

PST pad-mounted switchgear with iST control



General

Eaton provides both automatic load transfer and feeder fault and overcurrent protection in a single pad-mounted switchgear unit with its Cooper Power™ series PST (Pad-mounted Source Transfer) switchgear package, a self-contained load transfer device.

The PST switchgear represents the union of several time-proven products. The CI vacuum fault interrupter performs three-phase switching and three-phase fault interruption in the PST Model-6 switchgear. The iST control detects loss of source health and automatically transfers the load between the preferred and alternate sources as well as provides fault detection. The microprocessor controlled VFI interruption on the PST Model-9 switchgear allows for independent fault interruption for two separate loads.

Features

- Low profile, self-contained; self-powered deadfront design
- Vacuum interruption
- Three-phase switching and fault and overcurrent protection
- Automatic or manual operation
- SCADA operable
- Communication protocols, ethernet, fiber, etc.
- Programmable “No-blink” parallel restoration through sync check or non-parallel restoration
- Fault Block
- Fast Transfer—6 cycles or less
- Fully integrated controls
- Metering
- Event recording for post event diagnostics



Powering Business Worldwide

Automatic source transfer

All electrical distribution systems are subject to service interruptions and outages; however, there are many critical loads which cannot tolerate prolonged service interruptions. For such applications, a load-transfer scheme is used to minimize outage times. In a load transfer scheme, power is normally supplied from a preferred source and is automatically switched to an alternate source (utility or backup generation), if the preferred source health is degraded for any reason. Upon restoration of preferred source health the load can automatically be switched back, in either a parallel-return mode (preferred-source switch closes before alternate source switch opens) or a non-parallel return mode (alternate-source switch opens before preferred-source switch closes). The parallel-return transfer mode eliminates an outage when switching back to the preferred source; however, the sources must be in synch to avoid excessive current flows between the two sources.

Product description

The Pad-mounted Source Transfer (PST) package provides protection against loss of source health as well as overcurrent and fault protection for critical loads. It features deadfront source and tap cable compartments, and a sealed tank, which houses the switching and fault interrupting components.

Source compartment

The source compartment houses the preferred and alternate source cable connections, the controls, and handles for manual operation of the source switches.

Tank

The PST switchgear tank contains: six potential transformers, which provide input to the iST control system to monitor the source health; current transformers, which provide input to the iST control system, to sense overload and fault conditions; two three-phase, Type CI interrupters, which perform the three-phase switching and PST Model-6 fault interruption; and, insulating liquid, which serves as the dielectric medium.

Tap compartment

The tap compartment houses the tap cables and connections, as well as the manual operation handles for the two VFI fault interrupters on the PST Model-9 switchgear.

Optional configuration

The PST switchgear is designed in the industry-standard Model-6 configuration (Figure 12) however, occasionally two critical loads must be served, each independently, from the same source. To accommodate this need, the PST can be provided in a Model-9 configuration (see Figure 13). The Model-9 configuration is supplied with an iST-921 control and an iST-901 control. Each control operates a separate three-phase interrupting VFI with the iST-921 control providing the source transfer logic. This arrangement of two separate controls, operating VFI interrupters, provides independent overcurrent and fault protection for the critical loads serviced by each tap.

CI technology

Switching and fault interruption are both accomplished with Eaton's Cooper Power series motor-charged, Type CI interrupters. The CI interrupters feature our long-life, maintenance free, vacuum interrupters, which assure many years of trouble free performance.

When energized, a motor winds the CI interrupter mechanism to charge the closing and opening springs; this provides quick-close and quick-open operation of the vacuum interrupters. Each CI interrupter can also be operated manually, should control power be lost. A hotstick-operable lever can be operated to manually close or trip the CI interrupter, while a hotstick-operable push-pull handle can be operated for manual charging of the springs. Viewing ports provide access to the contact position indicators and operation counters for each interrupter.

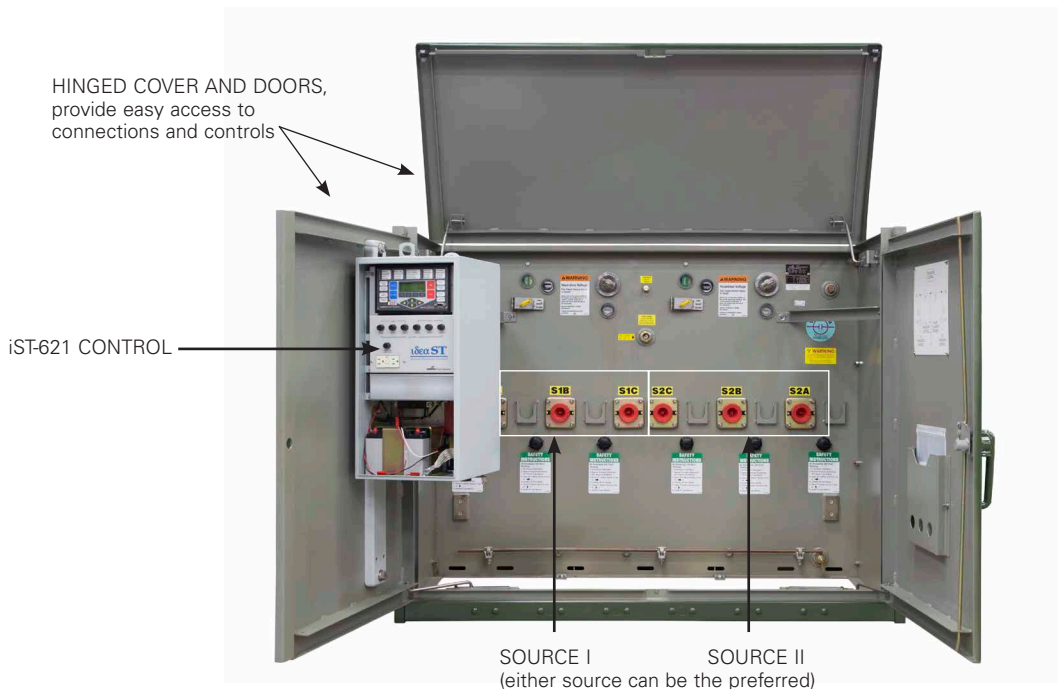


Figure 1. Front view of PST Model-6 switchgear (source cabinet).

