C's Ultradur™ Finishing System** protects the steel with a thorough cleaning, phosphatizing and sealing, dense epoxy powder coating, and high solids acrylic topcoating for ultraviolet protection. This tough, uniform, multistage, baked-on finish provides exceptional performance proved by a vigorous battery of industry tests.
- 18 **Wide bulkhead-type doors** provide easy access to low-voltage control compartment.
- 19 **Door flanges**—deep double-thickness 90-degree flanges on the extra-rugged control-compartment doors overlap with 90-degree flanges around door openings, adding rigidity and assuring compression of gasketing.
- 20 **Vents** promote ventilation and prevent condensation. Baffles and filters inside the vents thwart probing, foil tampering, and keep out contaminants.
- 21 **Lastingly resilient compression gasketing** completely seals each control-compartment door opening . . . keeps water out.
- 22 **Instruction manual holder.**
- 23 **Enclosure base** is formed from continuous deep 90-degree flanges. Resilient closed-cell gasket protects the finish on the flange from being scratched during installation and isolates it from the alkalinity of a concrete foundation.
- 24 **Penta-Latch® Mechanism** provides vandal-resistant three-point door latching for S&C Pad-Mounted Gear. The Penta-Latch Mechanism latches automatically when the door is closed and can be unlatched only with a pentahead socket wrench or tool. The latching mechanism is fully coordinated with the provisions for padlocking—a padlock can be installed only after the door is closed and completely latched, and the mechanism can be unlatched only after the padlock has been removed. A stainless-steel protective hood shields the padlock shackle to discourage tampering.



Figure 8. Low-voltage control compartment in source-transfer pad-mounted gear is conveniently located, gives full access to controls without exposure to high voltage.



COMPONENTS — Continued**S&C's Micro-AT Source-Transfer Control has all the features you need for reliable, programmed automatic transfer on your primary-selective system . . . plus options to bring you the ultimate in control circuitry.**

The Micro-AT Source-Transfer Control is utilized in S&C Source-Transfer Pad-Mounted Gear in conjunction with Mini-Rupter Switches driven by stored-energy operators, to provide for automatic source transfer of common-bus primary-selective systems. This control continuously monitors the condition of both power sources and initiates automatic switching when preferred-source voltage has been lost (or reduced to a predetermined level) for a period of time sufficient to confirm that the loss is not transient. The switch associated with the preferred source is automatically opened and the alternate-source switch is then automatically closed, restoring power to all loads.

The Micro-AT control uses an advanced electronic microprocessor to perform specific control operations, as directed by settings programmed into the device at the factory and in the field. These settings, which consist of the source-transfer control's operating characteristics and voltage-, current-, and time-related operating parameters, are entered into the control by means of a keypad on the front panel of the control.

To simplify entry and review of the settings on the liquid-crystal display (LCD), the operating characteristics have been grouped together as a series of items in the "CONFIGURE" menu. Similarly, the voltage-, current-, and time-related operating parameters have been

grouped together as a series of items in the "VOLTAGE," "CURRENT," and "TIME" menus, respectively. A particular item can be accessed for display by first pressing the appropriate menu key and then scrolling through the items, using the "NEXT" or "LAST" item key. To prevent unauthorized changes to the operating characteristics and operating parameters, each item is protected by an access code; the correct access code must be entered before the item can be altered.

Field adjustable operating characteristics include selection of preferred source, automatic or hold return mode, and open-transition (nonparalleling) or closed-transition (paralleling) automatic retransfer. If desired, the source-transfer control can be permanently set at the factory for hold return and/or open-transition automatic retransfer. Operating parameters that are field adjustable include loss-of-source and return-of-source voltage levels, in addition to the voltage level for the optional unbalance detection feature. The current level for the optional overcurrent-lockout feature is also field adjustable as are the time delays for loss-of-source and return-of-source voltages and for lockout reset, which is furnished with optional overcurrent lockout. Additional optional features include provisions for remote indication and supervisory control.

Proven solid-state electronic circuitry and outstanding design features assure the superior performance of the S&C Micro-AT Source-Transfer Control.

S&C solid-state electronic devices offer the superior reliability and serviceability required for the rigors of operation in power equipment. Metal-oxide surge protectors at critical points in the control circuits provide the optimum in surge protection—S&C's unique surge control has been field proven through years of successful application in hostile utility-substation environments. And 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 C37.91.1); 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 tests are performed to identify and eliminate any components that might

be prone to early failure. They include a dielectric test; 72-hour screening test consisting of 24 hours at maximum-design operating temperatures followed by 48 hours of temperature cycling; and functional tests (both before and after the screening test).

Printed-circuit-board construction assures high reliability. All components are applied at well below MIL-STD design guidelines, minimizing component stress, power-supply requirements, and internal heating. Voltage-level settings are maintained within $\pm 3\%$ accuracy over an ambient temperature range of -40°F to $+160^{\circ}\text{F}$. Interconnecting-cable connector pins and receptacle contacts are gold-over-nickel plated. And all output relay contacts are of silver-cadmium oxide to ensure long service life. Output circuits are relay isolated.

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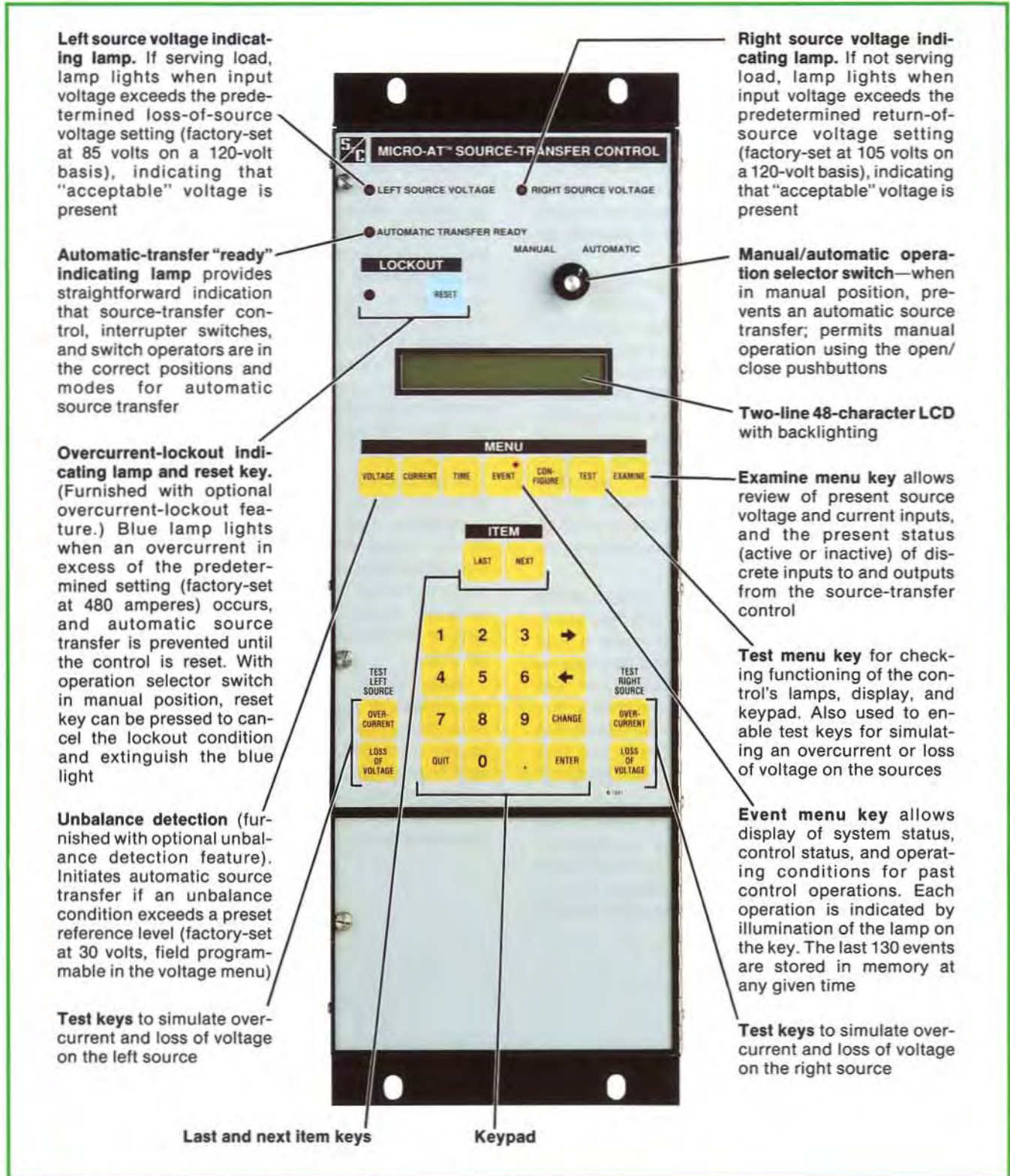