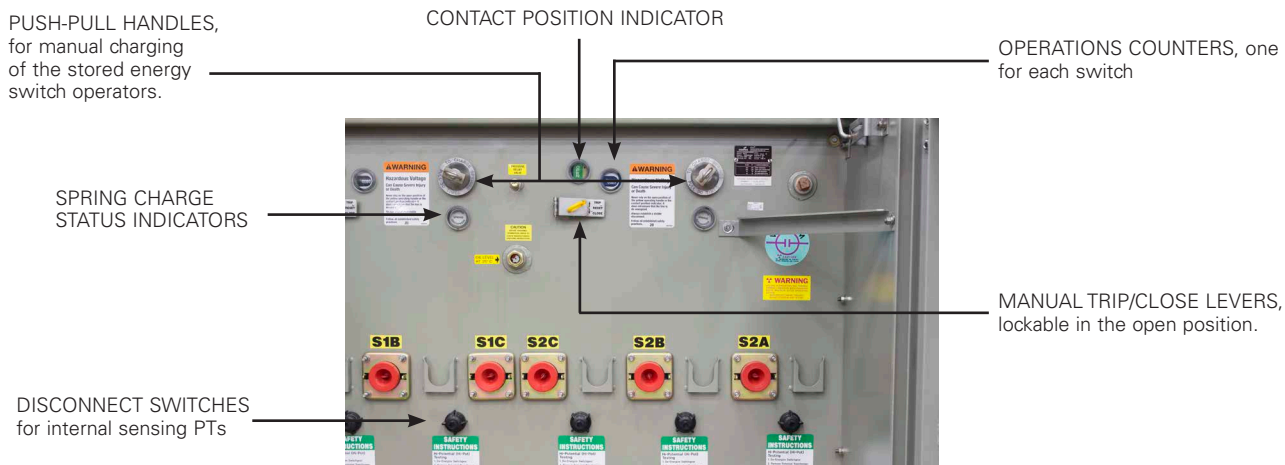


Figure 2. Close-up view of the source front plate.

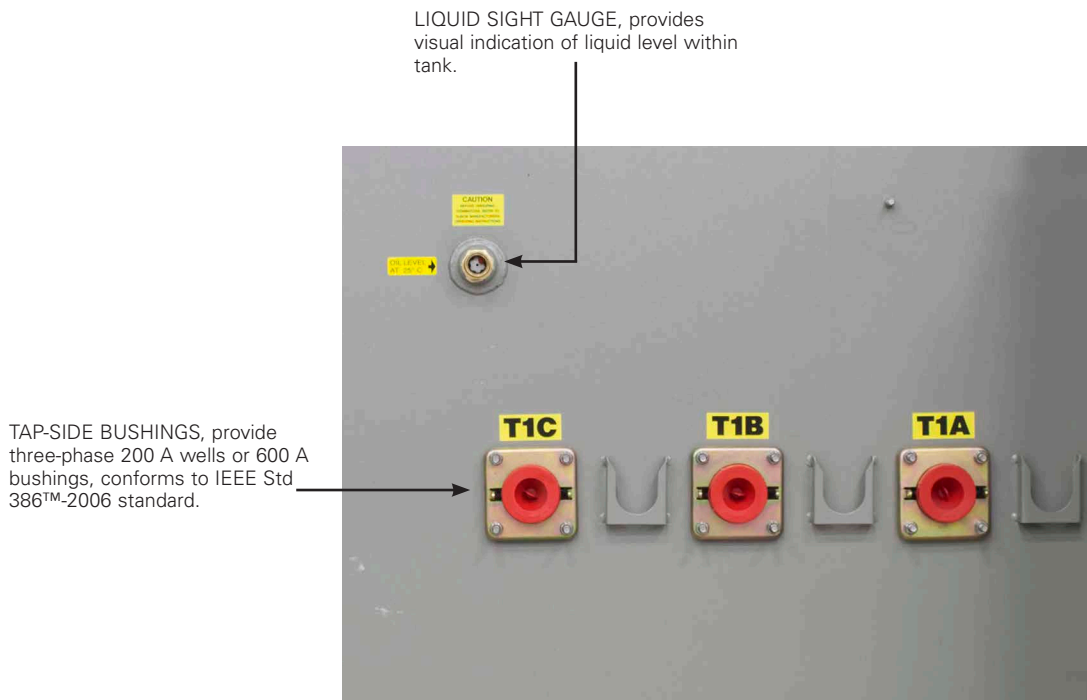


Figure 3. PST Model-6 switchgear tap-side view.

iST control

iST relay

The iST family of source transfer relays for two sources is a member of the Eaton's Cooper Power series Edison[®] Idea[™] line of protective relays. The iST relay family consists of the iST-621 for single feeder applications, and iST-921 and iST-901 for two feeder applications. The iST relay family also provides advanced metering, control, and communications, and event analysis tools.

The iST relays use ProView[®] application software for PCs running the Microsoft[®] Windows[®] operating system. The Idea Workbench[™] feature of ProView permits the user to add additional functionality.

Applications

The iST relays are designed for applications with one or two feeders.

- The iST-621 is the source transfer relay for configurations with two sources and a single feeder. Phase and ground overcurrent protection for the feeder is included.
- The iST-921 and iST-901 relays are designed for use as a pair on two feeder applications.
 - The iST-921 is the source transfer relay for two sources and includes phase and ground overcurrent protection for the first feeder.
 - The iST-901 relays provides phase and ground overcurrent protection for the second feeder.