Figure 9. Closeup of front panel of Micro-AT Source-Transfer Control.



COMPONENTS — Continued

All controls for stored-energy operators and source-transfer control are readily accessible, easily identified, and conveniently located within a grounded, steel-enclosed low-voltage compartment . . . it's isolated from medium voltage and shielded from the elements.

High-speed stored-energy switch operators provide automatic trip-open and trip-closed operation of the S&C Mini-Rupters in response to signals from the Micro-AT Source-Transfer Control. Their quick-make quick-break mechanisms are automatically recharged after each trip operation when voltage is present on the associated source.

S&C's stored-energy operators are employed in S&C Source-Transfer Pad-Mounted Gear to provide high-speed power operation of two Mini-Rupter Switches. In conjunction with the interrupter switches, the stored-energy operators provide high-speed automatic source transfer and circuit interruption for critical loads. These operators incorporate a quick-make quick-break, stored-energy mechanism which opens and closes the Mini-Rupter swiftly and positively. Source transfer is accomplished in 10 cycles plus any time delay for coordination. The quick-make quick-break mechanism is solenoid tripped in response to a control signal, or manually tripped using open/close pushbuttons or the emergency-trip provisions.

The stored-energy operators provide both automatic trip-open and automatic trip-closed switch operation. Motor charging of the operator's quick-make quick-break mechanism is automatic after each opening or closing operation when voltage is present on the associated source. The stored-energy operators are integrally mounted within the grounded, steel-enclosed low-voltage compartment which is located in one side of the pad-mounted gear—isolated from medium voltage.

All internal parts of the stored-energy operators are galvanized, zinc-nickel plated, or of nonferrous materials to protect against corrosion. Gold-surfaced auxiliary switch contacts are provided on the stored-energy operators for external control circuits serving solid-state devices.

Decoupling mechanisms are provided to permit convenient decoupling of the switches from the switch operators for functional testing of source-transfer schemes and elective exercising of stored-energy switch operators, without disturbing medium-voltage power circuits. Decoupling is readily accomplished by releasing the coupled-position latch and moving the decoupler handle upward to the decoupled position. When the operator is decoupled, its associated Mini-Rupter Switch is locked open or closed, depending upon switch position at the time of decoupling. The decoupler indicator located on the decoupler handle shows whether the operator is coupled to the interrupter switch or decoupled. While an operator is decoupled, the "ready" lamp on the Micro-AT control will not light—serving as another reminder of the decoupled condition.

A number of optional features are offered that further enhance operating flexibility. The optional *anti-paralleling device* is available to preclude paralleling of the incoming sources. This device prevents the manual or automatic closing of one interrupter switch when the other interrupter switch is closed. *Auxiliary switches*, to follow the position of the interrupter switch and/or the stored-energy operator, are also offered as options.

Other available options include *key interlocks* to guard against opening fuse-compartment doors unless both interrupter switches are locked open, and *mechanical cable interlocks* to prevent operation of a source interrupter switch when the associated switch-compartment door is open. These interlocks are required for users who must comply with the National Electrical Code.



Remote-control receptacle (optional) for attachment of optional remote-control station to permit open-close operations from an adjacent area—manual/automatic operation selector switch on Micro-AT Source-Transfer Control must be in manual position

Open/close pushbuttons permit local electrical operation when manual/automatic operation selector switch is in manual position

Three-position operation selector: *Operating position* permits manual or electrical opening and closing of switch or, when switch is decoupled, exercising and testing of stored-energy operator without opening or closing interrupter switch; *lock position* prevents all electrical and mechanical operation when padlocked; *charging position* permits manual charging of operator mechanism while prohibiting electrical and mechanical tripping

Operation counter registers number of operations of stored-energy operator

Emergency trip: Keyed end of dual-purpose manual handle can be inserted into port to initiate local manual open-close operation *when control power is not available* for local electrical operation

Operator targets show whether quick-make quick-break mechanism is charged or discharged, and whether operator is in switch-open or switch-closed position

Charging shaft for insertion of notched end of dual-purpose manual handle for charging quick-make quick-break mechanism *in the event control power is not available*

Switch-position target indicates whether Mini-Rupter Switch is open or closed

Decoupler handle permits convenient decoupling of switch from switch operator for functional testing of source-transfer schemes and exercising of switch operators without disturbing medium-voltage power circuits

Decoupler indicator shows whether switch operator is coupled to the Mini-Rupter Switch or decoupled

Dual-purpose manual handle—upper notched end of dual-purpose handle is used for charging and lower keyed end of handle is used for tripping the quick-make quick-break mechanism *when control power is not available*

Figure 10. Low-voltage control compartment showing features of the high-speed stored-energy switch operators.



Figure 11. Decoupler handle moves upward to decouple . . . downward to couple.



COMPONENTS — Continued

S&C's field proven Mini-Rupter Switches are power operated . . . handle all your three-pole switching requirements up through 600 amperes at 14.4 kv, 400 amperes at 25 kv, with two-time duty-cycle fault-closing ratings of 22,400 amperes rms asymmetrical at 14.4 kv, 20,000 amperes rms asymmetrical at 25 kv.

Multifinger, convex, silver-plated copper contacts provide equalized, four-point pressure on the blade's silver-clad contact surfaces

Cypoxy Insulators provide generous leakage distance and are self-scouring and nontracking

Arc compressor provides controlled circuit interruption without external arc or flame, and without the need for separate auxiliary blades. A unique lip-seal wipes blade as blade exits arc compressor—keeps arc under compression, directs arc gases through deionizing suppressor vent

Multipurpose, one-piece, formed hard-drawn copper blade features silver-clad contact surfaces on both sides—it's utilized for circuit closing, continuous current carrying, and circuit interrupting. The blade's simple, reliable, high-speed action is unlike the uncertain action of auxiliary interrupting-blade-and-contact mechanisms which are dependent upon retention of correct sequencing with the main blade and contact, and upon spring assistance to snap the interrupting blade open

Cypoxy operating shaft positions blades in "fixtured" alignment. S&C's Cypoxy resin system is employed as the assembly medium to produce a unified insulated shaft with blade supports and journals permanently molded in place

Strain-guard terminals. Terminal pads and support brackets on voltage sensors are uniquely designed to protect Mini-Rupter against damage from excessive cable or foundation movement. This design permits terminal pad to deflect when such movement occurs but prevents transmission of forces to the stationary blade-support contact . . . assures ideal contact position and pressure

S&C Voltage Sensors—each consisting of a high-voltage capacitor and series transformer—produce an output voltage directly proportional to line-to-ground voltage, with relay accuracy over an ambient temperature range of -40° F to +160° F; provide three-phase sensing and control power for the automatic source-transfer scheme; supply power to charge and trip the stored-energy operators; and replace apparatus support insulators. Their construction assures high cantilever strength, and BIL and dielectric characteristics equivalent to that of the apparatus insulators replaced. These sensors require no primary fusing. Secondary conductors of the voltage sensors are shielded from medium voltage by switch-frame channels