To address the needs of automation, Energy Management Systems (EMS), and SCADA systems, the iST family of relays provide advanced power quality, load (tap) metering, control, and communications capabilities.

Transfer logic

The comprehensive transfer logic includes the following features:

Five source preference selections:

- Source 1 preferred; Normal restoration
- Source 1 preferred; Hold on alternate
- Source 2 preferred; Normal restoration
- Source 2 preferred; Hold on alternate
- No Source Preference

Normal restorations can be either Non-parallel with an adjustable time delay, or Parallel with sync-check.

The Parallel with Sync Check Restoration Mode supervises source closing for both automatic and manual operations. The Sync Check function compares the phase rotation, voltage magnitude, phase angle, and frequency of both sources. Paralleling of the sources is permitted only when all parameters are within the customer-configurable thresholds. In automatic mode, it permits closing the preferred source prior to opening the alternate source to achieve a "blinkless" transfer.

In manual mode, the Sync Check function prevents accidental paralleling of non-synchronous sources. If parallel restoration is not enabled, both source switches cannot be closed in manual mode from the relay panel.

The alternate source can be either a utility line or a generator. Settings for generator startup time, standby time, and shutdown time are included.

There are seven independent parameters for Source Health. Each has a settable threshold and time delay.



Figure 4. iST relay front plate.

Any combination can be enabled to declare an unhealthy source:

- Two levels of phase-ground undervoltage (27)
- Positive sequence undervoltage (27P)
- Two levels of underfrequency (81U)
- Two levels of overfrequency (81O)

Four independent parameters declare Source Restoration. Any combination can be enabled to declare a restored source:

- Minimum phase-ground voltage (59)
- Minimum positive sequence voltage (59P)
- Minimum frequency (81U)
- Maximum frequency (81O)

Overcurrent protection

For single feeder applications, the iST-621 relay offers overcurrent protection of the single load, and separate inverse curves for phase and residual CLPU overcurrent elements to minimize nuisance trips. The TCC selection includes industry standard IEEE[™] and IEC curves, industry standard recloser curves, 106 through 165, plus five commonly used fuse curves.

For dual feeder applications, the iST-921 relay offers independent inverse time phase and residual overcurrent protection for feeder 1 and the iST-901 relay offers independent inverse time phase and residual overcurrent protection for feeder 2.

A fault block function is included to enable or disable automatic transfer during an overcurrent (OC) event.

When enabled in the iST-621 single feeder application, fault block prevents an automatic transfer while the OC element is picked up. When an OC trip occurs, the iST-621 relay is switched to manual mode to prevent automatic operations until the relay is reset.

When enabled in the iST-921 / iST-901 two feeder application, fault block prevents an automatic transfer while either OC element is picked up. When the OC element drops out, or after a trip, automatic operation of the source switches resumes.

Metering

The iST relay family offers extensive metering capabilities, including:

- Instantaneous voltage and frequency of each source, and feeder current.
- Current, Watts, VARS, and power factor of each feeder.
- Demand metering (current and four quadrant power) of each feeder
- Energy metering (four quadrant) of the feeder
- Harmonics metering through the 15th harmonic including THD for all voltage and all current channels.

iST relays automatically use the PTs of the connected source for all power, energy, and other voltage-related metering.

Use the Idea Workbench feature to customize the iST relays

The iST is a fully functional family of relays, ready to use right out of the box. However, there are applications where custom control logic, or custom functions need to be added to the relay. The Idea Workbench feature is a revolutionary graphical software programming environment which permits the user to customize the iST relays.

- Add new features or protective functions by means of Idea Workbench Custom Modules. These operate in the same fashion as the plug-ins for popular internet browsers. Your investment in the relay is protected as future needs and developments may be addressed through new Custom Modules.
- Create custom control and protection logic using over 400 programming signals and tools, all selectable from drag-off Toolboxes. Logic created using these tools can then be saved as Custom Modules to be reused or shared with associates.
- Monitor and control practically every aspect of the relay's operation.
- Create custom metering and measurement quantities.
- Create custom sequence of event records.
- Configure communication protocols to match existing SCADA system mappings.

The Idea Workbench offers the user the ability to rapidly and accurately create customizations by working the way the engineer thinks, by using logic diagram and flowchart construction methods. No equation-based or command-based logic programming is required. See Figure 5.

The Idea Workbench also addresses some of the more difficult questions associated with custom relay programming, namely:

Clarity: Compared to that offered by equation and command based programming techniques, graphical programming results in customizations whose operation is intuitive.

Testing: ProView software provides a Virtual Test Set™ (VTS), which can be used to test the developed logic with realistic fault signals. During test, the logic diagrams become “live” showing the state of all variables, logic gates, contacts, counters, etc. To avoid any question of how the custom logic interacts with the relay itself, the VTS environment models the entire relay in addition to the custom programming. Unlike other programming environments, the Idea Workbench does not require the user to have an actual relay or relay test set on hand to verify the proper operation of the programmed logic.

Documentation: Notes regarding how the custom logic operates may be embedded within the Idea Workbench. This improves the ability of others to quickly understand how the logic is designed to work. Links to external files may also be embedded in the Idea Workbench, providing fast access to larger documents stored on company's network servers.

Portability: If the original data files are lost, the entire Idea Workbench may be uploaded from the relay, complete with logic diagrams, embedded notes and external reference links.