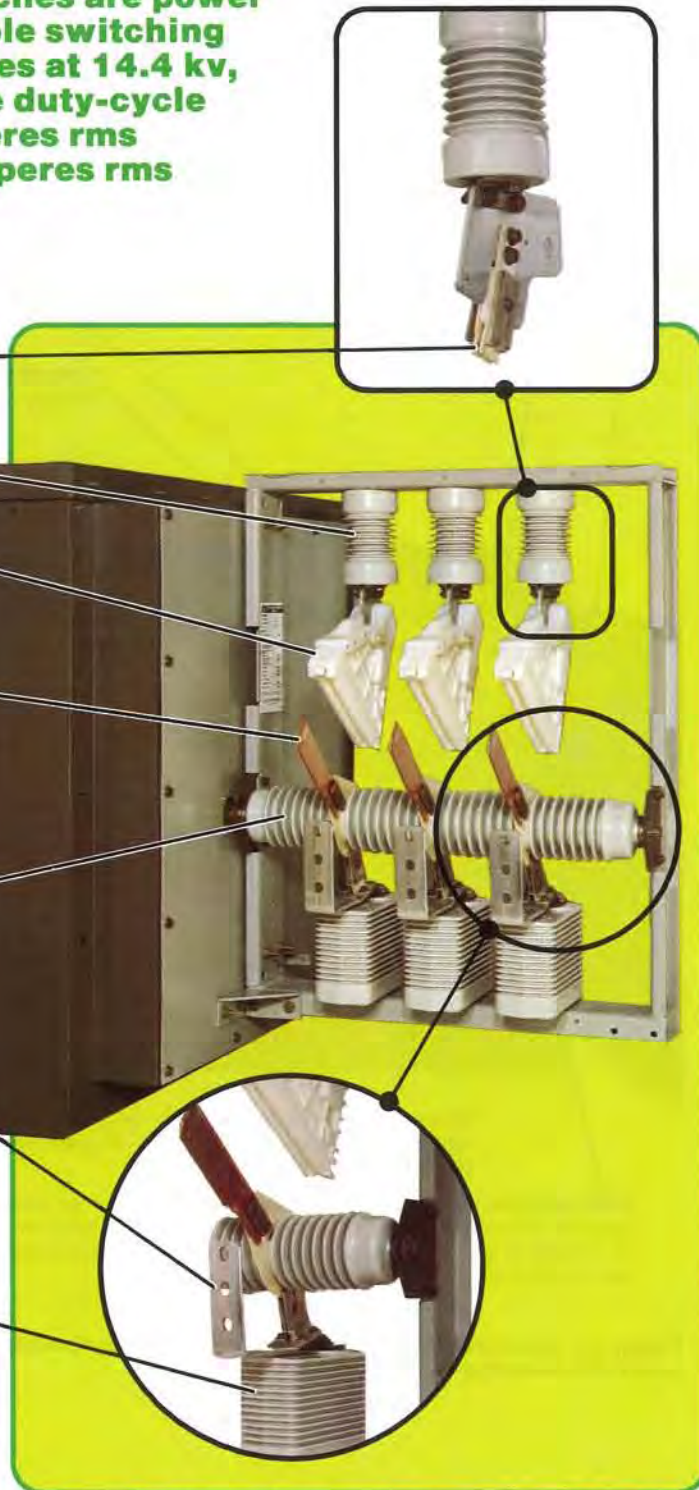


Figure 12. Mini-Rupter Switches are positioned back-to-back and mounted in tandem with the low-voltage compartment, permitting direct-drive power operation by stored-energy operators. One of the 14.4-kv, 600-amp Mini-Rupters is shown with barriers removed for clarity.

You have a choice of three S&C Power Fuses with Uni-Rupter . . . Type SML-20 or SML-4Z Power Fuses, or Fault Fiter Electronic Power Fuses . . . all have blown-fuse indication.