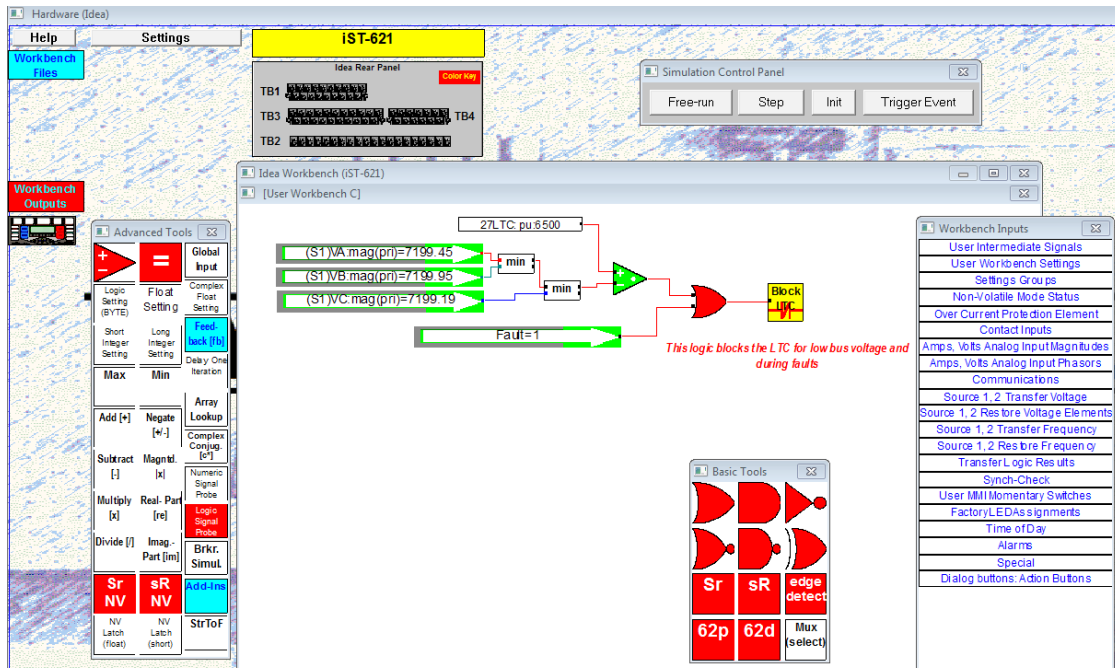


Figure 5. The Idea Workbench graphical customization environment.

Event records and analysis tools

The iST family of relays share the same event records and analysis tools as all Edison Idea relays. The Edison Idea relay allows for the display of event records in a variety of formats including waveforms (oscillography), magnitude plots, phasor diagrams, symmetrical component diagrams and more. ProView, the software for the Edison Idea relay, also provides a unique Application Diagram View that provides a one-screen view of everything that is going on in the relay. Many of these event views are also available in On-Line View mode, where it is possible to monitor the status of the relay in real-time, including phasor diagrams and the Sync Scope, which is ideal for verifying PT and CT phasing during commissioning.

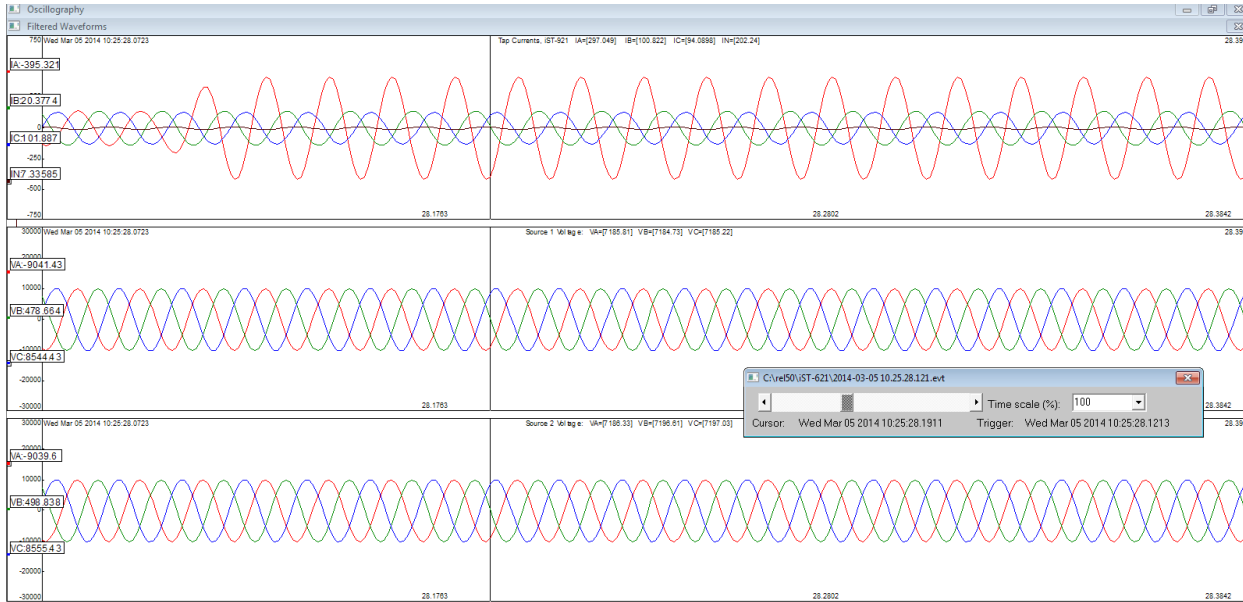


Figure 6. Current and voltage waveforms.