S&C's Uni-Rupter† permits single-pole live switching of fuses . . . a firm, vigorous opening pull on the fuse with a hookstick is all that's required to achieve circuit interruption. Uni-Rupter self-resets for the next opening operation and has separate current-carrying and fault-closing contacts

Labyrinthine silencer—a breakthrough in power-fuse exhaust control that virtually eliminates venting. Fuse operation is silent

SML-20 Power Fuse (pictured above) features S&C's SMU-20 Fuse Unit, designed for universal use on both your underground and overhead distribution systems. SML-20 Power Fuses are rated 200E or 200K amp max continuous; 22,400 amp rms asymmetrical (14,000 amp rms symmetrical) interrupting at 14.4 kv; 20,000 amp rms asymmetrical (12,500 amp rms symmetrical) interrupting at 25 kv

SML-4Z Power Fuse (pictured above) uses S&C's SM-4 Refill Unit and is rated 200E amp max continuous; 20,000 amp rms asymmetrical (12,500 amp rms symmetrical) interrupting at both 14.4 kv and 25 kv

Fault Fiter Electronic Power Fuse (pictured above) is rated 400 amp max continuous and 22,400 amp rms asymmetrical (14,000 amp rms symmetrical) interrupting at 14.4 kv; 200 amp max continuous and 20,000 amp rms asymmetrical (12,500 amp rms symmetrical) interrupting at 25 kv. Fuse uses replaceable interrupting module and reusable control module

Blown-fuse target is lustrous-red color . . . projects from top of SML-20 Power Fuse upper end fitting when fuse unit has operated . . . automatically resets within end fitting when blown fuse unit is replaced . . . and fuse condition is easily checked with fuse in closed position

Blown-fuse target is brilliant blaze-orange color . . . appears at top of interrupting module after electronic power fuse operates . . . and factory-preset target is lucent by daylight or flashlight

Blown-fuse target is fluorescent fire-red color . . . moves to "BLOWN" indicator window in translucent holder when fuse operates, and fluoresces at night when illuminated with a flashlight, permitting positive visual check of fuse condition without removing fuse from mounting . . . and target is reset by simply replacing the expendable refill unit

† S&C Power Fuses with Uni-Rupter have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, with a two-time capability of 13,000 amperes rms asymmetrical. These values define the available fault current into which the fuse can be closed the specified number of times (once or twice), when operated vigorously through its full travel without hesitation, with the Uni-Rupter remaining operable and able to carry and interrupt rated current.

Figure 13. Protection of your distribution system may be achieved using one of these three fuses. Each fuse is equipped with Uni-Rupter, for single-pole live switching of single-phase or three-phase load circuits.



OPTIONS

Choose from a wide variety of optional features—in addition to those already described—that will further enhance the level of flexibility and operating convenience you can achieve on your power distribution system . . . here are just a few of the available choices.

Dual-purpose front barriers for fuses and switches. Fuse barriers in their normal position (left-hand phase) guard against inadvertent contact with live parts. They can be lifted out and inserted into the open gaps when fuses are in the disconnect position (center phase). For switches, a single-piece three-phase barrier (not shown) is furnished plus a window panel to permit visual check of switch position without removing barrier

Surge Arresters are available in 9-kv through 18-kv ratings for application at source-side switch terminals. Arresters are grounded through a low-impedance bus



Cable guides (require use of a cable pit or base spacer) assist in cable training

Base spacers are available, either steel-compartmented to match the pad-mounted gear enclosure or noncompartmented, to provide increased elevation of ungrounded parts above mounting pad



Switch-terminal adapters may be added to accommodate two conductors per phase. Inset shows one switch terminal with an adapter in place



Current sensors, included with optional overcurrent-lockout feature, mount on each source conductor—just below cable terminator—to provide sensing for conditions that indicate a source transfer should not be performed

Ground studs—available on switch and fuse terminals, as well as on the ground pad in each compartment—matched to the short-circuit rating of the gear, are conveniently located for easy access

Figure 14. S&C Source-Transfer Pad-Mounted Gear showing a few of the available optional features. An optional stainless-steel enclosure is also available for users requiring the ultimate in corrosion resistance.

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