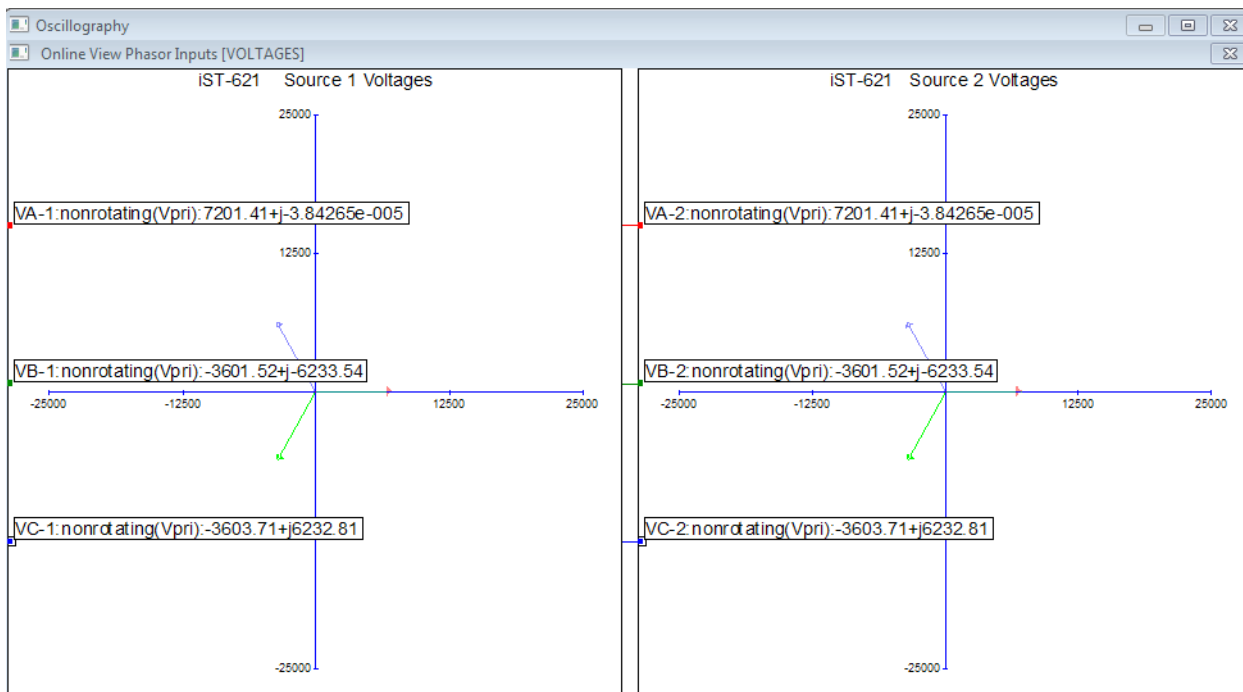


Figure 7. Source 1 and Source 2 phase diagrams.

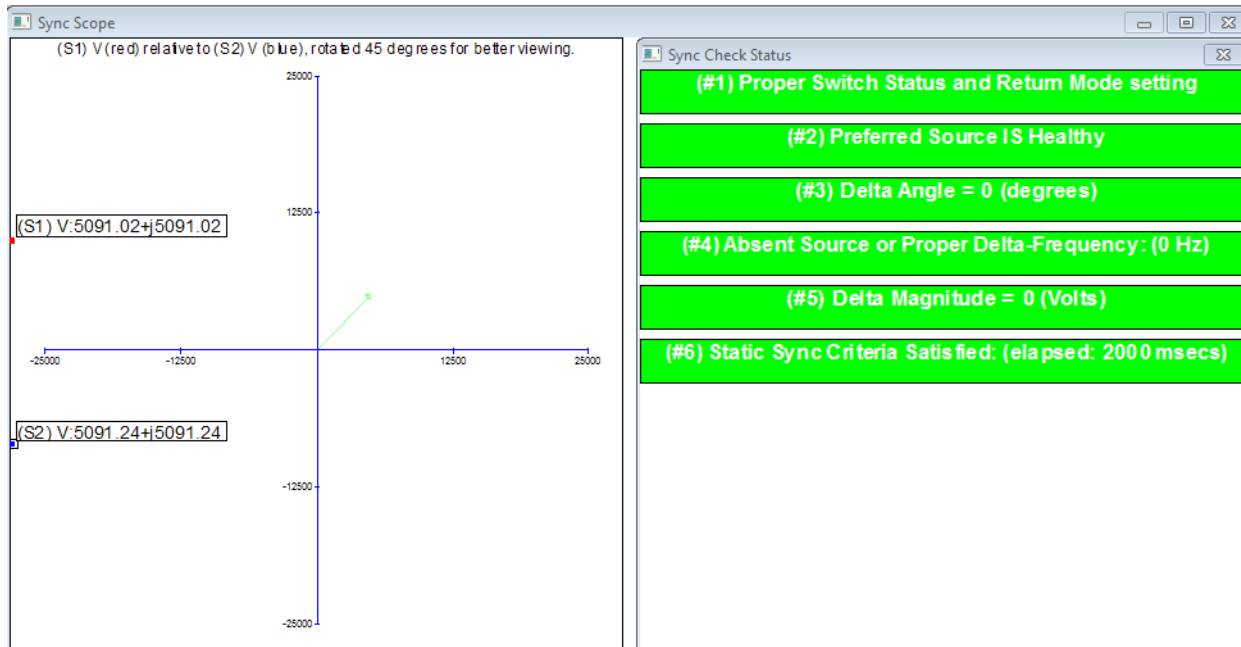


Figure 8. Sync scope.

Relay-Replay™ feature

To evaluate the effect different settings would have on the relay, the Relay-Replay™ feature of the Edison Idea software allows the user to make any number of setting changes and replay an existing event using these new settings without the need for an actual relay or expensive test equipment. The operation of every aspect of the relay's performance, from which elements pick-up, the response time of those elements that do and the operation of any custom programming made via the Idea Workbench can be observed. This tool provides unprecedented "what-if" analysis capabilities.

Virtual Test Set (VTS)

To evaluate settings against any arbitrary fault, the Edison Idea relay ProView software permits the user to create a virtual event record through use of the Virtual Test Set (VTS) feature. The VTS allows complete control over:

- Pre-fault and post-fault voltage and current level
- Selection of dc time constant
- Control over fault dynamics
- Control of frequency change, rate of change and acceleration during faults
- Control over simulated breaker open and close times

Communications

Both Modbus RTU and DNP 3.0 communication protocols are included with the iST relay family. A Communications Workbench™ provides the user the ability to customize communication maps, add or delete information, add control points, and even create new signals to be brought out through communications. The iST relay family features two RS-232 auto-baud (57600 kbps max) communication ports and an optional port with either RS-485, serial fiber optic, or various Ethernet options (RJ-45, multi-mode fiber, single-mode fiber). Contact your Eaton representative for availability of other communication protocols.

Control cabinet

The iST relay is factory installed in a control cabinet made of the same material as the PST switchgear. As a standard, the control cabinet is located on the inside of the source cabinet, mounted onto the door in such a manner which removes the control cabinet from the airspace above cable openings.

The control cabinet, as a standard, includes a fused 120 V convenience receptacle, as well as a 120 V heater powered from the PST switchgear sensing PTs to reduce condensation.

To protect the iST relay, the control cabinet will also be provided with one fuse for each voltage input from the PST switchgear.

For better performance reliability, the iST control cabinet includes a battery to ensure extended power to the relay during extended outages where a healthy source is not immediately available.

Optionally, the control cabinet can be supplied with a terminal strip for customer monitoring of auxiliary switches to monitor the position of all interrupters within the PST switchgear.

The control cabinet is shipped, factory installed on the PST switchgear, and prewired to the sensing potential and current transformers, as well as the optional auxiliary switches.

Additional options

- 8 or 13 amp-hour battery
- 12 Vdc radio provision, and mounting space (contact factory for more information)
- 120 Vac battery charging circuit for spare batteries



Optional auxiliary switch terminal strip for user monitoring of switch status, independent of relay optional. (Not shown.)

Figure 10. iST control.

Dimensional information

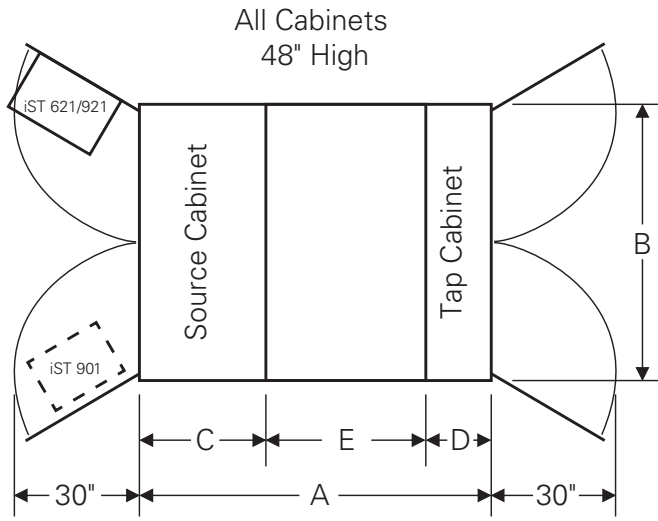


Figure 11. PST switchgear cabinet and dimensions.

Note: Dimensional information is for reference only, actual dimensions may vary depending on features included. All dimensions are shown in inches.

Table 1. PST Model-9 Switchgear Dimensions

kV	Figure 11 Label	Source/Tap 600 A/200 A	Source/Tap 600 A/600 A	Source/Tap 200 A/200 A
15 and 25	A	101*	101	101**
	B	70	70	70
	C	36	36	36*
	D	22*	22	22*
	E	43	43	43
35	A	105	109	99
	B	70	70	70
	C	40	40	34
	D	22	26	22
	E	43	43	43

* Dimension can be reduced by 6" if required.

** Dimension can be reduced by 12" is required.

Table 2. PST Model-6 Switchgear Dimensions

kV	Figure 11 Label	Source/Tap 600 A/200 A	Source/Tap 600 A/600 A	Source/Tap 200 A/200 A
15 and 25	A	90*	90	90*
	B	62	62	62
	C	36	36	36*
	D	22*	22	22*
	E	32	32	32
35	A	92	98	86
	B	70	70	70
	C	40	40	34
	D	20	26	20
	E	32	32	32

* Dimension can be reduced by 6" if required.

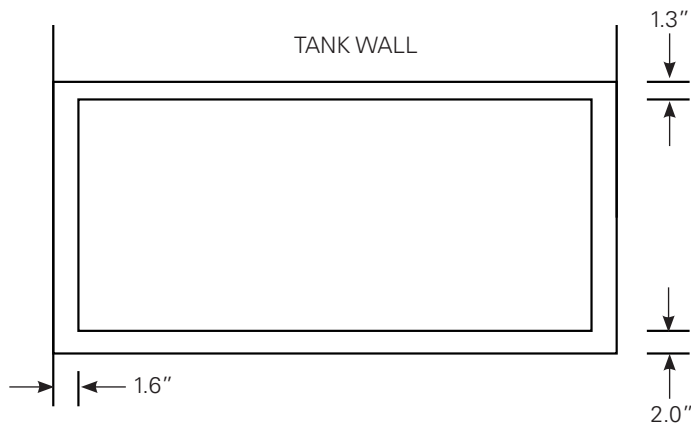


Figure 12. Typical cable opening in MV cabinet.

Specifications

Table 3. Electrical Ratings PST Transfer Switchgear

Description	15 kV	25 kV	35 kV
Maximum Design Voltage, kV	15.5	27	38
BIL, kV	95	125	150
1-Minute Withstand Voltage (60 Hz) Interrupter and Terminators, kV	35	40	50
Continuous Current (max), A	600	600	600
Interrupting Current (sym./asym.), kA	12/20	12/20	12/20
Momentary Current 10 cycles (asym.), kA	20	20	25
1 Second Withstand Current (sym.), kA	12	12	12
Making Current (sym.), kA	12	12	12
Transformer Magnetizing Interrupting Current, A	21	21	21
Cable Charging Interrupting Current, A	15	15	20
Capacitive, A	10	25	40

Table 4. Interrupting Duty Cycle

Percent of Interrupting Current Rating	Number of Operations
15 - 20	88
45 - 55	112
90 - 100	32
Total	232

Table 5. Switching and Transfer Times

Direction of Transfer Transition	Type of Return (Cycles)	First Interrupter Reaction Time* (Cycles)	Transition Time* (Cycles)
Preferred to Alternate	Non-Parallel	2.0 to 3.0	5.0 to 6.0
Alternate to Preferred	Non-Parallel	2.0 to 3.0	5.0 to 6.0
Alternate to Preferred	Parallel**	5.0 to 6.0	2.0 to 3.0

* Time from expiration of time delay to first opening (or closing) of high-voltage interrupter. Add about 1 cycle to values shown to allow for iST control contact time.

** Parallel return time does not include sync check time.

PST switch ordering information

Table 6. Basic Models

Model	Nominal Voltage (Kv)	Catalog Number
6	15	KPST62
	25	KPST65
	35	KPST68
9	15	KPST92
	25	KPST95
	35	KPST98

Please specify system voltage and sensing PT primary connection (delta or wye).

For different amperage ratings, replace the last digit of the catalog number with the approximate digit from the Amperage Rating Table (Table 7).

Table 7. Bushing Configuration

Voltage Rating	Bushing Amperage Rating (Source/Tap)		
	600 A/600 A	600 A/200 A*	200 A/200 A*
15	1	2	3
25	4	5	6
35	7	8	9

* PST switchgear ordered with 15 or 25 kV rating are equipped with wells only on the 200 Amp side.

Table 8. Construction

Tank Style	Material	Construction
Vault-Mounted Style*	Tank Material	Mild Steel construction with non-corrosive hardware (STANDARD) 304L Stainless steel construction
Pad-Mounted Style	Tank/Cabinet Material	Mild Steel construction with non-corrosive hardware (STANDARD) 304L Stainless steel construction
Paint color		Bell Green/Munsell 7GY (STANDARD) Other paint color, top coat on external surfaces only (specify the Federal Spec Paint number)

* Change first two digits of descriptor using Table 7 above from "KP" to "KV".

Table 9. Distribution Automation (Model-9 only)

Description	Motor Operator Positions
No motor operators/provisions (STANDARD)	N/A
Motor operator provisions*	On tap ways
Motor operators*	

* Motor operators require semaphores.

Table 10. Auxiliary Switch

Type	Position
Two-Stage Auxiliary Switch	Specify the ways: Source, Tap, or All

Table 11. Indicators (Model-9 only)

Description	Indicator Positions
Operation counter	On tap ways
Semaphore*	On tap ways

* Position indicator linked directly to operating mechanism and viewable through tank window.

Table 12. Grounding Options (select only one)

Ground Stud (**STANDARD**)

1/2" Round copper ground-bus

3" stand-off bracket for 1/2" round bus

NEMA® Ground Pad (welded to tank)

Flat copper ground-bus

Table 13. Fault Indicator Provisions (select only one)

No Fault Indicator provisions

Provisions for Fault Circuit Indicators (FCI) (1.06" dia. hole with removable SS backing plate)*

Provisions for S.T.A.R.™ FCI with large FISHEYE™

Provisions for S.T.A.R. FCI with small remote

Provisions for LED Display Indicator

* Accommodates future installation of S.T.A.R. FCI type indicators

Table 14. Service Items

Description	
1" drain plug with 3/8" sampler (STANDARD)	Select only one
1" drain valve with 3/8" sampler	
Penta-head door bolt (STANDARD)	Select only one
Hex-head door bolt	

Table 15. Key Interlocks

Description
Provisions for key interlocks on tap ways (Model-9 only)*
None

* The switch handle will be designed for use with a KIRK® Key type B interlock with a 3/4" bolt travel and 1" bolt projection.

Table 16. Decals

Danger High Voltage	
Internal Mr. Ouch, bilingual	Specify Location
External Mr. Ouch, bilingual	
Non PCB	

iST control ordering information

Constructing a catalog number

To order a standard iST control for use with PST Model-6 Automated Transfer Switchgear with an 8 amp-hour battery, wye connected voltage, mild steel cabinet, domestic front panel, standard auxiliary contacts, serial fiber optic communications and English labelling, the catalog number would be constructed in this manner:

Ordering information required

To order an iST control:

1. Use the chart at right and Table 17 to construct a catalog number that describes the required switch.
2. From Tables 18-23, specify the catalog numbers that describe the required accessories for each control.

KiSt

Basic letters for an iST Control

621

Scheme application:

621 for use with a PST Model-6

921 for use with a PST Model-9: controls 2 source and 1 tap ways[†]

901 for use with a PST Model-9: controls 1 tap way[†]

1 Battery:

1 for 8 amp hour battery.

2 for 13 amp hour battery

1 Voltage connection scheme:

1 for Wye connected voltage inputs

1 Cabinet Option

1 for mild steel cabinet

2 for stainless steel cabinet

1 Front Panel

1 for Fully customizeable, domestic front panel

1 Auxiliary input and output contacts

1 for Standard contacts; 8 input/8 output

3 Communications

1 for RS-485 DC (Modbus/DNP only)

3 for Serial fiber optic communications

4 for Ethernet fiber optic/fiber optic communications MRTJ/MTRJ

5 for Ethernet fiber optic/wire communications MTRJ/RJ45

6 for Ethernet wire/wire communications RJ45/RJ45

7 for Standard (No communications)

8 for Ethernet single mode fiber optic/fiber optic communication

E Language

E for English Language

X for Other language required[‡]

KiSt 621 1 1 1 1 1 3 E

KiSt621111113E is the catalog number for the control in the example above

[†] A PST (Model-9) Source Transfer Package required both the KiSt921 and KiSt901 controls for operation.

[‡] Contact factory.

Table 17. iST Control

Description	Catalog Number
Basic iST Automated Source Transfer Control	KiST
Specify control application:	
621 = iST621 control for PST Model-6 application; Factory mounted with PST Model-6 package Control only for S control retrofit for PST Model-6 Control only replacement for existing iST621 control	621
921 = iST921 control for PST Model-9 application; controls 2 source and 1 tap way [†] Factory mounted with PST Model-9 package Control only for S control retrofit for PST Model-9 ^{*††} (not yet available) Control only replacement for existing iST921 control	921
901 = iST901 control for PST Model-9 application; controls 1 tap way [†] Factory mounted with PST Model-9 package Control only replacement for existing iST901 control	901
Battery:	
1 = 8 amp-hour battery	1
2 = 13 amp-hour battery	2
Voltage Connection Scheme:	
1 = Wye connected primary voltage inputs	1
2 = Delta connected primary voltage inputs	2
Cabinet Option	
1 = Mild steel cabinet	1
2 = Stainless steel cabinet	2
Front Panel	
1 = Fully customizable front panel; domestic	1
Auxiliary input and output contacts	
1 = Standard contacts; 8 input/8 output	1
Communications^{‡‡}	
1 = RS-485 D.C. isolate (DNP/Modbus only)	1
3 = Serial fiber optic (ST) communications	3
4 = Ethernet fiber optic/fiber optic communications with MTRJ/MTRJ connections	4
5 = Ethernet fiber optic/wire communications with MTRJ/RJ45 connections	5
6 = Ethernet wire/wire communications with RJ45/RJ45 connections	6
7 = Standard (none)	7
8 = Ethernet single mode fiber optic/fiber optic communication	8
Language	
E = English	E
X = Other language required [‡]	X

† A PST Model-9 Source Transfer Package requires both the KiST921 and the KiST901 controls for operation.

* Future Option; the PST Model-9 Retrofit kit is not yet available.

†† A PST Model-9 Retrofit requires only the KiST921 to operate the source ways; the existing KTPG controls will still be utilized for Taps.

‡ Contact factory

‡‡ All iST controls include two RS-232 serial ports, one for front panel configuration with the second port located on the back panel for SCADA/DA serial communications.

Accessories

Table 18. Auxiliary Switch Termination*†

Description	Catalog Number
Auxiliary switch receptacle and wiring	KiST-1801-2

* For connecting customer specified, additional A&B Auxiliary Switch contacts from the PST switchgear.

† For use only with the KiST621 and KiST921 controls.

Table 19. Convenience Outlet

Description	Catalog Number
Fused 120 Vac, 3-wire polarized GFCI convenience outlet	KiST-2970-1

Table 20. Automation Packages

Description	Catalog Number
Full automation accessory; 12 Vdc radio provision (Radio and fiber-optic/RS232 interface not included)	KiST-3770-1

Table 21. Communication Support Equipment

Description	Catalog Number
RS-232 cable, 6-ft., DB-9F and DB-9M, for direct connection between DATA PORT and PC	KME5-66
DB-9F to DB-25M Cable, 6 feet length	KP2412A3

Table 22. Cables

Description	Catalog Number
KiST921 Cables for S Control Retrofit; PST Model-9	TBD - FUTURE

Table 23. Miscellaneous Accessories

Description	Catalog Number
120 Vac Battery charger for spare batteries	KME5-60-1

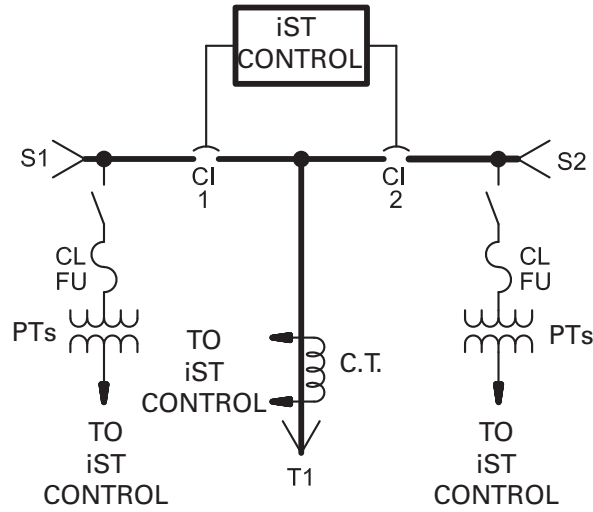


Figure 13. PST Model-6 switchgear diagram.

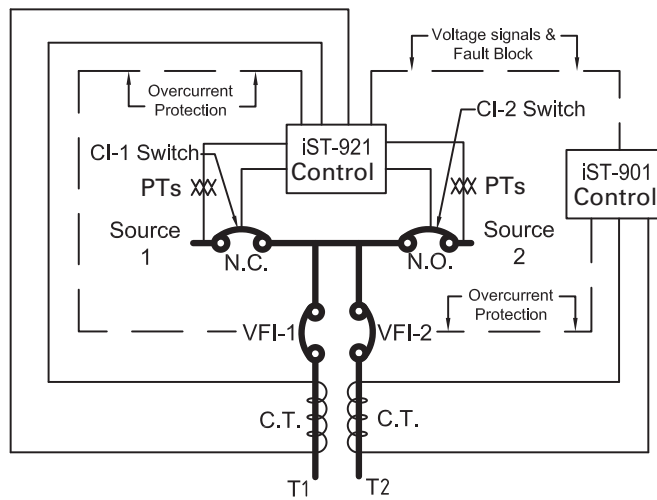


Figure 14. PST Model-9 switchgear diagram.

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